SEDAR

Southeast Data, Assessment, and Review

SEDAR 33

Gulf of Mexico Greater Amberjack

Stock Assessment Report

March 2014

SEDAR
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North Charleston, SC 29405

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1. Introduction

1.1 SEDAR Process Description

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. The improved stock assessments from the SEDAR process provide higher quality information 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. 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 is organized around three workshops. First is the Data Workshop, during which fisheries, monitoring, and life history data are reviewed and compiled. Second is the Assessment process, which is conducted via a workshop and several webinars, during which assessment models are developed and population parameters are estimated using the information provided from the Data Workshop. Third and final is the Review Workshop, during which independent experts review the input data, assessment methods, and assessment products. The completed assessment, including the reports of all 3 workshops and all supporting documentation, is then forwarded to the Council SSC for certification as ‘appropriate for management’ and development of specific management recommendations.

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

SEDAR Review Workshop Panels consist of a chair, three reviewers appointed by the Center for Independent Experts (CIE), and one or more SSC representatives appointed by each council having jurisdiction over the stocks assessed. The Review Workshop Chair is appointed by the council having jurisdiction over the stocks assessed and is a member of that council’s SSC. Participating councils may appoint representatives of their SSC, Advisory, and other panels as observers.

2. Gulf of Mexico Greater Amberjack Management History

2.1. Fishery Management Plan and Amendments

Original GMFMC FMP:

The Reef Fish Fishery Management Plan was implemented in November 1984. The regulations, designed to rebuild declining reef fish stocks, included: (1) prohibitions on the use of fish traps, roller trawls, and powerhead-equipped spear guns within an inshore stressed area; (2) a minimum size limit of 13 inches total length (TL) for red snapper with the exceptions that for-hire boats were exempted until 1987 and each angler could keep 5 undersize fish; and, (3) data reporting requirements.

GMFMC FMP Amendments affecting Greater Amberjack:

Description of Action	FMP/Amendment	Effective Date
Set a 28-inch fork length minimum size limit and 3 fish per person per day bag limit for recreational harvest of greater amberjack, with a 2-day possession limit allowed for qualified charter vessels and head boats on trips that extend beyond 24 hours, and a 36-inch fork length minimum size limit of greater amberjack for commercial harvest. Established a longline and buoy gear boundary and expanded the stressed area to the entire Gulf coast. Established a commercial reef fish permit.	Amendment 1	1990
Established a moratorium on the issuance of new reef fish permits for a maximum period of three years; established an allowance for permit transfers. Added Almaco jack and banded rudderfish to the fishery management unit.	Amendment 4	1992
Created an Alabama special management zone (SMZ) and a framework procedure for future specification of SMZs. Established restrictions on the use of fish traps in the Gulf of Mexico EEZ, and implemented a three-year moratorium on the use of fish traps by creating a fish trap endorsement. Required that finfish be landed head and tails intact	Amendment 5	1994
Established reef fish dealer permitting and record	Amendment 7	1994

keeping.		
Extended the reef fish permit moratorium through December 31, 1995 and allowed collections of commercial landings data for initial allocation of individual transferable quota (ITQ) shares. Established historical captain status for purposes of ITQ allocation.	Amendment 9	1994
Implemented a new commercial reef fish permit moratorium for no more than five years or until December 31, 2000, permitted dealers can only buy reef fish from permitted vessels and permitted vessels can only sell to permitted dealers, established a charter and headboat reef fish permit.	Amendment 11	1996
Reduced the greater amberjack bag limit from three fish to one fish per person, and created an aggregate bag limit of 20 reef fish for all reef fish species not having a bag limit.	Amendment 12	1997
Initiated a 10-year phase-out on the use of fish traps in the EEZ from February 7, 1997 to February 7, 2007, after which fish traps would be prohibited, and prohibited the use of fish traps west of Cape San Blas, Florida.	Amendment 14	1997
Commercial harvest of greater amberjack closed March, April and May of each year. Prohibited harvest of reef fish from traps other than permitted reef fish traps, stone crab traps, or spiny lobster traps.	Amendment 15	1998
(1) The possession of reef fish exhibiting the condition of trap rash on board any vessel with a reef fish permit that is fishing spiny lobster or stone crab traps is prima facie evidence of illegal trap use and is prohibited except for vessels possessing a valid fish trap endorsement; (2) that NOAA Fisheries establish a system design, implementation schedule, and protocol to require implementation of a vessel monitoring system (VMS) for vessels engaged in the fish trap fishery, with the cost of the vessel equipment, installation, and maintenance to be paid or arranged by the owners as appropriate; and, (3)	Amendment 16A	1998

that fish trap vessels submit trip initiation and trip termination reports. Prior to implementing this additional reporting requirement, there will be a one-month fish trap inspection/compliance/education period, at a time determined by the NOAA Fisheries Regional Administrator and published in the *Federal Register*. During this window of opportunity, fish trap fishermen will be required to have an appointment with NMFS enforcement for the purpose of having their trap gear, permits, and vessels available for inspection. The disapproved measure was a proposal to prohibit fish traps south of 25.05 degrees north latitude beginning February 7, 2001. The status quo 10-year phase-out of fish traps in areas in the Gulf EEZ is therefore maintained.		
Set a slot limit for banded rudderfish and lesser amberjack of 14 inches to 22 inches FFL, and set an aggregate recreational bag limit of 5 fish for those species in aggregate. The purpose of these actions was to reduce harvest of juvenile greater amberjack that were misidentified as banded rudderfish or lesser amberjack.	Amendment 16B	1999
Extended the commercial reef fish permit moratorium for another five years, from its previous expiration date of December 31, 2000 to December 31, 2005	Amendment 17	2000
Prohibited vessels with commercial harvests of reef fish aboard from also retaining fish caught under recreational bag and possession limits. Vessels with both for-hire and commercial permits were limited to the minimum crew size outlined in its Certificate of Inspection when fishing commercially. Prohibited the use of reef fish other than sand perches for bait. Required commercially permitted reef fish vessels to be equipped with VMS.	Amendment 18A	2006
Established two marine reserve areas off the Tortugas area and prohibits fishing for any	Amendment 19	2002

species and anchoring by fishing vessels inside the two marine reserves.		
Established a 3-year moratorium on the issuance of new charter and headboat vessel permits in the recreational for hire fisheries in the Gulf EEZ. Allowed transfer of permits. Required vessel captains/owners to participate in data collection efforts.	Amendment 20	2002
Continues the Madison-Swanson and Steamboat Lumps marine reserves for an additional 6 years, until July 2010. Modified the fishing restrictions within the reserves to allow surface trolling during May – October.	Amendment 21	2004
Established bycatch reporting methodologies for the reef fish fishery.	Amendment 22	2005
Extended the commercial reef fish permit moratorium indefinitely. Established a permanent limited access system for the commercial fishery for Gulf reef fish. Permits issued under the limited access system are renewable and transferable.	Amendment 24	2005
Extended the recreational for-hire reef fish permit moratorium indefinitely. Established a limited access system on for-hire reef fish and CMP permits. Permits are renewable and transferable in the same manner as currently prescribed for such permits.	Amendment 25	2006
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.	Amendment 27	2008
Maintain the three-year stepped rebuilding plan based on a constant F_{OY} projection as specified in Secretarial Amendment 2, and establish TAC at 1.9 mp for 2008 through 2010 and 3.5 mp from 2011 through 2012. Establish accountability measures that allow the Regional Administrator to close a sector when that sector's allocation of TAC has been reached or projected to be reached. If recreational landings exceed the sector's share of TAC, the RA will file a notice	Amendment 30A	2008

reducing the length of the recreational fishing season for the time necessary to recover the overage in the following fishing year. If commercial landings exceed the commercial quota, the Regional Administrator shall issue a notice reducing the commercial quota in the following year by the amount the quota was exceeded in the previous year. Increase the recreational minimum size limit for greater amberjack to 30-inches FL, and eliminate the bag limit for captain and crew. Establish commercial quotas for 2008 through 2010 of 503,000 pounds and for 2011 and 2012 of 938,000 pounds.		
Longline endorsement requirement - Vessels must have average annual reef fish landings of 40,000 pounds gutted weight or more from 1999 through 2007 The longline boundary in the eastern Gulf is extended from the 20-fathom depth contour to the 35-fathom depth contour from June - August. Vessels are limited to 1000 hooks of which no more than 750 of which can be rigged for fishing or fished.	Amendment 31	2010
Establishes a commercial trip limit of 2,000 pounds. Establishes an annual catch limit equal to the acceptable biological catch at 1,780,000 pounds. Establishes allocations and annual catch targets, which act as quotas for the commercial and recreational sectors. The commercial allocation is 27% and the recreational allocation is 73% of the allowable catch. Until a future stock assessment is completed, or the annual catch limit is exceeded, the commercial quota will be 409,000 pounds, and the recreational quota will be 1,130,000 pounds. The 2013 commercial quota will be reduced by the 2012 landing overage after those numbers have been finalized.	Amendment 35	2012

Management and quota overage information from Amendment 30A to Amendment 35 for greater amberjack

Prior to Amendment 30A, there was not a specified allocation of the stock ACL for the recreational and commercial sectors. In Amendment 30A, the Council selected an interim allocation (73% recreational: 27% commercial) that would remain in effect until the Council, through the recommendations of an Ad Hoc Allocation Committee, could implement an amendment that fairly and equitably addressed the allocation of Greater Amberjack between the recreational and commercial sectors.

GMFMC Regulatory Amendments:

September 2010:
Provides a more specific definition of buoy gear by limiting the number of hooks, limiting the terminal end weight, restricting materials used for the line, restricting the length of the drop line, and where the hooks may be attached. In addition, the Council requested that each buoy must display the official number of the vessel (USCG documentation number or state registration number) to assist law enforcement in monitoring the use of the gear, which requires rulemaking.

January 2011:
Intended to avoid in-season quota closures during peak economic fishing months, maximize social and economic benefits, and potentially provide biological benefits by protecting the Greater Amberjack stock during the peak spawning period. This regulatory framework action modifies the existing Greater Amberjack recreational fishing season, creating a June 1 - July 31 closed season. This closure coincides with the open recreational seasons for other managed reef fish species such as red snapper.

2.2. Emergency and Interim Rules

January 1, 2009 - NOAA's National Marine Fisheries Service (NOAA Fisheries Service) has published a final rule implementing interim measures in the Gulf of Mexico reef fish fishery. The rule published in the Federal Register on December 2, 2008, and the measures are effective January 1, 2009. The Gulf of Mexico Fishery Management Council (Council) requested a temporary rule be effective at the beginning of 2009 to address overfishing of Gag, as well as Red Snapper, Greater Amberjack, and Gray Triggerfish until more permanent measures can be implemented through Amendment 30B to the Fishery Management Plan for the Reef Fish Resources of the Gulf of Mexico. The interim rule will, with respect to Greater Amberjack, require operators of federally permitted Gulf of Mexico commercial and for-hire reef fish vessels to comply with the more restrictive of federal or state reef fish regulations when fishing in state waters for Red Snapper, Greater Amberjack, Gray Triggerfish, and Gag.

2.3. Secretarial Amendments

Secretarial Amendment 2 (2003):

Sets MSY, OY, MFMT, and MSST levels for Greater Amberjack that are in compliance with the Sustainable Fisheries Act, and it establishes a ten-year rebuilding plan for Greater Amberjack based on three-year intervals. No specific management measures were proposed in this amendment, since the Greater Amberjack harvest is currently within the TAC specified for the first three-year interval.

2.4. Control Date Notices

Control date notices are used to inform fishermen that a license limitation system or other method of limiting access to a particular fishery or fishing method is under consideration. If a program to limit access is established, anyone not participating in the fishery or using the fishing method by the published control date may be ineligible for initial access to participate in the fishery or to use that fishing method. However, a person who does not receive an initial eligibility may be able to enter the fishery or fishing method after the limited access system is established by transfer of the eligibility from a current participant, provided the limited access system allows such transfer. Publication of a control date does not obligate the Council to use that date as an initial eligibility criteria. A different date could be used, and additional qualification criteria could be established. The announcement of a control date is primarily intended to discourage entry into the fishery or use of a particular gear based on economic speculation during the Council's deliberation on the issues. The following summarizes control dates that have been established for the Reef Fish FMP. A reference to the full *Federal Register* notice is included with each summary.

November 1, 1989:
Anyone entering the commercial reef fish fishery in the Gulf and South Atlantic after November 1, 1989, may not be assured of future access to the reef fish resource if a management regime is developed and implemented that limits the number of participants in the fishery [54 FR 46755].

November 18, 1998:
The Council is considering whether there is a need to impose additional management measures limiting entry into the recreational-for-hire (i.e., charter vessel and headboat) fisheries for reef fish and coastal migratory pelagic fish in the EEZ of the Gulf and, if there is a need, what management measures should be imposed. Possible measures include the establishment of a limited entry program to control participation or effort in the recreational-for-hire fisheries for reef fish and coastal migratory pelagic [63 FR 64031] (In Amendment 20 to the Reef Fish FMP, a qualifying date of March 29, 2001, was adopted).

July 12, 2000:
The Council is considering whether there is a need to limit participation by gear type in the commercial reef fish fisheries in the exclusive economic zone of the Gulf and, if there is a need, what management measures should be imposed to accomplish this. Possible measures include modifications to the existing limited entry program to control fishery participation, or effort, based on gear type, such as a requirement for a gear endorsement on the commercial reef fish vessel permit for the appropriate gear. Gear types which may be included are longlines, buoy gear, handlines, rod-and-reel, bandit gear, spear fishing gear, and powerheads used with spears [65 FR 42978].

October 15, 2004:

The Council is considering the establishment of an individual fishing quota program to control participation or effort in the commercial grouper fisheries of the Gulf. If an individual fishing quota program is established, the Council is considering October 15, 2004, as a possible control date regarding the eligibility of catch histories in the commercial grouper fishery [69 FR 67106].

December 31, 2008:

The Council voted to establish a control date for all Gulf commercial reef fish vessel permits. The control date will allow the Council to evaluate fishery participation and address any level of overcapacity. The establishment of this control date does not commit the Council or NOAA Fisheries Service to any particular management regime or criteria for entry into this fishery. Fishermen would not be guaranteed future participation in the fishery regardless of their entry date or intensity of participation in the fishery before or after the control date under consideration. Comments were requested by close of business April 17, 2009 [74 FR 11517].

2.5. Management Program Specifications

Table 2.5.1. General Management Information

Gulf of Mexico

Species	Greater Amberjack
Management Unit	Gulf of Mexico
Management Unit Definition	Gulf of Mexico EEZ
Management Entity	Gulf of Mexico Fishery Management Council
Management Contacts SERO / Council	Steven Atran Dr. Carrie Simmons
Current stock exploitation status	Overfished, undergoing overfishing (2010)
Current spawning stock biomass status	4.587 million pounds, whole weight (2010 SEDAR Greater Amberjack Update, using data through 2009)

Table 2.5.2. Specific Management Criteria

Criteria	Gulf of Mexico - Current (2009)		Gulf of Mexico - Proposed	
	Definition	Value	Definition	Value
MSST	$(1-M)*B_{MSY}$	11.048 mp ww	SEDAR 33	SEDAR 33
MFMT	$F_{30\%SPR}$	0.33	SEDAR 33	SEDAR 33
MSY	$F_{30\%SPR}$	0.33	SEDAR 33	SEDAR 33
F_{MSY}	$F_{30\%SPR}$	0.33	SEDAR 33	SEDAR 33
OY	Equilibrium Yield @ F_{OY}	4.806 mp ww	SEDAR 33	SEDAR 33

F_{OY}	75% of F_{MSY}	0.25	F_{OY} = 65%,75%, 85% F_{MSY}	SEDAR 33
M	n/a	0.25	M	SEDAR 33

NOTE: "Proposed" columns are for indicating any definitions that may exist in FMPs or amendments that are currently under development and should therefore be evaluated in the current assessment. "Current" is those definitions in place now. Please clarify whether landings parameters are 'landings' or 'catch' (Landings + Discard). If 'landings', please indicate how discards are addressed.

Stock Rebuilding Information

The Greater Amberjack update assessment was completed and reviewed by the Scientific and Statistical Committee (SSC) at their March 2011 meeting. At that meeting, the SSC moved that the Southeast Data, Assessment, and Review (SEDAR) update assessment for Greater Amberjack (SEDAR 9 Update 2010) was the best scientific information available; however, they did not accept it as adequate for management. In addition, the yield projections were considered unreliable because they showed large sensitivity to small changes in initial conditions, fishing mortality rates, and catch. The SSC next focused on whether the assessment results were sufficient for setting acceptable biological catch (ABC) under the control rule. Both Tier 1 and Tier 2 of the ABC control rule, which was developed by the SSC, require stable yield projections. Therefore, the SSC decided to use Tier 3b from the ABC control rule, in which the ABC is based on the most recent year's landings, for setting the Greater Amberjack overfishing limit (OFL) and ABC (GMFMC 2012).

Gulf of Mexico Greater Amberjack are managed under the Fishery Management Plan for the Reef Fish Resources of the Gulf of Mexico (FMP). On November 13, 2012, NMFS issued a final rule to implement Amendment 35 to the FMP. Amendment 35 established a Greater Amberjack commercial annual catch limit (ACL) of 481,000 pounds (lb), an annual catch target (ACT) (equal to the commercial quota) of 409,000 lb, and a 2,000-lb commercial trip limit for Greater Amberjack. Accountability measures for Greater Amberjack allow for in-season closures of the commercial sector when the applicable ACT is reached or projected to be reached. If despite such closure, landings exceed the ACT, NMFS will reduce the ACT and ACL the following year by the amount of the overage from the prior fishing year. Reducing the stock ACL by 18% from no action is expected to end overfishing; whether overfishing has ended will remain unknown until completion of the next benchmark assessment, scheduled in 2013.

Table 2.5.3. Stock projection information

(This provides the basic information necessary to bridge the gap between the terminal year of the assessment and the year in which any changes may take place or specific alternative exploitation rates should be evaluated)

Gulf of Mexico

Requested Information	Value
First Year of Management	2014
Projection Criteria during interim years should be based on (exploitation or harvest)	Fixed Exploitation
Projection criteria values for interim years should be	Average of previous 3 years

determined from (terminal year, average of X years)	

*Fixed Exploitation would be $F=F_{MSY}$ (or $F<F_{MSY}$) that would rebuild overfished stock to B_{MSY} in the allowable timeframe. Fixed harvest would be maximum fixed harvest with $F<=F_{MSY}$ that would allow the stock to rebuild to B_{MSY} in the allowable timeframe.

Projections:

Project future stock conditions and develop rebuilding schedules if warranted, including estimated generation time. Develop stock projections in accordance with the following:

A) If stock is overfished:
  $F=0$, $F_{Current}$, F_{MSY}, F_{OY}
  $F=F_{Rebuild}$ (max that permits rebuild in allowed time)
B) If stock is undergoing overfishing:
  $F= F_{Current}$, F_{MSY}, F_{OY}
C) If stock is neither overfished nor undergoing overfishing:
  $F= F_{Current}$, F_{MSY}, F_{OY}
D) If data limitations preclude classic projections (i.e. A, B, C above), explore alternate models to provide management advice

Table 2.5.4. Quota Calculation Details

If the stock is managed by quota, please provide the following information

Current Quota Value	1.78 mp ww
Next Scheduled Quota Change	2014
Annual or averaged quota?	Annual
If averaged, number of years to average	n/a
Does the quota include bycatch/discard?	Yes

2.6. Management and Regulatory Timeline

Table 2.6.1. Annual Commercial Greater Amberjack Regulatory Summary *(Note: SWG = Shallow Water Grouper, ww = whole weight, gw = gutted weight, rw = round weight))*

	Fishing Year	Size Limit	Quota	Open date	Close date
1990	365 days	36" FL	n/a	Jan 1	Dec 31
1991	"	"	"	"	"
1992	"	"	"	"	"
1993	"	"	"	"	"
1994	"	"	"	"	"
1995	"	"	"	"	"
1996	"	"	"	"	"
1997	"	"	"	"	"
1998	273 days	"	"	Jan 1, Jun 1	Mar 1, Dec 31
1999	"	"	"	"	"
2000	"	"	"	"	"
2001	"	"	"	"	"
2002	"	"	"	"	"
2003	"	"	2.9 mp ww	"	"
2004	"	"	"	"	"
2005	"	"	"	"	"
2006	"	"	5.2 mp ww	"	"
2007	"	"	"	"	"
2008	"	"	0.503 mp ww	"	"
2009	219 days	"	"	"	Mar 1, Nov 7
2010	209 days	"	0.373 mp ww"	"	Mar 1, Oct 28
2011*	106 days	"	0.342 mp ww	"	Mar 1, Jun 18
2012	60 days	"	0.237 mp ww	Jan 1	Mar 1

Note: 2011* there was an adjustment to the commercial quota after it was closed June 18, 2011 based on projections. However, landings data indicated the quota had not been met so it was re-opened for 60 days Sept 1-Oc 31, 2011. http://sero.nmfs.noaa.gov/fishery_bulletins/bulletin_archives/2011/documents/pdfs/fb11-062_2011_gaj_comm_opening_and_quota_increase.pdf

Table 2.6.2. Annual Recreational Greater Amberjack Regulatory Summary *(Note: SWG = Shallow Water Grouper, ww = whole weight, gw = gutted weight)*

	# Fishing Days	Size Limit	Bag Limit	Open date	Close date
Pre-1990	365 days	28" FL	3 fish/person/day	Jan 1	Dec 31
1990	"	"	"	"	"
1991	"	"	"	"	"
1992	"	"	"	"	"
1993	"	"	"	"	"
1994	"	"	"	"	"
1995	"	"	"	"	"
1996	"	"	"	"	"
1997	"	"	1 fish/person/day	"	"
1998	"	"	"	"	"
1999	"	"	"	"	"
2000	"	"	"	"	"
2001	"	"	"	"	"
2002	"	"	"	"	"
2003	"	"	"	"	"
2004	"	"	"	"	"
2005	"	"	"	"	"
2006	"	"	"	"	"
2007	"	"	"	"	"
2008*	"	30" FL	"	"	"
2009*	309 days	"	"	"	Oct 24
2010*	365 days	"	"	"	Dec 31
2011*	304 days	"	"	Jan 1, Aug 1	Jun 1, Dec 31
2012*	"	"	"	"	"

*Recreational quotas by year, in million lbs whole weight:

2008: 1.368 mp ww
2009: 1.368 mp ww
2010: 1.243 mp ww
2011: 1.315 mp ww
2012: 1.368 mp ww

3. Assessment History and Review

Greater Amberjack, Lesser Amberjack, Banded Rudderfish, and Almaco Jack were added to the Gulf of Mexico Reef Fish Fishery Management Plan (FMP) [55 FR 2079] in 1989, following an explosive rise in the reported landings of amberjack species in the mid-1980s.

In 1993, a weight based population model was applied (Simple Likelihood Method –SLM, Parrack 1990, 1992, 1996) to investigate the exploitation status of Greater Amberjack through 1991 (Cumming-Parrack 1993). In 1996, an age based virtual population analysis (VPA) was applied by McClellan and Cummings (1996) using the ADAPT method (Gavaris 1988, Powers and Restrepo 1991) to assess the status of the resource through 1995. Turner et al. (2000) applied a VPA using the VPA-2box procedure (Porch 1999) in 2000 to assess the status through 1998.

Following the assessment by Turner et al. in 2000, a rebuilding plan was established in 2003 under Secretarial Amendment 2 to the Gulf of Mexico Reef Fish FMP [68 FR 39898]. The biological reference points and status criteria at equilibrium were defined as Maximum Sustainable Yield (MSY) = $F_{30\%SPR}$ and an Optimum Yield (OY) = $F_{40\%SPR}$. The Maximum Fishing Mortality Threshold (MFMT) was defined as $F_{30\%SPR}$ and the Minimum Spawning Stock Threshold (MSST) was defined as (1-M)*B_{MSY} with natural mortality (M) equal to 0.24. A proxy for F_{MSY} was defined as $F_{30\%SPR}$ for greater amberjack because biomass-based estimates were considered less accurate than SPR-based estimates in the 2000 assessment.

In 2006 a benchmark stock assessment for Gulf of Mexico Greater Amberjack was conducted under the Southeast Data Assessment and Review Process (SEDAR, http://safmc.net/science-and-statistics/sedar-stock-assessment-program). For the 2006 stock evaluation, three assessment models were considered (SEDAR, 2006) including: (1) a VPA using the same procedure as in the 2000 evaluation (VPA 2-box (Porch 1999), (2) a non-equilibrium surplus production model (ASPIC), and (3) a State-Space Age-Structured Production Model (SSASPM, Porch 2002). The VPA was presented for continuity with the 2000 stock assessment (Turner et al. 2000). ASPIC and SSASPM were presented because these models have less rigid assumptions on life history inputs including knowing the age structure of the catch explicitly, the latter assumption had been raised as a concern in using the VPA. The SEDAR 9 AW recommended the ASPIC production model as the final preferred model selected for the assessment of the stock status using data through 2004 (SEDAR, 2006). In 2010, an update assessment was conducted using the ASPIC model (SEDAR 2011) using data through 2009.

Following the SEDAR 9 benchmark assessment and the SEDAR 9 update assessment, changes were made to the rebuilding plan for Greater Amberjack. In 2008, Amendment 30A to the Reef Fish FMP readjusted the Annual Catch Limits (ACL), established accountability measures, and established separate quota allocations for the commercial and recreational sectors (73% recreational and 27% commercial) [73 FR 38139]. Amendment 30A also increased the recreational size limit from 28 to 30 inches fork length and implemented a zero bag limit for captain and crew of for-hire vessels. In 2011, Amendment 35 modified the ACL based on the landings in recent years and established a commercial trip limit [77 FR 67574].

In 2013 a benchmark stock assessment was conducted for the Gulf of Mexico Greater Amberjack (SEDAR 33). Two population models were presented in the SEDAR 33 assessment. They were the statistical catch at age model, Stock Synthesis (SS), and the ASPIC production model. SS was the primary assessment model selected for the current stock evaluation using data through 2012. ASPIC models were presented under continuity conditions as well as under additional exploratory conditions.

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4. Regional Maps

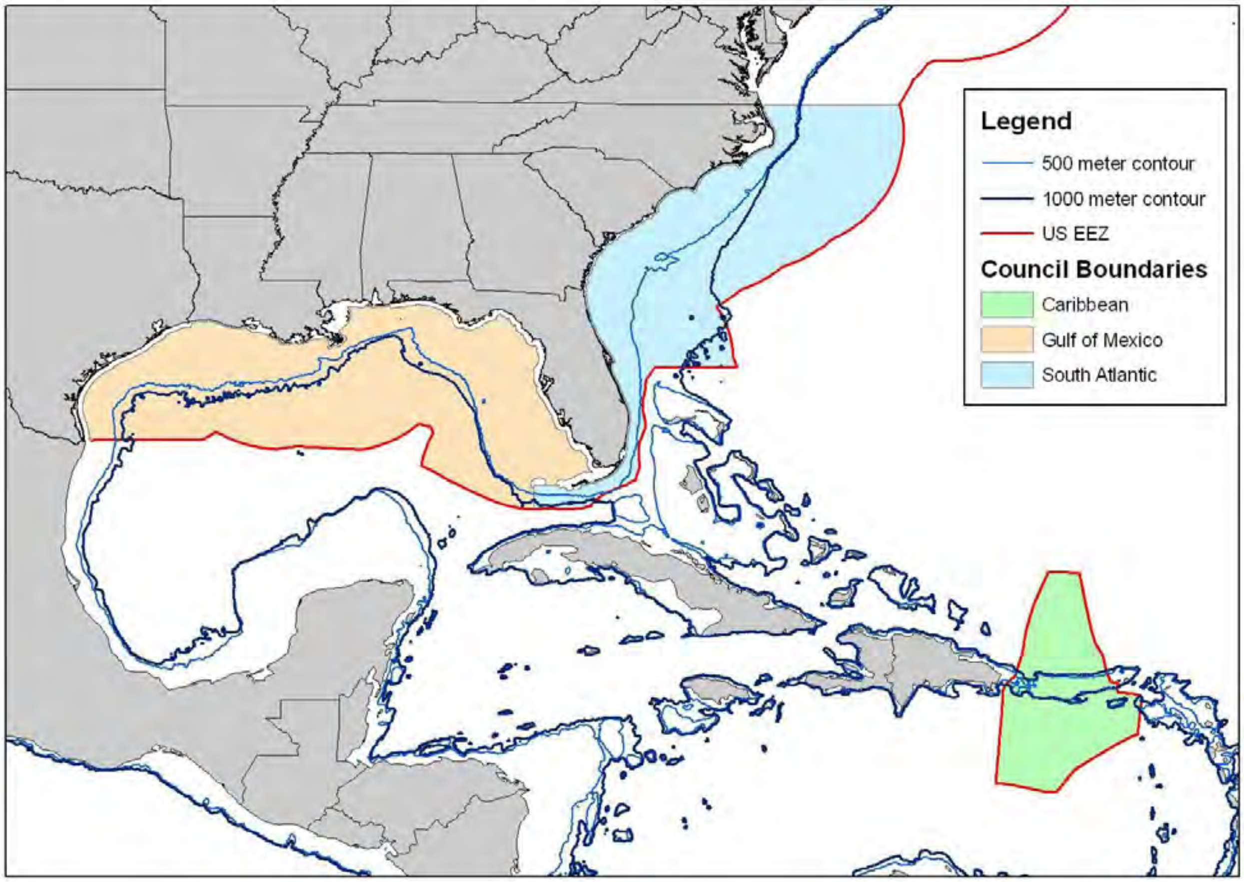

Figure 4.1: South Atlantic, Gulf of Mexico, and Caribbean Fishery Management Council boundaries, and United States EEZ.

5. Assessment Summary Report

Executive Summary

The SEDAR 33 benchmark assessment for Gulf of Mexico Greater Amberjack (*Seriola dumerili*) was conducted through a Data Workshop (May 20-24, 2013; Tampa, FL), 20 Assessment Workshop webinars (June 20, 2013 - January 15, 2014), and a Review Workshop (February 24-27, 2014; Miami, FL).

The RW Panel was presented outputs and results of the SEDAR 33 Gulf of Mexico Greater Amberjack stock assessment. Overall the RW Panel was impressed with and commends the quality of work done by the assessment team (AT). The two models presented to the RW Panel were the ASPIC model and a newly developed Stock Synthesis (SS) model. The RW Panel agreed that the ASPIC model provides continuity with previous assessments, but is no longer the preferred method for determination of stock status and management advice for Greater Amberjack. The RW Panel chose the SS model as the preferred framework to advance the stock assessment; however, the RW Panel had several concerns with the current SS model configuration and performance. The RW Panel's main concern was the jitter analysis, which was used to verify model convergence by starting all model parameters in numerous different initial values and then examining the end results in terms of whether the objective function, model parameters, and important output metrics are unchanged. After 50 jitter runs, large changes were evident in several key outputs when the starting point was changed. Another place where the convergence problem is evident is in the profile likelihood with respect to the steepness parameter, where sudden and inexplicable high values occur in several places on otherwise convex curves. For Gulf of Mexico Greater Amberjack it is the view of the RW Panel that the optimal configuration of SS has not yet been found. Addressing the issues identified by the Review Workshop is needed before the assessment model can be accepted as properly configured and consistent with standard practices. The RW Panel offered several suggestions to further develop the model. At the end of the workshop, the RW Panel did not recommend a specific base model. Hence, the panel made no assessment of overfishing or overfished status.

Stock Status and Determination Criteria

Because a base model configuration was not identified during the Review Workshop, the RW Panel was unable to make these determinations. Continuity runs for ASPIC found the stock to be at or slightly above the overfished status. The current ASPIC assessment shows substantial improvement of stock condition from the 2010 SEDAR 9 Update - although this improvement was likely caused by changes to the calculation of the indices. Stock Synthesis model runs were highly variable in their evaluation of the stock condition although most runs indicated an overfished stock. While showing highly variable results with regard to the question of overfished, ASPIC and most SS runs presented to the RW Panel did not indicate that Greater Amberjack were currently undergoing overfishing.

Stock Identification and Management Unit

The management unit for Gulf of Mexico Greater Amberjack extends from the United States–Mexico border in the west through the northern Gulf waters and west of the Dry Tortugas and the Florida Keys (waters within the Gulf of Mexico Fishery Management Council boundaries). Currently, the Council manages Greater Amberjack as one unit.

Assessment Methods

The primary assessment model selected for the Gulf of Mexico Greater Amberjack stock evaluation assessment was Stock Synthesis (SS) (Methot 2010) version 3.24j (beta). Descriptions of SS algorithms and options are available in the SS user's manual (Methot 2010) and at the NOAA Fisheries Toolbox website (http://nft.nefsc.noaa.gov/). Stock Synthesis is an integrated statistical catch-at-age model which is widely used for stock assessments in the United States and throughout the world. Stock Synthesis takes relatively unprocessed input data and incorporates many of the important processes (mortality, selectivity, growth, etc.) that operate in conjunction to produce observed catch, size and age composition and CPUE indices. In addition, SS can incorporate time series of environmental data. Because many of these inputs are correlated, the concept behind SS is that they should be modeled together, which helps to ensure that uncertainties in the input data are properly accounted for in the assessment. SS has the ability to incorporate an early, data poor time period for which only catch data are available and a more recent, data-rich time-period for which indices of abundance and length and age-length or age composition data are available.

The r4ss software (www.cran.r-project.org/web/packages/r4ss/index.html) was utilized extensively to develop various graphics for the SS outputs and also was used to summarize various SS output files and to conduct the parametric bootstrap. The SS parametric bootstrap procedure was the approach used to characterize the uncertainty in final model estimates and projections of future catches for a variety of alternative scenarios recommended by the AW Panel. This tool is based on parametric bootstrap analyses used with SS (Methot 2011).

Assessment Data

The SS model was fit to landings, discards, length composition, conditional age-length observations, and indices of abundance (Figure 5.1 – 5.5).

Fishery-independent Data

The fishery-independent indices recommended for use were the SEAMAP video survey, and the Panama City Laboratory trap video survey. The video survey indices were derived as the highest minimum count observed per 20 minute recording.

Fishery-dependent Data

The commercial logbook vertical line and longline indices provide standardized annual catch rates from the commercial fishery. The vertical line index was derived as pounds per hook hour, whereas the longline index was derived as pounds per hook. The approved terminal year for the recreational indices at the DW was 2012. The Marine Recreational Fisheries Statistical Survey (MRFSS) provided indices of abundance for the recreational fishery for the charter-for-hire and private angler fisheries. The MRFSS index was derived as the number of Greater Amberjack caught or discarded per angler hour. The approved terminal year for the recreational indices at the DW was 2012.

Discard Mortality Data

<u>Commercial</u>

For each year from 2007 to 2012, annual discard rates were calculated using observer reported data from the commercial reef fish and shark fisheries (Table 5.1). Rates were calculated by

Gulf of Mexico region (east and west) and fleet (handline, reef fish longline permit, and bottom longline shark permit). A discard rate of zero was assumed for all regions and fleets prior to the implementation of the 36 inch fork length commercial size limit in 1990. From 1990 to 2006 (years assumed to have commercial discards, but prior to data collection by observers), discard rate was defined as the mean discard rate for the years 2007-2012 by fleet and region. Due to low numbers of observed longline trips per year, the annual discard rates from 2007 to 2012 for each longline fleet were replaced with the mean rate over the years 2007-2012 by fleet and region. Total discards were calculated as: fleet/region specific discard rate*yearly fleet/region total effort reported to the coastal logbook program. Effort was in hook hours for the vertical line fishery and hooks fished for the longline fisheries.

Recreational

Estimates of recreational discards in numbers of fish (for SS) and in whole weight (for ASPIC) were provided through the SEDAR 33 DW. Multiple methods and assumptions for estimating discards in weight were explored for two reasons. The first reason is that discards of Greater Amberjack represent a large proportion of total recreational catch (Figure 5.6). This is especially evident in recent years where the discards make up approximately 75% of the total catch. Secondly, the sizes of discards were based on the sizes of landed fish, and the size distribution of landed fish has changed in association with the implementation of size and bag limits. Average discard rates for the recreational fishery are shown in Table 5.2.

Life History Information

Growth

Growth was modeled internally in SS as both sexes combined with a three parameter von Bertalanffy equation (L_{min}, L_{max}, and K). For this assessment, the L_∞ parameter was fixed at the value estimated by the DW. When the model was allowed to estimate this parameter, SS tended to reach the upper bound defined for the population (200 cm) and this was considered unreasonable. The assessment panel explored the implications of this behavior in sensitivity runs, and the model result was not affected significantly. Fish were assumed to be fully mature at age 2. The fecundity schedule was assumed directly proportional to female weight in the assessment model. The growth rate K and L_{min} (at a_{min} = 0.5 years) were both estimated in SS. The CV on growth in the AW Base model was 0.2.

L_∞ = fixed at 143.6 cm FL
K = 0.144798
L_{min} = 29.3403 (for a_{min} = 0.5 years)

Natural Mortality

The M at-age vector was developed according to a declining Lorenzen function and scaled to fully recruited fish ages 3+ by the point estimate of the Hoenig maximum age natural mortality estimator recommended by the SEDAR 33 DW of 0.28 y^{-1} (Figure 5.7).

Natural mortality was modeled as a declining Lorenzen function of size, held constant over time, scaled to the Hoenig maximum age point estimate as recommended by the DW. The reference age assumed in the Lorenzen function was 3 y as recommended by the DW. The resulting age-specific Lorenzen M vector was used in the Base SS Model run (Run1="LM Age0 M"). Three alternative vectors of M at age were considered to evaluate the impact on model results from assumptions on natural mortality. One was developed in an attempt to account for the approach that SS uses to advance ages (i.e. fish advance in age on January 1, "irrespective of time of birth"). Greater Amberjack undergo a contracted period of spawning with peak spawning in the early spring (April) thus in SS are advanced to age 1 at 9 months of life. Therefore, the input value of M for 'age 0' fish from the LM Age0 vector was reduced by 0.25 (or 3 months of 1 year) and this vector of M at age (Red_Age0 M) was considered as a sensitivity run. Two other sensitivity analyses on M were considered. The SEDAR 33 DW recommended considering a range of point estimates (high=0.35, low=0.15) for characterizing the Lorenzen M function (LOW_M, HIGH_M) for Greater Amberjack. These were also included as two additional SS sensitivity runs and provide additional information on the impact on SS model results from assumptions on M (at age) (Figure 5.8).

Selectivity
Three retention functions (logistic in form) were modeled for the COM_HL fleet(1950-1989, 1990-2007, 2008-2012), two for the COM_LL (1950-1989, 1990-2012), and four for the REC and Headboat fisheries (1950-1990, 1991-1997, 1998-2008, 2009-2012) to account for the minimum size limit that was implemented in 1990 (all fleets), 2008 (REC) and other regulatory implementations in 1997 (seasonal commercial closure) and in 2009. Modeling both selectivity and retention functions at the same time for the directed fleets was problematic, with contributing factors including very low sample sizes, truncated distributions, and the appearance of many small fish in some years. However, the addition of time varying retention blocks significantly improved the ability of SS to fit the observed length compositions. The standard errors for some selectivity and retention parameters were very high and indicate that these parameters were not well estimated.

Release Mortality
Three discard mortality rates were suggested by the discard mortality working group after the SEDAR 33 DW: 0%, 20%, and 40%. These rates were retained from the 2010 SEDAR 9 Update assessment. In addition, alternative characterizations of the release mortality value were considered in the SS assessment model including these values: 0%, 5%, 10%, and 15% (Figure 5.9). Since a base model was not proposed by the RW Panel, accepted discard mortality rates by fleet are not reported here.

Catch and Fishing Mortality Trends
Exploitation rate (catch in weight including discards / total biomass) was used as the proxy for annual fishing mortality rate. Predicted annual fishing mortality estimates (all fleets combined) show increasing but low levels of F through the late 1980s. Steady and large increasing trends in F were estimated between the early 1980s and continuing through the mid-1990s. Estimated total annual Fs have generally declined since the mid-1990s, with the exception of years between 2003 and 2005 which showed increases in F.

The trend in annual instantaneous fishing mortality (F) by fleet is variable, particularly since the years of implementation of fishery regulations (1987). In particular, annual Fs for the COM_HL fleet declined significantly since the early 1990s and have shown continued declines through recent years. Estimated annual Fs from the COM_LL fleet have remained very low over the time series, with the exception of significant increases beginning around 1981. Only small changes in COM_LL F were predicted (Figure 5.10).

Annual estimated Fs for the recreational REC fleet (combined private and charter) and the Headboat fleet showed similar patterns of increasing F beginning in the early 1980s continuing until the early 1990s (similar to the COM_HL fleet). Estimated REC F declined sharply between 1991 and 1995, and has remained relatively stable since, with only moderate increases in estimated F (Figure 5.10).

Stock Abundance and Biomass Trends
Total biomass and spawning biomass show significant declining trends from the beginning of the time series (1950) lasting through the late 1990s. Estimated total biomass increased from the late 1990s through about 2003. Stock Synthesis-estimated total biomass has oscillated since 2003.

Estimated spawning biomass generally followed the trajectory of total biomass. Spawning stock biomass increased from the late 1990s through about 2003, then decreased through 2006. Since then, SS estimated total biomass has increased continuously. The mean age of Gulf of Mexico Greater Amberjack was predicted to be ~ 1.9 y in the virgin state. The population mean age declined significantly to 0.6 soon thereafter, then increased in the early 1950s to about 1.0 and remained nearly unchanged until around 2010. The SS estimated average age at the beginning of 2012 was 0.6. The trajectory of SS estimated age in the population suggests that rather large changes in average age occurred initially, and since the mid-1980s average age in the population has experienced moderate increases and decreases. Estimated average age indicates about a 20% decline since 2010 from 0.98 to 0.6. These results are difficult to interpret since increasing mean age can result from the increasing age of a recovering population, or from recruitment failure. Likewise, decreasing mean age can result from juvenescence due to overexploitation, or from a series of strong recruitment classes.

Scientific Uncertainty
ASPIC
Bootstrap analyses were performed to estimate variability around the estimated parameters and projection analyses were also performed for different scenarios of fishing mortality and for different scenarios of constant yield.

Stock Synthesis
Uncertainty in parameter estimates was quantified by computing asymptotic standard errors for each parameter. Asymptotic standard errors are calculated by inverting the Hessian matrix (i.e., the matrix of second derivatives) after the model fitting process. Asymptotic standard errors provide a minimum estimate of uncertainty in parameter values. The internal bootstrap procedure in SS was used to characterize the uncertainty in final model estimates and projections of future caches for a variety of alternative scenarios recommended by the SEDAR 33 AW Panel. Uncertainty on SS model estimates of important parameters of interest may be summarized including: growth parameters, selectivity parameters, recruitment deviations) and other key quantities of interest (e.g., total virgin biomass, spawning biomass (SSB), current SSB, etc.).

Significant Assessment Modifications

The greatest change between this assessment of Greater Amberjack and the 2011 SEDAR 9 Update was the transition in modeling environments from ASPIC to Stock Synthesis. Other substantial modifications include the integration of depth-related discard mortality rates by sector, integration of the Marine Recreational Information Program into the recreational landings data, examinations of episodic mortality events and other environmental covariates such as the *Deepwater Horizon* oil spill, and the utilization of video-derived indices of abundance.

Sources of Information

The contents of this summary report were taken from the SEDAR 33 Gulf of Mexico Data, Assessment, and Review Workshop reports and addenda.

Tables

Table 5.1. Average lengths, sample sizes, and average weights of observed Greater Amberjack discards and observed Seriola discards by commercial handline and bottom longline fisheries.

	Commercial Fishery	Average Length (cm)	Sample Size	Average Weight (lbs)
Greater Amberjack	Handline	68.62	647	10.63
	Longline	92.58	519	23.39
Seriola ≤ 60cm	Handline	41.8	202	2.88
	Longline	43.8	149	3.26

Table 5.2. Average discard rates by fishing mode and regulatory period for the recreational charterboat, private angler and headboat fisheries.

Years	Headboat	Charterboat	Private
1981-1989	0.0585	0.0510	0.3230
1990-1997	0.9520	0.9279	1.7034
1998-2008	1.1964	1.0962	3.7634
2009-2012	1.4732	1.4636	4.7476

Figures

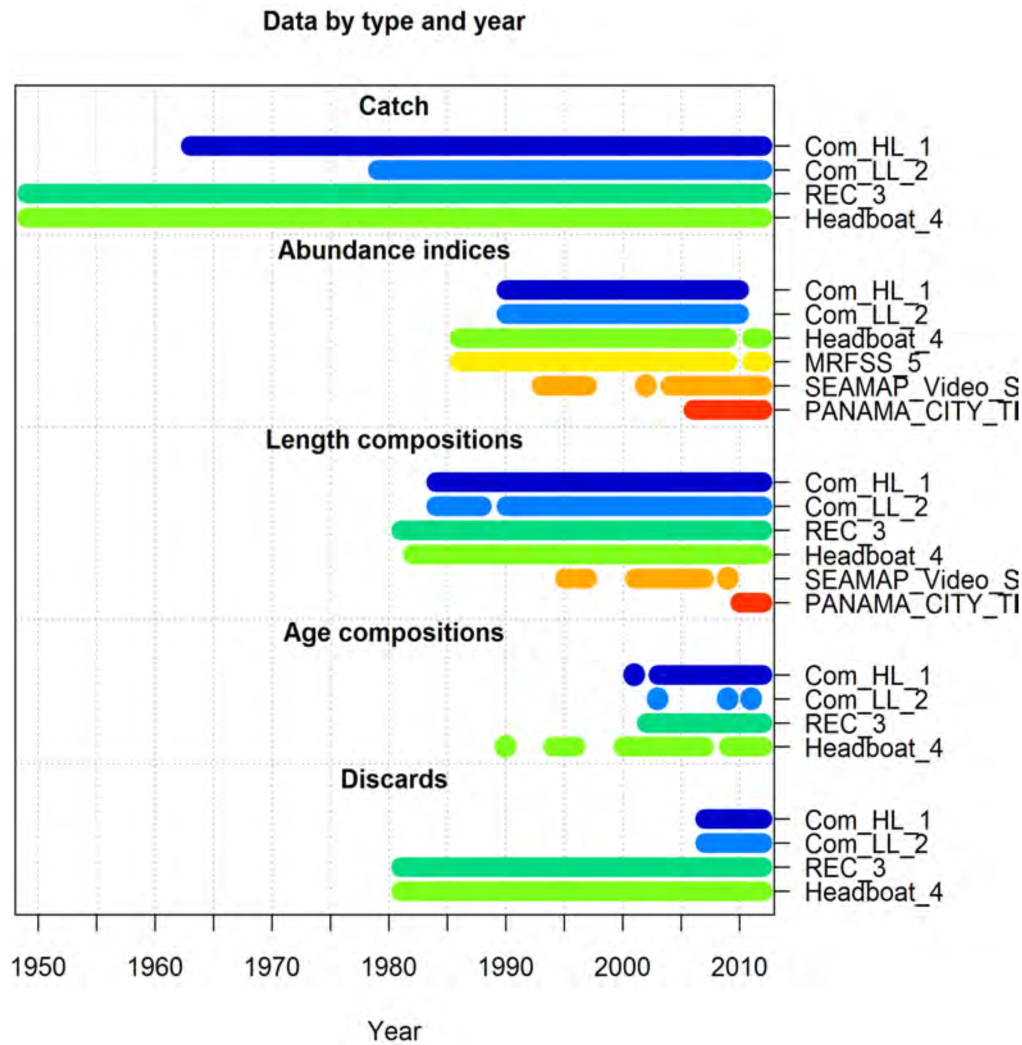

Figure 5.1. Graphical presentation of all data inputs for SEDAR 33 Greater Amberjack SS stock assessment.

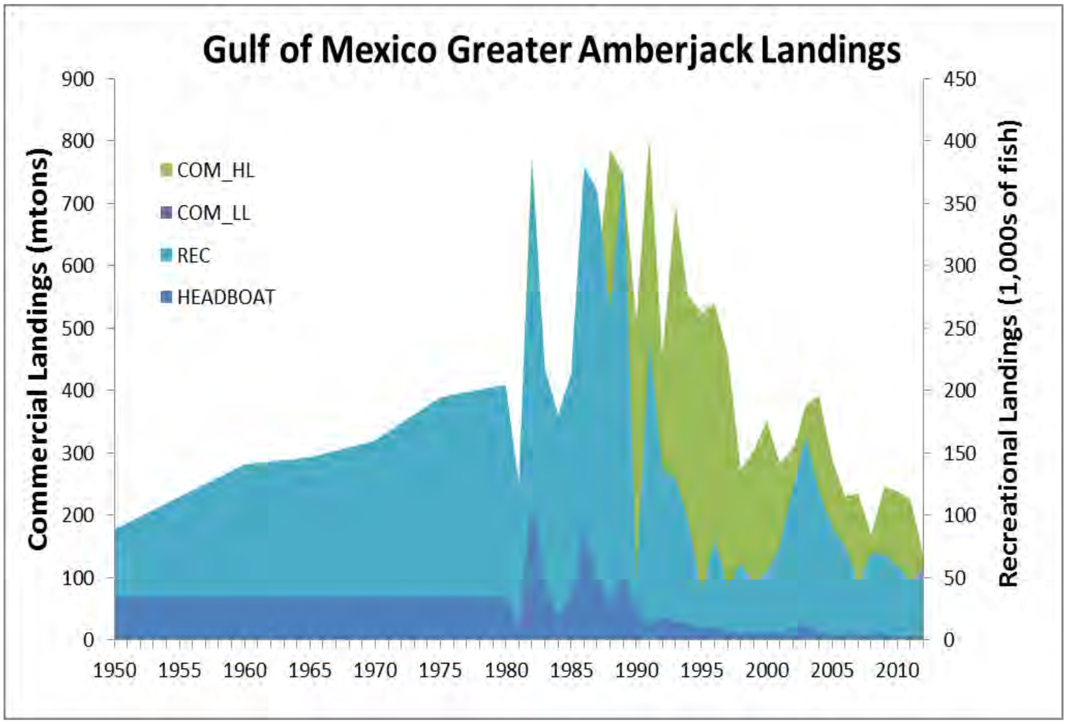

Figure 5.2. Landings for Gulf of Mexico Greater Amberjack. Landings are partitioned into four components: COM_HL = commercial line gears, COM_LL = commercial bottom longline, REC = recreational charterboat, private angler fisheries and Headboat. Units are whole weight (mtons) commercial, numbers of fish (recreational, 1,000's of fish).

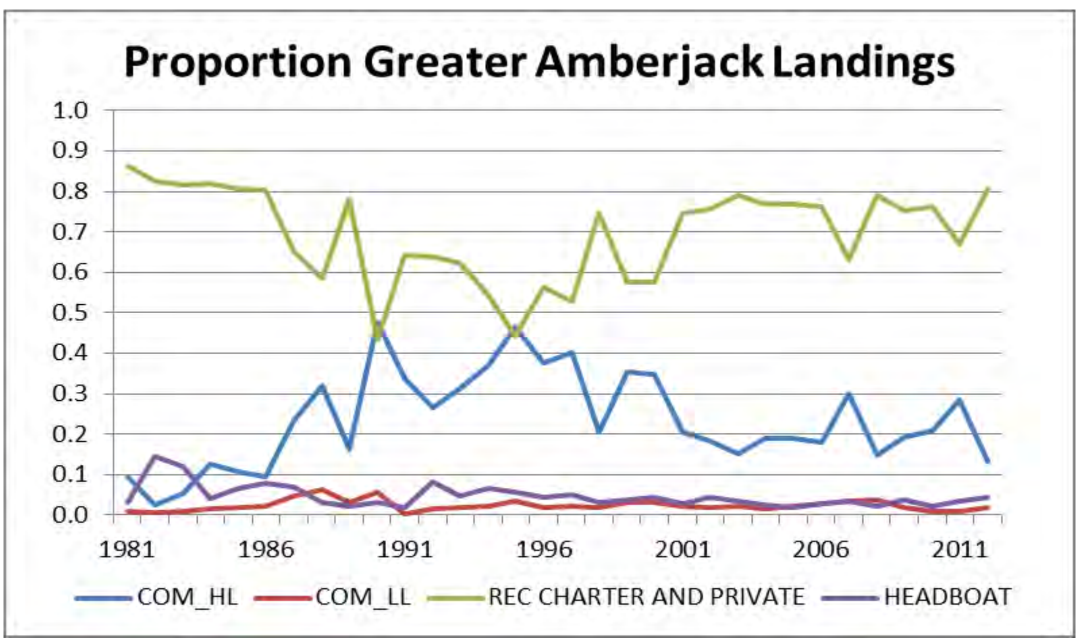

Figure 5.3. Proportion of Greater Amberjack landings by fishery and year for 1981-2012.

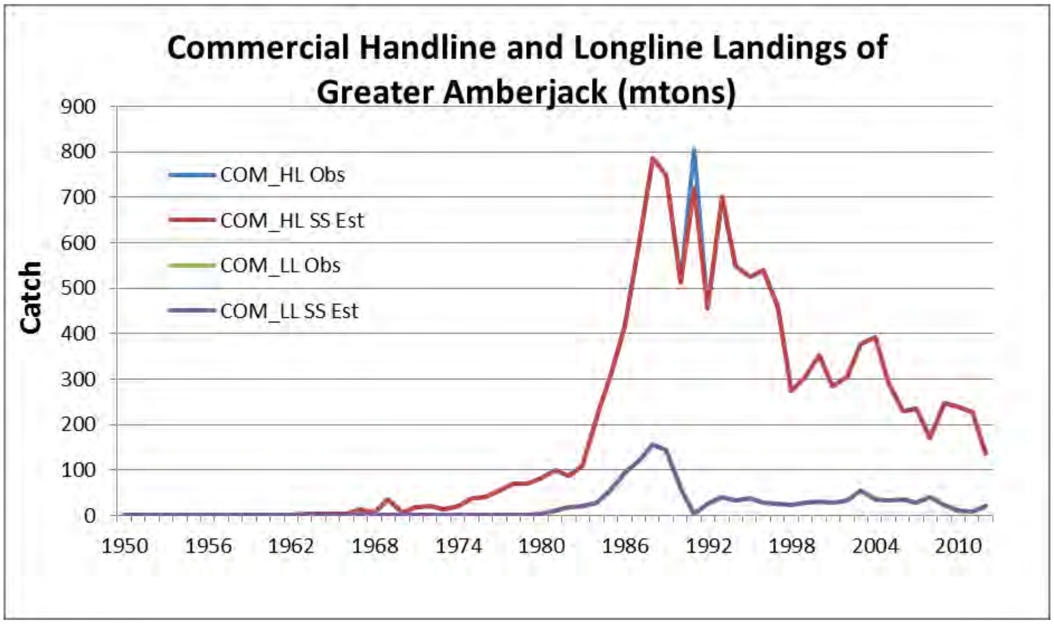

Figure 5.4. Reported and SS estimated landings of Greater Amberjack for commercial fisheries (units=mtons). Plots are of retained landings only.

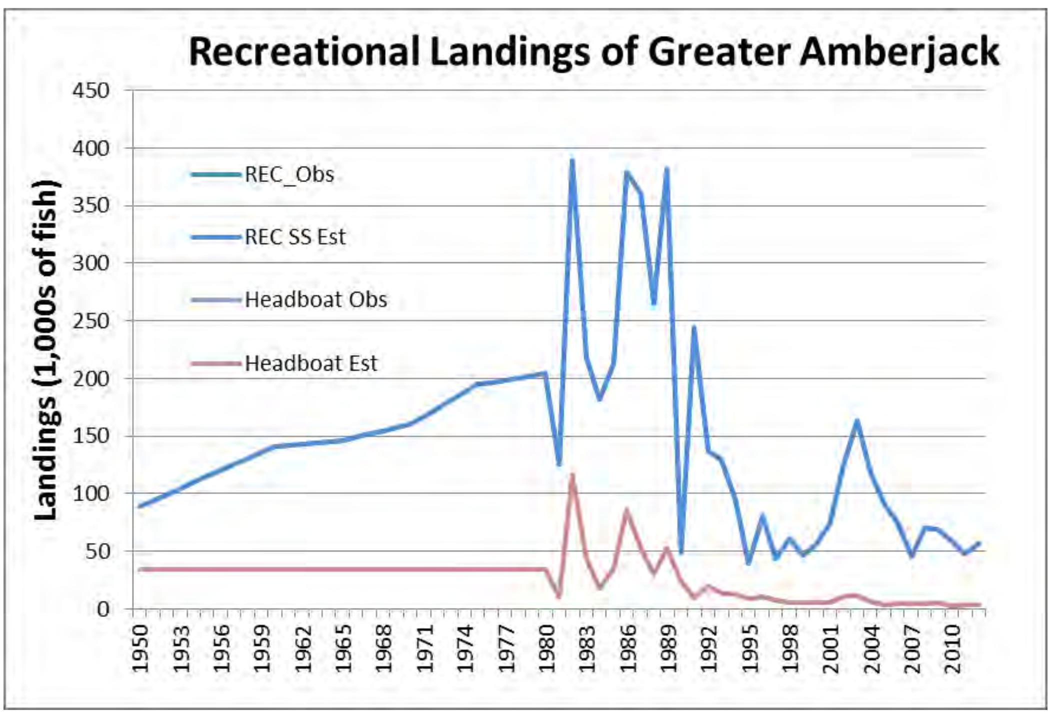

Figure 5.5. Reported and SS estimated landings of Greater Amberjack for recreational fisheries (units = 1,000s of fish). Plots are of retained landings only.

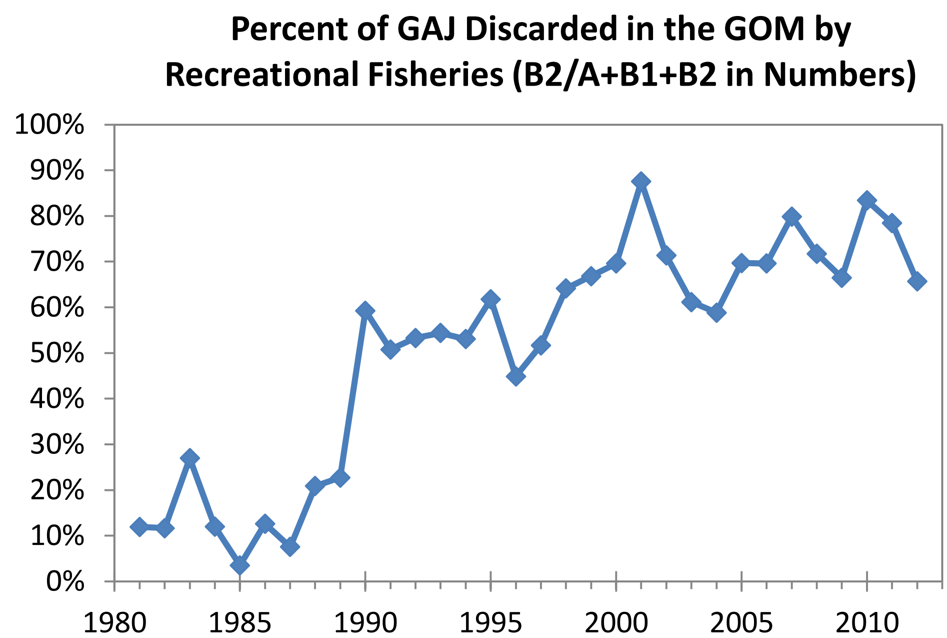

Figure 5.6. Annual percentages of Greater Amberjack discarded in the Gulf of Mexico by recreational fisheries. Annual values are calculated as the total number of discarded Greater Amberjack (B2) divided by the total number caught (A+B1+B2).

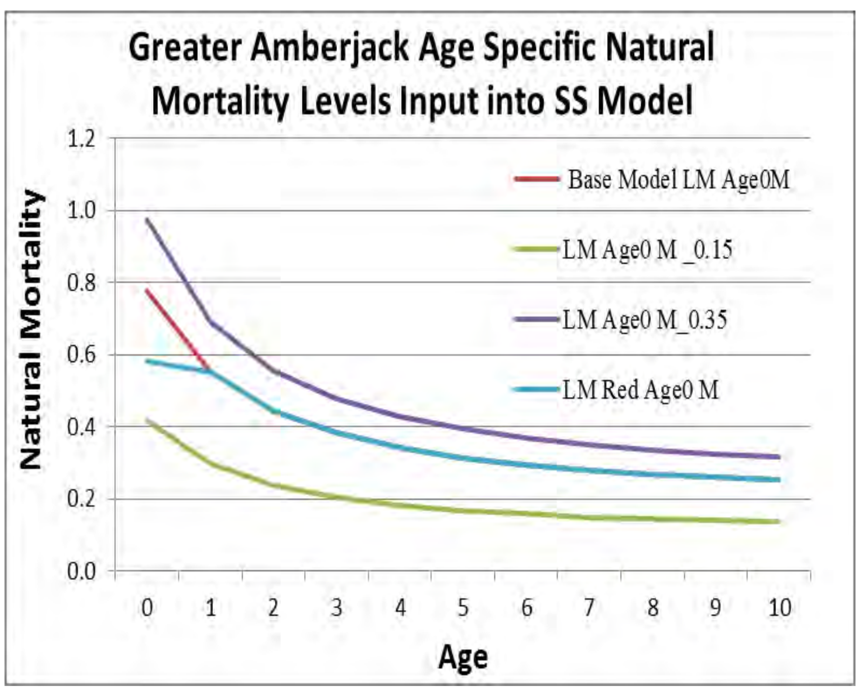

Figure 5.7. Natural mortality at age used in into the Stock Synthesis model for the AW Base Model run (LM Age0 M) for Greater Amberjack and three alternative characterizations of M at age.

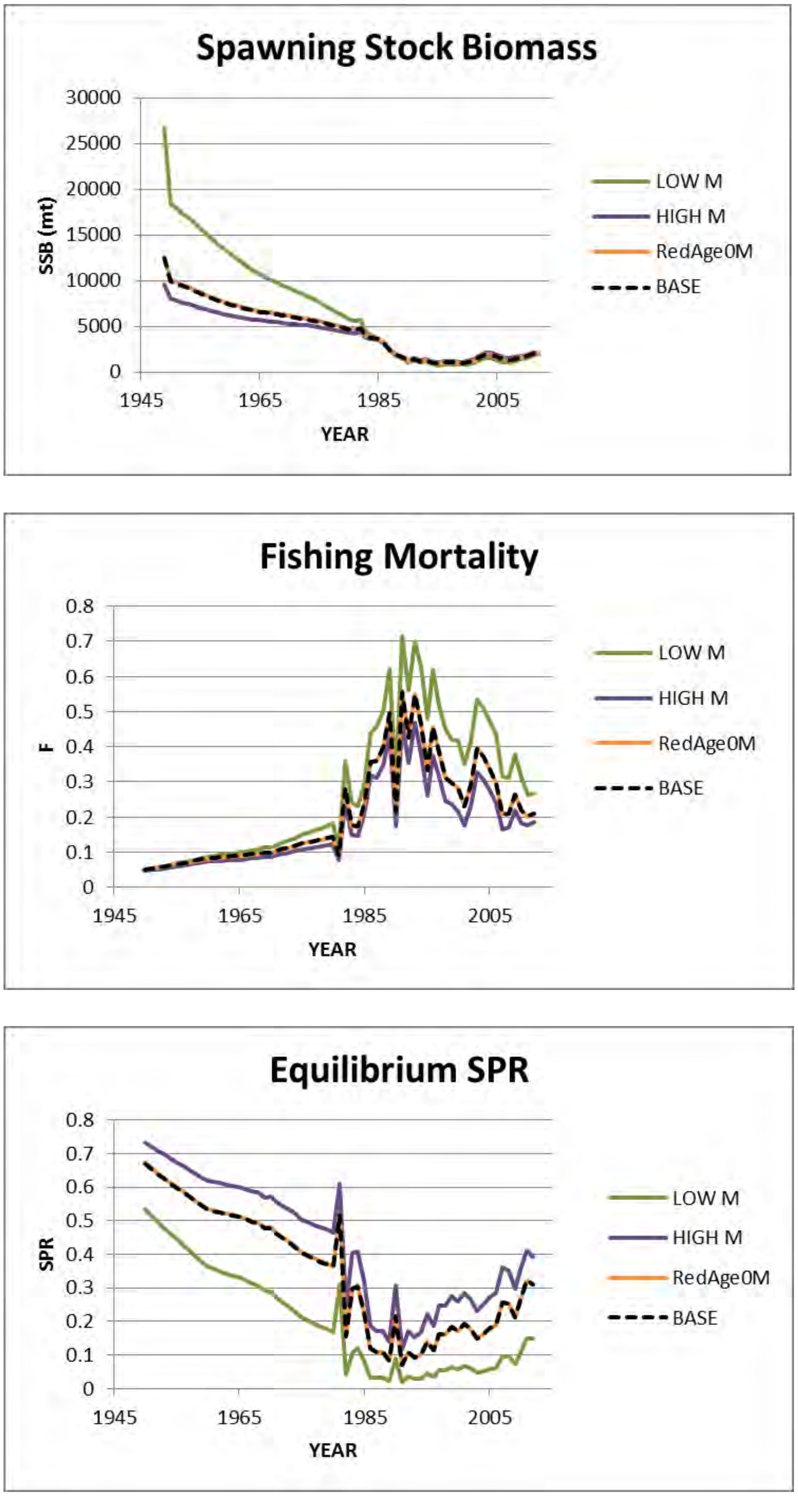

Figure 5.8. Sensitivity analyses for the AW Base Model Run model configuration at four alternative natural mortality scenarios (Base Model Lorenzen M = 0.28, LOW M (0.,15), HIGH M (0.35), and Lorenzen M at age for age 0 reduced. Top Panel = spawning biomass (SSB), Middle Panel = Recruitment, Bottom Panel = spawning potential ratio (SPR).

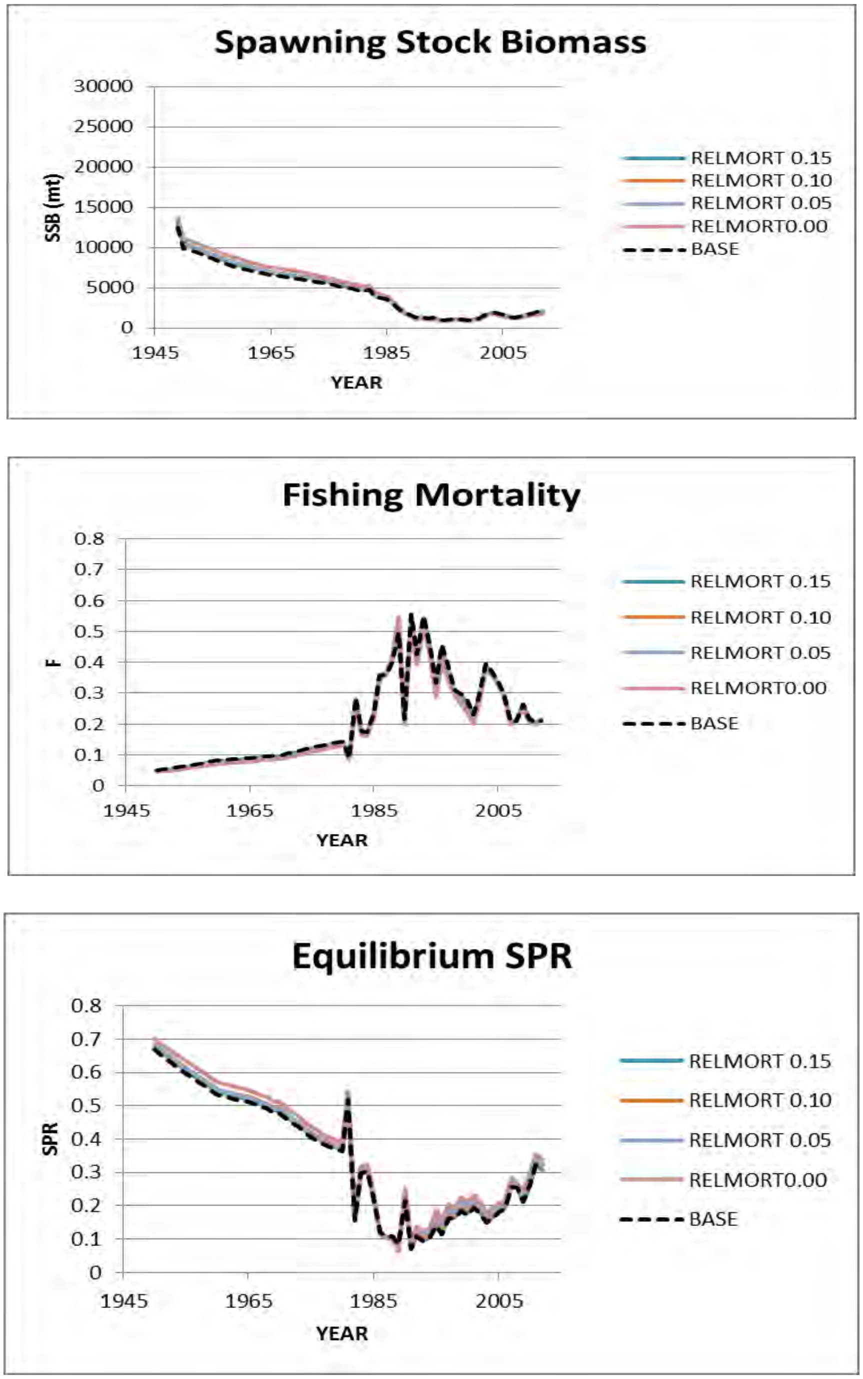

Figure 5.9. Sensitivity analyses for Gulf of Mexico Greater Amberjack with varying assumptions of release mortality. Top Panel = spawning biomass (SSB), Middle Panel = Recruitment, Bottom Panel = spawning potential ratio (SPR).

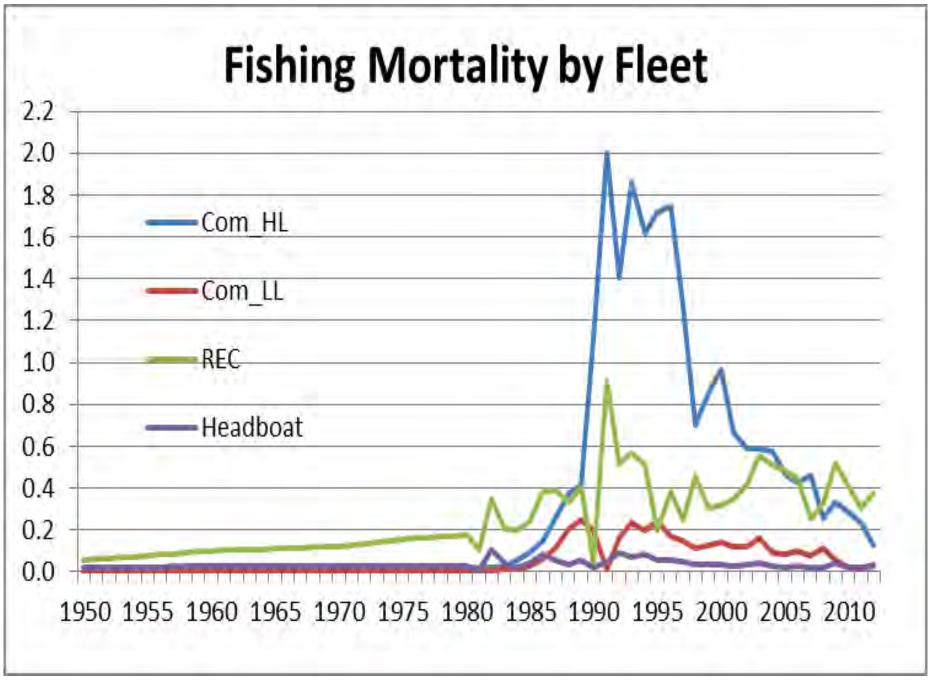

Figure 5.10. Fleet-specific fishing mortality for Gulf of Mexico Greater Amberjack for the AW Base Model run (LM Age0 M).

6. SEDAR Abbreviations

ABC	Acceptable Biological Catch
ACCSP	Atlantic Coastal Cooperative Statistics Program
ADMB	AD Model Builder software program
ALS	Accumulated Landings System; SEFSC fisheries data collection program
ASMFC	Atlantic States Marine Fisheries Commission
B	stock biomass level
BMSY	value of B capable of producing MSY on a continuing basis
CFMC	Caribbean Fishery Management Council
CIE	Center for Independent Experts
CPUE	catch per unit of effort
EEZ	exclusive economic zone
F	Fishing mortality (instantaneous)
FMSY	Fishing mortality to produce MSY under equilibrium conditions
FOY	Fishing mortality rate to produce Optimum Yield under equilibrium
FXX% SPR	Fishing mortality rate resulting in retaining XX% of the maximum spawning production under equilibrium conditions
FMAX	Fishing mortality that maximizes the average weight yield per fish recruited to the fishery
F_0	Fishing mortality close to, but slightly less than, F_{Max}
FL FWCC	Florida Fish and Wildlife Conservation Commission
FWRI	(State of) Florida Fisheries and Wildlife Research Institute
GA DNR	Georgia Department of Natural Resources
GLM	General Linear Model
GMFMC	Gulf of Mexico Fishery Management Council
GSMFC	Gulf States Marine Fisheries Commission
GULF FIN	GSMFC Fisheries Information Network
M	natural mortality (instantaneous)
MARMAP	Marine Resources Monitoring, Assessment, and Prediction
MFMT	Maximum Fishing Mortality Threshold, a value of F above which overfishing is deemed to be occurring
MRFSS	Marine Recreational Fisheries Statistics Survey; combines a telephone survey of households to estimate number of trips with creel surveys to estimate catch and effort per trip
MRIP	Marine Recreational Information Program
MSST	Minimum Stock Size Threshold, a value of B below which the stock is deemed to be overfished
MSY	maximum sustainable yield
NC DMF	North Carolina Division of Marine Fisheries
NMFS	National Marine Fisheries Service
NOAA	National Oceanographic and Atmospheric Administration
OY	Optimum Yield
SAFMC	South Atlantic Fishery Management Council
SAS	Statistical Analysis Software, SAS Corporation
SC DNR	South Carolina Department of Natural Resources
SEDAR	Southeast Data, Assessment and Review

SEFSC	Southeast Fisheries Science Center, National Marine Fisheries Service
SERO	Southeast Regional Office, National Marine Fisheries Service
SPR	Spawning Potential Ratio, stock biomass relative to an unfished state of the stock
SSB	Spawning Stock Biomass
SSC	Science and Statistics Committee
TIP	Trip Incident Program; biological data collection program of the SEFSC and Southeast States.
Z	total mortality, the sum of M and F

SEDAR

Southeast Data, Assessment, and Review

SEDAR 33
Section II: Data Workshop Report

Gulf of Mexico Greater Amberjack

August 2013

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

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1. Introduction

1.1 Workshop Time and Place

The SEDAR 33 Data Workshop for Gulf of Mexico Greater Amberjack (*Seriola dumerili*) was held May 20-24, 2013 in Tampa, Florida.

1.2 Terms of Reference

1. Review stock structure and unit stock definitions, considering whether changes are required.
2. Review, discuss, and tabulate available life history information.
    - Evaluate age, growth, natural mortality, and reproductive characteristics

- Provide appropriate models to describe growth, maturation, and fecundity by age, sex, or length as applicable
- Evaluate the adequacy of available life-history information for conducting stock assessments and recommend life history information for use in population modeling

3. Recommend discard mortality rates.
    - Review available research and published literature
    - Consider research directed at greater amberjack as well as similar species from other areas
    - Provide estimates of discard mortality rate by fishery, gear type, depth, and other feasible or appropriate strata
    - Include thorough rationale for recommended discard mortality rates
    - Provide justification for any recommendations that deviate from the range of discard mortality provided in the last update or other prior assessment

4. Provide measures of population abundance that are appropriate for stock assessment.
    - Consider and discuss all applicable fishery-dependent and independent data sources
    - Document all programs evaluated; address program objectives, methods, coverage, sampling intensity, and other relevant characteristics
    - Provide maps of fishery and survey coverage
    - Develop fishery and survey CPUE indices by appropriate strata (e.g., age, size, area, and fishery) and include measures of precision and accuracy; rank indices with regard to their suitability for use in assessment modeling
    - Discuss the degree to which available indices adequately represent fishery and population conditions
    - Recommend which data sources are considered appropriate for use in assessment modeling
    - Complete the SEDAR index evaluation worksheet for each index considered

5. Characterize commercial and recreational catch, including both landings and discards in both pounds and numbers.
    - Evaluate and discuss the adequacy of available data for accurately characterizing harvest and discard by fishery sector or gear
    - Provide length and age distributions if feasible, and maps of fishery effort and harvest
    - Provide maps of fishery effort and harvest

6. Describe any environmental covariates or episodic events that would be reasonably expected to affect population abundance.

7. Provide any information available about demographics and socioeconomics of fishermen, especially as they may relate to fishing effort.

8. Provide recommendations for future research, including guidance on sampling design, intensity, and appropriate strata and coverage.

9. Prepare the Data Workshop report providing complete documentation of workshop actions and decisions (Section II of the SEDAR assessment report).
    - Develop a list of tasks to be completed following the workshop

- Review and describe any ecosystem consideration(s) that should be included in the stock assessment report

1.3 List of Participants

Data Workshop Panel

Cameron Ainsworth	USF	Mandy Karnauskas	SEFSC
Robert Allman	SEFSC	Walter Keithly	Gulf SSC
Neil Baertlein	SEFSC	Linda Lombardi	SEFSC
Beverly Barnett	SEFSC	Behzad Mahmoudi	FWRI
Donna Bellais	GSMFC	John Mareska	Gulf SSC
Dave Chagaris	FWRI	Beverly Sauls	FWC
Mary Christman	MCCSC	Vivian Matter	SEFSC
Jason Delacruz	RFSA	Debra Murie	UF
Doug DeVries	SEFSC	Adam Pollack	SEFSC
Gary Fitzhugh	NMFS	Ted Switzer	FWRI
Dave Gloeckner	SEFSC	Michael Schirripa	SEFSC
Arnaud Gruss	RSMAS	Chris Stallings	USF
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Council and Agency Staff

Ryan Rindone	SEDAR	Charlotte Schiaffo	GMFMC
Jessica Stephen	SERO	Patrick Davis	SEFSC
Rich Malinowski	SERO	Steven Atran	GMFMC
Doug Gregory	GMFMC	Jessica Stephen	SERO
Kathy Guindon	FWRI	Patrick Gilles	SEFSC
Meaghan Bryan	SEFSC	Shannon Cass-Calay	SEFSC
Jakob Tetzlaff	SEFSC	Adyan Rios	SEFSC

Data Workshop Observers

Chad Hanson	PEG	Alicia Gray	USF

1.4 List of Data Workshop Working Papers

Document Number	Species	Title	Authors
Data Workshop Documents			
SEDAR33-DW01	Both	Greater Amberjack and Gag Grouper Catches from Mississippi Laboratories Fishery Independent Surveys	Pollack and Ingram
SEDAR33-DW02	Gag	Protection of Grouper and Red Snapper Spawning in Shelf-Edge Marine Reserves of the Northeastern Gulf of	Koenig and Coleman

		Mexico: Demographics, Movements, Survival and Spillover Effects	
SEDAR33-DW03	Gag	Fishery-Independent Indices of Abundance for Gag (*Mycteroperca microlepis*) in the Northeastern Gulf of Mexico, with Intrinsic Habitat Quality Controlled and Contrasted	Lindberg, Christman, and Marcinek
SEDAR33-DW04	GAJ	Characterization of Greater Amberjack Discards in Recreational For-Hire Fisheries	Sauls and Cernak
SEDAR33-DW05	Gag	Characterization of Gag Discards in Recreational For-Hire Fisheries	Sauls and Cernak
SEDAR33-DW06	Gag	Condition and Relative Survival of Gag *Mycteroperca microlepis* Discards Observed Within a Recreational Hook-and-Line Fishery	Sauls
SEDAR33-DW07	Gag	Natural Mortality of Gag Grouper from 1950 to 2009 Generated by an Ecosim Model	Chagaris and Mahmoudi
SEDAR33-DW08	Gag	Satellite derived indices of red tide severity for input for Gulf of Mexico Gag grouper stock assessment	Walter, Christman, Landsberg, Linton, Steidinger, Stumpf, Tustison
SEDAR33-DW09	Gag	Use of otolith microchemistry to improve fisheries-independent indices of recruitment for gag (*Mycteroperca microlepis*): linking estuarine nurseries to nearshore reefs in the eastern Gulf of Mexico	Jones, Switzer, Houston, and Peebles
SEDAR33-DW10	Both	Incorporating various Gulf of Mexico Integrated Ecosystem Assessment products into the Stock Synthesis Integrated Assessment Model framework	Schirripa, Methot, et al.
SEDAR33-DW11	Gag	Evaluation of natural mortality rates and diet composition for gag (*Mycteroperca microlepis*) in the West Florida Shelf ecosystem using the individual-based, multi-species model OSMOSE	Gruss, Schirripa, Chagaris, Drexler, Simons, Verley, Shin, Karnauskas, Penta, de Rada, and Ainsworth
SEDAR33-DW12	GAJ	Seasonal movement and mixing rates of greater amberjack in the Gulf of Mexico and assessment of exchange with the South Atlantic spawning stock.	Murie, Parkyn, and Austin

SEDAR33-DW13	Gag	Observer reported size distribution and discard characteristics of Gulf of Mexico Gag from the commercial vertical line and bottom longline fisheries	Johnson
SEDAR33-DW14	GAJ	Observer reported size distribution and discard characteristics of Gulf of Mexico Greater Amberjack from the commercial vertical line and bottom longline fisheries	Johnson
SEDAR33-DW15	Gag	SEAMAP Reef Fish Video Survey: Relative Indices of Abundance of Gag	Campbell, Rademacher, Felts, Noble, Felts, and Salisbury
SEDAR33-DW16	GAJ	SEAMAP Reef Fish Video Survey: Relative Indices of Abundance of Greater Amberjack	Campbell, Rademacher, Felts, Noble, Felts, and Salisbury
SEDAR33-DW17	Gag	Update concerning species misidentifications in the commercial landing data of gag groupers and black groupers in the Gulf of Mexico	Chih
SEDAR33-DW18	Gag	Use of the Connectivity Modeling System to estimate movements of gag grouper (*Mycteroperca microlepis*) recruits in the northern Gulf of Mexico	Karnauskas, Paris, Zapfe, Gruss, Walter, and Schirripa
SEDAR33-DW19	Both	A meta-data analysis of discard mortality estimates for gag grouper and greater amberjack	Lombardi, Campbell, Sauls, and McCarthy
SEDAR33-DW20	Gag	Gag Life History Working Group Draft Working Document	Gag Life History Working Group
SEDAR33-DW21	GAJ	Greater amberjack (*Seriola dumerili*) otolith ageing summary for Panama City laboratory (2009-2012)	Allman, Trowbridge, and Barnett
SEDAR33-DW22	Gag	Age, length, and growth of gag (*Mycteroperca microlepis*) from the northeastern Gulf of Mexico: 1978-2012	Lombardi, Fitzhugh, and Barnett
SEDAR33-DW23	Gag	Catch and bycatch of gag grouper in the Gulf of Mexico shark and reef fish bottom longline fishery based on observer data	Gulak and Carlson
SEDAR33-DW24	GAJ	Catch and bycatch of greater amberjack in the Gulf of Mexico shark and reef	Gulak and Carlson

		fish bottom longline fishery based on observer data	
SEDAR33-DW25	GAJ	Regional stock structure of greater amberjack in the southeastern United States using otolith shape analysis	Crandall, Parkyn, and Murie
SEDAR33-DW26	Both	Relative abundance of gag grouper and greater amberjack based on observer data collected in the reef fish bottom longline fishery	Carlson, Gulak, Scott-Denton, and Pulver
SEDAR33-DW27	GAJ	Non-lethal sex determination of greater amberjack with direct application to sex ratio analysis of the Gulf of Mexico stock	Smith, Murie, and Parkyn
SEDAR33-DW28	Gag	Gag *Mycteroperca microlepis* Findings from the NMFS Panama City Laboratory Trap & Camera Fishery-Independent Survey – 2004-2012	DeVries, Gardner, Raley, and Ingram

Reference Documents			
SEDAR33-RD01	GAJ	SEDAR 9: Gulf of Mexico Greater Amberjack Stock Assessment Report	SEDAR
SEDAR33-RD02	GAJ	2010 SEDAR 9 Update: Gulf of Mexico Greater Amberjack	SEDAR
SEDAR33-RD03	Gag	SEDAR 10: Gulf of Mexico Gag Stock Assessment Report	SEDAR
SEDAR33-RD04	Gag	2009 SEDAR 10 Update: Gulf of Mexico Gag	SEDAR
SEDAR33-RD05	GAJ	Gulf of Mexico Greater Amberjack Management History	GMFMC
SEDAR33-RD06	Gag	Gulf of Mexico Gag Management History	GMFMC
SEDAR33-RD07	Gag	Status of Gulf of Mexico Gag Grouper: Results and Projected Implications of the Revisions and Sensitivity Runs Suggested by the Grouper Review Panel	SEFSC
SEDAR33-RD08	Gag	Final Model for Gulf of Mexico Gag Grouper as Recommended by the SEDAR Grouper Review Panel: Revised results and projections	SEFSC
SEDAR33-RD09	Gag	Stock Assessment of Gag in the Gulf of Mexico: SEDAR Update Assessment Rerun	SEFSC
SEDAR33-RD10	GAJ	Preliminary Analysis of Tag and Recapture Data of the Greater	McClellan and Cummings

		Amberjack, *Seriola dumerili*, in the Southeastern United States	
SEDAR33-RD11	GAJ	Trends in the Gulf of Mexico Greater Amberjack Fishery through 1998: Commercial Landings, Recreational Catches, Observed Length Frequencies, Estimates of Landed and Discarded Catch at Age, and Selectivity at Age	Cummings and McClellan
SEDAR33-RD12	GAJ	Age, growth, and reproduction of greater amberjack, *Seriola dumerili*, in the southwestern north Atlantic	Harris
SEDAR33-RD13	GAJ	Age, Growth and Sex Maturity of Greater Amberjack (*Seriola dumerili*) in the Gulf of Mexico	Murie and Parkyn
SEDAR33-RD14	Gag	Annual Indices and Trends of Abundance for Gag (*Mycteroperca microlepis*) on the Shallow Continental Shelf in the Northeastern Gulf of Mexico	Lindberg, Christman, Marcinek, and Bohrmann
SEDAR33-RD15	Gag	Stock Identification of Gag, *Mycteroperca microlepis*, Along the Southeast Coast of the United States	Chapman, Sedberry, Koenig, and Eleby
SEDAR33-RD16	Gag	A Tag and Recapture Study of Gag, *Mycteroperca microlepis*, off the Southeastern U.S.	McGovern, Sedberry, Meister, Westendorff, Wyanski, and Harris
SEDAR33-RD17	Gag	Empirical Use of Longevity Data to Estimate Mortality Rates	Hoenig
SEDAR33-RD18	Gag	Discard composition and release fate in the snapper and grouper commercial hook-and-line fishery in North Carolina, USA	Rudershausen, Buckel, and Williams
SEDAR33-RD19	Gag	Modeling Protogynous Hermaphrodite Fishes Workshop	Sheperd, Shertzer, Coakley, and Caldwell
SEDAR33-RD20	GAJ	Field Based Non-Lethal Sex Determination and Effects of Sex Ratio on Population Dynamics of Greater Amberjack, *Seriola dumerili*	Smith

2 Life History

2.1 Overview

The life history workgroup (LHW) reviewed and discussed data collected since the last Gulf of Mexico greater amberjack stock assessment in 2005 and offered recommendations. Updated information was examined on age, growth, reproduction, genetics, mortality and movement. A summary of the data presented, discussed and recommendations made is presented below.

2.1.1 Life History Workgroup Members

Robert Allman-NMFS, Panama City, FL, (leader-greater amberjack)
Beverly Barnett-NMFS, Panama City, FL, (rapporteur)
Gary Fitzhugh-NMFS, Panama City, FL (leader-gag)
Kathy Guindon-FL FWRI, St. Petersburg, FL
Linda Lombardi-NMFS, Panama City, FL
John Mareska-Reef Fish SSC, Dauphin Island, AL
Debra Murie-University of Florida, Gainesville, FL
Chris Stallings-University of South Florida, Tampa, FL

2.1.2 The LHW group addressed the following topics

1. Stock definitions
2. Habitat requirements
3. Natural Mortality
4. Age
5. Growth
6. Reproduction
7. Movement and Migrations
8. Conversion factors

2.2 Stock Definitions

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

Recent studies conducted on otolith shape analysis, tagging, and genetics show evidence for regionalization, particularly off of Louisiana, but there is some mixing still occurring.
Otolith shape analysis revealed no significant difference between the Gulf and Atlantic stocks, but within the Gulf, the Louisiana stock is slightly different from that along the West Florida (WFL) shelf (Crandall et al. 2013 SEDAR33-DW25). Otolith shape analyses from samples collected from the WFL shelf are more similar in structure to South Florida otoliths than they are to those collected off Louisiana (Crandall et al. 2013 SEDAR33-DW25). However, the difference was not great enough to consider greater amberjack off of Louisiana as a sub-stock.

Dart tagging of 1,550 greater amberjack was employed to evaluate seasonal movement patterns and mixing rates, with 198 tags returned from 172 recapture locations, with three fish being caught and reported multiple times (Murie et al. 2013 SEDAR33-DW29). Results found little mixing between the Keys and Gulf of Mexico fish, similar to McClellan and Cummings (1997). Pop-up archival satellite (PSAT) tagging of large, mature fish (3 females and 2 males) off Louisiana during spawning season (March-April 2010) showed the fish stayed in the general vicinity of release locations during the spawning season (Murie et al. 2011 SEDAR33-DW12). This supports the regional differences between Louisiana and the rest of the Gulf as observed in the otolith shape analysis study. In general, there is some regional variation in mixing rates, but most greater amberjacks were recaptured or remained in the same regions where they were initially released.

Although there is evidence for sub-regional structure in the Gulf, there is not enough compelling evidence to change stock structure. Therefore, the life history group recommended keeping the two stocks (Atlantic versus Gulf) as two separate management units without further subdivision within the Gulf stock.

2.2.1 Genetic results

Microsatellite work on 543 samples from four regions (NW-GULF, NE-GULF, FL-W and FL-KEY) was performed to estimate mixing rates of the Gulf of Mexico stock with the Atlantic stock (Murie et al. 2013 SEDAR33-DW12). Results showed a weak genetic differentiation among subregions in the Gulf. A Bayesian implementation of a MIGRATE analysis showed that the model best supported was for two stocks (Atlantic and Gulf) exchanging migrants at an equal (symmetrical) rate; panmixia was not supported (Murie et al. 2013 SEDAR33-DW12).

2.2.2 Recommendations

Use satellite tags to discern annual and seasonal large-scale movement patterns and mixing rates.

Consider larval transport or *Sargassum* transport models as a method to determine mixing rates and source populations.

2.3 Habitat Requirements

Throughout the Gulf of Mexico juvenile greater amberjack are commonly collected in association with pelagic *Sargassum* mats (Bortone et al. 1977). YOY greater amberjack (< 200 mm SL) are most common during May-June in offshore waters of the Gulf (Wells and Rooker 2004a). The sizes of individuals associated with *Sargassum* range from approximately 3-20 mm SL (age range: 40-150 d) (Wells and Rooker 2004b). Individuals larger than 30 mm TL are common in NOAA small pelagic trawl surveys (Ingram 2005 SEDAR9-DW-22), as well as the headboat fishery (Manooch and Potts 1997a), suggesting a shift in habitat (pelagic to demersal) occurs at 5-6 months of age. After shifting to demersal habitats, sub-adults and adults congregate around reefs, rock outcrops, and wrecks. Since greater amberjack are only seasonally abundant in certain parts of their range, they likely utilize a variety of habitats and/or areas each year.

2.4 Natural Mortality

2.4.1 Young-of-the-year

Wells and Rooker (2004b) used catch-curve analysis to estimate mortality for amberjack 40-130 days and reported a Z of 0.0045/d (0.45%/d). The cumulative mortality estimated for a 100 d period (40-139 days) was 36%. They concluded that this estimate provided baseline information on mortality of young-of-the-year (YOY) greater amberjack; however, more detailed studies will be needed to adequately determine mortality rates for YOY. Furthermore, SEDAR 9 DW (SEDAR 9 2006) reported that since mortality during the first year of life is likely to be lower than 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).

2.4.2 Sub-adult/adult

The natural mortality rate reported for greater amberjack from SEDAR 9 was 0.28/d based on a maximum age of 15 years (based on Hoenig's 1983 method). This value was consistent with other Gulf of Mexico studies which reported the same maximum age (Manooch and Potts 1997b; Thompson et al. 1999; Murie and Parkyn 2008). The maximum age (15 yrs.) and therefore the estimate of natural mortality (Hoenig (1983) M = 0.28/d) did not change for SEDAR 33 despite the addition of age observations from more recent years (2009-2012). The SEDAR 9 LHW commented that since M was estimated from an exploited population, the value is likely to be biased high and suggested using an M of 0.25 for baseline evaluations, and recommended a range of M = 0.2 to 0.35 for sensitivity evaluations. The baseline of M= 0.25 was based on a maximum age of 17 yr. old fish from the South Atlantic (Manooch and Potts 1997a). Since the majority of ages for SEDAR 33 were collected from the recreational fishery, it is likely that larger/older individuals were under represented in the dataset. Agreeing that an M of 0.25 was a reasonable midpoint, the LHW suggested a range of M's of 0.15 to 0.35 (see Turner et al. 2000). During previous SEDAR workshops it has been noted that it is unlikely that natural mortality is constant across all sizes and ages and that an age-variable approach should be considered, such as the Lorenzen method (2005; Fig. 1).

The instantaneous total mortality rate (Z) for all observations was 0.75 using a catch curve based on the age distribution of fully recruited fish (ages 3+; Ricker 1975). This rate was near the upper range given by Manooch and Potts (1997b) for the Gulf of Mexico headboat fishery using a catch curve (0.68 to 0.70; sampling years 1988 and 1993 respectively). Manooch and Potts (1997b) commented that Z may have been overestimated since headboat anglers are less experienced and less likely to land large amberjack compared to commercial fishermen. For the U.S. South Atlantic, Manooch and Potts (1997a) estimated Z from the commercial and headboat fishery as 0.61 for ages 8+.

2.4.3 Recommendations

The LHW recommends an M of 0.25 for baseline evaluations and a range of 0.15 to 0.35 for sensitivity evaluations.

Expand sampling in the commercial fishery to try and obtain larger/older individuals since most ages to date are from the recreational fishery.

Use fishery-independent surveys to sample YOY greater amberjack over the entire first year of life.

2.5 Age

Several regional studies have examined the age and growth of greater amberjack (*Seriola dumerili*) off the Southeastern U.S. Burch (1979) used scales to age greater amberjack from the Florida Keys to a maximum of 10 years. Manooch and Potts (1997b) considered scales to be unreliable and used sectioned sagittal otoliths (hereafter otoliths) to age greater amberjack from head boat catches off Alabama and NW Florida obtaining a maximum age of 15 years. Thompson et al. (1999) reported a maximum age of 15 years using otoliths to age amberjack caught off Louisiana. Greater amberjack collected off the U.S. South Atlantic were aged by Manooch and Potts (1997a) from the commercial and head boat fishery and Harris et al. (2007) from the recreational, commercial and fishery-independent surveys with reported maximum ages of 17 and 13 years, respectively. More recently, Murie and Parkyn (2008) aged greater amberjack caught throughout the Gulf of Mexico using otoliths from the commercial and recreational fisheries, as well as fishery independent surveys, and obtained a maximum age of 15 years. Wells and Rooker (2004a) aged young-of-the-year amberjack associated with *Sargassum* in the NW Gulf of Mexico using otolith microstructure obtaining ages ranging from 39-150 days.

A total of 4,151 greater amberjack otolith-based ages collected from 1980 through 2012 were included in SEDAR 33, however, most ages were from collections made during 2007 to 2012 (Fig. 2). These ages include 1,838 ages previously reported in Murie and Parkyn (2008). The majority (71%) of greater amberjack ages were collected from the recreational fishery and of these recreational samples, 62% were collected from the charter boat fishery. The remaining ages were from the commercial fishery (17%), fishery-independent surveys (10%) or unknown (2%) (Table 1). Greater amberjack otoliths were collected from all of the Gulf States, with over half from the West Florida Shelf and more than a third from off Louisiana.

Since the last greater amberjack assessment (SEDAR 9), production ageing programs have been developed by NMFS Panama City Laboratory and the Gulf States Marine Fisheries Commission. Prior to processing and ageing greater amberjack otoliths from these programs, a workshop was conducted by Dr. Debra Murie (University of Florida) at the Panama City Laboratory on August 10-11, 2010, to train the Panama City staff and other gulf state personnel in processing and ageing of greater amberjack otoliths. Ages were assigned by counting opaque zones, including any partially completed opaque zones on the otolith margin, and the degree of marginal zone completion. Ageing protocols were documented in an illustrated otolith ageing manual (Murie and Parkyn 2013a). Each otolith section was assigned one of the following readability codes: good, readable (i.e., fair), difficult, unreadable or poor prep (unreadable due to preparation). Marginal increment analysis indicated that opaque zones in otoliths are laid down primarily in the spring to summer months (Manooch and Potts 1997a, b; Harris et al. 2007; Murie and Parkyn 2008). Therefore, age was advanced by one year if a large translucent zone was visible on the margin and capture date was 1 January to 30 June; after 30 June age was equal to opaque zone count. By this traditional method, an annual age cohort is based on a calendar year rather than time since spawning (Jearld 1983; Vanderkooy and Guindon-Tisdel 2003). Biological (fractional) ages were also estimated for use in fitting growth curves. Biological age accounts for the difference in time between peak spawning (defined as 1 April for greater amberjack) and capture date (difference in days divided by 365). This fraction is added to annual age if capture date is after 1 April and subtracted if capture date is before 1 April (Vanderkooy and Guindon-Tisdel 2003).

To test the repeatability of ageing (i.e., precision), a reference set of 100 otolith sections was assembled by personnel from the University of Florida. Slides for this reference collection were randomly chosen from all available slides at the University of Florida (n=2,014) in the same proportion as ages sampled from the fisheries landings for all gears combined (as per pers. comm., Nancie Cummings, SEFSC). Dr. Debra Murie's ages served as the reference ages, since she was most experienced and had worked with other amberjack ageing experts from the U.S. South Atlantic. Average percent error (APE; Beamish and Fournier 1981) was used to estimate precision between the reference ages and reader ages. Two primary readers read all greater amberjack archived at the Panama City laboratory. Panama City reader 1 and reader 2 APEs compared to the reference age set were 2.6% and 3.1%, respectively. A comparison of the consensus age between the two Panama City readers and the reference ages was 1.6%. The reference set was also read by a gulf state amberjack ager from the Louisiana Department of Wildlife and Fisheries (APE = 1.5%). Generally in a production ageing setting, an APE ≤5% is considered acceptable for moderately long-lived species with relatively difficult to read otoliths (Morison et al. 1998; Campana 2001).

Ages from greater amberjack otoliths ranged from young-of-the-year (< 1 yr) to 15 yrs. The Panama City laboratory rejected 7% of otoliths due to diffuse opaque zones or preparation problems, while the University of Florida rejected <5% and the gulf states did not report their rejection rate. As noted in previous studies, there was large variation is size-at-age for greater amberjack. Of the directed fisheries, the recreational fishery collected the youngest individuals with 86% age 2-4 yrs (mean = 3.5 yrs) (Fig. 3), while the few commercial hand-line and long-line ages were on average older, with mean ages of 4.5 and 5.1 yrs, respectively. Fishery-independent surveys collected the youngest individuals with over half age ≤ 1 year (mean = 1.7 yrs).

2.5.1 Recommendations

Continue annual ageing workshops and reference collection exchanges among laboratories to standardize methods. As a group, decide how to deal with fish that form an opaque zone late in the year (i.e., to count last opaque zone or not).

Due to the difficulty in distinguishing the first annulus from the core region, measurements should be taken on a subset of young-of-the-year to age one greater amberjack otoliths to use as a reference.

Since there is large variation in length-at-age and Murie and Parkyn (2008) found a significant relationship between otolith weight and body weight, examine the relationship between otolith weight and age.

Cross-reference trip tickets and log book data to Biological Sampling Database to complete spatial records (depth, grid, etc.) to allow for increased analysis of spatial demographics.

Expand sampling of commercial and recreational spear landing and long-line landings, as these are under-represented in the dataset.

Expand sampling in the Western Gulf of Mexico, in particular off Texas, as this region is under-represented in the dataset.

A general recommendation of the LHW is to expand design-based fishery-independent sampling to elucidate regional (i.e., eastern and western GOM) and sub-regional differences in the demographics of greater amberjack.

2.6 Growth

Rooker and Wells (2004a) aged young-of-the-year greater amberjack (35-210 mm SL) associated with *Sargassum* in the Gulf of Mexico off Texas. Growth was estimated at 1.65 and 2.00 mm/d for sampling years 2000 and 2001 respectively. The late-season (April) cohort experienced the fastest growth both years.

Estimated von Bertalanffy growth equations have been previously published from the Gulf of Mexico and U.S. South Atlantic (Burch 1979; Thompson et al. 1999; Harris et al. 2007; Murie and Parkyn 2008). For the last benchmark assessment (SEDAR 9) catch-at-length data were converted to catch-at-age data using the growth curve developed by Thompson et al. (1999) for fish collected off Louisiana. Updated age data and resulting von Bertalanffy growth function analyses were reviewed by the LHW. All von Bertalanffy growth models were size-modified for the effects of minimum size limits (Diaz et al. 2004). Growth curves were calculated for all observations and for the recreational fishery and included ages reported in Murie and Parkyn (2008). Too few observations were available for a meaningful analysis from the commercial fishery. Differences in growth and maximum size between sexes have been noted in greater amberjack (Burch 1979; Thompson et al. 1999; Harris et al. 2007; Murie and Parkyn, 2008), therefore separate growth curves were also estimated for males and females.

Updated size-modified growth curves for greater amberjack were within the range of previously published estimates (Fig 4; Table 2). Male and Female growth curves were compared using a likelihood ratio test for coincident curves (Kimura 1980; Haddon 2001) and a significant difference was noted ($p < 0.001$) with female $L\infty$ greater than that of males (1640 mm FL and 1339 mm FL, respectively). Maximum and average size was also greater for females compared to males (maximum size = 1,940 mm and 1,814 mm FL; average size = 867 mm and 847 mm FL, respectively), and females made up a disproportionate number of fish ≥1000 (mm) FL (68%).

2.7 Reproduction

2.7.1 Maturity

Cummings and McClellan (2000) noted that maturation information reported by Burch (1979) for South Florida 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 gonad histology, 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 *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, or 27-29 inches) (Harris et al. 2007). Murie and Parkyn (2008) estimated that 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). Based on Murie and Parkyn (2008) using *macroscopic* analysis, there was a <10% probability that females sexually matured between 1 and 2 years of age.

There was concern that the differences in sexual maturity of greater amberjack in the Atlantic versus the Gulf of Mexico may be due to differences in the methods used to stage gonads. This concern was based on sexual maturity of greater amberjack in the Atlantic being determined using histological analysis of gonads (Harris et al. 2007) whereas Murie and Parkyn (2008) primarily relied on macroscopic examination of gonads and, more recently, histological sections (Murie and Parkyn, unpubl. data). In addition, staging female gonads as immature versus mature (but resting) is complex and there was concern that the staging criteria was being applied differently between the South Atlantic and Gulf of Mexico data.

To resolve these concerns, a small set (n=24) of histological slides of ovaries from greater amberjack in the Gulf of Mexico, specifically of females collected during the spawning season, were exchanged between personnel providing the reproductive staging for the Gulf of Mexico (Debra Murie; Murie and Parkyn 2008) and for the South Atlantic (David Wyanski, South Carolina DNR; Harris et al. 2007). In addition, further discussions by Debra Murie with David Wyanski indicated that sexual maturity of greater amberjack in the South Atlantic was based only on fish for which staging categories of immature and mature were definite (non-ambiguous). The South Atlantic analysis specifically excluded fish that could not definitely be assigned to categories of immature versus mature (but resting). It is well recognized by reproductive biologists that these categories are the most difficult to assign fish into based on either macroscopic or histological observations because of the species-specific suite of reproductive characteristics necessary for definitive staging. Comparative staging of the histological slides by Debra Murie and David Wyanski indicated that there was perfect agreement for 17 females that were categorized as either definitely immature or definitely mature. The remaining 7 slides were from females that could not be positively staged as immature or mature (but resting), indicating that these two staging categories were where disagreements arose. Therefore, to characterize the sexual maturity of greater amberjack in the Gulf of Mexico using an identical methodology as that used in Harris et al. (2007), observations were based on histological sections and only fish that could be scored as definitely immature versus definitely mature were used in the analysis. Additionally, females that were obviously mature during the spawning season because they visibly had large developed eggs or flaccid spawned-out ovaries were also scored as mature because their maturity status was not in question. However, no females were scored as immature without histological analysis.

Characterizing sexual maturity of greater amberjack in the Gulf of Mexico using identical criteria as Harris et al. (2007) indicated that 50% of females attain sexual maturity between 820-830 mm FL (~32-33 inches FL) (Fig. 5). The smallest female that was definitely sexually mature was 717 mm FL and the largest female that was definitely immature was 877 mm FL. Based on these modified criteria, 50% of female greater amberjack in the Gulf of Mexico were determined to be sexually mature by age 3 (Fig. 6). The youngest, definitely mature female was 2 years old and the oldest, definitely immature female was 3 years old.

Based on the modified criteria used to define sexual maturity of greater amberjack in the Gulf of Mexico, which was identical to that used in Harris et al. (2007; D. Wyanski, pers. comm.), females in the Gulf are still characterized as attaining sexual maturity at a larger size and older age than females in the South Atlantic.

2.7.2 Spawning Frequency

Spawning frequency has not been estimated for greater amberjack in the Gulf of Mexico. A reproductive study in the South Atlantic based on greater amberjack spawning offshore of the Florida Keys estimated spawning frequency for that stock (Harris et al. 2007). Spawning frequency was estimated at 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.

2.7.3 Duration and Spatial Differences in Spawning Intensity

Studies in the 1990s on greater amberjack in the Gulf of Mexico estimated the spawning season off Louisiana peaked in April-June based on increased gonad weight (Beasley 1993) and in May and June by Thompson et al. (1991). Wells and Rooker (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. Murie and Parkyn (2008), using fishery-dependent as well as fishery-independent data from the Gulf of Mexico from 1989-2008, found that peak spawning occurred during March and April, and by May there was a marked decrease in female gonadosomatic index. However, Murie and Parkyn (unpubl. data) found one female collected off the Louisiana coast that had oocytes in an advanced stage of vitellogenesis in October. Other reports indicate that 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).

In the South Atlantic, early studies on greater amberjack conducted in south Florida indicated that the maximum gonad development occurred in the spring months (Burch 1979). Sedberry et al. (2006) documented greater amberjack spawning in the South Atlantic on both the middle and outer shelf 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.

Studies conducted in the South Atlantic have consistently estimated that the greater amberjack peak spawning season occurs in April and May, with spawning females collected between January to June (Sedberry et al. 2006; Harris et al. 2007). Studies conducted in the Gulf of Mexico have estimated that peak spawning occurs a month earlier during March and April (Wells and Rooker 2004a; Murie and Parkyn 2008), with some indication that it can occur as late as April-June (Beasley 1993; Thompson et al. 1991).

2.7.4 Batch 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). 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).

2.7.5 Sex Ratio

Overall sex ratio estimates for greater amberjack in the Gulf of Mexico indicated that it was near 1:1 (based on non-lethal field sexing) or had a moderate female skew (Murie and Parkyn 2008 data set) (Smith et al. 2013, SEDAR33-DW26). The overall sex ratios ranged from 1:1 to 0.5:1, with estimates varying between 0.4:1 and 1.1:1 depending on sampling regime and sampling location. Yearly sex ratio estimates from 2002–2008 from the Murie and Parkyn (2008) dataset had a mean value of 0.55:1 (M:F) but showed variation in the degree of female-skewing over the years. Beasley (1993) and Thompson et al. (1999, which include Beasley’s data) have previously reported an overall moderately female-skewed sex ratio for greater amberjack off Louisiana.

Sex ratio estimates for fish greater than 1 m FL were female skewed for the non-lethal sexing of fish in the Gulf of Mexico, as well as in the dataset of Murie and Parkyn (2008) for the Gulf of Mexico (Smith et al. 2013, SEDAR33-DW26). Previous sex ratios estimated for fish larger than 1 m FL have also shown female skewing, both in the Gulf of Mexico (Beasley 1993; Thompson et al. 1999) and the US South Atlantic (Harris et al. 2007; Smith 2011). Overall, the average male to female sex ratio for fish greater than 1 m FL in the Gulf of Mexico was 0.43 +/-0.02 (%SE).

2.7.6 Recommendations

There is a lack of information on spawning frequency and fecundity with size and age for greater amberjack in the Gulf of Mexico. Given the observed differences in sexual maturity, peak spawning season, and potential growth differences between the South Atlantic and Gulf of Mexico stocks of greater amberjack, it should be a research priority to obtain information on spawning frequency and fecundity with size and age for Gulf of Mexico greater amberjack.

Given that sex ratios are skewed to females for fish > 1 m fork length (Smith et al. 2013 SEDAR33-DW27), if release mortality is low (Murie and Parkyn 2013b SEDAR33-DW29), then a slot size limit could be explored as a means of rebuilding female SSB.

2.8 Movement and Migration

2.8.1 Transformation

Young-of-the-year (YOY) Gulf greater amberjack are often found in association with pelagic *Sargassum* mats throughout the Gulf (Wells and Rooker 2004, Bortone et al. 1977). While associated with pelagic *Sargassum* in the northwestern Gulf, YOY amberjack range in size from approximately 3-210 mm SL (age range: 39-150 d) (Wells and Rooker 2004), with growth ranging 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, as well as growth being significantly greater for those YOY amberjack collected in the offshore zone (15-70 nm offshore) (Wells and Rooker 2004).

2.8.2 Post settlement

YOY greater amberjack (< 200 mm SL) are most common during May-June in offshore waters of the northwestern Gulf (Wells and Rooker 2004). Individuals <250 mm fork length are more common in the summer survey of the SEAMAP Groundfish Survey whereas fish >250 are more common in the fall survey (Pollack and Ingram 2103; SEDAR33-DW01). Greater amberjack mostly between 200-400 mm total length are caught in the NOAA small pelagic trawl survey (Pollack and Ingram 2013; SEDAR33-DW01) and when >480 mm total length show up in the headboat fishery (Manooch and Potts 1997). This implies that greater amberjack >400 mm TL start to associate with structure.

2.8.3 Age-2 and older

Sub-adult and adult greater amberjack congregate around submerged oil rigs, reefs, rocky outcrops, offshore springs, 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.

Analysis of tag and recapture data of greater amberjack suggests little exchange (0.94%-1.5%) between the Atlantic and Gulf Greater amberjack populations (McClellan and Cummings 1997; Murie et al. 2011, SEDAR33-DW12). Recaptures observed 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.

More recently, Murie et al. (2011, SEDAR33-DW12) analyzed recapture data of greater amberjack tagged from coastal waters of west Florida through to Louisiana and observed that recaptured amberjack had travelled an average distance from their tagging site of 69.54 ± 188.96 km. However, the median distance of recaptures was only 8.0 km, indicating most fish were caught near where they were tagged. The maximum observed distance traversed (straight-line track) was by an amberjack tagged in Apalachicola, FL, and recaptured near Tampico, Mexico (1501 km), as well as another amberjack tagged off the west coast of Florida and recaptured later in Jamaica (1231 km) (Murie et al. 2013, SEDAR33-DW12).

2.8.4 Recommendations

More tagging information is necessary to understand seasonal movements of greater amberjack in the Gulf of Mexico (see Stock ID section). Satellite tags may provide better habitat and seasonal information compared to conventional dart tags that cannot provide serial location information on the fish throughout the year.

2.9 **Conversion factors**

SEDAR 9 provided length and weight relationships in English units using data from the NMFS Trip Interview Program (TIP) and from the Gulf States Marine Fisheries Commission Fisheries Information Network (FIN) data base. For SEDAR 33 meristic relationships were updated using datasets from NMFS Panama City, Gulf States Marine Fisheries Commission, Florida Fish and Wildlife Research Institute and the University of Florida. These data were collected from 1980 to 2012 and obtained from the commercial and recreational fisheries and fishery-independent surveys.

2.9.1 Length conversion

Since SEDAR 9 it has been noted that total length (TL) is measured differently depending on the sampling program. Usually either a maximum total length (Max TL; pinching the caudal fin to maximum length; Kahn et al. 2004) or natural total length (Nat TL; tail laid flat) was recorded. For greater amberjack fork length (FL) was selected as the standard length measure because the size limits in the fisheries are by fork length. Conversions were calculated for Max TL, Nat TL and all TL to FL. To be consistent with SEDAR 9, conversions from FL to TL, Max TL and Nat TL were calculated in metric and English units (Table 3).

2.9.2 Length to weight conversions

FL was converted to whole weight (WW) using English and metric units (Fig. 7; Table 3). Few gutted weights (GW) were available in the updated datasets, therefore the SEDAR 9 DW conversion from FL to GW is repeated here: GW (lbs) = $7.0 \times 10^{-4} * (FL\ (in)^{2.8948})$.

2.9.3 Recommendations

Request that all sampling programs use FL as the standard measurement for greater amberjack.

To increase the sample size for weight conversions the LHW recommends that both WW and GW be taken over a range of greater amberjack sizes.

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2.13 Tables

Table 1. Number of Gulf of Mexico greater amberjack ages by state and sector.

STATE	COMMERCIAL	RECREATIONAL	FISHERY-INDEPENDENT	UNKNOWN	TOTAL
Alabama		353	8		**361**
Florida	146	1,597	382	89	**2,214**
Mississippi	2	7	2		**11**
Louisiana	554	906	13	5	**1,478**
Texas		77	10		**87**
TOTAL	**702**	**2,940**	**415**	**94**	**4,151**

Table 2. Estimated von Bertalanffy growth parameters for greater amberjack. (Note: *SEDAR 33 includes ages reported in Murie and Parkyn 2008).

Stock	Model	Location	$L\infty$ (mm)	k	t_0
South Atlantic					
	Burch (1979)	South FL	1643	0.174	-0.653
	Manooch and Potts (1997a)	SE Atlantic	1514	0.119	-1.23
	Harris et al. (2007)	SE Atlantic	1242	0.28	-1.56
Gulf of Mexico					
	Manooch and Potts (1997b)	Gulf of Mexico	1109	0.227	-0.791
	Thompson et al. (1999)	Louisiana	1389	0.25	-0.79
	Murie and Parkyn (2008): All	Gulf of Mexico	1240	0.28	-1.01
	Murie and Parkyn (2008): Females	Gulf of Mexico	1280	0.26	-1.12
	Murie and Parkyn (2008): Males	Gulf of Mexico	1197	0.29	-0.92
	SEDAR 33 All observations*	Gulf of Mexico	1436	0.175	-0.954
	SEDAR 33 Recreational*	Gulf of Mexico	1458	0.207	0
	SEDAR 33 Females*	Gulf of Mexico	1640	0.138	-1.347
	SEDAR 33 Males*	Gulf of Mexico	1339	0.196	-0.95

Table 3. SEDAR33 meristic regressions for greater amberjack from the Gulf of Mexico (1991-2012), RSE – residual standard error, r^2 is not part of the output for R non-linear regressions

Conversion and units	Equation	Sample Size	r^2 values/RSE	Data Ranges
FL (mm) to TL (mm)	TL = 36.113 + FL * 1.085	1,564	0.9894	FL (mm): 74 – 1474
TL (mm) to FL (mm)	FL = -24.703 +TL * 0.912			TL (mm): 82 – 1605
FL (mm) to Natural TL (mm)	Natural TL = 38.9876 + FL * 1.0780	1,054	0.9771	FL (mm): 258 – 1474
Natural TL (mm) to FL (mm)	FL = -16.148 + Natural TL * 0.9063			Natural TL (mm): 294 – 1596
FL (mm) to Maximum TL (mm)	Maximum TL = 20.5556 + FL * 1.1183	495	0.9948	FL (mm): 74 – 1420
Maximum TL (mm) to FL (mm)	FL = -14.984 + Maximum TL*0.8896			Maximum TL (mm): 82 – 1605
FL (mm) to WW (kg)	WW = 1.640 x 10^{-07} * (FL^2.633)	1,865	1.019 (RSE)	FL (mm): 74 – 1829
FL (cm) to WW (kg)	WW = 7.046 x 10^{-05}* (FL^2.633)			WW (kg):0.01 – 58.06
FL (in) to TL (in)	TL = 1.4218 + FL * 1.0848	1,564	0.9894	FL (in): 3 – 58
TL (in) to FL (in)	FL = -0.9726 +TL * 0.912			TL (in): 3 – 63
FL (in) to Natural TL (in)	Natural TL = 1.5349 + FL * 1.0780	1,054	0.9771	FL (in): 10 – 58
Natural TL (in) to FL (in)	FL = -0.6357 + Natural TL * 0.9063			Natural TL (in): 11 – 63
FL (in) to Maximum TL (in)	Maximum TL = 0.8093 + FL * 1.1183	495	0.9948	FL (in): 3 – 56
Maximum TL (in) to FL (in)	FL = -0.5899 + Maximum TL *0.8896			Maximum TL (in): 3 – 63
FL (in) to WW (lbs.)	W. Wt = 1.808 x 10^{-03} * (FL^2.633)	1,865	2.247 (RSE)	FL (in): 7 – 72 WW (lbs.): 0.02 – 128

2.14 Figures

Figure 1. Lorenzen (2005) M projections based upon inputs of fixed values of Hoenig (1983) for Gulf of Mexico greater amberjack.

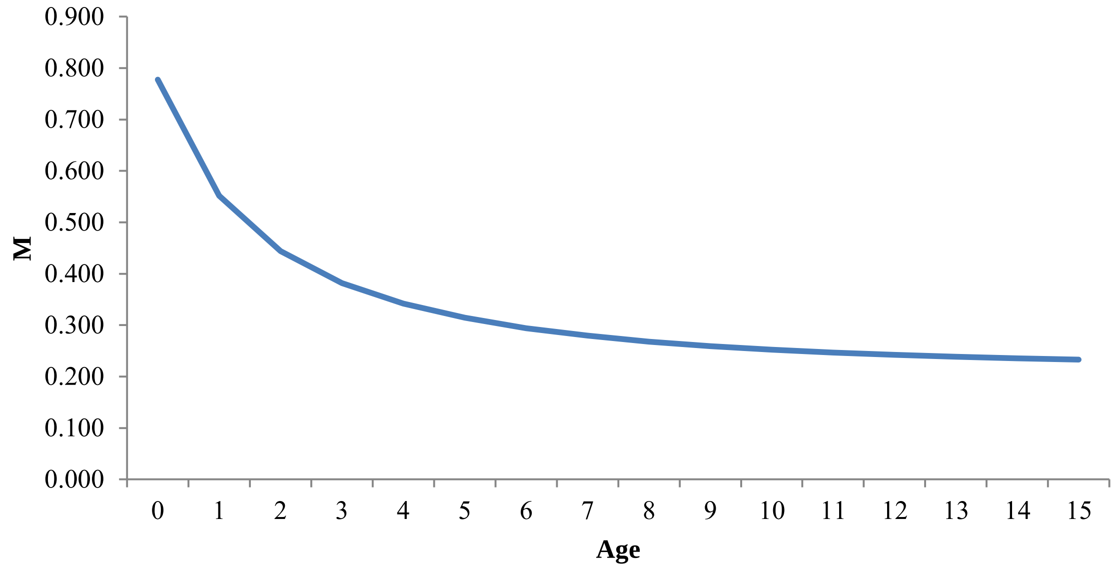


Figure 2. Number of Gulf of Mexico greater amberjack ages by sampling year.

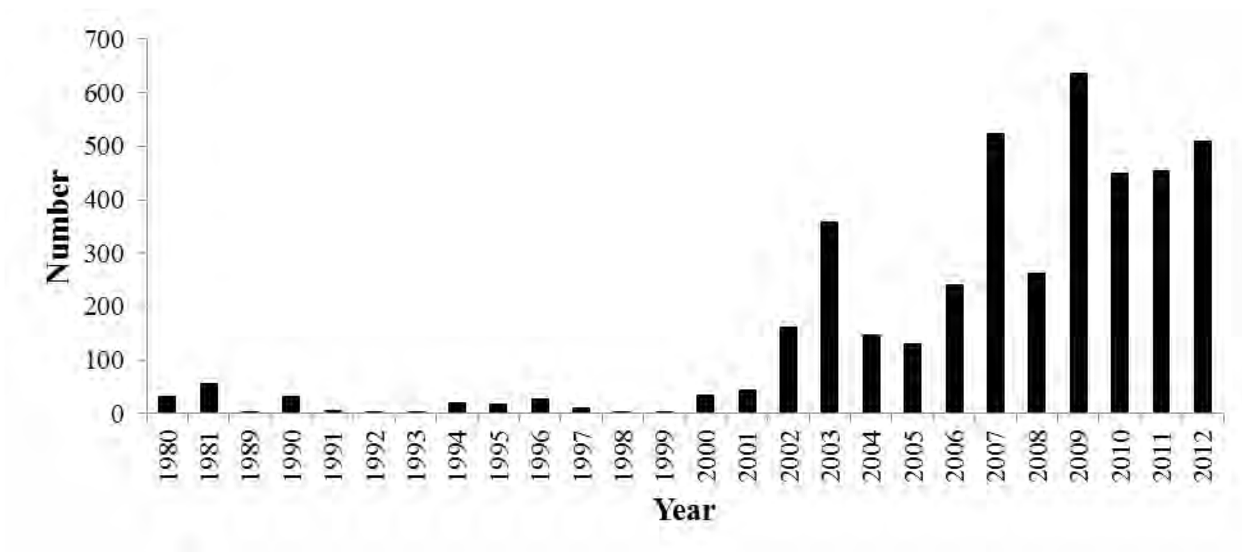


Figure 3. Number of Gulf of Mexico greater amberjack by age class (a. recreational, (b. commercial and (c. fishery-independent survey. Commercial observations include only those with a recorded gear type.

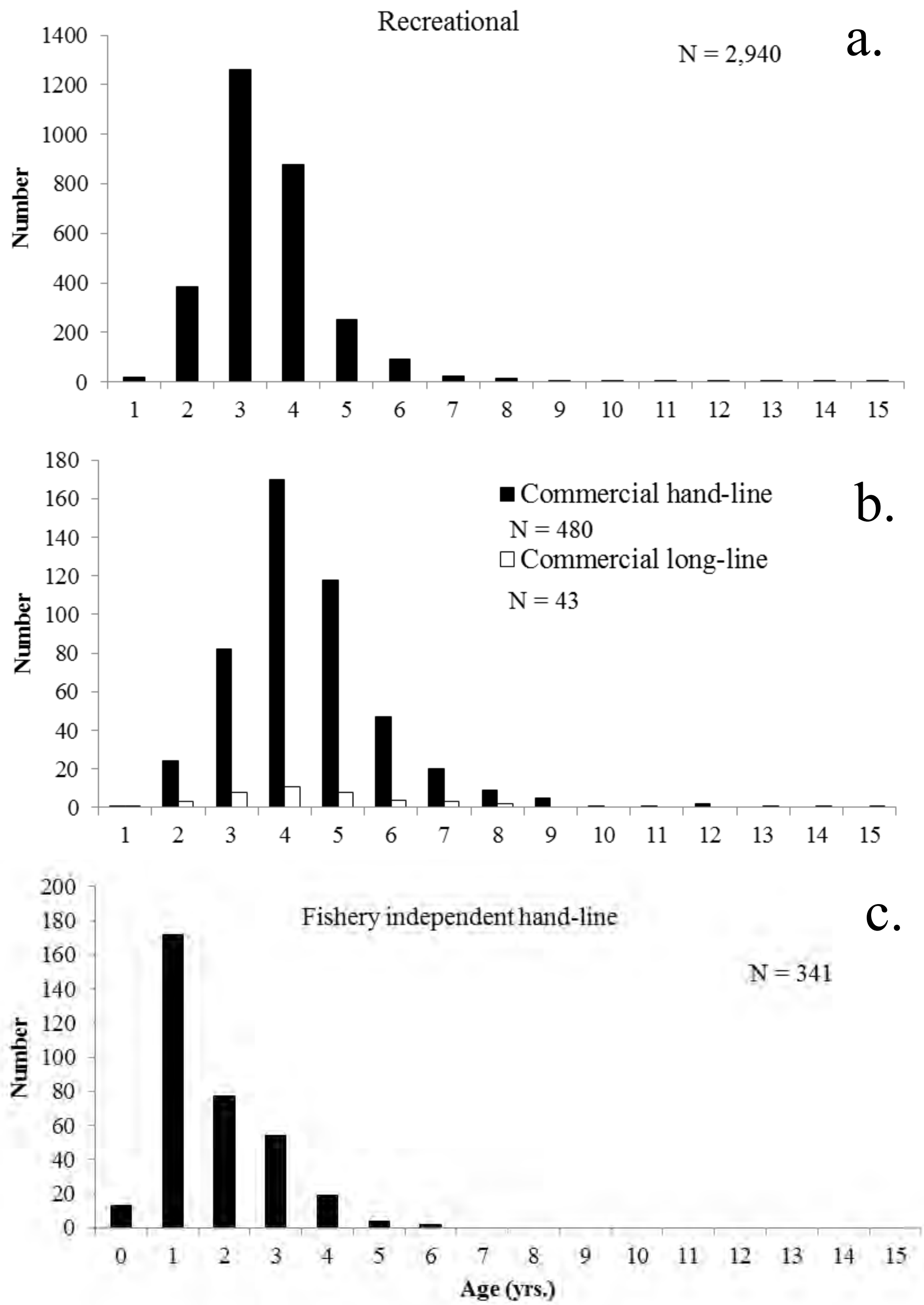


Figure 4. Size modified von Bertalanffy growth curves for greater amberjack (a.) from the Gulf of Mexico collected in 1980-2012 for biological ages 0-15 years (observed mean size-at-age (black circles) ± standard deviations and estimated size-at-age (red line) from size-modified von Bertalanffy growth model) and (b.) a comparison of published growth curves for greater amberjack from the Gulf of Mexico (GOM), Louisiana (LA) and south Atlantic (SA).

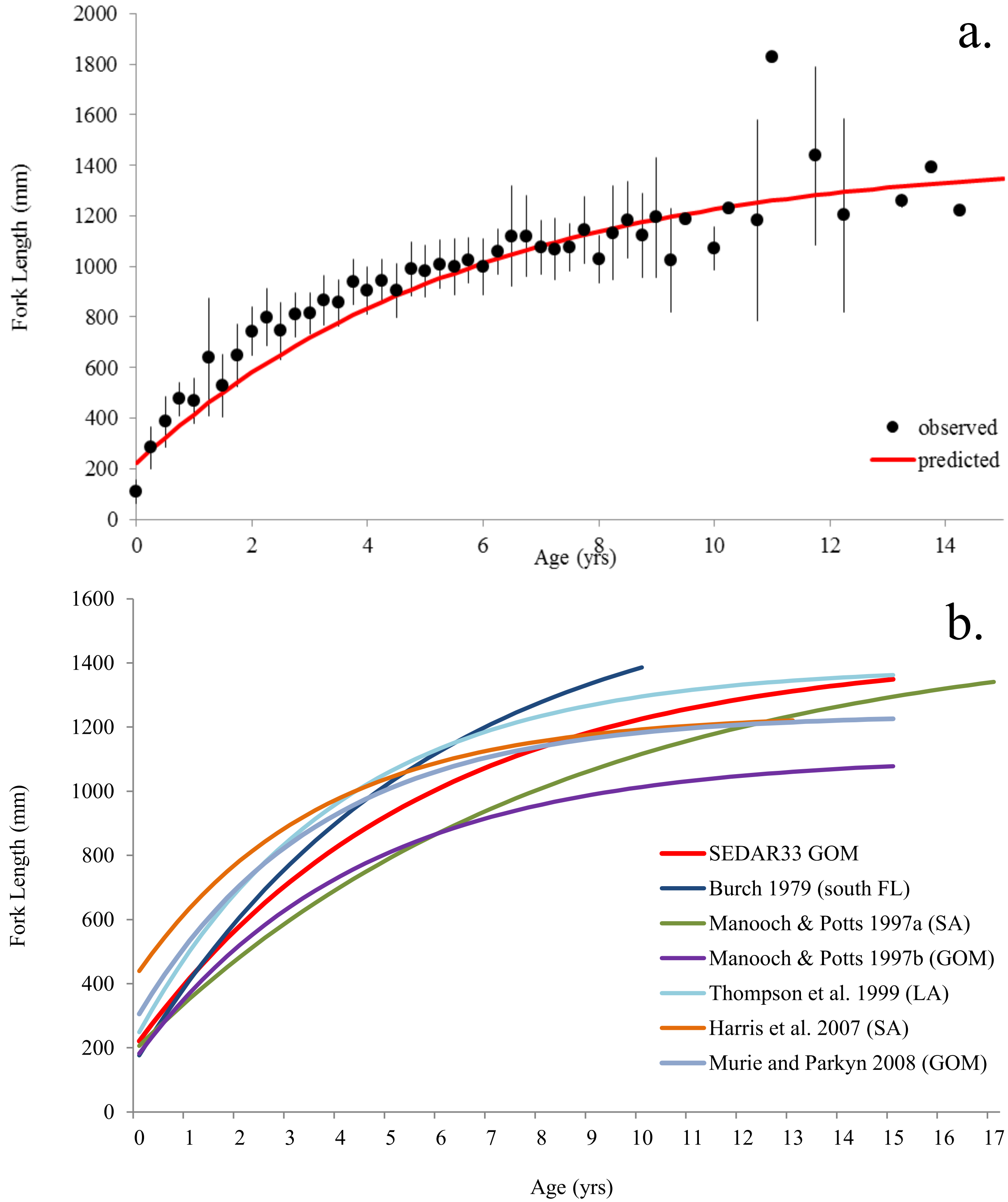


Figure 5. Proportion of mature female greater amberjack in the Gulf of Mexico by size, based on staging criteria used in Harris et al. (2007) for greater amberjack in the South Atlantic.

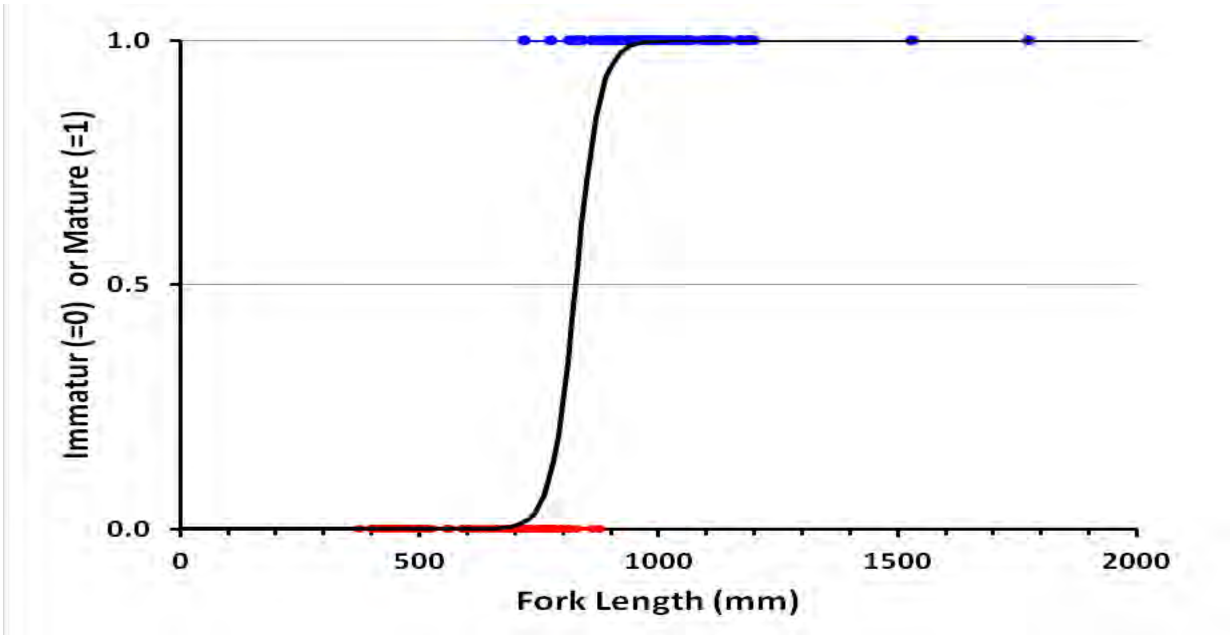


Figure 6. Proportion of mature female greater amberjack in the Gulf of Mexico by age, based on staging criteria used in Harris et al. (2007) for greater amberjack in the South Atlantic.

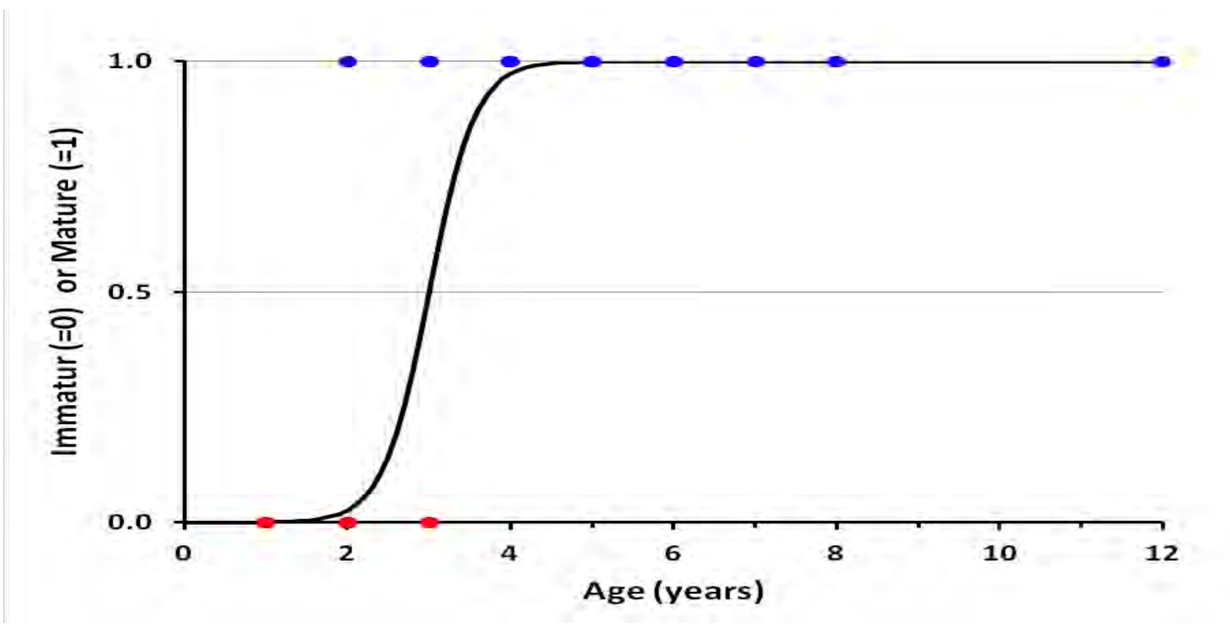
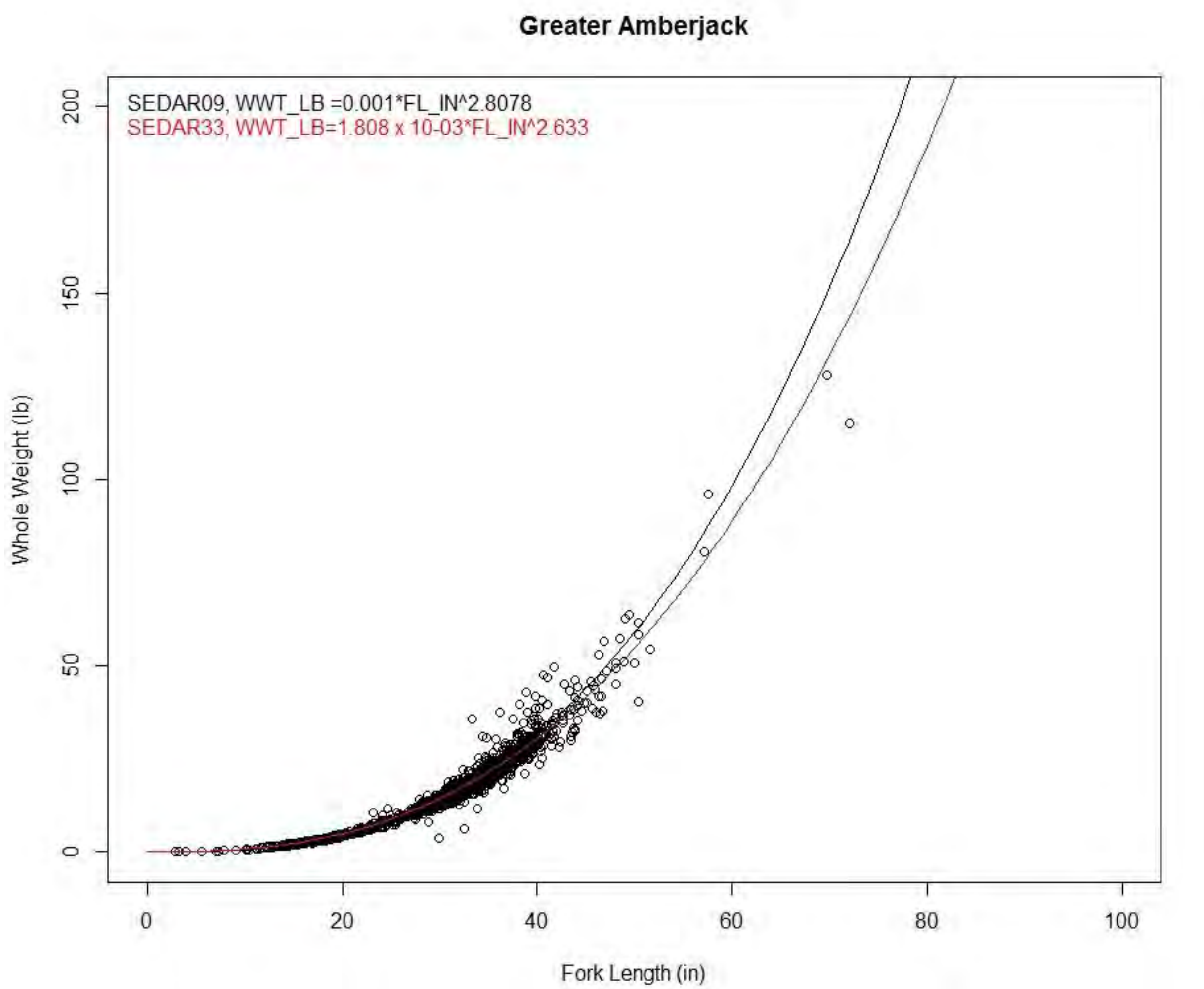


Figure 7. SEDAR 33 observed whole weight (lbs) on fork length (in) with fitted line from SEDAR 9 (black line) and SEDAR 33 (red line).



3 Commercial Fishery Statistics

3.1 Overview

Commercial landings of greater amberjack for the U.S. Gulf of Mexico were constructed using primarily data housed in the NOAA's Southeast Fisheries Science Center's Accumulated Landings System (ALS) from 1963 through 2012. Landings reported to Louisiana and Alabama, for 2000 and 2002 through 2012 respectively, were obtained from each of the states' trip ticket collections kept at the GulfFIN data warehouse. In constructing the 1963-2012 time series, port of landing was used to assign water body when water body was not present. For missing or unclassified gears, proportions from the Coastal Fisheries Logbook Program (CFLP) were used when available. Florida General Canvass gear proportions were applied to Florida landings. A greater amberjack to other identified amberjack species (*Seriola sp.*) proportion were applied to unclassified amberjack landings by species.

Discards were calculated for the directed fishery using CFLP discard logbook data, as well as from the reef fish observer program.

Commercial landings lengths were provided by year, and gear (handline, longline, and other). Commercial discard lengths from observer data were provide for 2006-2012. Commercial landings ages were provided by year and gear.

3.1.1 Participants in SEDAR 33 Data Workshop Commercial Workgroup

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Jason Delacruz, Commercial Fisherman
David Gloeckner, NMFS Miami (rapporteur)
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3.1.2 Issues Discussed at the Data Workshop

Commercial landings issues the workgroup addressed included historical landings, boundaries, gears, and the apportioning of greater amberjack from unclassified amberjack. For greater amberjack discards the workgroup discussed the disparity in estimates constructed from self-reported logbook and directed fishery observer data. Size composition discussions included the representativeness of lengths sampled dockside sampling, as well as from otoliths obtained from dockside samples.

3.2 Review of Working Papers

The workgroup considered data and analyses presented from the following workshop working paper.

3.3 Commercial Landings

Most of the commercial landings were compiled from the ALS from 1963-2012. Greater amberjack landings are provided in by year and gear (handline, longline, and other). There are several situations where the landings data may not have the desired level of resolution. The following issues were identified:

1. Only annual data are available for 1962 – 1977
2. In 1963 some landings are only reported as water body code 5000 (Gulf of Mexico).
3. For Florida, gear and fishing area are not available for monthly data for 1977 - 1984
4. For Louisiana, gear and fishing area are not available for 1990 - 1999
5. For Texas, gear and fishing area are not available for 1990 - 2011.

There is a lack of resolution for the 1963 - 1977 period, however there was no need to distribute the annual percentages by gear and fishing area by month for this time period.

For the landings on the west coast of Florida during the period 1977 - 1996, data on the allocation of landings gear and fishing area are available from the Florida general canvass data which has annual landings data by gear and water body from 1976 to 1996. Proportions from the annual general canvass were applied to the monthly ALS data to provide the desired resolution for the landings time series. The annual Florida general canvass landings data were used from 1977 – 1989 to allocate gear and statistical area to the landings.

To supply gears and areas for the Louisiana data, CFLP data were used to apportion landings accordingly.

Landings in Texas from 1978 to 1983 were classified as gear code ‘0’ or ‘215’ (unclassified gear or shrimp trawl). No vertical (hand or electric) or longline gear was present for TX landings. To account for the missing gears, apportioning of Texas landings by gear for 1978 through 1984 was performed by using proportions.

To supply gears and areas for the Texas landings beginning in 1990, CFLP data were used to apportion landings accordingly.

In summary, for landings 1990 and later the gear allocations available in the general canvass (trip ticket) data were retained and the gear allocations from the CFLP were used for Louisiana (1990 - 1999, the Louisiana trip ticket data without gear designations for 2000 - 2003) and for Texas landings.

Further details regarding the data in ALS and General Canvass can be found Appendix A.

Louisiana landings from 2000-2012, and Alabama landings from 2002-2012, were obtained from GulfFIN and subsequently replaced those found in ALS. Since ALS contains monthly summaries of state trip ticket data, the workgroup felt the use of a state's raw trip ticket data would likely produce more accurate landings.

Decision 1: It was the workgroup's recommendation to use state trip ticket data where available. This includes Louisiana's 2000-2012 and Alabama's 2002-2012 trip ticket data.

3.3.1 Boundaries

Gulf of Mexico landings are spatially distributed using the statistical areas 1 to 21, reaching from statistical area 1 in the Florida Keys to statistical area 21 bordering Mexico, see Figure 3.1.

The CFLP landings are reported by statistical area 1-21. ALS landings are reported by water body. When available, water body code is converted to statistical areas using the first two digits of the water body codes. When ALS water body is not available, county of landing is used to assign the nearest statistical area.

The Gulf of Mexico and South Atlantic stock boundary lays in areas 1 and 2. The Gulf of Mexico landings from areas 1 and 2 are taken from water bodies north of highway U.S. 1 in the Florida Keys and north of the boundary line that extends from Key West to the Dry Tortugas. Waters west of the Dry Tortugas are considered to be the Gulf of Mexico (Figure 3.2).

> **Decision 2:** The workgroup's recommendation was to maintain the region boundaries as defined by the Gulf of Mexico Council boundaries between statistical grid areas 1 and 21.

3.3.2 Gears

The workgroup investigated reported gears landing greater amberjack from various data sources (ALS, CFLP, and GulfFIN) and determined the predominate gears to be handline and longline. It was the workgroup's recommendation to then categorize landings into three gear groups: handline, longline, and other. A list of gears included in the handline and longline categories can be found in Table 3.1.

> **Decision 3:** The workgroup suggested three gear groupings to characterize the greater amberjack fishery (handlines, longlines, and other). Handlines include hook and line, electric/hydraulic bandit reels, and trolling.

3.3.3 Unclassified Amberjack

Prior to 1992 all greater amberjack landings were reported as unclassified amberjack (*Seriola sp.*, NMFS code '0030'). In 1992 amberjack began to be reported to species and the relative amount of landings reported as unclassified amberjack decreased. As defined by the genus *Seriola*, species possibly reported as unclassified amberjack include greater amberjack, lesser amberjack, almaco jack and banded rudderfish. Discussions with port agents and industry representatives corroborated this list of possible species. To apportion the unclassified amberjack to greater amberjack, a proportion of greater amberjack to other identified amberjack was recommended by the workgroup to be calculated by state using ALS data from 1992-2012. Open and closed season of greater amberjack were also taken into account. Resulting proportions (Table 3.2) were applied to unclassified amberjack species by state and season.

> **Decision 4:** The workgroup recommended applying greater amberjack proportions to the unclassified amberjack using 1992-2012 ALS data.

Also discussed was the possible apportioning of unclassified jacks (Carangidae sp. NMFS code ‘1799’). After discussion with port agents and industry representatives it was felt that there should be no apportioning of unclassified jacks to greater amberjack. All parties felt the unclassified jacks would only include smaller jack species in the genus *Caranx* or *Selene*, such as blue runner, jack crevalle, lookdowns, etc.

> **Decision 5:** The workgroup recommended not apportioning unclassified jack landings to greater amberjack.

Final calculated greater amberjack landings can be found in Table 3.3 and Figure 3.3.

3.4 Discards and Bycatch

Commercial Discards Preliminary Analyses

Commercial discards were separately calculated using discard rates as reported by fishers and rates reported by fisheries observers. The discard rates were multiplied by year-specific total effort as reported to the coastal logbook program to estimate total discards. Analytical methods used are briefly described here.

Fisher reported data

Fisher reported data were used for the calculation of greater amberjack discards. Available fisher reported data included discard information for the period January 1, 2002 to December 31, 2012 from fishing trips in the Gulf of Mexico. Those data included reports from vertical line (handline and electric reel) vessels. The available data for other gears had been judged during prior assessments as insufficient for discards to be calculated.

Available data were filtered to remove records with logical inconsistencies (e.g., reported fishing more than 24 hours), and records missing effort (missing number of lines fished, hooks per line, or hours fished). Data reported from trips with discards or fishing effort in both the Gulf of Mexico and South Atlantic were excluded from the analyses because discard rates and fishing effort cannot be reliably apportioned within single trips. Coastal logbook data (used to calculate total effort) were additionally filtered to remove likely data outliers. Those data that exceeded the 99.9 percentile of the population for any variable used to calculate effort (e.g., number of lines, hooks per line) were excluded. Finally, only those trips with reported landings of species in the reef fish fishery management plan were retained.

An additional data filter was used because commercial discards may be under reported. A 20 percent sample of fishers was required to report to the discard logbook program in order to renew their federal fishing permits. Fishers remain in reporting compliance by returning completed discard logbooks or returning discard logbooks with reports of “no discards”. The percentage of discard reports from vertical line vessels returned with “no discards” has increased from 42 to 73 percent in southern Florida (McCarthy, 2011). Commercial vertical line trips in southern Florida that had fishery observers onboard, however, report only 10 percent of trips had no discards. To reduce the likelihood of using discard rates that were erroneously low, the data set was filtered to remove records of “no discards” reported.

Two separate analyses were used to estimate yearly discards of greater amberjack using fisher reported discard data. One method followed the methods used in the 2010 assessment update (continuity method). Data were stratified by year and the reported number of hooks per line fished (1-2 hooks/line, 3-9, and more than 9 hooks). Discard rates were defined as discards per trip. Nominal discard rates were calculated for each stratum. Total effort (vertical line trips) was calculated from the coastal logbook data set for each stratum. Discards for each stratum were then calculated as: stratum mean discard rate*stratum total effort. Yearly discards were calculated as the sum of discards across all strata within a year.

A second method for calculating discards used a modeling approach similar to those used to construct indices of abundance. Seven factors were examined using generalized linear models (GLM) to determine which of those factors had a significant influence on the discard rate of greater amberjack (see table below).

Factor	**Levels**	**Value**
Year	11	2002-2012
AJ season	2	Open, closed
Subregion	6	Statistical areas 1-5, 6, 7, 8, 9-12, 13-21
Days at sea	2	1, 2+ days
Crew	3	1, 2, 3+ crew members
Hooks hours fished[1]	4	1-40, 41-160, 161-960, and >960 hook hours
Month	12	Jan-Dec

[1] Hook hours fished included in the proportion positive (binomial) analysis only

The delta lognormal model approach (Lo et al. 1992) was used to calculate yearly standardized discard rates. This method combines separate general linear model (GLM) analyses of the proportion of trips that discarded greater amberjack and the discard rates on trips reporting greater amberjack discards to construct a single standardized discard rate. Parameterization of each model was accomplished using a GLM analysis (GENMOD; Version 8.02 of the SAS System for Windows © 2000. SAS Institute Inc., Cary, NC, USA).

For each GLM analysis of proportion trips with discards, a type-3 model was fit, a binomial error distribution was assumed, and the logit link was selected. The response variable was proportion of discard trips. During the analysis of discard rates on trips with greater amberjack discards, a type-3 model assuming lognormal error distribution was examined. The linking function selected was "normal", and the response variable was log(discard rate) where log(discard rate)=ln(number of greater amberjack/hook hours fished). All 2-way interactions among significant main effects were examined. Higher order interaction terms were not examined.

A forward stepwise regression procedure was used to determine the set of fixed factors and interaction terms that explained a significant portion of the observed variability. Each potential factor was added to the null model sequentially and the resulting reduction in deviance per degree of freedom was examined. The factor that caused the greatest reduction in deviance per degree of freedom was added to the base model if the factor was significant based upon a Chi-Square test ($p<0.05$), and the reduction in deviance per degree of freedom was ≥1%. This model then became the base model, and the process was repeated, adding factors and interactions individually until no factor or interaction met the criteria for incorporation into the final model.

Once a set of fixed factors was identified, the influence of the YEAR*FACTOR interactions were examined. YEAR*FACTOR interaction terms were included in the model as random effects. Selection of the final mixed model was based on the Akaike's Information Criterion (AIC), Schwarz's Bayesian Criterion (BIC), and a chi-square test of the difference between the –2 log likelihood statistics between successive model formulations (Littell et al. 1996).

The final delta-lognormal models were fit using a SAS macro, GLIMMIX (Russ Wolfinger, SAS Institute). Yearly discards were calculated as: yearly standardized discard rate*yearly total effort. Yearly effort was taken from commercial fisher reports to the coastal logbook program. For both the methods described above, discards for the years prior to 2002 (years prior to the collection of discard rate data) were calculated using the mean discard rates calculated for the years 2002-2009 for each stratum (continuity method) or for the years 2002-2007 (delta-lognormal method) applied to the yearly effort reported during the years 1990-2001. The range of years included when calculating the mean discard rate differed between the two methods because the continuity method followed the methods of the 2010 update assessment. For the delta-lognormal method, mean discard rates were calculated over the period 2002-2007 because there were consistent open seasons and size limits across those years. In addition, much more restrictive greater amberjack commercial quotas began in 2008. That change in regulations may have resulted in changes in discard rates in the commercial fishery.

During the years 1990-1992 in Florida, only 20% of commercial fishing vessels were selected to report fishing effort to the coastal logbook program. The fishing effort reported by Florida vessels was expanded by a factor of five to calculate discards for the years 1990-1992. All other states reported total fishing effort in federal waters, therefore, no adjustment of reported effort was needed for discard calculation.

Observer data

The SEFSC began an observer program for commercial vertical line (handline and bandit rig) and bottom longline reef fish trips in July 2006. The number of observed trips was much lower than the number of trips reported to the discard logbook program. Observer data reported from vertical line vessels were used to calculate nominal discard rates. Nominal rates were used due to the limited sample size of the data set.

Two methods were used for the calculation of greater amberjack discards. Observers report catch, discards, and effort for each observed reel. Discard rate, therefore, may be calculated for each reel, set (defined as fishing in a specific area, regardless of the number of times hooks are dropped), and trip. The first method used reel-specific discard rates and the second used trip-specific discard rates. For both methods, discard rates were determined for vertical line vessels during open and closed greater amberjack seasons using each complete year of available observer data (2007-2012). As with the fisher reported data, discards were calculated as: stratum-specific discard rate*stratum-specific effort (as reported to the coastal logbook program). Yearly discards were calculated as the sum of all strata within a year. The mean discard rate within a season (open or closed) across all years of observer data (2007-2012) was used to calculate discards during the years 1990-2001.

Calculated discards for both methods are provided in Table 3.4. Discards calculated using observer reported discard rates an order of magnitude higher than those calculated using fisher reported data.

Data workshop recommendations

Examine Individual Fishing Quota (IFQ) effects on discard rates of greater amberjack

This issue affects the calculation of discards prior to 2007 when using observer data. Other than the first six months of the observer program, all observer data was collected when some species were managed using IFQs. Fishers report that IFQs have resulted in fundamental changes in commercial fisher behavior that may affect catch and discard rates of other species in addition to the species directly regulated through IFQs. A thorough examination of this issue will likely require months of analyses and only preliminary work has been completed. SEFSC personnel will be investigating this issue during the remainder of the year.

Use the ratio of fisher reported to observer reported discard rates to adjust fisher reported rates

This recommendation acknowledges that fisher reported discard rates are often much lower than those reported by observers. It was recommended that the pre-IFQ (2002-2006) fisher reported rates, as adjusted, be used to calculate discards for the years 1990-2002. Adjusted fisher reported rates are also recommended for calculating discards during 2007-2012. Use of fisher reported rates is recommended due to small sample size of the observer data where some strata (season, region, year) are unpopulated.

3.5 Commercial Effort

The distribution of directed commercial effort in trips by year was compiled from the Coastal Fisheries Logbook Program (CFLP) for 1993-2012 and supplied here for information purposes. These data are presented in Figure 3.4. The distribution of harvest, as reported to the CFLP, is also displayed in Figure 3.5.

3.6 Biological Sampling

Biological sample data were obtained from the TIP sample data at NMFS/SEFSC and from the reef fish observer program SEFSC's Galveston laboratory. Data were filtered to eliminate those records that included a size or effort bias, non-random collection of length data, were not from commercial trips, fish were selected by quota sampling, or the data was not collected shore-side. These data were further limited to those that could be assigned a year, gear, and state. Data that had an unknown sampling year, gear, or sampling state were deleted from the file.

3.6.1 TIP Samples

Commercial length samples are available for all gear groups between 1983 and 2012. The number of fish sampled for length had a high of 965 for handline gear in 1994 to zero for a number of years for other gear (Table 3.5). The number of lengths sampled was consistently greater than 100 for handline gear with the exception of seven years. The number of lengths from the longline fishery were considerably lower than those available for handline. For other gear, there were often no lengths available for a given and had a sampling high of 78 in 1989.

For age samples, the numbers of sampled fish were considerably lower. Age samples were primarily from 1997-2012, with the exception of two otoliths collected in 1990. There were sampling highs of 100 and 11 for handline and longline respectively. Handline had a sampling low of 1 in 1999, while longline and other gear often none. It was the workgroup's recommendation to therefore combine samples across strata. Table of age samples can be found in Table 3.6.

3.6.2 Size frequency data from commercial fisheries observers

Fishery observer data have been collected from the Gulf of Mexico reef fish fishery since July, 2006. Data collection efforts have been primarily directed towards the vertical line and bottom longline fisheries. Vessels were randomly selected for observer coverage within gear (handline/electric/hydraulic reel vertical line and bottom longline), region (eastern and western Gulf of Mexico), and season (Jan-Mar, Apr-Jun, etc.) strata. Sampling within each gear/region/season stratum was apportioned by the fishing effort (days at sea) reported within each stratum for the previous year. Strata with the highest effort received greater observer coverage (more observer days at sea) than did those strata with lower reported effort.

The observer data were more detailed than the self-reported fishing effort and landings data included in the coastal logbook data set. For example, total catch, including discarded fish, was recorded for each set; where set was defined as fishing at a specific location. A majority (76% longline and 72% vertical line) of amberjack were measured (fork length) and the disposition (kept, discarded dead, discarded alive, kept for bait, unknown) of each fish was recorded.

Observer data was used to examine the catch and discard characteristics of the two fisheries that catch gag using data during 2006-2012. Tables were constructed for number of trips and number of discards by region and year. Regions were defined as Gulf of Mexico statistical areas 1-12 (east) and 13-21 (west). The numbers of trips with greater amberjack observed are included in Table 3.7 and Tables 3.8A-3.8B (trips by gear, year, and region). Data was pooled to maintain confidentiality as covered under NOAA Administrative Order 216-100 and indicated as confidential data in tables. Cells with less than 3 vessels are not shown.

The available observer reported gag size and disposition data were used to construct size frequency histograms of discarded and kept fish for each gear. Gears included vertical lines (handline and electric/hydraulic reels) and bottom longlines. No attempt was made to account for the fraction of fish that was not measured (e.g., if 70% of discarded fish within a stratum were measured while 95% of kept fish were measured in the same stratum, no adjustment was made for that difference in sampling fraction). Length data is presented in fork length. Less than 1% of the data were in total length and these were not used in the size composition histograms (0.6% in the bandit gear and 0.2% in the longline). None of the longline data were in total length and one observation of the vertical line measured fish were in total length (1%). Total length was converted to fork length using Forklengthmm= (-24.703 + (TotalLengthmm*0.912)).

Yearly changes in the size frequency of discarded and kept greater amberjack were examined. Histograms were produced following stratification of the data by year, region, and gear. Sample sizes of observed fish are provided within each figure.

Prior to 2007, observer data were available for the period July-December, 2006. During 2006-2012, the commercial fishery was subject to seasonal closures so data were stratified by fishing season (open and closed), region, and gear and size frequency histograms constructed for each stratum.

Size frequency histograms of observed greater amberjack discards and kept fish are provided in the figures listed below. In the western subregion, longline data could not be presented due to confidentiality restrictions.

Figure 3.6 Commercial bottom longline eastern Gulf of Mexico 2006-2012 observed greater amberjack size composition by year.

Figure 3.7 Commercial vertical line eastern Gulf of Mexico 2006-2012 observed greater amberjack size composition by year.

Figure 3.8 Commercial vertical line western Gulf of Mexico 2006-2012 observed greater amberjack size composition by year.

Figure 3.9 Commercial bottom longline eastern and western Gulf of Mexico observed greater amberjack size composition by fishing season (2006-2009).

Figure 3.10 Commercial vertical line eastern and western Gulf of Mexico observed greater amberjack size composition by fishing season (2006-2009).

3.7 Comments on Adequacy of Data for Assessment Analyses

Overall the workgroup felt the landings were adequate for assessment analyses. The landings time series ran from 1963-2012, and were more confident in the later years as reports to species became more common. The workgroup felt confident in apportioning the unclassified amberjack using only the *Seriola* sp to develop the proportions. The exclusion of unclassified jack for apportioning may be a departure from past assessment, but after discussion with port agents and industry representatives, the workgroup felt this decision would lead to more accurate landings. The regional boundaries set and the landings by gear group were also agreed upon by the workgroup.

There was high level of uncertainty in the discard estimations due to the disparity in discard rates between the self-reported logbook data and the observer data. Generally speaking the observer discard rates were an order of magnitude greater than those in the self-reported logbook data. It was felt that the observer data was more likely accurate but only provided discard rates back to 2007. The impact of red snapper, and later grouper, IFQ on discard rates was also a concern. Further investigations and analyses are ongoing.

The workgroup felt the commercial landings length samples should be adequate for assessment analyses. There appears to be an adequate number of samples for most years for both handline and longline. Other gear may also have adequate sample sizes for a handful of years. There were considerably fewer age samples, and thus a higher level of uncertainty. Samples will likely need to be combined across strata.

3.8 Research Recommendations for Greater Amberjack

Landings
-Improved dockside sampling for catch composition
-Improved dealer reporting to species

Discard
-Increased observer coverage.
-More representative observer coverage.
-Most appropriate method for incorporation of IFQ data into discard estimations

3.9 Literature Cited

McCarthy, K. 2011. Calculated discards of yellowtail snapper from commercial vertical line fishing vessels in southern Florida. SEDAR22-RD02. SFD-2011-016.

Lo, N.C., L.D. Jackson, J.L. Squire. 1992. Indices of relative abundance from fish spotter data based on delta lognormal models. Can. J. Fish. Aquat. Sci. 49: 2515-2526.

Littell, R.C., G.A. Milliken, W.W. Stroup, and R.D Wolfinger. 1996. SAS® System for Mixed Models, Cary NC, USA: SAS Institute Inc., 1996. 663 pp.

3.10 Tables

Table 3.1 ALS gear code grouping.

NMFS Code	Description	Group
600	Troll & Hand Lines Cmb	Handline
610	Lines Hand, Other	Handline
611	Rod and Reel	Handline
612	Reel, Manual	Handline
613	Reel, Electric or Hydraulic	Handline
616	Rod and Reel, Electric (Hand)	Handline
614	Long Line, Vertical	Longline
675	Lines Long Set With Hooks	Longline
676	Lines Long, Reef Fish	Longline
677	Lines Long, Shark	Longline
*	All other codes	Other

Table 3.2 Greater amberjack proportions applied to unclassified amberjack landings by state and season.

State	GAJ Season	GAJ Proportion
TX	OPEN	97.40%
LA	OPEN	86.62%
MS	OPEN	86.38%
AL	OPEN	82.16%
FL	OPEN	89.03%
TX	CLOSED	0.57%
LA	CLOSED	2.45%
MS	CLOSED	11.16%
AL	CLOSED	7.13%
FL	CLOSED	54.14%

Table 3.3 Annual greater amberjack landings in gutted pounds for 1963-2012

Year	Handline	Longline	Other	Total
1963	8,426			8,426
1964	6,111		185	6,296
1965	5,185			5,185
1966	7,315			7,315
1967	28,888			28,888
1968	11,389			11,389
1969	72,129			72,129

1970	13,055		463	13,518
1971	38,055			38,055
1972	32,407		8,796	41,203
1973	27,777		185	27,963
1974	41,110		185	41,296
1975	77,128		185	77,314
1976	84,073		1,481	85,554
1977	110,253		8,351	118,605
1978	147,618		1,463	149,081
1979	144,788	2,686	2,390	149,863
1980	167,710	4,704	4,090	176,503
1981	209,611	22,213	810	232,634
1982	182,126	38,812	648	221,586
1983	230,751	45,090	93	275,934
1984	462,271	60,966	61	523,299
1985	640,371	113,135	7,554	761,060
1986	883,210	201,271	719	1,085,200
1987	1,229,809	249,379	21,283	1,500,470
1988	1,633,405	326,621	36,299	1,996,325
1989	1,550,690	299,945	41,365	1,891,999
1990	942,603	110,970	161,807	1,215,380
1991	1,488,728	6,083	218,766	1,713,576
1992	922,641	50,783	48,073	1,021,497
1993	1,373,822	81,008	106,422	1,561,251
1994	1,085,029	66,947	85,741	1,237,717
1995	1,083,634	78,671	32,995	1,195,300
1996	1,079,907	53,769	64,592	1,198,268
1997	953,572	53,716	20,921	1,028,208
1998	565,124	48,132	17,296	630,553
1999	598,937	55,059	49,165	703,160
2000	694,500	59,822	55,066	809,389
2001	564,272	55,994	40,514	660,780
2002	612,852	67,890	36,842	717,584
2003	779,169	115,611	23,891	918,671
2004	796,652	70,909	35,932	903,493
2005	588,113	66,522	32,293	686,928
2006	467,058	72,298	25,074	564,430
2007	485,221	54,860	15,175	555,256
2008	342,968	82,712	19,718	445,398
2009	507,756	46,619	13,895	568,270
2010	478,780	20,978	28,572	528,330
2011	461,530	15,648	18,435	495,613
2012	273,027	39,730	20,030	332,787

Table 3.4 Greater amberjack yearly commercial vertical line vessel discards calculated from fisher reported and observer reported data. Continuity = 2010 update assessment methods using fisher reported data; Modeled rate = standardized discard rates taken from delta-lognormal model results. Discards are reported in number of fish.

Year	Continuity	Modeled Rate	Observer (reel)	Observer (trip)
1990	13,632	12,696	107,234	71,168
1991	23,955	25,757	217,542	144,376
1992	19,937	16,175	136,619	90,670
1993	22,925	17,910	151,266	100,391
1994	23,405	19,727	166,614	110,577
1995	23,571	18,661	157,616	104,605
1996	26,181	21,314	180,018	119,473
1997	26,826	22,467	189,754	125,934
1998	27,438	23,239	196,277	130,263
1999	27,917	25,118	212,151	140,799
2000	27,346	24,110	203,637	135,148
2001	25,397	22,675	191,517	127,104
2002	36,241	46,799	200,601	133,133
2003	36,289	24,744	210,679	139,822
2004	26,158	28,322	187,928	124,722
2005	14,288	7,876	179,724	119,278
2006	8,400	11,997	174,754	51,678
2007	11,219	13,288	144,565	89,805
2008	11,503	7,289	299,715	307,146
2009	13,963	9,719	80,880	101,750
2010	3,344	4,195	53,346	119,005
2011	4,899	7,575	88,884	42,650
2012	12,633	17,198	261,805	108,273

Table 3.5 Number of commercial length samples for greater amberjack.

Year	Handline	Longline	Other
1983	22	0	1
1984	129	13	4
1985	145	73	76
1986	102	16	9
1987	19	11	7
1988	49	17	0
1989	132	5	78
1990	587	52	1
1991	586	35	16
1992	844	74	26
1993	727	60	4
1994	965	39	15
1995	733	58	2
1996	523	43	41

1997	570	52	3
1998	507	102	1
1999	690	146	2
2000	707	117	0
2001	387	58	1
2002	723	63	1
2003	493	86	4
2004	241	76	0
2005	131	37	16
2006	58	20	0
2007	119	24	0
2008	33	10	0
2009	123	9	0
2010	73	4	2
2011	87	12	0
2012	107	0	0

Table 3.6 Number of commercial age samples for greater amberjack.

Year	Handline	Longline	Other
1990	2	0	0
1991	0	0	0
1992	0	0	0
1993	0	0	0
1994	0	0	0
1995	0	0	0
1996	0	0	0
1997	2	1	0
1998	2	0	0
1999	1	0	0
2000	18	0	0
2001	8	0	20
2002	38	9	33
2003	18	1	15
2004	27	1	12
2005	31	1	0
2006	21	5	23
2007	31	0	0
2008	69	11	37
2009	38	3	54
2010	89	11	21
2011	100	0	0
2012	2	0	0

Table 3.7 Number of trips with observed greater amberjack by gear, region, and amberjack season during 2006-2012.

Gear	season	East	West
Bottom longline	Closed	53	11
	Open	49	7
Vertical line	Closed	262	40
	Open	244	63

Table 3.8 Number of trips with observed greater amberjack by gear, year, and region.

A. Bottom longline.

Year	East	West
2006	5	0
2007	7	0
2008	3	Confidential data
2009	16	4
2010	26	7
2011	38	4
2012	7	Confidential data

B. Vertical line.

Year	East	West
2006	23	13
2007	78	19
2008	38	15
2009	39	7
2010	52	6
2011	92	13
2012	184	30

3.11 Figures

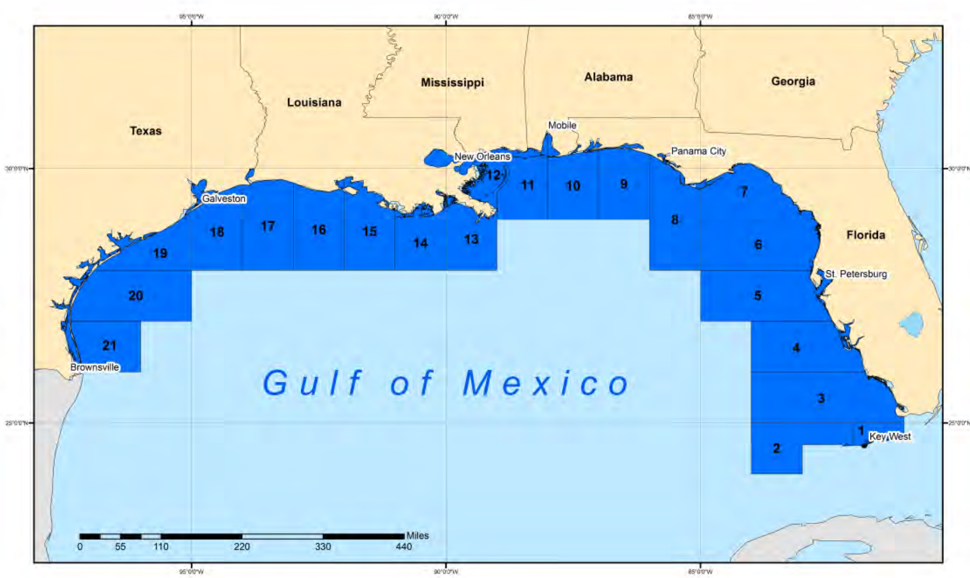

Figure 3.1 Gulf of Mexico

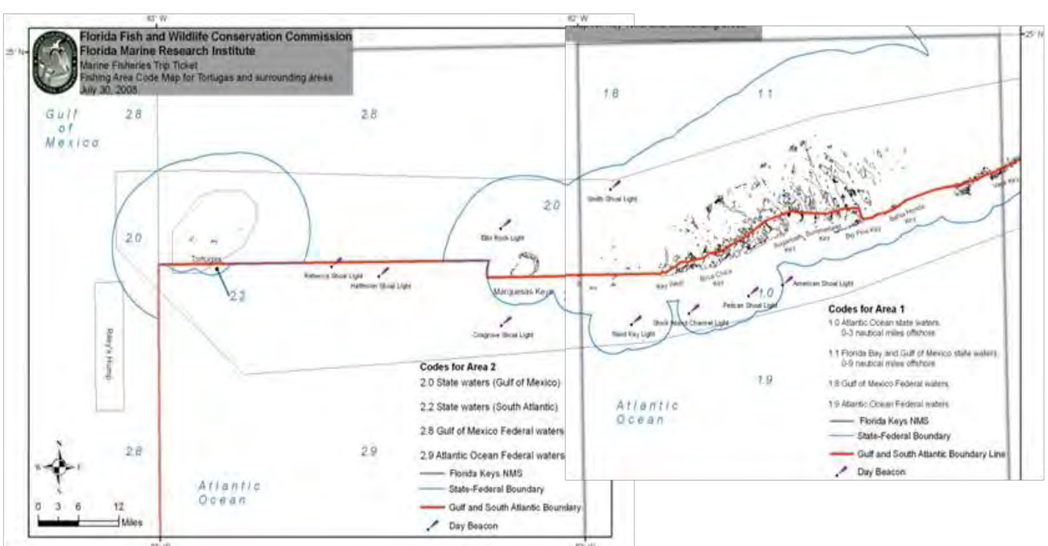

Figure 3.2 Close-up of the southern boundary as defined by the Gulf of Mexico/South Atlantic Council boundary.

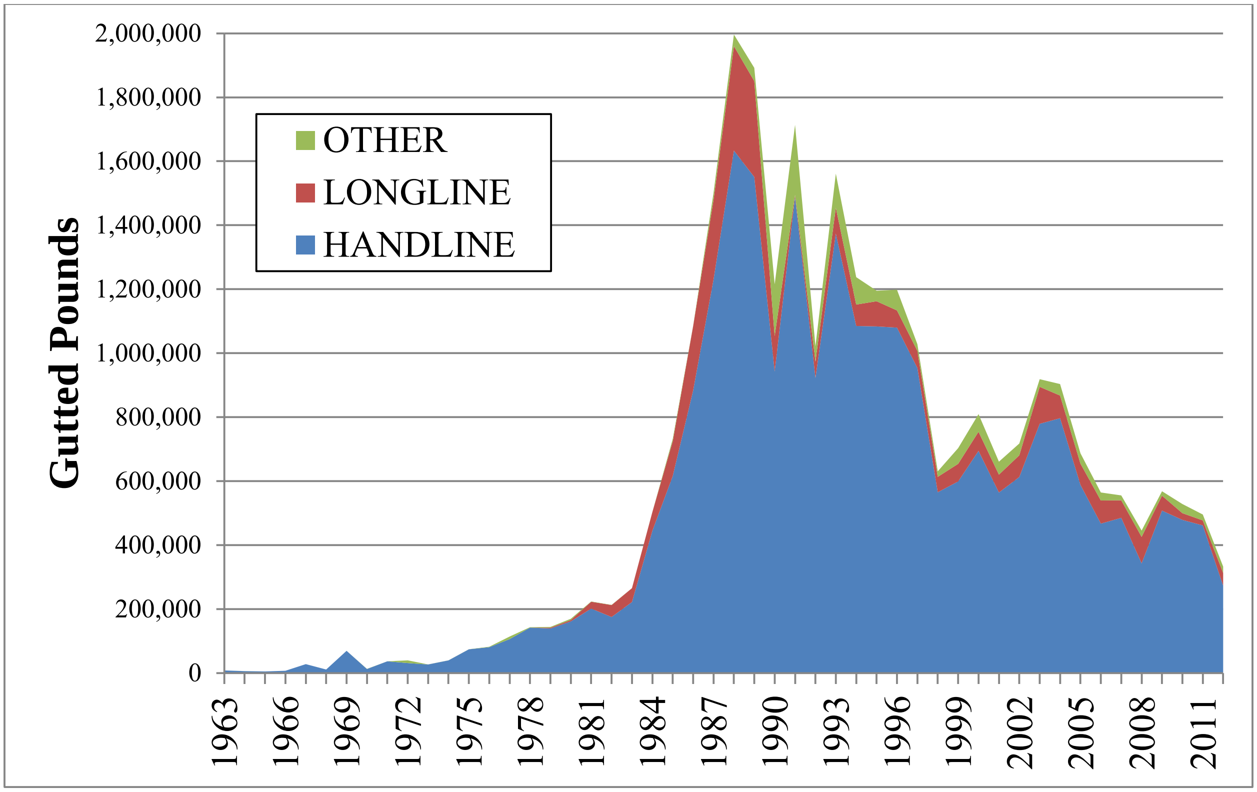

Figure 3.3 Gag grouper landings, in gutted weight pounds by gear.

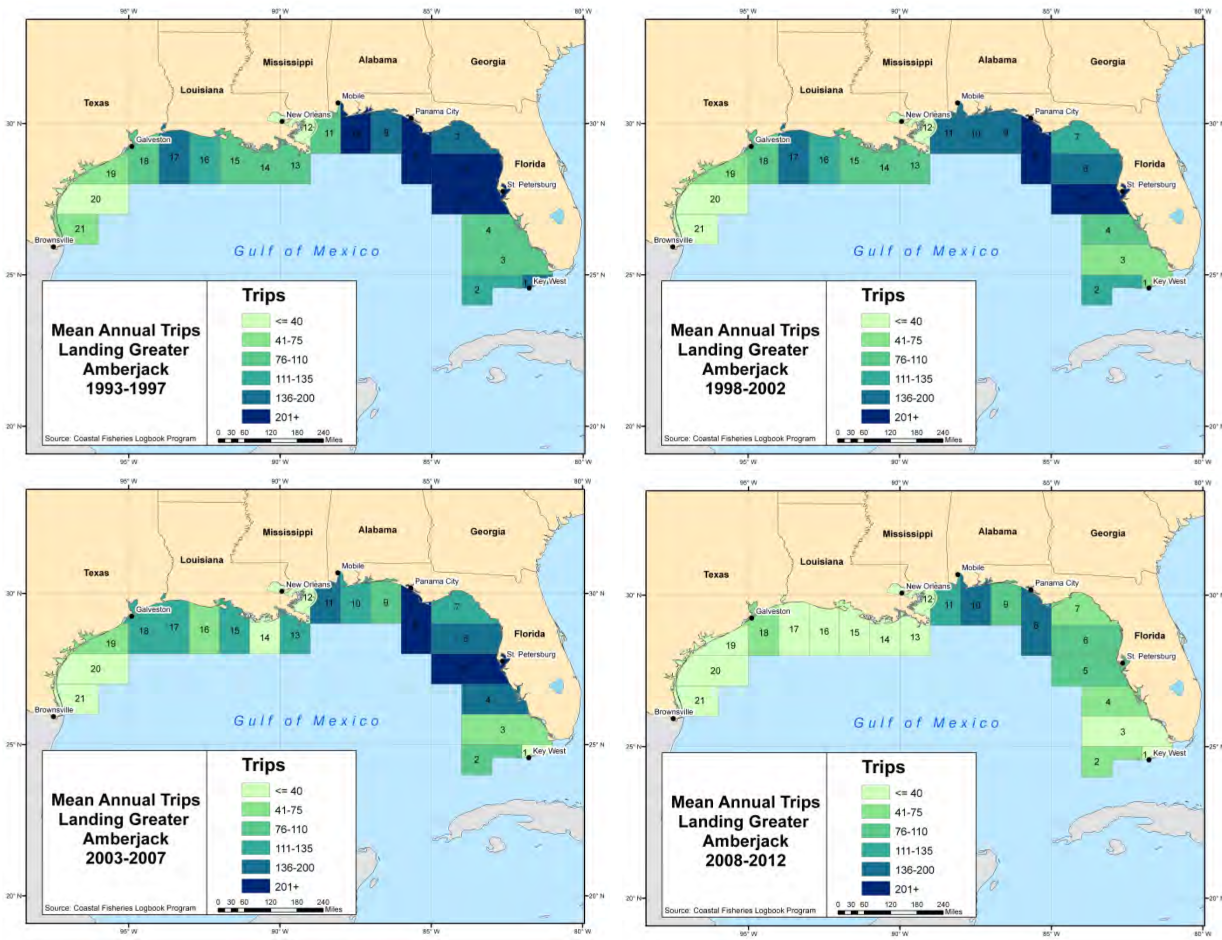

Figure 3.4 Maps of greater amberjack effort in the Gulf of Mexico as reported to the CFLP

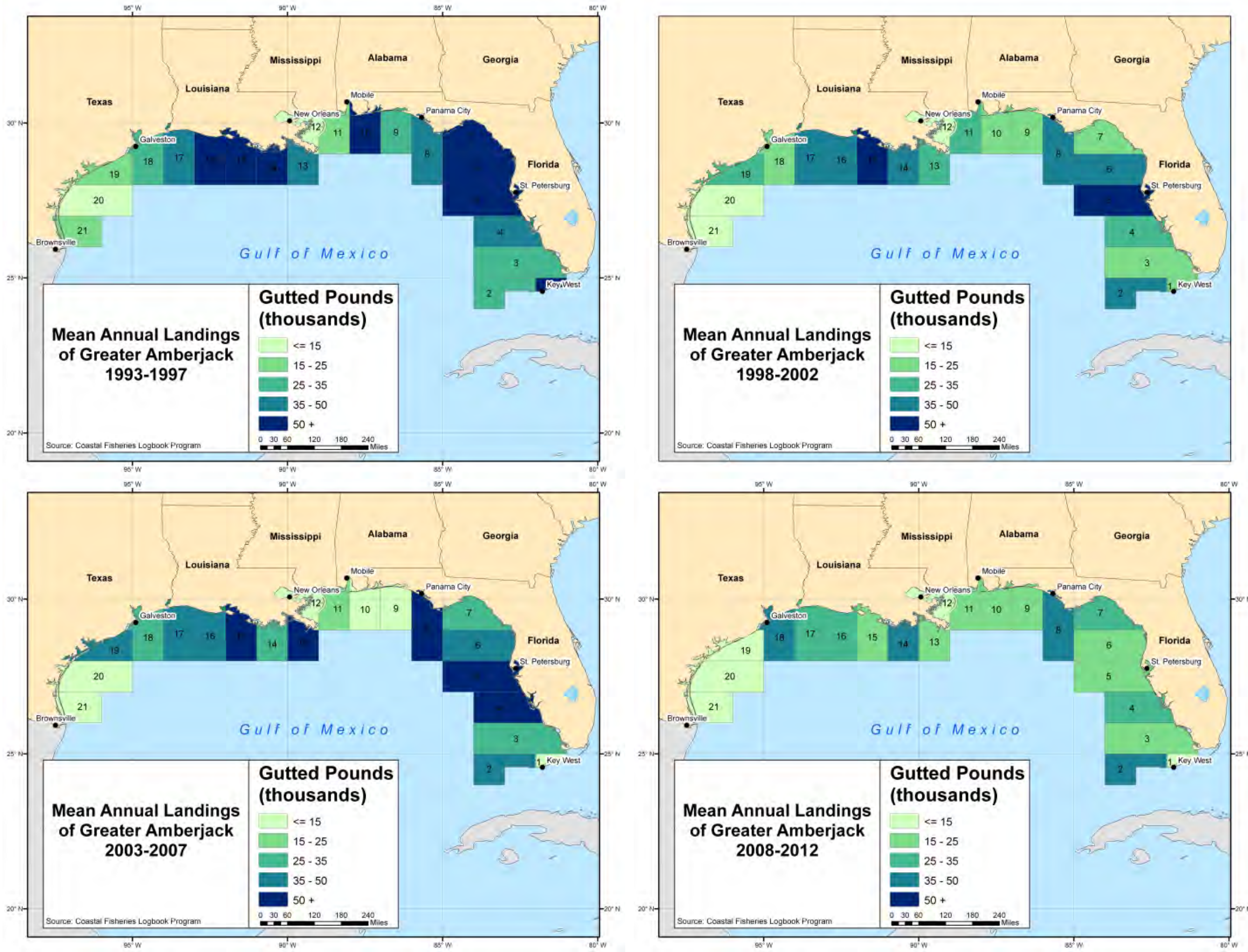

Figure 3.5 Maps of gag grouper harvest in the Gulf of Mexico as reported to the CFLP

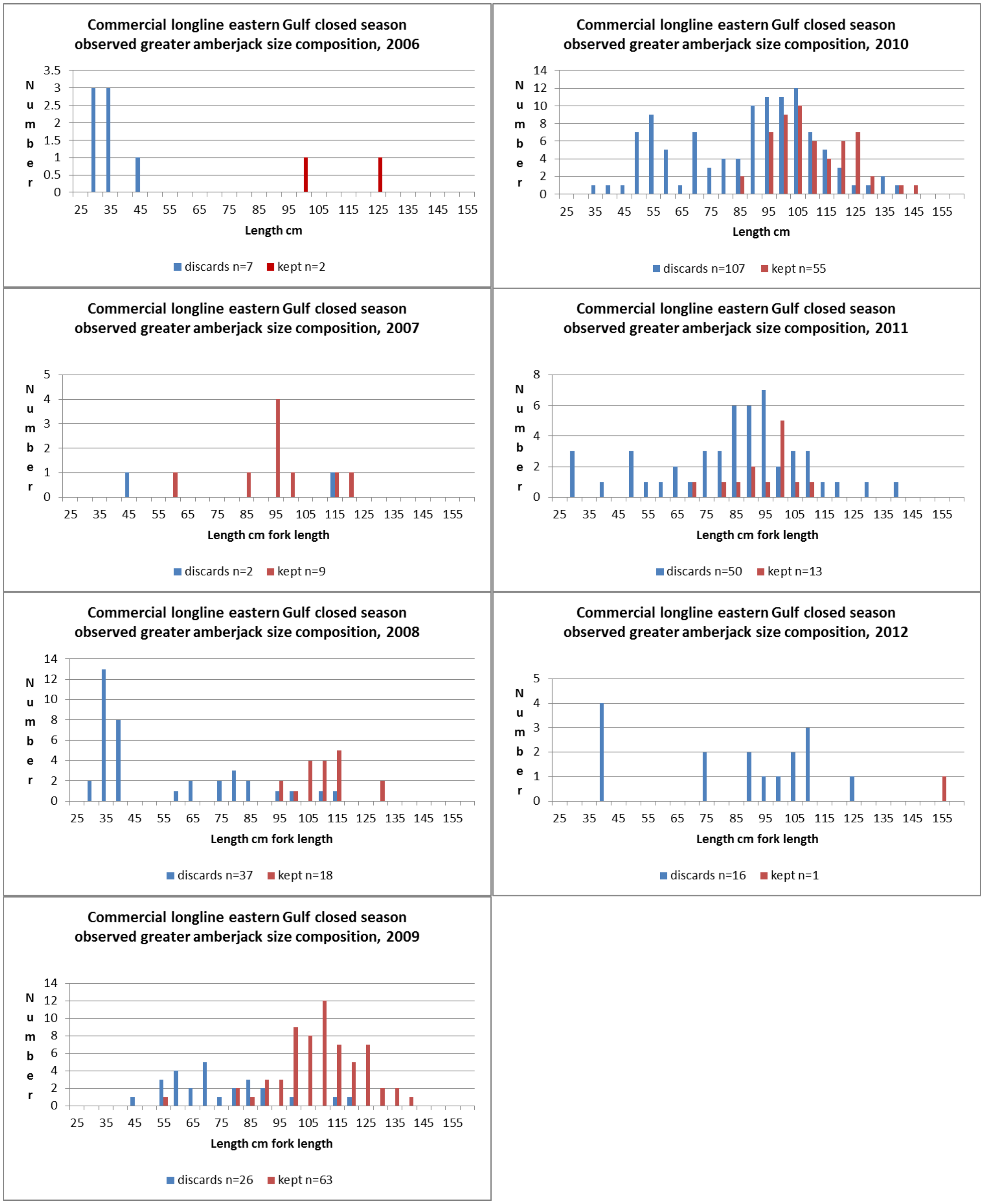

Figure 3.6 Commercial bottom longline eastern Gulf of Mexico 2006-2012 observed greater amberjack size composition by year.

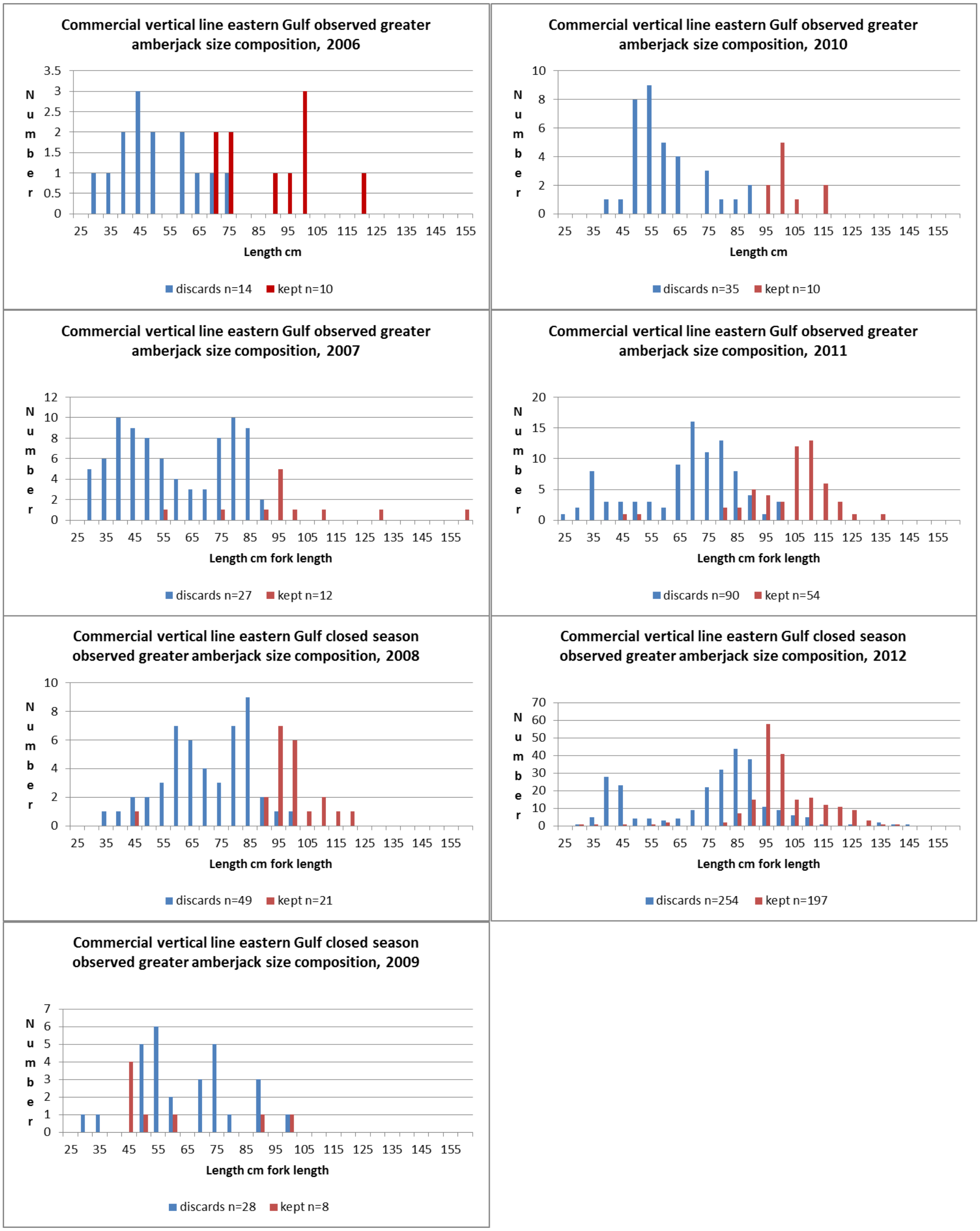

Figure 3.7 Commercial vertical line eastern Gulf of Mexico 2006-2012 observed greater amberjack size composition by year.

Figure 3.8 Commercial vertical line western Gulf of Mexico 2006-2012 observed greater amberjack size composition by year.

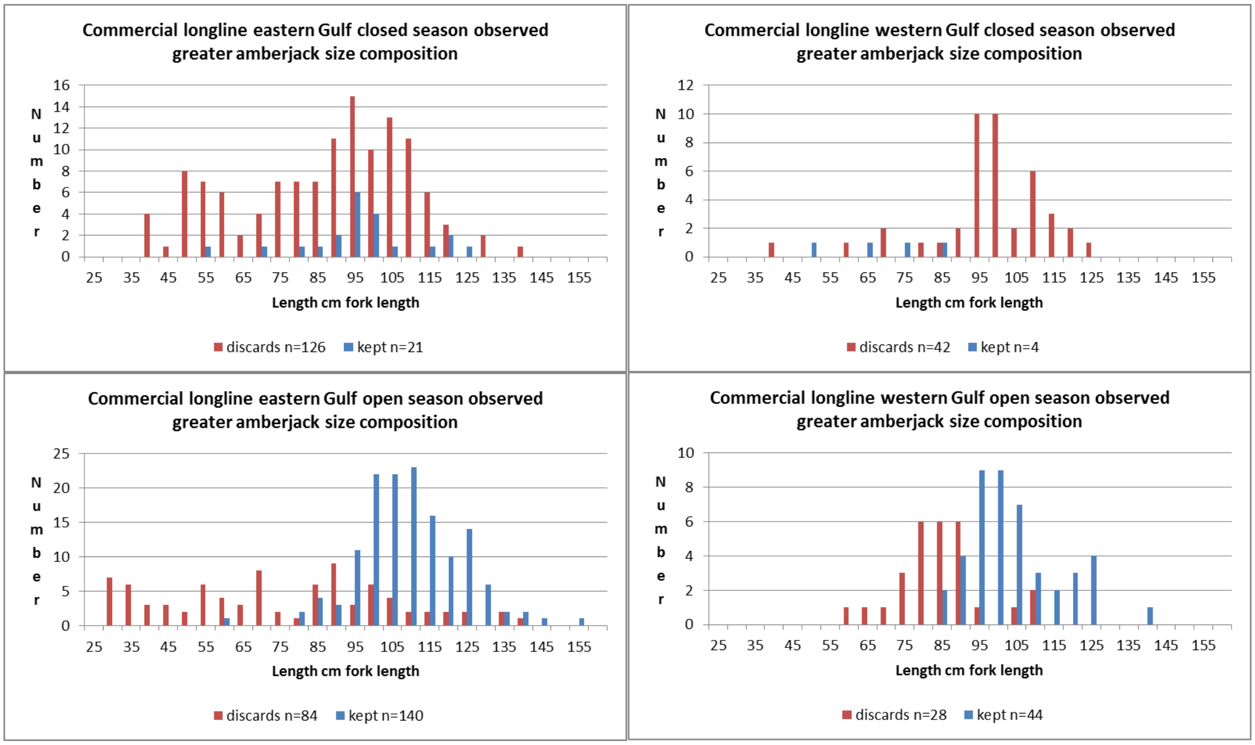

Figure 3.9 Commercial bottom longline eastern and western Gulf of Mexico observed greater amberjack size composition by fishing season (2006-2009).

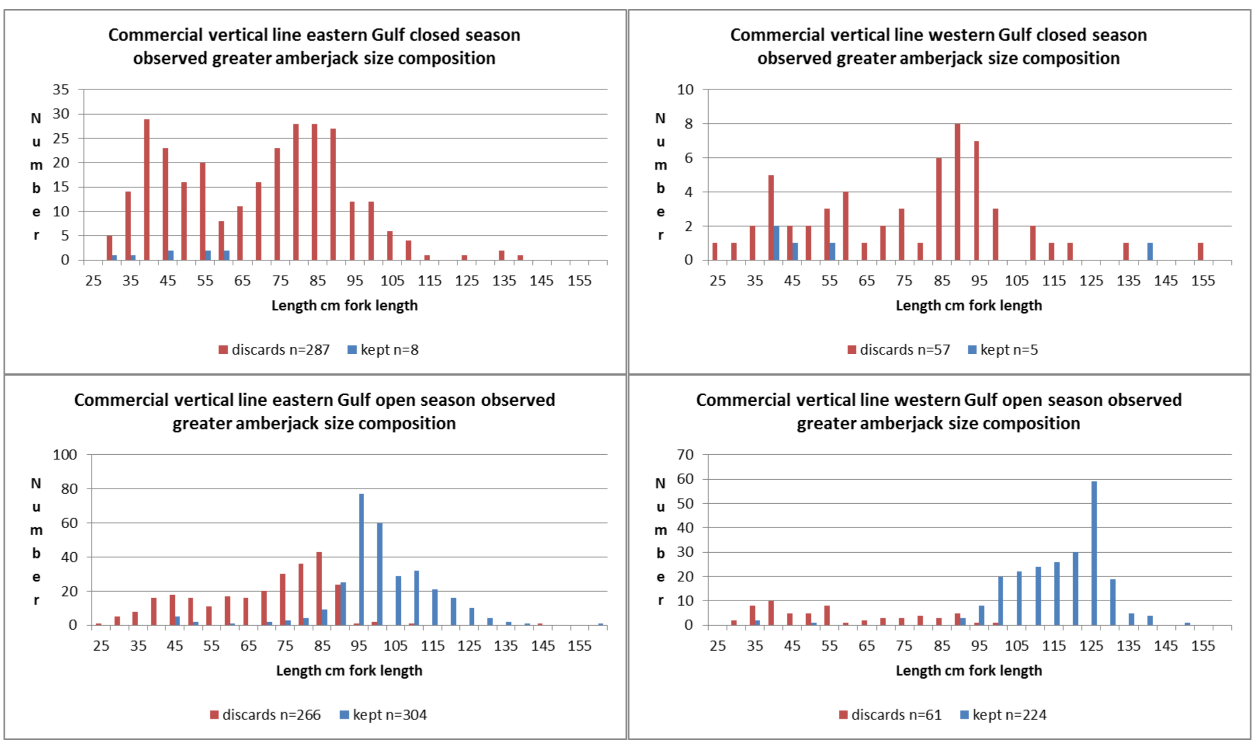

Figure 3.10 Commercial vertical line eastern and western Gulf of Mexico observed greater amberjack size composition by fishing season (2006-2009).

3.12 APPENDIX A:

NMFS SECPR Accumulated Landings System (ALS)

Information on the quantity and value of seafood products caught by fishermen in the U.S. has been collected starting in the late 1800s (inaugural year is species dependent). Fairly serious collection activity began in the 1920s. The data set maintained by the Southeast Fisheries Science Center (SEFSC) in the SECPR database management system is a continuous dataset that begins in 1962.

In addition to the quantity and value, information on the gear used to catch the fish, the area where the fishing occurred and the distance from shore are also recorded. Because the quantity and value data are collected from seafood dealers, the information on gear and fishing location are estimated and added to the data by data collection specialists. In some states, this ancillary data are not available.

Commercial landings statistics have been collected and processed by various organizations during the 1962-to-present period that the SECPR data set covers. During the 16 years from 1962 through 1978, these data were collected by port agents employed by the Federal government and stationed at major fishing ports in the southeast. The program was run from the Headquarters Office of the Bureau of Commercial Fisheries in Washington DC until 1970. After 1970 it was run by the newly created National Marine Fisheries Service, which had replaced the Bureau of Commercial Fisheries. Data collection procedures were established by Headquarters and the data were submitted to Washington for processing and computer storage. In 1978, the responsibility for collection and processing were transferred to the SEFSC.

In the early 1980s, the NMFS and the state fishery agencies within the Southeast began to develop a cooperative program for the collection and processing of commercial fisheries statistics. With the exception of two counties, one in Mississippi and one in Alabama, all of the general canvass statistics are collected by the fishery agency in the respective state and provided to the SEFSC under a comprehensive Cooperative Statistics Program (CSP).

The purpose of this documentation is to describe the current collection and processing procedures that are employed for the commercial fisheries statistics maintained in the SECPR database.

1960 - Late 1980s
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Although the data processing and database management responsibility were transferred from the Headquarters in Washington DC to the SEFSC during this period, the data collection procedures remained essentially the same. Trained data collection personnel, referred to as fishery reporting specialists or port agents, were stationed at major fishing ports throughout the Southeast Region. The data collection procedures for commercial landings included two parts.

The primary task for the port agents was to visit all seafood dealers or fish houses within their assigned areas at least once a month to record the pounds and value for each species or product type that were purchased or handled by the dealer or fish house. The agents summed the landings and value data and submitted these data in monthly reports to their area supervisors. All of the monthly data were submitted in essentially the same form.

The second task was to estimate the quantity of fish that were caught by specific types of gear and the location of the fishing activity. Port agents provided this gear/area information for all of the landings data that they collected. The objective was to have gear and area information assigned to all monthly commercial landings data.

There are two problems with the commercial fishery statistics that were collected from seafood dealers. First, dealers do not always record the specific species that are caught and second, fish or shellfish are not always purchased at the same location where they are unloaded, i.e., landed. Dealers have always recorded fishery products in ways that meet their needs, which sometimes make it ambiguous for scientific uses. Although the port agents can readily identify individual species, they usually were not at the fish house when fish were being unloaded and thus, could not observe and identify the fish.

The second problem is to identify where the fish were landed from the information recorded by the dealers on their sales receipts. The NMFS standard for fisheries statistics is to associate commercial statistics with the location where the product was first unloaded, i.e., landed, at a shore-based facility. Because some products are unloaded at a dock or fish house and purchased and transported to another dealer, the actual 'landing' location may not be apparent from the dealers' sales receipts. Historically, communications between individual port agents and the area supervisors were the primary source of information that was available to identify the actual unloading location.

Cooperative Statistics Program
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In the early 1980s, it became apparent that the collection of commercial fisheries statistics was an activity that was conducted by both the Federal government and individual state fishery agencies. Plans and negotiations were initiated to develop a program that would provide the fisheries statistics that are needed for management by both Federal and state agencies. By the mid-1980s, formal cooperative agreements had been signed between the NMFS/SEFSC and each of the eight coastal states in the southeast, Puerto Rico and the US Virgin Islands.

Initially, the data collection procedures that were used by the states under the cooperative agreements were essentially the same as the historical NMFS procedures. As the states developed their data collection programs, many of them promulgated legislation that authorized their fishery agencies to collect fishery statistics. Many of the state statutes include mandatory data submission by seafood dealers.

Because the data collection procedures (regulations) are different for each state, the type and detail of data varies throughout the Region. The commercial landings database maintained in SECPR contains a standard set of data that is consistent for all states in the Region.

A description of the data collection procedures and associated data submission requirements for each state follows.

Florida

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

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

Georgia

Prior to 1977, the National Marine Fisheries Service collected commercial landings data Georgia. From 1977 to 2001 state port agents visited dealers and docks to collect the information on a regular basis. Compliance was mandatory for the fishing industry. To collect more timely and accurate data, Georgia initiated a trip ticket program in 1999, but the program was not fully implemented to allow complete coverage until 2001. All sales of seafood products landed in Georgia must be recorded on a trip ticket at the time of the sale. Both the seafood dealer and the seafood harvester are responsible for insuring the ticket is completed in full.

South Carolina

Prior to 1972, commercial landings data were collected by various federal fisheries agents based in South Carolina, either U.S. Fish or Wildlife or National Marine Fisheries Service personnel. In 1972, South Carolina began collecting landings data from coastal dealers in cooperation with federal agents. Mandatory monthly landings reports on forms supplied by the Department are required from all licensed wholesale dealers in South Carolina. Until fall of 2003, those monthly reports were summaries collecting species, pounds landed, disposition (gutted or whole) and market category, gear type, and area fished; since September 2003, landings have been reported by a mandatory trip ticket system collecting landings by species, disposition and market category, pounds landed, ex-vessel prices with associated effort data to include gear type and amount, time fished, area fished, along with vessel and fisherman information.

South Carolina began collecting TIP length frequencies in 1983 as part of the Cooperative Statistics Program. Target species and length quotas were supplied by NMFS and sampling targets were established for monthly commercial trips by gear sampling was set to collect those species with associated length frequencies. In 2005, SCDNR began collecting age structures (otoliths and spines) in addition to length frequencies, using ACCSP funding to supplement CSP funding. Typically for every four fish measured a single age structure was collected. This sampling periodicity was changed in 2010 to collect both a length and age structure from every fish intercepted as a recommendation from the SEFSC.

North Carolina
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The National Marine Fisheries Service prior to 1978 collected commercial landings data for North Carolina. Port agents would conduct monthly surveys of the state's major commercial seafood dealers to determine the commercial landings for the state. Starting in 1978, the North Carolina Division of Marine Fisheries entered into a cooperative program with the National Marine Fisheries Service to maintain the monthly surveys of North Carolina's major commercial seafood dealers and to obtain data from more dealers.

The North Carolina Division of Marine Fisheries Trip Ticket Program (NCTTP) began on 1 January 1994. The NCTTP was initiated due to a decrease in cooperation in reporting under the voluntary NMFS/North Carolina Cooperative Statistics Program in place prior to 1994, as well as an increase in demand for complete and accurate trip-level commercial harvest statistics by fisheries managers. The detailed data obtained through the NCTTP allows for the calculation of effort (i.e. trips, licenses, participants, vessels) in a given fishery that was not available prior to 1994 and provides a much more detailed record of North Carolina's seafood harvest.

NMFS SECPR Annual Canvas Data for Florida

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

Area of capture considerations: ALS is considered to be a commercial landings database which reports where the marine resource was landed. With the advent of some State trip ticket programs as the data source the definition is more loosely applied. As such one cannot assume reports from the ALS by State or county will accurately inform you of Gulf vs. South Atlantic vs. Foreign catch. To make that determination you must consider the area of capture.

4 Recreational Fishery Statistics

4.1 Overview

Recreational landings and discards of greater amberjack in the Gulf of Mexico were compiled for the period 1981-2012 from federal and state databases. Sampling intensities of fish lengths by recreational fishing mode and year were considered, and length frequency distributions were developed by year for Gulf of Mexico greater amberjack. A summary of the issues discussed and data presented at the data workshop is included here.

4.1.1 Recreational Workgroup Members

Jeff Isely (Leader), NOAA Fisheries, Miami, FL; Vivian Matter, NOAA Fisheries, Miami, FL; Beverly Sauls, FL FWC, St. Petersburg, FL.

4.1.2 Issues Discussed at the Data Workshop

The Workgroup discussed several issues that needed to be resolved before data could be compiled. The issues are listed below and are described in more detail in the following sections.

1) Calibration of Marine Recreational Fisheries Statistics Survey charterboat estimates (1981-1997).
2) Calibration of Marine Recreational Fisheries Statistics Survey estimates to Marine Recreational Information Program estimates (1981-2003).
3) Species identification (unidentified genus and family landings)
4) Use of shore mode estimates.
5) Adjustments and substitutions (1981-1985).
6) Estimating recreational landings in weight.
7) Estimating discards for the Southeast Region Headboat Survey.
8) Estimating discards for the Texas Parks and Wildlife Department.
9) Monroe county landings

4.1.3 Gulf of Mexico Fishery Management Council Jurisdictional Boundaries

Gulf of Mexico Fishery Management Council Jurisdictional Boundaries are presented in Figure 4.11.1.

4.2 Review of Working Papers

The workgroup reviewed one working paper.

SEDAR33-DW4, *Characterization of Greater Amberjack Discards in Recreational For-Hire Fisheries. Beverly Sauls and Bridget Cermak.*
This working paper presents a summary of available information on the size, release condition, and disposition of greater amberjack collected by trained observers since 2005 during at-sea surveys on for-hire vessels in the Gulf of Mexico. Additionally, a summary of information

collected from a self-recruited volunteer angler catch card program is provided and compared to information collected from at-sea observer surveys.

4.3 Recreational Landings

A map and figures summarizing all recreational landings of greater amberjack in the Gulf of Mexico are provided in Figure 4.11.2.

4.3.1 Marine Recreational Fisheries Statistics Survey (MRFSS) and Marine Recreational Information Program (MRIP)

Introduction

The Marine Recreational Fisheries Statistics Survey (MRFSS) and the Marine Recreational Information Program (MRIP) provide a continuous time series since 1981 of estimated catch per unit effort, total effort, landings, and discards for six two-month periods (waves) each. MRFSS/MRIP provides estimates for three recreational fishing modes: shore-based fishing (SH), private and rental boat fishing (PR), and for-hire charter and guide fishing (CH). When the survey first began in Wave 2 (Mar/Apr), 1981, headboats (HB) were included in the for-hire mode, but were excluded after 1985 to avoid overlap with the Southeast Region Headboat Survey (SRHS) conducted by the NMFS Beaufort, NC lab.

The MRFSS/MRIP survey covers coastal Gulf of Mexico states from Florida to Louisiana. The state of Texas was included in the survey from 1981-1985, although not all modes and waves were covered. The state of Florida is sampled as two sub-regions. The east Florida sub-region includes counties adjacent to the Atlantic coast from Nassau County south through Miami-Dade County, and the west Florida sub-region includes Monroe County (Florida Keys) and counties adjacent to the Gulf of Mexico. Separate estimates are generated for each Florida sub-region, and those estimates may be post-stratified into smaller regions based on proportional sampling.

The MRFSS/MRIP design incorporates three complementary survey methods for estimating catch and effort. Catch data are collected through angler interviews during dockside intercept surveys of recreational fishing trips after they have been completed. Effort data are collected using two telephone surveys. The Coastal Household Telephone Survey (CHTS) uses random digit dialing of coastal households to obtain detailed information about the previous two months of recreational fishing trips from the anglers. The weekly For-Hire Survey interviews charterboat operators (captains or owners) to obtain the trip information with only one-week recall period. Effort estimates from the two telephone surveys are aggregated to produce total effort estimates by wave. Catch rates from dockside intercept surveys are combined with estimates of effort from telephone interviews to estimate total landings and discards by wave, mode, and area fished (inland, state, and federal waters). Catch estimates from early years of the survey are highly variable with high proportional standard errors (PSE's), and sample size in the dockside intercept portion have been increased over time to improve precision of catch estimates. Full survey documentation and ongoing efforts to review and improve survey methods are available at: http://www.st.nmfs.gov/st1/recreational.

Survey methods for the for-hire fishing mode have seen the most improvement over time. Catch rate data have improved through increased sample quotas and additional sampling to the intercept portion of the survey. As the random household telephone survey was intercepting relatively few anglers in the for-hire fishing mode, the For-Hire Telephone Survey (FHS) was developed to estimate effort in for this mode. The new method draws a random sample of known for-hire charter and guide vessels each week and vessel operators are called and asked directly to report their fishing activity. The FHS was pilot tested in the Gulf of Mexico in 1998 and officially adopted in 2000. The FHS does not consider the estimates during pilot years as official estimates; however, FHS data for these years have been used in past SEDARs (e.g. SEDAR 7 red snapper, SEDAR 16 king mackerel, etc.). As a result of the Deepwater Horizon oil spill in April 2010, the MRFSS/MRIP For-Hire Survey increased sampling rates of charterboat vessel operators from 10% to 40% from May, 2010 through June 2011.

A further improvement in the FHS method was the pre-stratification of Florida into smaller sub-regions for estimating effort. Pre-stratification defines the sample unit on a sub-state level to produce separate effort estimates by these finer geographical regions. The FHS sub-regions include three distinct regions bordering the Gulf of Mexico coast: NW Florida panhandle from Escambia to Dixie counties (sub-region 1), SW Florida peninsula from Levy to Collier counties (sub-region 2), and Monroe county (sub-region 3) The coastal household telephone survey method for the for-hire fishing mode continues to run concurrently with the newer FHS method.

Calibration of traditional MRFSS charterboat estimates

Conversion factors have been estimated to calibrate the traditional MRFSS charterboat estimates with the FHS for 1986-1997 in the Gulf of Mexico (SEDAR7-AW-03). The relationship between the old charterboat method estimates of angler trips and the FHS estimates of angler trips was used to estimate the conversion factors. Since these factors are based on effort, they can be applied to all species' landings. In the Gulf of Mexico, the period of 1981-1985 could not be calibrated with the same ratios developed for 1986+ because in the earlier 1981-1985 time period, MRFSS considered charterboat and headboat as a single combined mode. Thus, in order to properly calibrate the estimates from 1981-1985, headboat data from the Southeast Region Head-boat Survey (SRHS) were included in the analysis. To calibrate the MRFSS combined charterboat and headboat mode effort estimates in 1981-1985, conversion factors were estimated using 1986-1990 effort estimates from both modes, in equivalent effort units, an angler trip (SEDAR28-DW-12). These calibration factors were applied to the charterboat estimates and are tabulated in Table 4.10.1.

MRIP weighted estimates and the calibration of MRFSS estimates

The Marine Recreational Information Program (MRIP) was implemented in 2004. The MRIP was developed to generate more accurate recreational catch rates by re-designing the MRFSS sampling protocol to address potential biases including port activity and time of day. Revised catch and effort estimates, based on this improved estimation method, were released on January 25, 2012. These estimates are available for the Atlantic and Gulf Coasts for 2004 through 2012. Table 4.10.2 shows the differences between the Gulf of Mexico greater amberjack MRIP estimates and the MRFSS estimates for the time period 2004-2011.

As new MRIP estimates are available for a portion of the recreational time series that the MRFSS covers, conversion factors between the MRFSS estimates and the MRIP estimates were developed in order to maintain one consistent time series for the recreational catch estimates. Ratio estimators, based on the ratios of the means, were developed for Gulf of Mexico greater amberjack to hind-cast catch and variance estimates by fishing mode. In order to apply the charterboat ratio estimator back in time to 1981, charterboat landings were isolated from the combined CB/HB mode for 1981-1985. The MRFSS to MRIP calibration process is detailed in SEDAR31-DW25 and SEDAR32-DW-02. Table 4.10.3 shows the ratio estimators used in the calibration. Figure 4.11.3 shows the MRFSS versus MRIP adjusted AB1 estimates for Gulf of Mexico greater amberjack from 1981 to 2003.

Calculating landings estimates in weight

The MRFSS and the MRIP surveys use different methodologies to estimate landings in weight. To apply a consistent methodology over the entire recreational time series, the Southeast Fisheries Science Center (SEFSC) implemented a method for calculating average weights for the MRIP (and MRIP adjusted) landings. This method is detailed in SEDAR32-DW-02. The length-weight equation developed by the Life History Working Group (W=0.00006904*(L^2.638)) was used to convert greater amberjack sample lengths into weights, when no weight was recorded. W is whole weight in kilograms and L is fork length in centimeters.

1981, wave 1

MRFSS began in 1981, wave 2. In the Gulf of Mexico, catch for 1981 wave 1 was estimated by determining the proportion of catch in wave 1 to catch in all other waves for 1982-1984 by fishing mode and area. These proportions were then used to estimate wave 1 in 1981 from the estimated catches in other waves of that year. This methodology is consistent with past SEDARs (e.g., SEDAR 10 gag grouper and SEDAR 31 Gulf of Mexico red snapper).

Texas

Texas data from the MRFSS is only available from 1981-1985 and is sporadic, not covering all modes and waves. For these reasons, Texas boat mode estimates from the MRFSS were not included. Instead, TPWD data, which covers charter and private modes, were used to fill in theses modes prior to the start of the TPWD survey in May 1983. This methodology is consistent with past SEDARs (e.g. SEDAR 15, SEDAR 31).

Shore mode

The workgroup discussed the validity of the shore mode estimates generated by MRFSS/MRIP. The intercept data that led to these estimates were most likely the result of species or mode misidentification. Consistent with SEDAR 9, the workgroup recommended that all shore mode estimates be excluded.

Unidentified Jack Landings

Estimated landings of unidentified jack (Carangidae and Seriola spp.) in the earlier years of the MRFSS database are considerable. 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 Recreational Working Group analyzed the ratios of greater amberjack landings and discards over all other identified amberjacks and jacks by year. The average ratios of greater amberjack over identified amberjacks and jacks by year groups is shown below.

	Year group	Landings	Discards
Seriola (unidentified amberjack genus)	1981-1990	0.94	0.98
	1991-2012	0.77	0.98
Carangidae (unidentified jack family)	1981-1990	0.38	0.05
	1991-2012	0.14	0.10

The working group recommended this break in year groups around the 1990 size regulation change. Landings and discards were treated separately. A review of SERHS data suggested a disproportionate reduction in greater amberjack in the landings following the size-limit introduction. These recommendations differ slightly from SEDAR 9, where ratios were developed and applied by year, wave, mode, and state.

Monroe County

Monroe County MRFSS landings from 1981 to 2003 can be post-stratified to separate them from the MRFSS West Florida estimates. Post-stratification proportionally distributes the state-wide (FLE and FLW) effort into finer scale sub-regions and then produces effort estimates at this finer geographical scale. This is needed for the private and shore modes (all years) and charter boat mode (prior to FHS). FHS charter boat mode estimates are already pre-stratified, as discussed above. Monroe County MRIP landings from 2004 to 2012 can be estimated separately from the remaining West Florida estimates using domain estimation. The Monroe County domain includes only intercepted trips returning to that county as identified in the intercept survey data. Estimates are then calculated within this domain using standard design-based estimation which incorporates the MRIP design stratification, clustering, and sample weights.

Although Monroe county estimates can be separated using these processes, they cannot be partitioned into those from the Atlantic Ocean and those from the Gulf of Mexico. In the South Atlantic assessment for greater amberjack (SEDAR 15) Monroe county landings were included in the South Atlantic stock, stating that a major portion of the greater amberjack landings in Monroe County come from the Atlantic side of the island chain. In the previous assessment of Gulf of Mexico greater amberjack (SEDAR 9) these stratified estimates were not available. However, when dealing with Headboat Survey landings, SEDAR 9 allocated headboat areas 12 and 17 to the Atlantic side. In addition, the commercial workgroup for this SEDAR indicated that since 2006 about 90% of the commercial landings are from a South Atlantic area of capture. For all these reasons the recreational workgroup decided to allocate the Monroe county landings to the Atlantic and exclude them from this Gulf of Mexico assessment.

MRIP landings in numbers of fish and in whole weight in pounds are presented in Table 4.10.4. CVs associated with estimated landings in numbers are also shown.

4.3.2 Southeast Region Headboat Survey

Introduction

The Southeast Region Headboat Survey (SRHS) estimates landings and effort for headboats in the Gulf of Mexico. The SRHS began in the Gulf of Mexico in 1986 and extends from Naples, FL to South Padre Island, TX. Mississippi headboats were added to the survey in 2010. The South Atlantic and Gulf of Mexico Headboat Surveys generally include 70-80 vessels participating in each region annually. The Headboat Survey incorporates two components for estimating catch and effort. (1) Information about the size of fishes landed are collected by port samplers during dockside sampling, where fish are measured to the nearest mm and weighed to the nearest 0.01 kg. These data are used to generate mean weights for all species by area and month. Port samplers also collect otoliths for ageing studies during dockside sampling events. (2) Information about total catch and effort are collected via the logbook, a form filled out by vessel personnel and containing total catch and effort data for individual trips. The logbooks are summarized by vessel to generate estimated landings by species, area, and time strata. The SRHS does not generate variances of the landings estimates.

The Headboat Survey was inconsistent in LA in 2002-2006. There were no trip reports collected in LA in 2002. Trip reports from 2001 were used (by the HBS) as a substitute to generate estimates numbers caught (though there are some minor differences between the resulting estimates for the two years). In 2003, there were only a few trip reports but they were still used to generate the estimates. From 2004 to 2006 there were no trip reports or fish sampled, and no substitutes were used, so there are no estimates or samples from 2004 to 2006 due to funding issues and Hurricane Katrina. However, the MRFSS/MRIP For-Hire Survey included the LA headboats in their charter mode estimates for these years thereby eliminating this hole in the headboat mode estimates.

The SEDAR 9 DW Panel and SEDAR 10 DW panel (Matter, 2006) reported that greater than 99% of the trips in the Florida Keys (headboat area 12) and the Dry Tortugas (Area 17) landed fish caught from the Atlantic Ocean. As in previous Gulf of Mexico greater amberjack stock evaluations, landings from trips fishing in Gulf of Mexico greater amberjack the Florida Keys (headboat area 12) and landings from Atlantic based vessels to the Dry Tortugas (Area 17) were excluded.

Texas headboat estimates 1981-1985

Headboat landings estimates from 1981-1985 come from the MRFSS/MRIP survey for all states except Texas. The standard method used in past SEDARs (SEDAR 28-DW12) and applied here is to use the average Texas headboat mode estimates from SRHS from 1986-1988 to fill in the missing years. This differs slightly from SEDAR 9 when average Texas headboat estimates from 1986-1989 were used.

SRHS landings in numbers of fish and in whole weight in pounds are presented in Table 4.10.5.

4.3.3 Texas Parks and Wildlife Department

Introduction

The TPWD Sport-boat Angling Survey was implemented in May 1983 and samples fishing trips made by sport-boat anglers fishing in Texas marine waters. All sampling takes place at recreational boat access sites. The raw data include information on catch, effort and length composition of the catch for sampled boat-trips. These data are used by TPWD to generate recreational catch and effort estimates. The survey is designed to estimate landings and effort by high-use (May 15-November 20) and low-use seasons (November 21-May 14). SEFSC personnel disaggregated the TPWD seasonal estimates into waves (2 month periods) using the TPWD intercept data. This was done to make the TPWD time series compatible with the MRFSS/MRIP time series. TPWD surveys private and charterboat fishing trips. While TPWD samples all trips (private, charterboat, ocean, bay/pass), most of the sampled trips are associated with private boats fishing in bay/pass, as these trips represent most of the fishing effort. Charterboat trips in ocean waters are the least encountered in the survey.

Producing landings estimates in weight

In the TPWD survey, landings estimates are produced only in number of fish. In addition, the TPWD sample data does not provide weights, only lengths of the intercepted fish. Because TPWD length samples are measured as maximum possible total lengths, a TPWD length-weight equation for greater amberjack (W=10^(-5.848 +(3.281*log10(L))) where W is gutted weight in grams and L is maximum total length in mm) was used to convert lengths to weights (derived, TPWD). The SEFSC method (described above) was applied to the TPWD landings to obtain estimated landings in weight.

1981-1983 Texas estimates

The TPWD survey began with the high-use season in 1983 (May15, 1983). Texas charter and private mode estimates do not exist from the start of 1981 to May of 1983. Averages from TPWD 1983-1985 by mode and wave were used to fill in the missing estimates. These substitutions were not done in the previous assessment.

TPWD landings in numbers of fish and in whole weight in pounds for Texas are presented in Table 4.10.6.

4.3.4 Estimating Historical Recreational Landings

The historic time period for greater amberjack landings in the Gulf of Mexico is defined as pre-1981, and prior to the start of the Marine Recreational Fisheries Statistics Survey (MRFSS). Historic landing estimates will be developed using and presented during the Assessment Workshop.

4.4 Recreational Discards

A map and figures summarizing all recreational discards of greater amberjack in the Gulf of Mexico are provided in Figure 4.11.4.

4.4.1 MRFSS/MRIP discards

Discarded live fish are reported by the anglers interviewed by the MRIP/MRFSS. Consequently, neither the identity nor the quantities reported are verified. In a routine review, a spike in the 2001 discards was identified and investigated. The spike was due to a single intercept reporting a discard of 100 greater amberjack in Alabama wave 2. Although the high number was likely due to species misidentification, through a discussion with Alabama Marine Resources Division, it was decided that discard should have been distributed across the 4 anglers on the trip, rather than being assigned to a single angler.

Lengths and weights of discarded fish are not sampled or estimated by the MRFSS/MRIP. To characterize the size distribution of live discarded fishes, at-sea sampling of headboat discards was initiated in Alabama in 2004 and expanded to FLW in 2005 as part of the improved for-hire survey (SEDAR33-DW4).

MRFSS/MRIP estimates of live released fish (B2 fish) were adjusted in the same manner as the landings (i.e. using charterboat calibration factors, MRIP adjustment, substitutions, etc. described above in section 4.3.1). MRIP discards in numbers of fish and associated CVs are presented in Table 4.10.7.

4.4.2 Headboat Logbook Discards

The Southeast Region Headboat Survey (SRHS) logbook form was modified in 2004 to include a category to collect self-reported discards for each reported trip. This category is described on the form as the number of fish by species released alive and number released dead. Port agents instructed each captain on criteria for determining the condition of discarded fish. A fish is considered "released alive" if it is able to swim away on its own. If the fish floats off or is obviously dead or unable to swim, it is considered "released dead". These self-reported data are currently not validated within the Headboat Survey. The SRHS discard ratios were compared with the At-Sea Observer Data discard ratios in order to assess the validity of these discard estimates. The working group also compared the observer data to the MRIP charterboat discard ratio, which was used in SEDAR 9 as a proxy to estimate the headboat discards. After analyzing the different ratios, the working group chose to use the MRIP charterboat discard ratio as a proxy for all years, as charterboat ratios most closely matched the At-Sea Observer discards.

Final greater amberjack discard estimates (numbers of fish) from the SRHS by year are presented in Table 4.10.8.

4.4.3 Headboat At-Sea Observer Survey Discards

Observer surveys of recreational headboats provide detailed information of recreational catch, and in particular of recreational discards. Observer surveys were conducted in Alabama from 2004 to 2007, and in West Florida from 2005-2007 and 2009-2012. For each survey, headboat vessels were randomly selected throughout each year in each state. Trained biologists then boarded the selected vessels, with permission from a vessel's captain, and observed anglers as they fished. The data collected included number and species of landed and discarded fish, size of landed and discarded fish, and the release condition of discarded fish (FL only). Observers also recorded length of the trip, area fished (inland, state, and federal waters) and, in Florida, the minimum and maximum depth fished. In the Florida Keys (sub-region 3) some vessels that ran trips longer than 24 hours were also sampled to collect information on trips that fish farther from shore and for longer periods of time, primarily in the vicinity of the Dry Tortugas.

4.4.4 Texas Parks and Wildlife Department Discards

The TPWD recreational survey does not estimate discards. The recreational workgroup evaluated available data and recommended that due to extremely low catches of greater amberjack, a discard rate of zero should be applied. This is consistent with the previous assessment.

4.5 Biological Sampling

Length samples from recreational landings were obtained from the Marine Recreational Fisheries Statistics Survey, the Southeast Region Headboat Survey, the Texas Parks and Wildlife Department, the Fisheries Information Network, and the Trip Interview Program. Additionally, length data were available from observer programs operating in Florida, Alabama, and Louisiana. The years of observer coverage and the number of trips observed are described in Sauls (SEDAR33-DW4).

4.5.1 Sampling Intensity

MRFSS/MRIP Biological Sampling

The MRFSS/MRIP angler intercept survey includes the sampling of fish lengths from the harvested (landed, whole condition) catch. Up to 15 of each species landed per angler interviewed are measured to the nearest mm along a center line (defined as tip of snout to center of tail along a straight line, not curved over body). In those fish with a forked tail, this measure would typically be referred to as a fork length, and in those fish that do not have a forked tail it would typically be referred to as a total length with the exception of some fishes that have a single, or few, caudal fin rays that extend further. Weights are typically collected for the same fish measured although weights are preferred when time is constrained. Ageing structures and other biological samples are not collected during MRFSS/MRIP assignments because of concerns over the introduction of bias to survey data collection.

The number of greater amberjack measured in the Gulf of Mexico (FLW-TX) from

MRFSS/MRIP by year, mode, and state are summarized in Table 4.10.9. The number of angler trips with greater amberjack measured in the Gulf of Mexico (FLW-TX) from MRFSS/MRIP by year, mode, and state are summarized in Table 4.10.10. Shore mode and Monroe county samples have been excluded.

Headboat Survey Biological Sampling

Lengths were collected from 1986 to 2011 by headboat dockside samplers in the Gulf of Mexico, in all of the coastal Gulf States except Mississippi, where sampling started in 2010. Weights are typically collected for the same fish measured during dockside sampling. Also, biological samples (scales, otoliths, spines, stomachs and gonads) are collected routinely and processed for aging, diet studies, and maturity studies. Number of greater amberjack measured for length (either total or fork length) in the headboat fleet by year is presented in Table 4.10.11. Numbers of trips from which greater amberjack were measured (either total or fork) are presented in Table 4.10.12.

Texas Parks and Wildlife Department Biological Sampling

The TPWD Sport-boat Angling Survey samples fishing trips made by sport-boat anglers fishing in Texas marine waters. All sampling takes place at recreational boat access sites. Length composition of the catch for sampled boat-trips has been collected since the high-season of 1983 (mid-May). Total length is measured by compressing the caudal fin lobes dorsoventrally to obtain the maximum possible total length. Weights of sampled fish are not recorded.

The number of greater amberjack measured in the TPWD charter and private-rental modes are summarized by year in Table 4.10.13. The number of trips with measured greater amberjack in the TPWD charter and private-rental modes are summarized by year in Table 4.10.14.

The total number of greater amberjack length and age samples collected from recreational fisheries in the Gulf of Mexico from 1981 to 2012 are presented in Table 4.10.15.

4.5.2 Length Distributions

Recreational Landings

Length frequencies from recreational headboat landings were calculated by year (1992 to 2012). Length frequency histograms for the headboat fishery are presented in Figures 4.11.5. Greater amberjack length frequency distributions for samples collected from recreational charter boat and private boat fisheries located in the Gulf of Mexico from 1981 to 2012 are presented in Figure 4.11.6.

Changes in length frequency distributions were analyzed to examine the possible changes in selectivity-on-size. Changes in length frequency distributions appear to coincide with changes in fishing regulations and fishing behavior. Noticeable differences were found in the length frequency distributions of recreational length samples collected after 2007, when the bag limits per person per boat was cut from 4 to 2. These differences may indicate a change in selectivity on size due to the changes in fishing regulations.

Observer Programs

Length frequency histograms for harvested and discarded greater amberjack by year for Florida headboats, Florida charterboats, Alabama headboats, and Texas charterboats are presented in SEDAR31-DW04.

4.5.3 Recreational Catch-at-Age

Catch-at-age data were unavailable at the time of the data workshop. Matrices will be developed from direct observed age composition and presented at the assessment workshop.

4.6 Recreational Effort

Total recreational effort is summarized below by survey. Effort is summarized for all marine fishing by mode, regardless of what was caught. A map and figures summarizing MRFSS/MRIP and TPWD effort in angler trips are included in Figure 4.11.7. A map and figures summarizing SRHS effort in angler days are included in Figure 4.11.8.

4.6.1 MRFSS/MRIP Effort

Effort estimates for the recreational fishery survey are produced via telephone surveys of both anglers (private/rental boats and shore fishers) and for-hire boat operators (charterboat anglers, and in early years, party or charter anglers). The methods have changed during the full time series (see section 4.3 for descriptions of survey method changes and adjustments to survey estimates for uniform time-series of catch estimates). An angler-trip is a single day of fishing in the specified mode, not to exceed 24 hours. Monroe county, Texas, and shore mode effort estimates have been excluded from the MRFSS/MRIP estimates since these strata were excluded from the landings estimates of greater amberjack. Gulf of Mexico (FLW-TX) estimated number of angler trips for MRFSS (1981-2003) and MRIP (2004-2012) by year and state are presented in Table 4.10.16.

4.6.2 Headboat Effort

Headboats report catch and effort data for each trip via the SHRS logbooks. The captain of the vessel or designated crew member completes a logbook form for each trip. The form details the total number and weight of all the species kept, along with the total number of fish discarded for each species. Numbers of anglers on a given trip represents the measure of effort reported in the SRHS logbooks. Numbers of anglers are standardized, depending on the type of trip (length in hours), by converting number of anglers to “angler days” (e.g., 40 anglers on a half-day trip would yield 40 * 0.5 = 20 angler days). This standardization assumes that all anglers fished the entire time. Angler days are summed by month for individual vessels. Each month, port agents collect these logbook trip reports and check for accuracy and completeness. Although reporting via the logbooks is mandatory, compliance is not 100% and is variable by location. To account for non-reporting, a correction factor is developed based on sampler observations, angler numbers from office books and all available information. This information is used to provide estimates of total catch by month and area, along with estimates of effort.

Estimated headboat angler days are tabulated in Table 4.10.17. Estimated headboat angler days have decreased in the Gulf of Mexico in recent years. The most obvious factor which impacted the headboat fishery in both the Atlantic and Gulf of Mexico was the high price of fuel. This, coupled with the economic down, turn starting in 2008, has resulted in a marked decline in angler days in the Gulf of Mexico headboat fishery. Reports from industry staff, captains/owners, and port agents indicated fuel prices, the economy and fishing regulations are the factors that most affected the amount of trips, number of passengers, and overall fishing effort. Also important to note, is the decrease in effort in the Gulf of Mexico in 2010, the year of the Deepwater Horizon oil spill.

4.6.3 Texas Parks and Wildlife Effort

The TPWD survey is designed to estimate landings and effort by high-use (May 15-November 20) and low-use seasons (November 21-May 14). Only private and charterboat fishing modes are surveyed. Most of the sampled trips are from private boats fishing in bays/passes because these represent most of the fishing effort, but all trips (private, charterboat, ocean, bays/passes) are sampled. Charterboat trips in ocean waters are the least encountered in the survey. Estimates of TPWD angler trips are shown in Table 4.10.18 by year and season.

4.7 Tasks to Be Completed

1) Task: estimate historical recreational landings. Responsibility: Adyan Rios, NOAA Fisheries Expected Completion Date: To be presented into an Assessment Workshop working paper.

4.8 Research Recommendations

1) Evaluate the technique used to apply sample weights to landings.
2) Develop methods to identify angler preference and targeted effort.
3) Continue and expand fishery dependent at sea observer surveys to collect discard information. This would help to validate self-reported headboat discard rates.
4) Track Texas commercial and recreational discards.
6) Evaluate existing and new methods to estimate historical landings

4.9 Literature Cited

Diaz, G.A. and P.L. Phares. 2004. SEDAR7-AW03 Estimating conversion factors for calibrating MRFSS charterboat landings and effort estimates for the Gulf of Mexico in 1981-1997 with For-Hire Survey estimates with application to red snapper landings. National Marine Fisheries Service Southeast Fisheries Science Center, Sustainable Fisheries Division, Miami, FL.

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Sauls, B. and B. Cermak. 2013. SEDAR33-DW4 Characterization of Greater amberjack Discards in Recreational For-Hire Fisheries. Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, Saint Petersburg, FL.

SEDAR 9 Stock Assessment Report 1: Gulf of Mexico Greater Amberjack. SEDAR, North Charleston, SC 29405.

SEDAR 15 Stock Assessment Report 2: South Atlantic Greater Amberjack. SEDAR, North Charleston, SC 29405.

SEDAR 31 Stock Assessment Report: Gulf of Mexico Red Snapper. SEDAR, North Charleston, SC 29405.

4.10 Tables

Table 4.10.1 Gulf of Mexico MRFSS charterboat conversion factors and standard errors (in parentheses).

a) Apply to 1981-1985 charterboat/headboat mode in the Gulf of Mexico.

	WAVE					
STATE	1	2	3	4	5	6
AFW	0.883 (0.03)	0.883 (0.03)	1.104 (0.05)	1.104 (0.05)	0.883 (0.03)	0.883 (0.03)
MS	1.155 (0.11)	1.155 (0.11)	2.245 (0.11)	2.245 (0.11)	1.155 (0.11)	1.155 (0.11)
LA	0.962 (0.09)	0.962 (0.09)	2.260 (0.13)	2.260 (0.13)	0.962 (0.09)	0.962 (0.09)

b) Apply to 1986 – 1997 charterboat mode in LA, MS, and AL

	WAVE					
Area	1	2	3	4	5	6
Inshore	1.26 (1.31)	1.54 (1.27)	3.82 (1.26)	4.67 (1.26)	3.28 (1.27)	1.48 (1.28)
< 3 miles	0.74 (1.37)	0.75 (1.26)	1.49 (1.25)	2.28 (1.24)	0.64 (1.28)	0.52 (1.40)
> 3 miles	0.44 (1.28)	0.63 (1.24)	2.23 (1.23)	1.87 (1.24)	1.26 (1.23)	0.53 (1.28)

c) Apply to 1986- 1997 charterboat mode in FLW

	WAVE					
Area	1	2	3	4	5	6
Inshore	3.17 (0.16)	5.31 (0.16)	5.71 (0.16)	5.33 (0.16)	3.49 (0.16)	3.70 (0.16)
< 10 miles	0.95 (0.16)	1.10 (0.16)	1.78 (0.16)	0.70 (0.16)	0.48 (0.16)	0.98 (0.16)
> 10 miles	0.38 (0.16)	0.58 (0.16)	0.77 (0.16)	0.73 (0.16)	0.59 (0.16)	0.55 (0.16)

Table 4.10.2 Greater amberjack MRIP vs. MRFSS estimates of landings (number of fish) for the Gulf of Mexico 2004-2011. See accompanying graph below table.

Estimate Status	Year	Fishing Year	Common Name	MRFSS Unweighted Total Harvest (A+B1)	MRIP Weighted Total Harvest (A+B1)	Difference: MRIP - MRFSS	% Change from MRFSS	PSE for MRIP Weighted Total Harvest (A + B1)
FULL YEAR	2004	Calendar Year (Jan 1 - Dec 31)	GREATER AMBERJACK	102,856	122,947	20,092	19.5%	17.5
FULL YEAR	2005	Calendar Year (Jan 1 - Dec 31)	GREATER AMBERJACK	83,451	92,040	8,590	10.3%	23.7
FULL YEAR	2006	Calendar Year (Jan 1 - Dec 31)	GREATER AMBERJACK	61,640	81,251	19,611	31.8%	15.6
FULL YEAR	2007	Calendar Year (Jan 1 - Dec 31)	GREATER AMBERJACK	49,630	57,896	8,266	16.7%	16.9
FULL YEAR	2008	Calendar Year (Jan 1 - Dec 31)	GREATER AMBERJACK	65,994	72,625	6,631	10.0%	15.6
FULL YEAR	2009	Calendar Year (Jan 1 - Dec 31)	GREATER AMBERJACK	70,380	69,980	-400	-0.57%	17.1
FULL YEAR	2010	Calendar Year (Jan 1 - Dec 31)	GREATER AMBERJACK	67,156	70,828	3,672	5.47%	21.7
FULL YEAR	2011	Calendar Year (Jan 1 - Dec 31)	GREATER AMBERJACK	53,822	50,169	-3,653	-6.79%	13.7

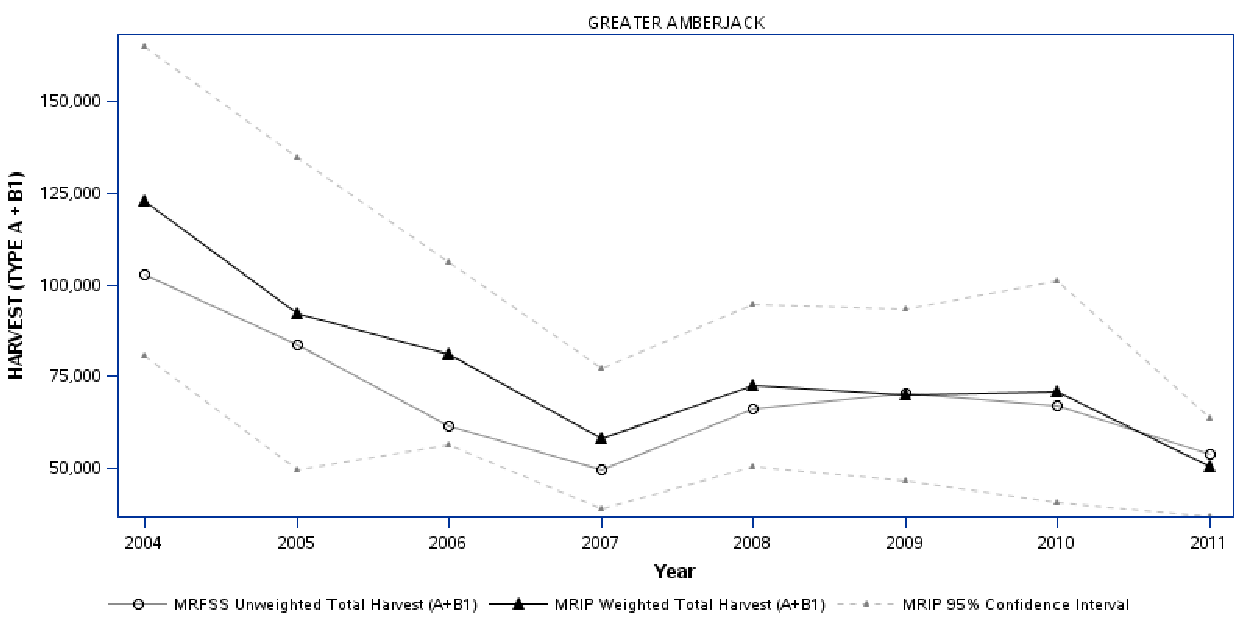


Table 4.10.3. Gulf of Mexico greater amberjack ratio estimators for adjusting MRFSS numbers and variance estimates (AB1 and B2) to MRIP numbers and variances for 1981-2003. The variances of the numbers ratio estimators are also shown.

	Numbers Ratio Estimator		Variance Ratio Estimator		Variance of Numbers Ratio Estimator	
MODE	**AB1**	**B2**	**AB1**	**B2**	**AB1**	**B2**
Charterboat	0.990659896	0.967315409	2.469089429	1.865918	0.000933099	0.001180978
Private	1.245957492	1.250137192	3.803004763	5.413436486	0.004990444	0.010505172
Shore		0.717537942		0.820368866		0.016672914
All	1.113184232	1.149810858	3.565618084	4.608392042	0.001558197	0.006364998

Table 4.10.4. Gulf of Mexico (FLW-LA) greater amberjack landings (numbers of fish and whole weight in pounds) from MRIP by year. Estimates from 1981-2003 have been adjusted to MRIP numbers. *CVs for 1981-1985 only reflect the private and shore mode CVs, since charter and headboat mode CVs are unavailable.

YEAR	Number	CV_num	Weight (lbs)
1981	126,547	0.59*	1,021,089
1982	495,560	0.26*	4,332,938
1983	251,713	0.32*	2,663,914
1984	189,811	1.76*	1,939,710
1985	236,755	0.99*	3,246,207
1986	377,766	0.34	5,600,709
1987	359,797	0.33	2,213,538
1988	264,687	0.30	2,143,326
1989	381,288	0.32	4,821,410
1990	47,931	0.65	606,523
1991	239,073	0.46	3,137,175
1992	136,811	0.22	1,834,438
1993	129,962	0.33	2,264,542
1994	94,229	0.28	1,422,498
1995	38,171	0.78	613,819
1996	79,520	0.31	1,188,452
1997	42,960	0.31	956,691
1998	60,822	2.03	1,243,262
1999	46,454	0.22	733,997
2000	55,002	0.18	917,941
2001	73,827	0.20	1,382,298
2002	120,999	0.13	1,907,812
2003	160,743	0.15	2,687,581
2004	118,377	0.19	2,249,552
2005	89,746	0.28	1,451,739
2006	75,315	0.17	1,560,151
2007	44,305	0.14	785,339
2008	69,475	0.18	1,209,542
2009	68,931	0.17	1,377,371
2010	58,901	0.24	1,181,379
2011	47,468	0.15	874,769
2012	56,933	0.14	1,194,976

Table 4.10.5 Gulf of Mexico greater amberjack landings (number of fish) from the SRHS by year. 1981-1985 headboat mode landings are substitutes for missing Texas headboat mode.

YEAR	Number	Weight (lbs)
1981	8,867	59,982
1982	8,867	59,982
1983	8,867	59,982
1984	8,867	59,982
1985	8,867	59,982
1986	86,024	750,632
1987	52,892	378,888
1988	29,660	173,613
1989	52,521	204,289
1990	24,260	77,654
1991	9,852	102,687
1992	19,747	312,152
1993	14,053	225,868
1994	13,116	213,119
1995	8,670	143,994
1996	10,511	139,588
1997	7,538	125,349
1998	5,110	88,595
1999	5,286	73,508
2000	6,000	100,732
2001	6,009	89,436
2002	10,689	160,636
2003	11,976	199,347
2004	6,242	108,769
2005	3,993	61,281
2006	4,726	79,892
2007	4,462	59,436
2008	4,823	54,544
2009	5,239	103,191
2010	2,571	53,203
2011	2,992	62,835
2012	3,836	99,680

Table 4.10.6 Texas greater amberjack landings (number of fish and whole weight in pounds) from TPWD by year.

YEAR	Number	Weight (lbs)
1981	982	8,247
1982	982	8,247
1983	417	5,553
1984	991	12,086
1985	1,538	7,104
1986	1,408	9,742
1987	607	3,868
1988	425	3,285
1989	437	4,113
1990	236	2,986
1991	438	5,502
1992	303	4,281
1993	66	1,103
1994	302	4,708
1995	890	12,441
1996	1,331	20,162
1997	987	11,055
1998	359	6,713
1999	433	7,062
2000	574	9,751
2001	780	13,031
2002	2,239	36,397
2003	2,372	40,967
2004	586	16,872
2005	847	20,917
2006	424	9,910
2007	1,069	16,774
2008	640	11,336
2009	128	2,643
2010	259	5,301
2011	150	2,943
2012	223	4,853

Table 4.10.7 Gulf of Mexico (FLW-LA) greater amberjack discards (numbers of fish) from MRIP by year. Estimates from 1981-2003 have been adjusted to MRIP numbers. *CVs for 1981-1985 only reflect the private and shore mode CVs, since charter and headboat mode CVs are unavailable.

YEAR	Discards	CV
1981	17,887	0.78*
1982	66,070	0.92*
1983	95,756	1.62*
1984	26,646	0.96*
1985	8,507	1.67*
1986	55,709	0.42
1987	33,121	0.58
1988	77,296	0.71
1989	124,605	0.95
1990	79,404	1.14
1991	247,251	0.29
1992	161,486	0.29
1993	157,520	0.31
1994	110,946	0.45
1995	66,737	0.53
1996	63,590	0.47
1997	48,629	0.39
1998	105,089	0.44
1999	95,339	0.28
2000	134,378	0.35
2001	548,751	0.43
2002	316,296	0.23
2003	261,787	0.31
2004	175,115	0.31
2005	211,553	0.31
2006	180,319	0.48
2007	188,085	0.30
2008	178,143	0.17
2009	137,730	0.15
2010	305,113	0.18
2011	179,098	0.21
2012	112,233	0.18

Table 4.10.8 Headboat mode greater amberjack discards (numbers of fish) for SRHS by year. 1981-1985 headboat mode discards are substitutes for missing Texas headboat mode.

YEAR	Discards
1981	488
1982	488
1983	488
1984	488
1985	488
1986	11,371
1987	640
1988	381
1989	3,053
1990	25,655
1991	9,407
1992	17,268
1993	14,056
1994	10,283
1995	9,022
1996	9,706
1997	5,429
1998	12,856
1999	8,948
2000	5,212
2001	12,149
2002	11,800
2003	10,249
2004	2,929
2005	3,911
2006	2,748
2007	5,215
2008	10,505
2009	9,232
2010	4,043
2011	4,230
2012	4,059

Table 4.10.9 Number of greater amberjack measured in the Gulf of Mexico in the MRFSS/MRIP by year, mode, and state.

	Cbt					Hbt				Priv					Grand
YEAR	LA	MS	AL	FLW	All	LA	AL	FLW	All	LA	MS	AL	FLW	All	Total
1981	2		10	17	29		3	1	4	9		6	18	33	66
1982			5	48	53	7		23	30	19		1	27	47	130
1983	33			49	82	21		30	51	7			4	11	144
1984	75			22	97	6		9	15	2				2	114
1985	14			8	22			30	30				2	2	54
1986	56		13	167	236							2	6	8	244
1987	100		118	423	641							11	150	161	802
1988			78	100	178					3			23	26	204
1989	13		66	38	117					6			9	15	132
1990			21	5	26							5	5	10	36
1991	63	3	79	93	238							5	4	9	247
1992	72		398	169	639					1		25	5	31	670
1993	10		40	59	109							4	8	12	121
1994	3	1	45	13	62					4		2	5	11	73
1995	4		6	25	35						1	1	1	3	38
1996	10		10	21	41					4		6	2	12	53
1997	5		27	79	111					3	1	1	1	6	117
1998	3		25	171	199								7	7	206
1999	10		64	468	542							25	14	39	581
2000	10		132	601	743					1		13	8	22	765
2001	22		77	328	427							30	9	39	466
2002	84		120	749	953							33	15	48	1,001
2003	98		218	703	1,019							55	21	76	1,095
2004	83		70	477	630					2		20	12	34	664
2005	22		35	213	270							34	18	52	322
2006	143		31	300	474							1	11	12	486
2007	46		48	216	310							3	6	9	319
2008	19		14	150	183					2	1	3	14	20	203
2009	13		6	185	204					6		1	5	12	216
2010	15		49	232	296							6	33	39	335
2011	14		26	422	462								25	25	487
2012	15		30	438	483					5		2	27	34	517
Grand Total	1,057	4	1,861	6,989	9,911	34	3	93	130	74	3	295	495	867	10,908

Table 4.10.10 Number of angler trips with measured greater amberjack in the Gulf of Mexico in the MRFSS/MRIP by year, mode, and state.

	Cbt					Hbt				Priv					Grand
YEAR	LA	MS	AL	FLW	All	LA	AL	FLW	All	LA	MS	AL	FLW	All	Total
1981	2		1	6	9		1	1	2	1		2	5	8	19
1982			3	12	15	7		14	21	8		1	10	19	55
1983	13			11	24	7		21	28	2			2	4	56
1984	13			16	29	5		7	12	1				1	42
1985	2			3	5			19	19				2	2	26
1986	17		5	24	46							2	4	6	52
1987	16		21	70	107							2	51	53	160
1988			19	28	47					3			12	15	62
1989	4		17	11	32					2			7	9	41
1990			12	3	15							3	3	6	21
1991	19	2	24	24	69							4	4	8	77
1992	24		85	47	156					1		14	5	20	176
1993	5		7	30	42							4	7	11	53
1994	2	1	13	7	23					3		1	4	8	31
1995	2		3	7	12						1	1	1	3	15
1996	4		4	8	16					2		3	2	7	23
1997	5		9	29	43					1	1	1	1	4	47
1998	2		11	67	80								7	7	87
1999	2		14	148	164							13	8	21	185
2000	3		36	171	210					1		8	6	15	225
2001	4		21	104	129							23	6	29	158
2002	23		31	181	235							14	8	22	257
2003	21		45	191	257							21	12	33	290
2004	20		20	155	195					1		10	9	20	215
2005	10		8	78	96							20	12	32	128
2006	34		10	75	119							1	7	8	127
2007	14		8	86	108							2	3	5	113
2008	8		7	64	79					1	1	2	12	16	95
2009	3		4	57	64					2		1	4	7	71
2010	5		10	89	104							4	17	21	125
2011	5		8	137	150								15	15	165
2012	6		12	135	153					3		1	18	22	175
Grand Total	288	3	468	2,074	2,833	19	1	62	82	32	3	158	264	457	3,372

Table 4.10.11 Number of greater amberjack measured in the Gulf of Mexico in the SRHS by year and area. Due to SRHS area definitions, West Florida and Alabama data are combined.

year	TX	LA	AL/FLW	All States
1986	209	18	371	598
1987	260	16	267	543
1988	189	20	163	372
1989	277	105	915	1,297
1990	107		130	237
1991	72	50	67	189
1992	87	210	68	365
1993	107	93	45	245
1994	141	24	91	256
1995	151	74	52	277
1996	47	76	36	159
1997	20	64	29	113
1998	30	70	28	128
1999	7	96	27	130
2000	4	33	88	125
2001	16	143	58	217
2002	14	124	24	162
2003	71	124	93	288
2004	52		21	73
2005	15	14	1	30
2006	10		15	25
2007	40		22	62
2008		66	32	98
2009	3	108	47	158
2010	13		32	45
2011	2	47	39	88
2012	162	142	39	343
Grand Total	2,106	1,717	2,800	6,623

Table 4.10.12 Number of trips with measured greater amberjack in the Gulf of Mexico in the SRHS by year and area. Due to SRHS area definitions, West Florida and Alabama data are combined.

year	TX	LA	AL/FLW	All States
1986	92	6	124	222
1987	74	6	100	180
1988	43	8	58	109
1989	46	34	225	305
1990	17		40	57
1991	22	9	36	67
1992	23	31	36	90
1993	40	31	20	91
1994	43	12	41	96
1995	55	33	22	110
1996	19	20	18	57
1997	10	20	15	45
1998	18	28	10	56
1999	6	36	13	55
2000	4	11	29	44
2001	4	35	22	61
2002	5	26	14	45
2003	32	29	33	94
2004	15		13	28
2005	9	4	1	14
2006	7		12	19
2007	12		14	26
2008		15	22	37
2009	2	23	27	52
2010	5		21	26
2011	1	6	15	22
2012	45	16	16	77
Grand Total	649	439	997	2,085

Table 4.10.13 Number of gag measured in the state of Texas in the TPWD by year and mode. 2012 data is through Nov 20th.

YEAR	Cbt	Priv	Grand Total
1983		18	18
1984		17	17
1985	4	78	82
1986	5	45	50
1987		24	24
1988	1	13	14
1989	2	9	11
1990		7	7
1991		20	20
1992	1	13	14
1993	6	6	12
1994		26	26
1995	6	35	41
1996	6	50	56
1997	8	36	44
1998	1	11	12
1999	2	13	15
2000	2	13	15
2001	17	26	43
2002	23	43	66
2003	24	46	70
2004	22	22	44
2005	18	18	36
2006	16	15	31
2007	38	15	53
2008	12	13	25
2009	4	21	25
2010	7	5	12
2011		13	13
2012		12	12
Grand Total	225	683	908

Table 4.10.14 Number of trips with measured greater amberjack in the state of Texas in the TPWD by year and mode. 2012 data is through Nov 20th.

YEAR	Cbt	Priv	Grand Total
1983		8	8
1984		10	10
1985	1	30	31
1986	1	15	16
1987		11	11
1988	1	7	8
1989	1	6	7
1990		6	6
1991		7	7
1992	1	7	8
1993	1	4	5
1994		12	12
1995	1	21	22
1996	2	27	29
1997	4	24	28
1998	1	8	9
1999	1	8	9
2000	1	8	9
2001	4	13	17
2002	6	19	25
2003	9	26	35
2004	6	12	18
2005	3	9	12
2006	8	11	19
2007	10	7	17
2008	5	11	16
2009	2	10	12
2010	2	3	5
2011		8	8
2012		6	6
Grand Total	71	354	425

Table 4.10.15 Number of greater amberjack length and age samples collected from recreational fisheries in the Gulf of Mexico from 1981 to 2012.

Year	Age samples headboat	Length samples headboat	Age samples charter boat & private boat	Length samples charter boat & private boat
1981	0	4	0	55
1982	0	30	0	97
1983	0	50	0	103
1984	0	14	0	98
1985	0	30	0	146
1986	0	597	0	280
1987	0	549	0	806
1988	0	366	0	214
1989	1	1292	0	133
1990	28	239	1	39
1991	4	420	2	292
1992	1	424	0	702
1993	1	318	0	130
1994	20	340	0	179
1995	17	277	0	69
1996	28	164	0	155
1997	8	115	0	141
1998	2	128	0	169
1999	1	130	0	542
2000	21	124	4	732
2001	17	217	5	479
2002	17	173	112	1090
2003	43	288	240	1181
2004	15	74	95	793
2005	17	35	69	400
2006	115	26	63	525
2007	69	62	157	509
2008	1	98	211	317
2009	126	398	363	673
2010	126	300	205	692
2011	73	160	227	761
2012	16	350	381	965

Table 4.10.16 Gulf of Mexico (FLW-TX) estimated number of **angler trips** for MRFSS (1981-2003) and MRIP (2004-2012) by year and state. TX boat mode angler trip estimates have been excluded. Shore mode angler trip estimates have been excluded. Florida Keys angler trip estimates have been excluded.

YEAR	FLW (fl_reg 1 and 2)	AL	MS	LA	Total
1981	3,064,770	306,156	331,601	992,986	4,695,513
1982	2,920,218	632,286	450,394	1,606,279	5,609,177
1983	3,842,743	484,173	538,918	1,786,898	6,652,732
1984	4,694,365	294,567	428,913	1,339,849	6,757,694
1985	4,978,672	294,055	404,970	1,338,503	7,016,200
1986	5,263,208	451,927	585,989	1,974,776	8,275,899
1987	5,456,702	292,391	498,646	1,859,711	8,107,451
1988	7,577,414	498,622	496,169	2,280,703	10,852,909
1989	6,073,002	417,751	430,327	1,754,103	8,675,183
1990	4,825,854	445,817	337,174	1,373,917	6,982,762
1991	5,733,631	360,650	463,812	1,748,850	8,306,942
1992	5,991,806	439,433	438,661	1,984,866	8,854,765
1993	5,509,952	542,996	483,693	2,119,075	8,655,716
1994	6,176,612	515,082	593,685	1,928,957	9,214,336
1995	5,934,015	617,363	636,680	2,400,669	9,588,726
1996	5,978,827	531,573	530,646	2,271,727	9,312,773
1997	6,442,128	653,387	664,141	2,363,251	10,122,907
1998	6,132,351	583,299	497,181	1,922,209	9,135,040
1999	6,177,586	664,380	449,058	2,048,764	9,339,787
2000	8,004,195	607,385	595,473	2,816,590	12,023,643
2001	8,316,767	887,894	694,059	2,764,039	12,662,760
2002	8,464,919	674,451	563,275	2,344,977	12,047,622
2003	9,189,575	912,487	772,027	3,398,922	14,273,010
2004	9,858,380	1,070,189	669,334	3,964,532	15,562,435
2005	9,581,249	883,670	490,337	2,906,178	13,861,434
2006	9,431,852	888,349	633,211	2,988,229	13,941,642
2007	9,782,286	1,060,491	855,175	3,299,482	14,997,433
2008	9,743,935	1,001,860	609,247	3,687,302	15,042,345
2009	8,698,717	940,990	769,572	3,359,031	13,768,310
2010	8,115,378	873,882	636,049	3,133,817	12,759,126
2011	7,705,435	1,281,219	854,602	3,454,320	13,295,576
2012	7,928,147	1,093,906	1,002,563	3,005,813	13,030,429
Total	217,594,691	21,202,681	18,405,583	76,219,325	333,422,280

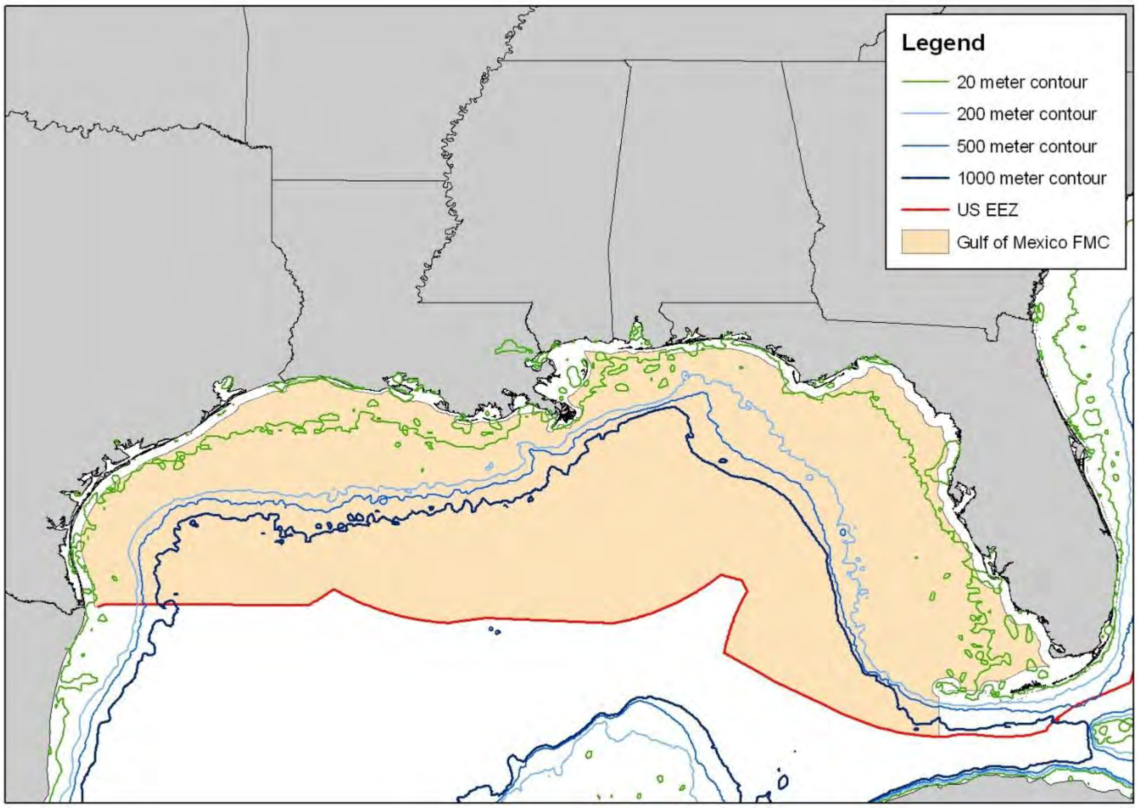
Table 4.10.17 Gulf of Mexico estimated number of **angler days** from SRHS by year and state.

year	AL	FLW	LA	MS	TX	Grand Total
1986	101,336	138,741	5,891		56,568	302,536
1987	76,111	140,938	6,362		63,363	286,774
1988	67,648	128,300	7,691		70,396	274,035
1989	57,233	151,092	2,867		63,389	274,581
1990	60,758	153,148	6,898		58,144	278,948
1991	62,392	111,920	6,373		59,969	240,654
1992	66,180	118,622	9,911		76,218	270,931
1993	73,703	134,195	11,256		80,904	300,058
1994	69,110	135,452	12,651		100,778	317,991
1995	67,798	114,612	10,498		90,464	283,372
1996	64,336	90,577	10,988		91,852	257,753
1997	65,599	83,843	9,008		82,207	240,657
1998	66,664	118,667	7,854		77,650	270,835
1999	60,959	115,158	8,026		58,235	242,378
2000	57,106	102,225	4,952		58,395	222,678
2001	55,748	101,495	6,222		55,361	218,826
2002	55,554	86,277	6,222		66,951	215,004
2003	62,555	81,656	6,636		74,432	225,279
2004	63,494	94,936			64,990	223,420
2005	52,797	77,436			59,857	190,090
2006	66,346	57,703	5,005		70,789	199,843
2007	67,997	68,883	3,076		63,210	203,166
2008	62,118	68,058	2,945		41,188	174,309
2009	65,623	76,815	3,268		50,737	196,443
2010	40,594	70,424	217	498	47,154	158,887
2011	77,303	79,722	1,886	1,771	47,284	207,966
2012	77,770	84,205	1,839	1,841	51,776	217,431
Grand Total	1,764,832	2,785,100	158,542	4,110	1,782,261	6,494,845

Table 4.10.18 Texas estimated number of **angler trips** from TPWD by year and season (High-May 15th -Nov 20th; Low- Nov 21st-May 14th).

Year	High	Low	Total
1983	669,126		669,126
1984	559,713	175,608	735,321
1985	611,251	261,821	873,072
1986	576,966	353,576	930,542
1987	775,656	361,874	1,137,530
1988	729,324	341,819	1,071,143
1989	714,053	243,593	957,645
1990	650,928	220,197	871,125
1991	675,614	225,488	901,102
1992	765,954	264,420	1,030,374
1993	721,964	328,451	1,050,415
1994	792,955	392,843	1,185,798
1995	727,097	426,173	1,153,270
1996	800,241	377,200	1,177,440
1997	776,296	324,887	1,101,183
1998	758,954	326,636	1,085,590
1999	887,954	432,612	1,320,566
2000	828,750	494,748	1,323,498
2001	791,628	359,044	1,150,672
2002	748,641	358,148	1,106,789
2003	762,020	369,657	1,131,677
2004	750,642	375,916	1,126,558
2005	702,874	358,604	1,061,479
2006	724,278	432,511	1,156,790
2007	720,219	337,594	1,057,814
2008	677,825	377,775	1,055,600
2009	711,885	329,143	1,041,027
2010	705,738	285,747	991,485
2011	743,213	382,188	1,125,401
2012	729,598	429,591	1,159,189
Grand Total	21,791,358	9,947,864	31,739,222

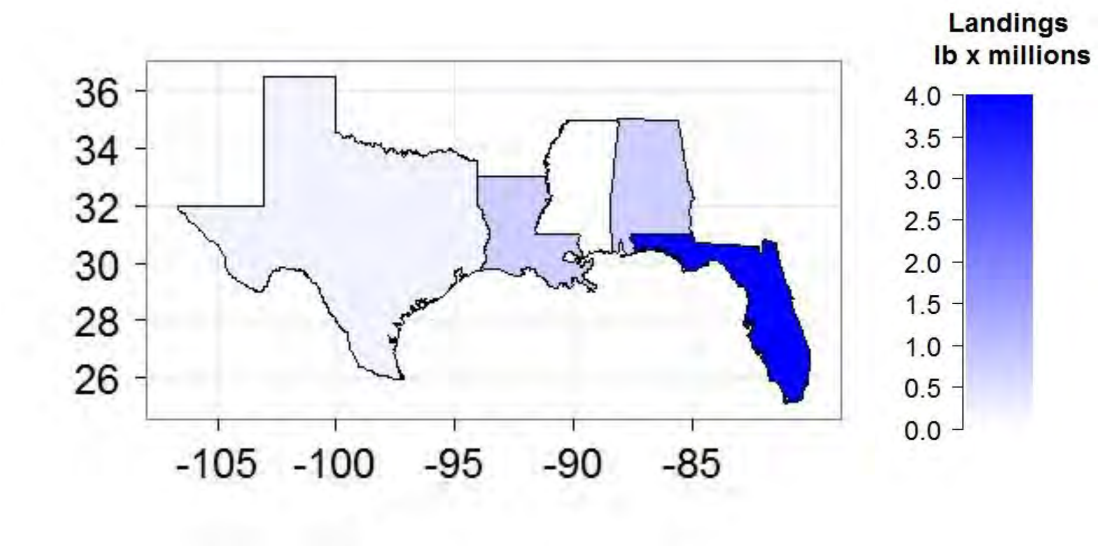
4.11 Figures



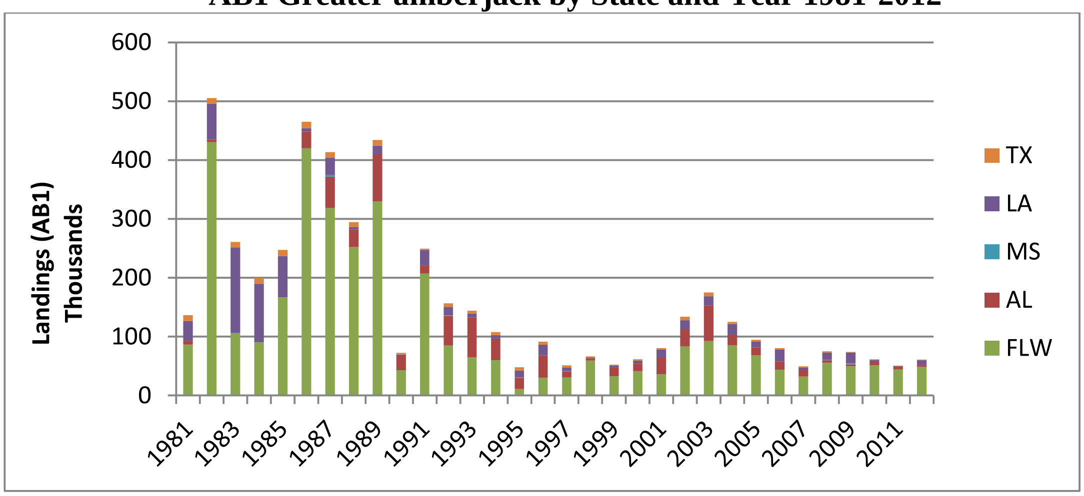
4.11.1 Gulf of Mexico Fishery Management Council Jurisdictional Boundaries.

Figure 4.11.2: Gulf of Mexico recreational ab1 landings (a) and b2 discards (b) for greater amberjack combined years 1981-2012

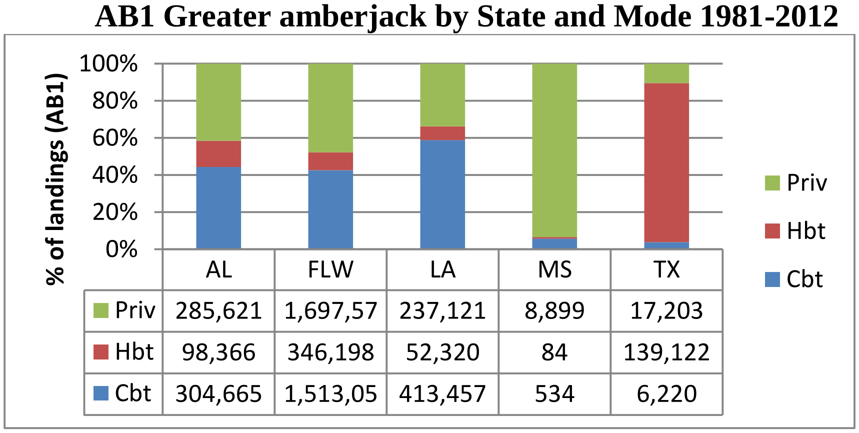
a) **AB1 Greater amberjack by State 1981-2012**



b) **AB1 Greater amberjack by State and Year 1981-2012**



c) **AB1 Greater amberjack by State and Mode 1981-2012**



	AL	FLW	LA	MS	TX
Priv	285,621	1,697,57	237,121	8,899	17,203
Hbt	98,366	346,198	52,320	84	139,122
Cbt	304,665	1,513,05	413,457	534	6,220

Figure 4.11.3 MRFSS AB1 estimates (number of fish) versus MRIP adjusted AB1 estimates for Gulf of Mexico greater amberjack 1981-2003.

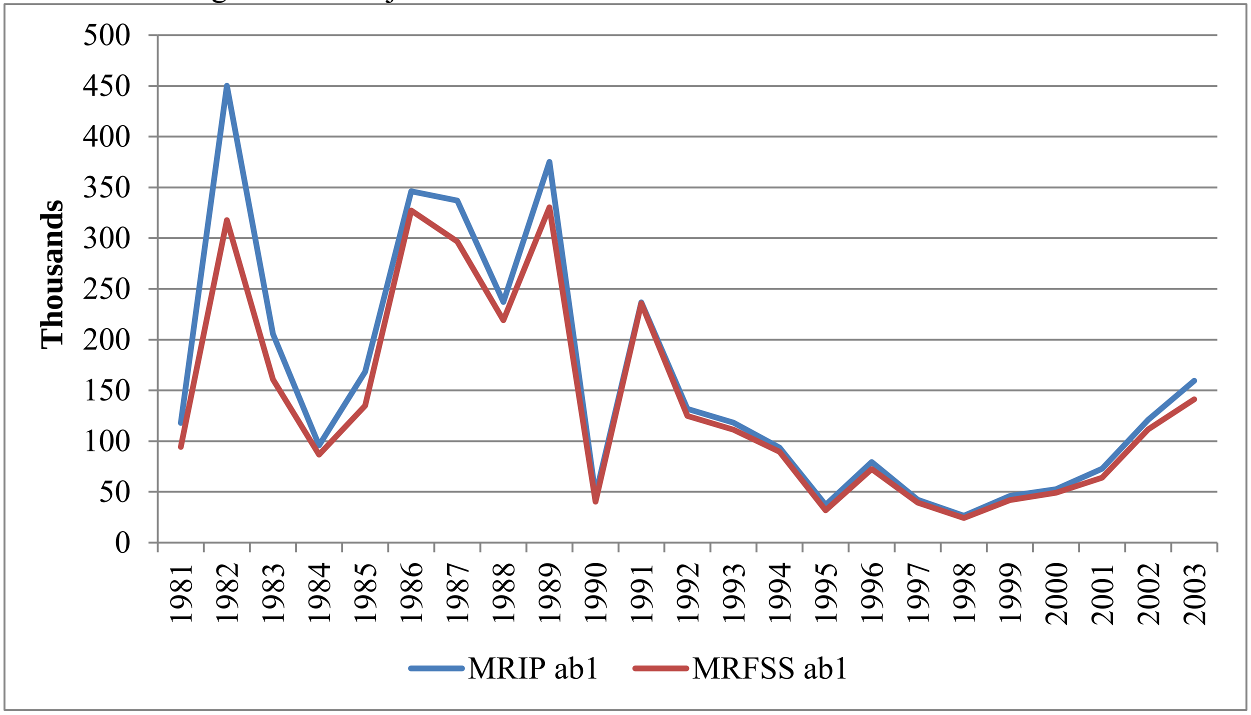
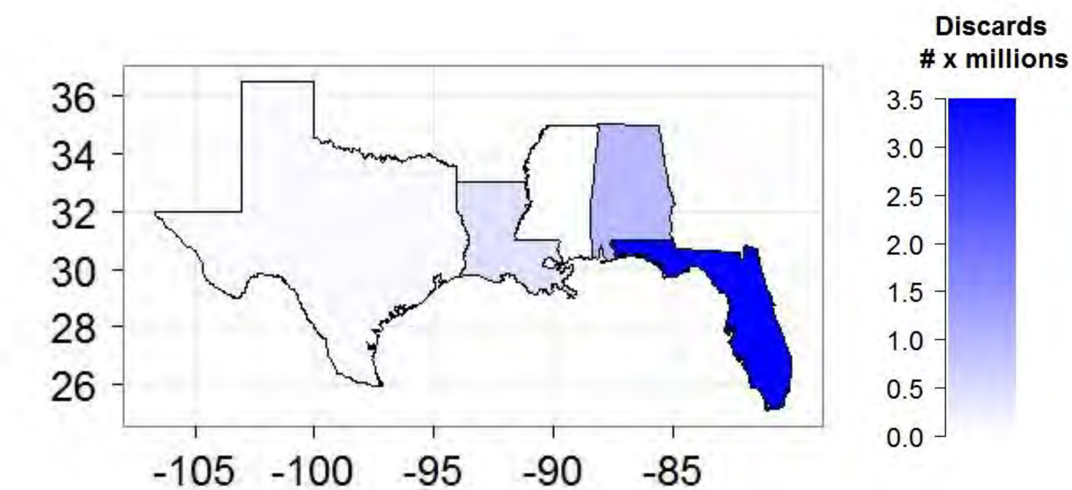
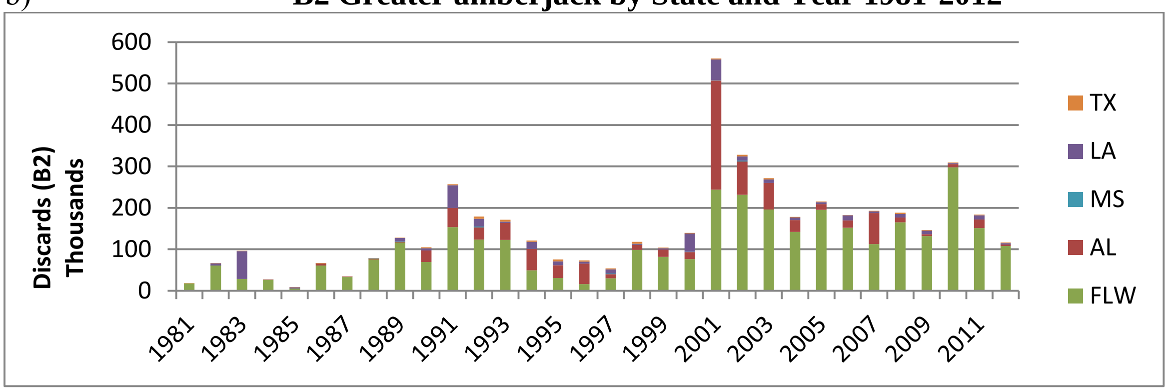


Figure 4.11.4: Gulf of Mexico estimated number of greater amberjack discards from MRFSS/MRIP and TPWD (1981-2011) by state (a), by state and year (b), and by state and mode (c). SRHS discard not yet included.

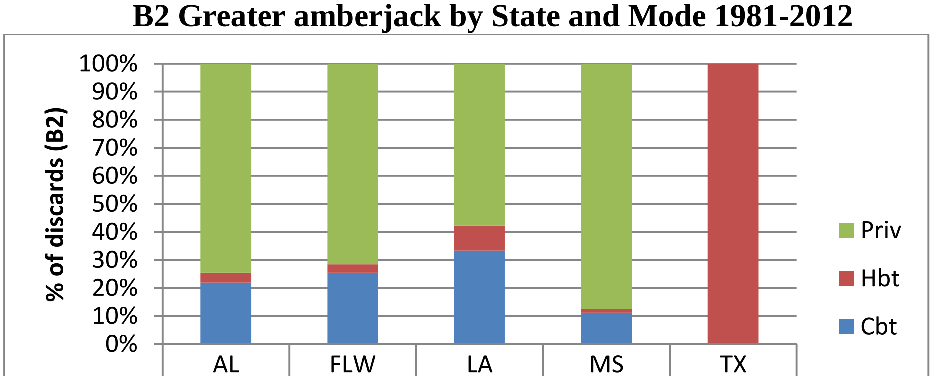
a) **B2 Greater amberjack by State 1981-2012**



b) **B2 Greater amberjack by State and Year 1981-2012**



c) **B2 Greater amberjack by State and Mode 1981-2012**



	AL	FLW	LA	MS	TX
Priv	695,239	2,436,473	223,127	7,672	
Hbt	32,498	102,215	33,956	111	66,148
Cbt	204,783	865,029	128,755	979	

Figure 4.11.5a: Greater amberjack length frequency distributions for samples collected from recreational headboat fisheries located in the Gulf of Mexico from 1991 to 2001.

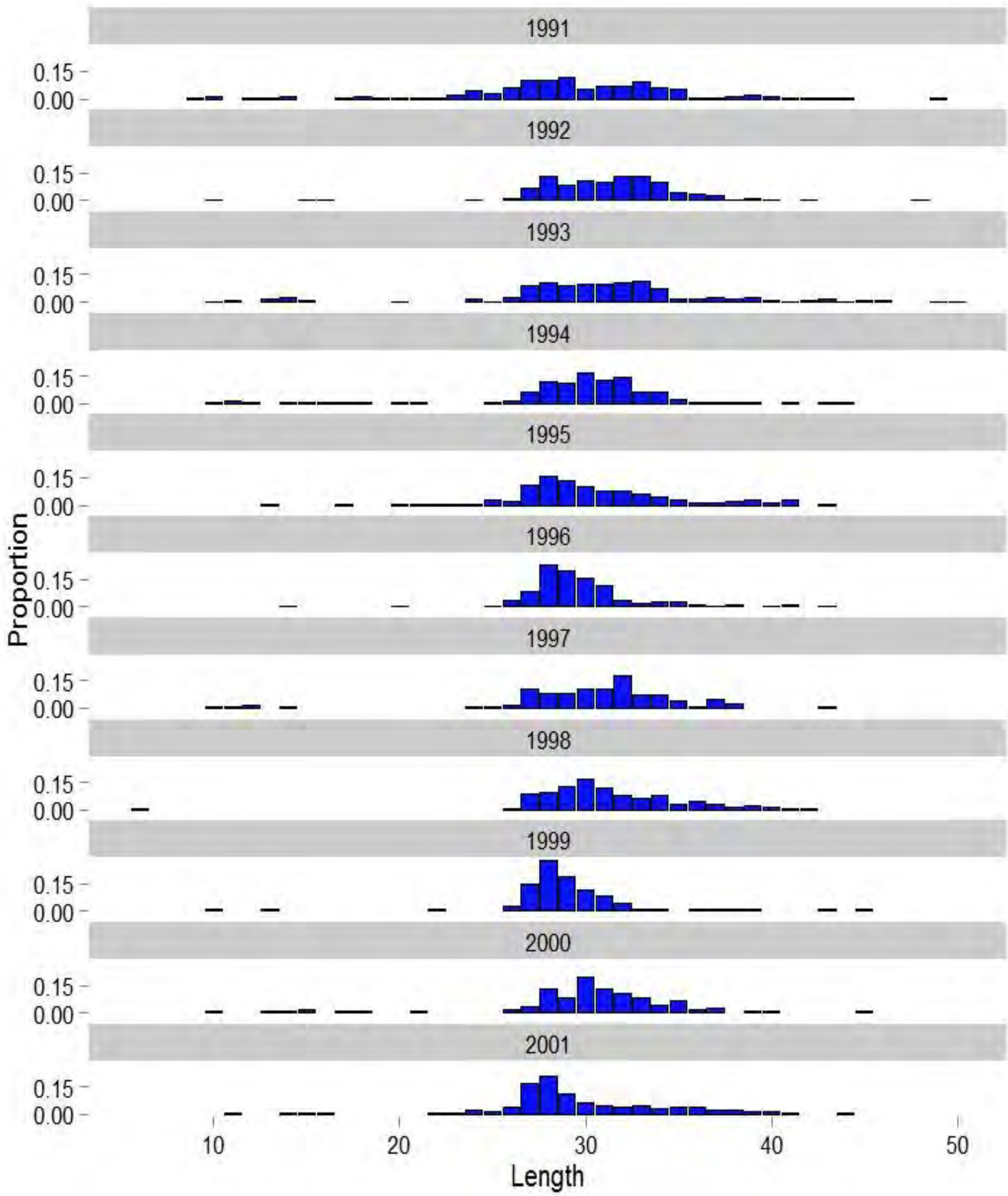


Figure 4.11.5b: Greater amberjack length frequency distributions for samples collected from recreational headboat fisheries located in the Gulf of Mexico from 2002 to 2012.

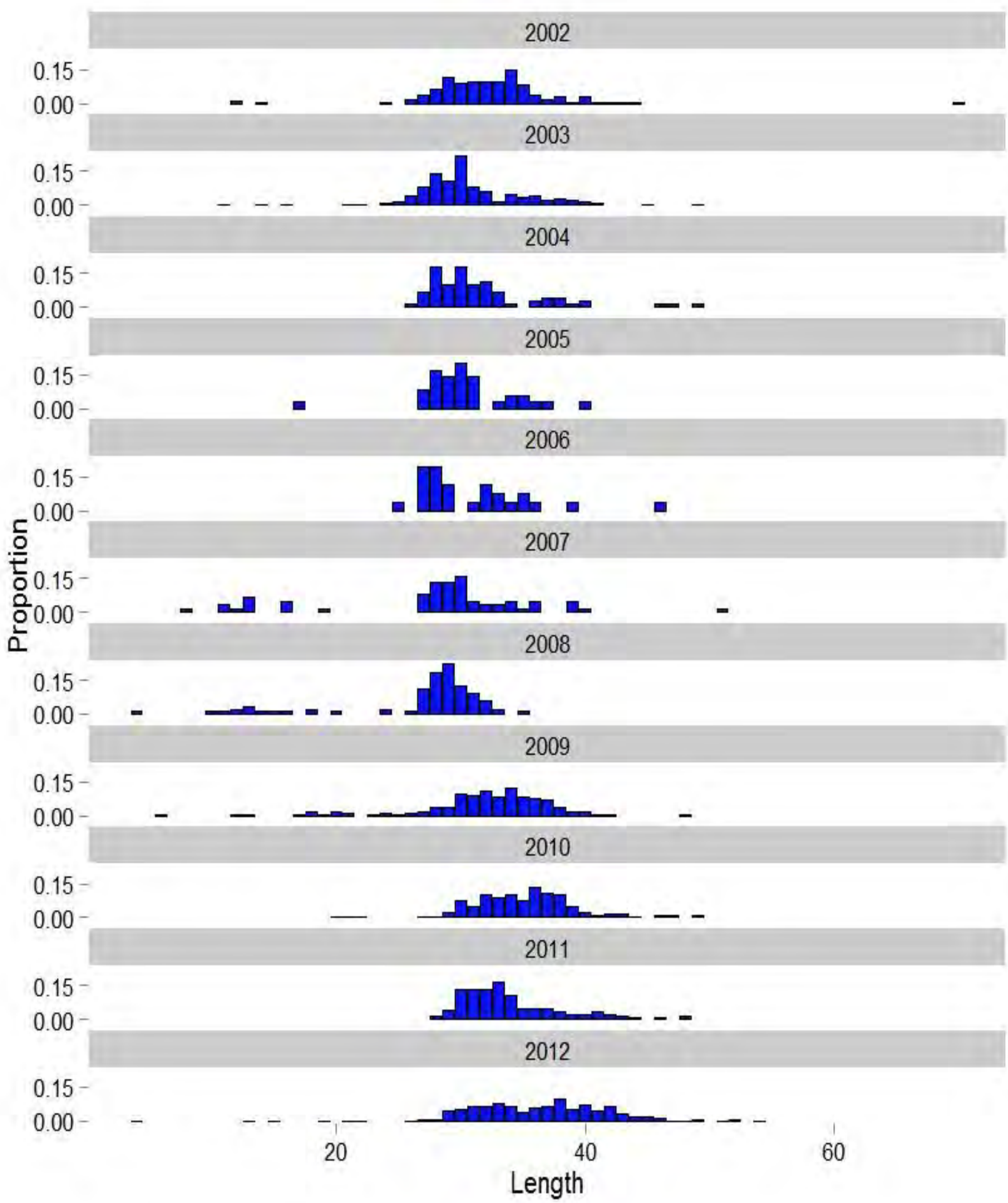


Figure 4.11.6a: Greater amberjack length frequency distributions for samples collected from recreational charter boat and private boat fisheries located in the Gulf of Mexico from 1991 to 2001.

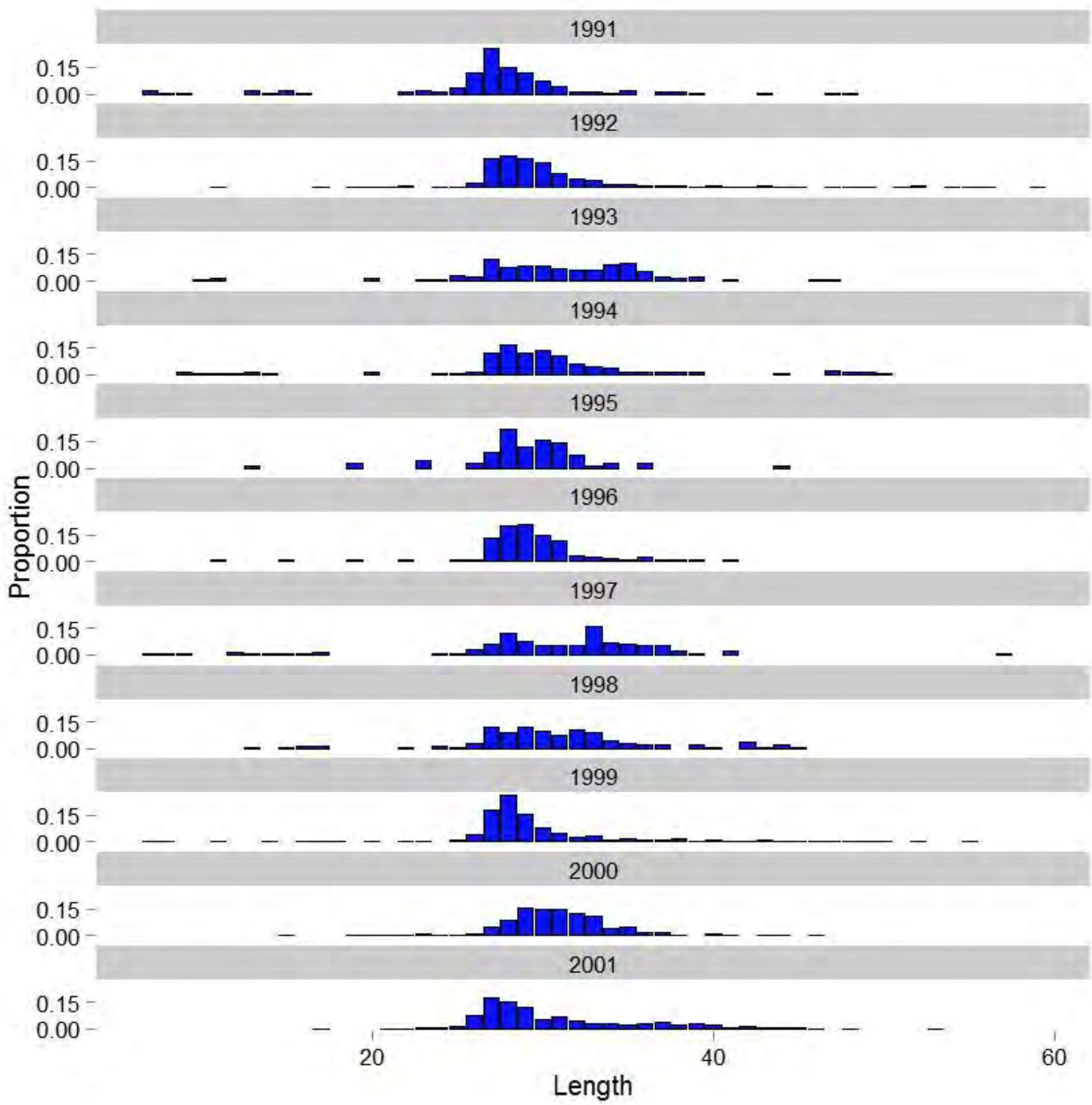


Figure 4.11.6b: Greater amberjack length frequency distributions for samples collected from recreational charter boat and private boat fisheries located in the Gulf of Mexico from 2002 to 2012.

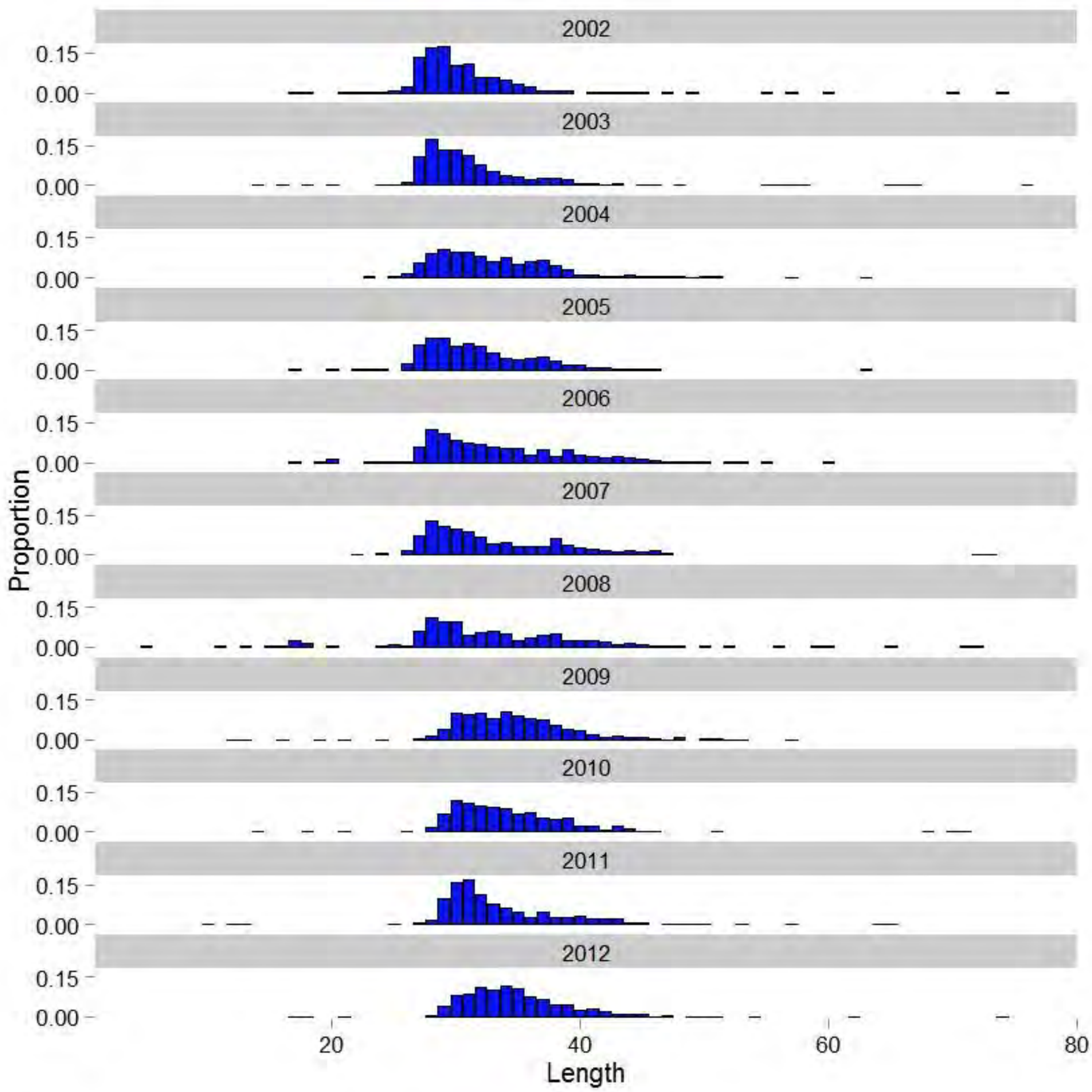
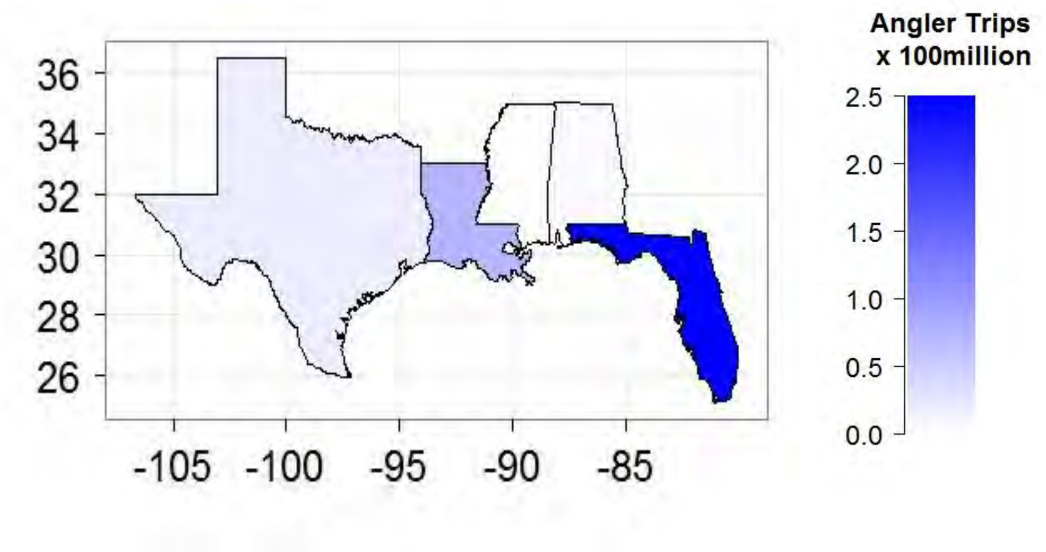
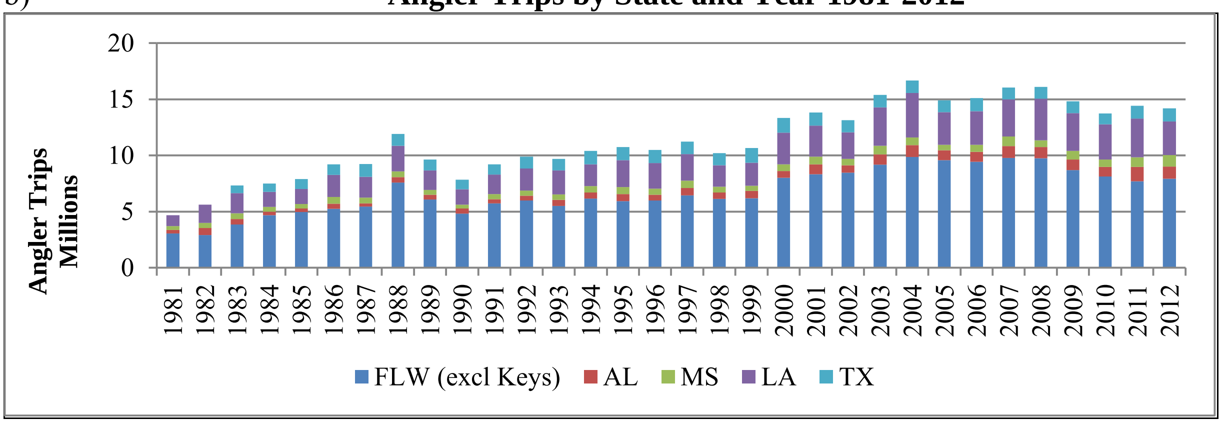


Figure 4.11.7: Gulf of Mexico estimated number of angler trips from MRFSS/MRIP (1981-2012) and TPWD (1983-2012) by state (a), by state and year (b), and by state and mode (c).

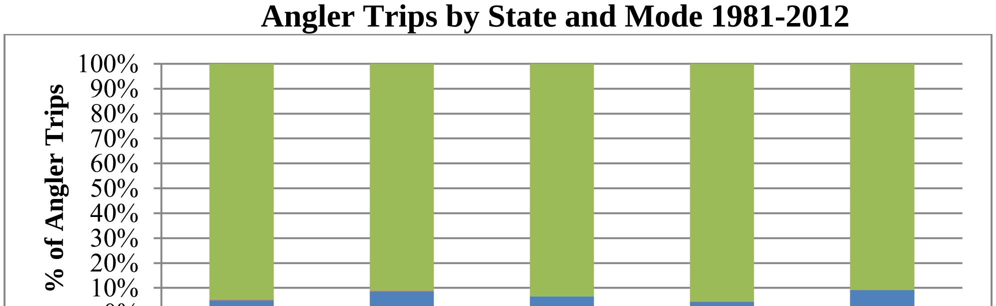
a) **Angler Trips by State 1981-2012**



b) **Angler Trips by State and Year 1981-2012**



c) **Angler Trips by State and Mode 1981-2012**

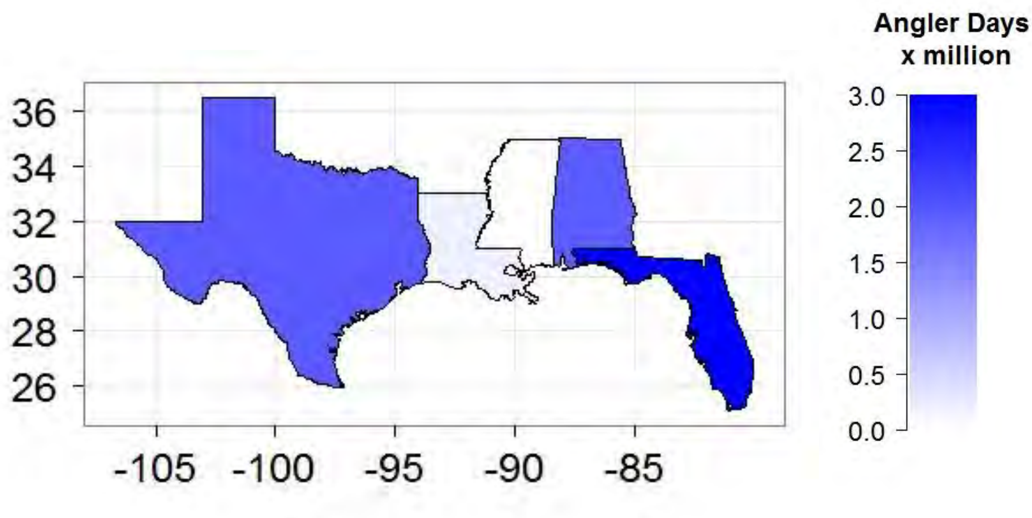


	FLW (excl Keys)	AL	MS	LA	TX
Priv	205,911,135	19,309,977	17,202,246	72,776,443	28,832,809
Hbt	555,174	69,072		43,262	
Cbt	11,128,382	1,823,632	1,203,337	3,399,619	2,906,412

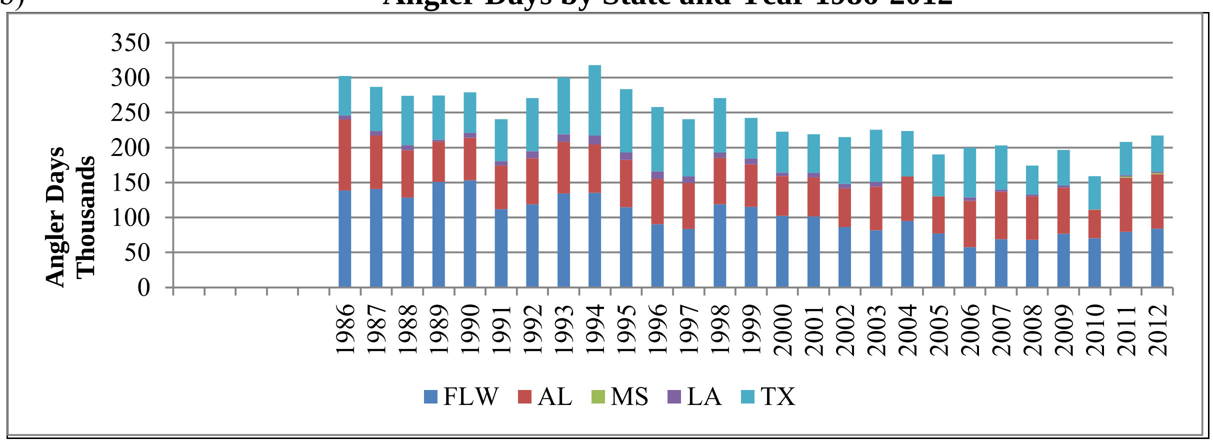
***Hbt (1981-1985); TX (1983-2012)**

Figure 4.11.8: Gulf of Mexico estimated number of angler days from SRHS (1986-2012) by state (a) and by state and year (b)

a) **Angler Days by State 1986-2012**



b) **Angler Days by State and Year 1986-2012**



5. Measures of Population Abundance

5.1 Overview

Analytical results of numerous data sets were presented to the Index Working Group (IWG) of both fishery-dependent and fishery-independent origin. The working papers containing full descriptions of the data sets and analytical methods are listed in section 5.2. In addition, a simplified chart, depicting spatial coverage of each data set is included in Figure 5.8.1. For rationalization for the recommendation/exclusion of particular indices, see the 'Comments on Adequacy for Assessment' section for the particular index contained in the appropriate section below. Two fishery-independent and four fishery-dependent indices of abundance are recommended for use in the assessment by the IWG and include:

Fishery-independent
- SEAMAP video
- Panama City video

Fishery-dependent
- MRFSS
- Headboat survey
- Commercial handline survey
- Commercial longline survey

Other indices and/or datasets that were considered and not recommended for use in the assessment by the IWG include:

Fishery-independent
- FWRI video
- SEAMAP groundfish
- SEAMAP ichthyoplankton
- NMFS bottom longline
- NMFS pelagic survey

Fishery-dependent
- Reef fish bottom longline observer

5.1.1 Group Membership

Members of the IWG included: Meaghan Bryan, Matthew Campbell, Shannon Cass-Calay, Mary Christman, Doug DeVries, Walter Ingram, Kevin McCarthy, Adam Pollack (workgroup lead), Adyan Rios, Steve Saul and Ted Switzer.

5.2 Review of Working Papers

The IWG reviewed the following papers:

SEDAR33-DW01	-	Greater Amberjack and Gag Grouper Catches from Mississippi Laboratories Fishery Independent Surveys
SEDAR33-DW16	-	SEAMAP Reef Fish Video Survey: Relative Indices of Abundance of Greater Amberjack
SEDAR33-DW26	-	Relative abundance of gag grouper and greater amberjack based on observer data collected in the reef fish bottom longline fishery
SEDAR33-AW01	-	Fisheries-independent data for gag and greater amberjack from reef-fish video surveys on the West Florida Shelf, 2008-2012.
SEDAR33-AW05	-	Greater Amberjack, *Seriola dumerili,* Findings from the NMFS Panama City Laboratory Trap & Camera Fishery-Independent Survey – 2004-2012
SEDAR33-AW11	-	Standardized Catch Rates of Gulf of Mexico Gag Grouper from Recreational Inshore, Charterboat, and Private Boat Fisheries (MRFSS) 1986 to 2010
SEDAR33-AW12	-	Standardized catch rates for greater amberjack from the commercial longline and commercial handline fishery in the U.S. Gulf of Mexico
SEDAR33-AW21	-	Standardized Catch Rates for Greater Amberjack from the Gulf of Mexico Headboat Fishery 1986-2011
SEDAR33-AW22	-	Standardized Catch Rates of Greater Amberjack from the Gulf of Mexico Recreational Charterboat and Private Boat Fisheries (MRFSS) 1986 to 2012

Note that even though some papers were submitted as Assessment Workshop documents, draft versions were reviewed during the Data Workshop.

5.3 Fishery Independent Indices

5.3.1 SEAMAP Reef Fish Video

The primary objective of the annual Southeast Area Monitoring and Assessment Program

(SEAMAP) reef fish video survey is to provide an index of the relative abundances of fish species associated with topographic features (e.g. reefs, banks, and ledges) located on the continental shelf of the Gulf of Mexico (GOM) from Brownsville, TX to the Dry Tortugas, FL. Secondary objectives include quantification of habitat types sampled (video and side-scan), and collection of environmental data throughout the survey. Because the survey is conducted on topographic features the species assemblages targeted are typically classified as reef fish (e.g. red snapper, *Lutjanus campechanus*), but occasionally fish more commonly associated with pelagic environments are observed (e.g. hammerhead shark, *Sphyrna lewini*). The survey has been executed from 1992-1997, 2001-2002, and 2004-2012 and historically takes place from May – August. The 2001 survey was abbreviated due to ship scheduling, during which, the only sites that were completed were located in the western Gulf of Mexico. Types of data collected on the survey include diversity, abundance (minimum count), fish length, habitat type, habitat coverage, and bottom topography. The size of fish sampled with the video gear is species specific however greater amberjack sampled over the history of the survey had fork lengths ranging from 101.0 – 2065.0 mm, and mean annual fork lengths ranging from 571.8 – 759.9 mm. Age and reproductive data cannot be collected with the camera gear but beginning with the 2012 survey, a vertical line component will be coupled with the video drops to collect hard parts, fin clips, and gonads.

5.3.1.1 Methods of Estimation

Data Filtering Techniques

Various limitations either in design, implementation, or performance of gear causes limitations in calculating minimum counts and are therefore dropped from the design-based indices development and analysis as follows. In 1992, each fish was counted every time it came into view over the entire record time and the total of all these counts was the maximum count. Maximum count methodologies are not preferred and the 1992 video tapes were destroyed during Hurricane Katrina and cannot be re-viewed, so 1992 data is excluded from analyses (unknown number of stations). The 2001 survey was abbreviated due to ship scheduling, during which, the only sites that were completed were located in the western GOM. Because of the spatial imbalance associated with data gathered in 2001, that entire year has been dropped (80 total sites). Stratum 1 (South Florida) and stratum 7 (S. Texas) are blocks that contain very little reef and were not consistently chosen for sampling and were also dropped (184 total sites). Occasionally tapes are unable to be read (i.e. organisms cannot be identified to species) for the following reasons including: 1) camera views are more than 50% obstructed, 2) sub-optimal lighting conditions, 3) increased backlighting, 4) increased turbidity, 5) cameras out of focus, 6) cameras failed to film. In all of these cases the station is flagged as ‘XX’ in the data set and dropped (190 total sites). Sites that did not receive a stratum assignment are also dropped (62). By these criteria the data set is reduced 4744 down to 4228 sites analyzed.

Gear and deployment

The SEAMAP reef fish survey has employed several camcorders in underwater housings since 1992. Sony VX2000 DCR digital camcorders mounted in Gates PD150M underwater housings were used from 2002 to 2005 and Sony PD170 camcorders during the years 2006 and 2007. In

2008 a stereo video camera system was developed and assembled at the NMFS Mississippi Laboratories Stennis Space Center Facility and has been used in all subsequent surveys. The stereo video unit consists of a digital stereo still camera head, digital video camera, CPU, and hard drive mounted in an aluminum housing. All of the camcorder housings we have used were rated to a maximum depth of 150 meters while the stereo camera housings are rated to 600 meters. Stereo cameras are mounted orthogonally at a height of 50 cm above the bottom of the pod and the array is baited with squid during deployment.

At each sampling site the stereo video unit is deployed for 40 minutes total, however the cameras and CPU delay filming for 5 minutes to allow for descent to the bottom, and settling of suspended sediment following impact. Once turned on, the cameras film for approximately 30 minutes before shutting off and retrieval of the array. During camera deployment the vessel drifts away from the site and a CTD cast executed, collecting water depth, temperature, conductivity, and transmissivity from the surface to the maximum depth. Seabird units are the standard onboard NOAA vessels however the model employed was vessel/cruise dependent.

Video tape viewing

One video tape from each station is selected for viewing out of four possible. If all four video cameras face reef fish habitat and are in focus, tape selection is random. Videos are viewed for twenty minutes starting from the time when the view clears from suspended sediment. Viewers identify, and enumerate all species to the lowest taxonomic level during the 20 minute viewable segment. From 1993-2008 the time when each fish entered and left the field of view was recorded a procedure referred to as time in - time out (TITO) and from these data a minimum count was calculated. The minimum count is the maximum number of individuals of a selected taxon in the field of view at one instance. Each 20 minute video is evaluated to determine the highest minimum count observed during a 20 minute recording. The 2008-2011 digital video allows the viewer to record a frame number or time stamp of the image when the maximum number of individuals of a species occurred, along with the number of taxon identified in the image but does not use the TITO method. Both the TITO and current viewing procedure result in the minimum count estimator of relative abundance. Minimum count methodology is preferred because it prevents counting the same fish more than once and represents the conservative maximum number of fish that were at a location at one point in time.

Fish length measurement

Beginning in 1995 fish lengths were measured from video using lasers attached on the camera system with known geometry. However, the frequency of hitting targets with the laser is low and precluded estimating size frequency distributions. Additionally, the same fish can be measured more than once at a given station. So, the lengths measured provide the range of sizes observed. The stereo cameras used in 2008-2010 allow size estimation from fish images. The Vision Measurement System (Geometrics Inc.) was used to estimate size of greater amberjack. We estimated a length frequency distribution by weighting station length frequencies by station Minimum Counts.

Standardization

Delta-lognormal modeling methods were used to estimate relative abundance indices for red snapper (Lo *et al*. 1992). The main advantage of using this method is allowance for the probability of zero catch (Ortiz *et al.* 2000). The index computed by this method is a mathematical combination of yearly abundance estimates from two distinct generalized linear models: a binomial (logistic) model which describes proportion of positive abundance values (i.e. presence/absence) and a lognormal model which describes variability in only the nonzero abundance data (Lo *et al*. 1992).

The submodels of the delta-lognormal model were built using a backward selection procedure based on type 3 analyses with an inclusion level of significance of $\alpha = 0.05$. Binomial submodel performance was evaluated using AIC, while the performance of the lognormal submodel was evaluated based on analyses of residual scatter and QQ plots in addition to AIC. Additional model explored the use of other distributions (e.g. Poisson) to model the positive catch but were not used because appropriate diagnostic plots could not be produced.

Submodel Variables

Year: 1992-1997, 2002, and 2004-2012
Depth: 10 – 200 meters.
Max-relief: 0-6 meters.

5.3.1.2 Sampling Intensity and Time Series

During the years 1993-1997, 2001-2002, 2004-2012, a total of 4,577 total sites have been sampled in the Gulf of Mexico during the reef fish survey (Table 5.7.1). Annually the number of sites have varied ranging between 159 and 468, however since 1996 at least 200 sites have been sampled, and since 2005 at least 290 sites have been sampled annually.

5.3.1.3 Size/Age Data

Length frequency data gathered in this survey are constructed from survey data are presented by year for the years 1995-2011 in Figure 5.8.2. Upper and lower quartiles represented within boxes, whiskers extend to subsequent quartiles, and non-overlapping notches indicate groups for which median responses are likely different. Age data was unavailable.

5.3.1.4 Catch Rates

Lo and Standardized catch rates for the Gulf of Mexico are presented in Table 5.7.1 and in Figure 5.8.3.

5.3.1.5 Uncertainty and Measures of Precision

Annual CVs of catch rates are presented in Table 5.7.1. Plots of the positive mincount residuals and QQ plots of positive mincount residuals were produced and are presented in figure 5.8.4 and 5.8.5.

5.3.1.6 Comments on Adequacy for Assessment

Assessment scientists evaluated the abundance indices and coefficient of variation output and advised the working group that the gulf wide index was appropriate for use in the assessment models, therefore the gulf wide index is presented in this report. East and west Gulf of Mexico runs are available in the working document that was provided prior to the workshop. Evaluation of the positive catch QQ residual plots indicated that fit was poor and suggested that future models evaluate the feasibility of producing an index using other distributions (e.g. Poisson). At the time of the SEDAR data workshop the fit information (e.g. residuals) from a Poisson based model could not be produced nor evaluated so no further effort was made in this regard during the workshop and the delta log-normal model was accepted.

5.3.2 Panama City Video

In 2004 the SEFSC's Panama City laboratory initiated a fishery-independent trap survey (the survey) of natural reefs on the inner and mid-shelf of the eastern Gulf of Mexico off northwest Florida, and in 2005 video sampling was added. The survey's primary objective is to generate indices of relative abundance of federally-managed reef fishes for stock assessments and to inform fishery managers. Target species include snappers (red, vermilion, gray, and lane), groupers (gag, red, & scamp), gray triggerfish, red porgy, white grunt, black seabass, hogfish, and amberjacks. Secondary objectives of the survey include examining community structure, annual regional catch, recruitment, distribution, and demographic patterns of economically and ecologically important reef fish species. Annual sampling is conducted May-September. In 2008 the Florida Fish and Wildlife Conservation Commission’s Fish and Wildlife Research Institute (FWRI) joined with the Panama City and Pascagoula NOAA Fisheries Service labs in an effort to expand to the entire west Florida shelf the ongoing fishery independent reef fish surveys conducted by the latter two. Every effort is made to standardize the gear, survey design, sampling protocol, and analytical methods among the three agencies. All three groups collect visual data with stereo camera systems and Panama City and FWRI both use chevron traps. . The estimator of abundance was the maximum number of a given species in the field of view at any time during the 20 min analyzed (= min count of Gledhill and Ingram 2004), and length measurements, made using Vision Measurement System software, were only taken from a still frame showing the min count of a given species to eliminate the possibility of measuring the same fish more than once. Details on survey design and methodologies are described in SEDAR33-AW05 (DeVries et al. 2013).

5.3.2.1 Methods of Estimation

Data Filtering Techniques
Censored data sets were used in deriving the indices of relative abundance from video data. Data – both habitat classification and fish counts – from all sites were screened, and those with no evidence that hard or live bottom was in close proximity, as well as sites where the view was obscured for some reason (poor visibility, bad camera angle), were censored (excluded) from indices calculations. As a result of this screening, of video samples from east of the Cape San Blas, only 31 of 41 in 2005, 47 of 89 in 2006, 23 of 57 in 2007, 56 of 66 in 2008, 62 of 97 in 2009, 95 of 109 in 2010, 99 of 115, in 2011, and 100 of 115 in 2012 met the reef and visibility criteria and were retained. Of samples from west of the Cape, 24 of 25 sites in 2006, 29 of 29 in 2007, 29 of 31 in 2008, 42 of 47 in 2009, 52 of 53 in 2010, 57 of 64 in 2011, and 49 of 59 in 2012 were retained for analyses.

Standardization

Delta-lognormal modeling methods were used to estimate relative abundance indices for gag (Lo *et al*. 1992). The main advantage of using this method is allowance for the probability of zero catch (Ortiz *et al.* 2000). The index computed by this method is a mathematical combination of yearly abundance estimates from two distinct generalized linear models: a binomial (logistic) model which describes proportion of positive abundance values (i.e. presence/absence) and a lognormal model which describes variability in only the nonzero abundance data (Lo *et al*. 1992).

The submodels of the delta-lognormal model were built using a backward selection procedure based on type 3 analyses with an inclusion level of significance of $\alpha = 0.05$. Binomial submodel performance was evaluated using AIC, while the performance of the lognormal submodel was evaluated based on analyses of residual scatter and QQ plots in addition to AIC.

Submodel Variables

Year: 2005-2012
Depth: 6-49 m
Month: May-October
Region: east of Cape San Blas, west of Cape San Blas (zoogeographic boundary)

Annual Abundance Indices

For a full review of the backward selection procedure for each submodel and diagnostic plots, refer to SEDAR33-AW05.

For the abundance index for greater amberjack, year and region were retained in the binomial submodel, while year and depth were retained in the lognormal submodel. The AIC for the binomial and lognormal submodels were 3831.9 and 371.8, respectively. The diagnostic plots for the binomial and lognormal submodels indicated the distribution of the residuals is approximately normal.

5.3.2.2 Sampling Intensity and Time Series

A total of 800 stations were sampled from 2005 to 2012 during the Panama City NMFS lab trap and camera survey (Table 5.7.2 and Figures 5.8.6 and 5.8.7).

5.3.2.3 Size/Age Data

The sizes and estimated ages of greater amberjack represented in this index are presented in Figures 5.8.8 – 5.8.10.

5.3.2.4 Catch Rates

Standardized catch rates are presented in Table 5.7.3 and Figure 5.8.11.

5.3.2.5 Uncertainty and Measures of Precision

Annual CVs of catch rates are presented in Tables 5.7.3.

5.3.2.6 Comments on Adequacy for Assessment

The Panama City NMFS lab video survey index was conditionally recommended for inclusion in the stock assessment model for greater amberjack. This survey, with an 8 year time series beginning in 2005, covers the inner and mid-shelf of the northern portion of the west Florida shelf. The video survey strongly targets pre-recruit greater amberjacks - about 98% of those measured from stereo images during 2009-2012 were <762 mm FL, the recreational minimum size limit (Fig. 5.8.8). Although no age data were available from the survey, a comparison of the overall size distribution of greater amberjack measured from survey stereo images with age-specific size distributions derived from Florida specimens, ages 0-3, aged in other studies (subsample of age data described in Allman et al. 2013), strongly suggests that the majority observed were age 1, with fewer age 0's and 2's, and no age 3's (Fig. 5.8.9). Most, if not all, of the likely age 0 fish were only observed in 2012 – that year there was a modal group of small fish 154- 292 mm FL and it was the only year there were any individuals <300 mm FL (Fig. 5.8.10). The survey has undergone some geographic and bathymetric expansion over time, and a switch from a systematic to stratified random design; however, the model was able to account for these differences with the addition of year, depth and region variables.

5.3.3 FWRI Video

There has been a renewed emphasis in recent years to increase the availability of fisheries-independent data on reef fish populations in the Gulf of Mexico that reflect the status of fish populations as a whole, rather than just the portion of the population taken in the fishery. To meet the emerging needs of fisheries-independent data for reef fishes, the Fish and Wildlife Research Institute (FWRI) of the Florida Fish and Wildlife Conservation Commission has been working collaboratively with scientists from the National Marine Fisheries Service (NMFS) to expand regional monitoring capabilities and provide timely fisheries-independent data for a variety of state- and federally-managed reef fishes. One component of these efforts is a reef fish video survey designed to complement ongoing NMFS surveys of reef habitats along the shelf break (NMFS – Pascagoula) and in the northeastern Gulf of Mexico (NMFS – Panama City) by targeting portions of the West Florida Shelf off of Tampa Bay and Charlotte Harbor in depths from 10 – 110 m (Figure 5.8.12). The primary objective of this survey is to provide an index of the relative abundance of reef fishes associated with reef habitats. Types of data collected on the survey include abundance, diversity, fish length, habitat type, habitat coverage, and bottom topography.

To assure adequate spatial coverage of sampling effort, the WFS survey area is subdivided into four sampling zones comprised of two NMFS statistical zones (Tampa Bay: NMFS statistical zone 5; Charlotte Harbor: NMFS statistical zone 4) and two depth zones (Inshore: 10 – 37 m; Offshore: 37 – 110 m). Initiated in 2008, the FWRI video survey has been conducted annually through 2012, although there have been some modifications to the survey design through time. Prior to conducting exploratory sampling in 2008, the WFS survey area was subdivided into 1km x 1km sampling units. Results from 2008 indicated that 1km x 1km spatial scale was too large in relation to the small-scale habitat features characteristic of the WFS; accordingly, from 2009 onward the WFS survey area was subdivided into 0.1nm x 0.3 nm sampling units (E/W by N/S). Overall sampling effort (annual goal of n = 200 sampling units) was proportionally allocated among the four sampling zones based on habitat availability (TBN: Tampa Bay Nearshore; TBO: Tampa Bay Offshore; CHN: Charlotte Harbor Nearshore; CHO: Charlotte Harbor Offshore), and specific sampling units were selected randomly within each sampling zone.

Very little is known regarding the fine-scale distribution of reef habitat throughout much of the WFS, and due to anticipated cost and time requirements, mapping the entire WFS survey area was not feasible prior to initiating the FWRI video survey. For the 2008 video survey, the identification of sampling units with an increased probability of containing reef habitat (and inclusion in the sampling frame for the reef-fish survey) was based on bottom rugosity calculated from 100m-resolution interpolated bathymetry data. An examination of results from the 2008 survey indicated that a high proportion of sampling effort occurred at sites with no reef habitat (i.e., unconsolidated sediment). Accordingly, the sampling universe was updated in 2009 to include habitat information provided by commercial fishermen as well as published literature. Further, we implemented an adaptive strategy where a three-pass acoustic survey was conducted covering an area of 1nm to the east and west of the pre-selected sampling unit prior to sampling. In 2009 and part of 2010, the acoustic survey was conducted using the research vessel echo sounder, while for part of 2010 and 2011 onward the acoustic survey was conducted using an L3- Klein 3900 side scan sonar. Based on results from these acoustic surveys, sampling effort was randomly relocated to a nearby sampling unit should evidence of reef habitat be identified.

At each sampling station, 1-2 stationary underwater camera arrays (SUCAs) were deployed that consisted of a pair of stereo imaging system (SIS) units positioned at an angle of 180º from one another to maximize the total field of view. Each SIS unit consisted of an underwater housing containing a digital camcorder to record video and a pair of stereo cameras to capture still images at a rate of one per second. Each SUCA was baited (generally Atlantic mackerel) and deployed

for thirty minutes to assure that twenty minutes of continuous video and stereo images were recorded. All individual gear deployments were spaced a minimum of 100 m apart.
Twenty minutes of video data from one SIS per SUCA deployment were processed to quantify the relative abundance of all fishes observed (MaxN, or the maximum number of greater amberjack observed on a single video frame). In addition to data on relative abundance and observed habitat, geographic coordinates, depth, physiochemical conditions (e.g., temperature, salinity, dissolved oxygen, pH), and time of day were recorded at each specific sampling site.

5.3.3.1 Methods of Estimation

Data Filtering Techniques

Data from 2008 – 2012 were included in subsequent analyses. Data were filtered prior to analyses to exclude video deployments that were too turbid to conducting meaningful reads as well as unsuccessful video deployments (i.e., array landed on the side, array that moved during video).

Standardization

Delta-lognormal modeling methods were used to estimate relative abundance indices for greater amberjack (Lo *et al*. 1992). The main advantage of using this method is allowance for the probability of zero catch (Ortiz *et al.* 2000). The index computed by this method is a mathematical combination of yearly abundance estimates from two distinct generalized linear models: a binomial (logistic) model which describes proportion of positive abundance values (i.e. presence/absence) and a lognormal model which describes variability in only the nonzero abundance data (Lo *et al*. 1992). A backward stepwise selection procedure was employed to develop both sub-models. Type III analyses were used to test each parameter for inclusion or exclusion into the sub-model. Both variable inclusion and exclusion significance level was set as $\alpha = 0.05$, although marginal values were also considered for inclusion; year was retained in all models regardless of significance level.

Submodel Variables

Year: 2008 – 2012
Month: June – September
Depth: Inshore (10 – 37 m) and Offshore (37 – 110 m)
Latitude: North (Tampa Bay) and South (Charlotte Harbor)
Reef Habitat Observed: Y or N

5.3.3.2 Sampling Intensity and Time Series

From 2008 – 2012, a total of 968 SUCA deployments were made at 632 stations on the West Florida Shelf (Table 5.7.4). Due to weather and mechanical issues, annual sampling effort varied from 129 – 237 deployments.

5.3.3.3 Size/Age Data

Lengths of observed fishes are determined through stereo video measurements. However, due to no greater amberjack being observed during the early years of the survey and technical issues with calibration files during the recent years of the survey, no size data are currently available. Age data are unavailable.

5.3.3.4 Catch Rates

Standardized catch rates for the FWRI reef fish video survey are presented in Table 5.7.5 and Figure 5.8.13.

5.3.3.5 Uncertainty and Measures of Precision

Annual CVs of catch rates for the FWRI reef fish video survey are presented in Table 5.7.5. A QQ plot of positive MaxN residuals was produced and is presented in Figure 5.8.14.

5.3.3.6 Comments on Adequacy for Assessment

At present, this survey does not constitute a long-enough time series to be useful in the assessment of greater amberjack, especially with the absence of greater amberjack in 2008 as well as the dramatic increase in the proportion of stations sampled that actually contained reef habitat in conjunction with the incorporation of side scan sonar in 2010. However, in time this survey should provide valuable data that can be used in subsequent assessments. In addition to expanding the time series of this data through continued sampling, consideration should be given towards combining data from this survey with data from the NMFS – Panama City survey in developing indices of abundance that are representative of a broader spatial area. Even though these surveys employ similar methods, efforts to construct a single index of abundance would benefit significantly from some spatial overlap for a brief period of time (one to several years) so that results can be appropriately calibrated.

5.3.4 Other Fishery Independent Datasets

5.3.4.1 SEAMAP Groundfish Survey

Groundfish surveys have been conducted in the fall (October – November) since 1972 covering an area between 88° to 91°30′. In 1982, a second trawl survey began under SEAMAP during the summer (June – July). In 1987, the SEAMAP design was adopted for the fall survey. Under SEAMAP, sampling covered an area between Brownville, TX and Mobile Bay, AL. In 2008, the sampling area was expanded eastward to cover an area to the Florida Keys, thus fully covering the northern GOM. A full review of survey methodologies and descriptions of the datasets have been presented in detail by Nichols (2004) and Pollack and Ingram (2010).

A total of 18,596 successful trawl stations have been completed during the SEAMAP groundfish survey. Greater amberjack occurred at 218 stations (Table 5.7.6). Greater amberjack ranged in size from 106 to 392 mm, with those less than 250 mm primarily being caught during the summer survey and those over 250 mm in the fall survey. Greater amberjack do not occur at a high enough frequency for abundance indices to be produced for this stock assessment.

5.3.4.2 SEAMAP Ichthyoplankton Survey

The Southeast Area Monitoring and Assessment Program has supported collection and analysis of ichthyoplankton samples in the northern GOM since 1982. There were three main time series that were available for analysis: Spring Ichthyoplankton Survey (April - May, continental shelf edge to deep GOM waters), Summer Ichthyoplankton Survey (May – July, coast to continental shelf edge) and Fall Ichthyoplankton Survey (August – October, coast to continental shelf edge) (Figure 13). A full review of the survey methodologies were presented by Lyczkowski-Shultz and Hanisko (2004). Currently in the dataset, there are 5309 individuals identified as *Seriola spp.* However, at this time there is no way, outside of genetic analysis, to positively identify greater amberjack. Therefore, no abundance indices were produced for this stock assessment.

5.3.4.3 NMFS Small Pelagics Survey

Two surveys conducted by MSLABS can fall under the Small Pelagics Survey designation. The first survey was conducted between 1988 and 1996 and was previously analyzed for greater amberjack by Ingram (2005) and presented during SEDAR 9. The second Small Pelagics Survey was conducted between 2002 and 2012. A full description of the survey methodology is presented by Ingram (2008). In the second survey, occurrences of greater amberjack were very low (2.42%) (Table 5.7.7). Due to the low frequencies of occurrence for greater amberjack no abundance indices were produced for this stock assessment.

5.3.4.4 NMFS Bottom Longline Survey

Standardized bottom longline surveys have been conducted by MSLABS since 1995. The bottom longline survey has evolved over time to encompass the entire northern GOM, covering depths from 9 to 366 m. A full description of the evolution of the survey and survey methodologies was presented by Ingram *et al.* (2005). A total of 2760 stations have been sampled (Table 5.7.9). Greater amberjack do not occur at a high enough frequency for abundance indices to be produced for this stock assessment.

5.4 Fishery Dependent Indices

5.4.1 Commercial Longline

SEDAR33-AW12 used data from the National Marine Fisheries Service (NMFS) reef fish logbook program to develop greater amberjack abundance indices for the commercial longline fishery.

5.4.1.1 Methods of Estimation

Data filtering

Twenty-percent of vessels registered in FL were sampled between 1990 and 1992; therefore, indices of abundance were estimated for years between 1993 and 2012. Trips were selected for inclusion in the analyses based upon the species composition of the landings (Stephens and MacCall 2004). Trips were retained if this species composition reflected species usually associated with greater amberjack in the landings. This process was intended to select trips with a reasonable probability of catching greater amberjack, based upon some combination of location, timing, technique, habitat, etc.

The longline index was estimated from trips with at least 10 sets per day or 1-day trips. These criteria were used to select only trips that reported total effort for the entire trips, instead of daily effort.

Area 1 was dropped from the assessment, as was done during SEDAR 9, and the NMFS shrimp areas grouped as follows into "new_area" variable:

- Areas 17-22 = west LA and TX
- Areas 12-16 = LA
- Areas 6-11 = NW Florida and AL
- Areas 4 and 5 = west FL
- Areas 2 and 3 = SW Florida

Index standardization

Delta-lognormal modeling methods were used to estimate relative abundance indices for greater amberjack (Lo *et al*. 1992). The main advantage of using this method is allowance for the probability of zero catch (Ortiz *et al.* 2000). The delta-lognormal modeling approach combines separate generalized linear model (GLM) analyses of the proportion of successful trips (trips that landed greater amberjack) and the catch rates on successful trips to construct a single standardized CPUE index (Lo et al. 1992, Hinton and Maunder 2004, Maunder and Punt 2004). Parameterization of each model was accomplished using a stepwise approach and Akaike's information criteria (AIC). For each GLM procedure of proportion positive trips, a type-3 model assuming a binomial error distribution was assumed and the logit link was selected. The response variable was the proportion of successful trips across strata. For the analysis of the catch rates on successful trips, a type-3 model assuming lognormal error distribution was examined.

A stepwise approach was used to quantify the relative importance of the explanatory factors. The AIC, deviance, and degrees of freedom were calculated for each iteration and compared to determine the most parsimonious model and identify the explanatory variables that explained the greatest amount of variation in the data.

5.4.1.2 Sampling Intensity and Time Series

See SEDAR- AW12.

5.4.1.3 Size/Age Data

No size/age data is available.

5.4.1.4 Catch Rates

Results for the greater amberjack longline index standardization show no change during the start of the time series followed by a steady increase from 1998-2004 (Figure 5.8.15). The index then declined through 2007 and increased in 2008. After a short period of relative stability, the index declined sharply in 2011 and remained at a low value in the most recent year of time series.

5.4.1.5 Uncertainty and Measures of Precision

Annual CVs of the catch rates and plots of the binomial residuals and QQ plots of lognormal residuals were produced and are presented in SEDAR 33-AW12.

5.4.1.6 Comments on Adequacy for Assessment

The commercial longline relative index of abundance was recommended for use in the greater amberjack stock assessment by the SEDAR 33 IWG. This index was recommended because it represents a complete census of the fishing trips, it is a continuous time series from 1993-2012, and covers a broad geographical area.

5.4.2 Commercial Handline

SEDAR33-AW12 used data from the National Marine Fisheries Service (NMFS) reef fish logbook program to develop greater amberjack abundance indices for the commercial handline fishery.

5.4.2.1 Methods of Estimation

Data filtering

Twenty-percent of vessels registered in FL were sampled between 1990 and 1992; therefore, indices of abundance were estimated for years between 1993 and 2012. Trips were selected for inclusion in the analyses based upon the species composition of the landings (Stephens and MacCall 2004). Trips were retained if this species composition reflected species usually associated with greater amberjack in the landings. This process was intended to select trips with a reasonable probability of catching greater amberjack, based upon some combination of location, timing, technique, habitat, etc.

As per SEDAR 9, trips that fished with at most 10 hooks per line were included in the analysis. Area 1 was dropped from the assessment, as was done during SEDAR 9, and the NMFS shrimp areas grouped as follows into "new_area" variable:

- Areas 17-22 = west LA and TX
- Areas 12-16 = LA
- Areas 6-11 = NW Florida and AL
- Areas 4 and 5 = west FL
- Areas 2 and 3 = SW Florida

Index standardization

Delta-lognormal modeling methods were used to estimate relative abundance indices for greater amberjack (Lo *et al*. 1992). The main advantage of using this method is allowance for the probability of zero catch (Ortiz *et al.* 2000). The delta-lognormal modeling approach combines separate generalized linear model (GLM) analyses of the proportion of successful trips (trips that landed greater amberjack) and the catch rates on successful trips to construct a single standardized CPUE index (Lo et al. 1992, Hinton and Maunder 2004, Maunder and Punt 2004). Parameterization of each model was accomplished using a stepwise approach and Akaike's information criteria (AIC). For each GLM procedure of proportion positive trips, a type-3 model assuming a binomial error distribution was assumed and the logit link was selected. The response variable was the proportion of successful trips across strata. For the analysis of the catch rates on successful trips, a type-3 model assuming lognormal error distribution was examined.

A stepwise approach was used to quantify the relative importance of the explanatory factors. The AIC, deviance, and degrees of freedom were calculated for each iteration and compared to determine the most parsimonious model and identify the explanatory variables that explained the greatest amount of variation in the data.

5.4.2.2 Sampling Intensity and Time Series

See SEDAR- AW12.

5.4.2.3 Size/Age Data

No size/age data is available.

5.4.2.4 Catch Rates

Handline catch rate was calculated in weight in pounds of fish per hook-days. Results for the greater amberjack handline index standardization show no change during the start of the time series followed by an overall increase from 1998 to 2004 (Figure 5.8.16). The index then declined slightly through 2009 and then drastically increased in 2010. The highest value in the index was in 2011, and it was followed by a drastic decline in the final year of the time series, where the index ended at a level similar to that of 2004.

5.4.2.5 Uncertainty and Measures of Precision

Annual CVs of the catch rates and plots of the binomial residuals and QQ plots of lognormal residuals were produced and are presented in SEDAR 33-AW12.

5.4.2.6 Comments on Adequacy for Assessment

The commercial handline relative index of abundance was recommended for use in the greater amberjack stock assessment by the SEDAR 33 Index Working group. This index was recommended because it represents a complete census of the fishing trips, it is a continuous time series from 1993-2012, and covers a broad geographical area.

5.4.3 MRFSS

The Marine Recreational Fishery Statistics Survey (MRFSS) conducted by NOAA Fisheries (NOAA) collects information on shore based, charterboat and private/rental boat angler fishing. MRFSS provides information on participation, effort, and species-specific catch. Data are collected to provide catch and effort estimates in two-month periods ("waves") for each recreational fishing mode (shore fishing, private/rental boat, charterboat, or headboat/charterboat combined) and for each area of fishing (inshore, state Territorial Seas, U.S. Exclusive Economic Zone), in each Gulf of Mexico state (except Texas). Total catch information is collected by MRFSS on fish landed whole and observed by interviewers ("Type A"), fish reported as killed by the fishers ("Type B1") and fish reported as released alive by the fishers ("Type B2").

5.4.3.1 Methods of Estimation

MRFSS data were used to characterize abundance trends for the charterboat and private angler fisheries. Information on effort included hours fished and number of anglers as reported to the interviewer. Catch that was not observed by the interviewer (B1 and B2) was adjusted upwards by the ratio of non-interviewed to interviewed anglers in each group of anglers. The catch per unit effort was calculated on an individual group basis and was equal to the number of fish caught divided by the effort, where effort was the product of the number of anglers and the total hours fished. 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 were not investigated.

Data Filtering Techniques

Although MRFSS data from 1981-2012 were available for analyses, data prior to 1986 were excluded due to low numbers of annual interviews that resulted in missing data for multiple strata. Data for 2010 were excluded from the analysis due to significant fishing area closures during May to November that related to the Deepwater Horizon/BP Oil Spill, (http://sero.nmfs.noaa.gov/ClosureSizeandPercentCoverage.htm). Interviews that reported the shore mode and/or the inshore area were removed from the MRFSS data, because less than 0.1 percent of such interviews encountered greater amberjack. Data were limited to interviews that reported using hook and line since these represented over 98% of all private and charter interviews in the Gulf of Mexico. The Species Association Approach (Stephens and MacCall 2004) was explored to try and identify greater amberjack directed effort. However, this approach did not work well and was not used to restrict the MRFSS dataset.

Standardization

Delta-lognormal modeling methods were used to estimate a standardized abundance index for greater amberjack (Lo et al. 1992). The main advantage of using this method is allowance for the probability of zero catch (Ortiz et al. 2000). The delta-lognormal modeling approach combines separate generalized linear model (GLM) analyses of the proportion of successful trips (trips that landed greater amberjack) and of the catch rates on successful trips to construct a single standardized CPUE index (Lo et al. 1992, Hinton and Maunder 2004, Maunder and Punt 2004). Parameterization of each model was accomplished using a forward selection procedure based on reduction of AIC and a reduction in deviance of greater than one percent. For each GLM procedure of proportion positive trips, a type-3 model assuming a binomial error distribution was assumed and the logit link was selected. The response variable was the proportion of successful trips across strata. For the analysis of the catch rates on successful trips, a type-3 model assuming lognormal error distribution was examined. A "normal" linking function was selected and the response variable was calculated as the natural log of CPUE. The final delta-lognormal model was fit using a SAS macro, GLIMMIX (Russ Wolfinger, SAS Institute). YEAR*FACTOR interaction terms were included in the model as random effects. Models were weighted to account for changes in sampling effort that were implemented in 2000. Starting in 2000, data from FL were down-weighted by 1/6 and data from AL, MS and LA were down-weighted by 1/2.

Submodel Variables

Year: 1981-2009 and 2011-2012
Mode: Private, Charter
Region: (1) Southwest FL (Collier – Pinellas), (2) Northwest FL (Pasco – Franklin), (3) FL Panhandle (Gulf – Escambia) and AL, (4) MS and LA
Area: State, EEZ
Month: Dec-Jan, Feb-Mar, Apr-May, Jun-Jul, Aug-Sep, Oct-Nov
Season: Open, Closed
Hours: 1, 2, 3, 4, 5, 6, 7, 8, 9+ (binomial component only)

Annual Abundance Index

The following models resulted from the standardization procedures where *Success* is a binomial indicating whether or not a group of anglers caught greater amberjack, α represents the parameter estimate of each factor, μ represents the mean, and ε represents the error term.

$$Success = \mu + \alpha 1\ Year + \alpha 2\ Region + \alpha 3\ Area + \alpha 4\ Hours + \alpha 5\ Year*Hours + \varepsilon$$
$$Ln\ CPUE = \mu + \alpha 1\ Year + \alpha 2\ Mode + \alpha 3\ Region + \alpha 4\ Mode*Region + \varepsilon$$

Table 5.7.9 and Figure 5.8.17 summarize the relative standardized index, the corresponding confidence intervals and coefficients of variation, and the relative nominal CPUE. Final deviance tables are included in Table 5.7.10.

5.4.3.2 Sampling Intensity and Time Series

Tables of sample sizes across strata can be found in working document SEDAR 33-AW22.

5.4.3.3 Size/Age Data

No size/age data is available.

5.4.3.4 Catch Rates

Relative nominal CPUEs are presented in Table 5.7.9 and Figure 5.8.17.

5.4.3.5 Uncertainty and Measures of Precision

Annual CVs of catch rates are presented in Table 5.7.9 and Figure 5.8.17. Plots of the binomial residuals and QQ plots of lognormal residuals were produced and are presented in SEDAR 33-AW-22.

5.4.3.6 Comments on Adequacy for Assessment

The MRFSS relative index of abundance was recommended for use in the greater amberjack stock assessment by the SEDAR 33 Index Working group. This index was recommended because the MRFSS index covers a long time series, a large portion of the spatial domain of the stock (Louisiana to Florida), and provides the stock assessment model with a source of information about the recreational charterboat and private boat sectors of the greater amberjack fishery.

5.4.4 Headboat Survey

The Headboat Survey (HBS), conducted by NOAA Fisheries, has monitored hook and line catch and effort from party (head) boats in the Gulf of Mexico since 1986. Reported information for each trip includes landing date and location, vessel identification, the number of anglers, fishing location, trip duration and/or type (half/three-quarter/full/multi-day, day/night, morning/afternoon), and catch by species in number and weight.

5.4.4.1 Methods of Estimation

HBS data were used to characterize abundance trends for the headboat fishery. The CPUE was calculated on an individual trip basis and was equal to the number of fish caught on a given trip divided by the effort, where effort was the product of the number of anglers and the total hours fished. A full-day trip was assumed to be 10 hours. Numbers of headboat trips hitting or exceeding GAJ bag limits were explored and were considered infrequent enough to be retained in the analyses.

Data Filtering Techniques

Although headboat trips ranged in length from half a day to multiple days, trip length was observed to be confounded with region. Because of this, only full day trips were included in the analysis. Data for 2010 were excluded from the analysis due to significant fishing area closures from May to November that were related to the Deepwater Horizon/BP Oil Spill (http://sero.nmfs.noaa.gov/ClosureSizeandPercentCoverage.htm). Fishing behavior was assumed to have been altered by the implementation of closed seasons (see SEDAR33-RD05 for the management history of greater amberjack). The headboat data were subset such that only data collected during greater amberjack open seasons were used in the analysis.

Headboat trips can target any number of species on any given trip; therefore, species targeting is generally unknown. The Stephens-MacCall (2004) approach was used to identify trips that targeted greater amberjack. This approach uses the species composition of each trip in a logistic regression of species presence/absence to infer if effort on that trip occurred in similar habitat to greater amberjack habitat. If effort on a trip was determined to occur in similar habitat to greater amberjack, then that trip was used in the analysis (Stephens and MacCall 2004).

Standardization

Delta-lognormal modeling methods were used to estimate a standardized abundance index for greater amberjack (Lo et al. 1992). The main advantage of using this method is allowance for the probability of zero catch (Ortiz et al. 2000). The delta-lognormal modeling approach combines separate generalized linear model (GLM) analyses of the proportion of successful trips (trips that landed greater amberjack) and the catch rates on successful trips to construct a single standardized CPUE index (Lo et al. 1992, Hinton and Maunder 2004, Maunder and Punt 2004). Parameterization of each model was accomplished using a forward selection procedure based on reduction of AIC and a reduction in deviance of greater than one percent. For each GLM procedure of proportion positive trips, a type-3 model assuming a binomial error distribution was assumed and the logit link was selected. The response variable was the proportion of successful trips across strata. For the analysis of the catch rates on successful trips, a type-3 model assuming lognormal error distribution was examined. A "normal" linking function was selected and the response variable was calculated as the natural log of CPUE. The final delta-lognormal model was fit using a SAS macro, GLIMMIX (Russ Wolfinger, SAS Institute). YEAR*FACTOR interaction terms were included in the model as random effects.

Submodel Variables

Year: 1986-2009 and 2011-2012
Region: Central and South West TX (Area codes 26-27), Northwest TX (Area codes 25), and FL AL and LA (Area codes 21-22-23-24)
Season: Nov-Jan, Feb-Apr, May-July, Aug-Oct
Anglers: 1-10, 11-20, 21-30, 31-40, 41-50, 51-60, 61-70, 71+ (binomial component only)

Annual Abundance Index

The following models resulted from the standardization procedures where *Success* is a binomial indicating whether or not a group of anglers caught greater amberjack, α represents the parameter estimate of each factor, μ represents the mean, and ε represents the error term.

$$\textit{Success} = \mu + \alpha 1 \text{ Year} + \alpha 2 \text{ Region} + \alpha 3 \text{ Year*Region} + \varepsilon$$
$$\text{Ln CPUE} = \mu + \alpha 1 \text{ Year} + \alpha 2 \text{ Region} + \alpha 3 \text{ Season} + \alpha 4 \text{ Year*Region} + \varepsilon$$

Table 5.7.11 and Figure 5.8.18 summarize the relative standardized index, the corresponding confidence intervals and coefficients of variation, and the relative nominal CPUE. Final deviance tables are included in Table 5.7.12.

5.4.4.2 Sampling Intensity and Time Series

Tables of sample sizes across strata can be found in working document SEDAR 33-AW-21.

5.4.4.3 Size/Age Data

No size/age data is available.

5.4.4.4 Catch Rates

Relative nominal CPUEs are presented in Table 5.7.11 and Figure 5.8.18.

5.4.4.5 Uncertainty and Measures of Precision

Annual CVs of catch rates are presented in Table 5.7.11 and Figure 5.8.18. Plots of the binomial residuals and QQ plots of lognormal residuals were produced and are presented in SEDAR 33-AW-21.

5.4.4.6 Comments on Adequacy for Assessment

The headboat standardized index of abundance was recommended for use in the greater amberjack stock assessment by the SEDAR 33 Index Working group. This index was recommended because it covers a long time series, the entire spatial domain of the stock, and provides the stock assessment model with a source of information about the recreational headboat sector of the greater amberjack fishery.

5.4.5 Reef Fish BLL Observer

Catch rate series were developed for gag grouper and greater amberjack from a combined data set based on observer programs from the NMFS Panama City and Galveston Laboratories. On-board observers in the Reef fish Longline Fishery collected data from 2006-2012. For analysis, the data was subjected to a Generalized Linear Model (GLM) standardization technique that treats separately the proportion of sets with positive catches (i.e., where at least one fish was caught) assuming a binomial error distribution with a logit link function, and the catch rates of sets with positive catches assuming a lognormal error distribution with a log link function. Several categorical variables were constructed that were assumed to influence the probability and rate of capture. For the final gag grouper model, year and set depth were significant as the main effect in the binomial model and year, hook type and season in the lognormal model. The relative abundance index showed a general flat trend in abundance from 2006 to 2009 but increased thereafter to 2012. For greater amberjack, year, set depth, set begin and season were significant as the main effect in the binomial model and year and hook type in the lognormal model. The relative abundance index for greater amberjack was generally stable throughout the time series.

5.4.5.1 Comments on Adequacy for Assessment

This index was not recommended for use by the IWG mainly because it covers the same segment of the population as the commercial longline index (logbooks). In addition, it is a shorter time series when compared to the logbook data.

5.5. Research Recommendations made by Members of the IWG

- Expand the use of molecular genetics to identify the amberjack larvae in SEAMAP samples that cannot be positively identified as greater amberjack because diagnostic morphological characters are not yet developed.

- The IWG made note that the delta-lognormal index may not be the most appropriate distribution with some of the data presented. However, the lack of adequate diagnostics for different distributions prelude their use. The recommendation is that addition work be done with these other distribution (i.e. Poisson, negative binomial) in order to fully vet the methodology.

- A calibration study is needed between the FWRI/NMFS video survey.

- An exploration of the effects of the IFQ on the fishery dependent indices, specially the commercial handline and longline is needed. During the workshop, fisherman indicated that since the implementation of the IFQ, there has been a drastic change in fisheries behavior. There is also the possibility that dealers can directly influence this behavior. The need is to find a way to incorporate these years into the overall timer series or a recommendation to split the time series when the IFQ began.

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5.7 Tables

Table 5.7.1. GOM-wide greater amberjack lo and standardized index of abundance values by year design based model.

SurveyYear	*Frequency*	*N*	*LoIndex*	*StdIndex*	*SE*	*CV*	*LCL*	*UCL*
1993	0.15723	159	0.47200	1.14831	0.090376	0.19147	0.78568	1.67833
1994	0.27966	118	0.49831	1.21231	0.089951	0.18051	0.84738	1.73441
1995	0.29204	113	0.45749	1.11299	0.081160	0.17740	0.78270	1.58268
1996	0.15260	308	0.28655	0.69713	0.045083	0.15733	0.50991	0.95310
1997	0.14591	281	0.25085	0.61028	0.046058	0.18361	0.42401	0.87840
2002	0.34109	258	0.75454	1.83568	0.082089	0.10879	1.47768	2.28043
2004	0.18182	198	0.39662	0.96491	0.061284	0.15452	0.70969	1.31192
2005	0.22308	390	0.41865	1.01852	0.044949	0.10736	0.82221	1.26171
2006	0.14925	402	0.30351	0.73839	0.041943	0.13819	0.56081	0.97219
2007	0.17521	468	0.36762	0.89436	0.043879	0.11936	0.70503	1.13454
2008	0.16438	292	0.30484	0.74163	0.047110	0.15454	0.54544	1.00839
2009	0.22087	412	0.44078	1.07234	0.048554	0.11016	0.86088	1.33575
2010	0.23549	293	0.34333	0.83526	0.044116	0.12850	0.64665	1.07888
2011	0.24769	432	0.48580	1.18189	0.055936	0.11514	0.93950	1.48682
2012	0.25607	453	0.38472	0.93597	0.038541	0.10018	0.76642	1.14304

Table 5.7.2. Annual video survey sample sizes, % frequencies of occurrence, mean nominal video min counts, and standard errors of greater amberjack east and west of Cape San Blas, 2005-2012. Estimates calculated using censored data sets.

	Total sites sampled		% Freq of occurrence		Mean nominal min count		Standard error	
Year	East	West	East	West	East	West	East	West
2005	31		0.0		0.000		0.000	
2006	49	24	6.1	20.8	0.449	1.750	0.352	1.034
2007	29	23	10.3	34.8	0.310	1.348	0.217	0.568
2008	56	29	8.9	27.6	0.875	1.172	0.417	0.525
2009	62	42	32.3	40.5	1.903	0.833	0.580	0.193
2010	95	52	7.4	34.6	0.242	0.981	0.119	0.282
2011	100	58	2.0	15.5	0.020	0.224	0.014	0.078
2012	101	49	16.8	55.1	0.653	1.551	0.273	0.420

Table 5.7.3. Panama City lab video abundance indices for greater amberjack. The *frequency* listed is nominal frequency, *N* is the number of video stations, *Index* is the abundance index in CPUE units, *Scaled Index* is the index scaled to a mean of one over the time series, *CV* is the coefficient of variation on the index value, and *LCL* and *UCL* are 95% confidence limits.

Survey Year	*Frequency*	*N*	*Index*	*Scaled Index*	*CV*	*LCL*	*UCL*
2005	0.00000	31					
2006	0.10959	73	0.69957	0.94676	0.44831	0.40228	2.22820
2007	0.21154	52	0.63627	0.86111	0.37975	0.41329	1.79414
2008	0.15294	85	0.80661	1.09163	0.35090	0.55219	2.15804
2009	0.35577	104	1.26600	1.71335	0.19799	1.15752	2.53610
2010	0.17007	147	0.55889	0.75638	0.25408	0.45866	1.24734
2011	0.06962	158	0.12025	0.16274	0.38881	0.07684	0.34467
2012	0.29333	150	1.08473	1.46803	0.18495	1.01728	2.11851

Table 5.7.4. Summary of annual stationary underwater camera array (SUCA) sampling effort by spatial zone from 2008 – 2012. Values represent total number of sampling stations, while values in parentheses represent the total number of individual gear deployments (1 – 2 arrays deployed per station).

Region	2008	2009	2010	2011	2012	Total
TBN	5 (10)	25 (34)	16 (24)	56 (84)	54 (82)	156 (234)
TBO	18 (33)	33 (66)	25 (50)	49 (57)	36 (47)	161 (253)
CHN	20 (38)	28 (43)	23 (46)	35 (37)	36 (47)	142 (211)
CHO	24 (48)	30 (60)	29 (56)	42 (45)	48 (61)	173 (270)
Total	67 (129)	116 (203)	93 (176)	182 (223)	174 (237)	632 (968)

Table 5.7.5. Abundance indices for greater amberjack from 2008 – 2012.

Survey Year	*Frequency*	*N*	*Index*	*Standardized Index*	*CV*	*LCL*	*UCL*
2008	0.000000	109	.	.	.	.	.
2009	0.038462	182	0.23145	1.01914	0.72365	0.27834	3.73158
2010	0.041096	73	0.18192	0.80106	1.09366	0.13592	4.72127
2011	0.050926	216	0.16452	0.72444	0.63640	0.22569	2.32541
2012	0.082609	230	0.33052	1.45537	0.54180	0.52760	4.01458

Table 5.7.6. Nominal CPUE and percent occurrence for greater amberjack captured during the SEAMAP groundfish survey.

	Summer		Fall		Combined	
Year	CPUE	Percent	CPUE	Percent	CPUE	Percent
1972			0	0	0	0
1973			0	0	0	0
1974			0.0413	0.83	0.0413	0.83
1975			0.0214	0.36	0.0214	0.36
1976			065	0.33	0.0065	0.33
1977			0	0	0	0
1978			0.0125	0.63	0.0125	0.63
1979			0	0	0	0
1980			0	0	0	0
1981			0	0	0	0
1982	0	0	0	0	0	0
1983	0	0	0	0	0	0
1984	0	0	0.0354	0.88	0.0176	0.44
1985	0.0152	0.53	0.0235	0.29	0.0205	0.38
1986	0.0813	1.76	0	0	0.0291	0.63
1987	0.0478	0.33	0	0	0.0272	0.19
1988	0.0125	0.83	0	0	0.0062	0.41
1989	0	0	0	0	0	0
1990	0.1227	3.37	0.1025	1.95	0.1128	2.67
1991	0.2312	4.62	0.1562	3.16	0.1942	3.90
1992	0.0244	0.81	0	0	0.0127	0.42
1993	0.0047	0.40	0.2226	1.10	0.1191	0.77
1994	0.0723	1.92	0.0132	1.19	0.0432	1.56
1995	0.1169	4.20	0.0176	0.83	0.0669	2.51
1996	0.0315	0.82	0.0032	0.40	0.0171	0.61
1997	0.5095	2.60	0.0625	0.81	0.2785	1.67
1998	0	0	0	0	0	0
1999	0.2553	4.88	0.1053	2.42	0.1800	3.64
2000	0.0765	2.09	0	0	0.0378	1.04
2001	0	0	0.1911	1.76	0.1077	0.99
2002	0.4355	3.19	0.0042	0.39	0.2173	1.77
2003	0.0138	0.98	0.0033	0.36	0.0077	0.63
2004	0.1393	1.67	0.0160	1.75	0.0791	1.71
2005	0.0752	1.55	0.0277	1.18	0.0482	1.34
2006	0.1013	2.93	0	0	0.0523	1.51
2007	0.1406	6.36	0.0025	0.44	0.0705	3.36
2008	0.0643	1.99	0.0381	1.37	0.0500	1.65
2009	0.1306	2.12	0.0317	0.91	0.0854	1.57
2010	0.0429	0.81	0.0127	0.64	0.0290	0.73
2011	0.1459	2.14	0.0187	0.94	0.0957	1.67
2012	0.3128	3.51	0.0200	1.01	0.2157	2.68
Total	*0.1033*	*1.82*	*0.0290*	*0.63*	*0.0635*	*1.16*

Table 5.7.7. Nominal CPUE and percent occurrence for greater amberjack captured during the small pelagics survey.

Year	Stations	CPUE	Percent
2002	132	0.0400	1.52
2003	145	0	0
2004	101	0.8119	4.95
2006	73	0.1284	1.37
2007	146	0.0949	1.37
2008	167	0.5119	4.19
2009	122	0.0975	3.28
2010	136	0.1025	2.21
2011	131	0.0150	0.76
2012	111	0.2446	4.50
Total	*1264*	*0.20467*	*2.42*

Table 5.7.8. Nominal CPUE and percent occurrence for greater amberjack captured during the bottom longline survey.

Year	Station	CPUE	Percent
1995	77	0	0
1996	83	0.0102	1.20
1997	169	0	0
1999	161	0	0
2000	137	0	0
2001	277	0.0034	0.36
2002	212	0.0095	0.94
2003	280	0.0033	0.36
2004	249	0.0327	1.20
2005	95	0	0
2006	150	0	0
2007	156	0.0176	1.28
2008	108	0	0
2009	185	0	0
2010	151	0.0190	1.99
2011	128	0	0
2012	142	0.0292	2.82
Total	*2760*	*0.0082*	*0.62*

Table 5.7.9. Index values, upper confidence limits, lower confidence limits, and coefficient of variation for the MRFSS charterboat and private boat index for Gulf of Mexico greater amberjack.

Year	Standardized Index	CV	Lower 95% CI	Upper 95% CI	Nominal CPUE
1986	2.002	0.131	1.543	2.597	2.530
1987	1.132	0.136	0.864	1.485	1.563
1988	0.600	0.171	0.427	0.844	0.991
1989	1.722	0.165	1.240	2.391	1.498
1990	0.168	0.300	0.094	0.303	0.277
1991	1.553	0.169	1.110	2.171	2.051
1992	1.628	0.123	1.275	2.080	1.657
1993	0.759	0.168	0.544	1.059	1.021
1994	0.632	0.186	0.437	0.914	0.521
1995	0.361	0.261	0.216	0.603	0.364
1996	0.279	0.215	0.183	0.427	0.245
1997	0.262	0.215	0.171	0.401	0.298
1998	0.296	0.173	0.210	0.418	0.325
1999	0.432	0.129	0.335	0.559	0.400
2000	0.912	0.130	0.703	1.182	0.765
2001	1.231	0.121	0.967	1.566	1.201
2002	1.946	0.105	1.579	2.399	1.638
2003	1.793	0.107	1.449	2.218	1.615
2004	0.911	0.115	0.725	1.145	0.837
2005	0.778	0.135	0.594	1.018	0.754
2006	0.720	0.142	0.543	0.956	0.660
2007	0.847	0.145	0.635	1.129	0.697
2008	1.102	0.138	0.837	1.450	0.737
2009	1.019	0.143	0.767	1.356	0.732
2010					
2011	1.547	0.130	1.194	2.003	1.281
2012	1.366	0.125	1.065	1.753	1.341

Table 5.7.10. Final deviance tables for the Gulf of Mexico greater amberjack regressions for the MRFSS charterboat and private fishing modes using total catch. The table shows the order of the factors as they were added sequentially to the model such that fit diagnostics listed for each factor were the diagnostics from a model that included that factor and all of the factors listed above it in the table.

Binomial

Factor	Df	Deviance	Residual Df	Residual Deviance	AIC	% Deviance Reduced	log likelihood	Likelihood Ratio Test
Null	1	25300.90	135587	25300.90	25301.00	-	-12650.50	-
Region	3	21434.30	135584	3866.60	21434.40	0.15	-10717.20	3866.60
Area	1	19160.30	135583	2274.00	19160.40	0.11	-9580.20	2274.00
Year	25	18654.80	135558	505.50	18654.80	0.03	-9327.40	505.60
HRS	8	18305.20	135550	349.60	18305.20	0.02	-9152.60	349.60
Year*HRS	200	17927.20	135350	378.00	17927.20	0.02	-8963.60	378.00

Lognormal

Factor	Df	Deviance	Residual Df	Residual Deviance	AIC	% Deviance Reduced	log likelihood	Likelihood Ratio Test
Null	1	7797.10	135587	7797.10	-2439.80	-	1219.90	-
Mode	1	7579.70	135586	217.40	-6274.20	0.03	3137.10	3834.40
Region	3	7500.00	135583	79.70	-7707.40	0.01	3853.70	1433.20
Year	25	7488.00	135558	12.00	-7924.80	0.00	3962.40	217.40
Mode*Region	3	7391.00	135555	97.00	-9691.80	0.01	4845.90	1767.00

Table 5.7.11. Index values, upper confidence limits, lower confidence limits, and coefficient of variation for the headboat index for Gulf of Mexico greater amberjack.

Year	Standardized Index	CV	Lower 95% CI	Upper 95% CI	Nominal CPUE
1986	3.546	0.350	1.797	6.997	3.408
1987	1.774	0.384	0.845	3.724	1.778
1988	1.905	0.372	0.928	3.913	2.263
1989	1.493	0.385	0.710	3.139	1.494
1990	0.576	0.454	0.242	1.370	0.752
1991	0.728	0.433	0.318	1.668	0.791
1992	1.213	0.386	0.576	2.554	1.320
1993	0.735	0.401	0.340	1.591	0.641
1994	0.577	0.423	0.257	1.298	0.466
1995	0.681	0.416	0.306	1.513	0.534
1996	0.778	0.407	0.355	1.704	0.761
1997	0.597	0.446	0.255	1.399	0.526
1998	0.409	0.469	0.167	0.997	0.309
1999	0.547	0.493	0.215	1.390	0.576
2000	0.521	0.486	0.208	1.308	0.384
2001	0.916	0.426	0.405	2.073	0.878
2002	1.059	0.441	0.456	2.462	0.993
2003	1.425	0.417	0.640	3.172	1.230
2004	1.084	0.417	0.487	2.413	0.906
2005	0.482	0.470	0.197	1.179	0.389
2006	0.692	0.476	0.280	1.710	0.552
2007	0.420	0.486	0.167	1.054	0.436
2008	1.506	0.496	0.589	3.846	1.858
2009	0.729	0.445	0.311	1.705	0.987
2010					
2011	0.865	0.540	0.314	2.381	0.898
2012	0.742	0.537	0.271	2.031	0.869

Table 5.7.12. Final deviance tables for the Gulf of Mexico greater amberjack regressions from the headboat fishery using landings. The table shows the order of the factors as they were added sequentially to the model such that fit diagnostics listed for each factor were the diagnostics from a model that included that factor and all of the factors listed above it in the table. Although the interaction term between Year and Region (highlighted in gray) was included in the deviance analysis for the binomial component and in the GLM exercise, this interaction was not included in the final model because it did not converge.

Binomial

Factor	DF	Deviance	Residual Df	Residual Deviance	AIC	% Deviance Reduced	Log likelihood	Likelihood Ratio Test
Null	1	17001.60	12418	17001.60	17001.60	-	-8500.80	-
Year	25	16371.30	12393	630.30	16371.20	3.71	-8185.60	630.40
Region	2	16208.20	12391	163.10	16208.20	1.00	-8104.10	163.00
Year*Region	50	15691.00	12341	517.20	15691.00	3.19	-7845.50	517.20

Lognormal

Factor	DF	Deviance	Residual Df	Residual Deviance	AIC	% Deviance Reduced	log likelihood	Likelihood Ratio Test
Null	1	63799.50	12418	63799.50	55567.60	-	-27783.80	-
Region	2	62307.50	12416	1492.00	55273.60	2.34	-27636.80	294.00
Year	25	60905.70	12391	1401.80	54991.00	2.25	-27495.50	282.60
Season	3	60238.60	12388	667.10	54854.20	1.10	-27427.10	136.80
Year*Region	50	58777.20	12338	2128.50	54549.20	2.43	-27274.60	441.80

5.8 Figures

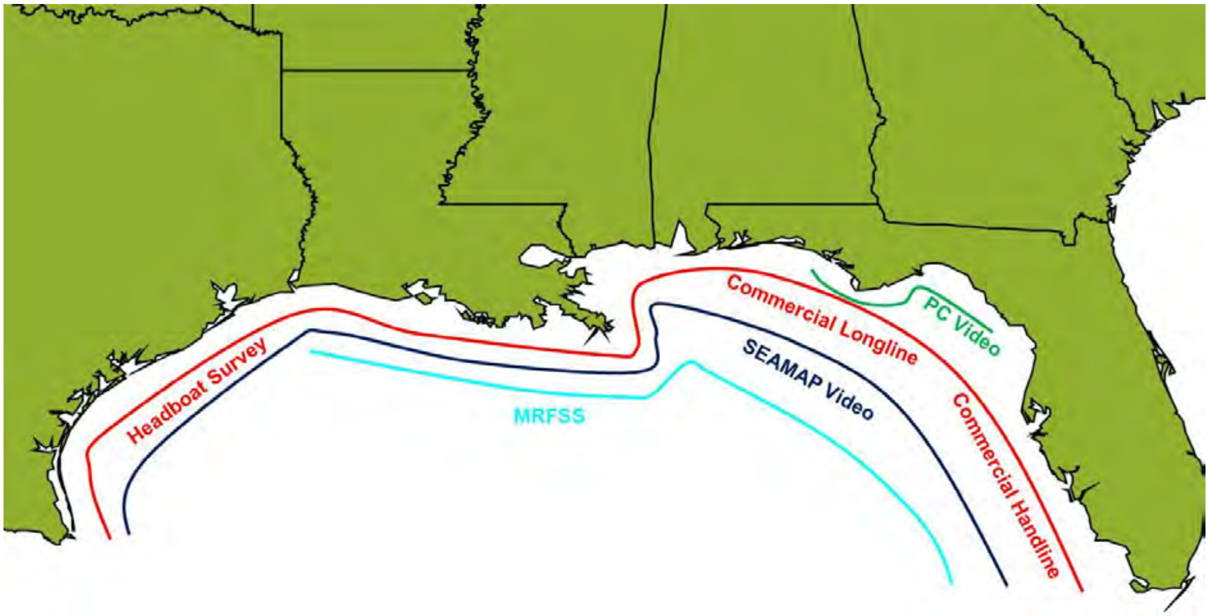

Figure 5.8.1. Spatial coverage of fishery-independent and fishery-dependent indices recommended for use.

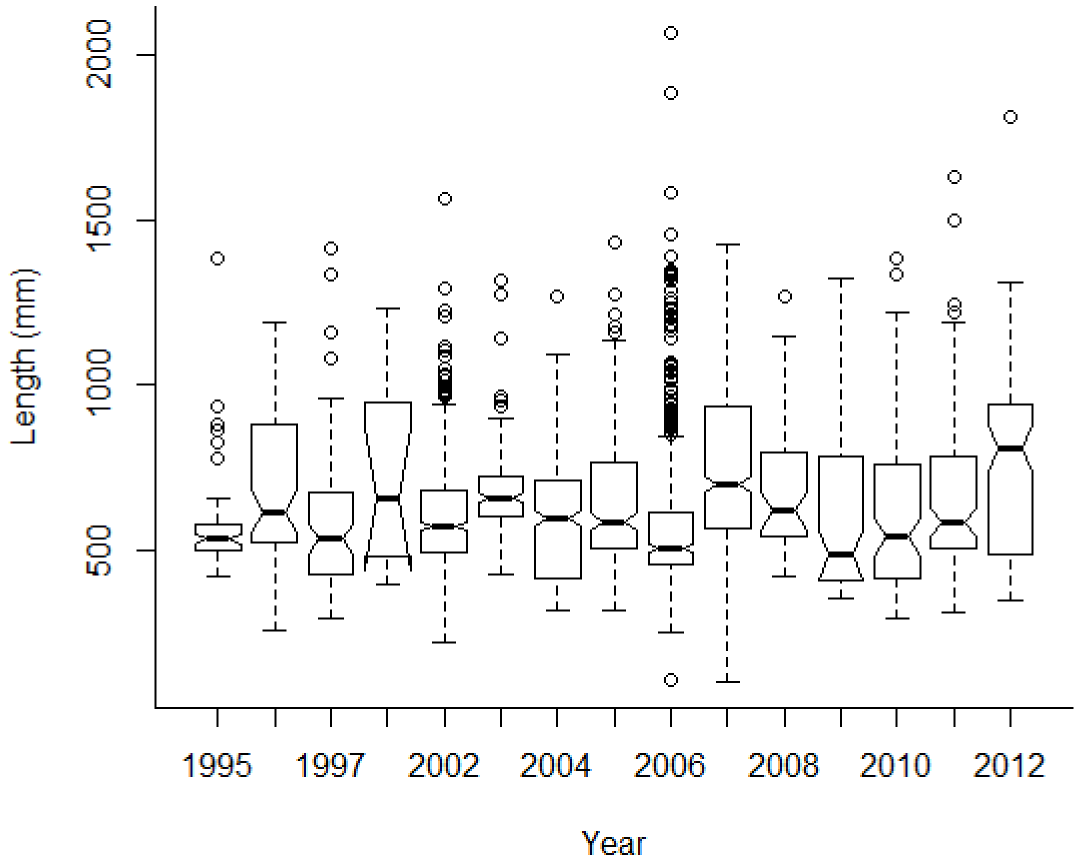

Figure 5.8.2. Greater amberjack mean lengths by year. Upper and lower quartiles represented within boxes, whiskers extend to subsequent quartiles, and non-overlapping notches indicate groups for which median responses are likely different.

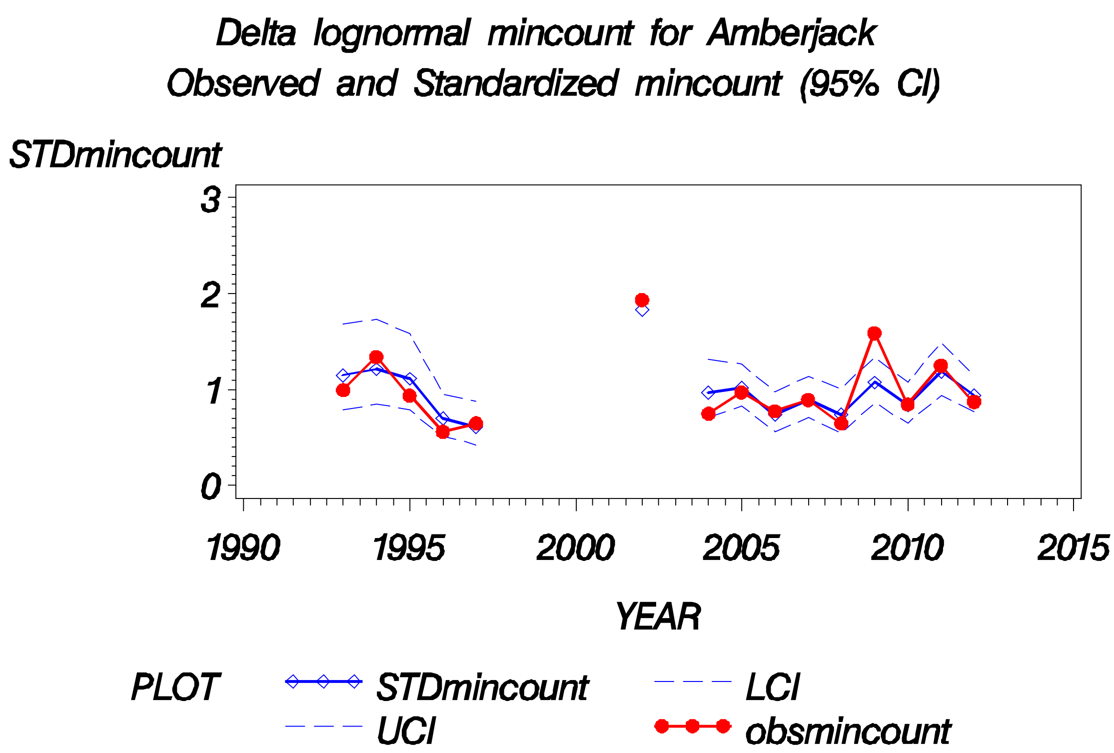

Figure 5.8.3. GOM-wide observed versus standardized mincount for design based model.

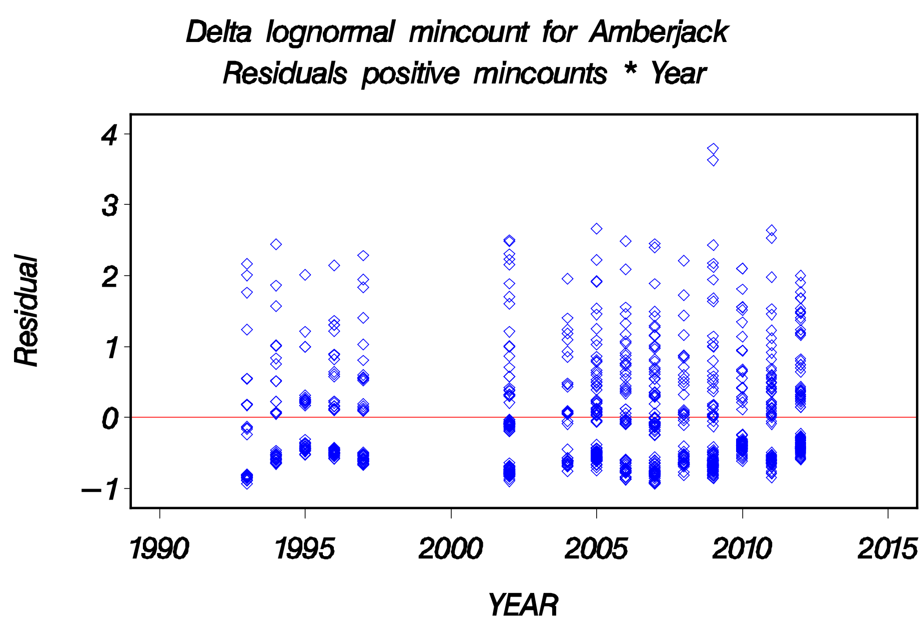

Figure 5.8.4. GOM wide residuals of positive mincounts by year for design based model.

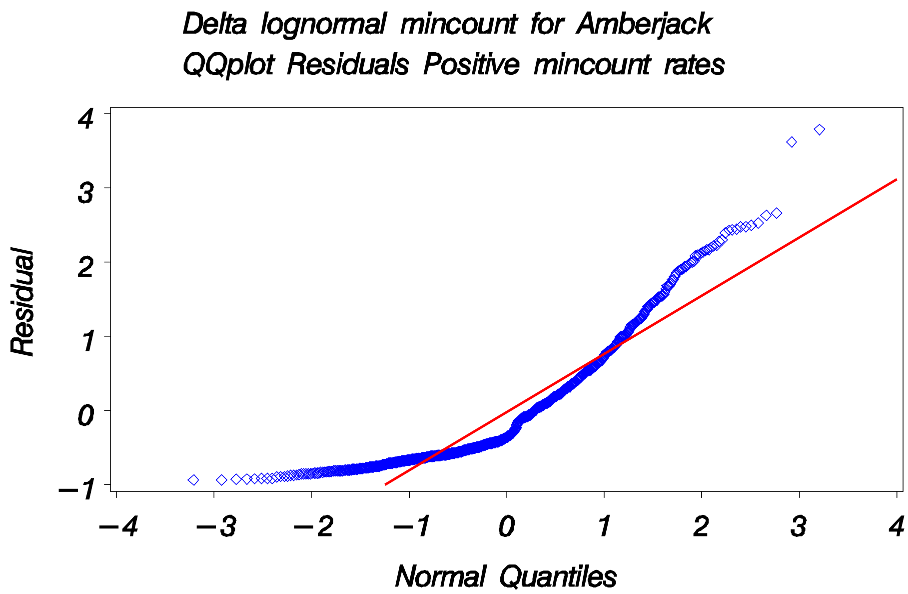

Figure 5.8.5. GOM-wide qqplot of residuals of positive mincounts from design based model.

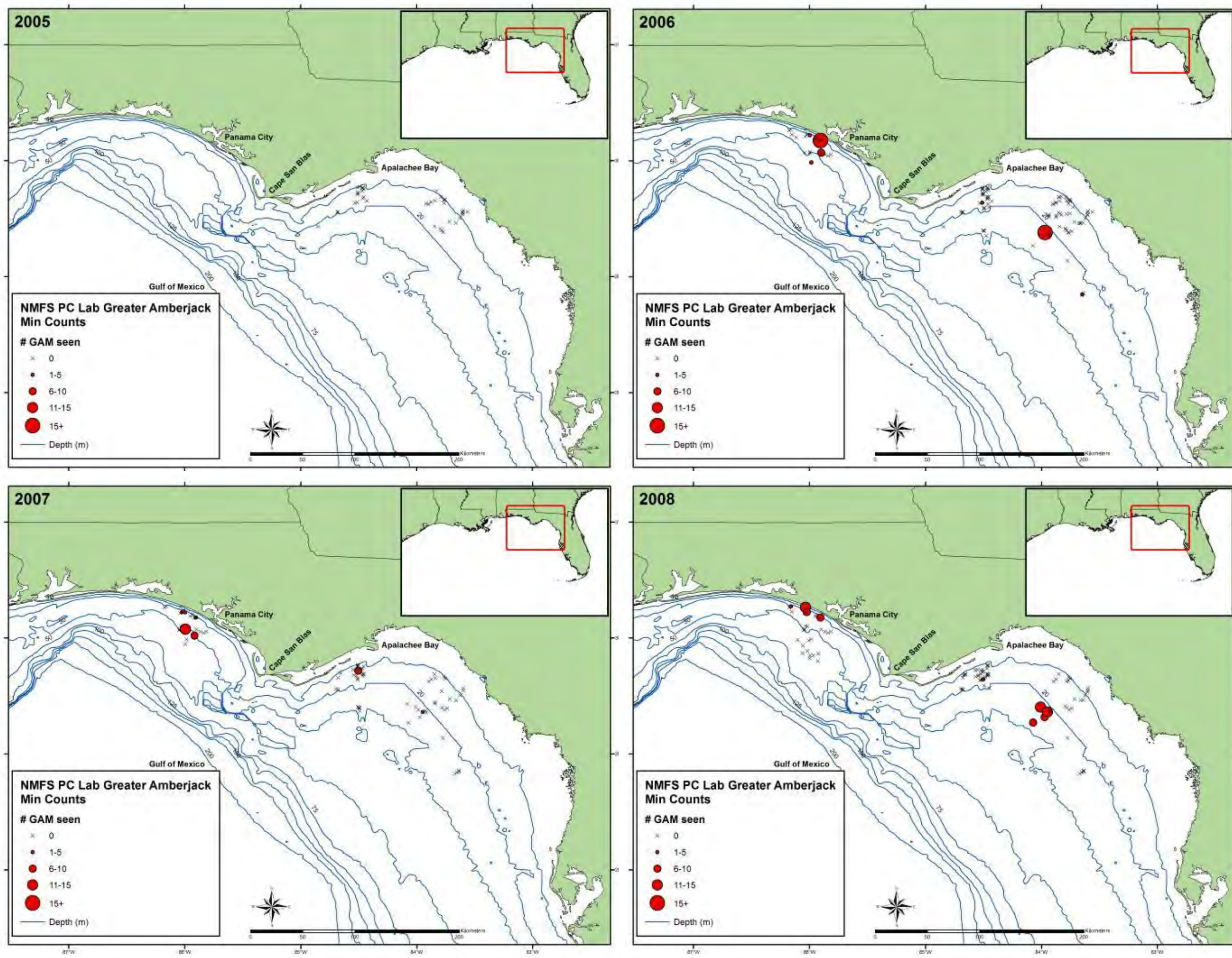

Figure 5.8.6. Annual distribution and relative abundance (min counts) of greater amberjack observed in the Panama City NMFS reef fish survey, 2005-2008, with stationary, high definition video cameras. Sites sampled with video gear, but where no greater amberjack were observed, are indicated with an X.

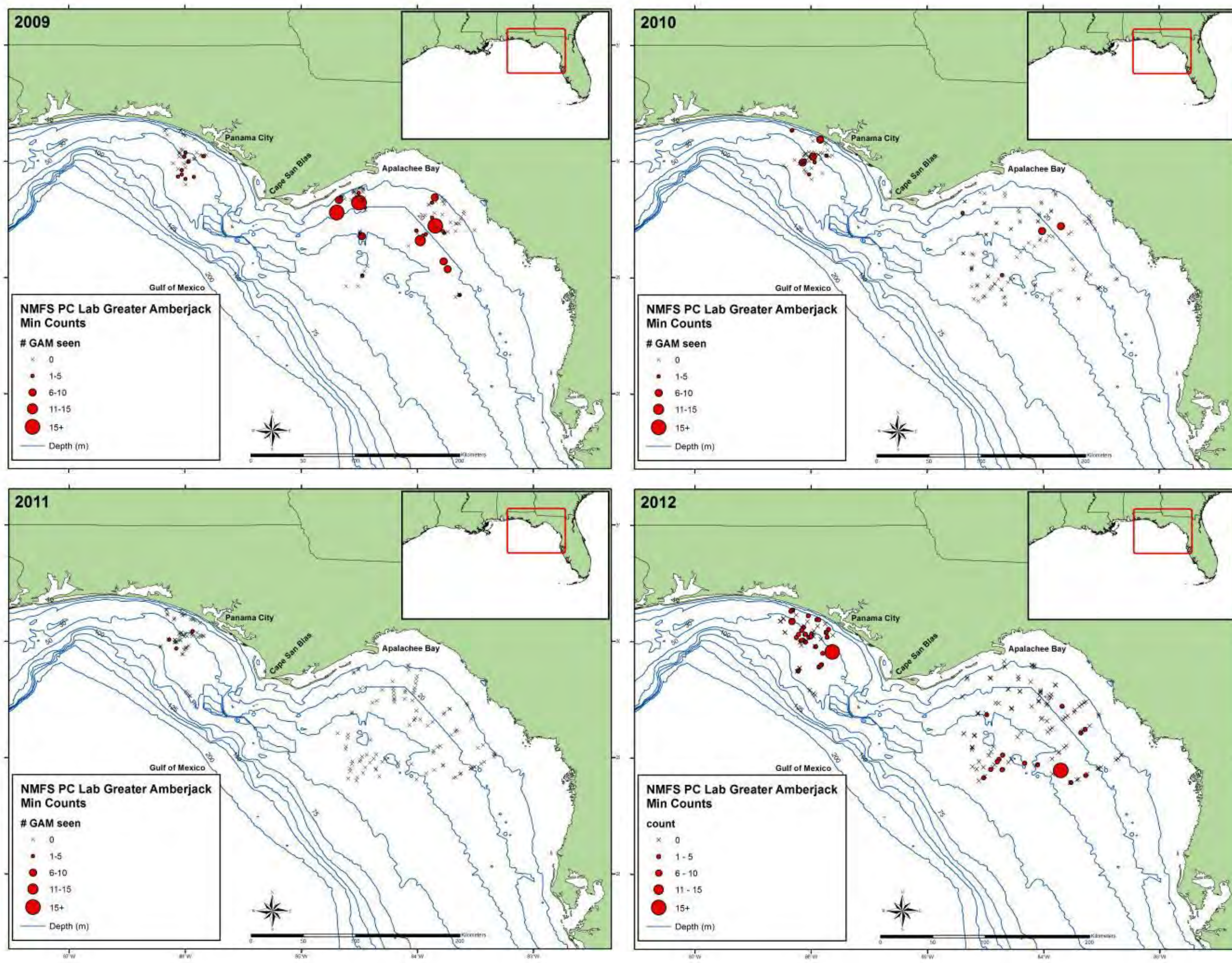

Figure 5.8.7. Annual distribution and relative abundance (min counts) of greater amberjack observed in the Panama City NMFS reef fish survey with stationary, high definition video or mpeg cameras, 2009-2012. Sites sampled with video gear, but where no greater amberjack were observed, are indicated with an X.

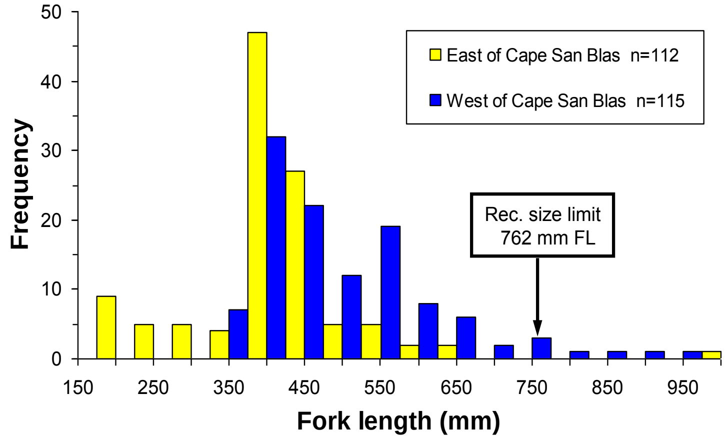

Figure 5.8.8. Overall size distributions of greater amberjack east and west of Cape San Blas observed with stereo cameras and measured using Vision Measurement System software, 2009-2012.

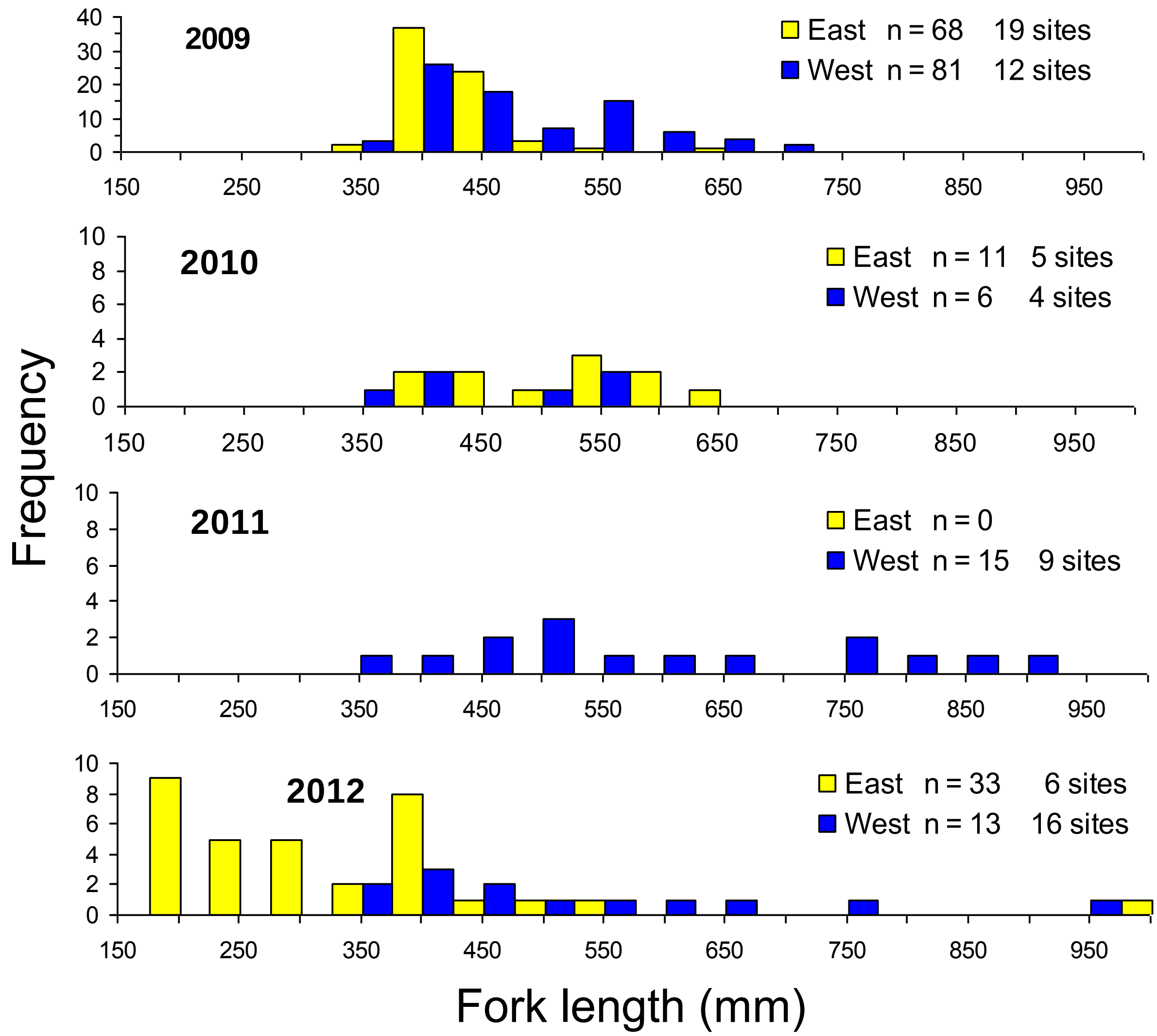

Figure 5.8.9. Annual size distributions of greater amberjack, 2009-2012, east and west of Cape San Blas measured from stereo images using Vision Measurement System software.

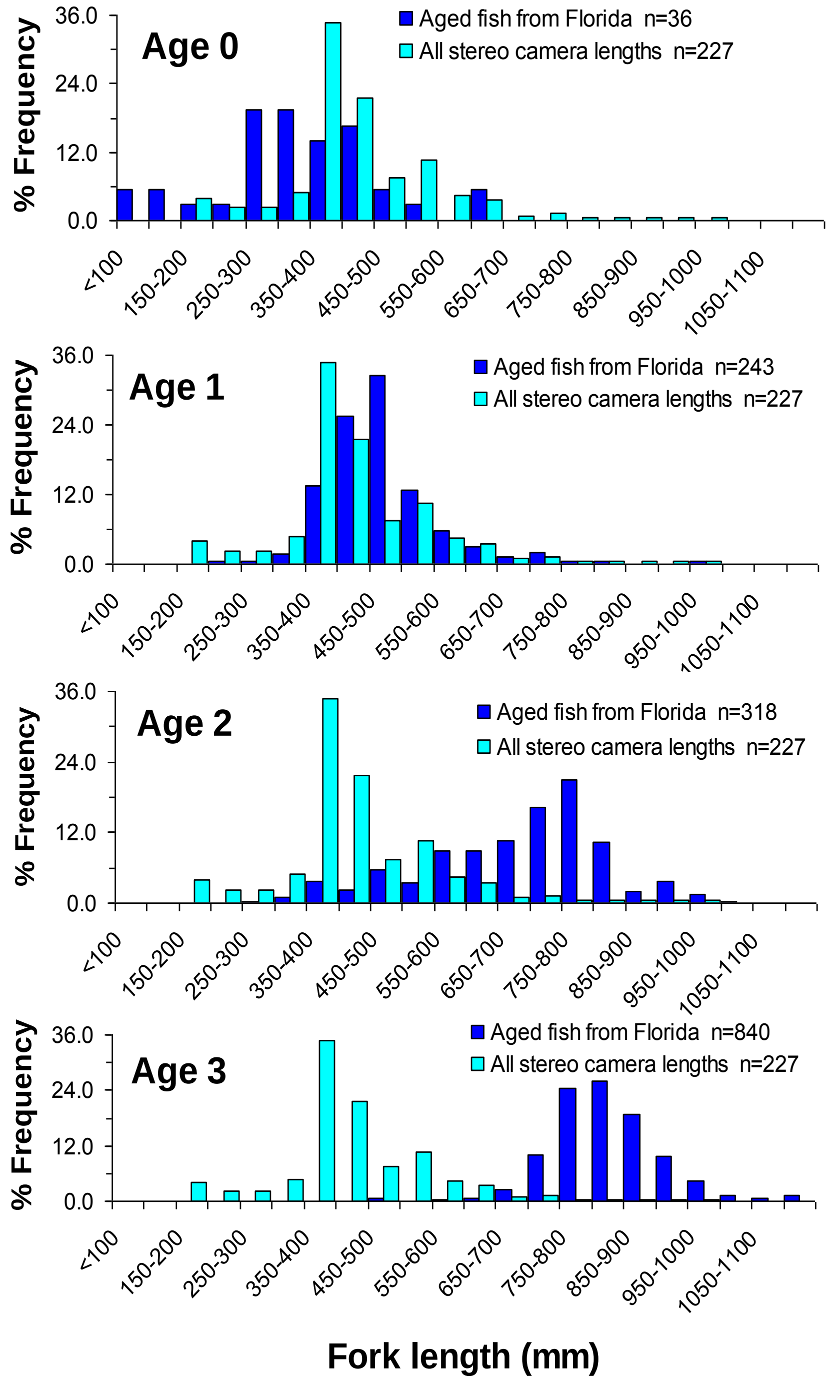

Figure 5.8.10. Comparison of age-specific size structure of greater amberjack, ages 0-3, from fish collected in Florida, 1980-2012 (data set described in Allman et al. 2013) with size distribution of all fish measured from Panama City survey stereo images, 2009-2012.

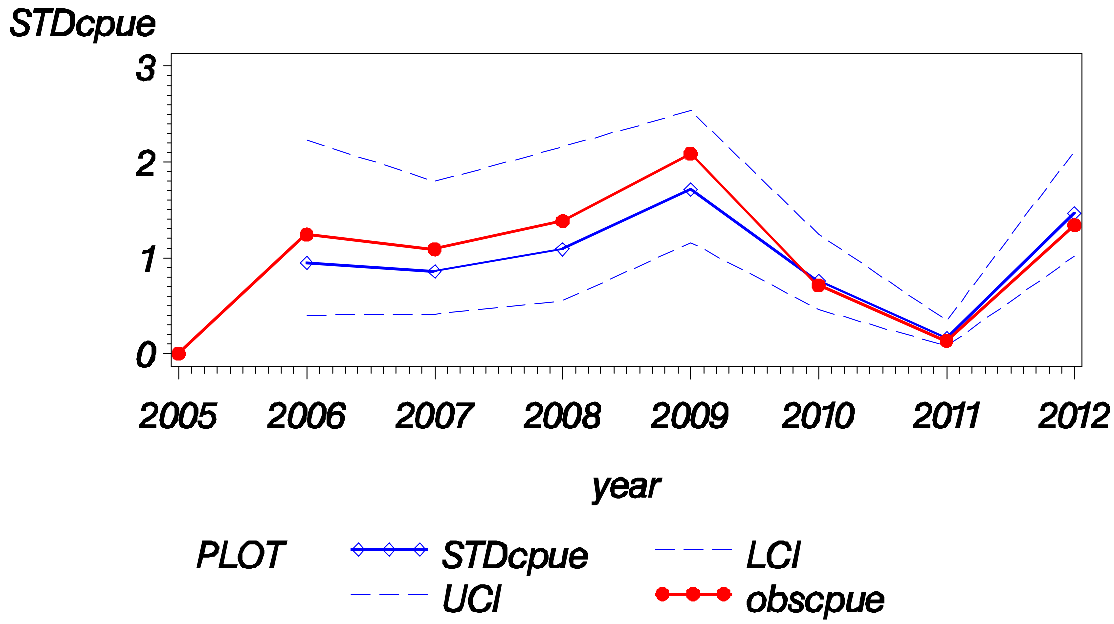

Figure 5.8.11. Annual index of abundance for greater amberjack from the Panama City NMFS lab video survey from 2005 to 2012. STDcpue is the index scaled to a mean of one over the time series. Obscpue is the average nominal CPUE, and LCI and UCI are 95% confidence limits.

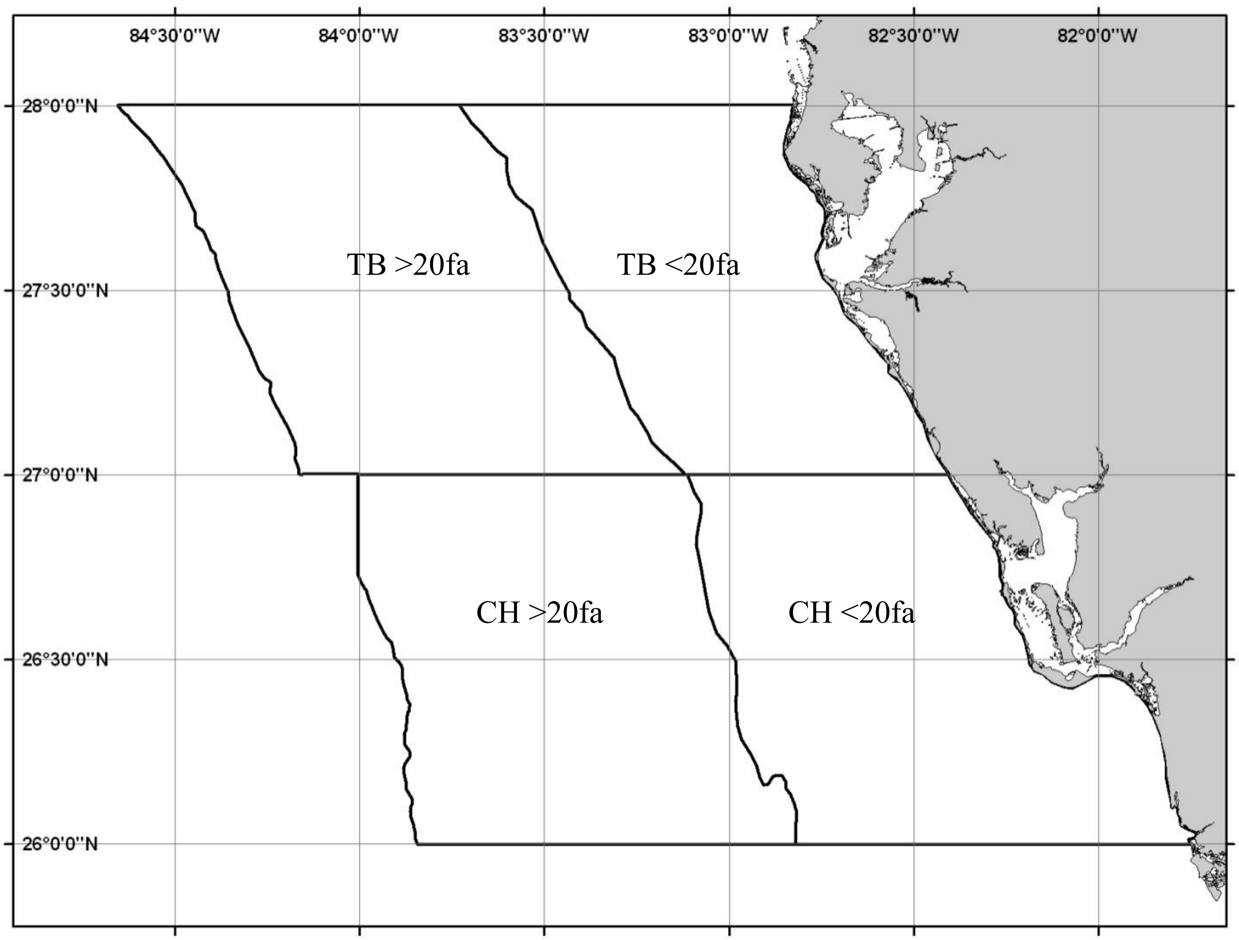

Figure 5.8.12. The West Florida Shelf survey area. The 20fa (37m) contour separates nearshore (i.e., TBN and CHN) and offshore (TBO and CHO) sampling zones. The sampling area includes waters 10m – 110m.

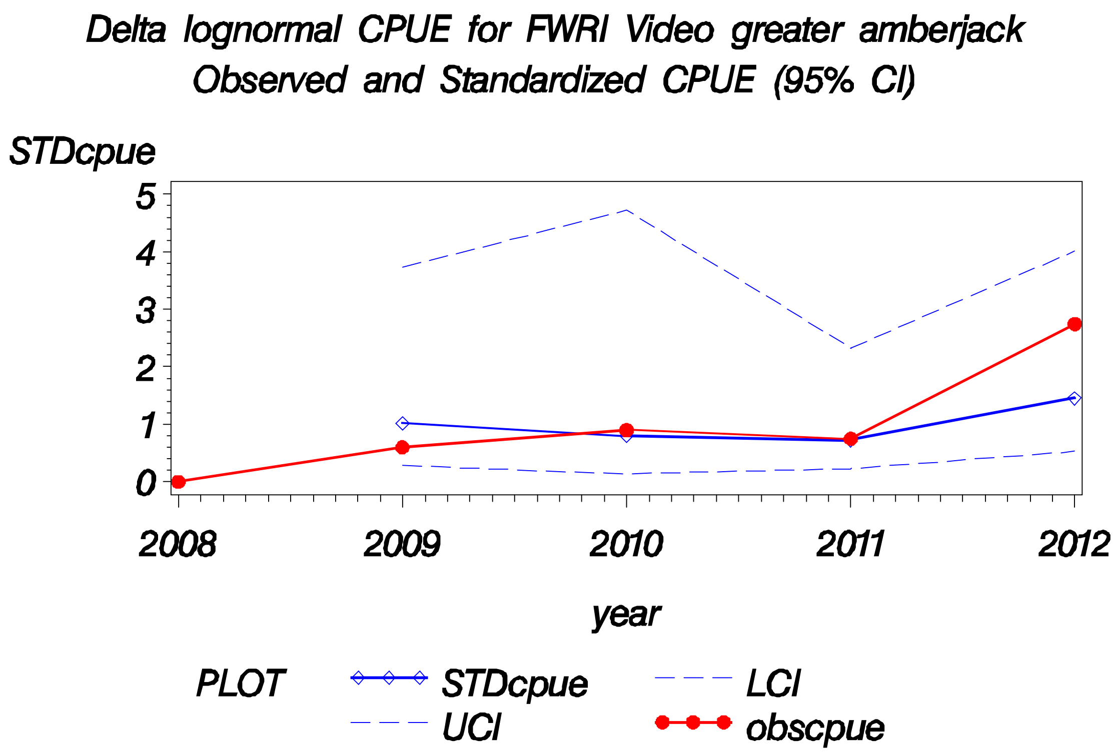

Figure 5.8.13. Abundance indices for greater amberjack from 2008 – 2012.

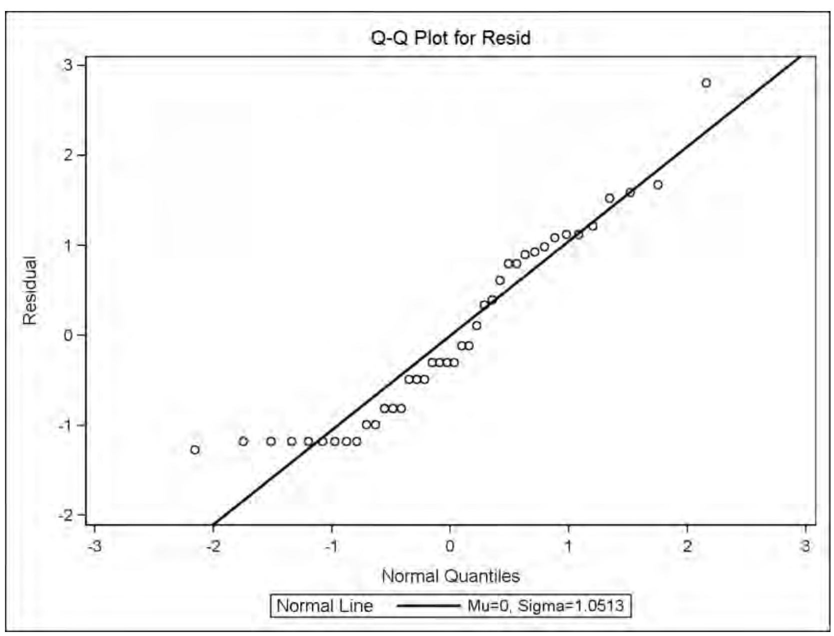

Figure 5.8.14. Q-Q plot of residuals from the lognormal sub-model for greater amberjack from 2008 – 2012.

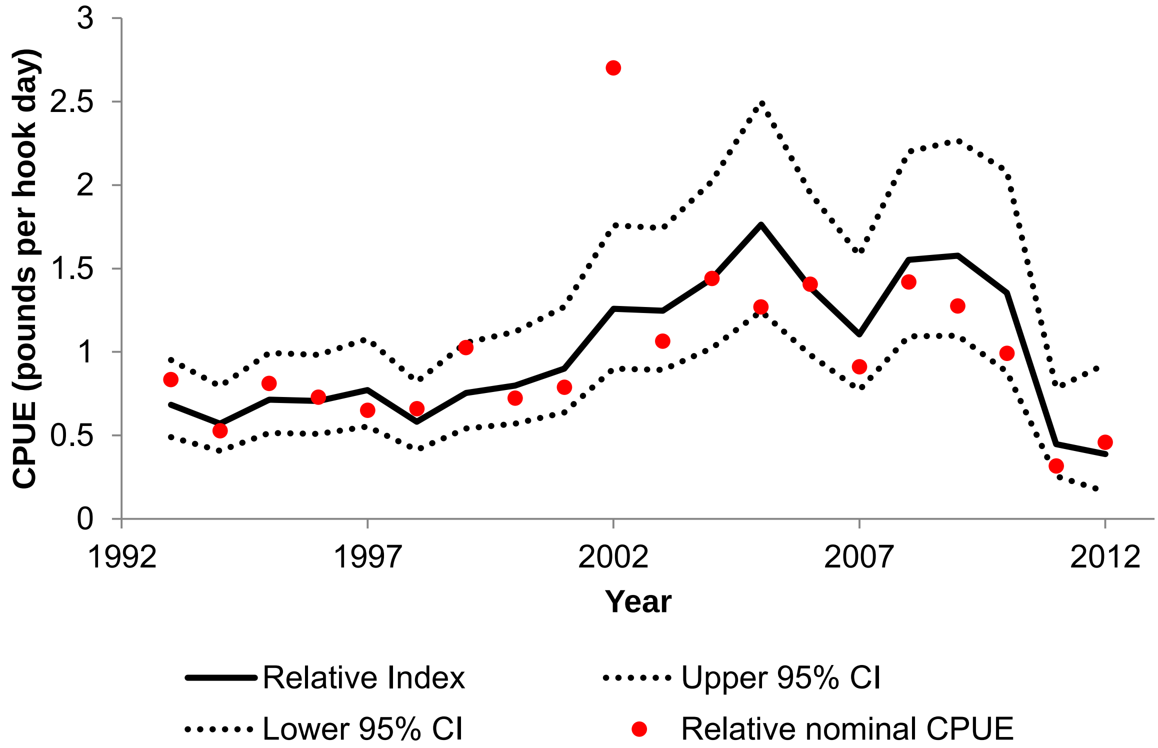

Figure 5.8.15. Estimated greater amberjack standardized index of abundance for the commercial longline fishery in the Gulf of Mexico.

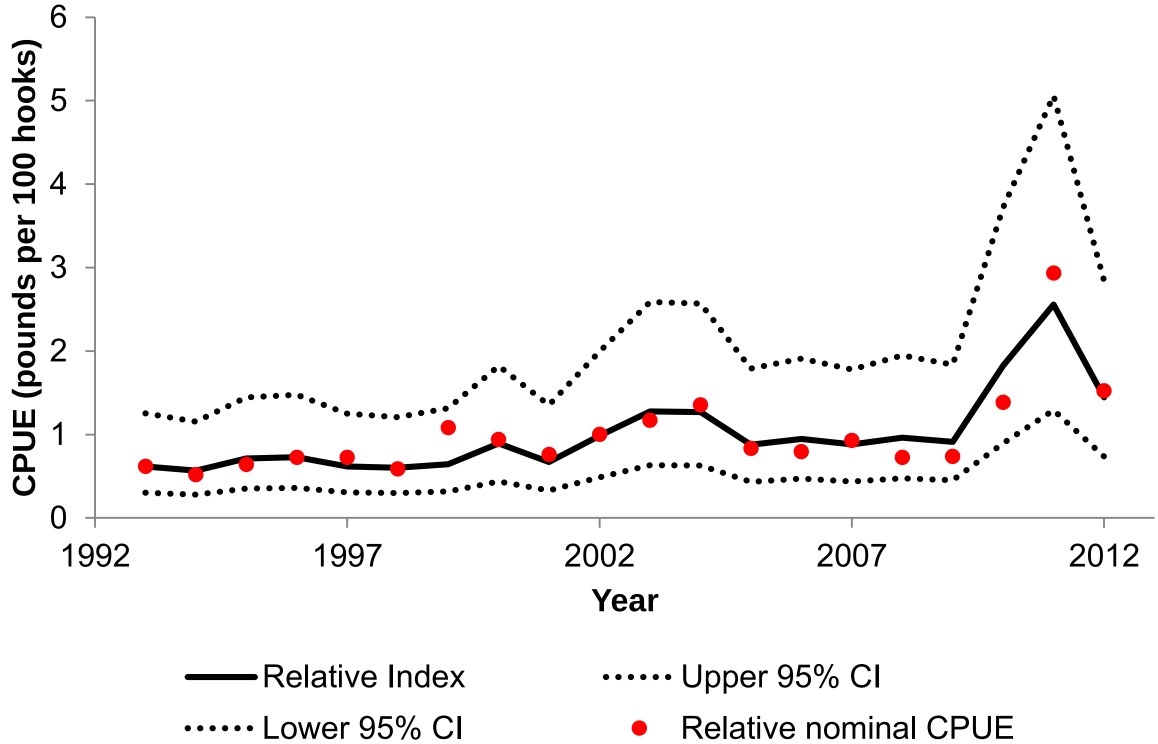

Figure 5.8.16. Estimated greater amberjack standardized index of abundance for the commercial handline fishery in the Gulf of Mexico.

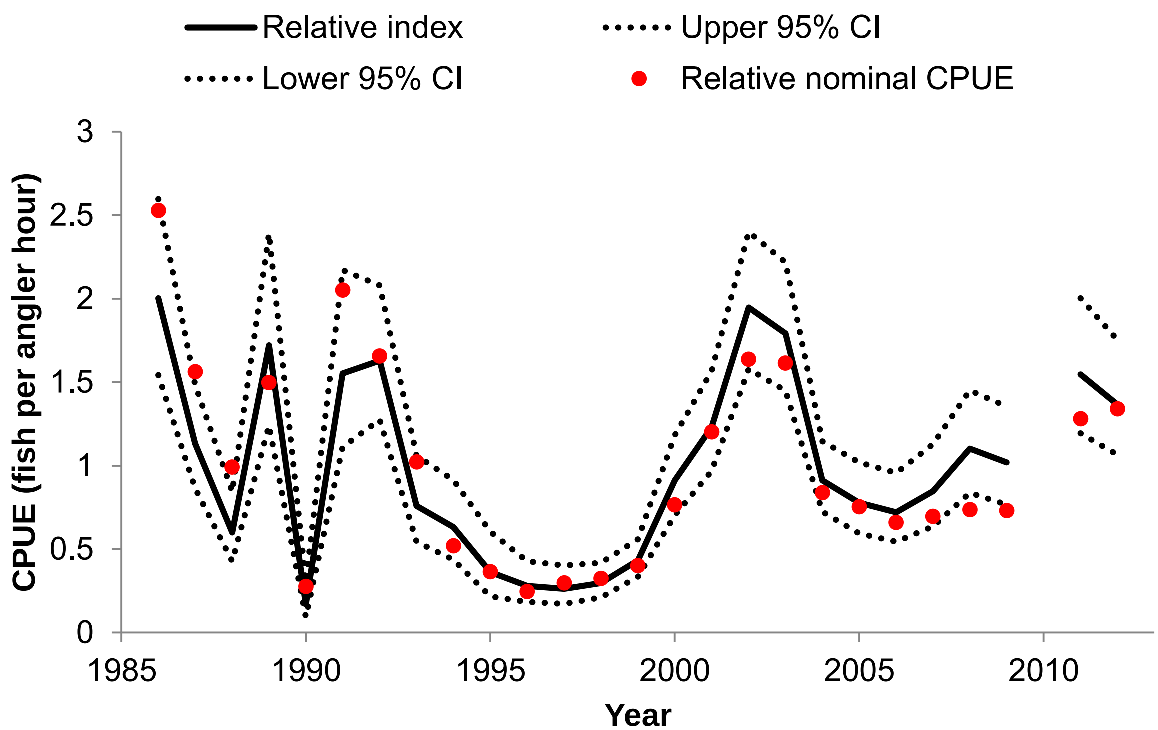

Figure 5.8.17. Estimated greater amberjack standardized index of abundance for the MRFSS charter and private angler fisheries in the Gulf of Mexico. CPUE values were normalized by the mean.

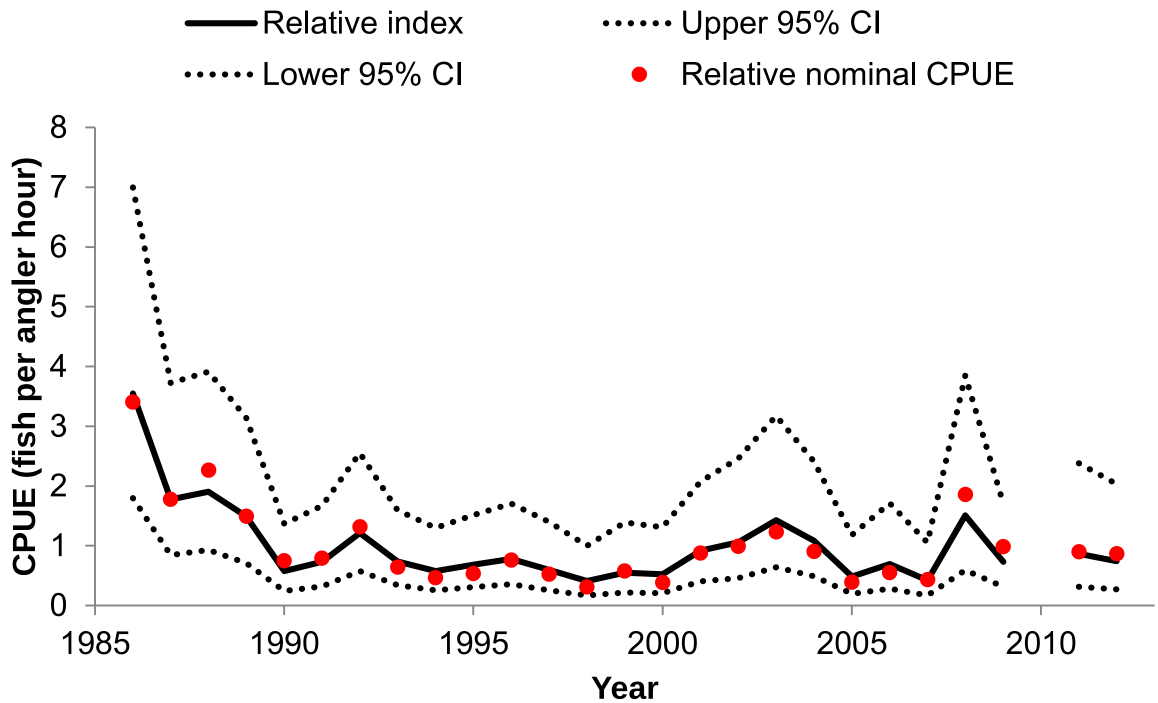

Figure 5.8.18. Estimated greater amberjack standardized index of abundance for the headboat fishery in the Gulf of Mexico. CPUE values were normalized by the mean.

6 Ad-Hoc Discard Mortality Rate Working Group

6.1 Group Membership

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6.2 Background

Discard mortality can be measured in three levels: immediate, short-term and long-term (Pollock and Pine 2007). Immediate discard mortality is measured from observations of fish immediately after being handled during normal fishing operations. Short-term mortality is typically measured in experimental studies, such as when fish are held in confinement (i.e., cage, holding tank) following exposure to capture or simulated capture (i.e., barometric chamber). Long-term mortality is tracked with tagging studies by modeling the recapture rate of marked fish or actively tracking individual fish with acoustic tags. Each of these methods (surface observation, experimental, and tagging) has associated caveats and assumptions that need to be considered when using resulting mortality estimates.

The most recent assessment for Gulf of Mexico (GOM) greater amberjack used 20% discard mortality for assessment model base runs and additional discard mortalities of 0% and 40% for model sensitivity runs (Table 6.1). These discard mortality rates were based on surface observations (i.e., immediate mortality) from fish caught and released onboard headboat and commercial vertical line vessels. The 2006 life history group advised that release mortality would likely be higher; and recommended sensitivity analyses across a range of release mortalities (20-50%) (SEDAR 2006a). During the 2010 update assessment, two projects reported fairly low discard mortality rates although the results were considered preliminary at that time (FL FWC/FWRI, immediate discard mortality = 3.8%; UF FAS, immediate discard mortality <2%; SEDAR 2011).

The purpose of this report is to review the current status of discard mortality estimates from both the commercial and recreational sectors for greater amberjack. Discard estimates are available directly from the commercial sector via the self-reported logbook program and commercial observer programs (Gulak and Carlson 2013, Johnson 2013). The recreational sector discard estimates have been collected through observers and a tag-recapture study (Sauls and Cermak 2013, Murie and Parkyn 2013). This report also comments on the types of discard data collected by observer programs.

6.3 Methods of Estimation

6.3.1 Surface Observations

Commercial immediate discard mortalities ranged from 6.5% to 32.4% (Table 6.3, Figure 6.1, see Table for references). Commercial logbook (self-reported data) percentages were: 23.8% (hand-line), 19.2% (long-line). Commercial observer program percentages were: 6.5% (hand-line), 16.1% (long-line, Johnson 2013), and 32.4% (long-line, Gulak and Carlson 2013). Discard mortality from self-reported logbook program and observer programs are based on the fate (condition) of the fish on release (dead or alive). Issues identified with these two sources include categories used to record discards via logbooks (most dead, all dead, most alive, all alive – more qualitative than quantitative) and the additional time fish are handled during observer commercial fishing operations (SEDAR 2013). However, these values do provide some baseline for recommending using alternative scenarios (20% and 40%) for discard mortality for greater amberjack caught by commercial vessels.

Several thousand greater amberjack were observed in the recreational hook-and-line fishery along the Florida's Gulf coast and the percentages of greater amberjack that either suffered immediate mortality or were not able to submerge immediately following release were small (2.4% headboats, 1.8% charter boats; Table 6.3, Figure 6.1, see Table for references). These low levels of discard mortality support the use of 0% in a sensitivity run. Currently, there are no data that suggests greater amberjack undergo delayed mortality.

It is important to note that estimates of immediate mortality only provide information on the status of the fish on release, while ignoring factors that might cause mortality over longer time periods.

6.3.2 Passive and acoustic tagging

The University of Florida, Fisheries and Aquatic Science Program, professors Deb Murie and Daryl Parkyn have been conducting both a passive and an acoustic tagging program for greater amberjack since 2007 (Murie et al. 2011, Parkyn and Murie 2012, Murie and Parkyn 2013). Greater amberjack (n = 1,550) were caught by both commercial and recreational fishing vessels using a variety of gears, with 198 tags returned (12.8%) as of May 2013 (Murie and Parkyn 2013). Of the 1,550 fish caught, only 11 were discarded dead (4 died on deck, 7 eaten by predators) providing an immediate mortality of 0.7%. Long term mortality estimates are not yet available from this passive tagging study (Table 6.1, Figure 6.1). Long-term mortality of 0% was estimated from five large mature fish tagged with pop-up archival satellite tags, and all fish were presumed alive when satellite tags disengaged 2 months later (Murie et al. 2011).

6.4 Depth Effect

There is no evidence to support changes in discard mortality with depth for greater amberjack. Data gathered on release mortality for greater amberjack were collected from depths ranging from 10 – 70 m in the recreational sector (Sauls and Cermak 2013) and similarly greater amberjack were tagged and released in depths 0 – 100 m (Murie and Parkyn 2013). In addition, most greater amberjack were observed self-venting at depths > 60 m (see below for more details, Murie and Parkyn 2013).

6.5 Thermal stress

All of the studies evaluated in this report estimated annual rates. There are no specific information that could be used to evaluate effects of seasonality or more specifically water temperature. Therefore, at this time there is no evidence to support changes in discard mortality with respect to season or water temperature aspects.

6.6 Hook Type Effects

Greater amberjack caught in the recreational sector experienced lower lethal injuries from circle hooks (3.5%) compared to other hook types (13.9%) (Sauls and Ayala 2012). Circle hooks have been mandated to be used in both recreational and commercial fisheries since 2008 (GMFMC 2013). Discard mortality for recreationally caught greater amberjack is very low (<3%) and these discard mortalities were estimated from a variety of hook types, therefore, an effect of hook type on discard mortality would likely not be substantial (Sauls and Cermak 2013, Murie and Parkyn 2013).

6.7 Venting and Bottom Release Devices

No quantitative data for greater amberjack were available to assess the effectiveness of venting devices on discard mortality estimates. Murie and Parkyn (2013) observed greater amberjack releasing air while ascending during capture. This is hypothesized to be due to the close approximation of the ribs to the swim bladder and could account for greater amberjack having limited issues with barotrauma (Murie and Parkyn 2013). The ability to self vent suggests that venting may not be needed to reduce discard mortality for this species.

6.8 Commercial Sector Release Mortality

Immediate discard mortality estimates for the commercial sector were calculated using self-reported commercial logbooks and at-sea observers. These methods of data collection have issues with data reporting (logbooks) and the length of time discarded fish remains on-board prior to release. Observer programs have been collecting data on discarded fish from commercial reef fish vessels since 2006. The type of data collected on discarded fish includes: fish identification, length, weight, condition of the fish on capture (alive, dead, alive-air bladder/stomach protruding, alive-eyes protruding, unknown), release fate (released dead, released alive, kept, unknown), hook location (mouth/jaw, internal, foul, unknown) and whether or not the fish was vented (SEFSC 2011, SEFSC 2013). Observers collect data on discarded fish from vessels using vertical line (handline and electric/hydraulic reels) or long-line gear and data collection typically takes less than 30 seconds per fish (pers. comm., reef fish and shark bottom long-line observer programs' administrators). The time spent per discarded fish may increase given several factors: gear type, number of fish captured in a single haul (e.g., the number of reels and number of hooks per reel), observer experience, flow of fishing operations, and sea state.

During SEDAR 31 (red snapper) discussions were conducted among commercial fishers, reef fish observer program personnel, and the discard mortality working group in regards to the discard mortality estimates derived from commercial observer programs (SEDAR 2013). Captains of commercial vessels expressed concern that discarded fish were kept on-board for prolonged periods of time and therefore the release mortality estimates derived from these data might not be reflective of normal operations aboard commercial vessels. Extended fish handling time might be the result of the data collection being conducted by observers that commercial fishers would not be conducting (e.g. exact measurements of fish and precise recording of incoming data). The amount of time a discarded fish is exposed to air may increase when an observer is on-board, but the amount of time would vary given the factors identified above. In particular, it would be more likely that fish caught by multiple bandit reels with multiple hooks would be exposed to air longer than fish caught on long-line gear that have hooks spaced apart further. While no specific estimates of discard mortality by gear for the commercial sector are being recommended, data on discards from observer programs do provide some baseline for recommending alternative scenarios for discard mortality.

6.9 Developing a Functional Response

Data are not available to develop a functional response (i.e., depth, length) for discard mortality for greater amberjack.

6.10 Comments and Recommendations

There are no new data or evidence to recommend different discard mortality estimates than what was applied in the last assessment for greater amberjack in the Gulf of Mexico. The discard mortality working group recommends the use of 20% discard mortality for assessment model base runs and additional discard mortalities of 0% and 40% as model sensitivity runs.

Recreational
Several thousand greater amberjack were caught in the recreational hook-and-line fishery along the Florida's Gulf coast and a small percentage of greater amberjack suffered immediate discard mortality (<3%). It is important to note that fish released dead are reported in MRFSS/MRIP B1 values and headboat logbooks; therefore, dead discards are accounted for in recreational harvest estimates. Therefore, the discard mortality working group's recommendation is that the numbers of greater amberjacks reported as dead discards in the MRFSS/MRIP and headboat logbooks are sufficient to account for the greater amberjack discarded dead for the recreational fishery. This recommendation is based on the current knowledge of immediate discard mortality. Currently, there are no data that suggests greater amberjack undergo delayed mortality.

Commercial
The only data available for reporting discard mortality for commercially caught greater amberjack were collected from self-reported log-books and observer programs. Immediate discard mortality estimates from logbooks varied slightly from estimates calculated in 2006.

Discard mortality estimates from observer programs were calculated from fish that were classified as ‘dead’ on release, and do provide some justification for recommending a base discard mortality of 20% and alternative sensitivities (0% and 40%) for model runs.

Future studies reporting discard mortality estimates should provide data tables that report the number of fish by discard condition (e.g. dead or alive), the number of fish by depth and by length bin, complete descriptions of gear (reel and hook type), and whether fish were properly vented. In addition, analyses of long-term mortality estimates from tag-recapture studies should account for effects of variable fishing effort over spatial and temporal scales.

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6.12 Tables

Table 6.12.1. Discard mortality estimates applied to previous assessments for greater amberjack in the Gulf of Mexico (GOM).

Assessment Year	Discard mortality	Citation
2010 update	0%, 20% (base), 40%	SEDAR 2011
2006	0%, 20% (base), 40%	SEDAR 2006a
2005	0% (base for SSASPM), 20%, 40%	Diaz et al. 2005
2000	20%	Turner et al. 2000

Table 6.12.2 List of citations not recommended for greater amberjack discard mortality estimates.

Citation	Rationale
McClellan and Cummings 1997	No applicable, looked at movement only, recapture rate did not adjust for biases in fishing effort across regions over 56 years
Parkyn and Murie 2012	Citation composed of only an abstract. Does not include discard mortality estimates
Stephen and Harris 2010	Primary author no confidence in using discard estimate provided in manuscript due to limited number of discards

Table 6.12.3. Meta-data of discard mortality estimates for greater amberjack (in order by year of citation). Discard mortality may refer to immediate (surface observation), short-term (cage or experimental study, or long-term (tag-recapture study). Size reported as fork length (mm).

Depth (m)	Season	Region	Method	Size Range mm Mean or Range	Discard Mortality	N	# dead	# alive	Hooks	Mode	Vent
Unknown	Year round	Gulf of Mexico	Surface Observations		25.0% (HL) 19.2% (LL)	34,992 (HL) 1,618 (LL)	8,757 (HL) 312 (LL)	26,235 (HL) 1,306 (LL)	Unknown	Commercial, variety of gear	Unknown
30-355 (mean 104)	Year round	Gulf of Mexico	Surface Observations	300-1500	32.4% (LL)	210	68	142	Circle	Commercial, long line	Selective
Unknown	Year round	Gulf of Mexico	Surface Observations	300-1650	6.5% (HL) 16.1% (LL)	1,146 (HL) 460 (LL)	75 (HL) 74 (LL)	1,071 (HL) 386 (LL)	Unknown	Commercial, variety of gear	Unknown
10-70 (mean 38.5)	Year round	Eastern Gulf of Mexico – FL, AL	Surface observation	160-1070	2.4%	1,521	37	1,458	Circle and J	Hook and line, Headboats	Selective
10-70 (mean 47.3)	Year round	NE Gulf of Mexico—FL	Surface observation	280-960	1.8%	547	10	537	Circle and J	Hook and line, charter boats	Selective
0-100	Year round	Gulf of Mexico	Surface observation	226-1412	0.7	1,550	11	1,539	Circle, J treble	Commercial Recreational Variety of gear	Selective
45-100	March	Gulf of Mexico – LA, FL	Tag-recapture Acoustic tags	>865	0%	5	0	5	Circle and J	Commercial Recreational Variety of gear	Not reporte
Unknown	Year round	Gulf of Mexico	Surface observations		23.5%	74,579			Unknown	Commercial, vertical line	Unknown

6.13 Figures

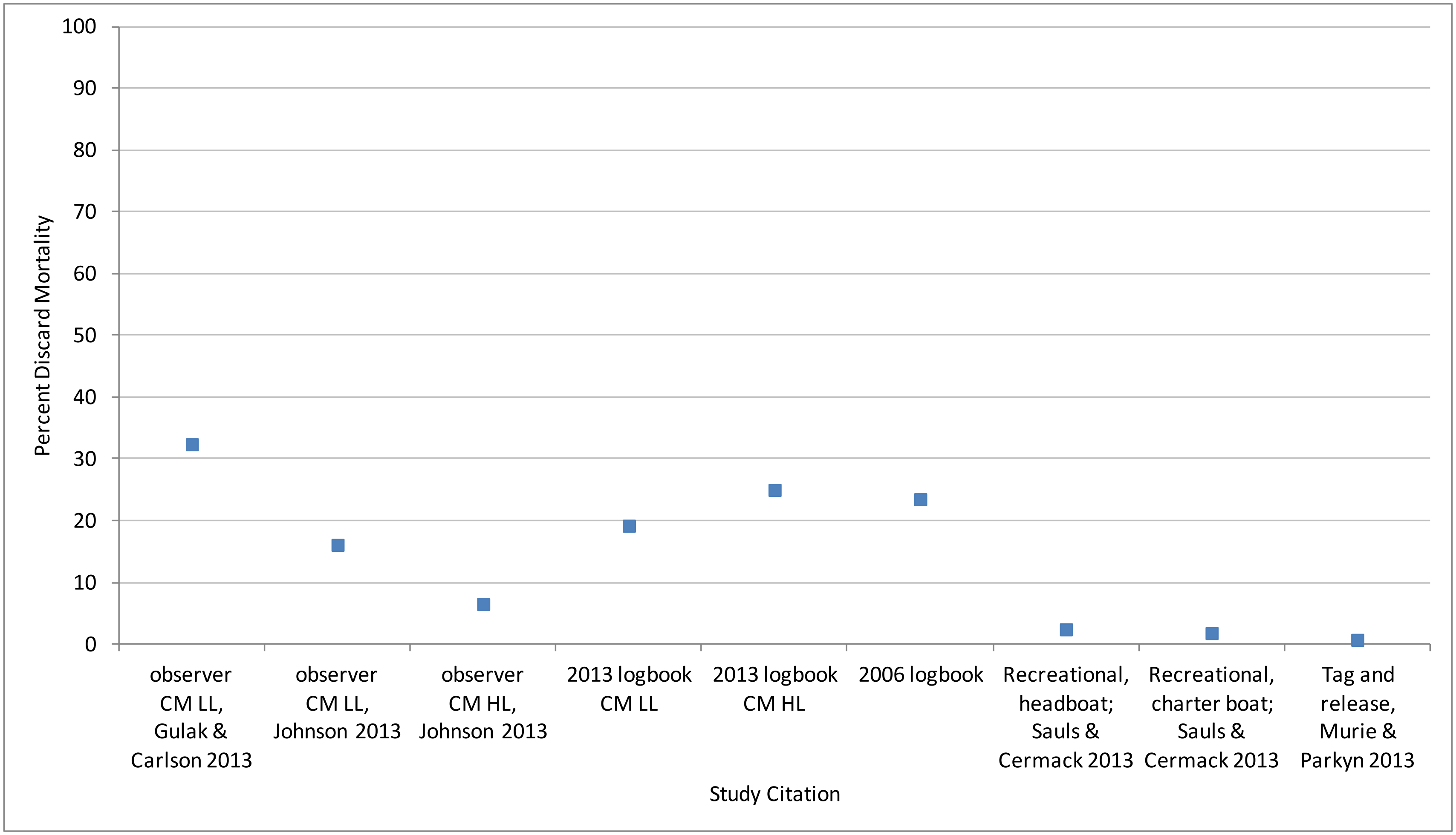

Figure 6.13.1. Estimates of discard mortality based on condition of fish on release (immediate mortality). CM = Commercial, LL = Long-Line, HL = Hand-Line

7 Analytic Approach

7.1 Overview

The lead analytical agency for Gulf of Mexico Greater Amberjack will be the Southeast Fisheries Science Center in Miami, FL.

7.2 Suggested analytic approach given available data

The assessment models to be used for SEDAR 33- Gulf of Mexico Greater Amberjack are specified in the Assessment Workshop Terms of Reference. Stock Synthesis and ASPIC models will be developed.

8 Research Recommendations

8.1 Life History

Natural Mortality

- Expand sampling in the commercial fishery to try and obtain larger/older individuals since most ages to date are from the recreational fishery.
- Use fishery-independent surveys to sample YOY greater amberjack over the entire first year of life.

Age

- Continue annual ageing workshops and reference collection exchanges among laboratories to standardize methods. As a group, decide how to deal with fish that form an opaque zone late in the year (i.e., to count last opaque zone or not).
- Due to the difficulty in distinguishing the first annulus from the core region, measurements should be taken on a subset of young-of-the-year to age one greater amberjack otoliths to use as a reference.
- Since there is large variation in length-at-age and Murie and Parkyn (2008) found a significant relationship between otolith weight and body weight, examine the relationship between otolith weight and age.
- Cross-reference trip tickets and log book data to Biological Sampling Database to complete spatial records (depth, grid, etc.) to allow for increased analysis of spatial demographics.
- Expand sampling of commercial and recreational spear landing and long-line landings, as these are under-represented in the dataset.
- Expand sampling in the Western Gulf of Mexico, in particular off Texas, as this region is under-represented in the dataset.
- A general recommendation of the LHW is to expand design-based fishery-independent sampling to elucidate regional (i.e., eastern and western GOM) and sub-regional differences in the demographics of greater amberjack.

Reproduction

- There is a lack of information on spawning frequency and fecundity with size and age for greater amberjack in the Gulf of Mexico. Given the observed differences in sexual maturity, peak spawning season, and potential growth differences between the South Atlantic and Gulf of Mexico stocks of greater amberjack, it should be a research priority to obtain information on spawning frequency and fecundity with size and age for Gulf of Mexico greater amberjack.
- Given that sex ratios are skewed to females for fish > 1 m fork length (Smith et al. 2013 SEDAR33-DW27), if release mortality is low (Murie and Parkyn 2013b SEDAR33-DW29), then a slot size limit could be explored as a means of rebuilding female SSB.

<u>Movement and Migration</u>

- More tagging information is necessary to understand seasonal movements of greater amberjack in the Gulf of Mexico (see Stock ID section). Satellite tags may provide better habitat and seasonal information compared to conventional dart tags that cannot provide serial location information on the fish throughout the year.

8.2 Commercial Fishery Statistics

<u>Landings</u>
-Improved dockside sampling for catch composition
-Improved dealer reporting to species

<u>Discard</u>
-Increased observer coverage.
-More representative observer coverage.
-Most appropriate method for incorporation of IFQ data into discard estimations

8.3 Recreational Fishery Statistics

1) Evaluate the technique used to apply sample weights to landings.
2) Develop methods to identify angler preference and targeted effort.
3) Continue and expand fishery dependent at sea observer surveys to collect discard information. This would help to validate self-reported headboat discard rates.
4) Track Texas commercial and recreational discards.
6) Evaluate existing and new methods to estimate historical landings

8.4 Measures of Population Abundance

- Expand the use of molecular genetics to identify the amberjack larvae in SEAMAP samples that cannot be positively identified as greater amberjack because diagnostic morphological characters are not yet developed.

- The IWG made note that the delta-lognormal index may not be the most appropriate distribution with some of the data presented. However, the lack of adequate diagnostics for different distributions prelude their use. The recommendation is that addition work be done with these other distribution (i.e. Poisson, negative binomial) in order to fully vet the methodology.

- A calibration study is needed between the FWRI/NMFS video survey.

- An exploration of the effects of the IFQ on the fishery dependent indices, specially the commercial handline and longline is needed. During the workshop, fisherman indicated that since the implementation of the IFQ, there has been a drastic change in fisheries behavior. There is also the possibility that dealers can directly influence this behavior. The need is to find a way to incorporate these years into the overall timer series or a recommendation to split the time series when the IFQ began.

8.5 Discard Mortality Rate

Future studies reporting discard mortality estimates should provide data tables that report the number of fish by discard condition (e.g. dead or alive), the number of fish by depth and by length bin, complete descriptions of gear (reel and hook type), and whether fish were properly vented. In addition, analyses of long-term mortality estimates from tag-recapture studies should account for effects of variable fishing effort over spatial and temporal scales.

SEDAR
Southeast Data, Assessment, and Review

SEDAR 33

Gulf of Mexico Greater Amberjack

SECTION III: Assessment Workshop Report

February 2014

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

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1. Workshop Proceedings

1.1. Introduction

1.1.1. Workshop Time and Place

The SEDAR 33 Assessment Workshop for Gulf of Mexico greater amberjack was conducted as a series of 20 webinars, which were held between July 23rd 2013 and January 15th, 2014.

1.1.2. Terms of Reference

1. Review and provide justification for any changes in data following the data workshop and any analyses suggested by the data workshop. Summarize data as used in each assessment model.
2. Develop population assessment models that are compatible with available data and document input data, model assumptions and configuration, and equations for each model considered. Consider past modeling approaches (SEDAR 9-2006, SEDAR 9 Update-2010).
3. Incorporate known applicable environmental covariates into the selected model, and provide justification for why any of those covariates cannot be included at the time of the assessment.
4. Provide estimates of stock population parameters, if feasible.
    - Include fishing mortality, abundance, biomass, selectivity, stock-recruitment relationship, and other parameters as appropriate given data availability and modeling approaches
    - Include appropriate and representative measures of precision for parameter estimates
5. Characterize uncertainty in the assessment and estimated values.
    - Consider uncertainty in input data, modeling approach, and model configuration
    - Provide appropriate measures of model performance, reliability, and 'goodness of fit'
    - Provide a continuity model consistent with the prior assessment configuration, if one exists, updated to include the most recent observations. Alternative approaches to a strict continuity run that distinguish between model, population, and input data influences on findings, may be considered
    - Provide measures of uncertainty for estimated parameters
6. Provide yield-per-recruit, spawner-per-recruit, and stock-recruitment evaluations.
    - Provide estimates of stock status for management criteria consistent with applicable FMPs, proposed FMPs and Amendments, other ongoing or proposed management programs, and National Standards for each model run presented for review.
    - Evaluate existing or proposed management criteria as specified in the management summary
    - Recommend proxy values or modifications to the current proxy value when necessary

7. Provide declarations of stock status relative to management benchmarks, or alternative data poor approaches if necessary.

8. Project future stock conditions (biomass, abundance, and exploitation) and develop rebuilding schedules if warranted; include estimated generation time. Define $F_{Current}$ as a single year or years and provide rationale for use. Stock projections (in both biomass and number of fish) shall be developed in accordance with the following:

   A) If stock is overfished:
      $F=0$, $F_{Current}$, F_{MSY}, F_{OY}
      $F=F_{Rebuild}$ (max that permits rebuild in allowed time)
   B) If stock is undergoing overfishing:
      $F= F_{Current}$, F_{MSY}, F_{OY}
   C) If stock is neither overfished nor undergoing overfishing:
      $F= F_{Current}$, F_{MSY}, F_{OY}
   D) If data limitations preclude classic projections (i.e. A, B, C above), explore alternate models to provide management advice

9. Provide a probability density function for the base model, or a combination of models that represent alternate states of nature, presented for review.
   - Determine the yield associated with a probability of exceeding OFL at P* values of 30% to 50% in single percentage increments for use with the Tier 1 ABC control rule
   - Provide justification for the weightings used in producing combinations of models if necessary

10. Provide recommendations for future research and data collection.
    - Be as specific as practicable in describing sampling design and intensity
    - Emphasize items which will improve future assessment capabilities and reliability
    - Recommend an appropriate interval and type for the next assessment

11. Prepare a spreadsheet containing all model parameter estimates, all relevant population information resulting from model estimates, and projection and simulation exercises. Include all data included in assessment report tables and all data that support assessment workshop figures.

12. Complete the Assessment Workshop Report (Section III: SEDAR Stock Assessment Report).

1.1.3. List of Participants

Panelists
Luiz Barbieri Kai Lorenzen Shannon Calay

Analysts
Jake Tetzlaff Meaghan Bryan Nancie Cummings Adyan Rios

Appointed Observers
Linda Lombardi Jay Gardner

Observers
Claudia Friess Skyler Sagarese Alisha Gray Cameron Ainsworth
Arnaud Gruss

Staff and Agency
Ryan Rindone John Walter Adyan Rios Jakob Tetzlaff
Jessica Stephen Mandy Karnauskas Nick Farmer Rich Malinowski
Michael Schirripa Steven Atran Julie Neer Mike Larkin
Jeff Isely

1.1.4. List of Assessment Workshop Working Papers

Assessment Workshop Documents			
SEDAR33-AW01	Both	Fisheries-independent data for gag and greater amberjack from reef-fish video surveys on the West Florida Shelf, 2008-2012	Switzer, Keenan, McMichael, and Ingram
SEDAR33-AW02	Gag	Length frequency distributions for gag groupers in the Gulf of Mexico from 1984-2012	Chih
SEDAR33-AW03	Gag	Age frequency distributions estimated with reweighting methods for gag groupers in the Gulf of Mexico from 1991 to 2012	Chih
SEDAR33-AW04	GAJ	Length frequency distributions and reweighted age frequency distributions for greater amberjacks in the Gulf of Mexico from 1984-2012	Chih
SEDAR33-AW05	GAJ	Greater amberjack *Seriola dumerili* Findings from the NMFS Panama City Laboratory Trap & Camera Fishery-Independent Survey – 2004-2012	DeVries, Raley, Gardner, and Ingram
SEDAR33-AW06	Gag	Summary of fishery-independent surveys of juvenile gag grouper in the Gulf of Mexico	Ingram, Pollack, and McEachron
SEDAR33-AW07	Gag	Standardized catch rate indices for gag grouper (*Mycteroperca microlepis*) landed by the commercial longline fishery in the U.S. Gulf of Mexico during 1990-2012	Cass-Calay
SEDAR33-AW08	Gag	Standardized catch rates for gag grouper from the United States Gulf of Mexico handline fishery during 1990-	

		2009	
SEDAR33-AW09	Gag	Standardized catch rates for gag grouper from the Gulf of Mexico headboat fishery during 1986-2011	
SEDAR33-AW10	Gag	Standardized Catch Rates of Gulf of Mexico Gag Grouper from Recreational Inshore, Charterboat, and Private Boat Fisheries (MRFSS) 1986 to 2010	
SEDAR33-AW11	GAJ	Standardized Catch Rates for Greater amberjack from the commercial longline and commercial handline fishery in the U.S. Gulf of Mexico	
SEDAR33-AW12	GAJ	Standardized Catch Rates for Greater amberjack from the Gulf of Mexico Headboat Fishery 1986-2011	
SEDAR33-AW13	GAJ	Standardized Catch Rates of Greater amberjack from the Gulf of Mexico Recreational Charterboat and Private Boat Fisheries (MRFSS) 1986 to 2012	
SEDAR33-AW14			Calay
SEDAR33-AW15	Gag	Standardized catch rates for gag grouper from the United States Gulf of Mexico handline fishery during 1990-2009	Bryan
SEDAR33-AW16	Gag	Standardized Catch Rates of Gulf of Mexico Gag Grouper from Recreational Inshore, Charterboat, and Private Boat Fisheries (MRFSS) 1986 to 2010	Bryan
SEDAR33-AW17	Gag	Standardized catch rates for gag grouper from the Gulf of Mexico headboat fishery during 1986-2010	Bryan
SEDAR33-AW18	GAJ	Commercial Indices of Abundance for Greater amberjack in the Gulf of Mexico	Rios
SEDAR33-AW19	GAJ	Standardized catch rates for greater amberjack from the Gulf of Mexico headboat fishery during 1986-2010	Rios
SEDAR33-AW20	GAJ	Standardized Catch Rates of Greater amberjack from the Gulf of Mexico Recreational Charterboat and Private Boat Fisheries (MRFSS) 1986 to 2012	Rios
SEDAR33-AW21	Gag	Red tide mortality on gag grouper 1980-2009	Gray, Ainsworth, Chagaris, and Mahmoudi

SEDAR33-AW22	Both	Ageing error matrices for SEDAR33: gag grouper and greater amberjack	Lombardi
SEDAR33-AW23	Gag	Meta-analysis of release mortality in the gag grouper fishery	Campbell, Lombardi, Sauls, and McCarthy
SEDAR33-AW24	Gag	Natural mortality rates and diet patterns of gag grouper (*Mycteroperca microlepis*) in the West Florida Shelf ecosystem in the 2000s: Insights from the individual-based, multi-species model OSMOSE-WFS	Gruss, Schirripa, Chagaris, Drexler, Simons, Verley, Shin, Oliveros-Ramos, Karnauskas, and Ainsworth

1.2. Panel Recommendations and Comment on Terms of Reference

1.2.1. Term of Reference 1

Review and provide justification for any changes in data following the data workshop and any analyses suggested by the data workshop. Summarize data as used in each assessment model.

All revisions to the data following the SEDAR 33 Data Workshop (DW) are reviewed in Section 2. The primary changes include: 1) aggregating landings, discards, and length composition data into four fishing fleets; commercial vertical line gears, commercial bottom longline, recreational charterboat and private angler , and recreational headboat fisheries, 2) re-estimation of commercial discards in numbers 3) converting estimates of commercial and recreational discards in numbers to discards in weights, and 4) re-standardization of the catch per unit of effort abundance indices for all fleets.

1.2.2. Term of Reference 2

Develop population assessment models that are compatible with available data and document input data, model assumptions and configuration, and equations for each model considered. Consider past modeling approaches (SEDAR 9-2006, SEDAR 9 Update-2010).

Two types of models were explored: statistical catch-at-age and Schaefer surplus production. The statistical-catch-at-age model was configured using Stock Synthesis (Methot 2011). The model description and configuration are described in Sections 3.1.1 and 3.1.3. Section 2 and Section 3.1.2 provides a complete description of all data inputs. Appendices A-D include all input files necessary to run the Stock Synthesis (SS) model.

ASPIC (Prager 1994) was used to fit the Schaefer non-equilibrium surplus production models to data on yield and CPUE. ASPIC model descriptions and configurations are described in Sections 3.3.1 and 3.3.3. Section 2 and Section 3.3.2 provide a complete description of all data inputs. Appendix E includes all input files necessary to run the ASPIC models.

1.2.3. Term of Reference 3

Incorporate known applicable environmental covariates into the selected model, and provide justification for why any of those covariates cannot be included at the time of the assessment.

At the time of the SEDAR 33 Greater amberjack stock assessment, no applicable environmental covariates were recommended by the data or assessment workshop panels

1.2.4. Terms of Reference 4

Provide estimates of stock population parameters, if feasible.

- *Include fishing mortality, abundance, biomass, selectivity, stock-recruitment relationship, and other parameters as appropriate given data availability and modeling approaches*
- *Include appropriate and representative measures of precision for parameter estimates*

Estimates of the assessment model parameters for the SS base model are reported with their associated standard errors in Section 3.2.2 and Table 3.1.4.1 and Table 3.2.2.1 for SS. Corresponding estimates of stock biomass, spawning stock biomass, recruitment, fishing mortality, and the stock- recruitment relationship are presented in Tables 3.2.4.1 and 3.2.6.1 and Figures 3.2.4.5 and Figure 3.2.6.1 for SS.

Estimates of the assessment model parameters from the ASPIC models are reported in Section 3.4.2 and in Table 3.4.2. Corresponding estimates of relative stock biomass and relative fishing mortality over time are presented in Figure 3.4.3.1.

1.2.5. Term of Reference 5

Characterize uncertainty in the assessment and estimated values.

- *Consider uncertainty in input data, modeling approach, and model configuration*
- *Provide appropriate measures of model performance, reliability, and 'goodness of fit'*
- *Provide a continuity model consistent with the prior assessment configuration, if one exists, updated to include the most recent observations. Alternative approaches to a strict continuity run that distinguish between model, population, and input data influences on findings, may be considered*
- *Provide measures of uncertainty for estimated parameters*

Model performance and stability are characterized in Sections 3.2.2 and 3.2.2.7 for SS. Stability and model performance were evaluated using the SS jitter procedures. Uncertainty in the assessment and estimated values was characterized using sensitivity analyses and a parametric bootstrap approach for SS. A description of the sensitivity analyses explored for the SS model is provided in Table 3.1.6.1. Results of the model performance and stability examinations are provided in Table 3.2.2.2 and Figures 3.2.2.1a – 3.2.2.1h.

Results of the sensitivity analysis and retrospective analysis on the final SS Base model are provided in Section 3.2.7, Table 3.2.7.1 and Figures 3.2.7.1 - 3.2.7.4 for SS. Uncertainty in the assessment parameters and estimated values is characterized in Section 3.2.7 and Tables 3.2.2.2.1 and Figure 3.2.4.4a, b for 1,500 bootstraps on the SS final Base model.

Model performance is characterized in Section 3.4.1 for the ASPIC models. Uncertainty in the assessment and estimated values was characterized using bootstraps and sensitivity analyses. Results of the ASPIC model bootstraps and sensitivity analysis are characterized in Sections 3.3.5 and 3.3.6 and in Tables 3.4.5.1, 3.4.6.1.1, 3.4.6.1.2, and 3.4.6.2.1.

1.2.6. Term of Reference 6

Provide yield-per-recruit, spawner-per-recruit, and stock-recruitment evaluations.

- *Provide estimates of stock status for management criteria consistent with applicable FMPs, proposed FMPs and Amendments, other ongoing or proposed management programs, and National Standards for each model run presented for review.*
- *Evaluate existing or proposed management criteria as specified in the management summary*
- *Recommend proxy values or modifications to the current proxy value when necessary*

Spawner-per-recruit, stock-recruitment, and yield-per-recruit evaluations are provided in Section 3.2.4 and Figures 3.2.4.5 and Figure 3.2.4.9 for SS.

1.2.7. Term of Reference 7

Provide declarations of stock status relative to management benchmarks, or alternative data poor approaches if necessary.

Stock status relative to reference points based on $F_{SPR30\%}$, FOY($F_{SPR40\%}$), and FMSY are characterized for the final SS Base model and sensitivity runs in Section 3.2.8.1 and Table 3.2.8.2. Plots of stock status are presented in Figures 3.2.8.1a-c.

Stock status relative to FMSY and MSST (0.75*B_{MSY}) is discussed in Section 3.4.8 for ASPIC.

1.2.8. Term of Reference 8

Project future stock conditions (biomass, abundance, and exploitation) and develop rebuilding schedules if warranted; include estimated generation time. Define $F_{Current}$ as a single year or years and provide rationale for use. Stock projections (in both biomass and number of fish) shall be developed in accordance with the following:

A) If stock is overfished:
$F=0$, $F_{Current}$, F_{MSY}, F_{OY}
$F=F_{Rebuild}$ (max that permits rebuild in allowed time)
B) If stock is undergoing overfishing:
$F= F_{Current}$, F_{MSY}, F_{OY}
C) If stock is neither overfished nor undergoing overfishing:
$F= F_{Current}$, F_{MSY}, F_{OY}
D) If data limitations preclude classic projections (i.e. A, B, C above), explore alternate models to provide management advice

Deterministic stock biomass, fishing mortality, and yield projections are presented in Section 3.2.9, Tables 3.2.8.2, Tables 3.2.9.1 - 3.2.9.2, and Figure 3.2.9.1 for SS. Projections were carried out for four levels of fishing mortality: 1) $F_{SPR30\%}$ (F_{MSY} proxy), 2) FOY=$F_{SPR40\%,}$ 3) $F_{CURRENT}$ (geometric mean of F 2010-2012, and 4) FMSY.

Stochastic projections of stock biomass and fishing mortality from the SS models are presented in Figures 3.2.9.2.1 and 3.2.9.2.2 for the $F_{30\%SPR}$ fishing mortality scenarios.

Relative stock biomass and relative fishing mortality projections for 2014-2042 are presented in Section 3.4.9 and in Figures 3.4.9.1.1 – 3.4.9.1.3 and Figures 3.4.9.2.1 – 3.4.9.2.3 for ASPIC. Projections were carried out for 9 levels of fishing mortality (F_{2012}) and 9 levels of constant catch.

1.2.9. Term of Reference 9

Provide a probability density function for the base model, or a combination of models that represent alternate states of nature, presented for review.

- *Determine the yield associated with a probability of exceeding OFL at P* values of 30% to 50% in single percentage increments for use with the Tier 1 ABC control rule*
- *Provide justification for the weightings used in producing combinations of models if necessary*

Probability distribution functions for the OFL will be developed for the final Base SS model recommended by the SEDAR 33 AP and made available to the Scientific and Statistical Committee (SSC) for the development of management advice, including OFL and ABC.

Three sensitivity scenarios were presented to characterize uncertainty in model specification for ASPIC.

1.2.10. Term of Reference 10

Provide recommendations for future research and data collection.

- *Be as specific as practicable in describing sampling design and intensity*
- *Emphasize items which will improve future assessment capabilities and reliability*
- *Recommend an appropriate interval and type for the next assessment*

Recommendations for future research and data collection were made in the SEDAR 33 Data Workshop (DW) report. Additional recommendations are made in Section 3.7

1.2.11. Term of Reference 11

Prepare a spreadsheet containing all model parameter estimates, all relevant population information resulting from model estimates, and projection and simulation exercises. Include all data included in assessment report tables and all data that support assessment workshop figures.

All assessment model inputs are presented in Appendix A-D for SS. All model parameter estimates and their associated standard errors are reported in Table 3.1.4.1 (Base model) and Table 3.2.2.1 (for 1,500 bootstrap runs on the Base model). Model uncertainty is presented in Figures 3.2.4.4 and Figures 3.2.7.1 - 3.2.7.2.

All assessment model inputs are presented in Appendix E-G for the ASPIC models. All parameter estimates are reported in Table 3.4.2.1. Model uncertainty is presented in Figure 3.4.3.1.

1.2.12. Term of Reference 12

Complete the Assessment Workshop Report (Section III: SEDAR Stock Assessment Report).

2. Data Review and Update

The main data components utilized in this stock assessment are described in the SEDAR 33 Gulf of Mexico Greater amberjack Data Workshop (DW) Report (SEDAR 2012). A number of the data inputs used in the SEDAR 33 Gulf of Mexico Greater amberjack stock evaluations were updated and finalized after the DW. Final data for 2012 were not available at the time of the DW for these components: recreational and commercial landings, recreational size frequencies, and discards in numbers and in weights from the recreational (headboat, charterboat and private) and commercial fisheries (vertical line, bottom longline). In addition, all of the indices of abundance were updated after the DW (i.e., MRFSS recreational index, commercial Vertical Line fishery abundance index, commercial bottom longline, and the headboat index). These updates and any other necessary modifications to the data provided at the DW are detailed in the following sections.

The following list summarizes the main data inputs used in the Greater Amberjack assessment models:

1. Landings
    i. Commercial vertical line: 1963-2012
    ii. Commercial longline: 1963-2012
    iii. Recreational – Charter/Headboat/Private : 1950-2012

2. Discards
    i. Commercial vertical line: 2007-2012 (observer program)
    ii. Commercial longline: 2007-2012 (observer program)
    iii. Recreational Charter/Headboat/Private: 1981-2012

3. Length composition of landings
    i. Commercial vertical line: 1984-2012
    ii. Commercial longline: 1984-2012
    iii. Recreational Charter/Headboat/Private: 1981-2012

4. Length composition of discards
    i. Commercial vertical line: 2006-2012 (observer program)
    ii. Commercial longline: 2006-2012 (observer program)
    iii. Headboat: 2005-2012 (observer program)
    iv. Charter: 2006-2012 (observer program)

5. Age composition
    i. Commercial vertical line: 1990-2012
    ii. Commercial longline: 1990-2012
    iii. Recreational Charter/Headboat/Private: 1989-2012

6. Fishery Dependent Abundance indices
    i. Commercial vertical line: 1990-2010
    ii. Commercial longline: 1990-2010
    iii. Headboat: 1986-2012
    iv. Charter/Private: 1986-2012

7. Fishery-independent
    i. SEAMAP video survey: 1993-1997, 2002, 2004-2012
    ii. Panama City Laboratory trap video survey: 2005-2012

8. Length composition data from fishery-independent survey
    i. SEAMAP video: 1995-2009
    ii. PC video: 2020-2012

A brief summary of each data input will be provided in the following sections.

2.1 Life history

The weight length relation estimated as: Weight (Kg) = 7.046E-05 * Fork-Length (cm)$^{2.633}$ was provided by the SEDAR 33 DW (Figure 2.1.1). The M at-age vector was developed according to a declining Lorenzen function and scaled to fully recruited fish ages 3+ by the point estimate of the Hoenig maximum age natural mortality estimator recommended by the SEDAR 33 DW of 0.28 y^{-1} (Figure 2.1.1).

For the Base model configuration natural mortality was modeled as a declining 'Lorenzen' function of size constant over time, scaled to the Hoenig maximum age point estimate as recommended by the DW (DW Report-Section 2.4, Table 2.1). The reference age assumed in the Lorenzen function was 3 as recommended by the DW. The resulting age specific Lorenzen M vector was used in the Base SS Model run (Run1="LM Age0 M"). Three alternative vectors of M at age were considered to evaluate the impact on model results from assumptions on natural mortality. One was developed in an attempt to account for the approach that SS uses to advance ages (i.e. fish advance in age on January 1, "irrespective of time of birth"). Greater amberjack undergo a contracted period of spawning with peak spawning in the early spring (April) thus in SS are advanced to age 1 at 9 months years of life. Therefore, the input value of M for 'age 0' fish from the LM Age0 vector was reduced by 0.25 (or 3 months of 1 year) and this vector of M at age (Red_Age0 M) was considered as a sensitivity run. Two other sensitivity analyses on the natural mortality parameter were considered. The SEDAR 33 DW recommended considering a range of point estimates (high=0.35, low=0.15) for characterizing the Lorenzen M function (LOW_M, HIGH_M) for greater amberjack. These were also included as two additional SS sensitivity runs and provide additional information on the impact on SS model results from assumptions on M (at age). Figure 2.1.1 presents the SS Model M at-age for the Base Model (LM Age0 M) and the alternative M at-age sensitivity characterizations used in the stock assessment.

Growth was modeled using a single sex von Bertalanffy function estimated internally in the stock assessment model (Stock Synthesis) using the age-length observations from the SEDAR 33 DW. More detailed description of how growth was input into the SS model configuration is given in Section 3.1.1.

Fish were assumed to be fully mature at age 2 (SEDAR 33 DW). The fecundity schedule was assumed directly proportional to female weight in the assessment model. The SEDAR 33 discard mortality working group recommended the use of 20% discard mortality for assessment model base runs and additional discard mortalities of 0% and 40% as model sensitivity runs. In addition, alternative levels of discard mortality (0%, 5%, 10% and 15%) were considered in sensitivity analyses of the population base model run.

In the stock assessment using the SS model, several of the life history parameters were estimated by the model and not fixed. Therefore, further discussions of pertinent life history metrics (i.e., growth, natural mortality) are also addressed in both the stock assessment Model "Configuration" and in the 'Parameters Estimated" sections (3.1.3 and 3.1.4) of the SEDAR 33 Assessment Report.

2.2 Landings

2.2.1 Commercial landings

Commercial landings data were provided by the SEDAR 33 DW; these data were assimilated into two main categories: commercial line fisheries (i.e., hook and line, vertical line, rod and reel = COM_RR) and commercial bottom longline (COM_LL). There were some minor landings reported for "miscellaneous" commercial gears (traps, trawls, seines) and these were apportioned into commercial vertical line gear and commercial bottom line gears in proportion to their annual representation of each. In general, reported commercial vertical line gear landings of this species increased gradually from 1963 through the mid-1980's showing significant increases between 1986 and the mid 1990's (Figure 2.2.1.1). Figure 2.2.1.2 presents the annual contribution of the commercial section to the overall greater amberjack fishery for 1981-2012 the period of time for which both commercial and recreational landings in weight are available. Landings from the commercial fishery sector increased to about 48% of the combined recreational and commercial fishery production by 1990 thereafter declining to about 20% of total fishery landings by 1998. Landings from the COM_LL fishery represent a minor component (~ 2%) of the overall recreational and commercial combined production.

The commercial landings included in the SEDAR 33 DW report were in gutted pounds. A conversion factor of 1.04 was applied to obtain commercial landings in whole pounds. The gutted to whole weight conversion factor of 1.04 was continued from the SEDAR 9 Update assessment of Greater Amberjack.

Commercial landings data were input into SS as metric tons, whole weight. Commercial landings data were input into ASPIC as pounds whole weight. Tables 2.2.1.1 (a, b) and Figure 2.2.1.1 and Figure 2.2.1.2 present commercial landings data and the contribution by the commercial fisheries to the overall commercial and recreational fisheries production combined.

2.2.2 Recreational landings

Recreational landings data were provided through the SEDAR 33 DW. Estimates from the charterboat and private angler (REC) were aggregated across all fishery sectors from the two data sources: a) MRFSS/MRIP estimates of landings from charterboat and private angler and, b) Texas Parks and Wildlife (charter, private). Headboat landings were maintained as a separate fleet (Headboat).

Tables 2.2.1.1a, b and Figure 2.2.1.1 present recreational landings data. Figure 2.2.1.2 presents the contribution of the recreational fishery landings to the overall combined commercial and recreational fishery production for 1981-2012, the time period, for which the both commercial and recreational landings are available in weight. Since 1981, recreational (REC (charterboat and private angler fisheries combined) landings represent the dominant component of the overall Greater Amberjack fishery production except for one year (1995). Between 1981 and 1989, average recreational landings made up 77% of the total combined recreational and commercial fishery production combined. Between 1990 and 1997, recreational landings made up 55% of the overall production. Since 1999, recreational landings of this species have fluctuated with small increases and decreases averaging about 73% through 2012 (Figure 2.2.1.2).

2.3 Discards

2.3.1 Commercial discards

Final estimates of commercial discards were calculated after the SEDAR 33 data workshop following working group and assessment staff recommendations. The methods used to estimate these discards are described below.

Reef fish and shark observer program data included numbers and lengths of commercially discarded Greater Amberjack from fishing trips that were observed between July, 2006 and December, 2012. Discards of Greater Amberjack included all of the discards reported as Greater Amberjack as well as a portion of the discards reported as unclassified Seriola. The portion of unclassified Seriola discards included as discards of Greater Amberjack was estimated based on the proportion of Greater Amberjack less than 60 cm to all Seriola spp. less than 60 cm derived from trips where all fish were identified to species (most fish reported as unclassified Seriola were below 60 cm). As a result, in the longline fishery, 31.6 % of the unclassified Seriola less than 60 cm were assumed to be Greater Amberjack. For the handline fishery, 27.1 % of the unclassified Seriola less than 60 cm were assumed to be Greater Amberjack.

$$Total\ GAJ\ Discards = \begin{matrix} GAJ \\ Discards \end{matrix} + \left(\begin{matrix} Unclassified \\ Seriola\ Discards \\ < 60\ cm \end{matrix} * \left(\frac{GAJ\ Discards\ < 60\ cm}{\begin{matrix} Seriola\ spp.Discards \\ < 60\ cm \end{matrix}} \right) \right)$$

For each year from 2007 to 2012, annual discard rates were calculated using observer reported data from the commercial reef fish and shark fisheries. Rates were calculated by Gulf of Mexico region (east and west) and fleet (handline, reeffish longline permit, and bottom longline shark permit). A discard rate of zero was assumed for all regions and fleets prior to the implementation of the 36 inch fork length commercial size limit in 1990. From 1990 to 2006 (years assumed to have commercial discards, but prior to data collection by observers), discard rate was defined as the mean discard rate for the years 2007-2012 by fleet and region. Due to low numbers of observed longline trips per year, the annual discard rates from 2007 to 2012 for each longline fleet were replaced with the mean rate over the years 2007-2012 by fleet and region. Total discards were calculated as: fleet/region specific discard rate*yearly fleet/region total effort reported to the coastal logbook program. Effort was in hook hours for the vertical line fishery and hooks fished for the longline fisheries. Annual discard rates, sample sizes, and discards in numbers for each fleet are included in Tables 2.3.1.1 – 2.3.1.3.

As the ASPIC model requires inputs in weight it was necessary to convert discards in numbers to weight. To obtain discards in weight, average weights were calculated from the average lengths of observed Greater Amberjack and Seriola discards. Average lengths for Greater Amberjack and Seriola discards were calculated by fishery (handline or longline), across all observed years (2006-2012), and across all regions (east and west Gulf). Average lengths (cm) were converted to weights (kg) using WW = $7.046 \times 10^{-5} * (FL^{2.633})$. Average lengths, sample sizes, and average weights of observed Greater Amberjack and Seriola discards are reported in Table 2.3.1.4.

A ratio of the Greater Amberjack discards that were originally reported as Seriola to all Greater Amberjack discards was estimated for each fishery. These ratios were used to determine the fraction of discards to convert using the average weight of observed Seriola, and the fraction to convert using the average weight of observed Greater Amberjack. For the longline fishery, 8.3% of Greater Amberjack discards were originally unclassified Seriola. For the handline fishery, 7.5% of Greater Amberjack discards were originally unclassified Seriola. Annual discards in numbers were adjusted by the time series of annual average weights (lbs) to obtain annual discards in whole weight (lbs). Annual discards in numbers and in whole weight (lbs) are included in Table 2.3.1.5 for the commercial fleets.

$$\begin{matrix}Discard\\Weights\end{matrix} = \left(\left(\frac{\begin{matrix}Obs.\\GAJ\end{matrix}}{\begin{matrix}Total\\GAJ\end{matrix}} \right) * \begin{matrix}Total\\GAJ\end{matrix} * \begin{matrix}Avg.\\Weight\\Obs.GAJ\end{matrix} \right) + \left(\left(1 - \frac{\begin{matrix}Obs.\\GAJ\end{matrix}}{\begin{matrix}Total\\GAJ\end{matrix}} \right) * \begin{matrix}Total\\GAJ\end{matrix} * \begin{matrix}Avg.Weight\\Obs.Unclass.\\Seriola\\< 60cm\end{matrix} \right)$$

2.3.2 Recreational discards

Estimates of recreational discards in numbers were provided through the SEDAR 33 DW. Discards from the recreational fishery (REC) were available as numbers of fish and for use in SS were input in the same units. Discards in numbers are included in Table 2.3.2.1.

Recreational discards in whole weight (lbs) for use in ASPIC were estimated after the SEDAR 33 DW. Discards in whole weight (lbs) are included in Table 2.3.2.2. The methods for estimating recreational discard weights are described below.

Multiple methods and assumptions for estimating discards in weight were explored for two reasons. The first reason is that discards of Greater Amberjack represent a large proportion of total recreational catch. This is especially evident in recent years where the discards make up approximately 75% of the total catch (Figure 2.3.2.1). Secondly, the sizes of discards were based on the sizes of landed fish, and the size distribution of landed fish has changed in association with the implementation of size and bag limits (Figure 2.3.2.2).

Three amendments to the GMFMC Reef Fish FMP were considered in the estimation of greater amberjack discard size. Amendment 1 enacted a 28 inch fork length recreational size limit and a three fish per angler personal bag limit in 1990. Amendment 12 implemented a one fish personal bag limit on January 15, 1997. Amendment 30A enacted a 30 inch fork length recreational size limit on August 4, 2008.

The first method was retained from the SEDAR 9 Update assessment of Greater Amberjack. This method assumed that increased discards rates, as compared to the discard rates prior to size or bag limits, were discards of legal size fish (discarded in association with bag limits). Two variations of the SEDAR 9 Update discard estimation procedure were explored. The first variation assumed that all discards were below the size limits, and the second assumed that discards had the same size distribution as the landings. The SEDAR 9 Update method and the two variations explored for SEDAR 33 are described below.

SEDAR 9 Update Method

For all years prior to 1990, discards in numbers (B2s) were converted to weight by multiplying by the average annual weight for each 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 regulations was attributed to the bag limit, and that fraction of the discards was sized with the average annual weight (for each respective fishery mode (charterboat, private angler, headboat)) above the size limit. The remaining fraction of the discards was attributed to the size limit and was sized with the average annual weight (for each respective fishery mode (charterboat, private angler, headboat)) below the 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. The four regulatory periods were pre-1990 (no bag or size limits), 1990 to 1996 (3 fish bag limit and 28 inch size limit), 1997 to 2008 (1 fish bag limit and 28 inch size limit), and 2009 to 2012 (1 fish bag limit and 30 inch size limit). Average discard rates by fishing mode and regulatory period are included in Table 2.3.2.3.

Average weights (kg) were obtained from average lengths (cm) using the weight-length relation recommended by the DW ($WW = 7.046 \times 10^{-5} * (FL^{2.633})$). Annual numbers of measured recreationally landed GAJ are included in Table 2.3.2.4. Due to small sample sizes by year and mode, average annual weights for SEDAR 33 were estimated from a 3-year running average of recreationally landed Greater Amberjack lengths. Estimated annual weights by mode obtained from the 3-year running average are included in Table 2.3.2.5.

A caveat of this method is that the sizes of discarded fish are estimated from the sizes of landed fish. Although illegal-size Greater Amberjack were observed after size limits were implemented, the size distribution of landed fish indicates that there was indeed a shift to legal-size fish. Thus, there is potential for the average size of fish below the size limit to be biased towards fish that are near the size limit.

As mentioned above, this method assumes that the increase in the discard rates after 1990, as compared to the discard rates prior to then, was attributed to discards of legal size fish. However, based on the distribution of observed sizes of landed GAJ, it is evident that many fish were likely discarded due to the size limit. Instead of partitioning between size limit and bag-limit associated discards, the following variations explore the extremes of this assumption.

SEDAR 9 Update Method Variation 1 (Low)

The first variation assumes that all discards of Greater Amberjack were undersized fish. This variation resulted in a lower estimate of total recreational discards in whole weight than the SEDAR 9 Update method (Figure 2.3.2.3).

Discards were sized using the annual average weight of Greater Amberjack that were both below the size limit and landed prior to 1990 (Table 2.3.2.6). Because of the changes in size limits, two periods were considered. They were pre-2009 (either no size limit or a size limit of 28 inches), and 2009 to 2012 (30 inch size limit).

This method assumes that all Greater Amberjack discards prior to 1990 were associated with small fish (less than 28 inches), but also that prior to 1990, small fish were occasionally landed at random. This method also assumes a constant length distribution for all years (for each respective fishing mode) based on the distribution calculated over the years 1986-1989.

While this method assumes smaller overall discard sizes than the SEDAR 9 Update method, it retains the assumption that all weights come from landed fish. As such, the distribution of the weights may be biased high if small Greater Amberjack prior to 1990 were not landed at random, and instead, slightly larger small fish were more likely landed than very small fish.

SEDAR 9 Update Method Variation 2 (High)

This second variation assumes that Greater Amberjack were landed (or discarded) without respect to size. This method resulted in a similar estimate of total recreational discards in whole weight as the SEDAR 9 Update continuity method (Figure 2.3.2.3)

Discards in numbers were converted to weight by multiplying by the average annual weight of landed Greater Amberjack for each respective fishing mode. Due to small sample sizes by year and mode, average annual weights were estimated from a 3-year running average.

When compared to the continuity method, the application of this second variation revealed that the continuity method effectively assumes that discarded Greater Amberjack have the same length distribution as landed Greater Amberjack. Figure 2.3.2.3 shows how each of the estimates of recreational discards in weight compare to each other, as well as how they compare to the estimates of the SEDAR 9 Update assessment.

2.4 Length composition

Length composition data were provided by the SEDAR 33 DW. Length composition data used in the SS assessment model are presented in Figures 2.4.1a – 2.4.1h. Lengths units are fork length in centimeters. Following the DW, length compositions were computed as numbers at length using the length data from the four directed fisheries (COM_HL, COM_LL, REC, Headboat) and the two fishery independent databases (SEAMAP video and Panama City trap video surveys). Length data were aggregated into 5-cm length bins. Length bins ranged from 10 cm to 200 cm, where the bin size represents the minimum size of the bin (e.g., the 5-cm length bin contains fish greater than or equal to 5 cm and less than 10 cm). Length data were stratified by calendar year and fishery/survey (COM_HL, COM_LL, REC, Headboat, SEAMAP, Panama City). The length composition sample sizes that were input into the SS models were capped at a maximum of 200 fish to prevent the length composition data from having undue influence on the model fitting process due to large sample sizes. For strata with fewer than 200 length observations the sample size was set equal to the number of observations measured. Figures 2.4.1a – 2.4.1h provide length composition data used in the SS model evaluation.

The length composition data that were relevant to the ASPIC models were the lengths from the observed commercial discards and from the sampled recreational landings. Average lengths were used to obtain weights of discarded greater amberjack as described in Section 2.3.

2.4.1 Commercial length composition

As summarized above, commercial length composition data were stratified by calendar year, fishery/survey (i.e., commercial vertical line gear fleets (COM_HL) and bottom longline gear (COM_LL) corresponding to the primary fleets reporting catches of Greater amberjack for the stock assessment. Each separate length composition sample was then aggregated into 5-cm length bins for use in SS. Length bins ranged from 5 cm to 200 cm, where the bin size represents the minimum size of the bin. Figures 2.4.1a – 2.4.1b and Figure 2.4.1e provide commercial length composition data used in the SS evaluation.

2.4.2 Recreational length composition

As summarized above, recreational length composition data of Gulf of Mexico Greater amberjack were stratified by calendar year, fishery/survey (i.e., recreational charterboat and private angler fisheries combined (REC) and Headboat (Headboat) corresponding to the primary recreational sectors fisheries considered for the stock assessment. Observations of discard length composition did not exist for the private angler fishery but were thought to be more similar to the headboat fleet thus the discard length composition was used to reflect private angler discard length composition. Weighted length compositions for the charterboat and private angler fisheries combined were developed by weighting the annual compositions by the landings according to the procedure described in SEDAR 7 and SEDAR 31.

Each separate annual fishery (REC, Headboat) length composition sample was then aggregated into 5-cm length bins for use in SS. Length bins ranged from 5 cm to 200 cm, where the bin size represents the minimum size of the bin. Figures 2.4.1c – 2.4.1f and Figure 2.4.1e provide recreational length composition data used in the SS evaluation.

2.4.3 Survey length composition

Length composition data sample of Gulf of Greater amberjack from the SEAMAP video and the Panama City Laboratory Trap Video surveys were provided by the SEDAR 33 DW. Length composition samples were handled identically to the recreational and commercial length composition samples. Individual survey length observations were aggregated into annual densities by 5-cm length bins for use in the SS model. Length bins ranged from 5 cm to 200 cm, where the bin size represents the minimum size of the (Figures 2.4.1f – 2.4.1h)

2.5 Age composition

Observations of Greater amberjack annular age at length were provided by the SEDAR 33 DW for the stock assessment and presented in Figures 2.5.1a – 2.5.1e. Age data were available for the commercial and recreational fisheries. Age observations used in the stock assessment were assumed to be representative of the distribution of ages in the population. The age data were stratified by calendar year, fishery/survey (commercial line gear, recreational (REC) and Headboat (HBOAT) modes. As for the recreational charterboat and private angler length composition, combined sector age compositions for the REC fleet were developed by reweighting the individual charterboat and private angler annual densities by each fleets respective landings.

An age estimation error matrix was developed following the DW to account for errors in the estimation of ages for Gulf Greater amberjack (Table 2.5.1). The matrix includes mean coded ages and their associated standard deviations. The standard deviations were obtained from an analysis of Greater amberjack ages estimated by two independent readers for a limited sample of n = 73 fish.

In the stock assessment model used in this assessment (SS) fish are advanced to the next age on January 1 regardless of birthdate. . SEDAR 33 DW-23 described the procedures used for age determinations of Greater amberjack data used in this assessment. Peak spawning in Gulf of Mexico Greater amberjack occurs during spring coinciding with the time of annulus deposition. The procedures for Greater amberjack age determinations incorporated: the advancing of increment count (i.e., annulus age) based on annuli number, otolith edge-type and capture-date, typically advancing increment counts for spring collected samples. Because there is a discrepancy between the date that ages are incremented in SS (Jan 1) and the assumed birthdate of Greater Amberjack (April 1) used to estimate biological age, the population growth curve was estimated in the SS model using the SEDAR 33 DW parameters as initial estimates.

Age composition data are not used in surplus production (ASPIC) models.

2.6. Indices

Six indices of abundance were recommended by the SEDAR 33 DW for use in the stock assessment. These were: 1) commercial vertical line index, 2) the commercial bottom longline index, 3) the MRFSS/MRIP catch per angler hour charter and private angler abundance index, 4) the Headboat survey index, 5) the SEAMAP video survey abundance index, and 6) the SEFSC, Panama City Laboratory trap video survey. The standardized indices (point estimates) and the coefficient of variation (CV) of each, updated through 2012 for each series was incorporated into the population modeling using SS (Tables 2.6.1.1, 2.6.1.4, and 2.6.3.1). The CVs were converted to log-scale standard errors for input into SS, adjusted as:

$$\log(SE) = \sqrt{\log_e\left(1 + CV^2\right)}$$

2.6.1 Fishery Dependent Indices

Some of the fishery dependent indices developed during SEDAR 33 and recommended in the SEDAR 33 DW differ in trend from the indices from previous evaluations of the Greater amberjack stock (i.e. MRFSS and the COM HL). Because ASPIC model results can be sensitive to changes in the indices, the methods used to develop the SEDAR 33 indices for Greater Amberjack were explored in depth during various SEDAR 33 assessment workshop webinars.

During AW webinars, both the data filtering and the index standardization methods were evaluated and modified as needed. All modifications were made based on recommendations from the assessment panel. The SEDAR 33 assessment working papers associated with the fishery-dependent indices were updated to describe the indices that were ultimately used in the SEDAR 33 assessment (SEDAR33-AW18, SEDAR33-AW19, and SEDAR33-AW20).

The fishery dependent indices developed for the current assessment are included in Table 2.6.1.1. Figures 2.6.1.1 – 2.6.1.4 provide the updated indices and a comparison to the indices developed by the previous SEDAR 9 and SEDAR 9 Update assessments for Greater Amberjack.

Below is a brief accounting of the primary differences in approaches used for index standardizations between the SEDAR 33 Assessment and the SEDAR 9 Update Assessment.

1. Combined private and charterboat (SEDAR33-AW20)
    - Excluded data from 1995 and 2010
    - Included data from 2011 and 2012
    - Rejected Stephens and MacCall method for trip selection
    - Developed and implemented guild approach for trip selection
    - Weighted data to account for changes in survey design (In 2000, sampling increased by six in FL and by two in the other Gulf of Mexico states)
2. Headboat (SEDAR33-AW19)
    - Grouped areas
    - Excluded data from 2010
    - Included data from 2011 and 2012
3. Vertical Line (Handline) (SEDAR33-AW18)
    - Required ≥ 1 hour fished per day away
    - Grouped areas
    - Included target only trips after Stephens and MacCall trip selection
    - Included data from 1990-1992, and 2010
    - Weighted data to account for changes in survey design (FL was sampled with 20% coverage in 1990-1992)
4. Longline (SEDAR33-AW18)
    - Discontinued the minimum requirement of 10 sets
    - Grouped areas
    - Included data from 1990-1992, and 2010
    - Weighted data to account for changes in survey design (FL was sampled with 20% coverage in 1990-1992)

The above indices were recomputed in terms of weight to accommodate the production model, which is cast in terms of biomass. When changes in size occur, an increase or decline in the catch rates in numbers does not necessarily imply a corresponding change in the catch rates in biomass. Previous SEDAR 9 and SEDAR 9 Update assessments for Greater Amberjack used indices developed in numbers per unit effort to reference abundance, which in the context of a biomass production model implies that average size/weight of individuals did not vary over time, even with the imposition of size limits. The SEDAR 33 assessment panelists reviewed and rejected that assumption.

Average recreational lengths of landed Greater amberjack from the headboat fishery and from the combined private and charterboat fishery both increased over the years for which their respective indices were developed (Figure 2.6.1.5). Major changes in average length are particularly evident after 2000 (when size and bag limits were first implemented) and after 2008 (when the size limit was increased from 28 to 30 inches and the bag limit was retained at 1 fish).

To account for these changes, recreational indices were adjusted using a time series of annual average weights. The annual weights were estimated from a 3-year running average of recreationally landed Greater amberjack lengths (Table 2.3.2.5, Figure 2.6.1.6). Average annual lengths were converted to weights using $WW = 7.046 \times 10^{-5} * (FL^{2.633})$. After multiplying each index by its respective time series of annual weights, the indices were relativized by their respective means.

Since the index for the combined charter and private modes is based on total catch, the average annual weights were adjusted to account for the proportion of fish that were discarded. The proportions that were used to weight the adjusted average are included in Table 2.6.1.2. In the high estimate, the discards were given the same average size as the landings. In the low estimate, the discards were given the average size of Greater Amberjacks landed prior to 1990 and below the appropriate size limit. Weighted average for the combined charterboat and private fishery are included in Table 2.6.1.3 and plotted in Figure 2.6.1.7.

The recreational indices in numbers and indices in biomass are plotted in Figures 2.6.1.8 and 2.6.1.9. The recreational indices in biomass are included in Table 2.6.1.4. As a result of this conversion, the overall trend in each recreational index exhibits less of an overall decline than exhibited by the indices from the SEDAR 9 and SEDAR 9 Update assessments. The indices in numbers and biomass differ the most in the early years when numbers are high and when average weight is low. During the initial years, the indices in biomass do not show the sharp decline that is present in the indices in numbers.

2.6.2 Segmented Recreational Indices

The recreational indices were divided into segments delineated by changes in size limit regulationsin 1990 (implementation of the 30” size limit) and in 2009 (implementation of the 28” size limit and 3 fish bag limit). Since average size did not change drastically in 1997, the indices were not broken in association with the reduction in the bag limit to 1 fish in 1997.

The recreational indices were segmented using two methods. The first involved re-standardizing the indices in numbers. The indices associated with each period were developed using the same stepwise variable selection and delta lognormal methods as described in their respective reports (SEDAR-AW19, SEDAR-AW-20). Trip selection was not repeated by period. The second method involved segmenting the indices in biomass that were described in section 2.6.2 and relativizing them by each segments respective mean. The segmented recreational indices in numbers and in biomass are included in Table 2.6.2.1. Figures 2.6.2.1 and 2.6.2.2 show how the broken indices compare to the unbroken recreational indices.

Because ASPIC requires indices in biomass, but catchability (q) is expected to change at the imposition of a size (or bag) limit, the segmented and re-relativized indices in biomass were chosen by the AW Panel to be used in SEDAR 33 ASPIC models.

2.6.3 Fishery Independent Indices

There were no updates to the fishery independent indices following the SEDAR 33 data workshop. The fishery independent indices of abundance used in the SS model are presented in Table 2.6.3.1. No fishery independent indices were incorporated into the ASPIC models.

2.7 Discard Mortality

Three discard mortality rates were suggested by the discard mortality working group after the SEDAR 33 data workshop. They were 0%, 20%, and 40%. These rates were retained from the SEDAR 9 Update assessment. In addition, alternative characterizations of the release mortality value were considered in the SS assessment model including these values: 0%, 5%, 10%, and 15%.

2.8 Tables

Table 2.2.1.1a. Commercial and recreational landings data used in the SEDAR 33 Gulf of Mexico Greater amberjack stock assessment for the Stock Synthesis model. Landings are partitioned into four components: COM_HL = commercial vertical line gears, COM_LL = commercial bottom longline, REC = recreational charterboat and private angler fisheries) and Headboat). Units are whole weight (mtons) commercial, numbers of fish (recreational, 1,000's of fish).

YEAR	COM_HL	COM_LL	REC	HEADBOAT
1950	0	0	89	35
1951	0	0	94	35
1952	0	0	99	35
1953	0	0	104	35
1954	0	0	110	35
1955	0	0	115	35
1956	0	0	120	35
1957	0	0	125	35
1958	0	0	131	35
1959	0	0	136	35
1960	0	0	141	35
1961	0	0	142	35
1962	0	0	143	35
1963	4	0	144	35
1964	3	0	145	35
1965	2	0	147	35
1966	3	0	149	35
1967	14	0	152	35
1968	5	0	155	35
1969	34	0	157	35
1970	6	0	160	35
1971	18	0	167	35
1972	19	0	174	35
1973	13	0	181	35
1974	19	0	188	35
1975	36	0	195	35
1976	40	0	197	35
1977	56	0	199	35
1978	70	0	201	35
1979	69	1	203	35
1980	81	2	205	35
1981	99	11	126	11

Table 2.2.1.1a. (continued).

1982	86	18	389	117
1983	109	21	218	43
1984	218	29	182	18
1985	305	54	212	35
1986	417	95	379	86
1987	588	119	360	53
1988	785	157	265	30
1989	748	145	382	53
1990	513	60	48	24
1991	805	3	240	10
1992	457	25	137	20
1993	695	41	130	14
1994	550	34	95	13
1995	526	38	39	9
1996	538	27	81	11
1997	459	26	44	8
1998	274	23	61	5
1999	304	28	47	5
2000	352	30	56	6
2001	284	28	75	6
2002	305	34	123	11
2003	377	56	163	12
2004	391	35	119	6
2005	291	33	91	4
2006	231	36	76	5
2007	235	27	45	4
2008	169	41	70	5
2009	246	23	69	5
2010	239	10	59	3
2011	226	8	48	3
2012	137	20	57	4

Table 2.2.1.b. Commercial and recreational landings data used in the SEDAR 33 Gulf of Mexico Greater amberjack stock assessment for the ASPIC model. Units are whole weight (lbs).

Year	Commercial Handline	Commercial Longline	Recreational Headboat	Recreational Charterboat and Private
1986	918,538	209,322	750,632	5,610,451
1987	1,279,001	259,354	378,888	2,217,406
1988	1,698,741	339,686	173,613	2,146,610
1989	1,612,718	311,943	204,289	4,825,524
1990	980,307	115,409	77,654	609,509
1991	1,548,277	6,326	102,687	3,142,678
1992	959,547	52,815	312,152	1,838,719
1993	1,428,774	84,248	225,868	2,265,645
1994	1,128,431	69,625	213,119	1,427,206
1995	1,126,980	81,818	143,994	626,260
1996	1,123,104	55,920	139,588	1,208,614
1997	991,715	55,865	125,349	967,747
1998	587,729	50,058	88,595	1,249,975
1999	622,894	57,261	73,508	741,058
2000	722,280	62,215	100,732	927,692
2001	586,843	58,234	89,436	1,395,329
2002	637,366	70,605	160,636	1,944,209
2003	810,336	120,236	199,347	2,728,549
2004	828,518	73,746	108,769	2,266,424
2005	611,637	69,183	61,281	1,472,655
2006	485,740	75,190	79,892	1,570,061
2007	504,630	57,054	59,436	802,113
2008	356,687	86,021	54,544	1,220,877
2009	528,066	48,484	103,191	1,380,014
2010	497,931	21,817	53,203	1,186,680
2011	479,991	16,274	62,835	877,712
2012	283,948	41,319	99,680	1,199,829

Table 2.3.1.1. Estimates of annual commercial discard rates, numbers of sampled trips, and calculated discards (in numbers) of Greater Amberjack by region for the handline fleet.

	Handline West Gulf of Mexico			Handline East Gulf of Mexico		
Year	**Discard Rate**	**Sample Size**	**Discards (in numbers)**	**Discard Rate**	**Sample Size**	**Discards (in numbers)**
1990	5.572E-03	216	21,546	3.678E-02	376	52,008
1991	5.572E-03	216	49,787	3.678E-02	376	65,386
1992	5.572E-03	216	26,053	3.678E-02	376	75,486
1993	5.572E-03	216	29,861	3.678E-02	376	76,877
1994	5.572E-03	216	33,393	3.678E-02	376	81,360
1995	5.572E-03	216	34,008	3.678E-02	376	61,001
1996	5.572E-03	216	38,651	3.678E-02	376	70,929
1997	5.572E-03	216	43,590	3.678E-02	376	55,960
1998	5.572E-03	216	45,888	3.678E-02	376	52,604
1999	5.572E-03	216	49,596	3.678E-02	376	56,886
2000	5.572E-03	216	46,796	3.678E-02	376	59,943
2001	5.572E-03	216	45,335	3.678E-02	376	47,637
2002	5.572E-03	216	47,028	3.678E-02	376	52,915
2003	5.572E-03	216	49,338	3.678E-02	376	55,924
2004	5.572E-03	216	43,464	3.678E-02	376	53,484
2005	5.572E-03	216	40,193	3.678E-02	376	60,222
2006	5.572E-03	216	38,349	3.678E-02	376	63,391
2007	2.128E-03	43	13,299	1.754E-02	56	33,119
2008	4.502E-03	21	24,252	6.811E-02	32	120,658
2009	3.490E-03	13	21,071	1.438E-02	34	46,341
2010	8.367E-03	19	35,607	1.829E-02	41	61,675
2011	2.729E-03	40	12,599	7.112E-03	70	25,753
2012	8.800E-03	80	47,547	6.246E-02	143	259,177

Table 2.3.1.2. Annual commercial discard rates, numbers of observed trips, and discards in numbers by region for the bottom longline shark permit fleet.

	West Gulf of Mexico Longline Shark Permit			East Gulf of Mexico Longline Shark Permit		
Year	**Discard Rate**	**Sample Size**	**Discards (in numbers)**	**Discard Rate**	**Sample Size**	**Discards (in numbers)**
1990	2.578E-05	37	124	7.585E-05	175	2,514
1991	2.578E-05	37	189	7.585E-05	175	4,462
1992	2.578E-05	37	86	7.585E-05	175	2,754
1993	2.578E-05	37	75	7.585E-05	175	2,339
1994	2.578E-05	37	118	7.585E-05	175	2,923
1995	2.578E-05	37	142	7.585E-05	175	2,341
1996	2.578E-05	37	142	7.585E-05	175	2,769
1997	2.578E-05	37	95	7.585E-05	175	3,054
1998	2.578E-05	37	92	7.585E-05	175	2,617
1999	2.578E-05	37	111	7.585E-05	175	2,526
2000	2.578E-05	37	33	7.585E-05	175	1,260
2001	2.578E-05	37	31	7.585E-05	175	1,092
2002	2.578E-05	37	24	7.585E-05	175	936
2003	2.578E-05	37	103	7.585E-05	175	1,118
2004	2.578E-05	37	47	7.585E-05	175	1,020
2005	2.578E-05	37	46	7.585E-05	175	736
2006	2.578E-05	37	51	7.585E-05	175	992
2007	2.578E-05	37	24	7.585E-05	175	992
2008	2.578E-05	37	8	7.585E-05	175	825
2009	2.578E-05	37	6	7.585E-05	175	461
2010	2.578E-05	37	7	7.585E-05	175	225
2011	2.578E-05	37	6	7.585E-05	175	328
2012	2.578E-05	37	24	7.585E-05	175	329

Table 2.3.1.3. Annual commercial discard rates, numbers of observed trips, and discards in numbers by region for the bottom longline reef permit fleet.

	West Gulf of Mexico Longline Reef Permit			East Gulf of Mexico Longline Reef Permit		
Year	**Discard Rate**	**Sample Size**	**Discards (in numbers)**	**Discard Rate**	**Sample Size**	**Discards (in numbers)**
1990	2.361E-04	27	26	7.472E-05	124	104
1991	2.361E-04	27	40	7.472E-05	124	185
1992	2.361E-04	27	18	7.472E-05	124	114
1993	2.361E-04	27	16	7.472E-05	124	97
1994	2.361E-04	27	25	7.472E-05	124	121
1995	2.361E-04	27	60	7.472E-05	124	164
1996	2.361E-04	27	0	7.472E-05	124	35
1997	2.361E-04	27	37	7.472E-05	124	135
1998	2.361E-04	27	164	7.472E-05	124	265
1999	2.361E-04	27	445	7.472E-05	124	583
2000	2.361E-04	27	1,198	7.472E-05	124	1,498
2001	2.361E-04	27	,843	7.472E-05	124	1,649
2002	2.361E-04	27	1,133	7.472E-05	124	1,460
2003	2.361E-04	27	1,022	7.472E-05	124	1,509
2004	2.361E-04	27	1,354	7.472E-05	124	1,543
2005	2.361E-04	27	1,078	7.472E-05	124	1,146
2006	2.361E-04	27	838	7.472E-05	124	1,312
2007	2.361E-04	27	534	7.472E-05	124	1,177
2008	2.361E-04	27	566	7.472E-05	124	1,293
2009	2.361E-04	27	676	7.472E-05	124	648
2010	2.361E-04	27	290	7.472E-05	124	406
2011	2.361E-04	27	304	7.472E-05	124	634
2012	2.361E-04	27	198	7.472E-05	124	432

Table 2.3.1.4. Average lengths, sample sizes, and average weights of observed Greater Amberjack discards and observed Seriola discards by commercial handline and bottom longline fisheries.

	Commercial Fishery	Average Length (cm)	Sample Size	Average Weight (lbs)
Greater Amberjack	Handline	68.62	647	10.63
	Longline	92.58	519	23.39
Seriola ≤ 60cm	Handline	41.8	202	2.88
	Longline	43.8	149	3.26

Table 2.3.1.5. Annual discards in numbers and in whole weight (lbs) by commercial handline and bottom longline fisheries.

	Discards in Numbers		**Discards in Whole Weight (lbs)**	
Year	Handline	Longline	Handline	Longline
1986	0	0	0	0
1987	0	0	0	0
1988	0	0	0	0
1989	0	0	0	0
1990	73,554	2,769	739,195	60,127
1991	115,173	4,875	1,157,458	105,866
1992	101,539	2,972	1,020,436	64,547
1993	106,738	2,527	1,072,689	54,876
1994	114,753	3,187	1,153,236	69,222
1995	95,009	2,706	954,812	58,764
1996	109,580	2,947	1,101,249	63,994
1997	99,550	3,321	1,000,446	72,120
1998	98,493	3,138	989,822	68,145
1999	106,481	3,666	1,070,106	79,613
2000	106,739	3,988	1,072,696	86,608
2001	92,972	3,615	934,343	78,512
2002	99,943	3,553	1,004,399	77,158
2003	105,262	3,752	1,057,847	81,478
2004	96,948	3,964	974,299	86,082
2005	100,415	3,007	1,009,137	65,298
2006	101,740	3,194	1,022,455	69,355
2007	46,418	2,727	466,485	59,217
2008	144,910	2,692	1,456,299	58,473
2009	67,412	1,791	677,469	38,886
2010	97,282	929	977,659	20,167
2011	38,351	1,271	385,421	27,612
2012	306,724	984	3,082,479	21,359

Table 2.3.2.1. Annual discards in numbers by fishing mode for the recreational charterboat, private angler and headboat fisheries.

	Recreational Discards in Numbers		
Year	Headboat	Charterboat	Private
1986	11,371	32,297	23,412
1987	640	1,566	31,555
1988	381	1,811	75,485
1989	3,053	8,171	116,434
1990	25,655	16,044	63,361
1991	9,407	211,979	35,271
1992	17,268	81,424	80,062
1993	14,056	85,992	71,528
1994	10,283	55,029	55,917
1995	9,022	9,642	57,095
1996	9,706	39,280	24,310
1997	5,429	19,101	29,528
1998	12,856	38,554	66,535
1999	8,948	41,010	54,329
2000	5,212	29,673	104,705
2001	12,149	54,194	494,557
2002	11,800	77,349	238,947
2003	10,249	54,901	206,886
2004	2,929	25,414	149,700
2005	3,911	21,422	190,130
2006	2,748	25,456	154,863
2007	5,215	32,768	155,316
2008	10,505	57,718	120,425
2009	9,232	57,062	80,668
2010	4,043	34,663	270,450
2011	4,230	44,961	134,138
2012	4,059	27,483	84,750

Table 2.3.2.2. Estimated annual discards in weight by mode and by estimation method.

	Headboat			Charterboat			Private		
Year	Cont.	Low	High	Cont.	Low	High	Cont.	Low	High
1986	66,587	34,481	66,587	218,516	157,207	218,516	129,454	96,083	129,454
1987	3,885	1,941	3,885	10,743	7,623	10,743	190,522	129,501	190,522
1988	1,757	1,155	1,757	12,106	8,817	12,106	446,108	309,791	446,108
1989	12,747	9,258	12,747	69,869	39,771	69,869	883,503	477,848	883,503
1990	418,619	77,795	108,933	252,647	78,094	182,305	1,026,641	260,033	422,962
1991	148,882	28,525	99,627	3,296,404	1,031,816	3,004,777	521,972	144,754	434,790
1992	276,451	52,363	242,880	1,282,205	396,333	1,173,253	1,120,710	328,576	1,045,124
1993	224,786	42,623	210,422	1,406,838	418,569	1,322,658	1,009,496	293,553	922,699
1994	165,814	31,182	151,439	972,262	267,855	898,495	735,796	229,486	618,739
1995	139,516	27,358	132,066	160,090	46,934	149,322	795,150	234,318	699,563
1996	151,297	29,432	142,064	649,276	191,197	627,791	334,886	99,770	323,654
1997	84,455	16,463	80,513	329,142	92,974	308,917	456,360	121,183	382,429
1998	200,276	38,984	189,130	621,992	187,662	576,137	1,039,072	273,060	923,265
1999	138,178	27,134	131,336	647,891	199,617	619,397	866,922	222,969	751,658
2000	79,783	15,805	73,061	475,950	144,434	451,134	1,681,366	429,714	1,479,948
2001	200,149	36,840	184,284	855,674	263,789	819,805	8,017,607	2,029,676	7,124,581
2002	193,976	35,782	180,362	1,223,905	376,497	1,167,885	3,827,557	980,646	3,687,574
2003	170,714	31,079	163,609	880,461	267,231	851,511	3,473,585	849,066	3,492,004
2004	47,112	8,882	45,008	420,746	123,706	409,839	2,486,298	614,374	2,501,675
2005	63,426	11,860	61,697	383,113	104,274	374,832	3,273,394	780,299	3,252,903
2006	43,559	8,333	36,782	452,946	123,908	437,165	2,410,200	635,561	2,349,752
2007	77,282	15,814	61,870	597,556	159,501	566,914	2,629,523	637,422	2,317,988
2008	172,262	31,855	151,582	1,025,914	280,946	980,542	2,066,785	494,226	1,828,401
2009	169,568	30,446	143,768	1,134,021	297,680	1,045,695	1,469,737	356,253	1,301,845
2010	79,696	13,333	77,649	665,123	180,830	646,174	4,824,083	1,194,387	4,724,774
2011	100,053	13,950	97,442	885,341	234,550	865,073	2,517,060	592,391	2,460,386
2012	97,708	13,386	95,506	540,799	143,372	529,436	1,636,555	374,279	1,636,310

Table 2.3.2.3. Average discard rates by fishing mode and regulatory period for the recreational charterboat, private angler and headboat fisheries.

Years	Headboat	Charterboat	Private
1981-1989	0.0585	0.0510	0.3230
1990-1997	0.9520	0.9279	1.7034
1998-2008	1.1964	1.0962	3.7634
2009-2012	1.4732	1.4636	4.7476

Table 2.3.2.4. Annual number of measured recreationally landed GAJ. Numbers are included for all measured Greater Amberjack as well as for the number of Greater Amberjack above and below the legal size limit.

	Headboat			Charterboat			Private		
Year	All	< SL	≥ SL	All	< SL	≥ SL	All	< SL	≥ SL
1986	597			225			5		
1987	549			621			161		
1988	366			174			26		
1989	1292			108			14		
1990	236	182	54	23	7	16	9	7	2
1991	189	88	101	226	103	123	9	6	3
1992	363	36	327	629	112	517	30	8	22
1993	245	58	187	98	19	79	11	3	8
1994	256	34	222	56	10	46	11	5	6
1995	277	52	225	21	1	20	2	1	1
1996	159	21	138	34	9	25	11	1	10
1997	113	19	94	85	6	79	6	2	4
1998	128	10	118	150	26	124	7	3	4
1999	130	22	108	489	111	378	38	7	31
2000	124	14	110	695	48	647	22	7	15
2001	217	57	160	397	96	301	39	13	26
2002	162	12	150	921	150	771	48	7	41
2003	286	42	244	992	123	869	76	3	73
2004	73	5	68	604	38	566	34	0	34
2005	30	3	27	264	30	234	52	7	45
2006	25	5	20	466	37	429	11	1	10
2007	62	15	47	286	38	248	9	1	8
2008	98	27	71	156	28	128	20	8	12
2009	156	15	141	197	16	181	12	1	11
2010	45	5	40	282	26	256	35	6	29
2011	88	2	86	438	53	385	25	1	24

Table 2.3.2.5. Time series of the annual average weights and the 3-year running average of recreationally landed greater amberjack lengths from which the average weights were estimated.

	Headboat			Charterboat			Private		
Year	All	< SL	≥ SL	All	< SL	≥ SL	All	< SL	≥ SL
1986	6.77	4.47	23.50	5.86	3.51	19.02	5.53	4.50	18.56
1987	6.86	4.64	21.94	6.07	3.97	18.87	6.04	4.79	18.68
1988	6.68	4.85	20.96	4.61	2.98	17.65	5.91	4.62	18.77
1989	8.55	5.49	19.18	4.18	2.67	17.88	7.59	5.23	20.41
1990	11.36	7.62	16.22	4.25	2.37	17.23	6.68	4.54	18.93
1991	14.17	9.81	15.88	10.59	4.26	16.58	12.33	8.14	16.36
1992	14.41	9.95	16.08	14.07	7.38	16.58	13.05	9.76	14.99
1993	15.38	10.12	16.72	14.97	7.76	16.53	12.90	8.03	15.54
1994	16.33	9.07	18.17	14.73	7.87	16.67	11.07	6.29	14.77
1995	15.49	9.64	17.01	14.64	8.85	15.90	12.25	5.78	15.83
1996	15.98	9.79	16.92	14.64	8.83	16.03	13.31	7.39	15.27
1997	16.17	9.51	17.61	14.83	8.48	15.92	12.95	5.43	16.40
1998	14.94	9.73	16.45	14.71	8.28	15.95	13.88	7.41	16.39
1999	15.10	9.81	16.09	14.68	7.79	15.84	13.84	7.09	16.79
2000	15.20	10.13	16.33	14.02	8.46	15.66	14.13	8.40	16.78
2001	15.13	10.37	16.05	15.17	8.08	16.91	14.41	8.14	16.97
2002	15.10	10.55	16.08	15.28	8.91	16.83	15.43	9.15	16.66
2003	15.51	10.56	16.30	15.96	8.89	17.06	16.88	9.48	17.48
2004	16.13	10.66	16.84	15.37	9.24	16.44	16.71	9.95	17.23
2005	17.50	9.90	18.27	15.78	9.95	16.54	17.11	9.27	17.96
2006	17.17	9.87	18.18	13.38	4.65	16.43	15.17	9.39	16.14
2007	17.30	8.52	18.71	11.86	4.62	15.34	14.92	8.17	17.75
2008	16.99	8.35	18.23	14.43	4.26	17.02	15.18	8.24	18.00
2009	18.33	4.70	26.52	15.57	3.78	20.39	16.14	4.76	22.85
2010	18.64	4.98	26.09	19.21	4.22	20.26	17.47	5.08	22.78
2011	19.24	5.20	26.04	23.04	3.25	19.21	18.34	4.90	22.46

Table 2.3.2.6. Average weights of Greater Amberjack landed and sampled prior to the implementation of size and bag limits in 1990.

Mode	1981 - 1989 Below 28 inches	1982 - 1989 Below 30 inches
Headboat	3.03	3.30
Charterboat	4.87	5.22
Private	4.10	4.42

Table 2.5.1. Age error matrix for Gulf of Mexico Greater amberjack used in the SEDAR 33 stock assessment. Data Source: Linda Lombardi (NOAA, NMFS, SEFSC Panama City Laboratory, personal communication). Age 0 set = 50% age1, ages 7+ set = age 6.

				AGE (Years)							
Mean age	0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5
SD (Age)	0.1	0.2	0.21	0.29	0.4	0.51	0.63	0.63	0.63	0.63	0.63

Table 2.6.1.1. Time series of fishery dependent indices of abundance data for Gulf Greater amberjack used in the SEDAR 33 stock evaluations. Series included are: commercial handline (COM_HL), commercial longline (COM_LL), recreational headboat (REC_HB), and recreational charterboat and private anglers (REC_CBPR).

	COM_HL		COM_LL		REC_HB		REC_CBPR	
Year	**Index**	**CV**	**Index**	**CV**	**Index**	**CV**	**Index**	**CV**
1986					3.5268	0.3463	2.7736	0.4657
1987					1.7878	0.3802	4.1456	0.4865
1988					1.9151	0.3682	0.7334	0.5616
1989					1.4690	0.3810	1.6020	0.5469
1990	0.6654	0.6161	0.5748	0.4003	0.5795	0.4505	0.1885	0.6984
1991	0.7433	0.5561	0.8185	0.3060	0.7394	0.4290	1.6439	0.5143
1992	0.5526	0.6102	1.2705	0.3290	1.2103	0.3819	1.6054	0.4709
1993	0.7812	0.5276	0.5674	0.2799	0.7402	0.3968	0.4672	0.5545
1994	0.8769	0.5244	0.4073	0.2667	0.5772	0.4185	0.3638	0.5546
1995	0.8139	0.5366	0.5972	0.2701	0.6860	0.4119	0.3833	0.5694
1996	1.0219	0.5225	0.5425	0.2967	0.7781	0.4034	0.2290	0.5967
1997	0.9059	0.5205	0.6230	0.2616	0.6071	0.4419	0.5063	0.5611
1998	0.8610	0.5285	0.6183	0.2707	0.4181	0.4651	0.2665	0.5447
1999	0.8845	0.5267	0.5706	0.2665	0.5605	0.4886	0.2120	0.5523
2000	0.9417	0.5384	0.5995	0.2721	0.5349	0.4817	0.6490	0.5334
2001	0.8720	0.5450	0.7296	0.2643	0.9164	0.4217	1.1412	0.4758
2002	1.0973	0.5387	0.9682	0.2634	1.0722	0.4372	1.2617	0.4599
2003	1.9737	0.5123	1.1111	0.2498	1.4314	0.4127	0.9799	0.4639
2004	1.7301	0.5264	1.2815	0.2609	1.0825	0.4125	0.7318	0.4691
2005	1.0025	0.5350	1.7578	0.2597	0.4837	0.4659	0.7803	0.4825
2006	1.2384	0.5194	1.3103	0.2581	0.6798	0.4720	0.5457	0.5109
2007	0.7260	0.5507	1.1043	0.2704	0.4249	0.4819	0.8246	0.4920
2008	0.9446	0.5595	1.5165	0.2606	1.5129	0.4919	0.7139	0.4879
2009	0.7282	0.6127	2.0343	0.2748	0.7275	0.4408	0.9018	0.4852
2010	1.6388	0.6409	1.9965	0.3562				
2011					0.8260	0.5363	1.6399	0.4991
2012					0.7130	0.5330	0.7097	0.5164

Table 2.6.1.2. Percentages of annual catch in number by mode for the combined charter and private fishery. These percentages were used to develop the adjusted average weights that were used convert the combined charter and private index in numbers to an index in biomass. This step was necessary as the charter and private index is based on catch and thus includes both landings and discards.

Year	% CBT Discards	% CBT Landings	% PRI Discards	% PRI Landings
1986	7.45	56.35	5.40	30.79
1987	0.40	32.72	8.03	58.85
1988	0.53	41.08	22.07	36.32
1989	1.62	27.79	23.02	47.58
1990	12.60	11.91	49.76	25.73
1991	43.59	45.64	7.25	3.52
1992	27.30	31.22	26.84	14.65
1993	29.91	29.89	24.88	15.31
1994	26.82	34.22	27.25	11.71
1995	9.19	8.83	54.42	27.56
1996	27.45	29.72	16.99	25.84
1997	20.86	28.97	32.24	17.93
1998	23.24	9.24	40.10	27.42
1999	28.92	17.09	38.32	15.67
2000	15.67	18.04	55.29	11.00
2001	8.70	4.31	79.44	7.55
2002	17.69	16.03	54.64	11.64
2003	12.99	15.19	48.96	22.85
2004	8.66	18.44	51.01	21.89
2005	7.11	7.26	63.10	22.52
2006	9.96	17.12	60.58	12.35
2007	14.10	12.06	66.83	7.00
2008	23.31	10.70	48.63	17.36
2009	27.61	15.67	39.03	17.69
2010	9.52	6.06	74.30	10.12
2011	19.84	14.02	59.20	6.93
2012	16.25	15.34	50.10	18.31

Table 2.6.1.3. Weighted averages for the combined charterboat and private fishery. These average weights were used to convert the charterboat and private index in number to an index in biomass. The low method assumes that all discards are associated with the size limit. The high method assumes that all discards are associated with the bag limits.

Year	Low Weighted Avg. Weight	High Weighted Avg. Weight
1986	6.10	6.32
1987	6.15	6.31
1988	5.82	6.23
1989	7.01	7.87
1990	5.73	7.82
1991	9.32	13.98
1992	8.84	13.85
1993	9.05	14.38
1994	9.31	14.28
1995	7.42	12.84
1996	10.22	14.84
1997	9.35	14.56
1998	7.96	14.22
1999	7.73	14.42
2000	7.33	14.49
2001	5.42	14.50
2002	7.32	15.32
2003	8.86	16.49
2004	9.15	16.55
2005	8.06	17.16
2006	7.78	15.71
2007	6.56	15.55
2008	7.58	15.80
2009	8.89	17.08
2010	6.68	17.65
2011	7.62	18.65
2012	9.55	19.29

Table 2.6.1.4. Recreational indices of abundance in biomass.

Year	**Headboat** (Index in biomass)	**Charter/Private Low** (Index in biomass)	**Charter/Private High** (Index in biomass)
1986	1.7538	2.2675	1.4181
1987	0.9216	3.4152	2.1168
1988	0.7498	0.5724	0.3699
1989	0.5208	1.5050	1.0204
1990	0.2089	0.1447	0.1194
1991	0.6649	2.0539	1.8592
1992	1.4456	1.9021	1.7989
1993	0.9409	0.5667	0.5438
1994	0.7218	0.4537	0.4203
1995	0.8527	0.3814	0.3981
1996	0.9671	0.3138	0.2750
1997	0.7646	0.6342	0.5964
1998	0.5223	0.2844	0.3067
1999	0.6987	0.2196	0.2473
2000	0.6367	0.6376	0.7613
2001	1.1804	0.8295	1.3391
2002	1.3916	1.2379	1.5642
2003	1.9403	1.1629	1.3078
2004	1.4126	0.8972	0.9803
2005	0.6479	0.8429	1.0838
2006	0.7726	0.5693	0.6940
2007	0.4281	0.7251	1.0374
2008	1.8538	0.7256	0.9126
2009	0.9621	1.0745	1.2468
2010			
2011	1.6157	1.6745	2.4744
2012	1.4246	0.9085	1.1080

Table 2.6.2.1. Segmented recreational indices of abundance in numbers (re-standardized) and segmented recreational indices of abundance in biomass (relativized, without re-standardizing).

Year	Broken Indices in Numbers		Broken Indices in Biomass		
	HB	CBPR	HB	CBPR - Low	CB-PR High
1986	1.6489	1.1012	1.7778	1.1688	1.1517
1987	0.8129	1.6330	0.9342	1.7604	1.7192
1988	0.8724	0.3806	0.7601	0.2950	0.3004
1989	0.6658	0.8852	0.5279	0.7758	0.8287
1990	0.7613	0.2798	0.2199	0.1885	0.1396
1991	1.0359	2.2073	0.6998	2.6761	2.1744
1992	1.7055	2.5460	1.5216	2.4783	2.1039
1993	1.0253	0.6266	0.9903	0.7384	0.6360
1994	0.7819	0.5252	0.7597	0.5911	0.4916
1995	0.8767	0.5728	0.8975	0.4969	0.4656
1996	0.9766	0.3708	1.0179	0.4089	0.3216
1997	0.7575	0.6602	0.8048	0.8263	0.6975
1998	0.5015	0.3551	0.5497	0.3706	0.3587
1999	0.7007	0.2948	0.7354	0.2861	0.2892
2000	0.6356	0.8491	0.6702	0.8307	0.8904
2001	1.1197	1.5109	1.2424	1.0808	1.5661
2002	1.3011	1.7452	1.4647	1.6129	1.8294
2003	1.8049	1.4368	2.0423	1.5152	1.5295
2004	1.3635	1.0452	1.4868	1.1690	1.1465
2005	0.5125	1.1015	0.6819	1.0982	1.2676
2006	0.8718	0.7407	0.8132	0.7418	0.8117
2007	0.5104	1.1330	0.4506	0.9448	1.2133
2008	1.7576	0.9992	1.9512	0.9454	1.0673
2009	0.9542	0.7670	0.7211	0.8813	0.7745
2010					
2011	1.1404	1.2085	1.2110	1.3735	1.5371
2012	0.9055	1.0245	1.0678	0.7452	0.6883

Table 2.6.3.1. Fishery independent indices of abundance used in the SS model for Gulf of Mexico greater amberjack.

Year	SEAMAP_ Video Survey	PANAMA_CITY_ TRAP_ VIDEO_SURVEY
1993	1.1483	
1994	1.2123	
1995	1.113	
1996	0.6971	
1997	0.6103	
2002	1.8357	
2004	0.965	
2005	1.0185	
2006	0.7384	0.9468
2007	0.8944	0.8611
2008	0.7416	1.0916
2009	1.0723	1.7134
2010	0.8353	0.7564
2011	1.1819	0.1627
2012	0.936	1.468

2.9 Figures

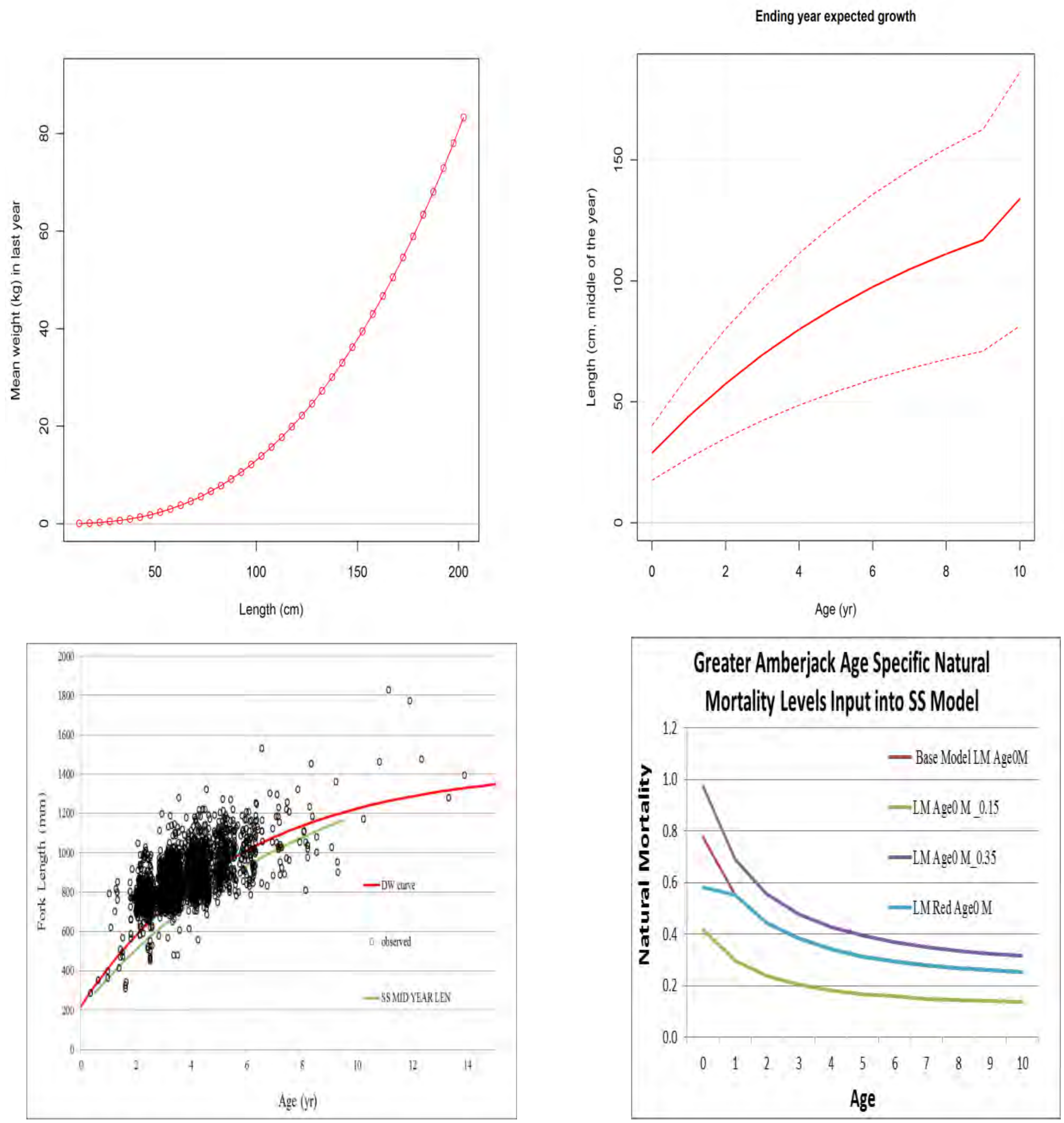


Figure 2.1.1. Life history characterization for Gulf of Mexico greater amberjack. Top Panel Left: Weight length relationship calculated using SEDAR 33 DW inputs. Top Panel Right: Estimated Von Bertalanffy SS growth curves and confidence intervals. Bottom Panel Left: SS estimated growth curve, growth curve estimated from SEDAR DW, and mean size at age from otolith age observations. Bottom Panel Right: Natural mortality at age used in into the Stock Synthesis model for the Base Model run (LM Age0 M) and three alternative characterization of M at age.

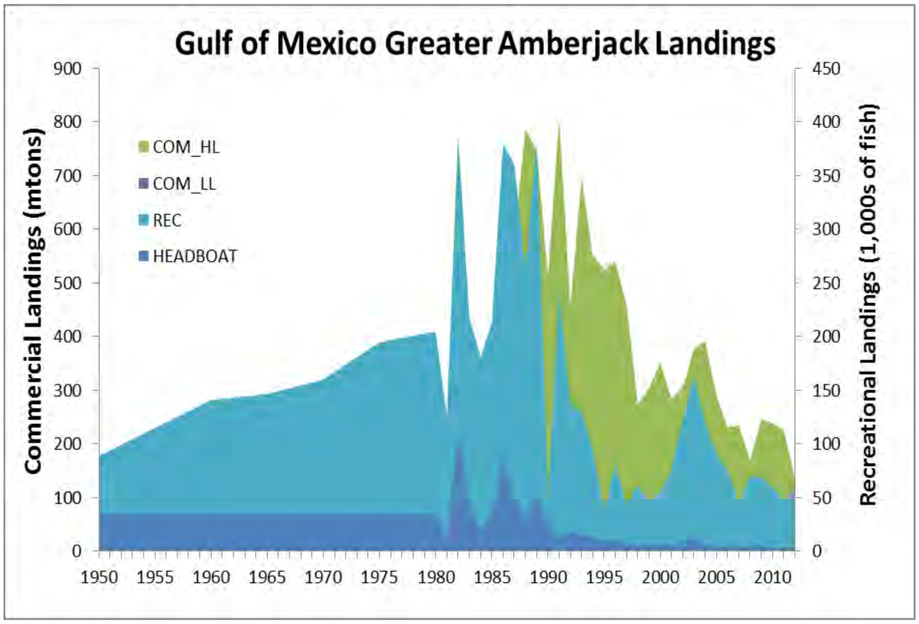


Figure 2.2.1.1. Landings (mtons, whole weight) for Gulf of Mexico greater amberjack. Landings are partitioned into four components: COM_HL = commercial line gears, COM_LL = commercial bottom longline, REC = recreational charterboat and private angler fisheries) and Headboat. Units are whole weight (mtons) commercial, numbers of fish (recreational, 1,000's of fish).

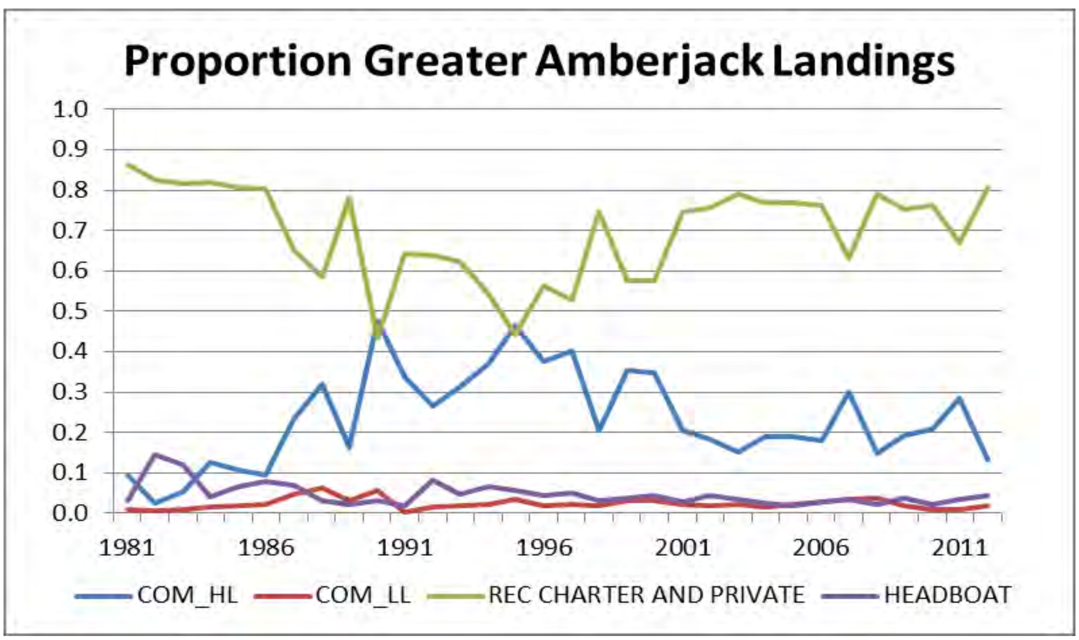


Figure 2.2.1.2. Proportion Greater amberjack landings by fishery and year for 1981-2012.

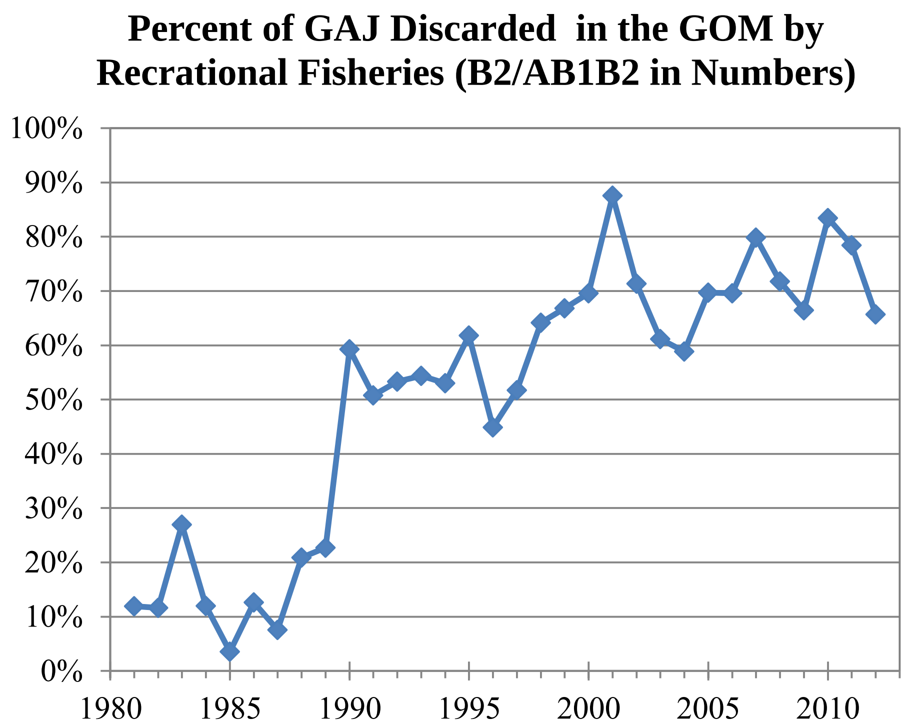


Figure 2.3.2.1. Annual percentages of Greater Amberjack discarded in the Gulf of Mexico by recreational fisheries. The annual values are calculated as the total number of discarded Greater Amberjack (B2) divided by the total number caught (AB1B2).

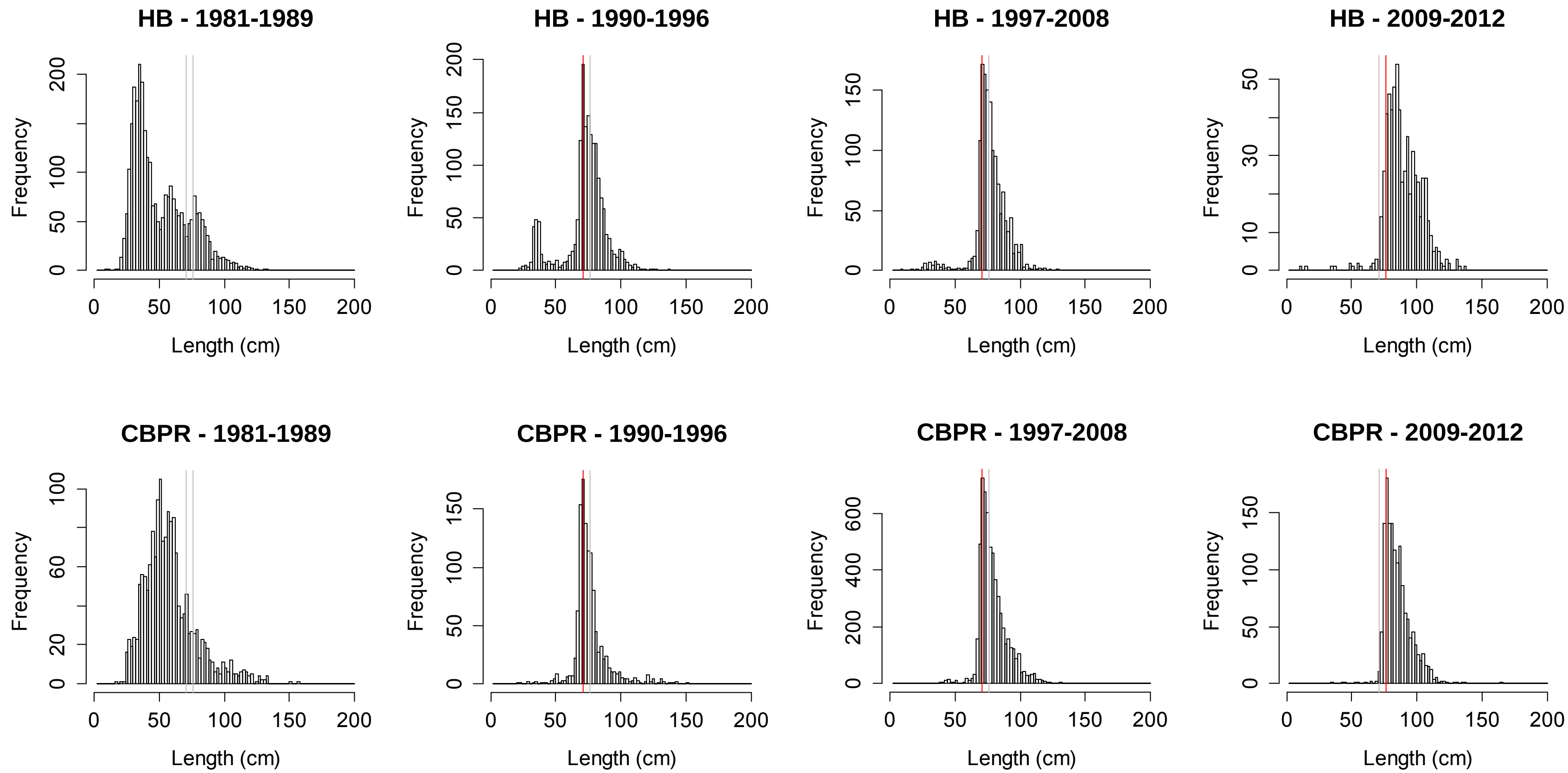
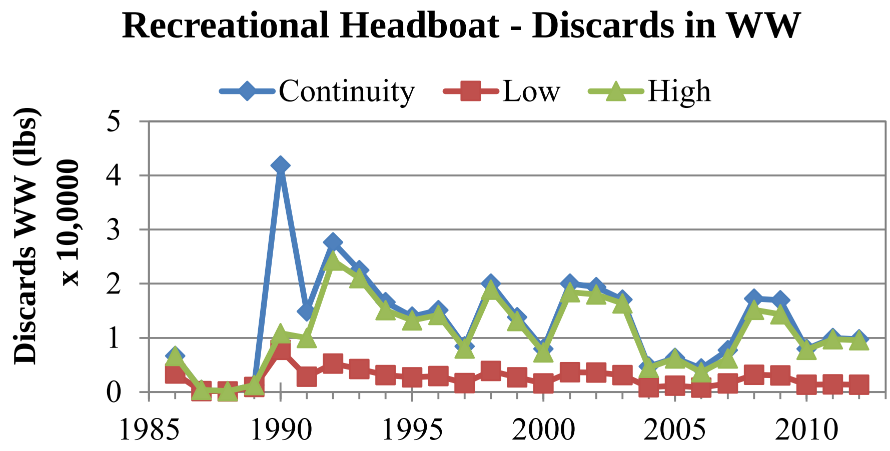
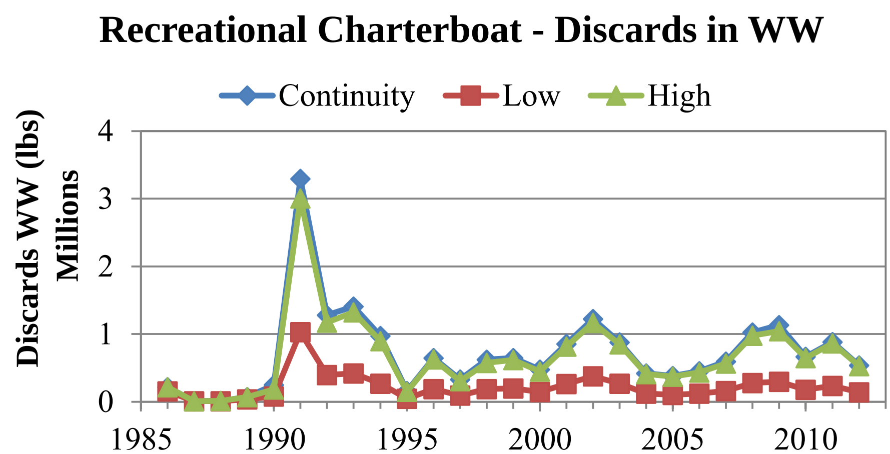


Figure 2.3.2.2. Length distributions of Greater Amberjack landed by recreational fisheries in the Gulf of Mexico. The red vertical lines indicate the size limits imposed during the respective time periods shown in each frame.





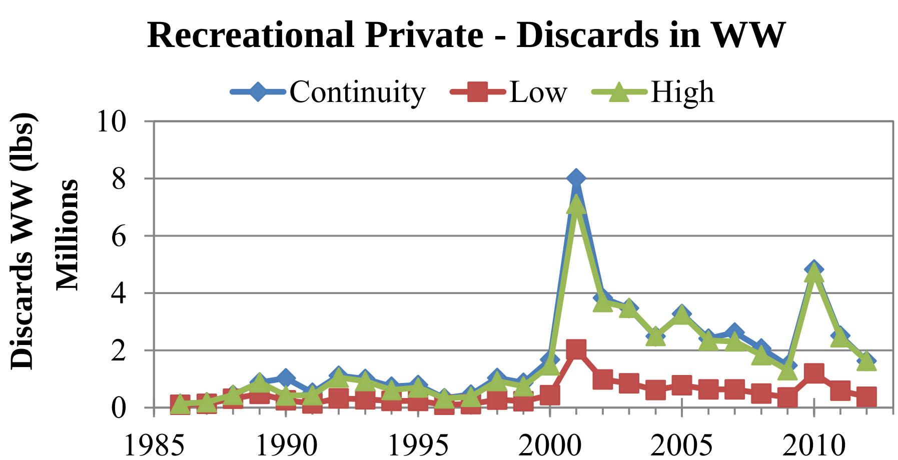


Figure 2.3.2.3. Estimates of total annual recreational discards in whole weight (lbs) by recreational fishing mode and method of estimation. Discard were converted using average lengths and estimated average weights of Greater Amberjack landed by recreational fisheries.

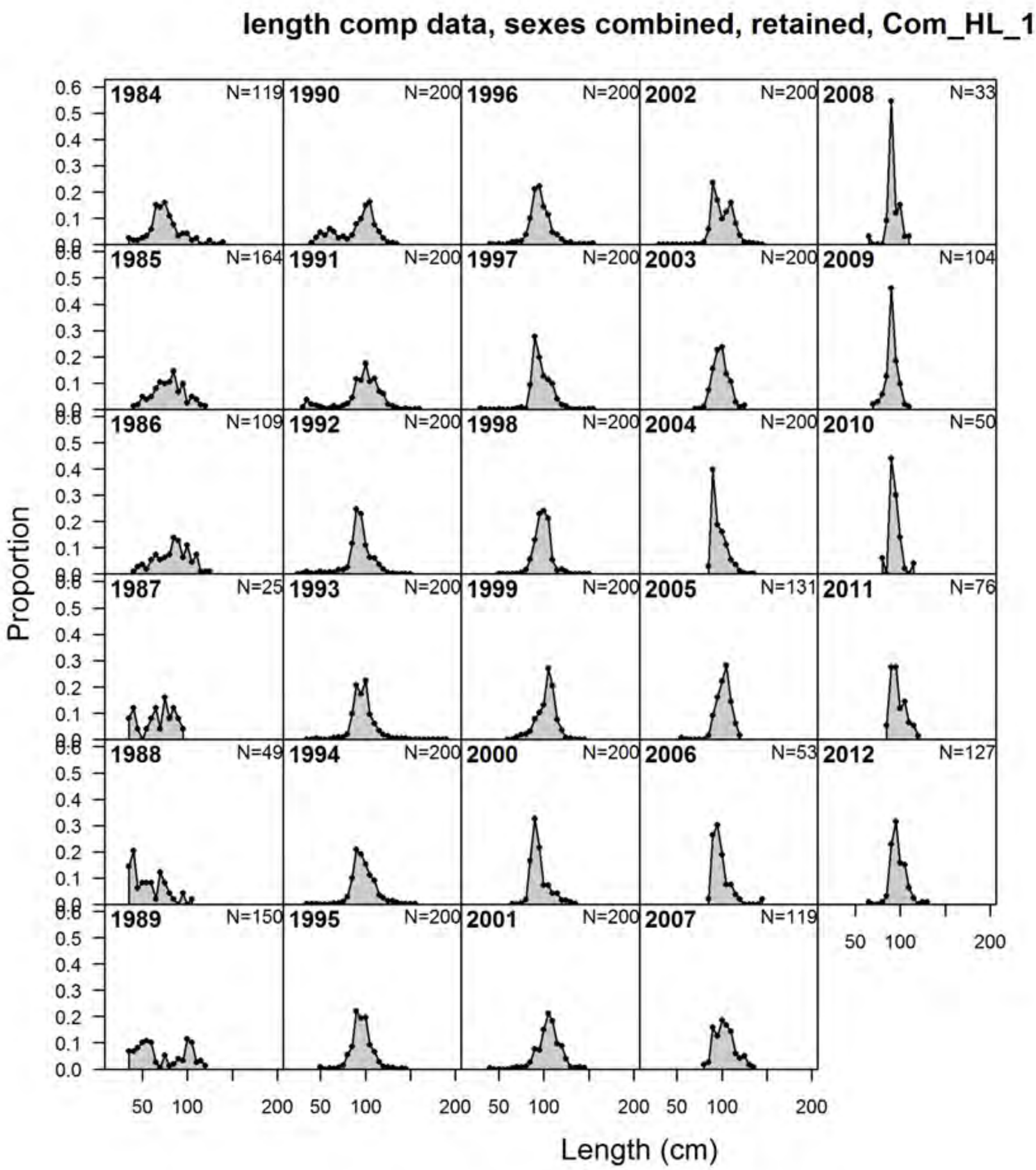


Figure 2.4.1a. Proportion of numbers at length for Gulf of Mexico greater amberjack in the commercial (COM_HL) fishery.

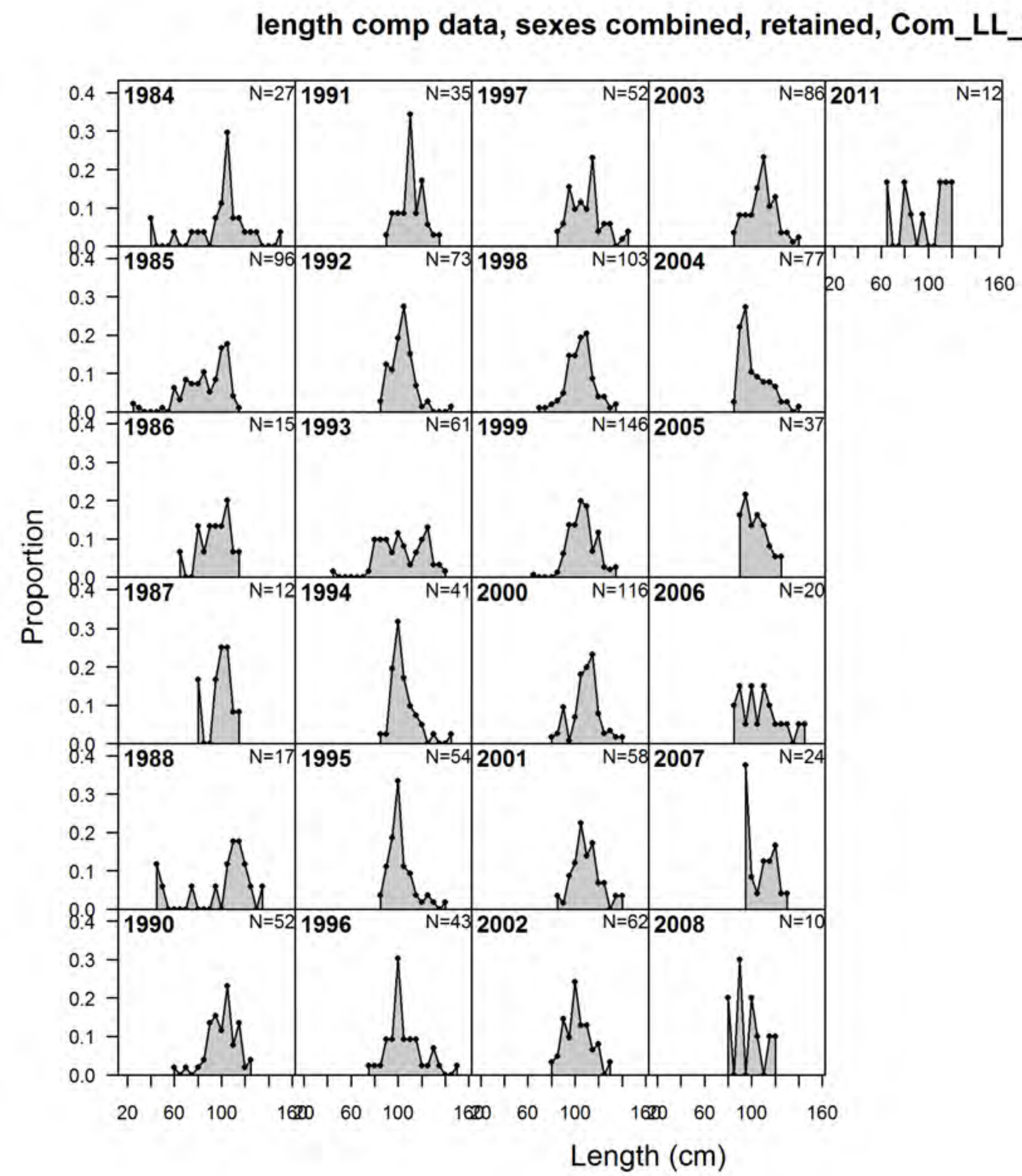


Figure 2.4.1b. Proportion of numbers at length for Gulf of Mexico greater amberjack in the commercial bottom longline fishery (COM_LL).

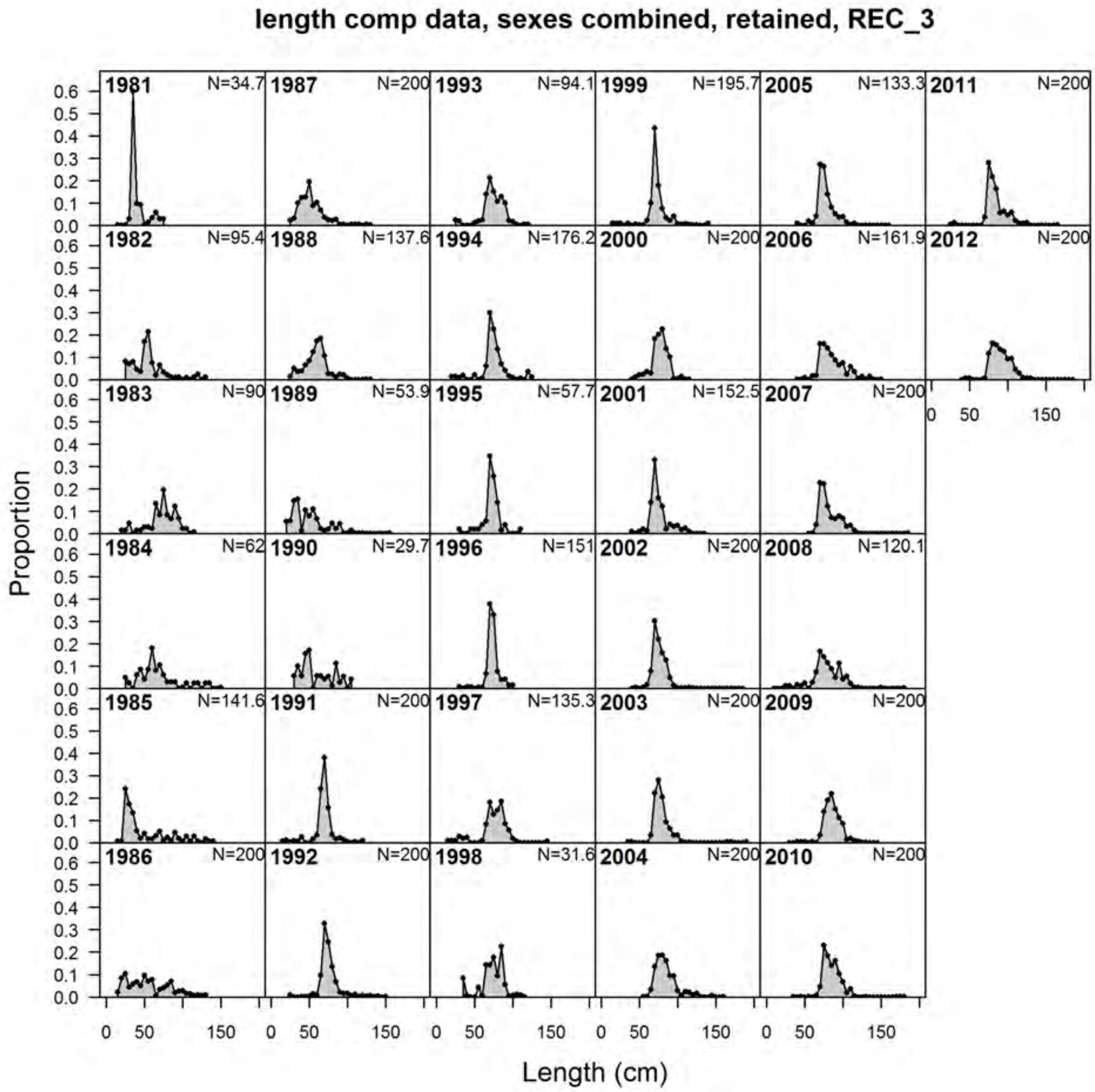


Figure 2.4.1c. Proportion of numbers at length for Gulf of Mexico greater amberjack in the recreational charter and private angler fisheries (REC).

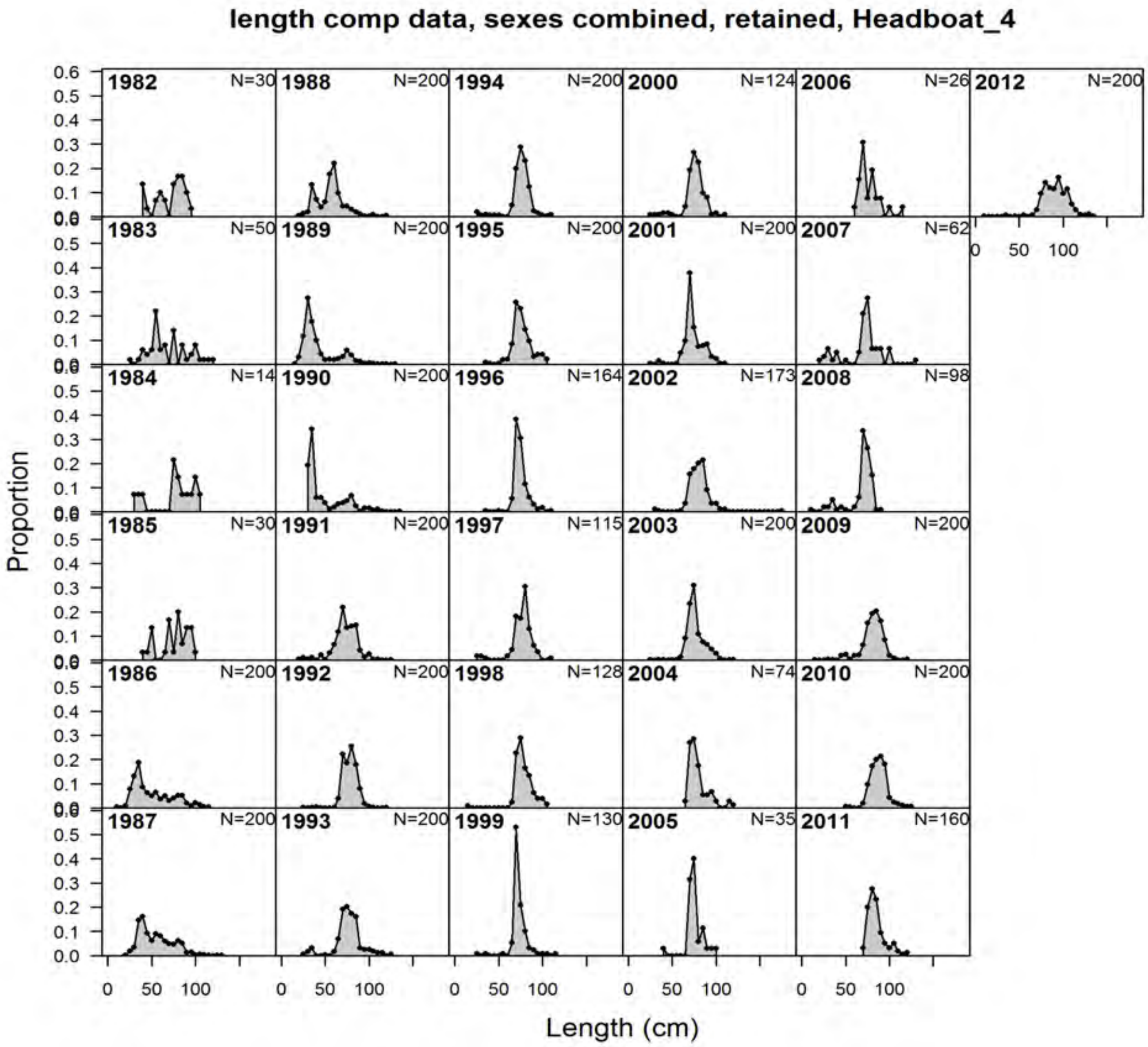


Figure 2.4.1d. Proportion of numbers at length for Gulf of Mexico greater amberjack in the recreational Headboat fisheries (Headboat).

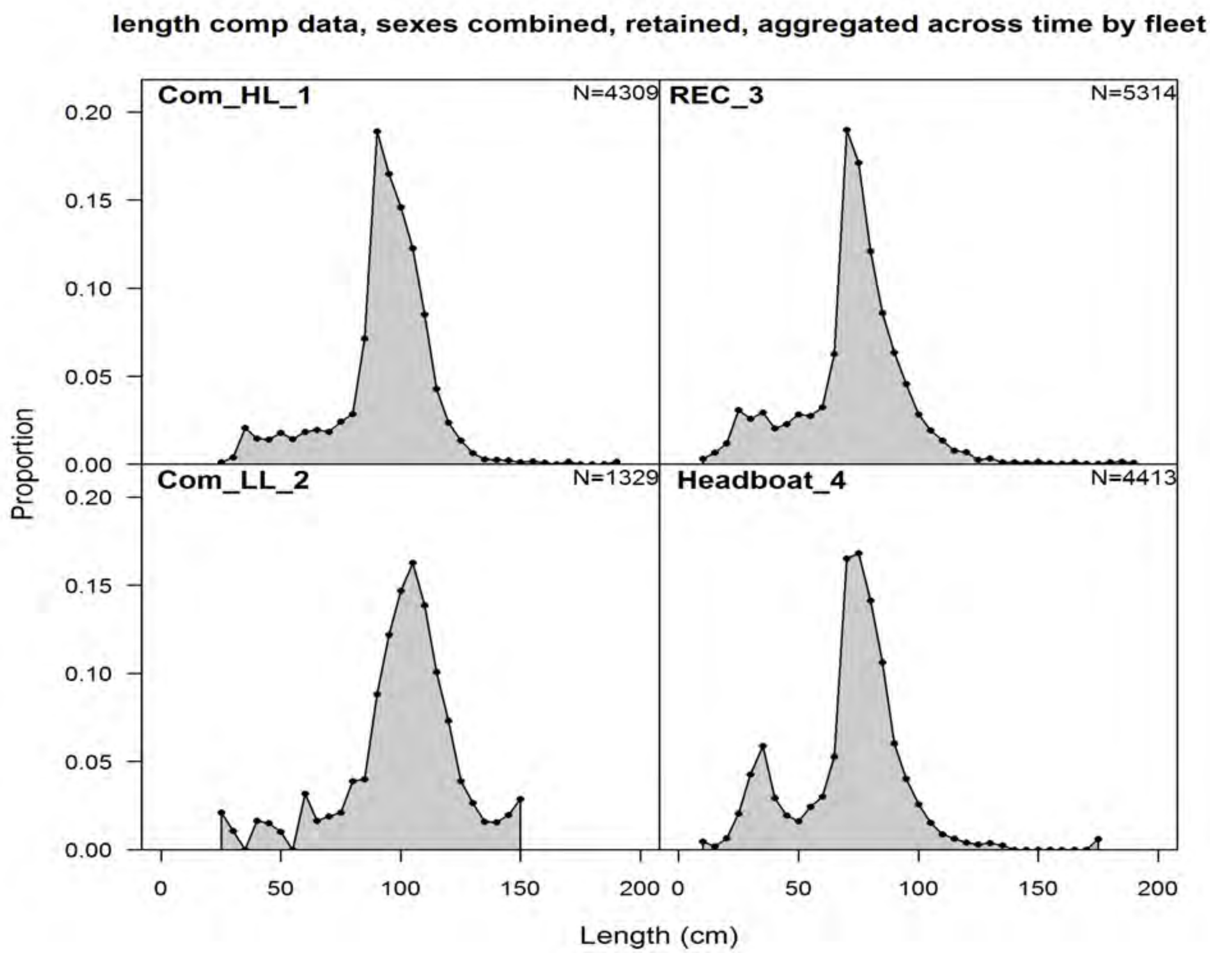
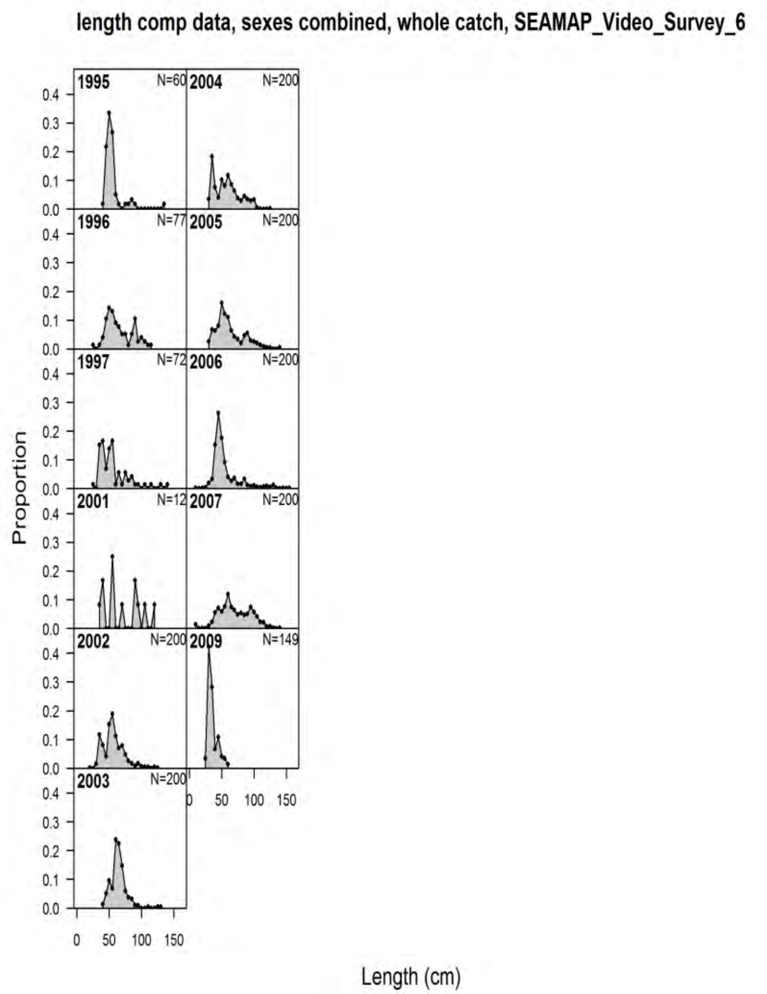
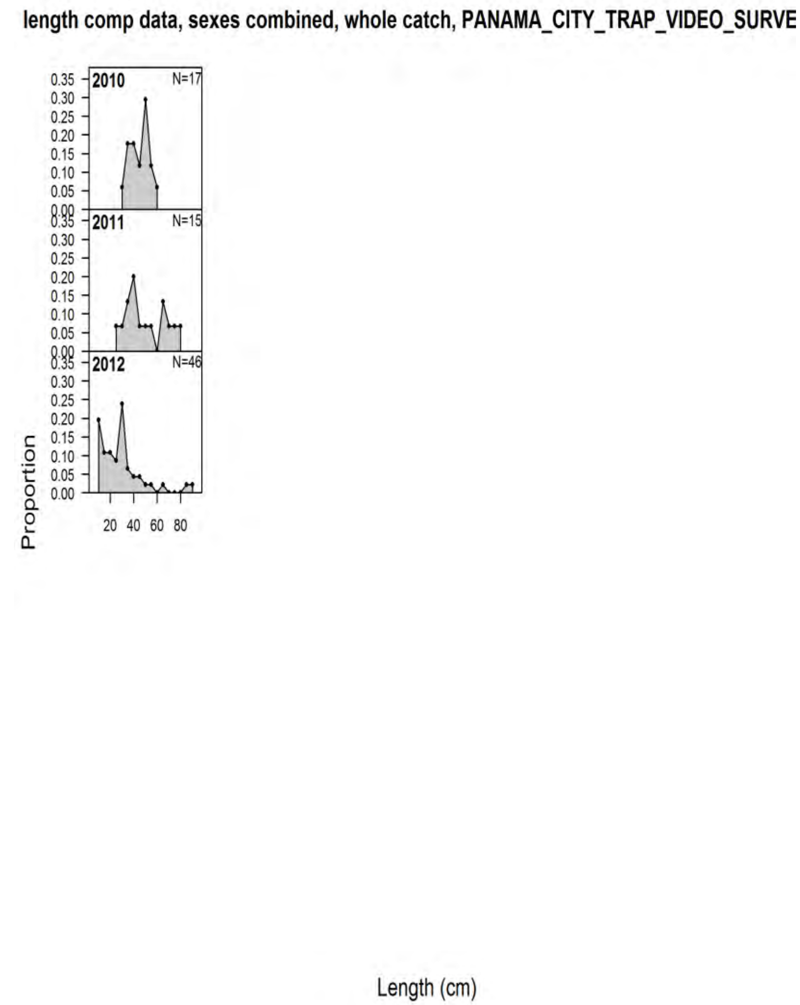


Figure 2.4.1e. Proportion of numbers at length aggregated across time for Gulf of Mexico greater amberjack for the four fishery dependent fleets in the SS model.



f.



g.

Figure 2.4.1 f, g. Proportion of numbers at length for Gulf of Mexico greater amberjack for the f) SEAMAP video survey and g) proportion of numbers at length for Gulf of Mexico greater amberjack for the Panama City Laboratory trap video survey.

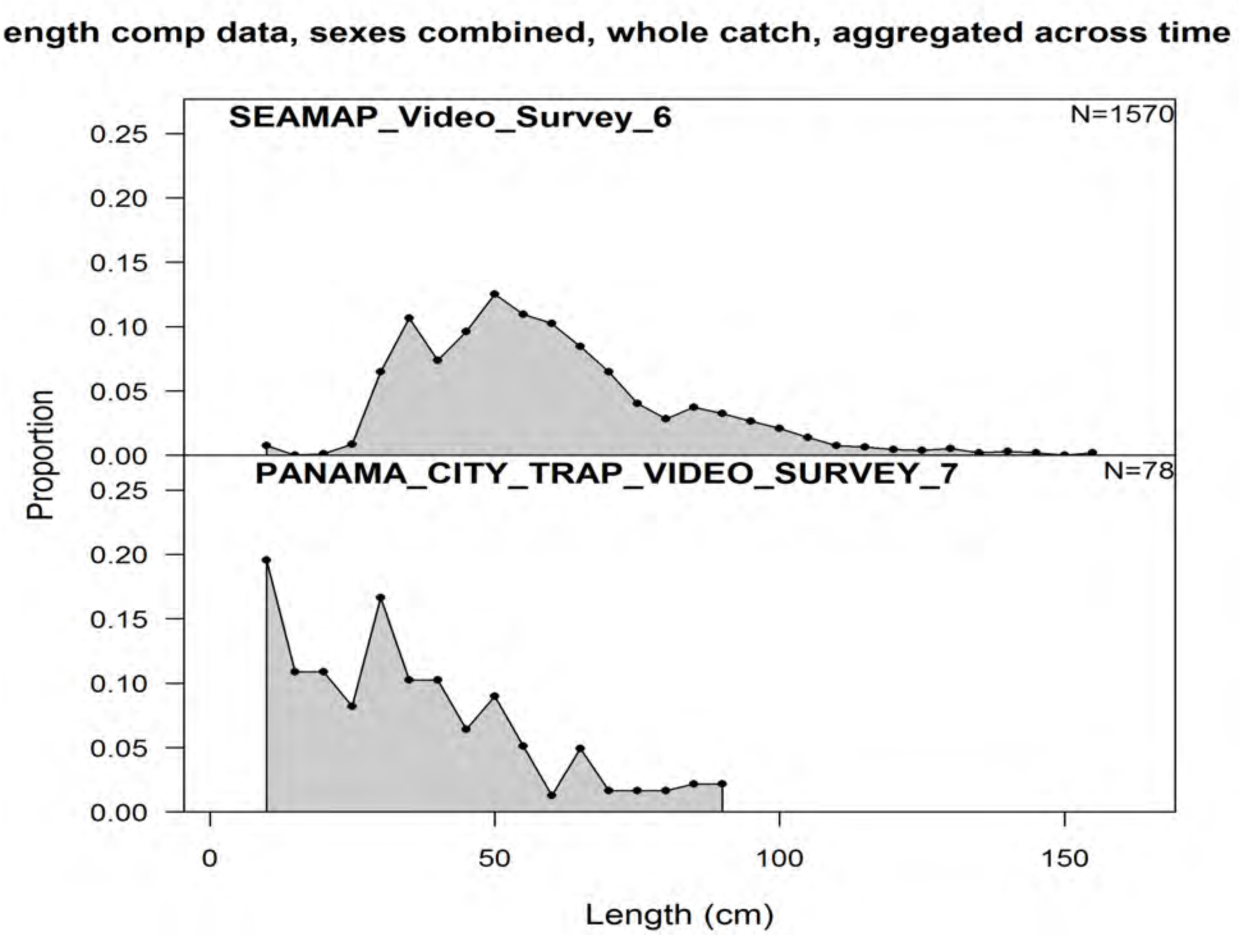
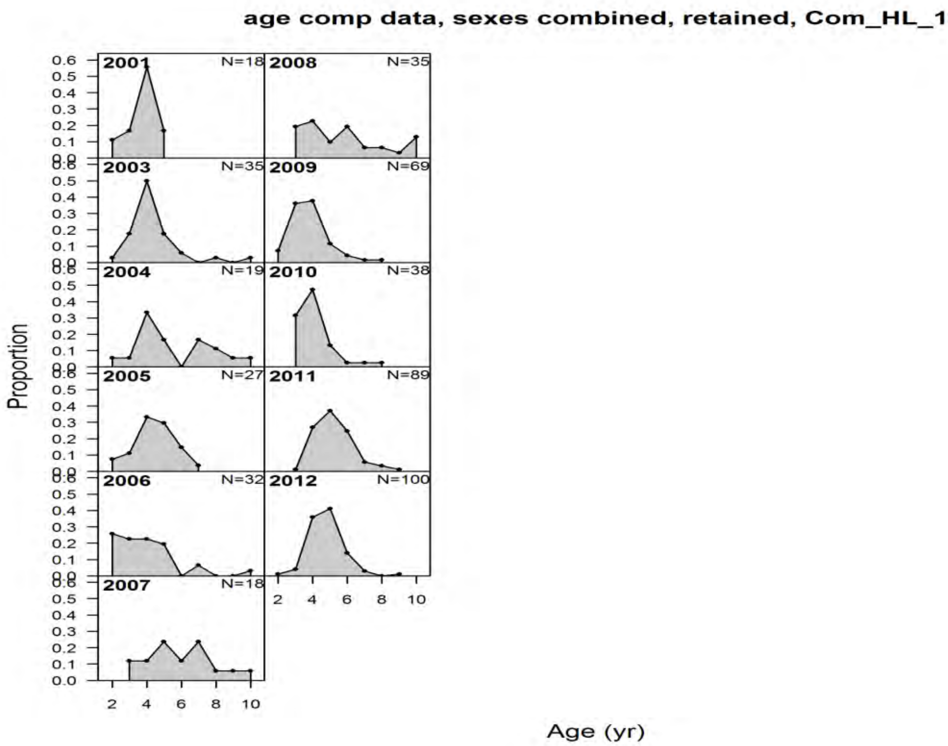


Figure 2.4.1h. Proportion of numbers at length aggregated across time for Gulf of Mexico greater amberjack for the two fishery independent video surveys in the SS model.



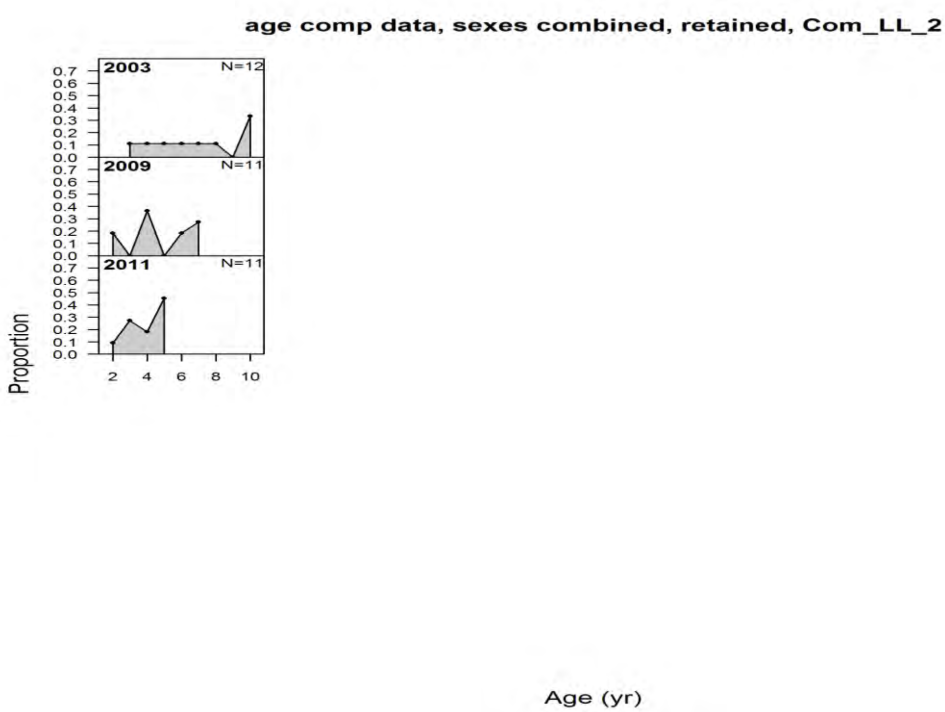


Figure 2.5.1a, b. Proportion of age, sexes combined for a) the commercial line (COM_HL) and b) the commercial longline (COM_LL) for Gulf of Mexico greater amberjack.

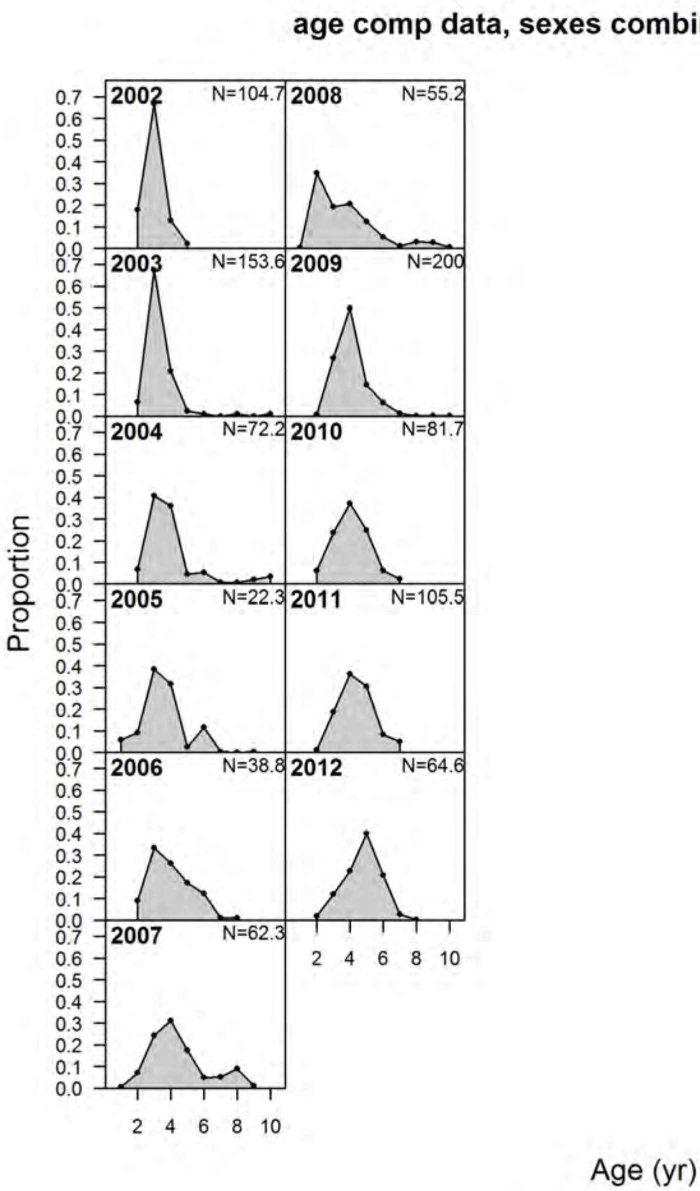


Figure 2.5.1c. Proportion of age, sexes combined recreational charterboat and private angler fisheries (REC) for Gulf of Mexico greater amberjack.

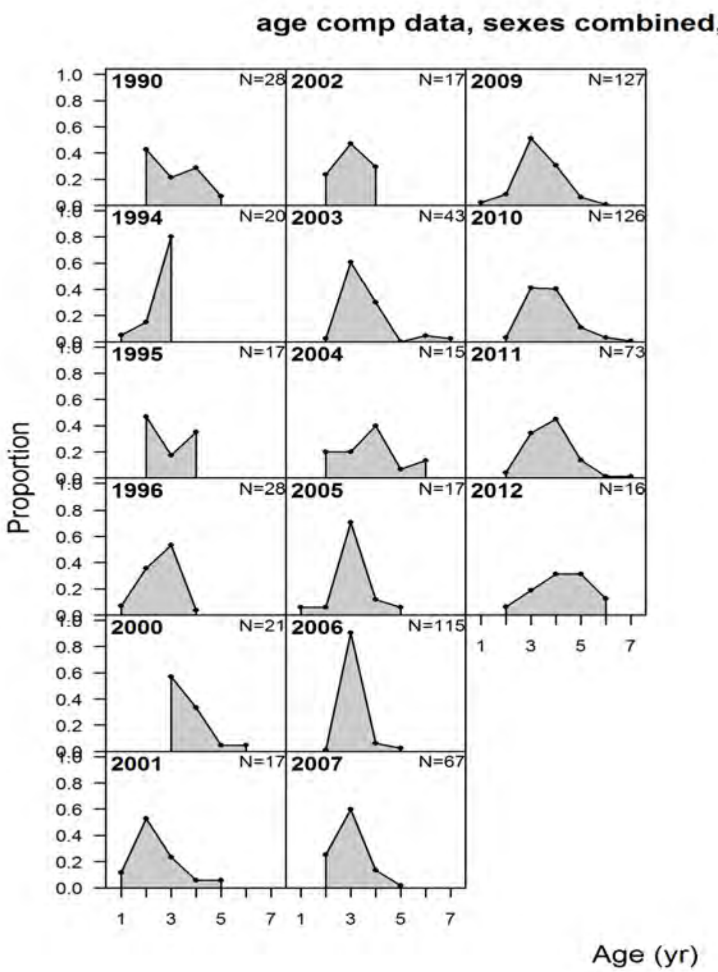


Figure 2.5.1d. Proportion of age, sexes combined for the recreational Headboat fishery for Gulf of Mexico greater amberjack.

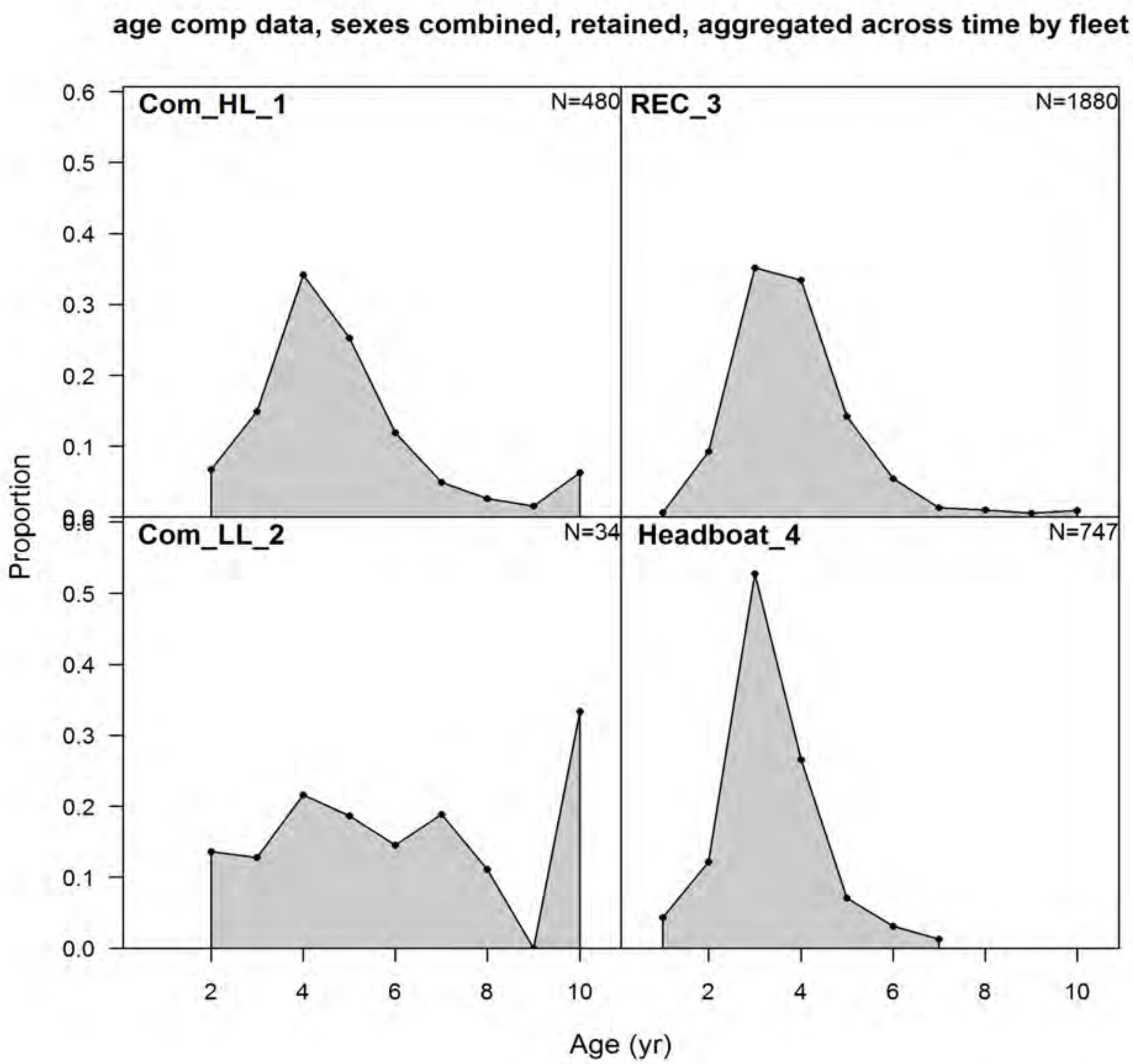


Figure 2.5.1e. Proportion of age, sexes combined for the four fleets in the SS model for Gulf of Mexico greater amberjack.

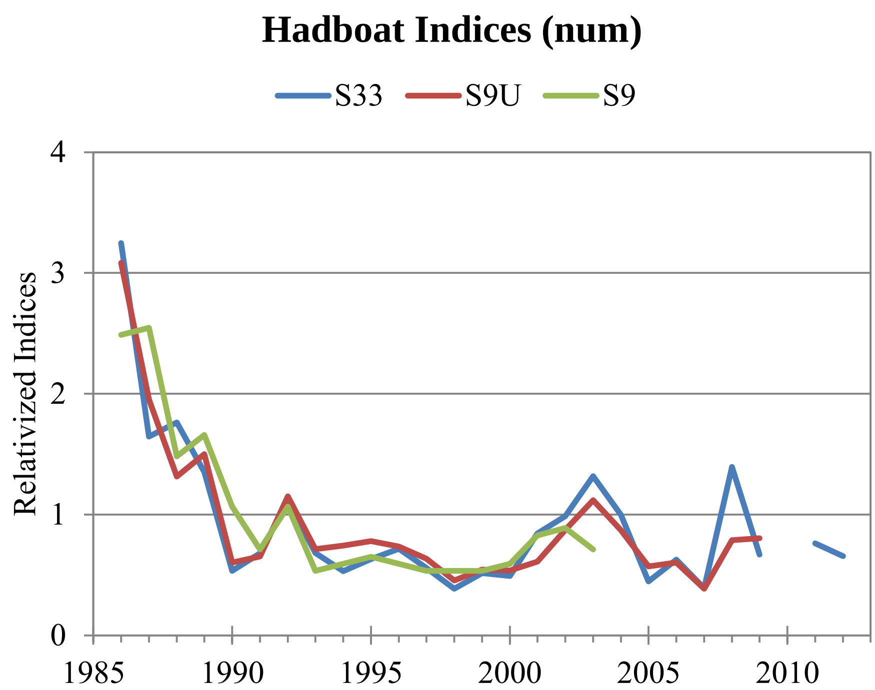


Figure 2.6.1.1. Headboat indices from the SEDAR 33 (S33), SEDAR 9 (S9), and SEDAR 9 Update (S9U) assessments for Greater Amberjack. Indices were relativized by their respective means during the overlapping period.

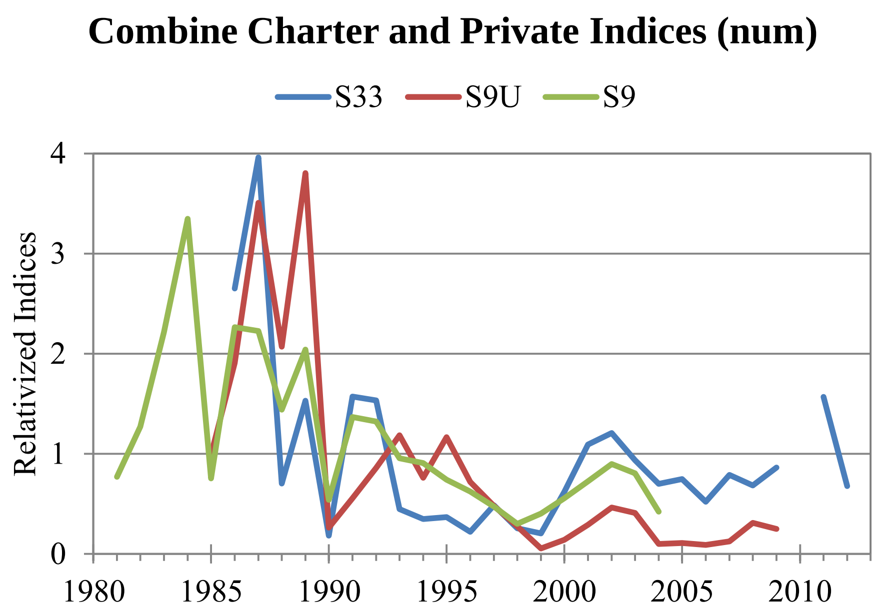


Figure 2..6.1.2. MRFSS indices from the SEDAR 33 (S33), SEDAR 9 (S9), and SEDAR 9 Update (S9U) assessments for Greater Amberjack. Indices were relativized by their respective means during the overlapping period.

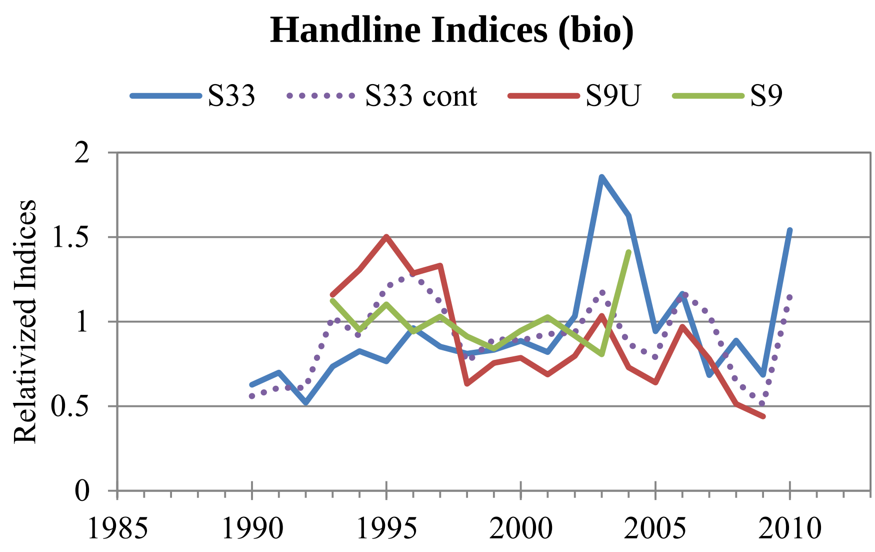


Figure 2.6.1.3. Handline indices from the SEDAR 33 (S33), SEDAR 9 (S9), and SEDAR 9 Update (S9U) assessments for Greater Amberjack. Indices were relativized by their respective means during the overlapping period.

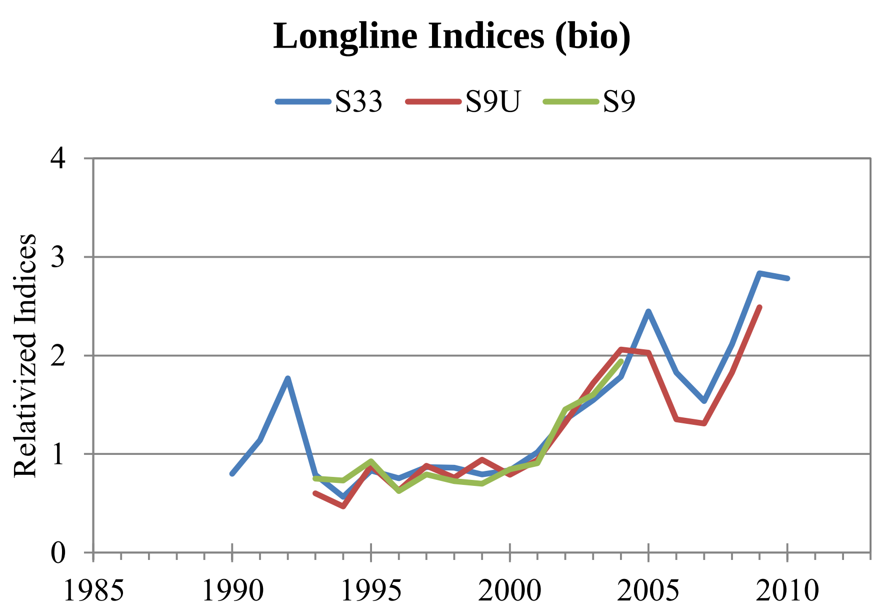


Figure 2.6.1.4. Longline indices from the SEDAR 33 (S33), SEDAR 9 (S9), and SEDAR 9 Update (S9U) assessments for Greater Amberjack. Indices were relativized by their respective means during the overlapping period.

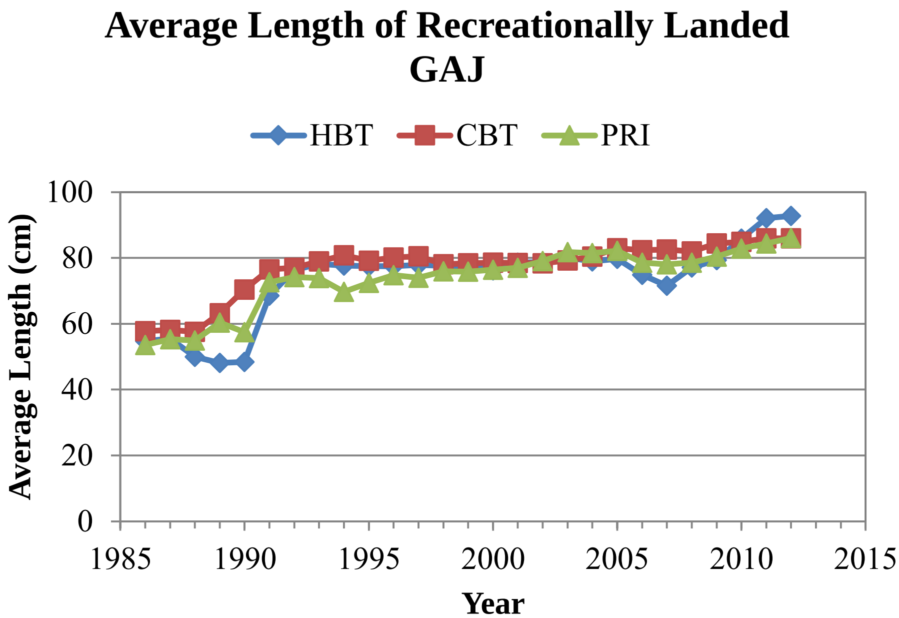


Figure 2.6.1.5. Three-year running average of recreationally landed Greater Amberjack lengths by fishing mode.

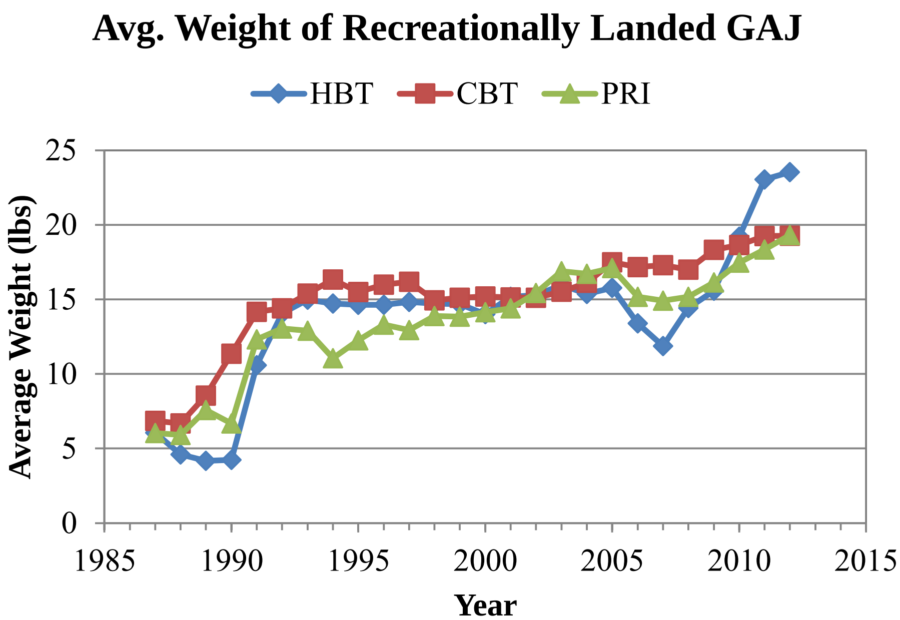


Figure 2.6.1.6. Time series of annual average weights of estimated from a 3-year running average of recreationally landed greater amberjack lengths by fishing mode.

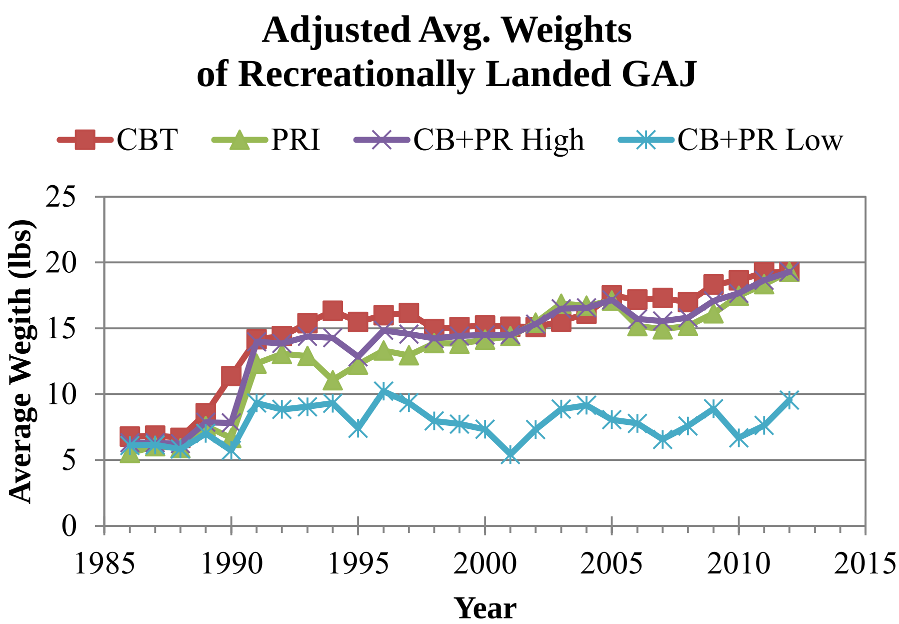


Figure 2.6.1.7. Time series of annual average weights of estimated from a 3-year running average of recreationally landed greater amberjack lengths by fishing mode.

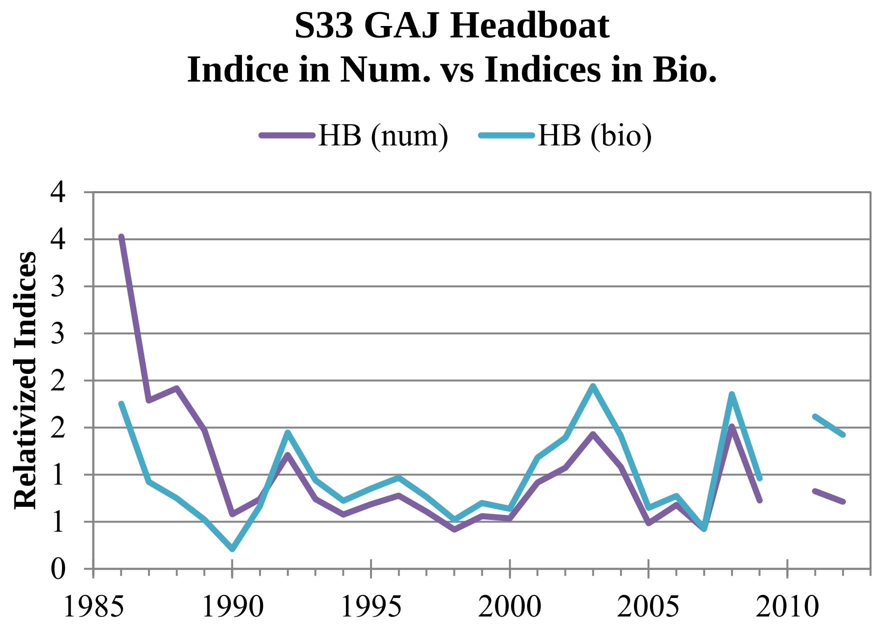


Figure 2.6.1.8. Headboat indices in numbers and in biomass from the SEDAR 33 assessment for greater amberjack. Indices were relativized by their respective means.

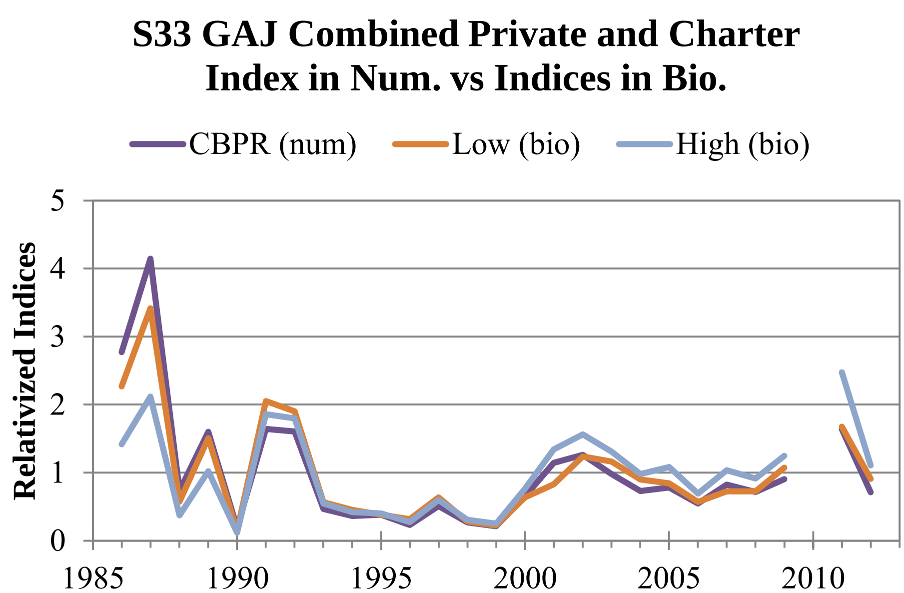


Figure 2.6.1.9. MRFSS combined charter and private indices in numbers and in biomass from the SEDAR 33 assessment for greater amberjack. Indices were relativized by their respective means.

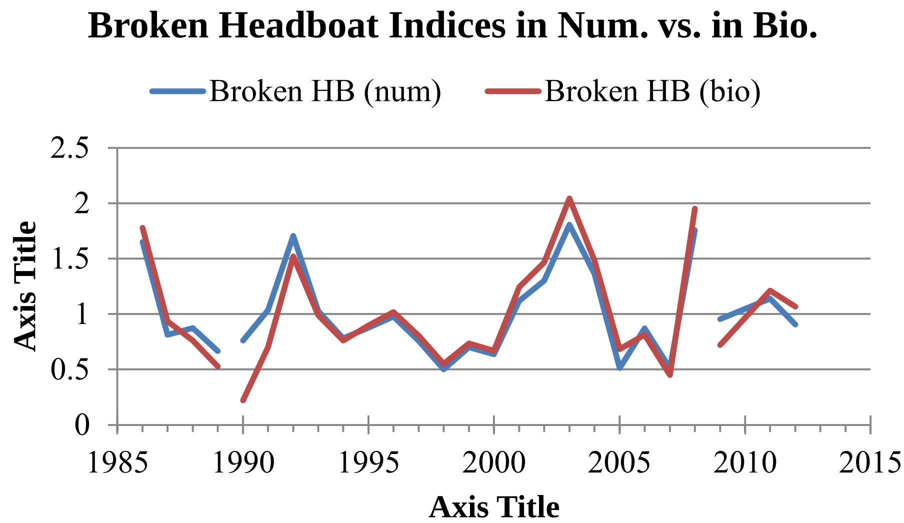


Figure 2.6.2.1. Broken headboat indices in numbers (re-standardized) and in biomass (relativized).

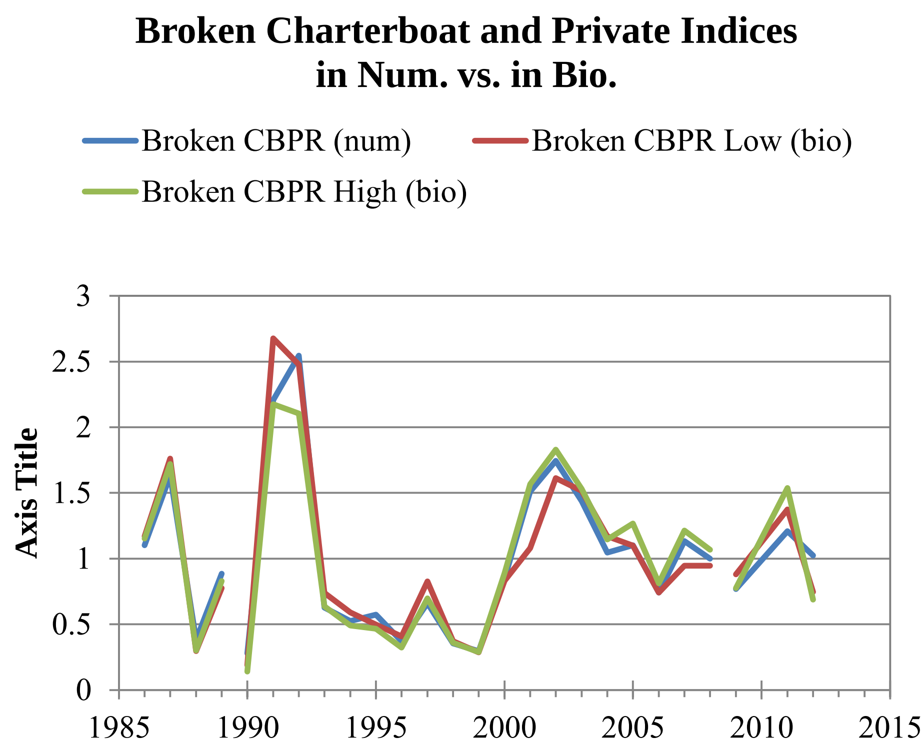


Figure 2.6.2.2. Broken charter and private indices in numbers (re-standardized) and in biomass (relativized).

3. Stock Assessment Models and Results

3.1 Stock Synthesis

3.1.1 Overview

Stock Synthesis (SS) is an integrated statistical catch-at-age model which is widely used for stock assessments in the United States and throughout the world. SS takes relatively unprocessed input data and incorporates many of the important processes (mortality, selectivity, growth, etc.) that operate in conjunction to produce observed catch, size and age composition and CPUE indices. In addition, SS can incorporate time series of environmental data. Because many of these inputs are correlated, the concept behind SS is that they should be modeled together, which helps to ensure that uncertainties in the input data are properly accounted for in the assessment. SS has the ability to incorporate an early, data poor time period for which only catch data are available and a more recent, data-rich time-period for which indices of abundance and length and age-length or age composition observations are available.

The primary assessment model selected for the Gulf of Mexico Greater amberjack stock evaluation assessment was stock Synthesis (Methot 2010) SS-V3.24S-safe; 07/24/2013. Stock Synthesis has been widely used and tested for assessment evaluations, particularly in the US west coast NMFS centers (Methot 2010). Descriptions of SS algorithms and options are available in the SS user's manual (Methot 2010) and at the NOAA Fisheries Toolbox website (http://nft.nefsc.noaa.gov/).

The SS parametric bootstrap procedure was used to characterize uncertainty and provide profiles of projected stock status and yields under a variety of conditions.

The r4ss software (www.cran.r-project.org/web/packages/**r4ss**/index.html) was utilized extensively to develop various graphics for the SS outputs and also was used to summarize various SS output files and to initially conduct the parametric bootstrap.

3.1.2 Data Sources

The SS model was fitted to landings, discards, length composition, conditional age-length observations, and indices of abundance. These categories of data included: annual landings (mtons), directed fishery discards (recreational and commercial), and standardized indices of relative abundance (combined recreational charterboat and private angler (REC), commercial vertical line gear fishery (COM_HL), commercial bottom longline gear fishery (COM_LL), SEAMAP video survey, and the Panama City Laboratory trap video survey. Although annual estimates of release mortality were not available, some information was available to characterize relative amounts of dead discards from the directed commercial vertical line gears (COM_HL) and the reeffish and shark longline fleets (COM_LL), recreational charterboat and the Headboat fisheries as described in the SEDAR 33 DW report. The detailed data used in the SS model fitting are as described in Section 2.

3.1.3 Model Configuration and Equations

The start year stock of the SS greater amberjack population model was 1950. The terminal year of data was 2012. SEDAR 33 DW provides details and a characterization of the fisheries for

Greater amberjack in the Gulf of Mexico since the late mid 1950's. The history of reported commercial landings exists since 1963 however; it is thought that some commercial removals prior to 1963 probably were occurring however the levels are not known. Recreational fishery removals were available since 1981 and were hindcast from 1955 to 1980 by the SEDAR 33 DW. It was generally thought that recreational removals of Greater amberjack prior to 1955 were not large. The SS assessment model was configured to include removals from four directed fisheries representing the commercial vertical line gear (COM_HL), commercial bottom longline gear (Com_LL), recreational charter and private angler fisheries (REC), and the headboat fishery (Headboat). As described above in the Data Section (Section 2.2.1), there were some minor landings reported for "miscellaneous" commercial gears (traps, trawls, seines).These "miscellaneous" commercial landings were apportioned into commercial vertical line gear and commercial bottom longline gears according to the annual representation of each. Five abundance indices representing four fleets and two surveys were incorporated into the SS assessment model data inputs. The four fishery dependent indices were the Com_HL, COM_LL, REC, and the Headboat fleets. The two surveys were the SEAMAP video (SEAMAP_Video) and the Panama City Laboratory trap video (Panama City Trap_Video) surveys. Initial exploitation rates in 1950 was estimated for the two fleets with non-zero landings (REC, Headboat). In addition, an SS sensitivity analysis was conducted on the initial conditions assuming virgin conditions in 1950.

Parameter values for the weight-length relationship, maturity schedule, and fecundity were fixed at the values given in the DW Workshop report (SEDAR 33 DW Report- Section 2.10, Table 3, Figures 1 and 5) and are presented again here in Figure 2.2.1.1 (this section). The Greater Amberjack maturity ogive was input as a fixed logistic function of age with full maturity set for ages 2 plus as recommended by the SEDAR 33 DW.

For the SS Base model configuration natural mortality was modeled as a declining 'Lorenzen' function of size constant over time, scaled to the Hoenig maximum age estimator point estimate as described above in the Data Update and Review Section. As detailed above, for the SS Base Model run, the "LM Age0 M" at age vector was input. The "LM Age0 M" vector did not incorporate an adjustment for time of spawning on the age-0 natural mortality value. Three sensitivity runs on the SS Base model were considered. Again, these considered the recommended range of point estimates of M input into the Lorenzen function (0.15, 0.35) and a third sensitivity incorporated the time of spawning into the calculation of M "at age-0" ("Red Age0 M" sensitivity, Run 2 in Table 3.1.6.1). These additional three characterizations of natural mortality were included as SS sensitivity runs and provide information on the impact on the SS model results of critical quantities (spawning stock biomass, fishing mortality, virgin stock) from input assumptions on natural mortality at age.

Growth was modeled internally in SS as both sexes combined with a three parameter von Bertalanffy equation (L_{min}, L_{max}, and K) (Figure 2.2.1.1). For this assessment, the Linfinity parameter was fixed at the value estimated by the DW. When the model was allowed to estimate this parameter, SS tended to reach the upper bound defined for the population (200 cm) and this was considered unreasonable. The assessment panel explored the implications of this behavior in sensitivity runs, and the model result was not affected significantly.

In SS, when fish recruit at the real age of 0.0 the body size is set equal to the lower edge of the first population bin (L_{bin}; fixed at 10-cm FL for the Greater amberjack stock assessment). Then, individuals grow linearly until they reach a real age (A_{min}) Then after reaching Amin (at Lmin), as fish advance in age, the size at age is characterized according to a von Bertalanffy growth equation. The value of A_{min} was fixed at 0.5, a fractional age which is representative of the midpoint of the spawning period (April per the DW). The Lmin value was selected for A_{min} based on empirical size at age observations by month provided by the DW, from the age 0 fish provided in the age-length data. L_{max} was specified as equivalent to L_{∞}. Variation in size at age was fixed (CV = 0.2) for the greater amberjack SS model since information on size conditioned on age was not available.

For the Greater Amberjack SS assessment, age data were input as reflective of age composition. Although SS can incorporate information on age at length (i.e., similar to age length key) in the model estimation process thus estimating the distribution of age within a length interval (Methot 2011), the DW advised that the size at age observations were not sufficient to develop age length keys. As described in Section 2.5 the age data from the SEDAR 33 DW was stratified by fishery into age (from age 0 to age 10) bins, with age 10 representing a plus group of ages 10+.

Size based selectivity patterns were specified for each fishery and survey in SS. Double normal functions were used to model selectivity for all of the fleets and surveys, except the commercial longline and the SEAMAP video survey, because of the flexibility this functional form provides. The double normal can model dome-shaped selectivity, but it also can model asymptotic selectivity by holding several of the function's parameters at fixed values. A logistic function (asymptotic) was used to model selectivity for the commercial longline and the SEAMAP video survey. Thus, six selectivity patterns were defined in the SS assessment model corresponding to each fishery or survey: 1) commercial vertical line gear (COM_HL), 1) commercial longline gear (COM_LL), 3) recreational charterboat and private angler combined (REC), 4) headboat fishery (Headboat), the 5) SEAMAP video survey (SEAMAP Video), and 6) Panama City Laboratory trap video Survey (Panama City Trap Video Survey). The SEDAR 33 Assessment Panel (AP) felt that the commercial longline fleet selectivity patterns was more representative when modeled as an asymptotic function, because there was no strong evidence of dome-shaped selectivity and the fit of the model was slightly improved (as reflected in smaller residuals) than when specifying a dome selectivity function.

Tables 3.1.3.1a – 3.1.3.1d provide retained and discarded length and age composition sample sizes for the four fleets and two surveys. As described earlier, length and age compositions were combined, and adjusted effective sample sizes (EFF N) were calculated by reweighting each individual annual density by the respective annual fishery landings as per SEDAR 7 and SEDAR 31.

The individual fishery dependent indices were modeled with the same selectivity as their corresponding fleets: 1) commercial vertical line gear abundance index-(COM_HL), 2) commercial bottom longline (COM_LL), MRFSS/MRIP abundance survey of charterboat and private angler fisheries (REC), and 4) Headboat fishery (HB). The COM_HL, COM_LL, and Headboat indices were input as indices modeling retained catch. The REC index was input as an index of total catch (retained landings and discards). Indices from the SEAMAP video and the

Panama City Laboratory trap video surveys were also input as surveys of total catch. Figures 3.1.3.1 a-f provides the standardized indices of abundance for the four fleets and two surveys used in the greater amberjack SS assessment.

Time-varying retention functions were used to allow for varying discards at size due to the impacts of fishery minimum size and bag limit regulations. These were implemented in 1990 (36 inch fork length- COM_HL, COM_LL and 28 inch fork length- REC, Headboat) and in 2008 (30 inch fork length- REC, Headboat). An additional time block was defined for both the recreational and commercial vertical line fisheries relating to fishery closures and management quotas (2008- COM_HL, and 2009- REC, Headboat). To summarize, the commercial fishery time varying blocks were defined as: 1) COM_HL 1950-1989, 1990-2007, 2008-2012 and 2) COM_LL as: 1950-1989, , 1990-2012. Time varying retention blocks were defined for the REC and Headboat fleets as: 1950-1990, 1991- 1998, 1998-2008 and 2009-2012.

For the assessment, the SS model configuration assumed a single Beverton-Holt stock-recruitment function and two of the three stock recruitment (“S/R”) parameters were estimated: log of unfished equilibrium recruitment (R0) and steepness (h). A third parameter representing the standard deviation in recruitment (*sigmaR*) was input as a fixed value of 0.6.

Stock synthesis is hard-coded to model recruits as age 0 fish. Annual deviations from the stock-recruit function were estimated in SS as a vector of deviations forced to sum to zero. Stock synthesis assumes a lognormal error structure for recruitment. Therefore, expected recruitments were bias adjusted. Prior to 1984, no length or age composition data are available, therefore no recruitment deviations were estimated. Instead the recruitment is fixed at the expected value obtained from the spawner-recruit relationship. Therefore the estimates are very precise (σ^2=0). Full bias adjustment was used from 1985 to 2011 when length and age composition data are available. Bias adjustment was phased in from no bias adjustment prior to 1979 to full bias adjustment in 1985 linearly. Bias adjustment was phased out over the last two years (2011-2012), decreasing from full bias adjustment to no bias adjustment, because the age composition data contains little information on recruitments for those years. The years selected for full bias adjustment were estimated following the methods of Methot and Taylor (2011).

For the SS Base assessment model runs all data inputs (abundance indices, length compositions, and age compositions) were equally weighted and no prior density was assumed for any of the SS estimated parameters.

The SS input files are presented in Appendices A-D.

3.1.4 Parameters Estimated

Table 3.1.4.1 provides a listing of all parameters included in the Greater Amberjack SS assessment model, both estimated and fixed. Results included are predicted parameter values and their associated standard errors from SS, initial parameter values, minimum and maximum values a parameter could be assigned, and the prior densities assigned to each parameter (if a prior was used). Table 3.1.1 presents the model estimates for the final SS Base model recommended by the SEDAR 33 Assessment Panel for Gulf Greater amberjack.

As mentioned in Section 3.1.1.3, the growth rate parameter (K) was estimated internally in SS (using the age and length composition data provided by the SEDAR 33 DW). Initial parameter estimates for the growth relationship (i.e., for the Lmin, Lmax, Amin parameters) were informed by external growth model fits using the empirical age length data developed by the DW. For the final Base Model, the Lmax parameter was fixed at the DW derived value for Linfinity (146.3 cm FL). Figure 2.1.1 presented the estimated growth curve from the SS Base model used in the stock assessment.

Selectivity functions were characterized as either asymptotic (COM_LL, SEAMAP VIDEO) or dome shaped (COM_HL, REC, HEADBOAT, Panama City trap Video). For the asymptotic functions, a two parameter logistic function was used. For the dome-shaped selectivity function, a six parameter double normal function was used.

Figures 3.2.3.1a - Figures 3.2.3.1c provide SS estimated ending year selectivity (2012), and retention curves for the four fisheries and two surveys included in the Greater amberjack SS model. In general many of the estimated selectivity parameters had large standard deviations (Table 3.1.4.1).

For the COM_HL and COM_LL fisheries it was necessary to fix the retention function shape parameter (P1) for period 1 (1950-1989) and also the retention function slope parameter (P2) for period 1 also. When allowed to estimate the retention parameters for time period 1 (1950-1989), SS tended to not estimate the proportion of small fish landed by the COM_HL fishery very well. For the REC and Headboat fisheries it was possible to estimate both the inflection and shape (slope) retention- function parameters for all time blocks.

As mentioned in the model configuration section (Virgin recruitment (R0) and steepness parameters were estimated in SS. Results from attempting to estimate steepness produced values around 0.84 and were thought to be reasonable for stock by the SEDAR 33 AP. The AP panel had considerable questions on the ability of the SS model to estimate steepness so the analyst conducted profiling of the steepness, the virgin recruitment, and the sigmaR parameters. The profile of sigmaR did not indicate that the initial input value choice of 0.6 was unreasonable so this parameter remained fixed at 0.6, throughout the SS assessment... Profiling of steepness and the R0 stock/recruitment parameters also did not suggest any major problems with SS in estimating either parameter for the Greater Amberjack SS model. The SS estimate of the R0 parameter for the Base model run was 7.776.

Additional fishing mortality rates used for recommending future harvest levels are estimated conditionally on other outputs from the model. For example, the values corresponding to the *F30%SPR*, and *FMSY* harvest rates are found by satisfying the constraint that given age specific population parameters (e.g., selectivity, maturity, mortality, weight-at-age), unique values exist that correspond to these fishing mortality rates.

In all, 80 parameters were included in the SS final Base model for greater amberjack including: two (2) to model growth, two (2) to model the Beverton & Holt stock recruitment function, 45 to characterize the selectivity and/or retention functions, two (2) to model the initial conditions for the REC and Headboat fleets, and 29 annual recruitment deviations.

3.1.5 Model Convergence

Uncertainty in the Gulf of Mexico Greater amberjack stock assessment was examined using multiple approaches.

Uncertainty in model parameter estimation performance was also addressed through an internal SS parameter "jitter" option which randomly changes the input parameter by a specified value. A jitter value of 10% was input for this assessment and 50 runs were made for the SS Base model run configuration. SS carries out the jitter exercise by randomly changing the initial starting values of the parameters by 10% thus altering the starting estimates across many runs. The purpose in changing the parameter starting estimates across numerous models is to explore the model's ability to reach a global solution (i.e., minima) from starting at different places along the likelihood space.

3.1.6 Uncertainty and Measures of Precision

Uncertainty in parameter estimates was quantified by computing asymptotic standard errors for each parameter (Table 3.1.4.1). Asymptotic standard errors are calculated by inverting the Hessian matrix (i.e., the matrix of second derivatives) after the model fitting process. Asymptotic standard errors provide a minimum estimate of uncertainty in parameter values.

The internal bootstrap procedure in SS was used to characterize the uncertainty in final model estimates and projections of future caches for a variety of alternative scenarios recommended by the SEDAR 33 AP. The bootstrap procedure is implemented using an R4SS function. Briefly, SS is first fit to the model of choice (i.e., Base model run configuration as in Run1, Table 3.1.6.1) and "N" new data sets (bootstrap sets) are created based on the original model (all parameters either fixed or estimated the same as the original model) and parametric sampling of the errors. Then using the R4SS function, SS is run on each separate bootstrap file, producing a separate result file (i.e., SS report.sso file) and the resulting "N" report files may be summarized to provide information on uncertainty in the model estimates and other additional output. Uncertainty on SS model estimates of important parameters of interest may be summarized including: growth parameters, selectivity parameters, recruitment deviations) and other key quantities of interest (e.g., total virgin biomass, spawning biomass (SSB), current SSB, etc.).

3.1.7 Sensitivity Analysis

Uncertainty in data inputs and model configuration assumptions was examined through various sensitivity analyses. In all, results of 16 separate SS model runs are included in this report describing the SS Base model configuration, sensitivity analyses, and data exclusions conducted to evaluate: a) assumptions of input M at-age, b) assumptions on growth, c) assumptions on initial conditions, d) consideration of the assumption on release mortality of discards from the directed fisheries (COM_HL, COM_LL, REC, Headboat), and e) estimation of the Beverton & Holt steepness parameter. Over the course of the Greater Amberjack stock assessment, many additional sensitivity analyses were explored. It is the main intent to present here those runs that best explored the sensitivity of key SS model parameters and/or demonstrated discord (or agreement) in model parameter estimates between runs. Table 3.1.6.1 describes the SS Model runs made in the stock assessment and all the alternative (sensitivity, retrospective) analyses made for the stock assessment.

Three sensitivity analyses on M were made by varying the level of M from that of the final Base Model. As described earlier, the final Base model M at-age vector was calculated assuming the Hoenig point estimate of M = 0.28y^{-1} for the Lorenzen function. Two additional M sensitivities considered a low and high value around the point estimate (M = 0.15 y^{-1} and 0.35 y^{-1}). In addition, a third sensitivity analysis on M was specified by accounting for the time of spawning of greater amberjack. This M at age vector was derived by reducing the Age0 M at age by 25%, to account for peak spawning in April (25% of year elapsed), while all other values of M at age remained unchanged.

The assumption of initial conditions was evaluated through two sensitivity runs (Run 6 and 11, Table 3.1.6.1). Run 6 assumed that the Greater Amberjack stock was in an unfished state in 1950, while Run 11 began in 1963 but estimated initial fishing mortality. As described earlier, the Base SS model assumed that some exploitation was occurring in the REC and Headboat fisheries at the start of the time series (1950).

In addition to evaluating impacts on the SS Base model from assumptions on steepness and M, the assumptions of data inputs were considered through 1) varying the parameter defining discard release mortality (across all fleets from the Base model) from the Base model value of 20% to 15%, 10%, 5%, and 0%.

Profiling exercises for the Beverton and Holt S/R parameters, conducted over values ranging from 0.6 to 0.99 indicated that the SS model performed reasonably well when estimating steepness, sensitivity was explored that evaluated this assumption. A sensitivity run, fixing the steepness parameter at 0.80, evaluated the sensitivity of the model results to this assumption.

Model performance was further explored using retrospective analysis of the model configuration recommended by the SEDAR 33 AP for the Base model (Run 1, Table 3.1.6.1) configuration. In all five retrospective analyses of the base model were made. For these runs, the SS Base model was refit while sequentially dropping the last five years of data (i.e., 2011, 2010-2011, 2009-2011, 2008-2011, 2007-2011, and 2006-2010) with all other SS inputs remaining unchanged. Retrospective analysis is used to look for systematic bias in estimates of key model output quantities such as spawning biomass, fishing mortality, spawner-recruit parameters, etc. over time.

A complete characterization of all the sensitivity and alternative models explored for the stock assessment were as below and further detailed in Table 3.1.6.1:

3.1.8 Benchmark/Reference Point Methods

Various stock status benchmarks and reference points are calculated in the SS model. The user can select reference points based on maximum sustainable yield (MSY), spawning potential ratio (SPR), and spawning stock biomass (SSB). Stock Synthesis calculates SPR as the equilibrium spawning biomass per recruit that would result from a given year's pattern and the levels of F's and selectivity's. For SPR-based reference points, SS searches for a fishing mortality (F) that will produce the specified level of spawning biomass per recruit relative to the un-fished value. For spawning biomass-based reference points, Both MSY and spawning biomass-based reference points are dependent on the stock-recruit relationship.

For the Gulf of Mexico Greater amberjack benchmarks and reference point calculations, SPR30% was the reference. The minimum stock size threshold (MSST) is defined as (1-M) * SSB_MSY (F30% SPR) where the M values used was the point estimate of M for fully recruited ages, resulting from the Hoenig maximum age natural mortality estimator recommended by the SEDAR 33 Data Workshop (i.e., M = 0.28y^{-1}). The maximum fishing mortality threshold (MFMT) is defined as F30%SPR. A stock is declared overfished if $SSB_{Current}$ / SSB@MSST < 1.0 and overfishing is occurring if $F_{Current}$ > MFMT (or FMSY, where the proxy for FMSY for this assessment is F30%SPR. For purposes of calculating FC_{urrent}, "current time period" is defined as the geometric mean of Fs for 2009-2011. $SSB_{Current}$ is the model estimated SSB for calendar year 2012. In addition, FOY is defined for the Greater Amberjack stock as F40%SPR. Recruitment deviations are not calculated for the forecast years; recruitment is derived from the model estimated stock-recruitment relationship.

For the calculation of benchmarks the Base Model SS configuration was used (Run 1, Table 3.1.6.1).

3.1.9 Projection Methods

A standard set of projections were made as according to the Terms of Reference for the greater amberjack AW. This set of projections encompasses four harvest scenarios designed to satisfy the requirements of Amendment 18, the National Environmental Policy Act, and the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA). These guidelines were used to set ABC for Greater Amberjack for Amendment 18. The standard projection model requires knowledge of future uncertainty in FMSY or the proxy for FMSY.

For the Greater Amberjack SS assessment, deterministic projections were carried out to evaluate stock status for a period of 30 years beginning in 2013 using the "forecast" option in SS. The terminal year of data for the stock assessment was 2012 therefore in order to initialize the projection at 2014, the 2013 landings were characterized as the landings from the most recent years (2012). SS estimates the fishing mortality rate to achieve the input 2012 catch value and estimates age 0 recruits from the estimated-spawner recruit model and the 2012 estimate of SSB. The evaluations were made according to these MSRA criteria:

A) If stock is overfished:
F=0, $F_{Current}$, F_{MSY}, F_{OY}
$F=F_{Rebuild}$ (max that permits rebuild in allowed time)

B) If stock is undergoing overfishing:
$F= F_{Current}$, F_{MSY}, F_{OY}

C) If stock is neither overfished nor undergoing overfishing:
$F= F_{Current}$, F_{MSY}, F_{OY}

Uncertainty in the projections was also evaluated as described earlier for the uncertainty characterization so the SS model was used to estimate model parameters and key quantities of interest, using the SS bootstrap procedure within R4SS function. Briefly, multiple sets of the data bootstrapped are produced using the Base model (Run 1, Table 3.1.6.1) configuration, and the SS model fitted to each simulated data set independently. The procedure was identical to that used to characterize the base model uncertainty with the only difference being that the run was extended to include the period of projections (30 years: 2013-2042). The stochastic projections were made assuming the same configuration form the Base model (LM Age0 M, estimate steepness and R0, Run 1 of Table 3.1.6.1).

3.1.10 Tables

Table 3.1. 3.1a. Number greater amberjack retained length observations used in the SS model for the four (4) directed fisheries: COM_HL, COM_LL, REC, and the Headboat fleet. When > 200 observations were available, effective N was capped at 200.

Year	COM_HL	COM_LL	REC	Headboat
1981	0	0	55	4
1982	0	0	97	30
1983	0	0	103	50
1984	119	27	98	14
1985	164	96	146	30
1986	109	15	280	597
1987	25	12	806	549
1988	49	17	214	366
1989	150	0	133	1292
1990	588	52	39	239
1991	586	35	292	420
1992	859	73	702	424
1993	719	61	130	318
1994	974	41	179	340
1995	731	54	69	277
1996	511	43	155	164
1997	567	52	141	115
1998	507	103	169	128
1999	687	146	542	130
2000	707	116	732	124
2001	387	58	479	217
2002	728	62	1090	173
2003	468	86	1181	288
2004	241	77	793	74
2005	131	37	400	35
2006	53	20	525	26
2007	119	24	509	62
2008	33	10	317	98
2009	104	9	673	398
2010	50	4	692	300
2011	76	12	761	160
2012	127	0	965	350

Table 3.1.3.1b. Number greater amberjack length discard size observations used in the SS model for the four (4) directed fisheries: COM_HL, COM_LL, REC, and the Headboat fleet and the two fishery independent surveys: SEAMAP Video and Panama City trap Video. When > 200 observations were available, effective N was capped at 200.

Year	COM_HL	COM_LL	REC	Headboat
2005				32
2006	19	7	80	80
2007	107	2	63	63
2008	81	37	0	0
2009	30	41	57	14
2010	46	132	241	45
2011	114	77	167	31
2012	275	16	176	53

Table 3.1.3.1c. Number greater amberjack length observations used in the SS model for the two fishery independent surveys: SEAMAP Video and Panama City trap Video surveys. When > 200 observations were available, effective N was capped at 200.

Year	SEAMAP Video Survey	Panama City Trap Video Survey
1995	60	
1996	77	
1997	72	
1998	0	
1999	0	
2000	0	
2001	12	
2002	624	
2003	218	
2004	373	
2005	237	
2006	513	
2007	522	
2008	0	
2009	227	
2010	0	17
2011	0	15
2012	0	46

Table 3.1.3.1d. Number greater amberjack age observations used in the SS model for the four (4) directed fisheries: COM_HL, COM_LL, REC, and the Headboat fleet. When > 200 observations were available, effective N was capped at 200.

YEAR	COM_HL	COM_LL	REC	HEADBOAT
1989	0	0	0	1
1990	2	0	2	28
1991	0	0	2	4
1992	0	0	0	1
1993	0	0	0	1
1994	0	0	0	20
1995	0	0	0	17
1996	0	0	0	28
1997	2	1	0	8
1998	2	0	0	2
1999	1	0	0	1
2000	0	0	4	21
2001	18	0	2	17
2002	4	0	105	17
2003	35	12	154	43
2004	19	1	72	15
2005	27	1	22	17
2006	32	1	39	115
2007	18	5	62	67
2008	35	0	55	1
2009	69	11	200	127
2010	38	3	82	126
2011	89	11	105	73
2012	100	0	65	16

Table 3.1.4.1. Listing of parameters from the SS Base model run for the Gulf of Mexico Greater amberjack SEDAR 33 stock assessment. The list includes predicted and fixed parameter values and their associated standard errors from SS Base Model Run, initial parameter values, minimum and maximum values a parameter could take, and prior densities assigned to parameters (when used). Parameters designated as fixed were held at their initial values. Table represents model selected by the SEDAR 33 Assessment Panel as the final Base model (LM Age0 M Natural Mortality scenario, Beverton and Holt steepness parameter estimated).

	Parameter										
	Predicted					**Prior**					
Label	**Value**	**Parm_StDev**	**Initial**	**Min**	**Max**	**PR_type**	**Prior**	**Pr_SD**	**Status**	**Active / Not Active Parameter**	**Description**
L_at_Amin_Fem_GP_1	29.3403	0.286726	32	10	50	No_prior	_	_	Estimated	A	Size at age 0.5
L_at_Amax_Fem_GP_1	143.6	_	143.6	100	160	No_prior	_	_	Fixed	NA	von Bertalanffy Linfintiy
VonBert_K_Fem_GP_1	0.144798	0.00148693	0.175	0.1	0.4	No_prior	_	_	Estimated	A	von Bertalanffy K
CV_young_Fem_GP_1	0.2	_	0.2	0.05	0.3	No_prior	_	_	Fixed	NA	Young growth CV
CV_old_Fem_GP_1	0.2	_	0.2	0.05	0.3	No_prior	_	_	Fixed	NA	Old growth CV
Wtlen_1_Fem	7.05E-05	_	7.05E-05	0.1	0.5	No_prior	_	_	Fixed	NA	Weight lengt a parameter
Wtlen_2_Fem	2.633	_	2.633	2	4	No_prior	_	_	Fixed	NA	weight length b parameter
Mat50%_Fem	82.5	_	82.5	70	100	No_prior	_	_	Fixed	NA	Maturity inflection point
Mat_slope_Fem	-0.1	_	-0.1	-1	0	No_prior	_	_	Fixed	NA	Maturity slope
Eggs/kg_inter_Fem	1	_	1	-3	3	No_prior	_	_	Fixed	NA	Fecundity scalar
Eggs/kg_slope_wt_Fem	0	_	0	-3	3	No_prior	_	_	Fixed	NA	Fecundity slope
SR_LN(R0)	7.77614	0.0309591	8	4	20	No_prior	_	_	Estimated	A	Virgin recruitment
SR_BH_steep	0.837618	0.0184726	0.8	0.2	0.99	No_prior	_	_	Estimated	A	Steepness
SR_sigmaR	0.6	_	0.6	0	2	dev	_	_	Fixed	NA	Stock recruit standard deviation
SR_envlink	0	_	0	-5	5	dev	_	_	Fixed	NA	Stock recruit environmetnal link
SR_R1_offset	-0.00963	0.223481	0	-5	5	dev	_	_	Estimated	A	Stock recruit offset
SR_autocorr	0	_	0	0	0.5	dev	_	_	Fixed	NA	Stock recruit autocorrelation
Main_RecrDev_1984	-1.22521	0.252366	_	_	_	dev	_	_	Estimated	A	1984 recruit deviation
Main_RecrDev_1985	0.370746	0.0827937	_	_	_	dev	_	_	Estimated	A	1985 recruit deviation

Table 3.1.4.1 (continued).

Main_RecrDev_1986	0.798742	0.0651459	_	_	_	dev	_	_	Estimated	A	1986 recruit deviation
Main_RecrDev_1987	-0.32958	0.145002	_	_	_	dev	_	_	Estimated	A	1987 recruit deviation
Main_RecrDev_1988	-0.08386	0.122859	_	_	_	dev	_	_	Estimated	A	1988 recruit deviation
Main_RecrDev_1989	1.15221	0.0567864	_	_	_	dev	_	_	Estimated	A	1989 recruit deviation
Main_RecrDev_1990	0.320652	0.129915	_	_	_	dev	_	_	Estimated	A	1990 recruit deviation
Main_RecrDev_1991	0.368891	0.117049	_	_	_	dev	_	_	Estimated	A	1991 recruit deviation
Main_RecrDev_1992	-0.37469	0.202451	_	_	_	dev	_	_	Estimated	A	1992 recruit deviation
Main_RecrDev_1993	0.489074	0.0999851	_	_	_	dev	_	_	Estimated	A	1993 recruit deviation
Main_RecrDev_1994	0.453369	0.100375	_	_	_	dev	_	_	Estimated	A	1994 recruit deviation
Main_RecrDev_1995	-1.04535	0.211722	_	_	_	dev	_	_	Estimated	A	1995 recruit deviation
Main_RecrDev_1996	-0.44237	0.156253	_	_	_	dev	_	_	Estimated	A	1996 recruit deviation
Main_RecrDev_1997	0.556411	0.0793496	_	_	_	dev	_	_	Estimated	A	1997 recruit deviation
Main_RecrDev_1998	-0.57578	0.137556	_	_	_	dev	_	_	Estimated	A	1998 recruit deviation
Main_RecrDev_1999	0.844472	0.0643935	_	_	_	dev	_	_	Estimated	A	1999 recruit deviation
Main_RecrDev_2000	0.911344	0.0606827	_	_	_	dev	_	_	Estimated	A	2000 recruit deviation
Main_RecrDev_2001	0.135753	0.0858681	_	_	_	dev	_	_	Estimated	A	2001 recruit deviation
Main_RecrDev_2002	-0.49857	0.0923913	_	_	_	dev	_	_	Estimated	A	2002 recruit deviation
Main_RecrDev_2003	-0.10142	0.0605441	_	_	_	dev	_	_	Estimated	A	2003 recruit deviation
Main_RecrDev_2004	-0.42519	0.0690107	_	_	_	dev	_	_	Estimated	A	2004 recruit deviation
Main_RecrDev_2005	0.0653	0.0525225	_	_	_	dev	_	_	Estimated	A	2005 recruit deviation
Main_RecrDev_2006	0.280796	0.0503245	_	_	_	dev	_	_	Estimated	A	2006 recruit deviation
Main_RecrDev_2007	0.260757	0.0587495	_	_	_	No_prior	_	_	Estimated	A	2007 recruit deviation
Main_RecrDev_2008	0.16441	0.07575	_	_	_	No_prior	_	_	Estimated	A	2008 recruit deviation
Main_RecrDev_2009	0.004002	0.0910575	_	_	_	No_prior	_	_	Estimated	A	2009 recruit deviation
Main_RecrDev_2010	-2.08725	0.279494	_	_	_	No_prior	_	_	Estimated	A	2010 recruit deviation
Main_RecrDev_2011	0.012335	0.107647	_	_	_	F	_	_	Estimated	A	2011 recruit deviation
InitF_1Com_HL_1	0	_	0	0	0.1	F	_	_	Fixed	NA	COM_HL iFleet nitial F
InitF_2Com_LL_2	0	_	0	0	0.1	F	_	_	Fixed	NA	COM_LLFleet initial F

Table 3.1.4.1 (continued).

InitF_3REC_3	0.031445	0.00790975	0.05	0	0.1	F	_	_	Estimated	A	REC initial F
InitF_4Headboat_4	0.009757	0.00243052	0.05	0	0.1	F	_	_	Estimated	A	Headboat Fleet Initial F
SizeSel_1P_1_Com_HL_1	105.282	1.22771	90	20	150	F	_	_	Estimated	A	Length Selex Parm 1
SizeSel_1P_2_Com_HL_1	-12.7787	40.2211	-3.4	-15	15	F	_	_	Estimated	A	Length Selex Parm 2
SizeSel_1P_3_Com_HL_1	7.20185	0.0393798	5.4	-15	20	F	_	_	Estimated	A	Length Selex Parm 3
SizeSel_1P_4_Com_HL_1	4.37483	0.43569	6.5	-15	15	F	_	_	Estimated	A	Length Selex Parm 4
SizeSel_1P_5_Com_HL_1	-15	_	-15	-15	15	F	_	_	Fixed	NA	Length Selex Parm 5
SizeSel_1P_6_Com_HL_1	-0.76623	0.222376	-15	-15	15	F	_	_	Estimated	A	Length Selex Parm 6
Retain_1P_1_Com_HL_1	50.8	_	50.8	10	100	F	_	_	Fixed	NA	Retention Parm 1
Retain_1P_2_Com_HL_1	1	_	1	1	20	F	_	_	Fixed	NA	Retention Parm 2
Retain_1P_3_Com_HL_1	1	_	1	0.1	1	F	_	_	Fixed	NA	Retention Parm 3
Retain_1P_4_Com_HL_1	0	_	0	-1	2	F	_	_	Fixed	NA	Retention Parm 4
DiscMort_1P_1_Com_HL_1	-2	_	-2	-10	10	F	_	_	Fixed	NA	Discard Mortality parm 1
DiscMort_1P_2_Com_HL_1	1	_	1	-1	2	F	_	_	Fixed	NA	Discard Mortality parm 2
DiscMort_1P_3_Com_HL_1	0.2	_	0.2	-1	2	F	_	_	Fixed	NA	Discard Mortality parm 3
DiscMort_1P_4_Com_HL_1	0	_	0	-1	2	F	_	_	Fixed	NA	Discard Mortality parm 4
SizeSel_2P_1_Com_LL_2	107.41	1.48311	100	15	150	F	_	_	Estimated	A	Length Selex Parm 1
SizeSel_2P_2_Com_LL_2	33.2378	0.960886	10	0.01	50	F	_	_	Estimated	A	Length Selex Parm 2
Retain_2P_1_Com_LL_2	50.8	_	50.8	10	100	F	_	_	Fixed	NA	Retention Parm 1
Retain_2P_2_Com_LL_2	1	_	1	1	20	F	_	_	Fixed	NA	Retention Parm 2
Retain_2P_3_Com_LL_2	0.9	_	0.9	0	1	F	_	_	Fixed	NA	Retention Parm 3
Retain_2P_4_Com_LL_2	0	_	0	-1	2	F	_	_	Fixed	NA	Retention Parm 4
DiscMort_2P_1_Com_LL_2	-2	_	-2	-10	10	F	_	_	Fixed	NA	Discard Mortality parm 1
DiscMort_2P_2_Com_LL_2	1	_	1	-1	2	F	_	_	Fixed	NA	Discard Mortality parm 2
DiscMort_2P_3_Com_LL_2	0.2	_	0.2	-1	2	F	_	_	Fixed	NA	Discard Mortality Parm 3
DiscMort_2P_4_Com_LL_2	0	_	0	-1	2	F	_	_	Fixed	NA	Discard Mortality parm 4
SizeSel_3P_1_REC_3	87.4477	0.0593339	90	20	125	F	_	_	Estimated	A	Length Selex Parm 1
SizeSel_3P_2_REC_3	-12.3157	94.554	-4.8	-20	15	F	_	_	Estimated	A	Length Selex Parm 2

Table 3.1.4.1 (continued).

SizeSel_3P_3_REC_3	7.49621	0.0533281	5.8	-25	15	F	_	_	Estimated	A	Length Selex Parm 3
SizeSel_3P_4_REC_3	-8.12438	54.7304	6.5	-20	15	F	_	_	Estimated	A	Length Selex Parm 4
SizeSel_3P_5_REC_3	-10	_	-10	-15	15	F	_	_	Fixed	NA	Length Selex Parm 5
SizeSel_3P_6_REC_3	0.543056	0.154034	0	-15	15	F	_	_	Estimated	A	Length Selex Parm 6
Retain_3P_1_REC_3	50.8	_	50.8	10	100	F	_	_	Fixed	NA	Retention Parm 1
Retain_3P_2_REC_3	1	_	1	1	20	F	_	_	Fixed	NA	Retention Parm 2
Retain_3P_3_REC_3	1	_	1	0.1	1	F	_	_	Fixed	NA	Retention Parm 3
Retain_3P_4_REC_3	0	_	0	-1	2	F	_	_	Fixed	NA	Retention Parm 4
DiscMort_3P_1_REC_3	-2	_	-2	-10	10	F	_	_	Fixed	NA	Discard Mortality parm 1
DiscMort_3P_2_REC_3	1	_	1	-1	2	F	_	_	Fixed	NA	Discard Mortality parm 2
DiscMort_3P_3_REC_3	0.2	_	0.2	-1	2	F	_	_	Fixed	NA	Discard Mortality parm 3
DiscMort_3P_4_REC_3	0	_	0	-1	2	F	_	_	Fixed	NA	Discard Mortality parm 4
SizeSel_4P_1_Headboat_4	83.1906	1.1143	90	20	125	F	_	_	Estimated	A	Length Selex Parm 1
SizeSel_4P_2_Headboat_4	-13.3549	32.5588	-3.3	-15	15	F	_	_	Estimated	A	Length Selex Parm 2
SizeSel_4P_3_Headboat_4	7.3108	0.0589987	6.5	-15	15	F	_	_	Estimated	A	Length Selex Parm 3
SizeSel_4P_4_Headboat_4	4.88981	0.328842	6.5	-15	15	F	_	_	Estimated	A	Length Selex Parm 4
SizeSel_4P_5_Headboat_4	-10	_	-10	-15	15	F	_	_	Fixed	NA	Length Selex Parm 5
SizeSel_4P_6_Headboat_4	-0.96794	0.211267	0	-15	15	F	_	_	Estimated	A	Length Selex Parm 6
Retain_4P_1_Headboat_4	50.8	_	50.8	10	100	F	_	_	Fixed	NA	Retention Parm 1
Retain_4P_2_Headboat_4	1	_	1	1	20	F	_	_	Fixed	NA	Retention Parm 2
Retain_4P_3_Headboat_4	1	_	1	0.1	1	F	_	_	Fixed	NA	Retention Parm 3
Retain_4P_4_Headboat_4	0	_	0	-1	2	F	_	_	Fixed	NA	Retention Parm 4
DiscMort_4P_1_Headboat_4	-2	_	-2	-10	10	F	_	_	Fixed	NA	Discard Mortality parm 1
DiscMort_4P_2_Headboat_4	1	_	1	-1	2	F	_	_	Fixed	NA	Discard Mortality parm 2
DiscMort_4P_3_Headboat_4	0.2	_	0.2	-1	2	F	_	_	Fixed	NA	Discard Mortality parm 3
DiscMort_4P_4_Headboat_4	0	_	0	-1	2	F	_	_	Fixed	NA	Discard Mortality parm 4
SizeSel_6P_1_SEAMAP_Video_Survey_6	42.2621	0.879405	100	15	150	F	_	_	Estimated	A	Length Selex Parm 1
SizeSel_6P_2_SEAMAP_Video_Survey_6	15.0376	1.15609	10	0.01	50	F	_	_	Estimated	A	Length Selex Parm 2

Table 3.1.4.1 (continued).

SizeSel_7P_1_PANAMA_CITY_TRAP_VIDEO_SURVEY_7	32.8648	2.66574	25	17.5	150				Estimated	A	Length Selex Parm 1
SizeSel_7P_2_PANAMA_CITY_TRAP_VIDEO_SURVEY_7	-9.47512	75.5804	-3	-15	15				Estimated	A	Length Selex Parm 2
SizeSel_7P_3_PANAMA_CITY_TRAP_VIDEO_SURVEY_7	-15	_	-15	-15	15				Fixed	NA	Length Selex Parm 3
SizeSel_7P_4_PANAMA_CITY_TRAP_VIDEO_SURVEY_7	7.7263	0.509223	4	-15	15				Estimated	A	Length Selex Parm 4
SizeSel_7P_5_PANAMA_CITY_TRAP_VIDEO_SURVEY_7	1.41354	1.29078	0	-15	15				Estimated	A	Length Selex Parm 5
SizeSel_7P_6_PANAMA_CITY_TRAP_VIDEO_SURVEY_7	-15	_	-15	-15	15				Fixed	NA	Length Selex Parm 6
AgeSel_1P_1_Com_HL_1	0.1	_	0.1	0.1	10				Fixed	NA	Age Selex Parm 1
AgeSel_1P_2_Com_HL_1	10	_	10	10	10				Fixed	NA	Age Selex Parm 2
AgeSel_2P_1_Com_LL_2	0.1	_	0.1	0.1	10				Fixed	NA	Age Selex Parm 1
AgeSel_2P_2_Com_LL_2	10	_	10	10	10				Fixed	NA	Age Selex Parm 2
AgeSel_3P_1_REC_3	0.1	_	0.1	0.1	10				Fixed	NA	Age Selex Parm 1
AgeSel_3P_2_REC_3	10	_	10	10	10				Fixed	NA	Age Selex Parm 2
AgeSel_4P_1_Headboat_4	0.1	_	0.1	0.1	10				Fixed	NA	Age Selex Parm 1
AgeSel_4P_2_Headboat_4	10	_	10	10	10				Fixed	NA	Age Selex Parm 2
AgeSel_6P_1_SEAMAP_Video_Survey_6	0.1	_	0.1	0.1	10				Fixed	NA	Age Selex Parm 1
AgeSel_6P_2_SEAMAP_Video_Survey_6	10	_	10	10	10				Fixed	NA	Age Selex Parm 2
AgeSel_7P_1_PANAMA_CITY_TRAP_VIDEO_SURVEY_7	0.1	_	0.1	0.1	10				Fixed	NA	Age Selex Parm 1
AgeSel_7P_2_PANAMA_CITY_TRAP_VIDEO_SURVEY_7	10	_	10	10	10				Fixed	NA	Age Selex Parm 2
Retain_1P_1_Com_HL_1_BLK1repl_1950	17.5	_	17.5	10	100				Fixed	NA	Retention Parm 1 Time block 1
Retain_1P_1_Com_HL_1_BLK1repl_1990	99.9945	0.171121	81	10	100				Estimated	A	Retention Parm 1 Time block 2
Retain_1P_1_Com_HL_1_BLK1repl_2008	96.5451	1.11566	81	10	100				Estimated	A	Retention Parm 1 Time block 3
Retain_1P_2_Com_HL_1_BLK1repl_1950	1	_	1	1	20				Fixed	NA	Retention Parm 2 Time block 1
Retain_1P_2_Com_HL_1_BLK1repl_1990	6.55776	0.137873	5	1	20				Estimated	A	Retention Parm 2 Time block 2
Retain_1P_2_Com_HL_1_BLK1repl_2008	7.18813	0.507381	5	1	20				Estimated	A	Retention Parm 2 Time block 3
Retain_2P_1_Com_LL_2_BLK2repl_1950	17.5	_	17.5	10	100				Fixed	NA	Retention Parm 1 Time block 1
Retain_2P_1_Com_LL_2_BLK2repl_1990	99.9983	0.0560845	81	10	100				Estimated	A	Retention Parm 1 Time block 2
Retain_2P_2_Com_LL_2_BLK2repl_1950	1	_	1	1	20				Fixed	NA	Retention Parm 2 Time block 1
Retain_2P_2_Com_LL_2_BLK2repl_1990	8.33837	0.441717	5	1	20				Estimated	A	Retention Parm 2 Time block 2

Table 3.1.4.1 (continued).

Retain_3P_1_REC_3_BLK3repl_1950	10.2682	7.69747	17.5	10	100				Estimated	A	Retention Parm 1 Time block 1
Retain_3P_1_REC_3_BLK3repl_1991	69.7895	0.897876	50	10	100				Estimated	A	Retention Parm 1 Time block 2
Retain_3P_1_REC_3_BLK3repl_1998	71.3344	0.415721	65	10	100				Estimated	A	Retention Parm 1 Time block 3
Retain_3P_1_REC_3_BLK3repl_2009	81.2212	0.714324	72	10	100				Estimated	A	Retention Parm 1 Time block 4
Retain_3P_2_REC_3_BLK3repl_1950	1.03885	1.14866	1	1	20				Estimated	A	Retention Parm 2 Time block 1
Retain_3P_2_REC_3_BLK3repl_1991	6.97925	0.373123	5	1	20				Estimated	A	Retention Parm 2 Time block 2
Retain_3P_2_REC_3_BLK3repl_1998	4.24891	0.192641	5	1	20				Estimated	A	Retention Parm 2 Time block 3
Retain_3P_2_REC_3_BLK3repl_2009	4.44256	0.259316	5	1	20				Estimated	A	Retention Parm 2 Time block 4
Retain_4P_1_Headboat_4_BLK3repl_1950	10.0192	0.610417	17.5	10	90				Estimated	A	Retention Parm 1 Time block 1
Retain_4P_1_Headboat_4_BLK3repl_1991	73.0761	0.667921	71	10	90				Estimated	A	Retention Parm 1 Time block 2
Retain_4P_1_Headboat_4_BLK3repl_1998	70.9293	0.518994	71	10	90				Estimated	A	Retention Parm 1 Time block 3
Retain_4P_1_Headboat_4_BLK3repl_2009	82.8648	0.968587	72	10	90				Estimated	A	Retention Parm 1 Time block 4
Retain_4P_2_Headboat_4_BLK3repl_1950	7.34516	0.444554	1	1	20				Estimated	A	Retention Parm 2 Time block 1
Retain_4P_2_Headboat_4_BLK3repl_1991	5.72736	0.25417	5	1	20				Estimated	A	Retention Parm 2 Time block 2
Retain_4P_2_Headboat_4_BLK3repl_1998	5.03381	0.220781	5	1	20				Estimated	A	Retention Parm 2 Time block 3
Retain_4P_2_Headboat_4_BLK3repl_2009	5.33019	0.301323	5	1	20				Estimated	A	Retention Parm 2 Time block 4

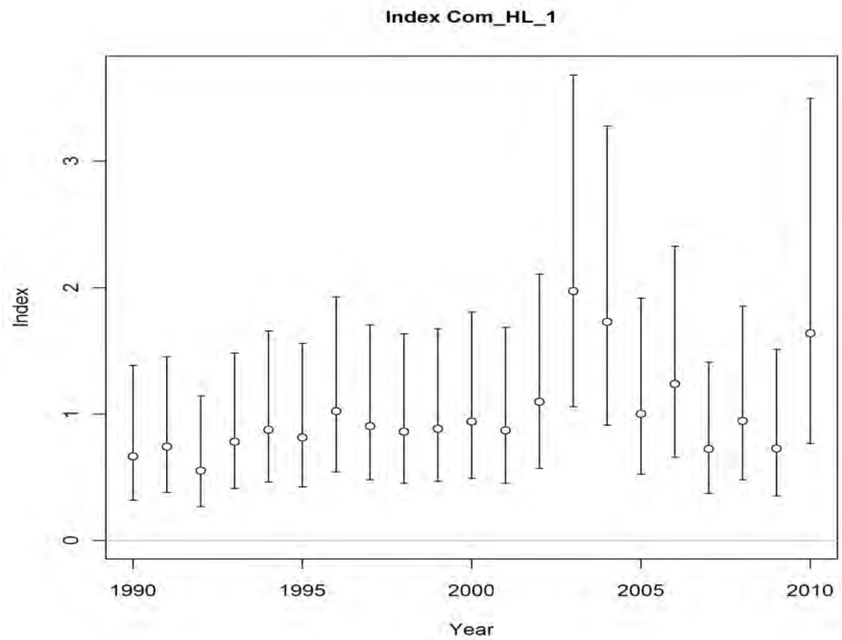
Table 3.1.6.1. Description of initial model runs and alternative runs (sensitivity, data exclusion, reweighting, and retrospective) conducted for the Gulf of Mexico Greater amberjack SS evaluation.

Run	**Name**	**Key**	**Description**
1	BASE	Final Base Model, Estimated Steepness, Estimated R0, M = DW)	Estimated K, M=0.28 input into Lorenzen scaled to reference age 2, estimate steepness, estimate virgin stock (R0), estimate virgin biomass offset, estimate recruitment deviations (1984-2011), input discards as discards, 3 time varying selectivity/retention blocks COM_HL (pre 1990, 1990-2007, 2008-2012); two blocks COM_LL (pre 1990, 1990-2012); and four time varying blocks recreational charterboat and private angler modes (REC) and four time blocks Headboat: pre 1990, 1991-1997, 1998-2008, 2009-2012.
2	RedAge0M	Sensitivity on estimation of Lorenzen M at age, adjusting M age 0 for spawning peak	Run 1 Configuration, DW LM at age for Age 0 adjusted for April 1 spawning.
3	EstLAgeMax	Sensitivity on estimation of SS results on input growth Lmax parameter	Run 1 Configuration, estimate Lmax growth parameter..
4	Low M	Sensitivity on estimation of Natural Mortality value input into Lorenzen	Run 1 Configuration, DW LM M at age vector alternative using 0.15 as input point estimate into LM function.
5	High M	Sensitivity on estimation of Natural Mortality value input into Lorenzen	Run 1 Configuration, DW LM M at age vector alternative using 0.35 as input point estimate into LM function.
6	Virg 1950	Sensitivity on initial conditions	Run 1 Model Configuration, assuming unfished conditions for start year.
7	Rel Mort 0.15	Sensitivity on Discard Mortality	Run1 Model Configuration, discard release mortality varied from 20% to 15% for all fleets.
8	Rel Mort 0.1	Sensitivity on Discard Mortality	Run1 Model Configuration , discard release mortality varied from 20% to 10% for all fleets.
9	Rel Mort 0.05	Sensitivity on Discard Mortality	Run 1 Model Configuration, discard release mortality varied from 20% to 5% for all fleets.

Table 3.1.6.1 (continued).

10	Rel Mort 0.0	Sensitivity on Discard Mortality	Run 1 Model Configuration, discard release mortality varied from 20% to 0% for all fleets.
11	InitFs 1963	Sensitivity on initial conditions	Run 1 Model Configuration, Start year= 1963.
12	Fix Stp 0.8	Sensitivity on Beverton & Holt S/R parameters	Run 1 Model Configuration, steepness fixed = 0.8.
	Retrospectives		
13	2011	Retrospective Analysis	Run 1 Model Configuration (Estimated Steepness, Estimated R0 LM Age0 M), 2012 data excluded.
14	2010	Retrospective Analysis	Run 1 Model Configuration (Estimated Steepness, Estimated R0, LM Age0 M), 2011-2012 data excluded.
15	2009	Retrospective Analysis	Run 1 Model Configuration (Estimated Steepness, Estimated R0, LM Age0 M), 2010-2012 data excluded.
16	2008	Retrospective Analysis	Run 1 Model Configuration (Estimated Steepness, Estimated R0, LM Age0 M), 2009-2012 data excluded.
17	2007	Retrospective Analysis	Run 1 Model Configuration (Estimated Steepness, Estimated R0, LM Age0 M), 2008-2012 data excluded.

3.1.11. Figures



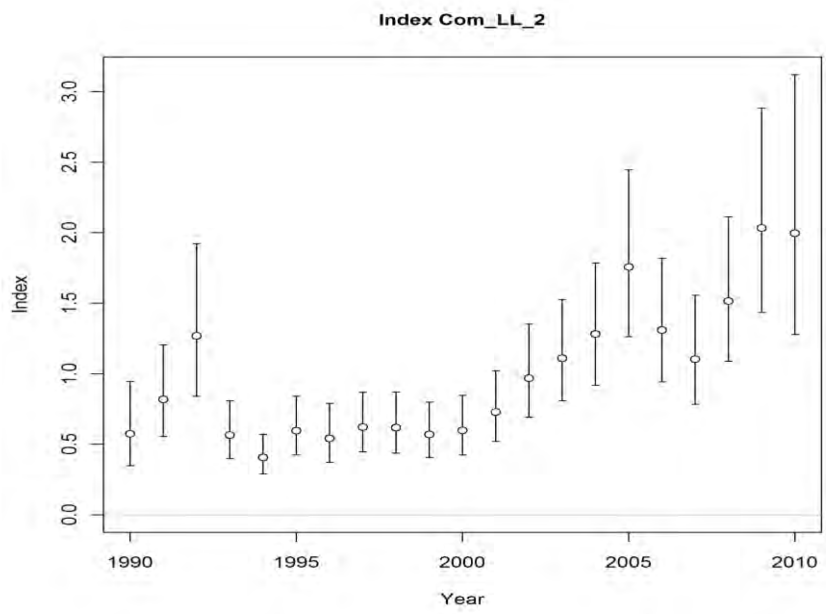
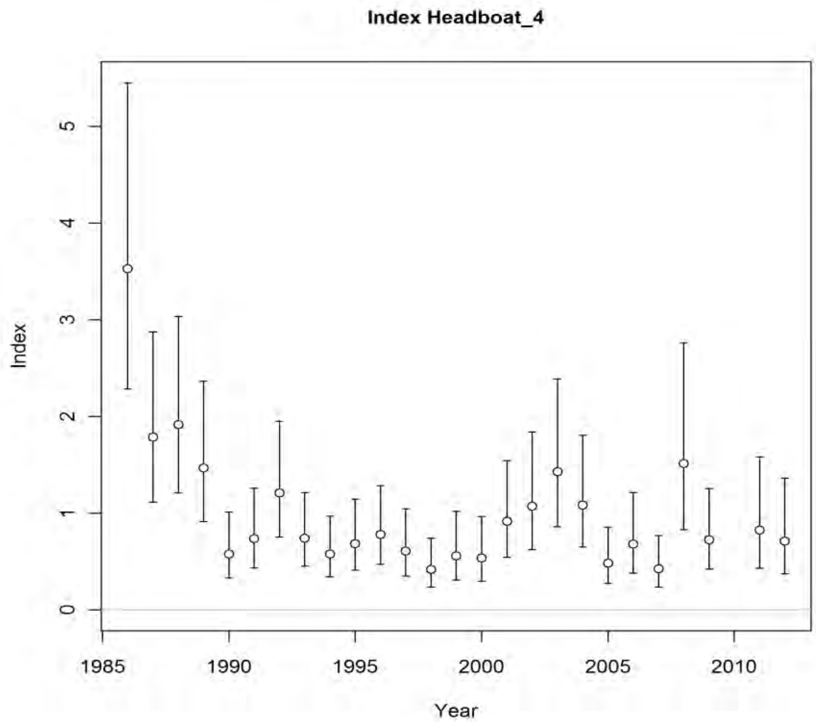


Figure 3.1.3.1a, b. Standardized indices of relative abundance and associated log-scale standard errors for Gulf of Mexico greater amberjack. The indices are from: a) commercial line gear fishery (COM_HL) and b) the commercial bottom longline fishery (COM_LL).



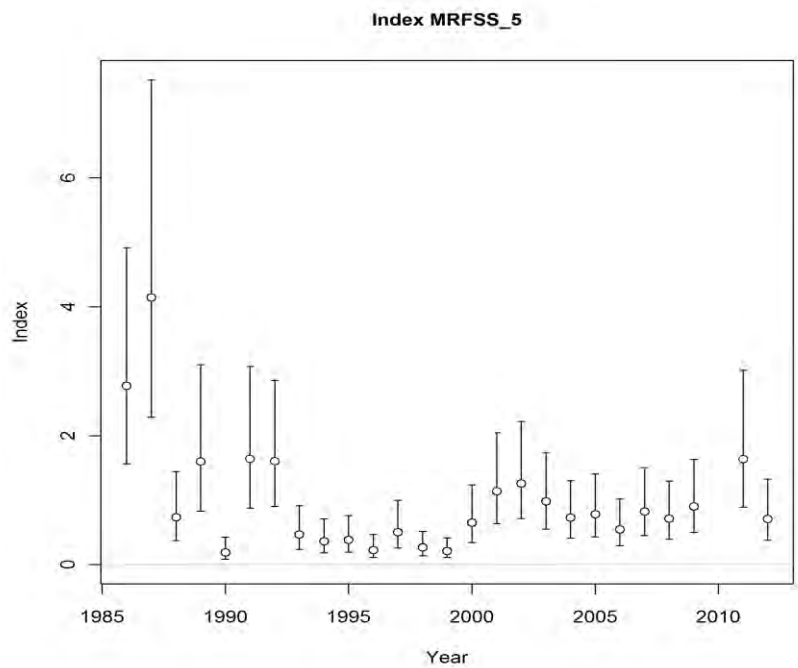
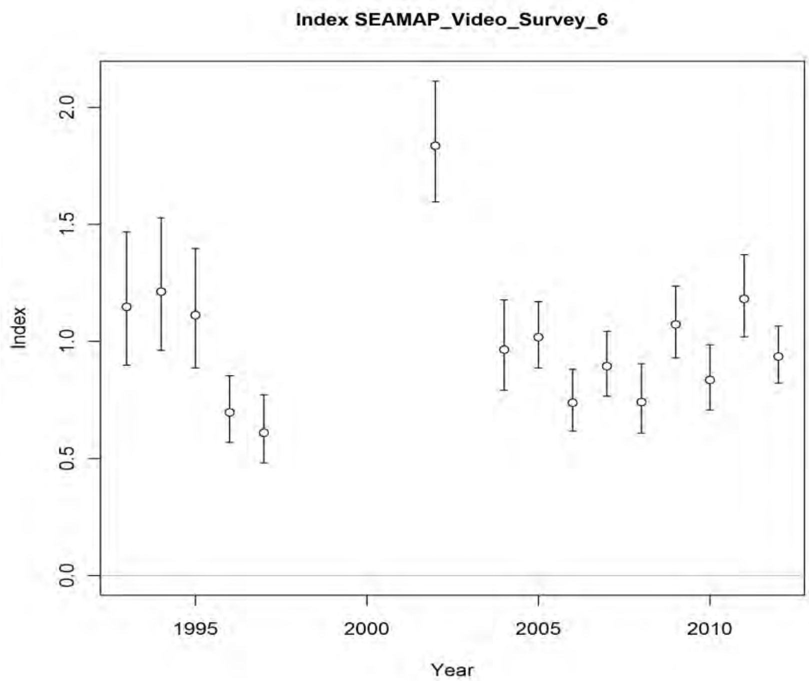


Figure 3.1.3.1c, d. Standardized indices of relative abundance and associated log-scale standard errors for Gulf of Mexico greater amberjack. The indices are from the c) recreational charter and private angler fishery (REC) and d) the Headboat (Headboat) fisheries. Fish per 1000 hours.



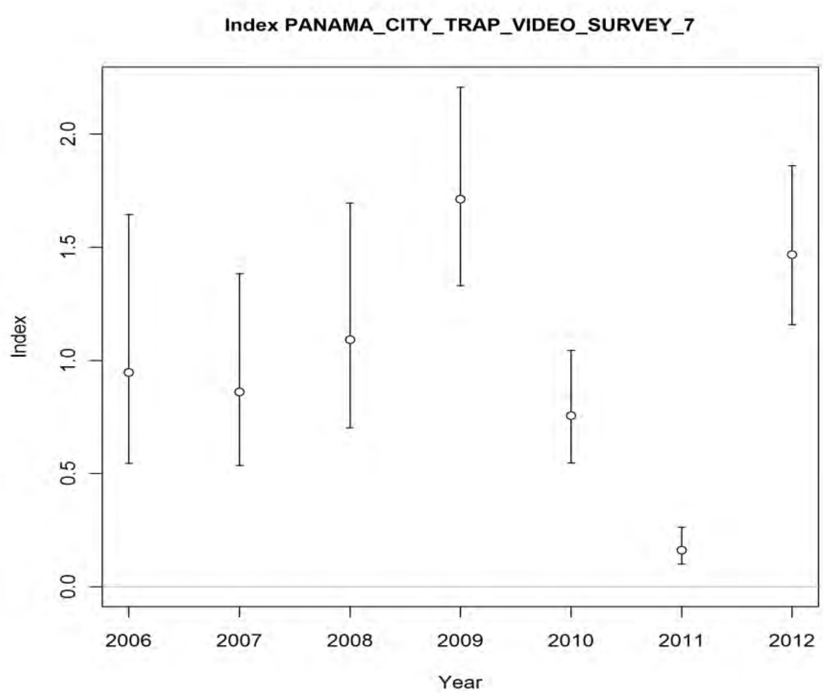


Figure 3.1.3.1e, f. Standardized indices of relative abundance and associated log-scale standard errors for Gulf of Mexico greater amberjack. The indices are e) the SEAMAP video survey (SEAMAP_Video), and f) Panama City Laboratory Trap Video survey (Panama City Trap Video.

3.2 SS Model Results

3.2.1 Measures of overall model fit

3.2.1.1 Landings

Stock Synthesis effectively treats the landings data as being known without error. Therefore, landings are fit precisely. Figure 3.2.1.1.1 presents the data inputs used in the Greater Amberjack SS stock assessment. Figure 3.2.1.1.2 provides reported landings and SS estimated landings for the four (4) dependent fleets modeled in SS.

3.2.1.2 Indices

In general SS fit the indices of abundance reasonably well and without indication of any major trending (Figure 3.2.1.2.1 (a-g)). As described in Section 2.6 (Data Update and Review) the indices for the commercial line gear, commercial longline, and Headboat fleets were input into SS as fleets reflecting retained landings, the REC fleet index and the indices for the SEAMAP Video and the Panama City trap Video survey were modeled as surveys reflecting total catch (landings and discards). The trend in SS estimated CPUE for the COM_HL and COM_LL suggested an increase in abundance around 2005 (Figure 3.2.1.2.1a, b). As with the observed indices, SS predicted indices indicated large variability over the entire time series for the COM_HL and COM_LL fleets. The two commercial fishery indices reflect fisherman reported trip specific landings throughout the Gulf of Mexico. Although landings of Greater Amberjack from commercial bottom longline gear exist, this species is not thought to be a major target of vessels using bottom longline gear.

The trend in SS estimated CPUE for the REC (combined charterboat and private angler fisheries) was fairly flat through 1999 (Figure 3.2.1.2.1c, d). SS predicted an increase in abundance from the REC fleet in 2000, followed by a decline again through 2005, and only moderately increasing CPUE through 2012. The trend in SS estimated CPUE for the Headboat fleet suggested a large decline in abundance from the start of the time series (1986) through 1990, flat through 2000, moderate increase from 2001-2003 followed by a decline since.

The SEAMAP and the Panama City trap video survey provided additional information on greater amberjack stock abundance from fishery independent sampling and represents total catch (Figure 3.2.1.2.1e, f).. The trend in SS estimated Greater Amberjack abundance for the SEAMAP survey varied without trend throughout the time series 1993-2012. The trend in SS estimated abundance form the Panama City Laboratory trap video survey remained largely unchanged over the length of the survey, 2006-2012 with a single exception of an anomalous sharp decline between 2009 and 2010. As noted by the SEDAR 33 DW, the SEAMAP survey reflects sampling that is Gulf wide while the Panama City Laboratory survey reflects more restricted geographical sampling from the northeastern Gulf of Mexico. It should be noted that the Panama City trap video survey generally references small Greater Amberjack (range =10 – 40 cm fork length), and so generally reflects trends in recruitment. The low observed value in 2011 may indicate a poor recruitment year, however the model did not fit that point well and the sample size was very low (n=15 fish).

Figure 3.2.1.2.1g presents the estimated trends for all the Greater Amberjack indices used in the SS assessment model. It should be noted that the indices cannot be directly compared since the represent different size/age classes (e.g. COM_LL references larger animals while the Panama City index references juvenile amberjack).

3.2.1.3 Discards
SS fit the discards reasonably well (Figures 3.2.1.3 (a – d). As noted in Section 2.3.9 (Data Review and Update Discards) for the SS assessment model, discards were incorporated into the assessment as numbers of fish and input with a moderate CV (0.25), thus allowing variability around the estimate to be incorporated into the model estimation. The observed annual discards showed large variability for all four directed fisheries. Estimates of recreational discards and their associated CV values are presented in the SEDAR 33 DW. In a previous assessment (SEDAR 28) the DW noted that "commercial discards are based on estimated encounter rates and effort. In years when multi-year averages are used to compute encounter rates, these estimates do not account for year-specific age structure". This observation is relevant to the discard estimation procedure used in this stock assessment as well. In addition, although it is likely that discarding was occurring at least since the mid 1990's (after the implementation of commercial 36 inch fork length size limit, actual observations from observers exist only since 2007. In addition, another factor contributing to uncertainty in commercial discards is the low coverage of the logbook survey (SEDAR 28 DW Table 3.11).

3.2.1.4 Retained Length composition
Length composition data has been reported) since 1984 for the commercial fleets and since 1981for the recreational fleets, and is described in the SEDAR 33 DW report. As described above in Section 2.4, commercial length composition was derived from the Trip Interview Program (TIP) and recreational samples from four sources: TIP, the MRFSS/MRIP survey, the Headboat survey, and the TPWD. Tables 3.1.3.1 (a-c) provide length composition sample sizes for the four fleets and two surveys. The COM_LL fleet was very sparsely sampled in all years and in 25 of the 28 years sampled the number of fish sampled for length was less than 100. In addition, length composition samples declined significantly in both commercial fleets (COM_HL, COM_LL) after 2003.

Due to the small sample sizes, insufficient representative sampling in some years and observations of unexpectedly small fish (well below the size limits) retained by the recreational and commercial fleets, SS fit the individual annual fishery length compositions only fairly well (Figures 3.2.1.4.1 (a – l). There are some trending issues and patterns in residuals are common. The lack of fit to the length composition information is not desirable, but is the result of an AP decision to allow the lack of fit in order to better fit selectivity and retention functions that appeared reasonable given the observed dynamics in fishing behavior. It is possible that alternative model formulations could better fit length composition while retaining reasonable behavior in the estimated retention and selectivity functions.

SS length composition fits for the COM_HL fleet were overall reasonable, when the addition of time varying retention was specified in the model (Figures 3.2.1.4.1a, b). However, there was still a discernible lack of fit in the some of the years of length compositions as evidenced by large residuals. This is evident particularly in the fitted compositions after 2004. SS tended to underestimate the quantity of small fish in the early years COM_HL composition, while overestimating the quantity of small fish just after the imposition of the size limit (1990).

SS length composition fits for the commercial line gear (COM_LL) were in general represented by very low sample sizes and poorer fits than for the other fleets (recreational or commercial) and also for the survey length composition fits (Figures 3.2.1.4.1 (c, d). This was not surprising given the low sample sizes in general with some years not represented at all in the length composition. SS generally underestimated the proportion of fish in many length bins, particularly in the earlier years. Both a dome shaped and asymptotic shape selectivity function was explored for modeling retained length composition; the AP felt that the logistic curve better represented the overall length composition of the COM_LL fleet and also using the logistic function resulted in reduced residuals in some years. Greater amberjack are not actively targeted by the Gulf of Mexico commercial reeffish or shark longline fishery so the very low sample sizes for many years are not particularly surprising. An interesting observation was that for the COM_LL after around 2006 fewer greater amberjack above 140 cm fork length were observed in the retained length composition however SS still tended to overestimate fish in these larger bins after 2005.

SS fits to the REC length composition was overall quite reasonable with little to no indication of fitting problems except the early years before 1987 (Figures 3.2.1.4.1 (e, f)). There was a slight pattern in residuals for small fish, about the time of the implementation of the size limit (1990) and for a number of years following a few large residuals are noted indicating that some fish below the recreational minimum size (28 inch fork length, 71 cm) were still being retained. Although the residuals in some length intervals are quite large, the number of fish observed in those length intervals was very small (typically 1-2).These could represent species misidentifications (e.g. lesser amberjack) and or data processing errors. The influence of the large residuals on the model result could be tested by removing the few fish caught below the size limit from the input data. Overall though, SS fit the recreational combined charterboat and private angler fishery length composition reasonably well.

SS fits to the Headboat length composition were fair with indication of fitting problems particularly in lightly sampled years (Figures 3.2.1.4.1(g, h)). As with other fleets, SS underestimated the number of small fish in some years. There was also a pattern in residuals for small fish, about the time of the implementation of the size limit (1990) and in several following years, indicating that some fish below the minimum size were still being retained. Although the residuals in some length intervals are quite large, the number of fish observed in those length intervals was very small (typically 1-2).These could represent species misidentifications (e.g. lesser amberjack) and or data processing errors. The influence of the large residuals on the model result could be tested by removing the few fish caught below the size limit from the input data.

SS fit the most of the years of SEAMAP length composition poorly and there was some tendency of the model to expect more fish in the larger size classes (Figures 3.2.4.1 (i, j).

SS fit the three years of length composition from the Panama City trap survey poorly (Figures 3.2.1.4.1 (k, l)). However, this is not unexpected since samples sizes were quite small (n < 20 in two of three years). A notable lack of fit occurred in 2012 at sizes below 20 cm. Many more fish were observed at these small sizes than were predicted by SS.

Figures 3.2.1.4.1(a - l) provide graphical summaries of the SS fits to the length composition data and distributions of Pearson residuals from the SS fits for each of the fleets (4) and the two (2) surveys. Figures 3.2.1.4. 1 (m – p) presents SS fits and Pearson residuals to the retained and total catch for the four fleets and two surveys aggregated across time.

3.2.1.5 Discarded Length Composition

Observations of greater amberjack discards from the four fleets (COM_HL, COM_LL, REC, and Headboat) existed only since 2006. In general samples were very sparse across all fleets, however SS fits to the discards were reasonable for many of the year-fleet components. Figures 3.2.1.5.1 (a – h) provide SS fitted trends and Pearson residuals for each of the yearly-fleet discard length compositions. The residual patterns did not indicate major problems of fitting to the discard length compositions. Lack of sampling of the discards likely contributed to the over and under estimation of individual years and length bins. Figures 3.2.1.5.1 (i – j) presents SS fits and Pearson residuals to the retained and total catch for the four fleets and two surveys aggregated across time.

3.2.1.6 Age composition

The SS model fits to the Greater Amberjack age composition samples are presented in Table 3.1.6.1 and Figures 3.2.1.6.1 (a - i). The age composition fits represent the estimates of age composition for each of the sampled "year-fleet" fishery partitions. For many strata the number of age observations for a year and/or a fleet was very low adding difficulty to the fitting process. Figures 3.2.1.6.1 (j-k) presents SS fits and Pearson residuals to the retained and total catch for the four fleets and two surveys aggregated across time.

In general SS estimated the age composition of the all of the fleets only fairly well. Sample sizes for the COM_LL fleet were extremely low in all years and only three years were represented. SS age composition fit for the REC fleets were superior to the other three fleets (COM_HL, COM_LL, and Headboat) and residual patters were reasonably behaved. Table 3.1.3.1d provides age composition sample sizes for the four fleets.

3.2.2 Parameter estimates & associated measures of uncertainty

Table 3.1.4.1 provides a listing of all parameters estimated in SS for the model recommended by the panel for final projections and status determinations; this was the final SS Base model configuration (Run 1 ,Table 3.1.6.1). This recommendation was based on extensive discussion and review of all of the sensitivity runs, the retrospective analyses, the results of profiling the steepness parameter, and inspection of the uncertainty results from the bootstrap analyses. These results will be detailed in the text below. Table 3.2.2.1 includes predicted parameter values and their associated standard errors from SS, initial parameter values, minimum and maximum values a parameter could be assigned for each run, and prior densities assigned to parameters. Parameters designated as fixed were held at their initial values.

Asymptotic standard errors are obtained in SS by inverting the Hessian matrix that is the matrix of second derivatives, after the final model fitting process. The standard errors of most of the parameters are reasonable. But the large standard errors for some of the selectivity and retention parameters for directed fisheries and surveys indicate that some parameters are not well estimated (Table 3.1.6.1).

Table 3.2.2.1 presents summary means, the median value, and asymptotic standard errors for the parameters estimated for N = 1,500 bootstrap runs on the final Base Model (Run ,Table 3.1.6.1) model in which steepness and R0 was estimated.

SS Model convergence was also examined by the SS jitter option. Summary results are presented in Table 3.2.2.2 and Figures 3.2.2.1 (b –h) for 50 jitter runs that were run against the final Base SS model configuration for Greater Amberjack. Of the 50 runs, 49 model runs resulted in likelihood values that were almost identical to that of the Base model (total likelihood = 5621). Results of the model runs that converged on nearly identical solutions predict very similar levels of SSB and SPR in 2012, F2012, FSPRTtgt(=F30SPR), SPRTtgt(=SPR@F30SPR) (Table 3.2.2.2.2, Figures 3.2.2.1 (g - h).

3.2.3 Fishery Selectivity

Predicted size selectivity and retention patterns are presented in Figures 3.2.3.1 (a – f) for the SS final Base Model (Run 1, Table 3.1.6.1). The COM_HL and the COM_LL indices were assumed to have the same selectivity patterns as the COM_HL and COM_LL fleets respectively. Similarly, the MRFSS and Headboat indices were assumed to have the same selectivity patterns as the REC and Headboat fleets. The selectivity of the SEAMAP survey and the Panama City Laboratory trap Video survey index were estimated using each of their respective length compositions.

Three retention functions (logistic in form) were modeled for the COM_HL fleet(1950-1989, 1990-2007, 2008-2012), two for the COM_LL (1950-1989, 1990-2012), and four for the REC and Headboat fisheries (1950-1990, 1991-1997, 1998-2008, 2009-2012) to account for the minimum size limit that was implemented in 1990 (all fleets), 2008 (REC) and other regulatory implementations in 1997 (seasonal commercial closure) and in 2009. For this assessment there were some length composition samples with which to characterize the length composition of the discards selectivity so additional focus was placed on modeling the retention function.

In general it was difficult to model both selectivity and retention functions at the same time for the directed fleets. Other contributing factors included very low sample sizes, truncated distributions, and the appearance of many small fish in some years. However, the addition of time varying retention blocks significantly improved the ability of SS to fit the observed length compositions.

The standard errors for some of the selectivity and retention parameters were very high and indicate that these parameters were not well estimated (Table 3.1.4.1).

The selectivity/retention patterns for the REC fleet were reasonably well behaved and overall produced superior length composition fits than for the other fleets or the two surveys. The fishery abundance indices for the MRFSS were assumed to have the same selectivity pattern as the REC fleet pattern

Size selectivity for the Panama City two surveys was modeled with the logistic finciton while the SEAMAP survey length selectivity was modeled using a 6 parameter double-normal function and two of the parameters were fixed (Table 3.1.4.1). The length composition from the SEAMAP survey shows that fish from about 4 cm to 54 cm were captured by the survey.

3.2.4 Recruitment

The SS model was able to estimate the steepness and R0 parameters for the Beverton – Holt stock recruitment (S/R) relationship with reasonable success. Profiling of the steepness parameter is presented in Figure 3.2.4.1 for the final Base Model configuration (Run 1, Table 3.1.6.1). Steepness was estimated to be 0.838 (standard deviation= 0.018) for the final Base model and this value was considered reasonable for this species.

In the Greater Amberjack SS assessment, SS was also able to estimate the S/R parameter, R0 (log of virgin recruitment level) without difficulty for the Base model (Run 1, Table 3.1.4.1). SS estimated ln(R0) to be 7.78 (sd=0.03) from the Base model. Profiling of the R0 parameter is presented in Figure 3.2.4.2 for the SS final Base model.

The expected variation in recruitment (sigma-R) was fixed at 0.6, which is customary in SS applications. According to a likelihood profile, the SS assumed input value of 0.6 was not contradicted (Figure 3.2.4.3).

Figure 3.2.4.4 (a, b) presents summary results for 1,500 bootstrap runs for the greater amberjack SS final Base model (Run 1, Table 3.1.6.1 configuration model in which steepness and R0 parameter was estimated). The bootstrap summary plot indicates that steepness and R0 were estimated reasonably well by SS. Steepness was estimated across the 1,500 bootstraps at 0.845(mean and median values) and the model maximum likelihood estimate was 0.838. The distribution of virgin recruitment level (R_VIRGIN in the Figure 3.4.4a) was reasonably narrow indicating a reasonable level of confidence in the model's ability to estimate virgin recruitment for the base model (Run 1, Table 3.1.6.1) . The mean and median estimates of R0 across the 1,500 bootstraps were 7.767 and 7.766 and the model maximum likelihood estimate was 7.776. The summarized bootstrap runs suggest the SS model reached similar estimates across all 1,500 bootstrap data sets. Figure 3.2.4b also includes projection years 2013-2042.
The spawner-recruit relationship as estimated from SS for the final Base Model (Run 1, Table 3.1.4.1) model configuration (estimating steepness and R0) is shown in Figure 3.2.4.5. Estimated recruit deviations varied without trend over the time series and a strong negative residual is noted in 2012. (Figure 3.2.4.6). This should be interpreted with caution since the recent years contain less information from which to estimate the level of recruitment as not all cohorts have fully contributed to the fishery.

Predicted abundance at age and mean age are presented in Figure 3.2.4.7 for the final Base model (Run 1, Table 3.1.4.1). Predicted age-0 recruits were also presented in Table 3.2.4.1 for the final Base model. SS estimated increased levels of recruitment between the mid-1980's through the mid 1990's (except for one year). Recent years (2008-2010) annual recruitments have been lower than the mean recruitment over the period 1985-2011. Estimated deviations of annual recruitment are generally similar except for 2010. The early years of SS estimated recruitment (around the mid 1980's), show large variability and include estimated recruitments that are higher than all other years of the time series. Recruitments since 2000 have been less variable and very near the expectation from the S/R relationship. Several years of fairly low recruitment (between 1997 and 1990) were also predicted by SS for the Base model run. Figures 3.2.4.6 and 3.2.4.8 illustrate the annual recruitment deviations.

Figure 3.2.4.9 presents SS estimated YPR and SPR for Gulf of Mexico greater amberjack as estimated for the final SS Base Model configuration.

3.2.5 Stock Biomass

SS estimated total biomass and spawning biomass are presented in Table 3.2.4.1 and Figure 3.2.5.1 for the final Base model run (Run 1, Table 3.1.6.1). Total biomass and spawning biomass show significant declining trends from the beginning of the time series (1950) lasting through the late 1990's. SS estimated total biomass increased from the late 1990's through about 2003. Since 2003, SS estimated total biomass has oscillated showing small increase and decreases continuously.

SS estimated spawning biomass generally followed the trajectory of total biomass. SS estimated spawning stock biomass increased from the late 1990's through about 2003, then decreased through 2006. Since then, SS estimated total biomass has increased continuously.
Predicted abundance at age was presented in Figures 3.2.4.7 and Figure 3.2.5.2 for the final SS Base model. SS predicted the mean age of Gulf of Mexico Greater Amberjack to be ~ 1.9 in the virgin state. The population mean age declined significantly to 0.6 soon thereafter, then increased in the early 1950's to about 1.0 and remained nearly unchanged until around 2010. The SS estimated average age at the beginning of 2012 was 0.6. The trajectory of SS estimated age in the population suggests that rather large changes in average age in the population occurred initially and since the mid 1980's average age in the population has experienced moderate increases and decreases. SS estimated average age indicates about a 20% decline since 2010 from 0.98 to 0.6 (Figure 3.2.5.3). These results are difficult to interpret since increasing mean age can result from the increasing age of a recovering population, or from recruitment failure. Likewise, decreasing mean age can result from juvenescence due to overexploitation, or from a series of strong recruitment classes.

3.2.6 Fishing Mortality

Exploitation rate (catch in weight including discards / total biomass) was used as the proxy for annual fishing mortality rate in this assessment. Predicted annual fishing mortality rates are presented in Tables 3.2.4.1 and 3.2.6.1 and Figure 3.2.6.1 (Top Panel for exploitation rate for all fleets combined) for the final SS Base model. Predicted annual fishing mortality estimates (all fleets combined) shows increasing but low levels of F through the late 1980s. Between the early 1980's and continuing through the mid 1990's, steady and large increasing trends in F were estimated. Since the mid 1990's estimated total annual F's have in general declined with the exception of years between 2003 and 2005 which showed increases in F.

The trend in annual instantaneous fishing mortality (F) by fleet is variable particularly since the years of implementation of fishery regulations (1987) (Table 3.2.6.1, Figure 3.2.6.1, lower panel for fleet specific F's). In particular, annual F's for the COM_HL fleet declined significantly since the early 1990s and has shown continued declines through recent years. Estimated annual Fs from the COM_LL fleet have been for the most part through remained very low over the time series, except for significant increases beginning around 1981. Only small changes in COM_LL F were predicted by the SS model.

Annual estimated Fs for the recreational REC fleet (combined private and charter) and the Headboat fleet showed similar patterns of increasing F beginning in the early 1980's continuing until the early 1990's as with the COM_HL fleet. Estimated REC F declined sharply between 1991 and 1995, and has remained relatively stable since with only moderate increases in estimated F (Figure 3.2.6.1).

The more recent years of declines in estimated F since the mid to late 1990's correspond to various management actions associated with the Gulf of Mexico greater amberjack fisheries including: a) implementation of the Fishery Management Plan for Reeffish Resources of the Gulf of Mexico (1990), b) implementation of size and bag limits (1990) for the recreational and commercial fisheries, c) implementation of a spawning season closure (1998) implementation of recreational and commercial quotas in 2003, and d) closures due to meeting quotas. In addition to these management actions, varying bag limits have been in place since the initial time of implementation in 1987.

3.2.7 Evaluation of Uncertainty

Tables 3.1.4.1 and 3.2.2.1 presented estimates of asymptotic standard errors for all SS estimated parameters for the Gulf of Mexico Greater Amberjack stock assessment for the final Base Model run configuration and across the summarized 1,500 bootstraps respectively. Table 3.1.6.1 provided a listing of all the sensitivity runs carried out for the stock assessment. Table 3.2.7.1 and Figures 3.2.7.1 - 3.2.7.4 provides results of all the sensitivity analyses considered for the stock assessment. Table 3.2.2.1 provide a complete listing of the mean and standard deviation from the summaries of the 1,500 bootstrap runs that were made for the final SS Base model run (Run 1, Table 3.1.6.1) . Detailed results are summarized in the following sections for the various sensitivity and retrospective and alternative run configurations that were conducted to further examine impacts on model results from varying assumptions on steepness, natural mortality, data exclusion, data weighting and discard release mortality.

The estimated standard errors estimated from the bootstrap analysis are generally very low for most parameters estimated in the stock assessment indicating that for most of the estimated parameters model precision of parameters estimated is reasonable (Table 3.2.2.1). Figure 3.2.4.6 presents estimates of the asymptotic standard errors for annual recruitment deviations. Annual Estimated asymptotic errors for the annual recruitment deviations ranged from -2.1 to 1.15 over the time series estimated. Several years were characterized by large recruitment deviations (1984, 2011) and as noted earlier these years are associated with years having little or no composition (age, length) or indices with which to inform the model. As noted earlier, in general, many of the standard errors associated with the selectivity parameters had large standard errors (Tables 3.2.2.1).

As discussed above, concerns around estimating the steepness parameter profiling of steepness and the virgin stock level (R0), and the recruitment standard deviation (sigmaR SS parameter) existed. Therefore, profiling of these parameters was carried out. Figures 3.2.4.1 – Figures 3.2.4.3 presented profiles for steepness, R0, and for sigmaR for the final Base model configuration (Run 1 Table 3.2.2.1). From the profile of sigmaR (Figure 3.2.4.3) the results did not indicate any major deviance from the input value specified for this fixed parameter (0.6) thus this model parameter value was not further adjusted in the final SS Base model configuration.

Figure 3.2.4.4 (a, b) presented the results of the bootstrap runs that were made for the final Base model (Run 1,Table 3.2.2.1). The results show that SS did not show any major difficulties with estimating the Beverton and Holt steepness parameter. The model estimated maximum likelihood value for steepness was 0.838; the bootstrap evaluations estimated a median value for steepness of 0.845 . The SEDAR 33 AP felt that a steepness of around 0.8 was reasonable for this species.

Table 3.2.7.1 and Figure 3.2.7.1 provides results of sensitivity analyses for the value of natural mortality input into the Lorenzen function. All comparisons were against the final base SS model configuration which estimated steepness and R0. Key model output quantities were examined including: 1) total biomass (virgin, current biomass) 2) spawning biomass (virgin, current), and recruitment (virgin, current). The trend results suggested that the model was sensitive to input assumptions regarding the level of natural mortality at age. Particularly to the LOW M (M = 0.15 point estimate input into the Lorenzen M function) which results in higher levels of virgin biomass. Estimated virgin total and virgin recruitment for the scenarios assuming the low value of the range suggested a very different level of virgin biomass than either for the final Base model input value (0.28 into the Lorenzen function) or for the model assuming the high end of the range (0.35) or the model that adjusted the M at age 0 (from the Base Model) to account for time of spawning, as input into the Lorenzen function. Neither varying the input level of M from the initial base level (0.28) altered the SS estimated current stock status from that of the Base Model relative to SPR30% (Table 3.2.7.1). In all cases, the current SSB was below SSB at SPR30.

Figure 3.2.7.2and Table 3.2.7.1 presents results of impacts on key quantities output from SS from varying steepness in response to concern over the model's ability to estimate this parameter under the sensitivity examination. Figure 3.3.2.7.2 provides SS results of varying assumptions on the Beverton – Holt steepness parameter, to the growth parameter assumptions, and to the assumptions on initial conditions. Results indicate that SS estimate of SSB, F and equilibrium SPR, and stock status relative to management benchmarks remained virtually unchanged from the base model.

Figure 3.2.7.3 and Table 3.2.7.1 present results from evaluating the impact of release mortality on SS estimates of SSB, F, equilibrium SPR, and stock status relative to management benchmarks. In general assumptions of release mortality had little to no impact on SS estimate of SSB, F and equilibrium SPR, and stock status relative to management benchmarks remained unchanged from the base model.

Figure 3.2.7.4 and Table 3.2.7.1presents results of retrospective analyses for 2005-2011. Three model output quantities shown in the plots are: 1) spawning biomass, 2) recruitment, and 3) spawning potential ratio (SPR). There was some variability in model estimate of the terminal year of data for these key parameters as years of data were dropped from the assessment but no strong systematic bias was either discernible nor did SS predict any large divergence in the estimates for any of the three parameters observed. Eliminating sequential years of data did not alter the SS estimated current stock status from the final Base Model run model relative to SPR30%.

As described earlier, the SS bootstrap procedure previously described in Section 3.1.6 (Methods) and 3.2.7 (Results, Uncertainty) was used to further explore uncertainty in the SS model assumptions. For the final Base model run (Run 1, Table 3.1.6.1) the parametric bootstrap procedure was carried out within the R4SS package. Due to time constraints only 1,500 bootstraps were made for the final Base Model. Figures 3.2.4.4 and Table 3.2.2.1 present the results for various key quantities estimated by SS.

3.2.8 Benchmarks/Reference points

Benchmarks for the SPR30% reference point are presented in Table 3.2.8.1. The SPR30% reference point was used as a proxy for FMSY as recommended in the SEDAR 33 Gulf of Mexico Greater Amberjack TORs. The maximum fishing mortality threshold (MFMT) was the fishing mortality rate that produced a SPR of 30%, $F_{SPR30\%}$. The minimum stock size threshold (MSST) was calculated as (1-*M*) * $SSB_{SPR30\%}$. Figures 3.2.8.1 (a, b) and 3.2.8.2 presents a phase plot of the SPR30% reference point for the stock assessment for the final Base Model run and each alternative model examined corresponding to varying assumptions of natural mortality at age, steepness, initial conditions, and discard mortality, and retrospective examinations. Table 3.1.6.1 presented details of each of the varying model configurations examined in the greater amberjack stock assessment. Figure 3.2.4.4b provides estimates of reference points for status determinations of the overfished and overfishing states (SSB_REF, _REF) from the bootstrap runs for the final base Model. These results in total suggest that the Gulf of Mexico greater amberjack remains slightly overfished under the majority of the model scenarios examined and the stock is undergoing a small degree of overfishing under most of the scenarios examined.

3.2.9 Projections

According to the SEDAR 33 Terms of Reference evaluations were made according to these MSRA criteria:

A) If stock is overfished:
$F=0$, $F_{Current}$, F_{MSY}, F_{OY}
$F=F_{Rebuild}$ (max that permits rebuild in allowed time)

B) If stock is undergoing overfishing:
F= $F_{Current}$, F_{MSY}, F_{OY}

C) If stock is neither overfished nor undergoing overfishing:
F= $F_{Current}$, F_{MSY}, F_{OY}

3.2.9.1 Deterministic

Projection results for forecasted retained catches (mtons) are presented in Tables 3.2.8.2 and 3.2.9.1 and 3.2.9.2. Deterministic projections are also presented in Figures 3.2.9.1.1 and 3.2.9.1.2 for the final SS Base model run requested by the SEDAR 33 AP. Metrics included are spawning stock biomass (SSB), SSB and fishing mortality (F) relative to $SSB_{SPR30\%}$, $F_{SPR30\%}$, and F_{MSY}. Projections are presented for the final base model (Run 1, Table 3.1.6.1).

3.2.9.2 Stochastic

Stochastic projections for the $F_{30\%SPR}$ benchmark were made using the SS parametric bootstrap procedure previously described in Section 3.1.9.

Projection results for forecasted retained catches (mtons) for 2013-2042 are presented in Figures 3.2.9.2.1 - 3.2.9.2.2 for the final SS Base model run requested by the SEDAR 33 AP. Metrics included are spawning stock biomass (SSB) and fishing mortality (F) relative to $SSB_{SPR30\%}$, and $F_{SPR30\%}$. Projections are presented for the final base model (Run 1, Table 3.1.6.1).

3.2.10 Tables

Table 3.2.2.1. Mean and standard deviation of parameter estimates from 1,500 bootstrap samples for Gulf of Mexico Greater amberjack for the Base model run (LM Age0 M Natural Mortality scenario, Beverton and Holt steepness and R0 parameters estimated). Fixed parameter can be identified by a SE = 0.0.

PARAMETER	Mean	Median	Standard error
L_at_Amin_Fem_GP_1	29.227	29.279	0.882
L_at_Amax_Fem_GP_1	143.600	143.600	0.000
VonBert_K_Fem_GP_1	0.147	0.147	0.003
SR_LN(R0)	7.767	7.766	0.035
SR_BH_steep	0.845	0.845	0.022
SR_envlink	0.000	0.000	0.000
SR_R1_offset	0.001	0.001	0.003
SR_autocorr	0.000	0.000	0.000
Main_RecrDev_1984	-0.957	-0.957	0.197
Main_RecrDev_1985	0.349	0.348	0.096
Main_RecrDev_1986	0.786	0.785	0.075
Main_RecrDev_1987	-0.293	-0.287	0.135
Main_RecrDev_1988	-0.086	-0.087	0.128
Main_RecrDev_1989	1.097	1.099	0.068
Main_RecrDev_1990	0.253	0.259	0.150
Main_RecrDev_1991	0.267	0.278	0.142
Main_RecrDev_1992	-0.409	-0.400	0.189
Main_RecrDev_1993	0.432	0.437	0.101
Main_RecrDev_1994	0.345	0.352	0.110
Main_RecrDev_1995	-0.844	-0.839	0.193
Main_RecrDev_1996	-0.533	-0.530	0.158
Main_RecrDev_1997	0.494	0.496	0.084
Main_RecrDev_1998	-0.569	-0.561	0.150
Main_RecrDev_1999	0.777	0.777	0.067
Main_RecrDev_2000	0.855	0.856	0.062
Main_RecrDev_2001	0.093	0.094	0.082
Main_RecrDev_2002	-0.517	-0.515	0.096
Main_RecrDev_2003	-0.126	-0.124	0.064
Main_RecrDev_2004	-0.435	-0.434	0.070
Main_RecrDev_2005	0.041	0.041	0.054
Main_RecrDev_2006	0.259	0.259	0.053
Main_RecrDev_2007	0.226	0.227	0.060
Main_RecrDev_2008	0.133	0.133	0.075

Table 3.2.2.1. (continued).

Main_RecrDev_2009	-0.099	-0.097	0.094
Main_RecrDev_2010	-1.463	-1.463	0.180
Main_RecrDev_2011	-0.075	-0.070	0.113
Late_RecrDev_2012	0.382	0.387	0.131
InitF_3REC_3	0.032	0.032	0.002
InitF_4Headboat_4	0.010	0.010	0.001
SizeSel_1P_1_Com_HL_1	105.834	105.515	2.586
SizeSel_1P_2_Com_HL_1	-8.776	-10.735	3.488
SizeSel_1P_3_Com_HL_1	7.211	7.209	0.066
SizeSel_1P_4_Com_HL_1	3.162	4.152	3.172
SizeSel_1P_5_Com_HL_1	-15.000	-15.000	0.000
SizeSel_1P_6_Com_HL_1	-0.848	-0.842	0.228
Retain_1P_1_Com_HL_1	50.800	50.800	0.000
Retain_1P_2_Com_HL_1	1.000	1.000	0.000
Retain_1P_3_Com_HL_1	1.000	1.000	0.000
Retain_1P_4_Com_HL_1	0.000	0.000	0.000
DiscMort_1P_1_Com_HL_1	-2.000	-2.000	0.000
DiscMort_1P_2_Com_HL_1	1.000	1.000	0.000
DiscMort_1P_3_Com_HL_1	0.200	0.200	0.000
DiscMort_1P_4_Com_HL_1	0.000	0.000	0.000
SizeSel_2P_1_Com_LL_2	106.787	106.711	2.328
SizeSel_2P_2_Com_LL_2	33.101	33.102	1.024
Retain_2P_1_Com_LL_2	50.800	50.800	0.000
Retain_2P_2_Com_LL_2	1.000	1.000	0.000
Retain_2P_3_Com_LL_2	0.900	0.900	0.000
Retain_2P_4_Com_LL_2	0.000	0.000	0.000
DiscMort_2P_1_Com_LL_2	-2.000	-2.000	0.000
DiscMort_2P_2_Com_LL_2	1.000	1.000	0.000
DiscMort_2P_3_Com_LL_2	0.200	0.200	0.000
DiscMort_2P_4_Com_LL_2	0.000	0.000	0.000
SizeSel_3P_1_REC_3	87.006	87.453	1.703
SizeSel_3P_2_REC_3	-11.499	-12.634	2.986
SizeSel_3P_3_REC_3	7.442	7.451	0.088
SizeSel_3P_4_REC_3	-7.581	-8.320	4.363
SizeSel_3P_5_REC_3	-10.000	-10.000	0.000
SizeSel_3P_6_REC_3	0.426	0.400	0.368
Retain_3P_1_REC_3	50.800	50.800	0.000
Retain_3P_2_REC_3	1.000	1.000	0.000
Retain_3P_3_REC_3	1.000	1.000	0.000

Table 3.2.2.1. (continued).

Retain_3P_4_REC_3	0.000	0.000	0.000
DiscMort_3P_1_REC_3	-2.000	-2.000	0.000
DiscMort_3P_2_REC_3	1.000	1.000	0.000
DiscMort_3P_3_REC_3	0.200	0.200	0.000
DiscMort_3P_4_REC_3	0.000	0.000	0.000
SizeSel_4P_1_Headboat_4	82.035	82.601	4.439
SizeSel_4P_2_Headboat_4	-8.113	-10.418	3.808
SizeSel_4P_3_Headboat_4	7.211	7.266	0.756
SizeSel_4P_4_Headboat_4	4.692	4.745	0.484
SizeSel_4P_5_Headboat_4	-10.000	-10.000	0.000
SizeSel_4P_6_Headboat_4	-1.041	-1.039	0.182
Retain_4P_1_Headboat_4	50.800	50.800	0.000
Retain_4P_2_Headboat_4	1.000	1.000	0.000
Retain_4P_3_Headboat_4	1.000	1.000	0.000
Retain_4P_4_Headboat_4	0.000	0.000	0.000
DiscMort_4P_1_Headboat_4	-2.000	-2.000	0.000
DiscMort_4P_2_Headboat_4	1.000	1.000	0.000
DiscMort_4P_3_Headboat_4	0.200	0.200	0.000
DiscMort_4P_4_Headboat_4	0.000	0.000	0.000
SizeSel_6P_1_SEAMAP_Video_Survey_6	41.807	41.878	1.202
SizeSel_6P_2_SEAMAP_Video_Survey_6	14.684	14.698	1.386
SizeSel_7P_1_PANAMA_CITY_TRAP_VIDEO_SURVEY_7	50.239	42.683	20.696
SizeSel_7P_2_PANAMA_CITY_TRAP_VIDEO_SURVEY_7	-6.326	-6.695	3.651
SizeSel_7P_3_PANAMA_CITY_TRAP_VIDEO_SURVEY_7	-15.000	-15.000	0.000
SizeSel_7P_4_PANAMA_CITY_TRAP_VIDEO_SURVEY_7	3.896	6.592	5.209
SizeSel_7P_5_PANAMA_CITY_TRAP_VIDEO_SURVEY_7	1.574	0.687	2.655
SizeSel_7P_6_PANAMA_CITY_TRAP_VIDEO_SURVEY_7	-15.000	-15.000	0.000
AgeSel_1P_1_Com_HL_1	0.100	0.100	0.000
AgeSel_1P_2_Com_HL_1	10.000	10.000	0.000
AgeSel_2P_1_Com_LL_2	0.100	0.100	0.000
AgeSel_2P_2_Com_LL_2	10.000	10.000	0.000
AgeSel_3P_1_REC_3	0.100	0.100	0.000
AgeSel_3P_2_REC_3	10.000	10.000	0.000
AgeSel_4P_1_Headboat_4	0.100	0.100	0.000
AgeSel_4P_2_Headboat_4	10.000	10.000	0.000
AgeSel_6P_1_SEAMAP_Video_Survey_6	0.100	0.100	0.000
AgeSel_6P_2_SEAMAP_Video_Survey_6	10.000	10.000	0.000
AgeSel_7P_1_PANAMA_CITY_TRAP_VIDEO_SURVEY_7	0.100	0.100	0.000
AgeSel_7P_2_PANAMA_CITY_TRAP_VIDEO_SURVEY_7	10.000	10.000	0.000

Table 3.2.2.1. (continued).

Retain_1P_1_Com_HL_1_BLK1repl_1950	17.500	17.500	0.000
Retain_1P_1_Com_HL_1_BLK1repl_1990	99.168	99.338	0.794
Retain_1P_1_Com_HL_1_BLK1repl_2008	95.628	95.630	1.457
Retain_1P_2_Com_HL_1_BLK1repl_1950	1.000	1.000	0.000
Retain_1P_2_Com_HL_1_BLK1repl_1990	6.613	6.614	0.183
Retain_1P_2_Com_HL_1_BLK1repl_2008	7.224	7.205	0.474
Retain_2P_1_Com_LL_2_BLK2repl_1950	17.500	17.500	0.000
Retain_2P_1_Com_LL_2_BLK2repl_1990	98.492	98.791	1.498
Retain_2P_2_Com_LL_2_BLK2repl_1950	1.000	1.000	0.000
Retain_2P_2_Com_LL_2_BLK2repl_1990	8.274	8.274	0.478
Retain_3P_1_REC_3_BLK3repl_1950	10.512	10.441	0.364
Retain_3P_1_REC_3_BLK3repl_1991	68.084	68.670	6.412
Retain_3P_1_REC_3_BLK3repl_1998	70.977	70.989	0.684
Retain_3P_1_REC_3_BLK3repl_2009	81.117	81.134	0.943
Retain_3P_2_REC_3_BLK3repl_1950	1.131	1.107	0.104
Retain_3P_2_REC_3_BLK3repl_1991	6.877	6.932	0.775
Retain_3P_2_REC_3_BLK3repl_1998	4.271	4.270	0.223
Retain_3P_2_REC_3_BLK3repl_2009	4.524	4.534	0.282
Retain_4P_1_Headboat_4_BLK3repl_1950	14.378	11.482	4.568
Retain_4P_1_Headboat_4_BLK3repl_1991	72.724	72.726	0.970
Retain_4P_1_Headboat_4_BLK3repl_1998	70.719	70.669	0.823
Retain_4P_1_Headboat_4_BLK3repl_2009	82.847	82.815	1.126
Retain_4P_2_Headboat_4_BLK3repl_1950	1.794	1.312	1.077
Retain_4P_2_Headboat_4_BLK3repl_1991	5.768	5.761	0.326
Retain_4P_2_Headboat_4_BLK3repl_1998	5.102	5.103	0.272
Retain_4P_2_Headboat_4_BLK3repl_2009	5.403	5.400	0.330

Table 3.2.2.2. Summary results for Gulf of Mexico Greater amberjack for model convergence level, total likelihood, unfished spawning biomass (R0), SSB@30%SPR (SSB_SPRTtgt), predicted spawning stock biomass in 2011 (SSB_2011, whole weight, mtons), predicted spawning potential ratio 2012 (SPR_2012), F_SPRTtgt (equals F30%SPR), Fcurrent), SSB_REF and F_REF from the SS jitter analysis for Base Model Run (LM Age0 M Natural Mortality scenario, Beverton and Holt steepness and R0 parameters estimated). $F_{Current}$ = geometric mean of F in 2010 through 2012. SSB_REF = SSB_2012 / SSB_MSST. MSST = (1.0-M) * SSB@30%SPR. F_REF= $F_{current}$ /F_SPRTtgt.

Run ID	Likelihood	R0	Steepness	Virgin Bio.	SSB SPRTtgt	SSB 2012	SPR 2012	F/ FSPR	F Current	Initial F REC	Initial F Headboat	SSB2012 /SSBSPRTtgt	FCurrent /FSPRTtgt
1	5603	7.778	0.838	19052	3322	2213	0.31	0.2	0.21	0.03	0.01	0.67	1.03
2	5607	7.758	0.848	18543	3252	2071	0.3	0.21	0.22	0.03	0.01	0.64	1.06
3	5604	7.777	0.838	19034	3319	2195	0.31	0.2	0.21	0.03	0.01	0.66	1.03
4	5602	7.763	0.834	18704	3241	2101	0.3	0.21	0.22	0.03	0.01	0.65	1.05
5	5604	7.777	0.838	19034	3319	2195	0.31	0.2	0.21	0.03	0.01	0.66	1.03
6	5630	7.738	0.848	18024	3150	1882	0.28	0.21	0.23	0.03	0.01	0.6	1.12
7	5596	7.77	0.847	18928	3335	2217	0.3	0.2	0.22	0.03	0.01	0.66	1.05
8	5604	7.777	0.838	19034	3319	2195	0.31	0.2	0.21	0.03	0.01	0.66	1.03
9	5596	7.77	0.847	18928	3335	2217	0.3	0.2	0.22	0.03	0.01	0.66	1.05
10	5618	7.765	0.832	18741	3238	2119	0.31	0.21	0.21	0.03	0.01	0.65	1.02
11	5603	7.778	0.838	19052	3322	2213	0.31	0.2	0.21	0.03	0.01	0.67	1.03
12	5596	7.756	0.844	18585	3259	2109	0.29	0.21	0.22	0.03	0.01	0.65	1.08
14	5596	7.77	0.847	18928	3335	2217	0.3	0.2	0.22	0.03	0.01	0.66	1.05
15	5598	7.77	0.847	18912	3332	2201	0.3	0.2	0.22	0.03	0.01	0.66	1.06
16	5605	7.777	0.838	19030	3318	2193	0.31	0.2	0.21	0.03	0.01	0.66	1.03
17	5605	7.764	0.835	18701	3245	2081	0.3	0.21	0.22	0.03	0.01	0.64	1.06
18	5603	7.778	0.838	19052	3322	2213	0.31	0.2	0.21	0.03	0.01	0.67	1.03
19	5603	7.778	0.838	19052	3322	2213	0.31	0.2	0.21	0.03	0.01	0.67	1.03
20	5596	7.77	0.847	18928	3334	2213	0.3	0.2	0.22	0.03	0.01	0.66	1.05
21	5596	7.77	0.847	18928	3335	2217	0.3	0.2	0.22	0.03	0.01	0.66	1.05
22	5596	7.756	0.844	18585	3259	2109	0.29	0.21	0.22	0.03	0.01	0.65	1.08
23	5605	7.777	0.839	19012	3316	2179	0.31	0.2	0.21	0.03	0.01	0.66	1.03
24	5603	7.778	0.838	19052	3322	2213	0.31	0.2	0.21	0.03	0.01	0.67	1.03
25	5604	7.777	0.838	19034	3319	2195	0.31	0.2	0.21	0.03	0.01	0.66	1.03
26	5603	7.778	0.838	19052	3322	2213	0.31	0.2	0.21	0.03	0.01	0.67	1.03
27	5602	7.778	0.838	19052	3321	2210	0.31	0.2	0.21	0.03	0.01	0.67	1.03
28	5593	7.782	0.848	19162	3380	2241	0.3	0.2	0.21	0.03	0.01	0.66	1.05
29	5596	7.77	0.847	18928	3335	2217	0.3	0.2	0.22	0.03	0.01	0.66	1.05
30	5596	7.758	0.841	18493	3217	2034	0.3	0.21	0.22	0.03	0.01	0.63	1.07

Table 3.2.2.2. (continued).

31	5602	7.778	0.838	19052	3321	2210	0.31	0.2	0.21	0.03	0.01	0.67	1.03
32	5604	7.777	0.838	19034	3319	2195	0.31	0.2	0.21	0.03	0.01	0.66	1.03
33	6477	7.372	0.99	12828	2544	1975	0.29	0.21	0.22	0.05	0.02	0.78	1.07
34	5598	7.77	0.847	18912	3332	2201	0.3	0.2	0.22	0.03	0.01	0.66	1.06
35	5632	7.75	0.841	18335	3191	1952	0.29	0.21	0.23	0.03	0.01	0.61	1.1
36	5596	7.77	0.847	18928	3335	2217	0.3	0.2	0.22	0.03	0.01	0.66	1.05
37	5603	7.778	0.838	19052	3322	2213	0.31	0.2	0.21	0.03	0.01	0.67	1.03
38	5617	7.744	0.845	18200	3176	1946	0.29	0.21	0.23	0.03	0.01	0.61	1.1
39	5609	7.764	0.847	18809	3310	2206	0.3	0.2	0.22	0.03	0.01	0.67	1.05
40	5604	7.777	0.838	19027	3318	2190	0.31	0.2	0.21	0.03	0.01	0.66	1.03
41	5596	7.755	0.844	18570	3257	2112	0.29	0.21	0.22	0.03	0.01	0.65	1.08
42	5596	7.77	0.847	18928	3335	2217	0.3	0.2	0.22	0.03	0.01	0.66	1.05
43	5596	7.756	0.844	18585	3259	2109	0.29	0.21	0.22	0.03	0.01	0.65	1.08
44	5604	7.777	0.838	19034	3319	2195	0.31	0.2	0.21	0.03	0.01	0.66	1.03
45	5618	7.779	0.835	19071	3315	2225	0.32	0.2	0.2	0.03	0.01	0.67	1
46	5598	7.77	0.847	18912	3332	2201	0.3	0.2	0.22	0.03	0.01	0.66	1.06
47	5636	7.762	0.838	18562	3218	2012	0.3	0.21	0.22	0.03	0.01	0.63	1.05
48	5598	7.77	0.847	18912	3332	2201	0.3	0.2	0.22	0.03	0.01	0.66	1.06
49	5602	7.778	0.838	19052	3321	2210	0.31	0.2	0.21	0.03	0.01	0.67	1.03
50	5603	7.778	0.838	19052	3322	2213	0.31	0.2	0.21	0.03	0.01	0.67	1.03

Table 3.2.4.1. Predicted total biomass (whole weight mtons), spawning biomass (whole weight mtons), age-0 recruits (thousand fish), and fishing mortality for Gulf of Mexico Greater amberjack from SS Base Model Run (LM Age0 M Natural Mortality scenario, Beverton and Holt steepness parameter estimated).

Year	Total Biomass	Spawning Biomass	Recruits	Fishing Mortality
1950	16037	10006	2354	0.0500
1951	15674	9759	2351	0.0531
1952	15309	9490	2347	0.0563
1953	14950	9209	2342	0.0594
1954	14602	8928	2337	0.0626
1955	14269	8653	2332	0.0658
1956	13951	8388	2327	0.0690
1957	13648	8135	2322	0.0723
1958	13359	7896	2317	0.0756
1959	13084	7669	2312	0.0790
1960	12822	7454	2307	0.0824
1961	12570	7250	2302	0.0839
1962	12350	7070	2297	0.0852
1963	12159	6911	2293	0.0868
1964	11987	6770	2289	0.0880
1965	11838	6646	2285	0.0891
1966	11706	6538	2282	0.0911
1967	11580	6436	2278	0.0939
1968	11449	6332	2275	0.0952
1969	11331	6238	2272	0.0996
1970	11189	6129	2268	0.0993
1971	11078	6041	2265	0.1045
1972	10934	5933	2261	0.1091
1973	10771	5811	2257	0.1132
1974	10598	5682	2252	0.1187
1975	10404	5538	2246	0.1253
1976	10185	5375	2239	0.1284
1977	9981	5220	2232	0.1326
1978	9780	5066	2224	0.1367
1979	9586	4917	2217	0.1395
1980	9408	4781	2209	0.1435
1981	9235	4649	2202	0.0906
1982	9558	4815	2211	0.2841
1983	8129	3968	2157	0.1773

Table 3.2.4.1 (continued).

1984	7844	3771	542	0.1724
1985	7096	3633	2596	0.2353
1986	6800	3243	3913	0.3583
1987	6516	2435	1201	0.3611
1988	5571	1925	1455	0.3993
1989	4871	1652	4811	0.4958
1990	5302	1303	1949	0.2147
1991	6186	1512	2143	0.5554
1992	5220	1242	957	0.4249
1993	4629	1366	2342	0.5485
1994	4203	1148	2131	0.4624
1995	4148	1002	452	0.3328
1996	3875	1115	861	0.4559
1997	3309	1102	2327	0.3847
1998	3597	1089	747	0.3117
1999	3604	1051	3050	0.2960
2000	4570	1128	3348	0.2816
2001	5706	1280	1610	0.2317
2002	6197	1649	923	0.2900
2003	5820	1997	1443	0.3954
2004	4967	1931	1035	0.3719
2005	4252	1694	1634	0.3354
2006	4097	1488	1952	0.2976
2007	4340	1385	1872	0.2078
2008	4906	1521	1749	0.2109
2009	5332	1748	1550	0.2633
2010	5291	1876	195	0.2194
2011	4852	2072	1631	0.2023
2012	4920	2210	1943	0.2102

Table 3.2.6.1. Fleet-specific estimates of fishing mortality rate in terms of exploitable biomass for Gulf of Mexico Greater amberjack from SS for the Base Model run Base model (LM Age0 M Natural Mortality scenario, Beverton and Holt steepness parameter estimated).

		Fleet Continuous Fishing Mortality			
Year	**Annual Exploitation Rate**	**Com_HL**	**Com_LL**	**REC**	**Headboat**
1950	0.050	0.000	0.000	0.056	0.023
1951	0.053	0.000	0.000	0.061	0.023
1952	0.056	0.000	0.000	0.065	0.024
1953	0.059	0.000	0.000	0.070	0.024
1954	0.063	0.000	0.000	0.074	0.024
1955	0.066	0.000	0.000	0.079	0.024
1956	0.069	0.000	0.000	0.083	0.025
1957	0.072	0.000	0.000	0.088	0.025
1958	0.076	0.000	0.000	0.092	0.025
1959	0.079	0.000	0.000	0.097	0.025
1960	0.082	0.000	0.000	0.102	0.026
1961	0.084	0.000	0.000	0.104	0.026
1962	0.085	0.000	0.000	0.106	0.026
1963	0.087	0.001	0.000	0.107	0.026
1964	0.088	0.000	0.000	0.109	0.026
1965	0.089	0.000	0.000	0.110	0.026
1966	0.091	0.001	0.000	0.113	0.027
1967	0.094	0.002	0.000	0.115	0.027
1968	0.095	0.001	0.000	0.118	0.027
1969	0.100	0.006	0.000	0.121	0.027
1970	0.099	0.001	0.000	0.124	0.027
1971	0.105	0.003	0.000	0.130	0.027
1972	0.109	0.004	0.000	0.137	0.028
1973	0.113	0.002	0.000	0.144	0.028
1974	0.119	0.004	0.000	0.151	0.028
1975	0.125	0.007	0.000	0.158	0.028
1976	0.128	0.008	0.000	0.162	0.029
1977	0.133	0.012	0.000	0.165	0.029
1978	0.137	0.015	0.000	0.169	0.029
1979	0.139	0.015	0.001	0.172	0.030
1980	0.143	0.018	0.001	0.176	0.030
1981	0.091	0.022	0.004	0.107	0.009
1982	0.284	0.020	0.008	0.348	0.105
1983	0.177	0.029	0.011	0.208	0.042

Table 3.2.6.1. (Continued).

1984	0.172	0.060	0.016	0.200	0.019
1985	0.235	0.090	0.032	0.240	0.040
1986	0.358	0.147	0.067	0.380	0.088
1987	0.361	0.257	0.115	0.387	0.056
1988	0.399	0.379	0.208	0.331	0.036
1989	0.496	0.408	0.250	0.408	0.057
1990	0.215	1.116	0.198	0.046	0.023
1991	0.555	2.000	0.016	0.915	0.048
1992	0.425	1.402	0.160	0.518	0.090
1993	0.549	1.861	0.234	0.569	0.073
1994	0.462	1.618	0.201	0.512	0.087
1995	0.333	1.720	0.239	0.201	0.056
1996	0.456	1.745	0.171	0.386	0.060
1997	0.385	1.272	0.146	0.246	0.049
1998	0.312	0.702	0.110	0.455	0.037
1999	0.296	0.857	0.130	0.305	0.033
2000	0.282	0.966	0.142	0.320	0.033
2001	0.232	0.670	0.119	0.345	0.026
2002	0.290	0.592	0.120	0.422	0.034
2003	0.395	0.591	0.166	0.551	0.039
2004	0.372	0.572	0.091	0.511	0.026
2005	0.335	0.465	0.085	0.481	0.021
2006	0.298	0.426	0.098	0.446	0.027
2007	0.208	0.459	0.075	0.253	0.024
2008	0.211	0.256	0.110	0.326	0.022
2009	0.263	0.333	0.057	0.519	0.044
2010	0.219	0.285	0.024	0.406	0.020
2011	0.202	0.232	0.015	0.303	0.022
2012	0.210	0.128	0.033	0.378	0.030

Table 3.2.7.1. Summary of SS results from sensitivity and retrospective analysis runs for Gulf of Mexico Greater amberjack. Results include steepness; virgin recruitment (thousand fish, R0), virgin total biomass (B0), total biomass 2012(Bcurrent), virgin spawning biomass (SSB_UNFISHED= SSB_BO), 2012 spawning biomass (SSB-2011), spawning potential ratio (SPR_2012). For the retrospective runs values for '2012" were the terminal year in the run (i.e., 2006 retrospective terminal year = 2006). Weight units are whole weight mtons.

Run	**Steepness**	**R0**	**B0**	**B2012**	**SSB0**	**SSB2012**	**SSB2012/SSB0**	**Equil SPR2012**
BASE	0.838	2,383	19,017	4,920	12,532	2,210	0.176	0.31
RedAge0M	0.838	1,981	19,165	4,924	12,666	2,228	0.176	0.31
EstLAgeMax	0.862	2,280	19,269	4,626	13,229	2,062	0.156	0.277
Low M	0.979	748	32,198	3,907	26,858	2,033	0.076	0.148
High M	0.724	4,485	17,403	5,611	9,584	2,223	0.232	0.392
Virg 1950	0.848	2,398	19,026	4,960	12,655	2,238	0.177	0.3
Rel Mort 0.15	0.807	2,447	19,585	4,729	12,947	2,148	0.166	0.307
Rel Mort 0.1	0.764	2,486	19,911	4,485	13,147	2,040	0.155	0.321
Rel Mort 0.05	0.736	2,500	19,989	4,193	13,187	1,898	0.144	0.325
Rel Mort 0.0	0.696	2,591	20,868	4,062	13,825	1,880	0.136	0.339
InitFs 1963	0.836	2,397	19,132	4,921	12,618	2,212	0.175	0.31
Fix Stp 0.8	0.8	2,523	20,182	4,846	13,327	2,201	0.165	0.298
Retrospective Terminal Year	**Steepness**	**R0**	**B0**	**B_2012**	**SSB0**	**SSB_TY**	**SSB_TY/SSB_0**	**Equil SPR_TY**
2011	0.828	2,432	19,509	4,914	12,885	1,931	0.15	0.306
2010	0.806	2,453	20,062	4,678	13,380	1,589	0.119	0.207
2009	0.847	2,502	20,551	4,316	13,771	1,764	0.128	0.214
2008	0.844	2,443	19,762	3,999	13,082	1,477	0.113	0.211
2007	0.81	2,545	20,801	4,147	13,877	1,776	0.128	0.291

Table 3.2.8.1. Reference points and benchmarks from sensitivity runs for Gulf of Mexico Greater Amberjack from SS. $F_{Current}$ refers to the mean of 2010-2012 values, except for retrospectives where $F_{Current}$ is the mean of the three most recent F estimates (e.g. for the 2009 retrospective, $F_{Current}$ = average F 2007-2009). MSST (Minimum Stock Size Threshold) is equal to (1-M)*SSB@FSPR30 with M = 0.28, or M=0.15, or M=0.35 representing the M value from the Hoenig maximum age mortality estimator for fully recruited ages from the SEDAR 33 DW corresponding to the Base Model M or the Low M or High M scenario. MFMT (Maximum Fishing Mortality Threshold) is equal to FSPR30. Spawning biomass units are weight in mtons, and yield units are mtons whole weight.

Run	**M**	**Fcurrent**	**SSB2012**	**Y@FSPR30**	**FSPR30**	**SSB@FSPR30**	**MFMT**	**MSST**	**F/MFMT**	**SSB/MSST**
BASE	0.28	0.211	2,210	1,584	0.205	3,313	0.205	2,385	1.028	0.927
RedAge0M	0.28	0.21	2,228	1,593	0.204	3,351	0.204	2,412	1.029	0.924
EstLAgeMax	0.28	0.224	2,062	1,554	0.196	3,583	0.196	2,580	1.141	0.799
Low M	0.15	0.281	2,033	1,741	0.147	7,958	0.147	6,765	1.909	0.3
High M	0.35	0.182	2,223	1,535	0.227	2,168	0.227	1,409	0.804	1.577
Virg 1950	0.28	0.215	2,238	1,595	0.204	3,380	0.204	2,434	1.054	0.92
Rel Mort 0.15	0.28	0.214	2,148	1,595	0.207	3,309	0.207	2,382	1.032	0.901
Rel Mort 0.1	0.28	0.209	2,040	1,583	0.212	3,176	0.212	2,286	0.988	0.892
Rel Mort 0.05	0.28	0.211	1,898	1,575	0.217	3,049	0.217	2,195	0.972	0.865
Rel Mort 0.0	0.28	0.208	1,880	1,584	0.224	2,960	0.224	2,131	0.925	0.882
InitFs 1963	0.28	0.211	2,212	1,590	0.205	3,330	0.205	2,398	1.028	0.923
Fix Stp 0.8	0.28	0.217	2,201	1,600	0.204	3,376	0.204	2,431	1.063	0.905
Retrospective Terminal Year	**R**	**Fcurrent**	**SSB_TY**	**Y@FSPR30**	**FSPR30**	**SSB@FSPR30**	**MFMT**	**MSST**	**F/MFMT**	**SSB/MSST**
2011	0.28	0.233	1,931	1,592	0.203	3,372	0.203	2,428	1.146	0.795
2010	0.28	0.267	1,589	1,484	0.194	3,413	0.194	2,458	1.38	0.646
2009	0.28	0.246	1,764	1,521	0.188	3,674	0.188	2,645	1.311	0.667
2008	0.28	0.27	1,477	1,492	0.189	3,482	0.189	2,507	1.425	0.589
2007	0.28	0.255	1,776	1,465	0.186	3,558	0.186	2,562	1.37	0.693

Table 3.2.8.2. Required SFA and MSRA evaluations using SPR 30% reference pointa for Gulf of Mexico Greater amberjack SS Base Model Run (assuming the LM_Age0 M). Spawning biomass and yield units are mtons, whole weight. $F_{Current}$ = geometric mean of $F_{2010-2012}$ and $SSB_{CURRENT}$ = SSB 2012.

Criteria	Definition	Base Model
FMSY or Proxy, Proxy=F30%SPR	F30%SPR	0.20
MFMT @F30SPR	F30%SPR	0.20
FOY	F40%SPR	0.15
FCURRENT	GEOMETRIC MEAN OF F (2010-2012)	0.21
FCURRENT / MFMT	F(2010-2012) / MFMT	1.03
FCURRENT / F40%SPR	F(2010-2012)/ F40 SPR	1.40
BASE M=0.28	**Base Natural Mortality (0.28 input into Lorenzen M function)**	
SSB_MSY OR PROXY mtons	Equilibrium SSB @ F30%SPR	3,309
MSST	(1-M)*SSB_MSY (F30%SPR) mtons	2,383
SSB_FMSY		2,366
SSB CURRENT (mtons)	SSB 2012	2,210
SSB CURRENT/ MSST	SSB 2012 / MSST	0.93
SSB CURRNT / SSB MSY	SSB 2012 / SSB MSY	0.94
EQUILIBRIUM MSY (mtons)	Equilibrium Yield @ F30%SPR	1,271
EQUILIBRIUM OY (mtons)	Equilibrium Yield @ FOY Where OY=F40%SPR	1,197

F30% SPR OFL	Annual Yield @ FMFMT (mtons)	Base Model Run
	OFL 2014	795
	OFL 2015	893
	OFL 2016	1,008
	OFL 2017	1,083
	OFL 2018	1,126
	OFL 2019	1,154
	OFL 2020	1,174
	OFL 2021	1,196
	OFL 2022	1,216

Table 3.2.8.2. (continued).

Annual OY (ACT)	**Annual Yield@ FOY (mtons) = F40% SPR**	866
	OFL 2014	666
	OFL 2015	786
	OFL 2016	878
	OFL 2017	943
	OFL 2018	992
	OFL 2019	1,029
	OFL 2020	1,065
	OFL 2021	1,097
	OFL 2022	1,119
FCURRENT	**Annual Yield @ FCURRENT (mtons)**	
	OFL 2014	804
	OFL 2015	902
	OFL 2016	1,016
	OFL 2017	1,090
	OFL 2018	1,132
	OFL 2019	1,159
	OFL 2020	1,178
	OFL 2021	1,199
	OFL 2022	1,218
FRebuild	**Annual Yield @FRebuild**	
	OFL 2014	795
	OFL 2015	893
	OFL 2016	1,008
	OFL 2017	1,083
	OFL 2018	1,126
	OFL 2019	1,154
	OFL 2020	1,174
	OFL 2021	1,196
	OFL 2022	1,216

Table 3.2.9.1. SS estimated deterministic spawning biomass (SSB) for the Base Model run and projected stock status for four fishing mortality scenarios: $F_{CURRENT}$, F_{SPR30}, FMSY, and F_{OY}=$F_{40\%SPR}$. Projection years are 2013-2042.

	Projection Scenario				**Projection Scenario**				**Projection Scenario**	
	FMSY	**FCURR**	**FSPR30**	**FSPR40**	**FMSY**	**FCURR**	**FSPR30**	**FSPR40**	**FMSY**	**FCURR**
YEAR	**SSB**	**SSB**	**SSB**	**SSB**	**SSB /SSBSPR30**	**SSB /SSBSPR30**	**SSB /SSBSPR30**	**SSB/ SSBSPR40**	**SSB /SSBMSY**	**SSB /SSBMSY**
2012	2218	2218	2218	2218	0.67	0.67	0.67	0.48	0.94	0.94
2013	2175	2175	2175	2175	0.66	0.66	0.66	0.47	0.92	0.92
2014	2106	2106	2106	2106	0.64	0.64	0.64	0.46	0.89	0.89
2015	2075	2245	2251	2415	0.63	0.68	0.68	0.52	0.88	0.95
2016	2154	2461	2474	2794	0.65	0.74	0.75	0.60	0.91	1.04
2017	2180	2610	2629	3107	0.66	0.79	0.79	0.67	0.92	1.10
2018	2155	2686	2709	3335	0.65	0.81	0.82	0.72	0.91	1.13
2019	2124	2732	2759	3512	0.64	0.83	0.83	0.76	0.90	1.15
2020	2101	2765	2795	3642	0.63	0.84	0.84	0.79	0.89	1.17
2021	2102	2823	2856	3803	0.64	0.85	0.86	0.82	0.89	1.19
2022	2106	2880	2916	3956	0.64	0.87	0.88	0.86	0.89	1.22
2023	2099	2912	2949	4053	0.63	0.88	0.89	0.88	0.89	1.23
2024	2090	2938	2977	4136	0.63	0.89	0.90	0.89	0.88	1.24
2025	2080	2959	3000	4206	0.63	0.89	0.91	0.91	0.88	1.25
2026	2069	2977	3019	4265	0.63	0.90	0.91	0.92	0.87	1.26
2027	2057	2992	3035	4314	0.62	0.90	0.92	0.93	0.87	1.26
2028	2043	3003	3047	4354	0.62	0.91	0.92	0.94	0.86	1.27
2029	2029	3012	3057	4387	0.61	0.91	0.92	0.95	0.86	1.27
2030	2012	3019	3065	4413	0.61	0.91	0.93	0.95	0.85	1.28
2031	1995	3025	3072	4436	0.60	0.91	0.93	0.96	0.84	1.28
2032	1977	3031	3077	4455	0.60	0.92	0.93	0.96	0.83	1.28
2033	1957	3035	3082	4471	0.59	0.92	0.93	0.97	0.83	1.28
2034	1935	3039	3087	4485	0.58	0.92	0.93	0.97	0.82	1.28
2035	1912	3042	3091	4497	0.58	0.92	0.93	0.97	0.81	1.28
2036	1888	3045	3094	4508	0.57	0.92	0.93	0.97	0.80	1.29
2037	1861	3048	3097	4517	0.56	0.92	0.94	0.98	0.79	1.29
2038	1833	3050	3100	4525	0.55	0.92	0.94	0.98	0.77	1.29
2039	1802	3053	3103	4533	0.54	0.92	0.94	0.98	0.76	1.29
2040	1769	3055	3106	4540	0.53	0.92	0.94	0.98	0.75	1.29
2041	1733	3057	3108	4546	0.52	0.92	0.94	0.98	0.73	1.29
2042	1693	3059	3111	4551	0.51	0.92	0.94	0.98	0.72	1.29

Table 3.2.9.2. SS estimated deterministic fishing mortality for the Base SS model and projected stock status metrics under four fishing mortality scenarios: $F_{CURRENT}$, F_{SPR30}, F_{MSY}, and FOY=$F_{40\%SPR}$. Projections years are 2013-2041.

	Projection Scenario				**Projection Scenario**				**Projection Scenario**			
	FMSY	**FCURR**	**FSPR 30**	**FSPR 40**	**FMSY**	**FCURR**	**FSPR30**	**FSPR 40**	**FMSY**	**FCURR**	**FSPR 30**	**FSPR40**
YEAR	**F**	**F**	**F**	**F**	**F/FSPR 30**	**F/FSPR 30**	**F/FSPR 30**	**F/SPR40**	**F/FMSY**	**F/FMSY**	**F/FMSY**	**F/FMSY**
2012	0.21	0.21	0.21	0.21	1.03	1.03	1.03	1.40	0.81	0.81	0.81	0.81
2013	0.20	0.20	0.20	0.20	0.99	0.99	0.99	1.34	0.78	0.78	0.78	0.78
2014	0.24	0.19	0.18	0.13	1.20	0.91	0.90	0.85	0.95	0.72	0.71	0.50
2015	0.25	0.19	0.19	0.14	1.24	0.95	0.94	0.90	0.98	0.75	0.74	0.53
2016	0.27	0.21	0.20	0.14	1.30	1.01	0.99	0.96	1.03	0.79	0.79	0.56
2017	0.27	0.21	0.21	0.15	1.33	1.04	1.02	1.00	1.05	0.82	0.81	0.58
2018	0.28	0.21	0.21	0.15	1.35	1.05	1.04	1.01	1.06	0.83	0.82	0.59
2019	0.28	0.22	0.21	0.15	1.36	1.06	1.04	1.02	1.07	0.83	0.82	0.59
2020	0.28	0.22	0.21	0.15	1.36	1.06	1.05	1.02	1.07	0.84	0.83	0.60
2021	0.28	0.22	0.21	0.15	1.37	1.06	1.05	1.03	1.08	0.84	0.83	0.60
2022	0.28	0.22	0.21	0.15	1.37	1.06	1.05	1.03	1.08	0.84	0.83	0.60
2023	0.28	0.22	0.21	0.15	1.38	1.06	1.05	1.03	1.09	0.84	0.83	0.60
2024	0.28	0.22	0.22	0.15	1.38	1.06	1.05	1.03	1.09	0.84	0.83	0.60
2025	0.28	0.22	0.22	0.15	1.39	1.07	1.05	1.03	1.10	0.84	0.83	0.60
2026	0.29	0.22	0.22	0.15	1.40	1.07	1.05	1.03	1.10	0.84	0.83	0.60
2027	0.29	0.22	0.22	0.15	1.40	1.07	1.05	1.03	1.11	0.84	0.83	0.60
2028	0.29	0.22	0.22	0.15	1.41	1.07	1.05	1.03	1.11	0.84	0.83	0.60
2029	0.29	0.22	0.22	0.15	1.42	1.07	1.05	1.03	1.12	0.84	0.83	0.60
2030	0.29	0.22	0.22	0.15	1.43	1.07	1.05	1.02	1.13	0.84	0.83	0.60
2031	0.29	0.22	0.21	0.15	1.44	1.06	1.05	1.02	1.14	0.84	0.83	0.59
2032	0.30	0.22	0.21	0.15	1.45	1.06	1.05	1.02	1.14	0.84	0.83	0.59
2033	0.30	0.22	0.21	0.15	1.46	1.06	1.05	1.02	1.15	0.84	0.83	0.59
2034	0.30	0.22	0.21	0.15	1.47	1.06	1.05	1.02	1.16	0.84	0.83	0.59
2035	0.30	0.22	0.21	0.15	1.49	1.06	1.05	1.02	1.17	0.84	0.83	0.59
2036	0.31	0.22	0.21	0.15	1.50	1.06	1.05	1.02	1.19	0.84	0.83	0.59
2037	0.31	0.22	0.21	0.15	1.52	1.06	1.05	1.02	1.20	0.84	0.83	0.59
2038	0.31	0.22	0.21	0.15	1.53	1.06	1.05	1.01	1.21	0.84	0.83	0.59
2039	0.32	0.22	0.21	0.15	1.55	1.06	1.05	1.01	1.23	0.84	0.83	0.59
2040	0.32	0.22	0.21	0.15	1.58	1.06	1.05	1.01	1.25	0.84	0.83	0.59
2041	0.33	0.22	0.21	0.15	1.60	1.06	1.05	1.01	1.27	0.84	0.83	0.59

3.2.11 Figures

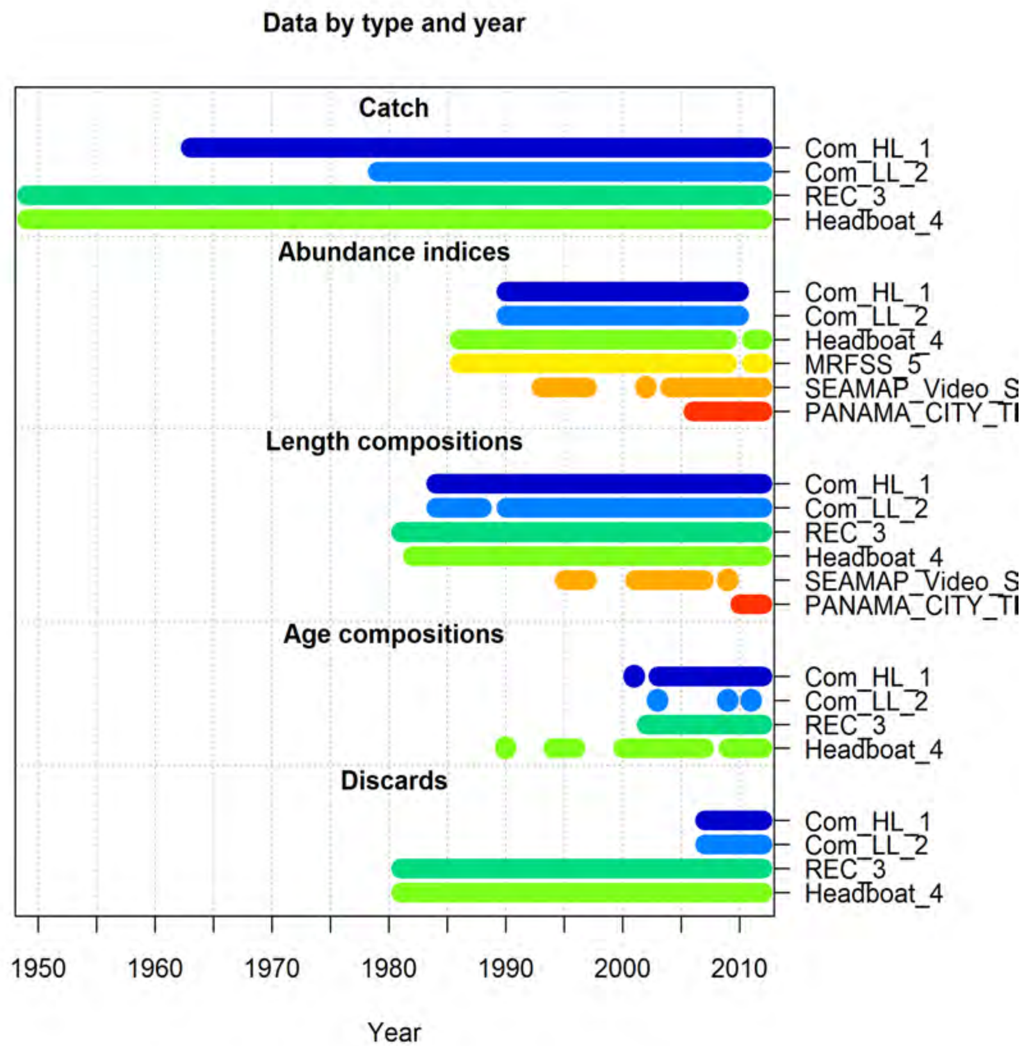
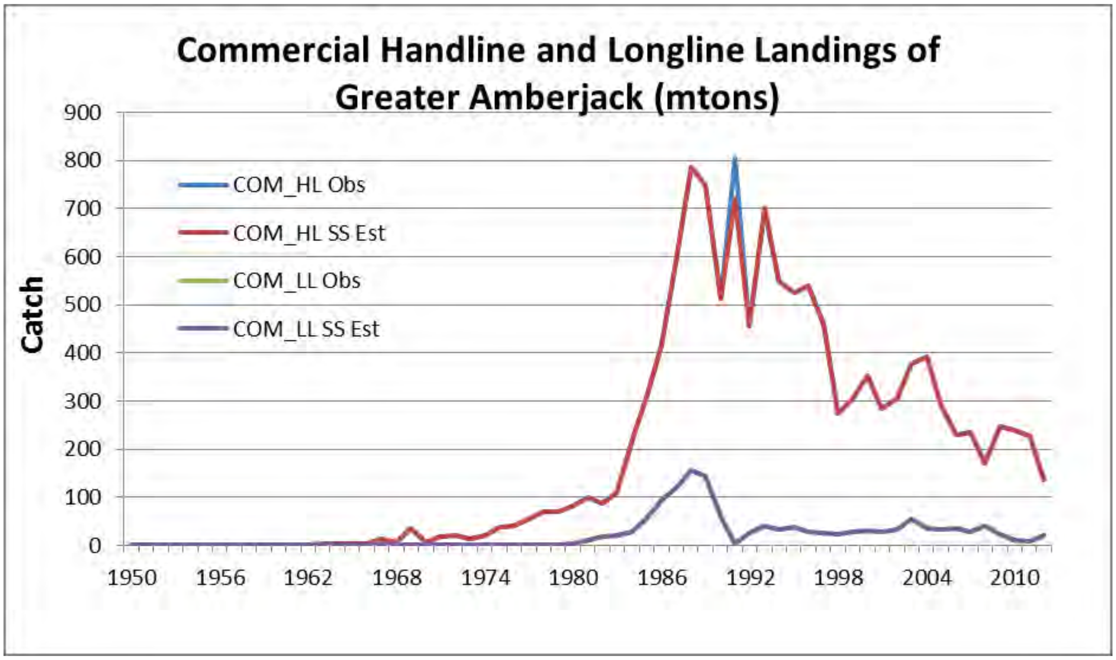


Figure 3.2.1.1.1. Graphical presentation all the data inputs for the SEDAR 33 Greater Amberjack SS stock assessment.



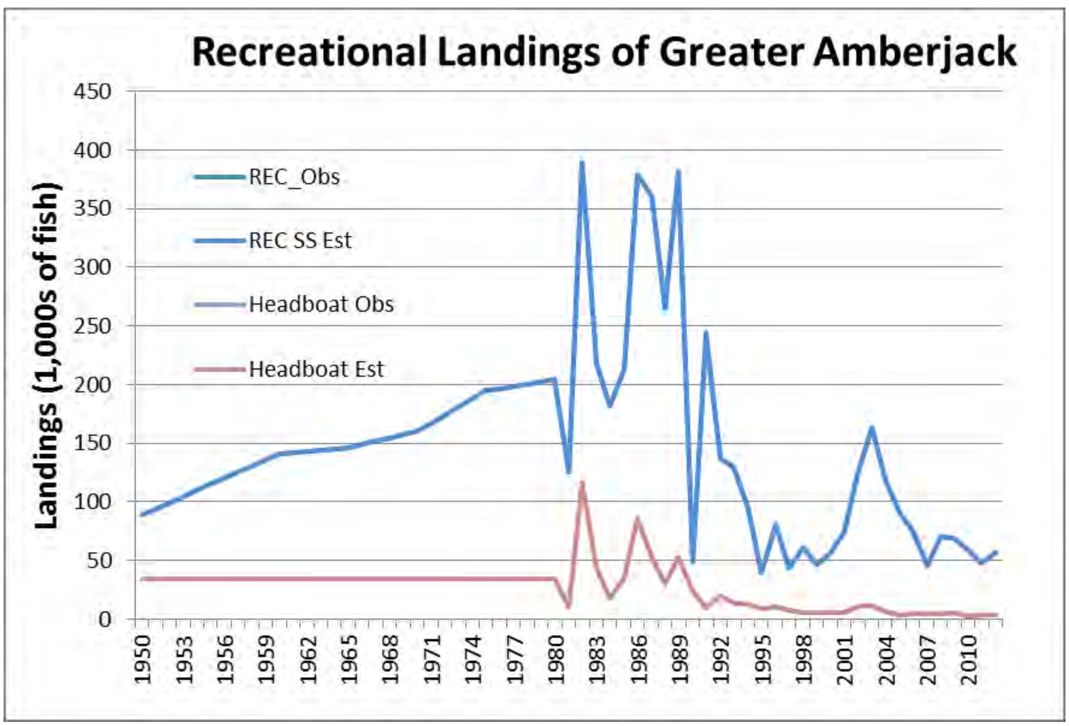
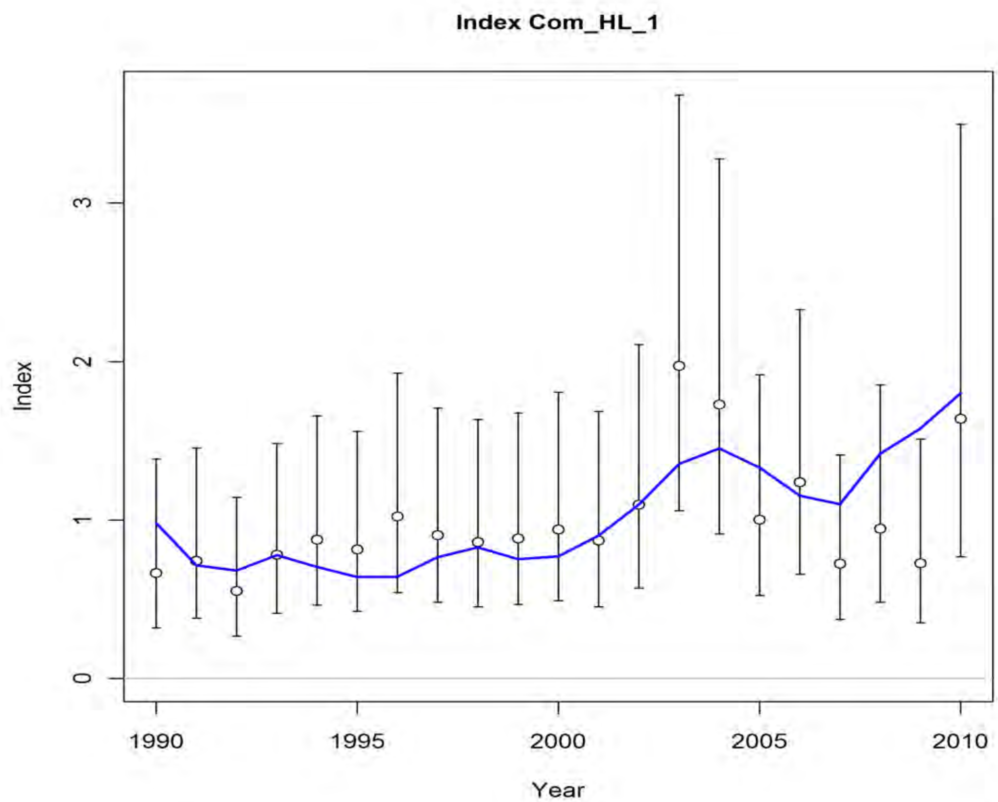


Figure 3.2.1.1.2. Reported and SS estimated landings of greater amberjack for the a) commercial and b) recreational fisheries for greater amberjack (commercial units=mtons, recreational (REC, Headboat) fisheries = 1,000s of fish. Plots are of retained landings only.



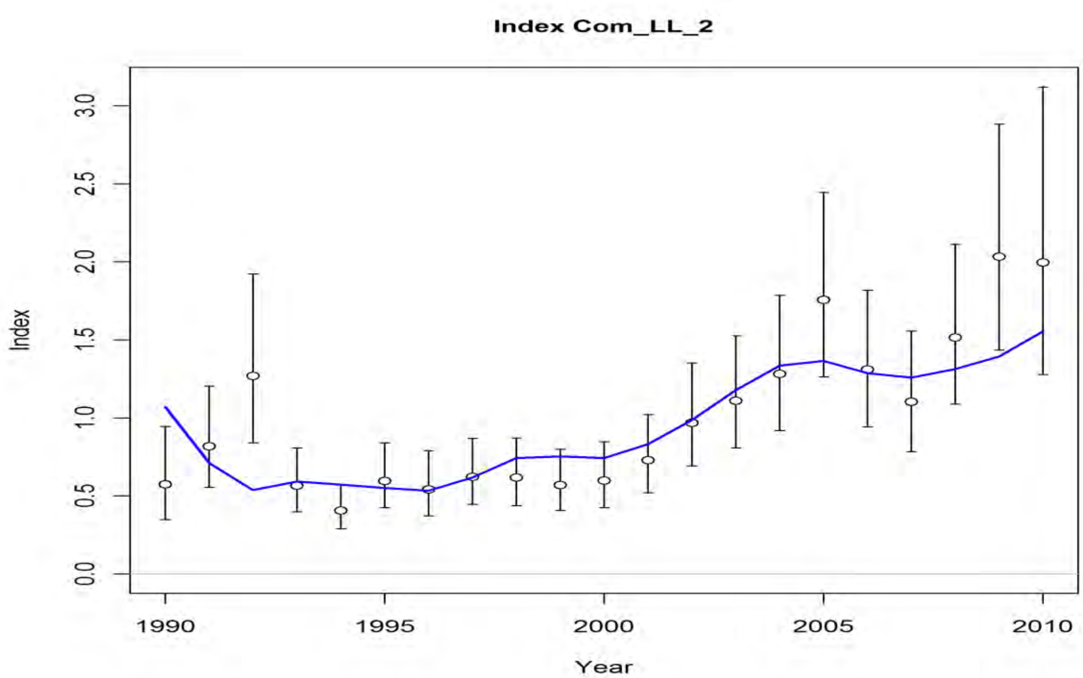
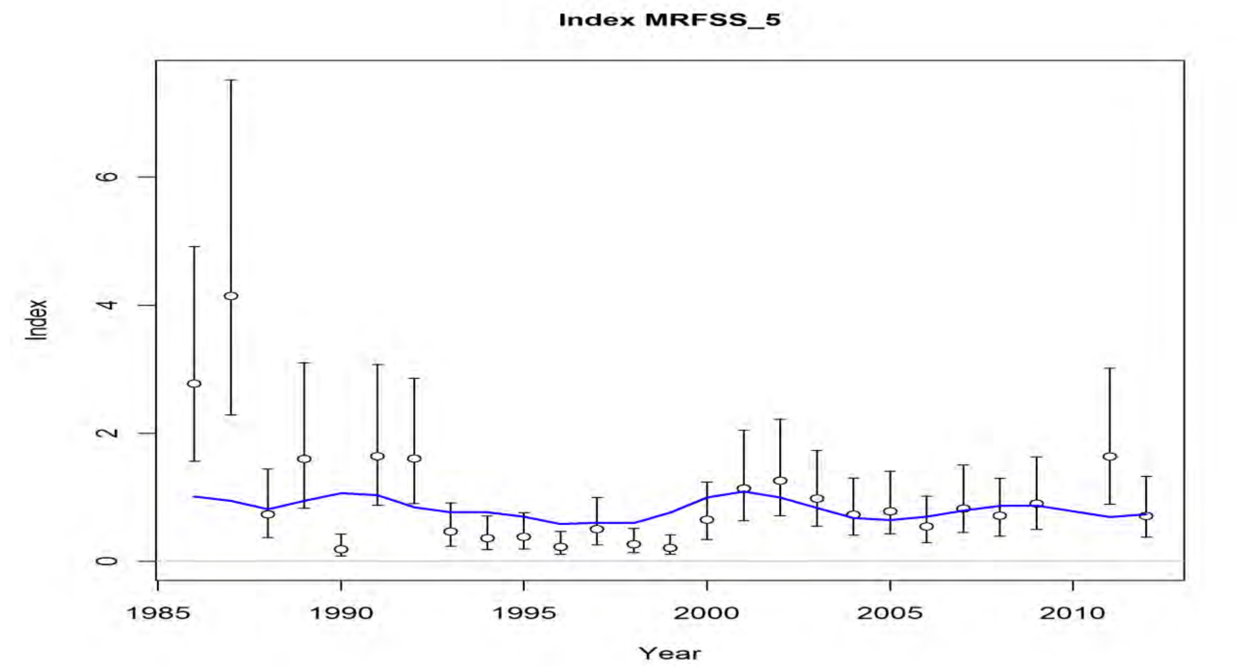


Figure 3.2.1.2.1a, b. Observed and predicted index of CPUE for Gulf of Mexico greater amberjack from SS Model 3. Indices include: a) commercial line gear fishery (COM_HL) and b) the commercial bottom longline fishery (COM_LL).



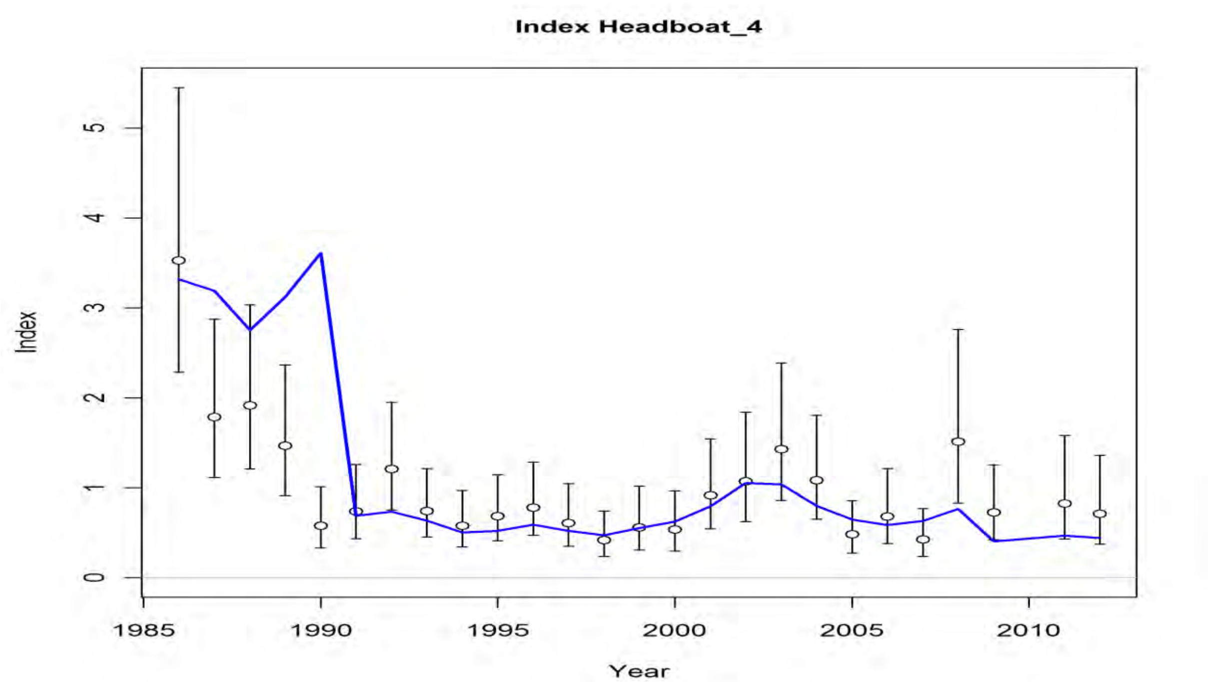
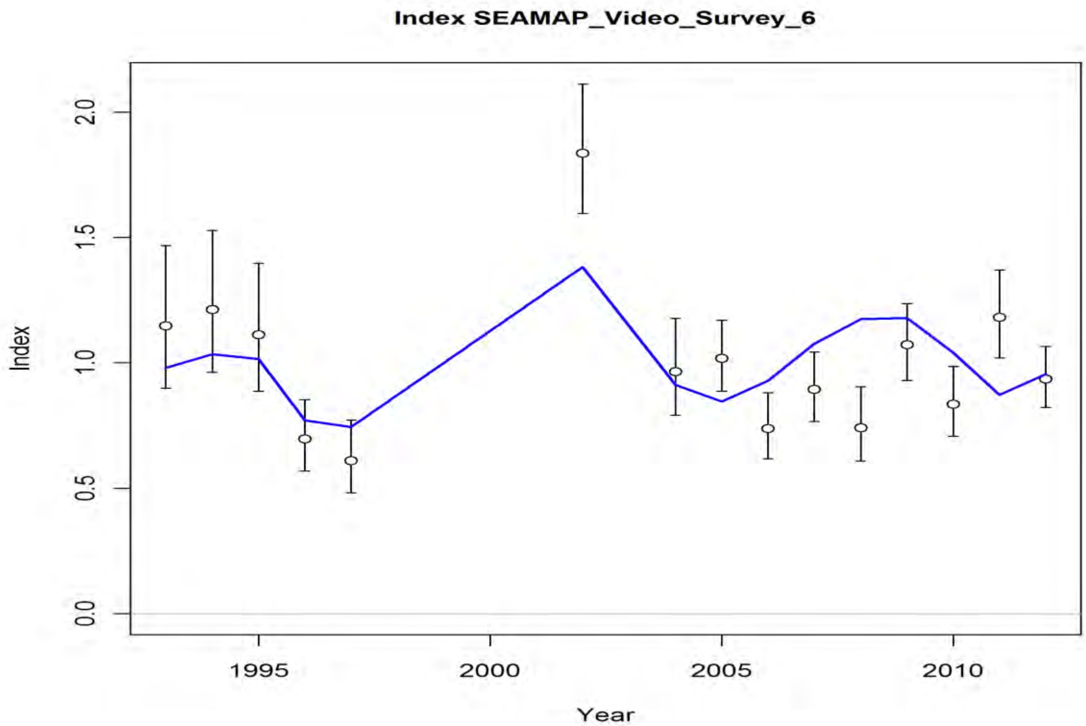


Figure 3.2.1.2.1c, d. Observed and predicted index of CPUE for Gulf of Mexico greater amberjack from SS Model 3. Indices include the c0 recreational charter and private angler fishery (REC) and d) the recreational Headboat (Headboat) fisheries.



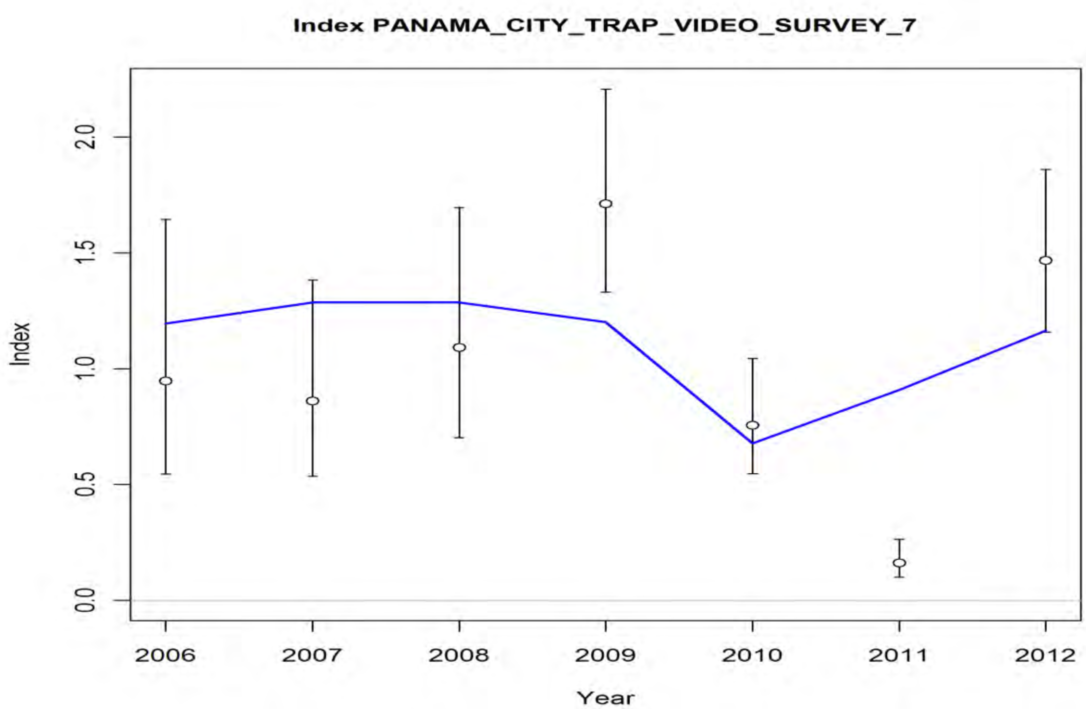


Figure 3.2.1.2.1e, f. Observed and predicted index of CPUE for Gulf of Mexico greater amberjack from SS Model 3. Indices include the e) SEAMAP video survey (SEAMAP_Video), and f) Panama City Laboratory Trap Video survey (Panama City Trap Video fishery independent surveys.

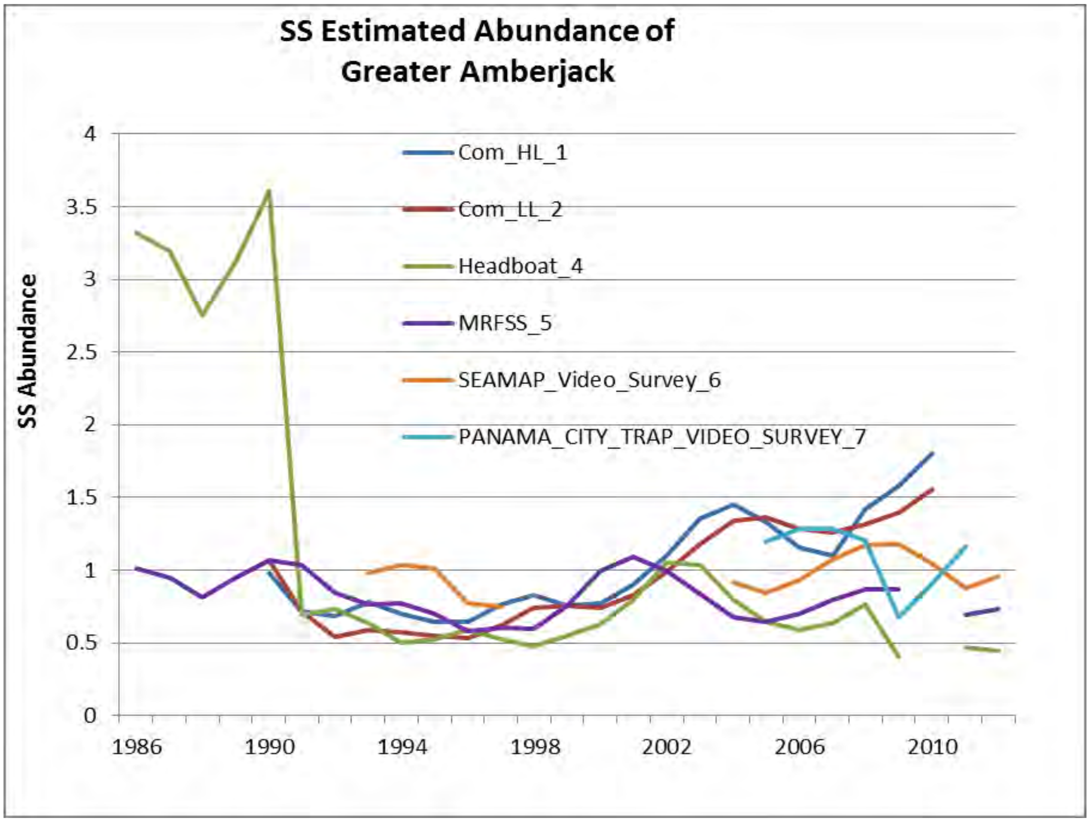


Figure 3.2.1.2.1g. SS estimated CPUE for Gulf of Mexico greater amberjack from SS Model for all the fleet and survey indices. NOTE: Indices cannot be directly compared because the reference different size/age classes.

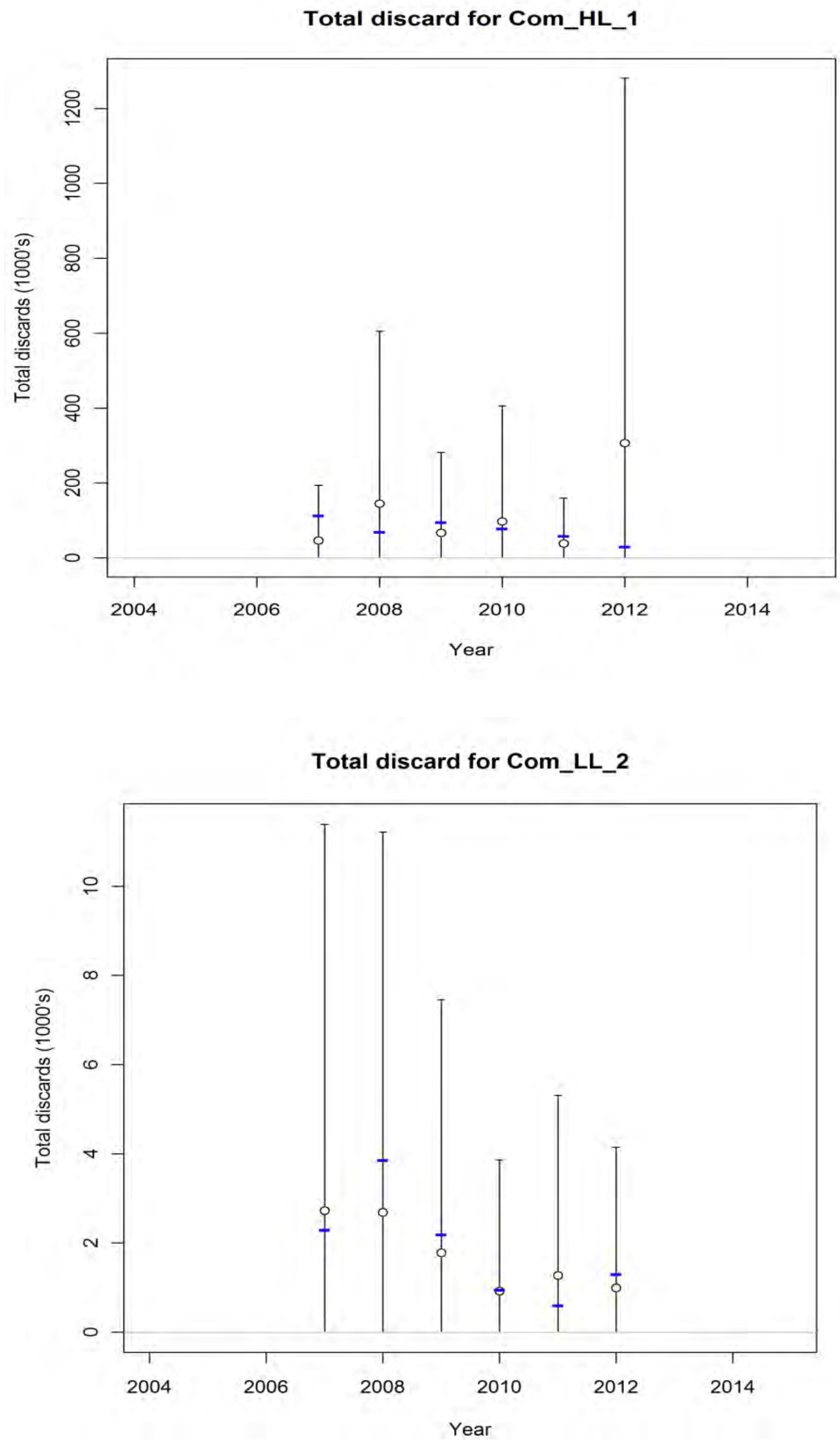
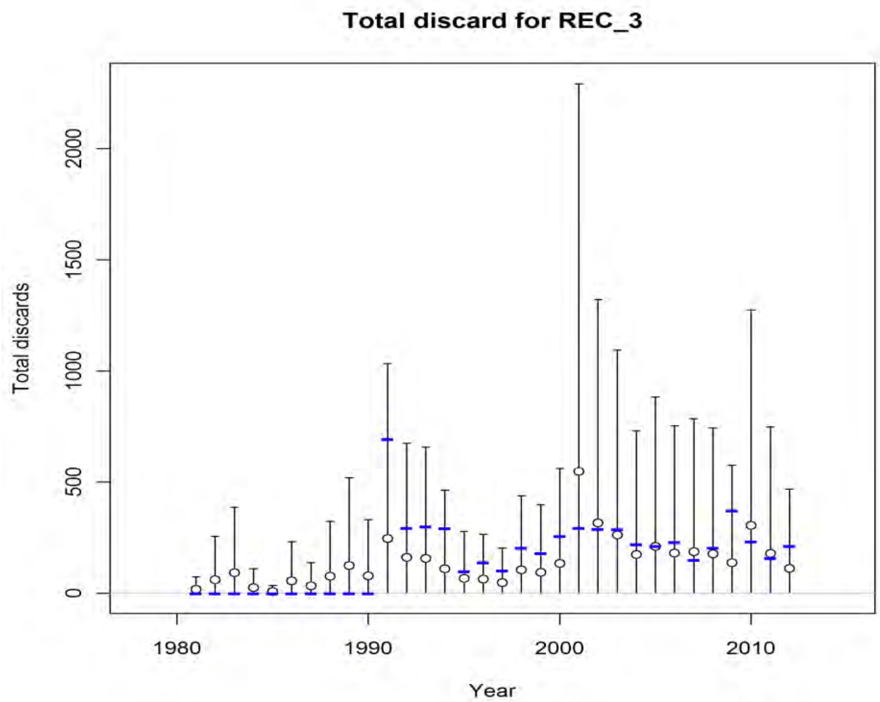


Figure 3.2.1.3.1a, b. Observed and estimated discard from the SS model for a) the COM_HL and b) COM_LL fleets.



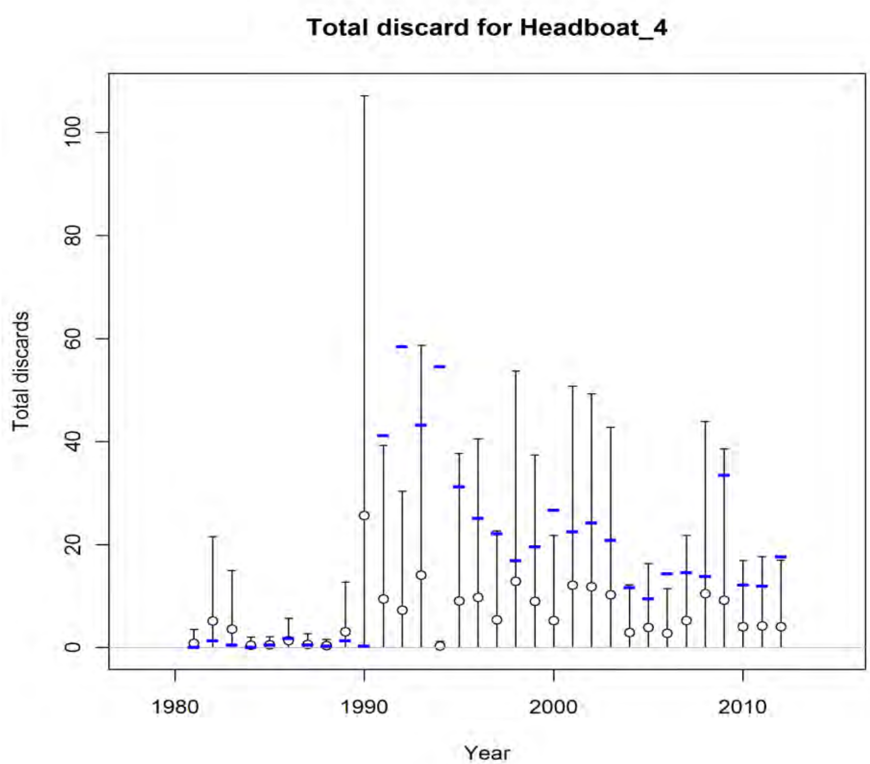


Figure 3.2.1.3.1c, d. Observed and estimated discard from the SS model for c) the REC and d) Headboat fleets.

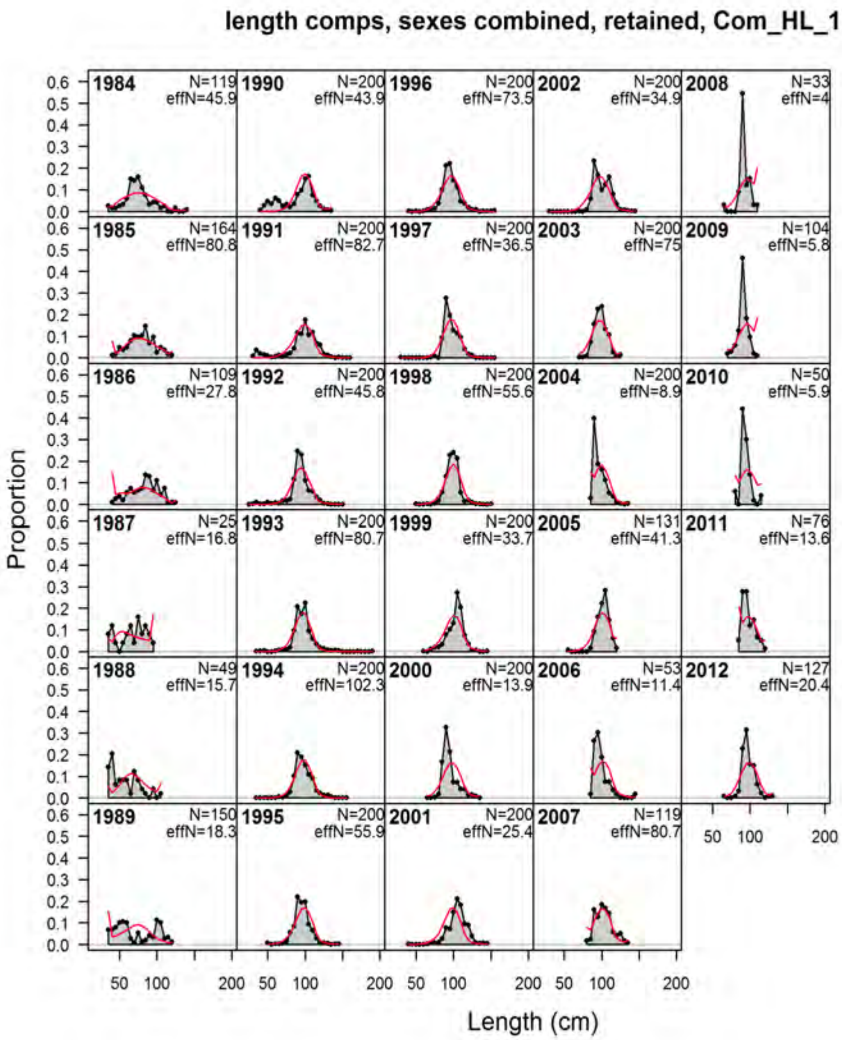


Figure 3.2.1.4.1a. Observed and predicted (lines) retained length compositions for Gulf of Mexico greater amberjack commercial line fishery (COM_HL) from the SS Base Model Run. Observed (N) sample sizes and effective sample sizes (effN) estimated by SS are also reported. Observed sample sizes were capped at a maximum of 200 fish.

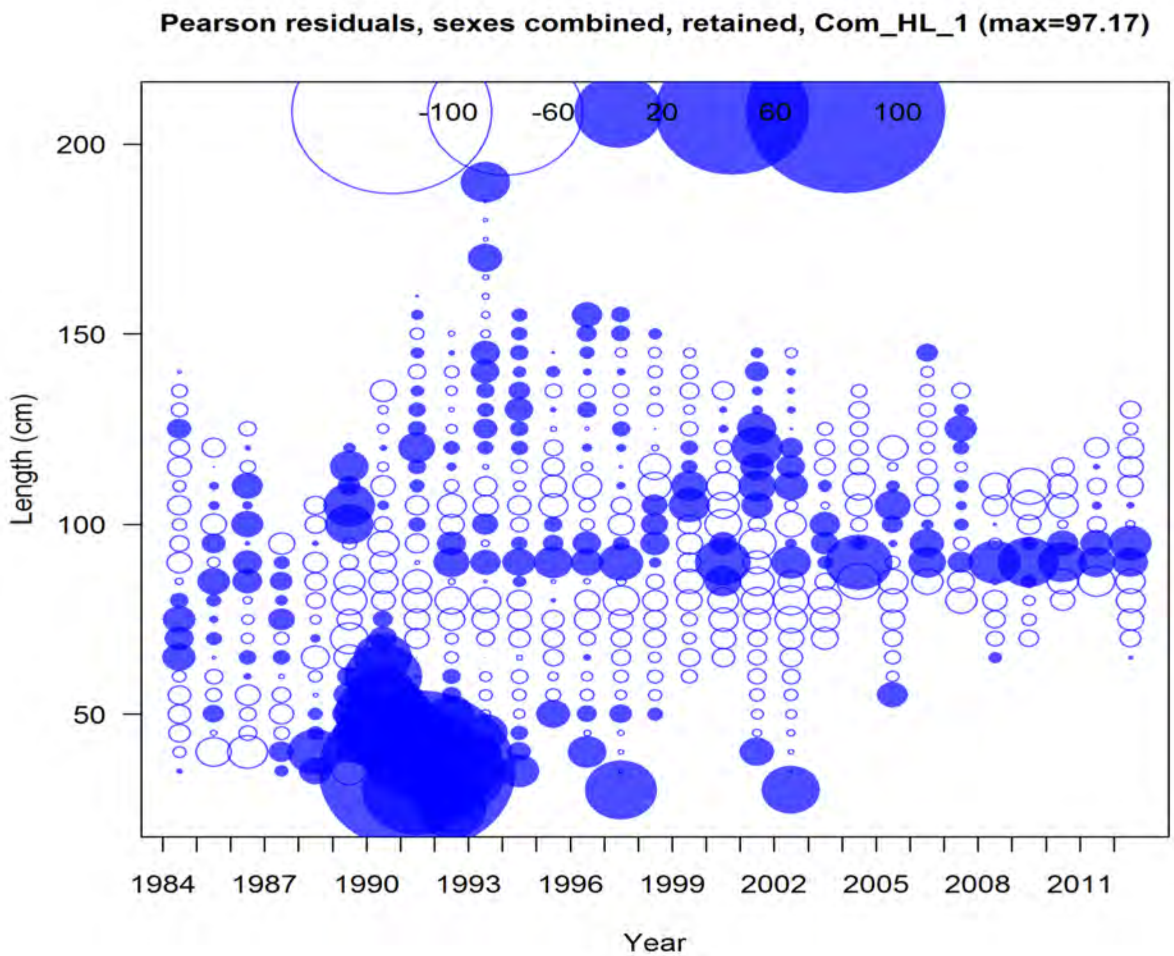


Figure 3.2.1.4.1b. Pearson residual distributions of retained length composition fits for Gulf of Mexico greater amberjack in the commercial bottom longline fishery (COM_HL) from the SS Base Model Run. Solid circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

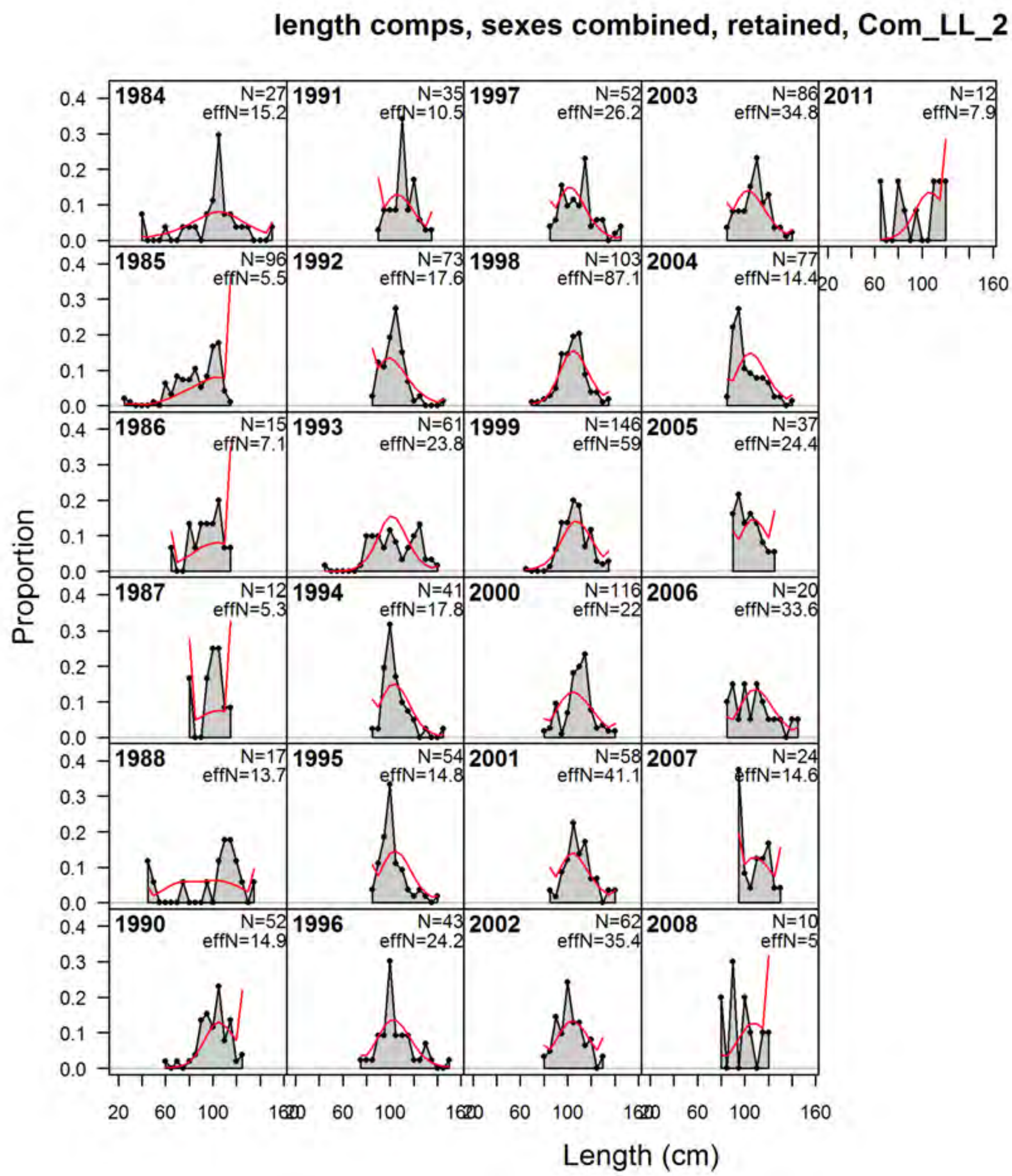


Figure 3.2.1.4.1c. Observed and predicted (lines) retained length compositions for Gulf of Mexico greater amberjack commercial line fishery (COM_LL) from the SS Base Model Run. Observed (N) sample sizes and effective sample sizes (effN) estimated by SS are also reported. Observed sample sizes were capped at a maximum of 200 fish.

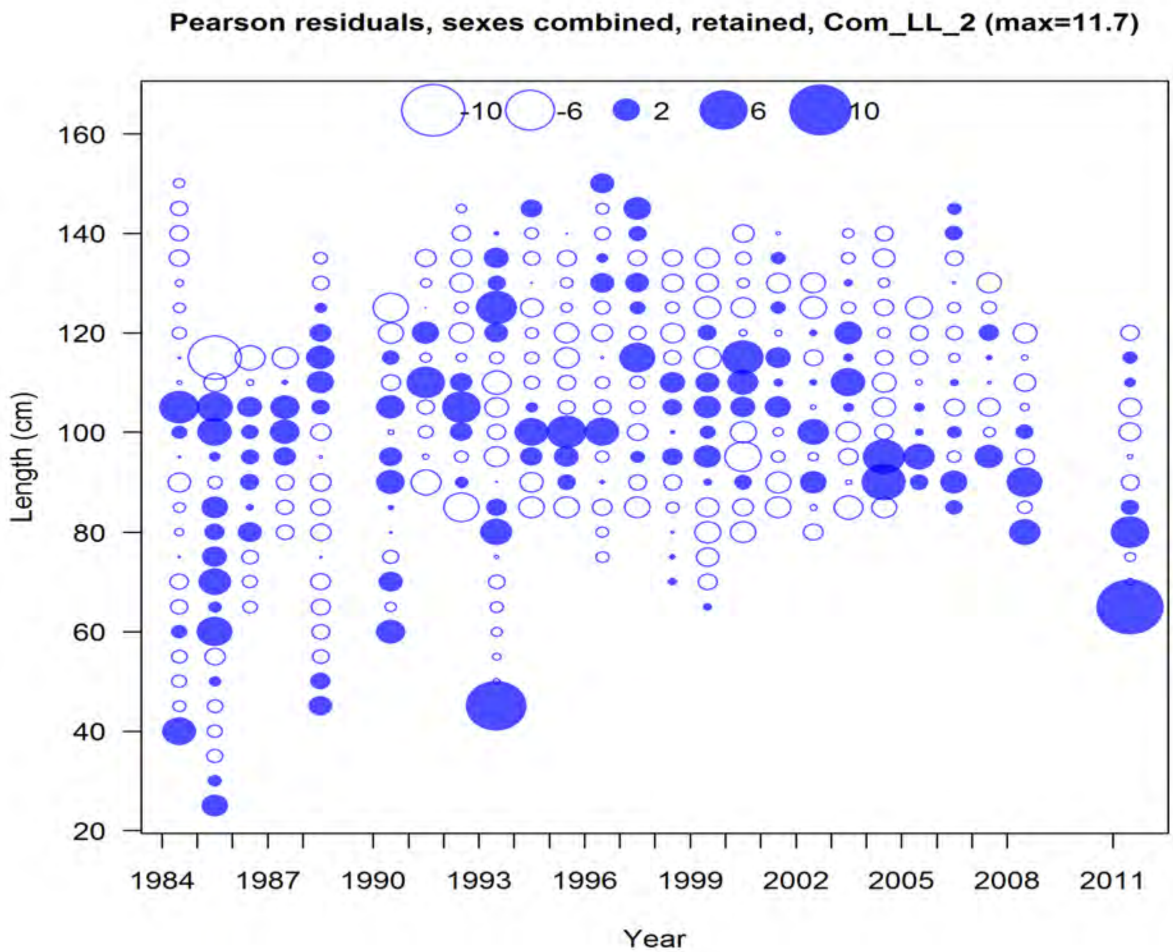


Figure 3.2.1.4.1d. Pearson residual distributions of retained length composition fits for Gulf of Mexico greater amberjack in the commercial bottom longline fishery (COM_LL) from the SS Base Model Run. Solid circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

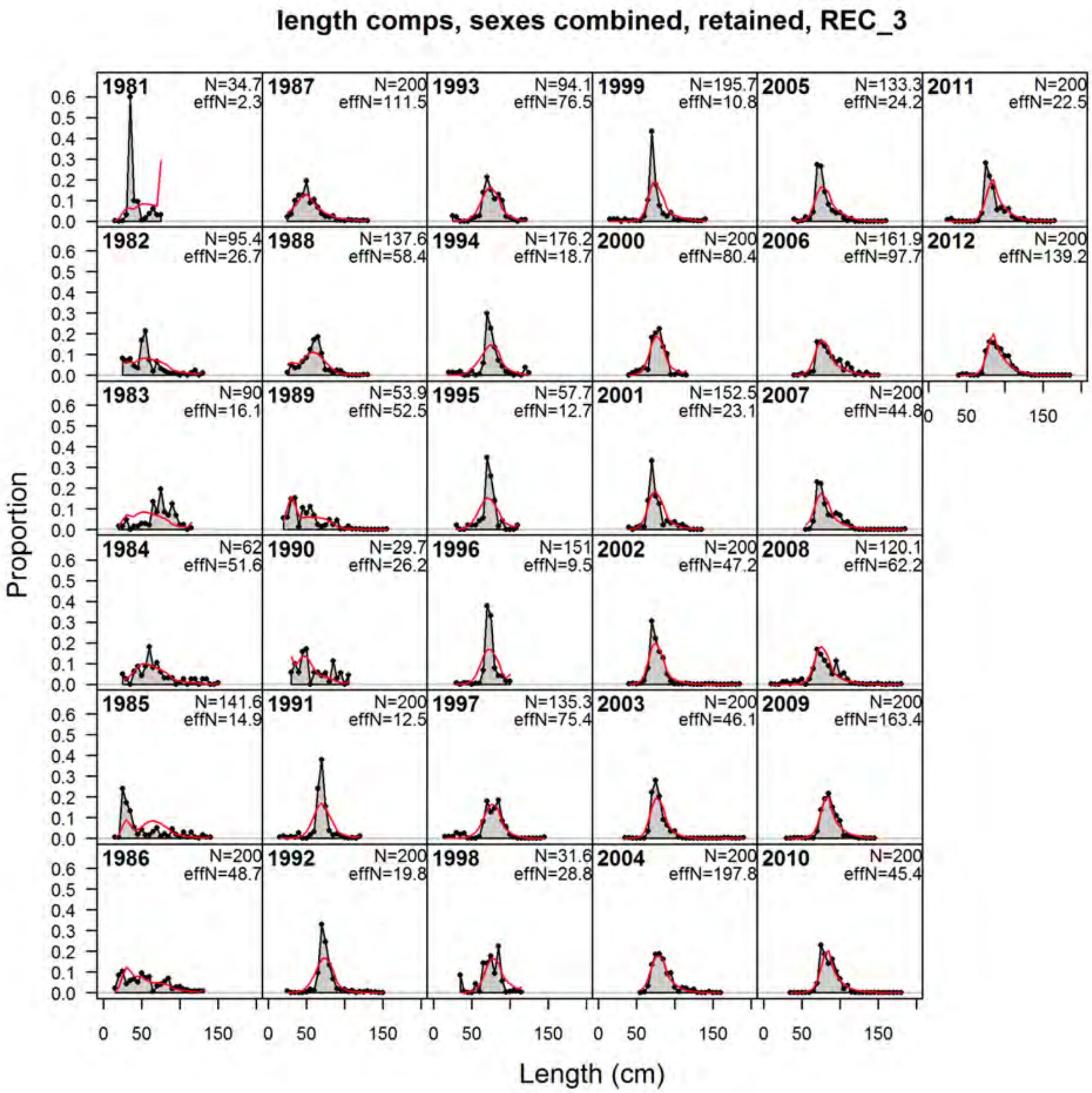


Figure 3.2.1.4.1e. Observed and predicted (lines) retained length compositions for Gulf of Mexico greater amberjack recreational (REC) fishery from the SS Base Model Run. Observed (N) sample sizes and effective sample sizes (effN) estimated by SS are also reported. Observed sample sizes were capped at a maximum of 100 fish.

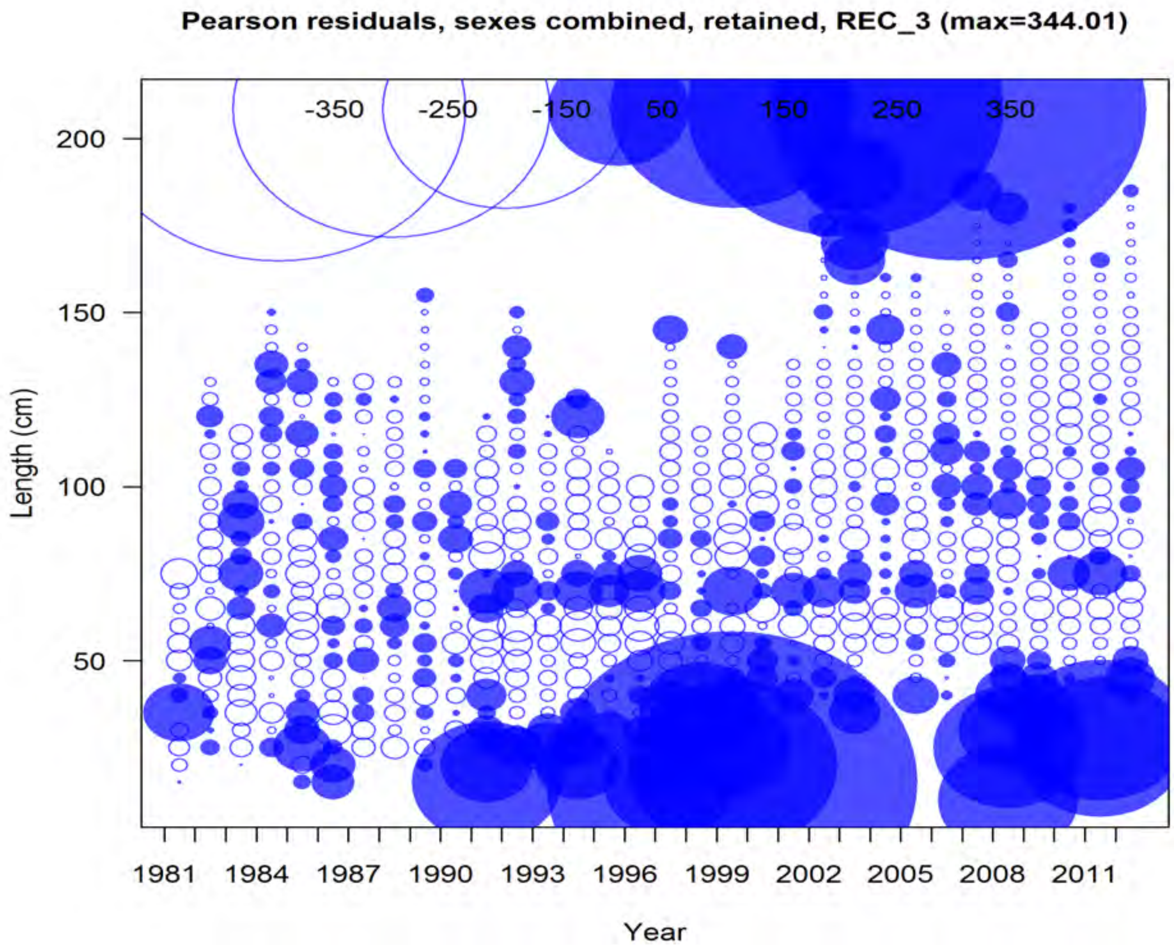


Figure 3.2.1.4.1f. Pearson residual of retained length composition fits for Gulf of Mexico greater amberjack in the recreational charter and private angler fisheries fishery (REC) from the SS Base Model Run. Solid circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

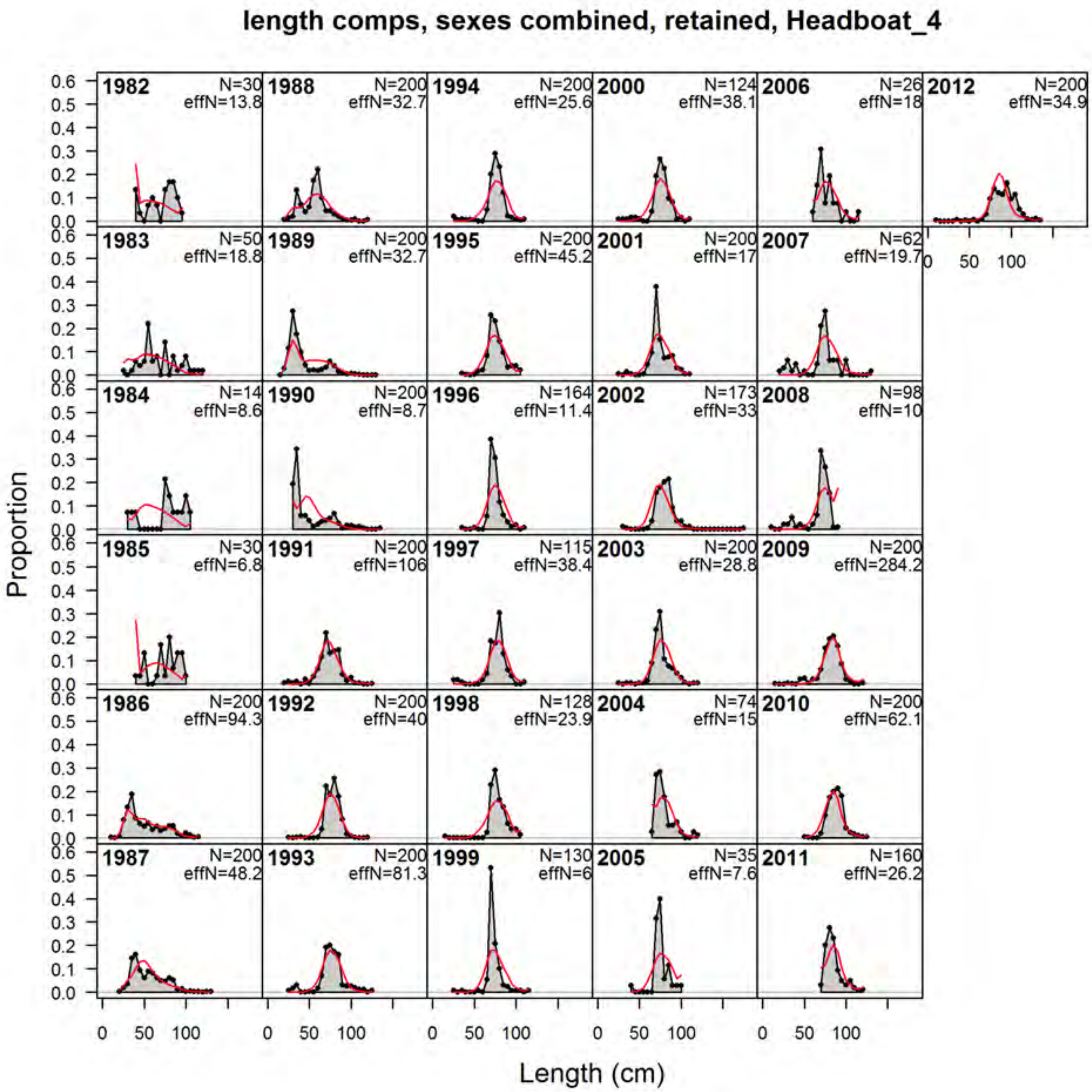


Figure 3.2.4.1.g. Observed and predicted (lines) retained length compositions for Gulf of Mexico greater amberjack recreational (Headboat) fleet from the SS Base Model Run. Observed (N) sample sizes and effective sample sizes (effN) estimated by SS are also reported. Observed sample sizes were capped at a maximum of 200 fish.

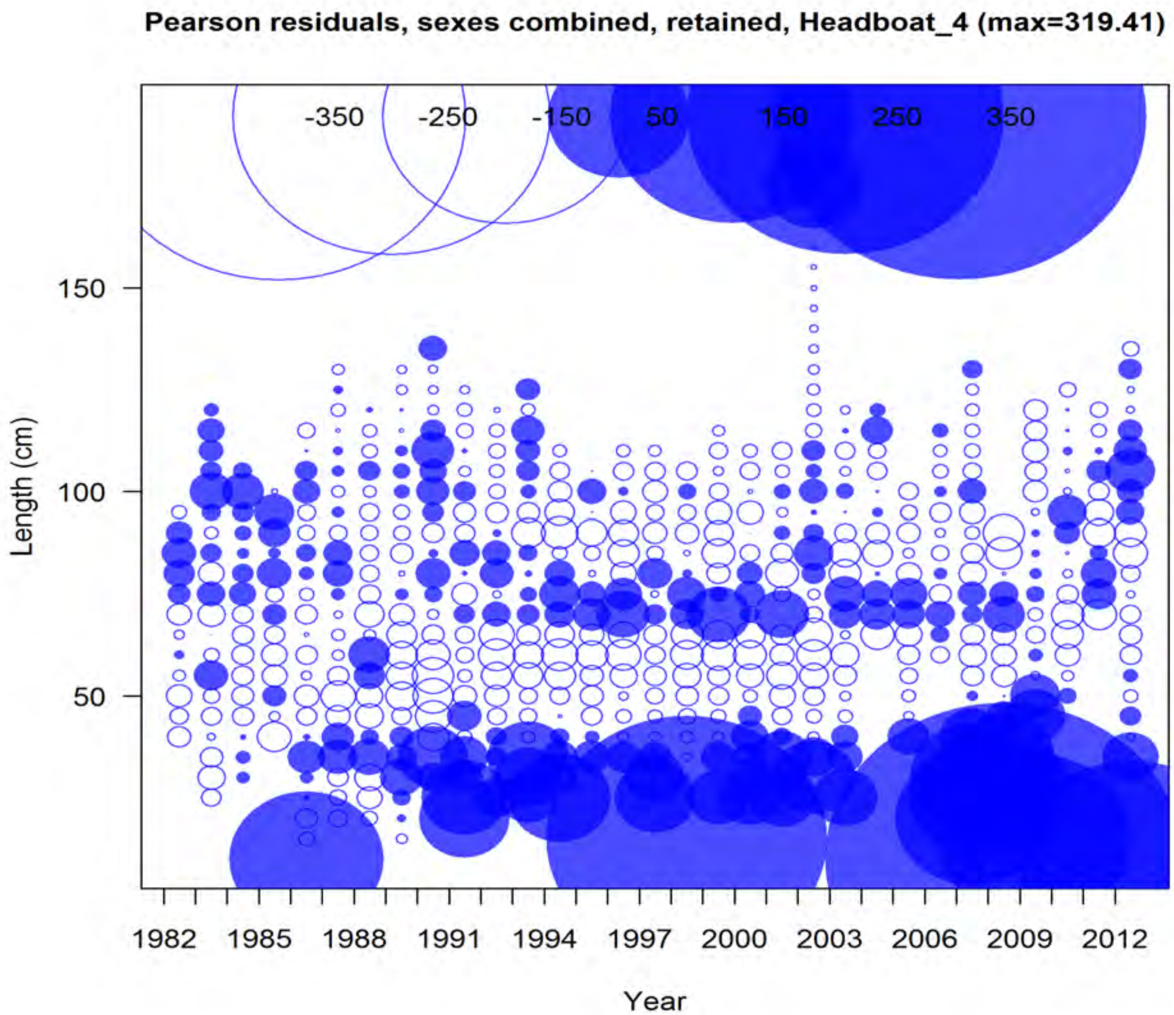


Figure 3.2.1.4.h. Pearson residual of retained length composition fits for Gulf of Mexico greater amberjack in the Headboat fishery (Headboat) from the SS Base Model Run. Solid circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

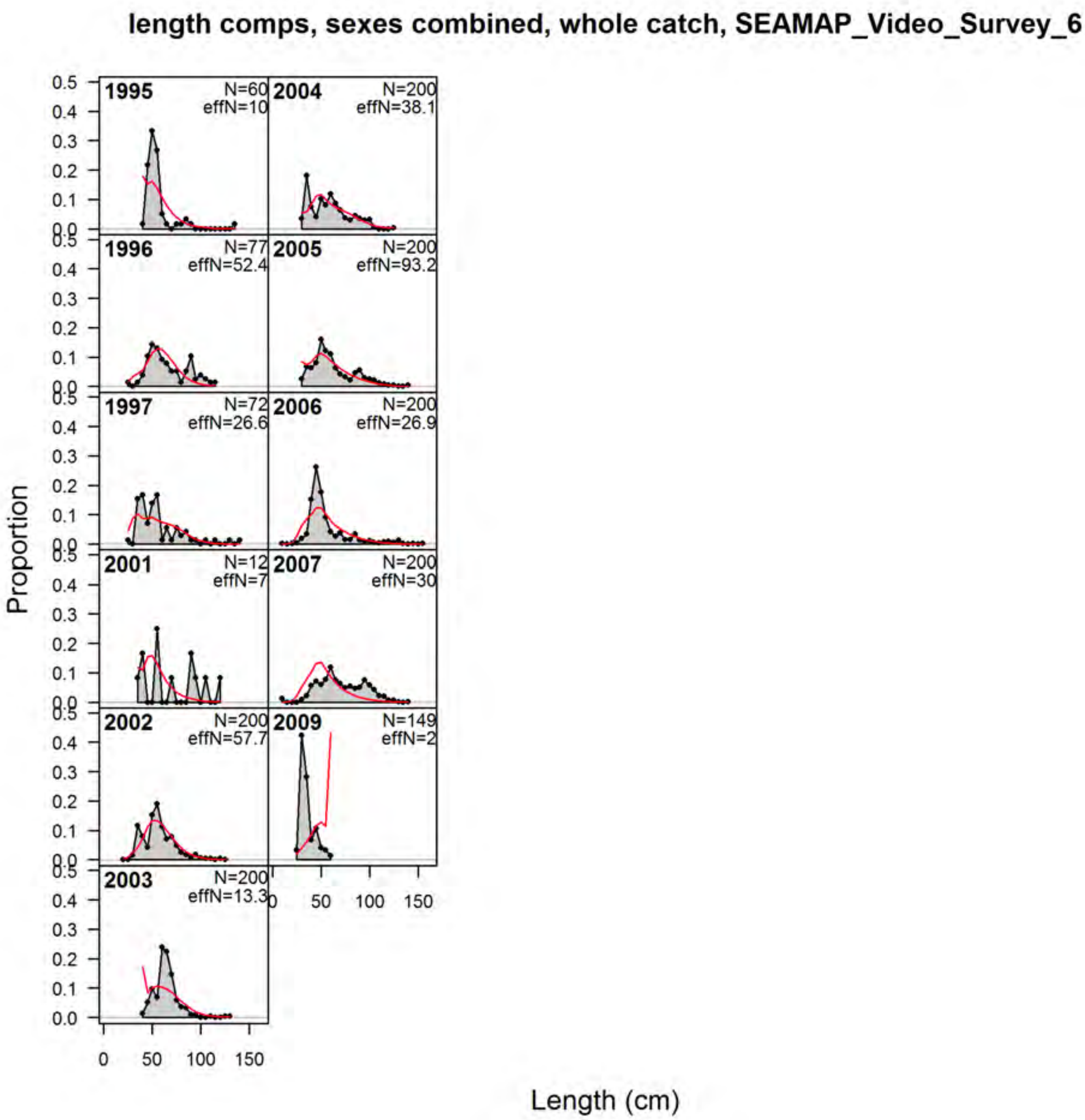


Figure 3.2.1.4.1i. Observed and predicted (lines) retained length compositions for Gulf of Mexico greater amberjack for the SEAMAP Video Survey from the SS Base Model Run. Observed (N) sample sizes and effective sample sizes (effN) estimated by SS are also reported. Observed sample sizes were capped at a maximum of 200 fish.

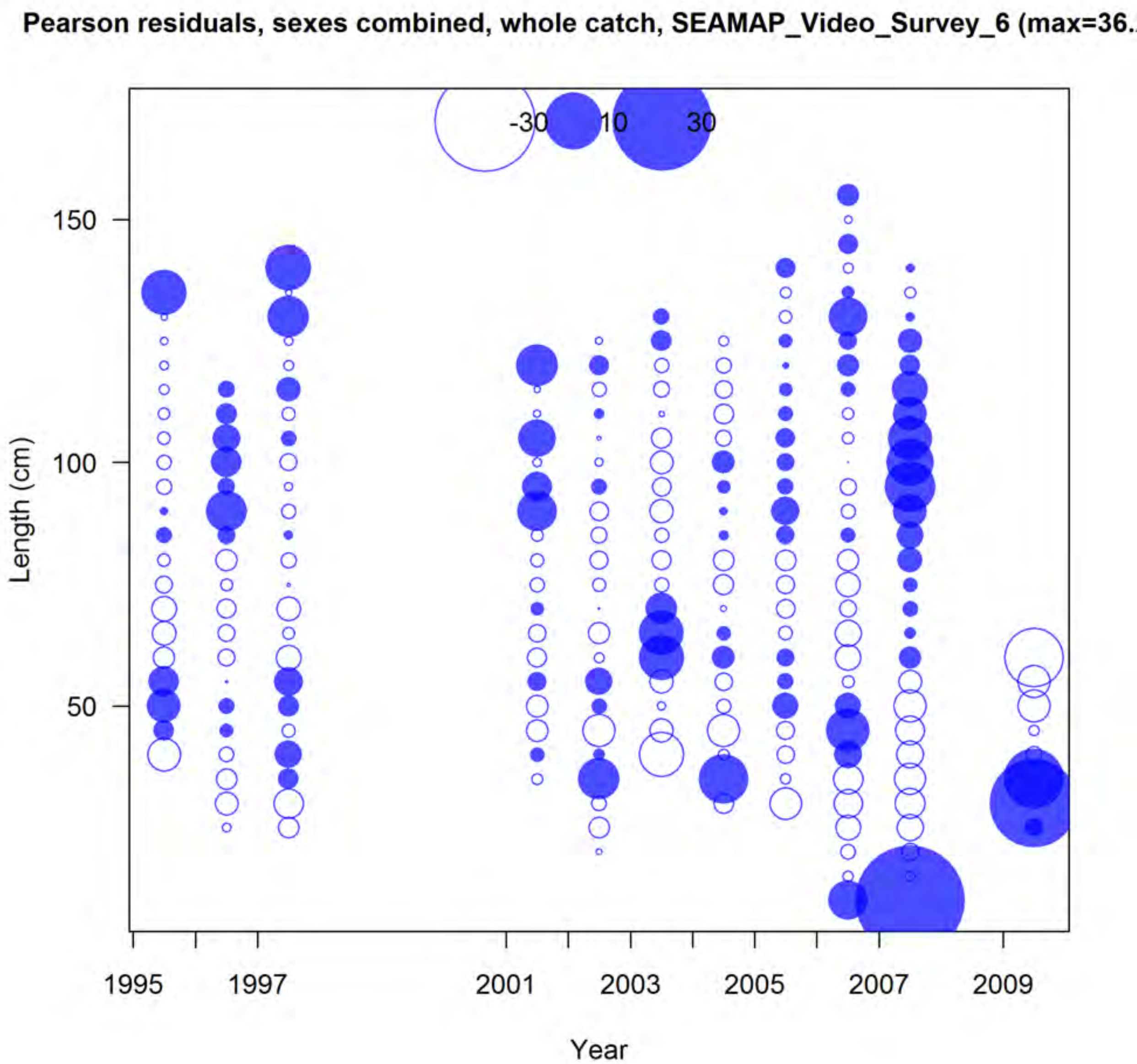


Figure 3. 2.1.4.1j. Pearson residuals of retained length composition fits for Gulf of Mexico greater amberjack in the SEAMAP trap video survey from the SS Base Model Run. Solid circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

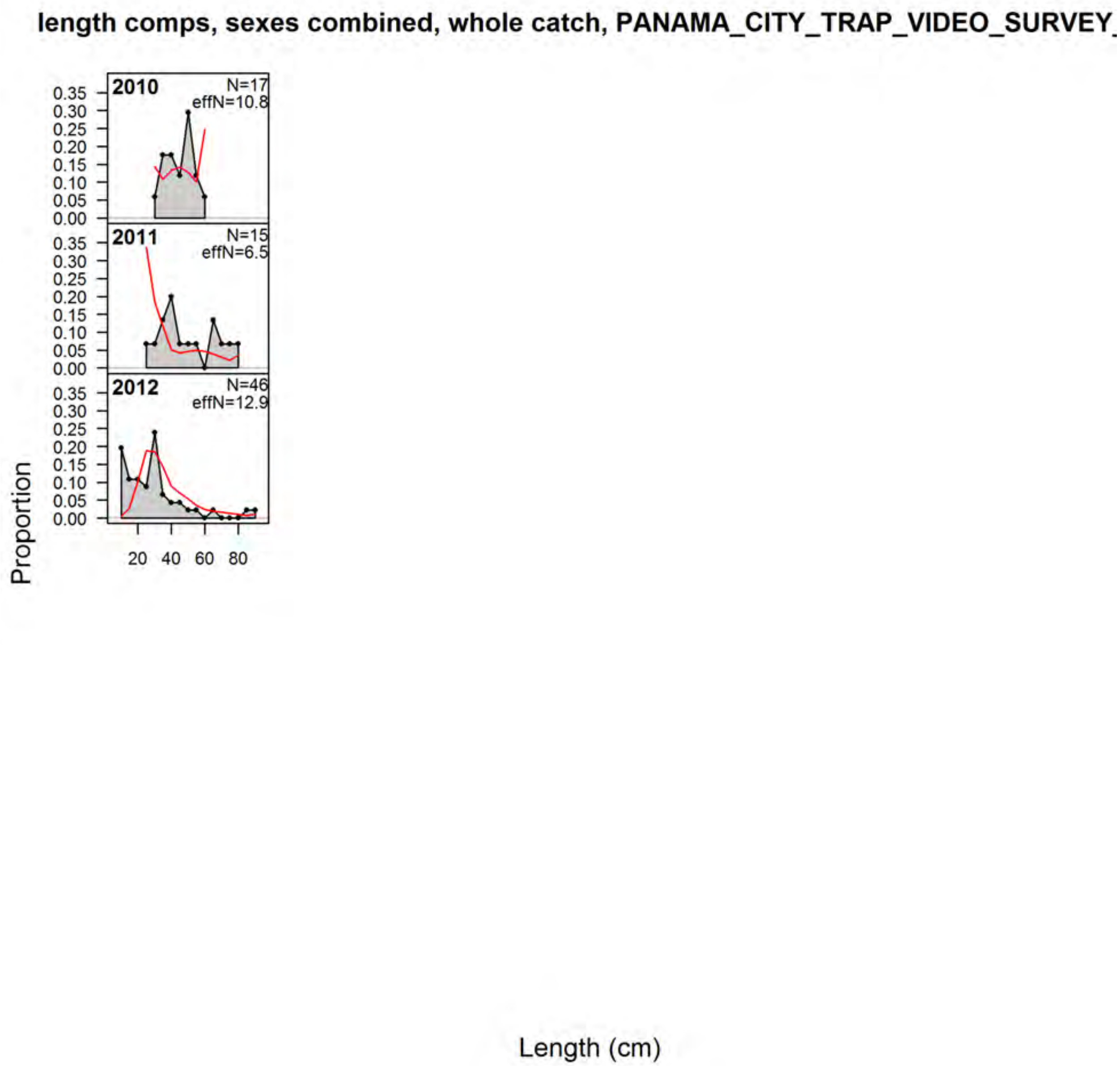


Figure 3.2.1.4.1k. Observed and predicted (lines) retained length compositions for Gulf of Mexico greater amberjack for the Panama City Trap Video Survey from the SS Base Model Run. Observed (N) sample sizes and effective sample sizes (effN) estimated by SS are also reported. Observed sample sizes were capped at a maximum of 200 fish.

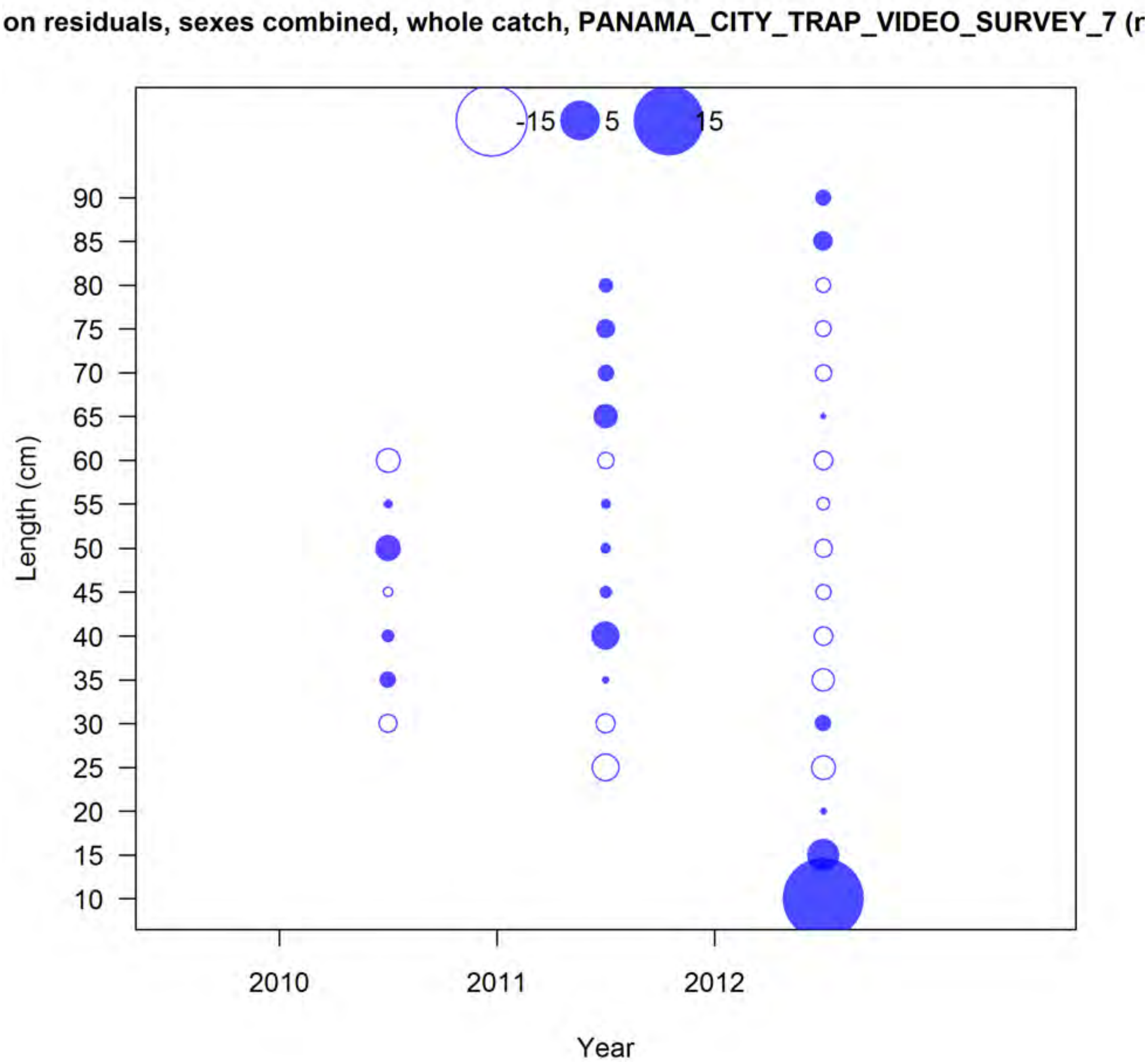


Figure 3.2.1.4.11. Pearson residuals of retained length composition fits for Gulf of Mexico greater amberjack in the Panama City trap video survey from the SS Base Model Run. Solid circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

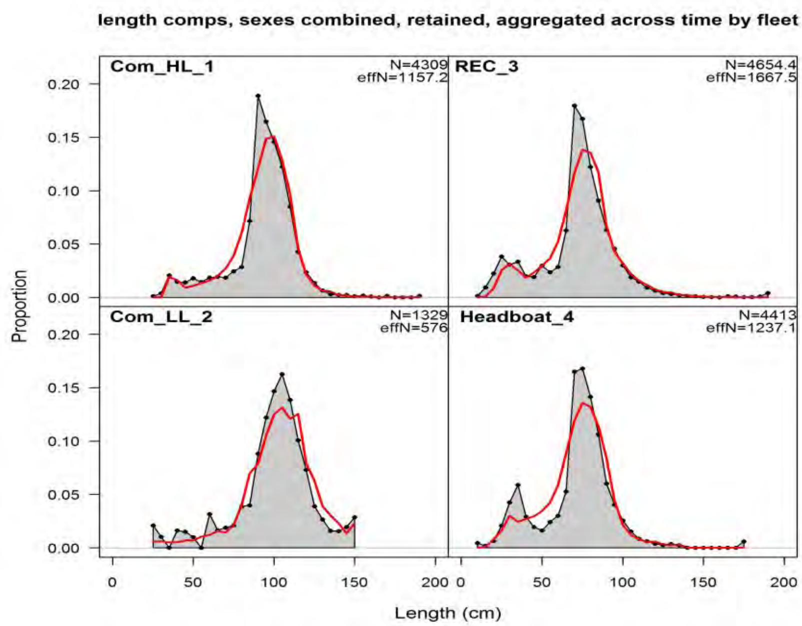


Figure 3.2.1.4.1m. Observed and predicted (lines) retained length compositions for Gulf of Mexico greater amberjack for three fleets (COM_HL, COM_LL, headboat) and total catch (REC) for the SS Base model run. Observed (N) sample sizes and effective sample sizes (effN) estimated by SS are also reported. Observed sample sizes were capped at a maximum of 200 fish.

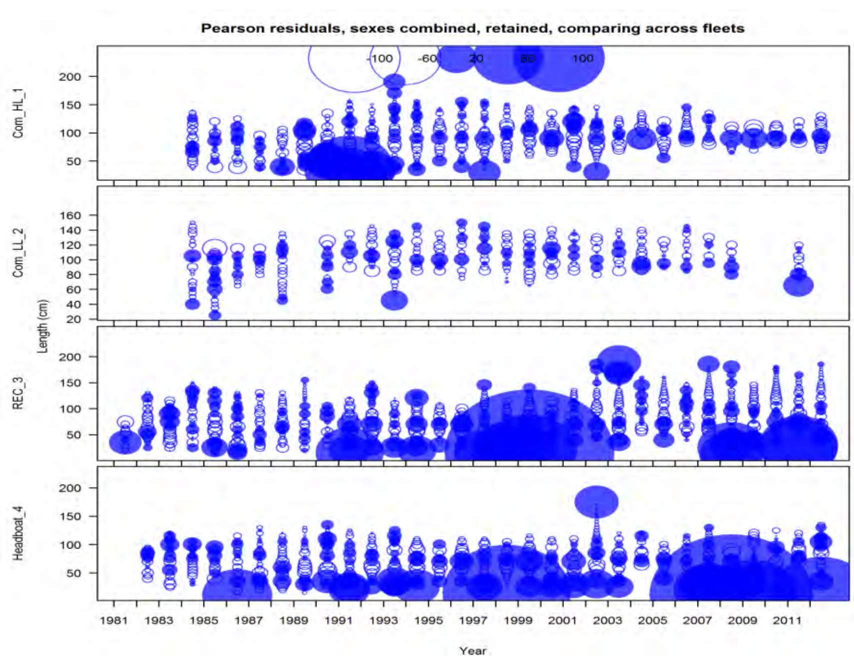


Figure 3.2.1.4.1n. Pearson residuals of retained length composition fits for Gulf of Mexico greater amberjack for four fleets for the SS Base model run. Solid circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

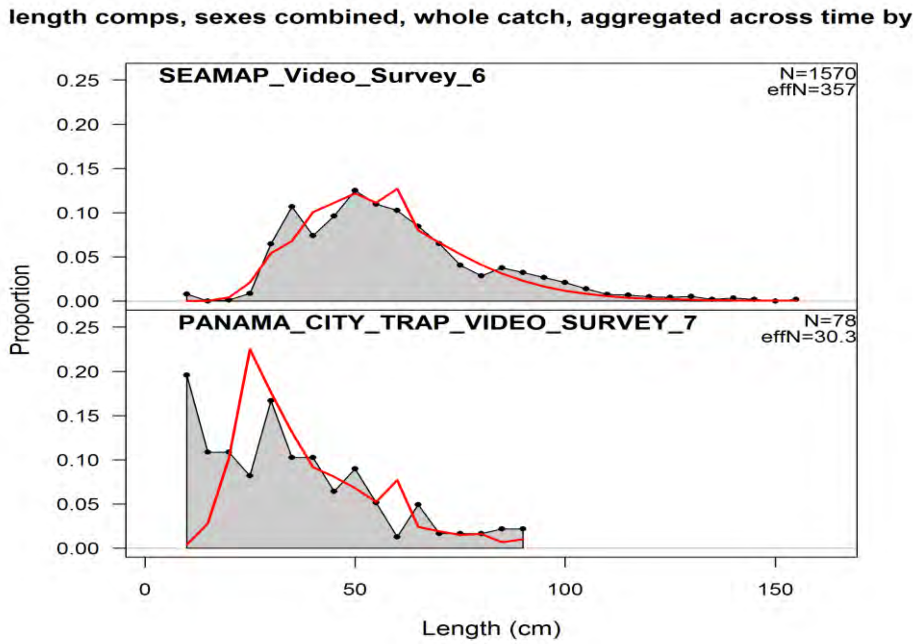


Figure 3.2.1.4.1o. Observed and predicted (lines) length compositions for Gulf of Mexico greater amberjack for two surveys. Observed (N) sample sizes and effective sample and effective sample sizes (effN) estimated by SS are also reported. Observed sample sizes were capped at a maximum of 200 fish.

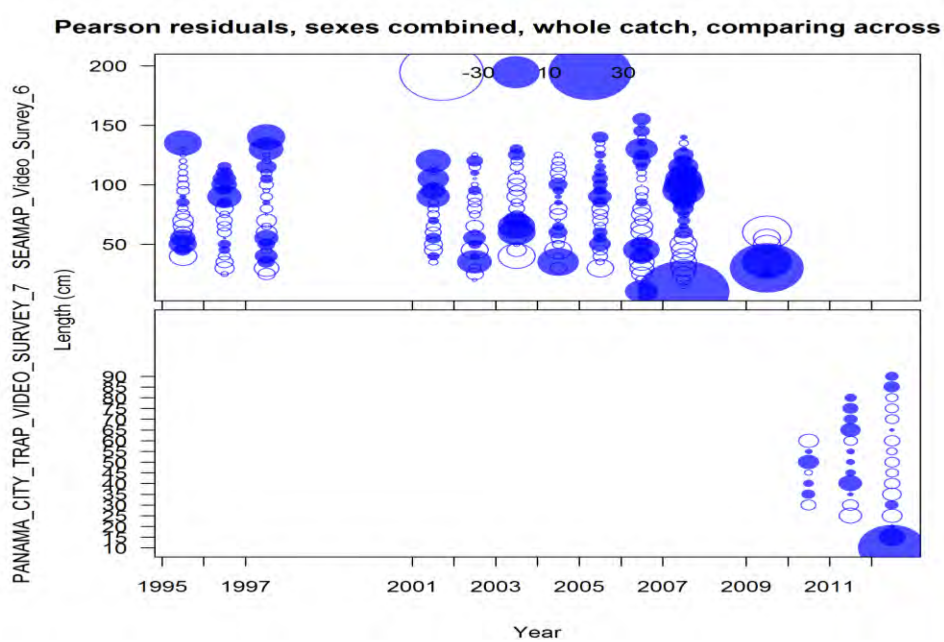


Figure 3.2.1.4.1p. Pearson residuals of length composition fits for Gulf of Mexico greater amberjack for two surveys for the SS Base model run. Solid circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

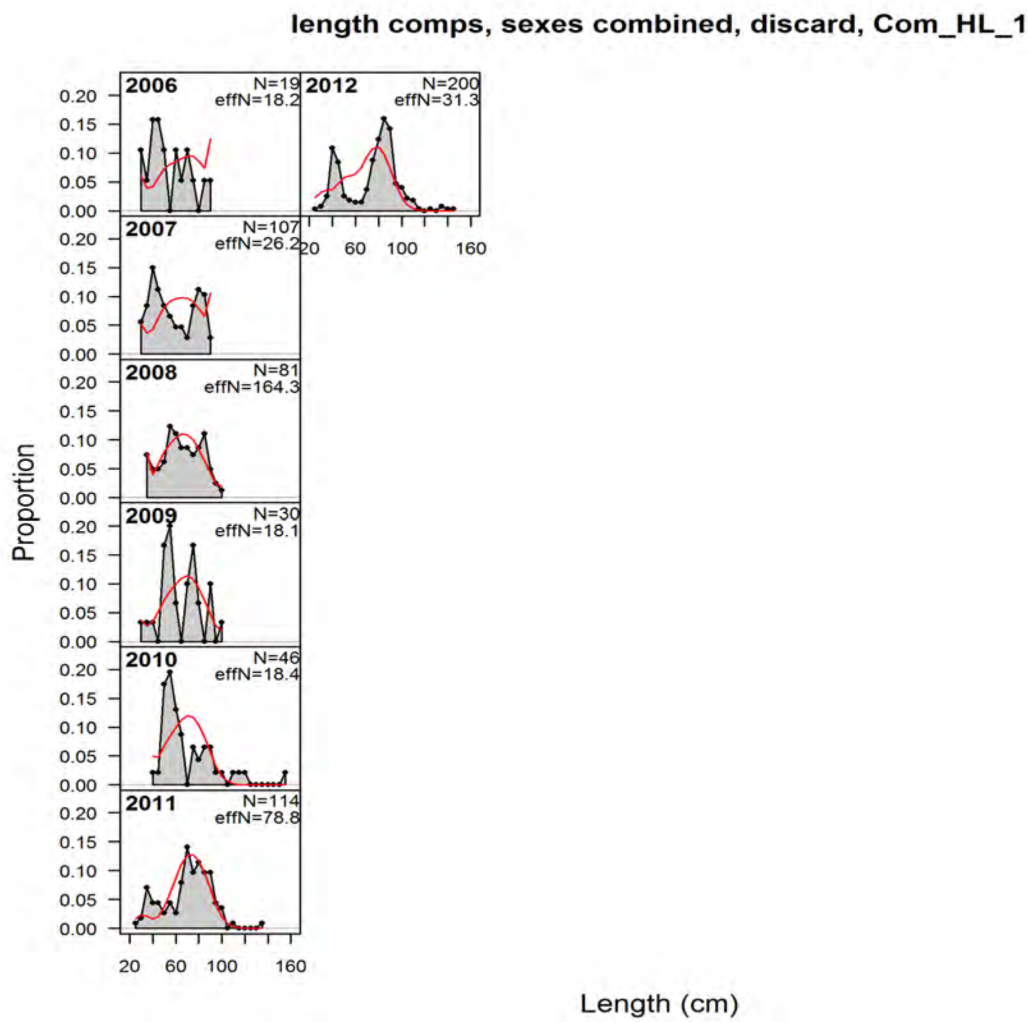


Figure 3.2.1.5.1a. Observed and predicted (lines) discarded length compositions for Gulf of Mexico greater amberjack commercial line fishery (COM_HL) from the SS Base Model Run. Observed (N) sample sizes and effective sample sizes (effN) estimated by SS are also reported. Observed sample sizes were capped at a maximum of 200 fish.

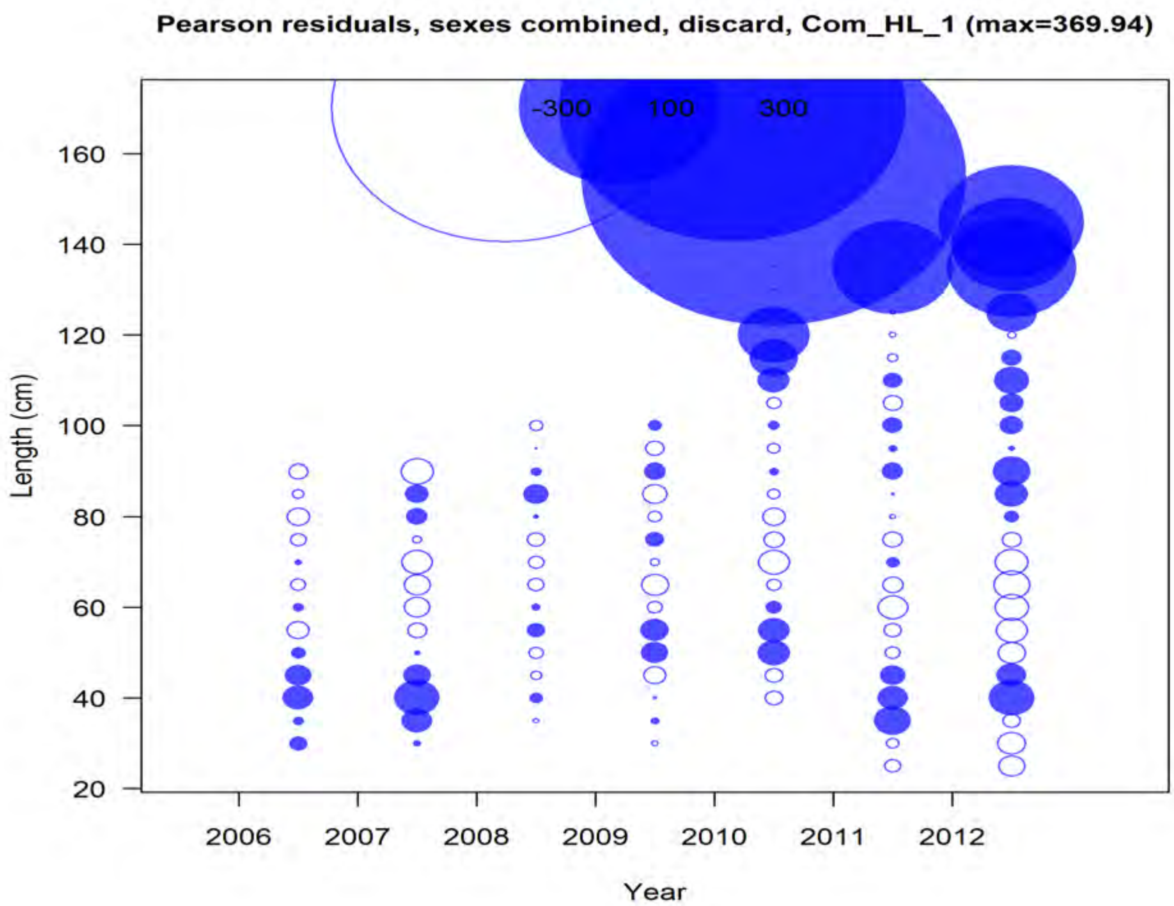


Figure 3.2.1.5.1b. Pearson residual distributions of discarded length composition fits for Gulf of Mexico greater amberjack in the commercial bottom longline fishery (COM_HL) from the SS Base Model Run. Solid circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

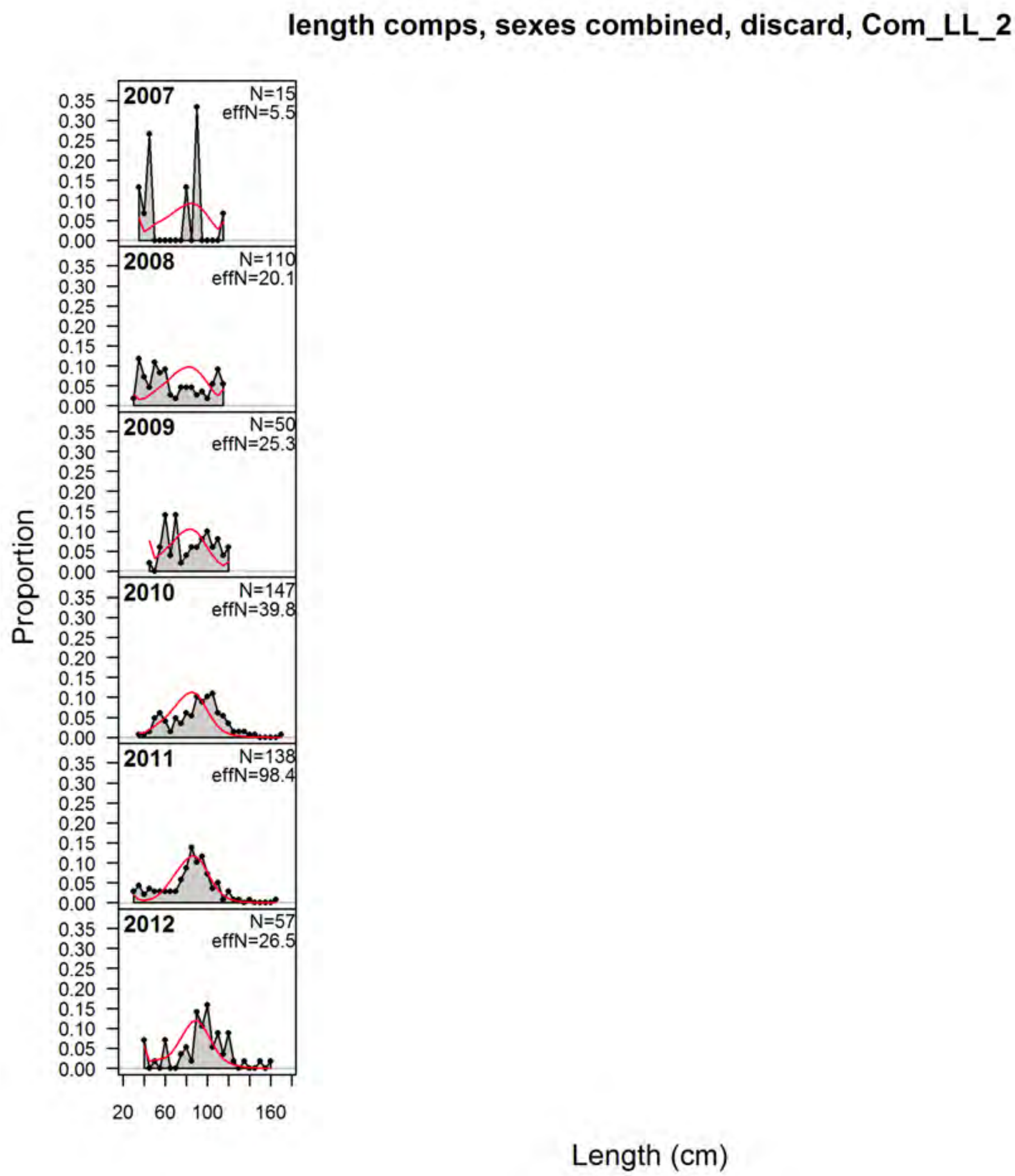


Figure 3.2.1.5.1c. Observed and predicted (lines) discarded length compositions for Gulf of Mexico greater amberjack commercial line fishery (COM_LL) from the SS Base Model Run. Observed (N) sample sizes and effective sample sizes (effN) estimated by SS are also reported. Observed sample sizes were capped at a maximum of 200 fish.

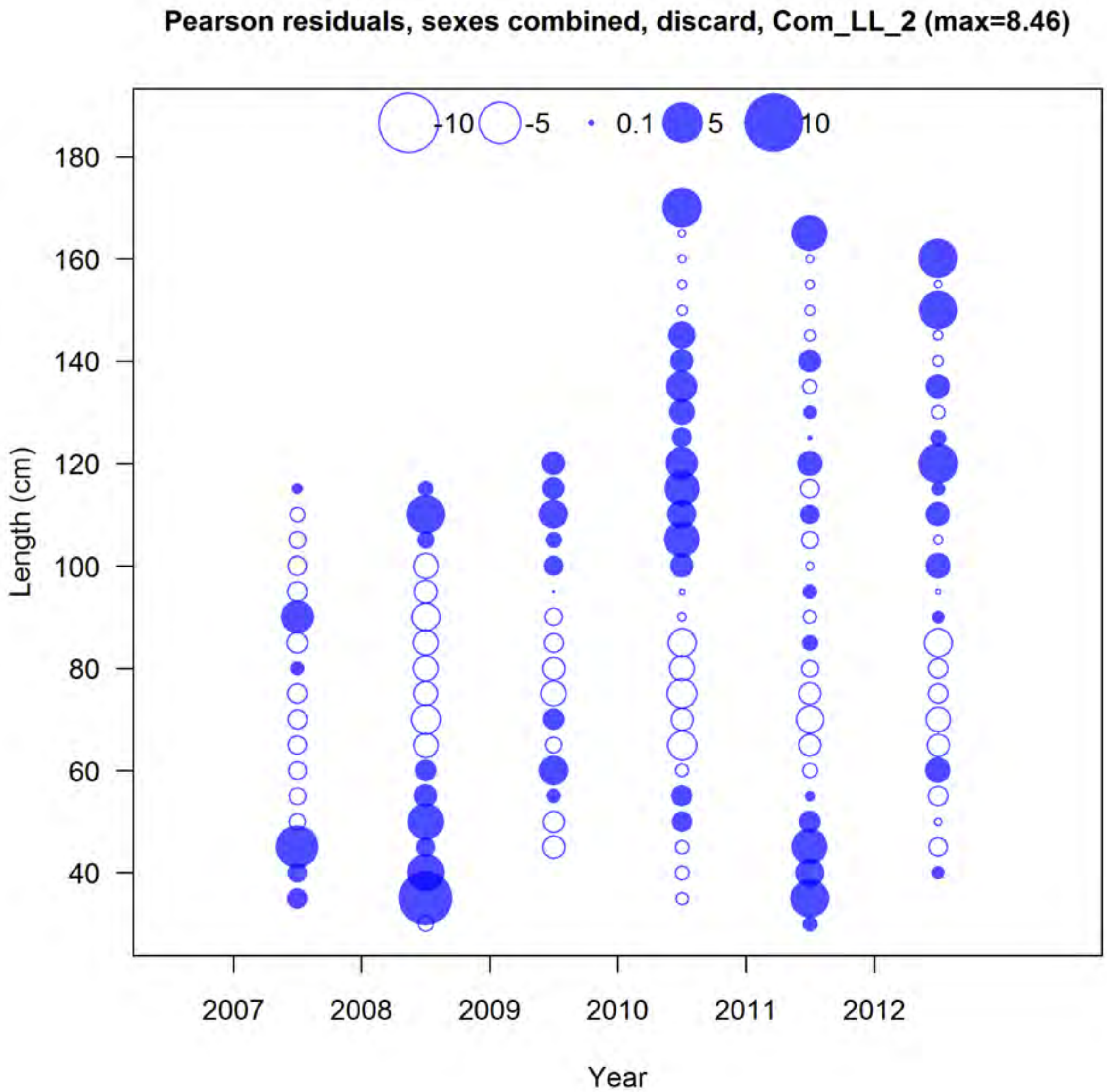


Figure 3.2.1.5.1d. Pearson residual distributions of discarded length composition fits for Gulf of Mexico greater amberjack in the commercial bottom longline fishery (COM_LL) from the SS Base Model Run. Solid circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

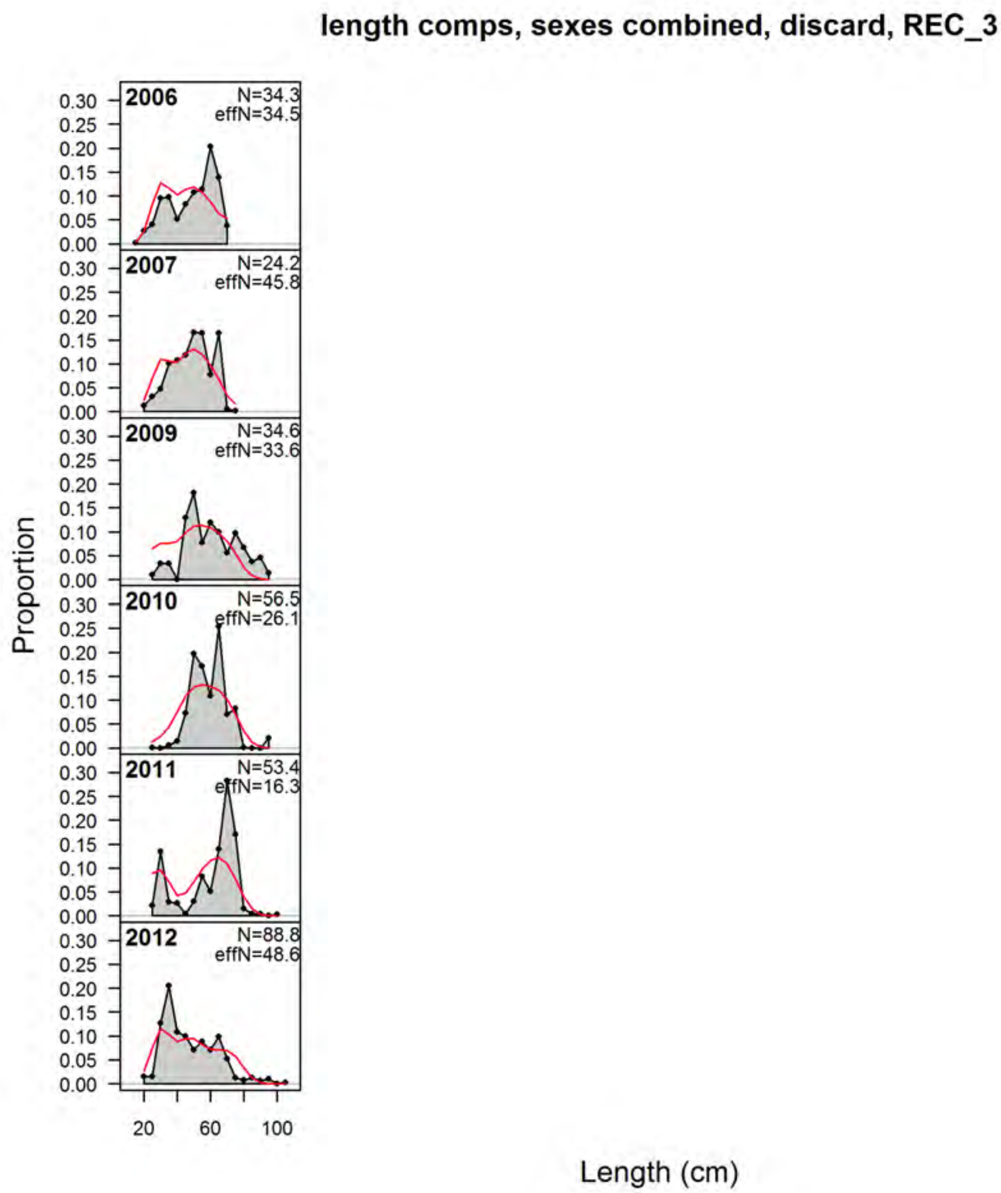


Figure 3.2.1.5.1e. Observed and predicted (lines) discarded length compositions for Gulf of Mexico greater amberjack recreational (REC) fishery from the SS Base Model Run. Observed (N) sample sizes and effective sample sizes (effN) estimated by SS are also reported. Observed sample sizes were capped at a maximum of 100 fish.

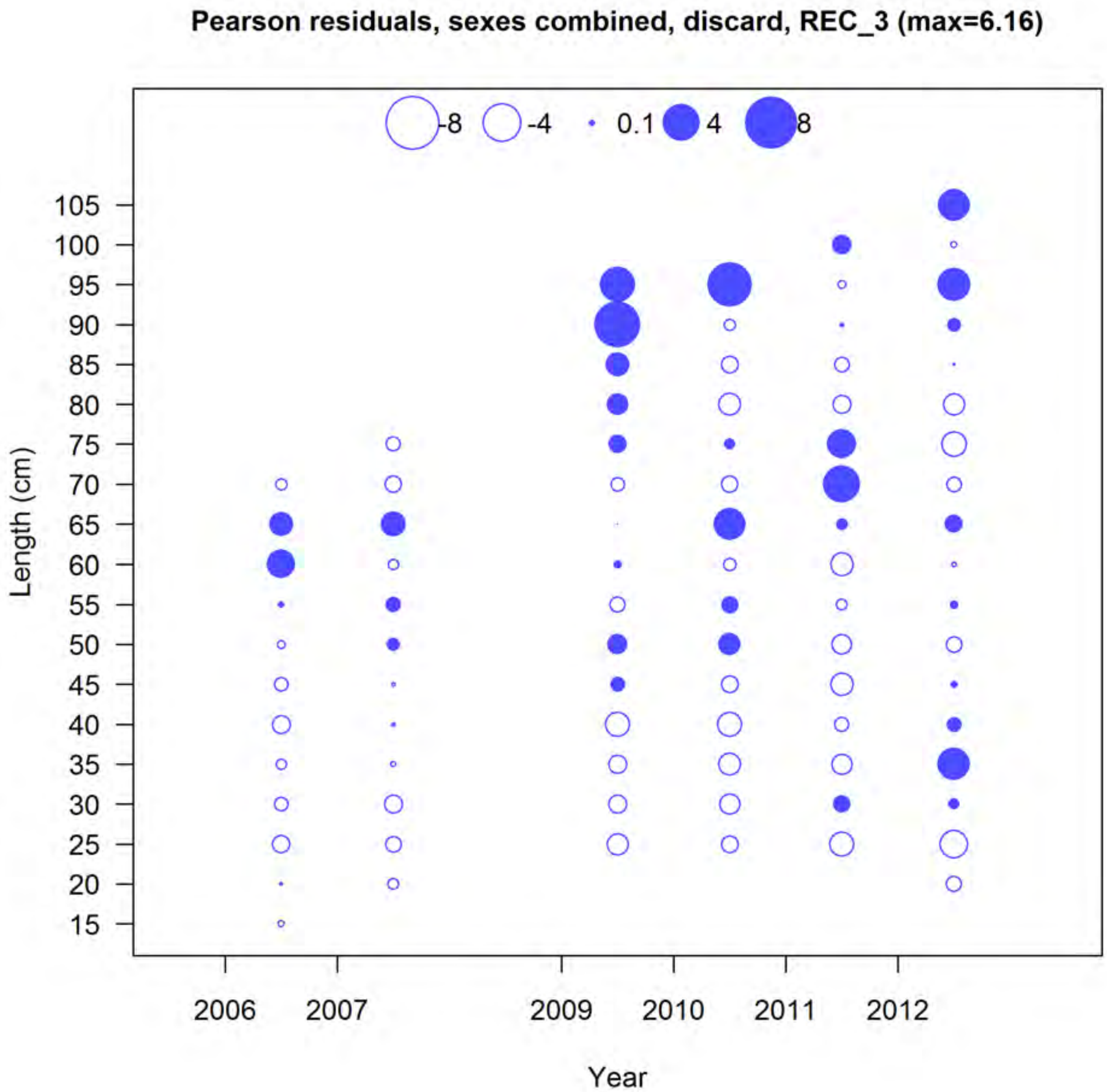


Figure 3.2.1.5.1f. Pearson residual of discarded length composition fits for Gulf of Mexico greater amberjack in the recreational charter and private angler fisheries fishery (REC) from the SS Base Model Run. Solid circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

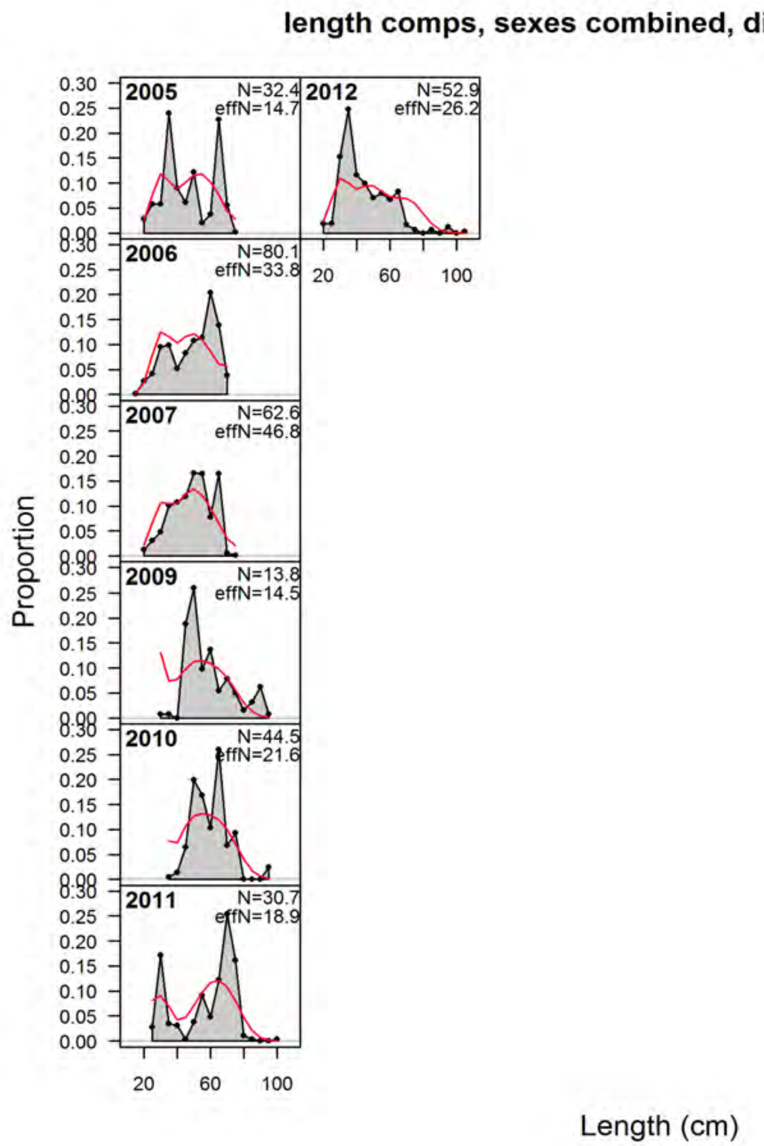


Figure 3.2.1.5.1g. Observed and predicted (lines) discarded length compositions for Gulf of Mexico greater amberjack recreational (Headboat) fleet from the SS Base Model Run. Observed (N) sample sizes and effective sample sizes (effN) estimated by SS are also reported. Observed sample sizes were capped at a maximum of 200 fish.

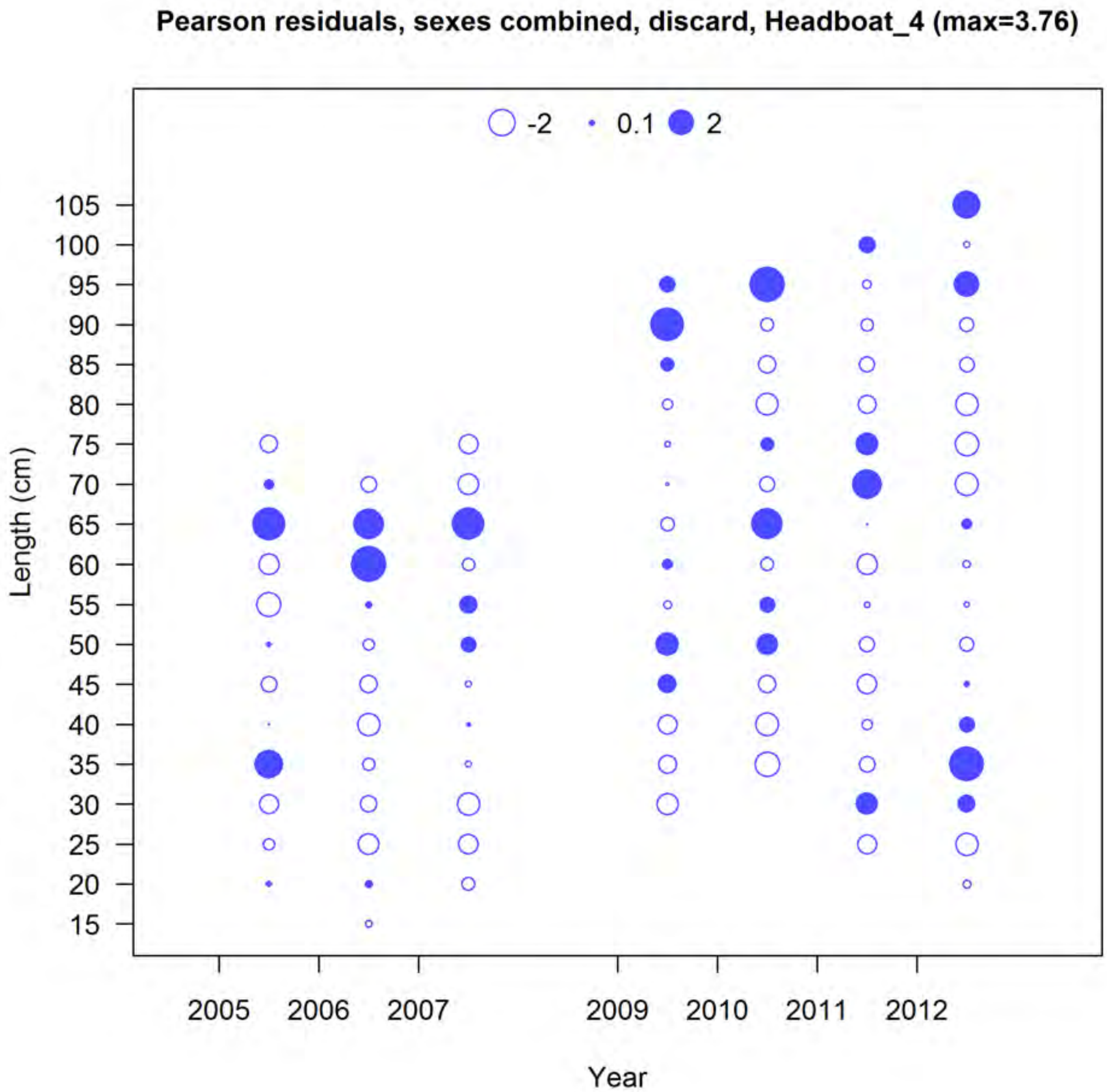


Figure 3.2.1.5.1h. Pearson residual of discarded length composition fits for Gulf of Mexico greater amberjack in the Headboat fishery (Headboat) from the SS Base Model Run. Solid circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

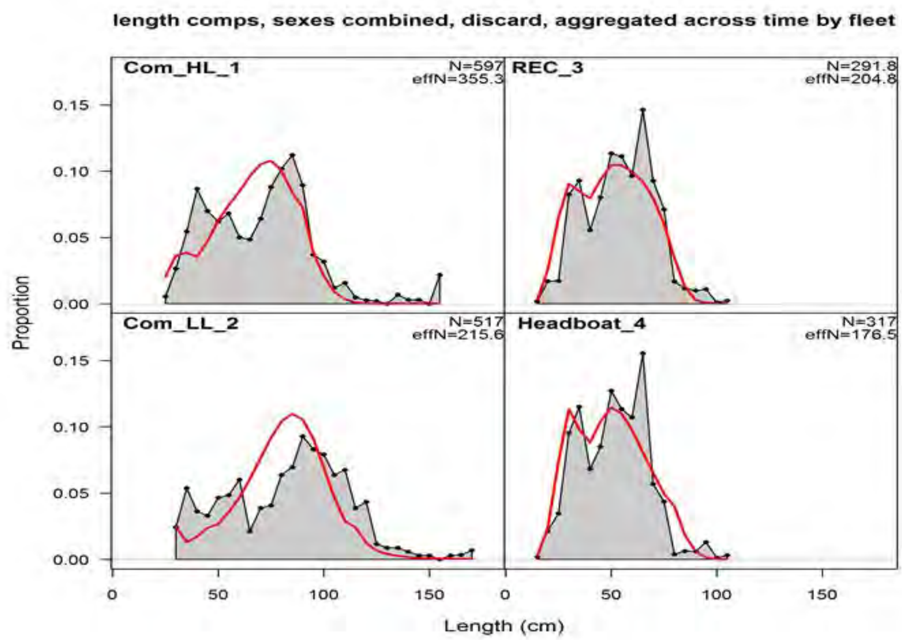


Figure 3.2.1.5.1i. Observed and predicted (lines) discarded length compositions for Gulf of Mexico greater amberjack for four fleets for SS Base Model Run. Observed (N) sample sizes and effective sample sizes (effN) estimated by SS are also reported. Observed sample sizes were capped at a maximum of 200 fish.

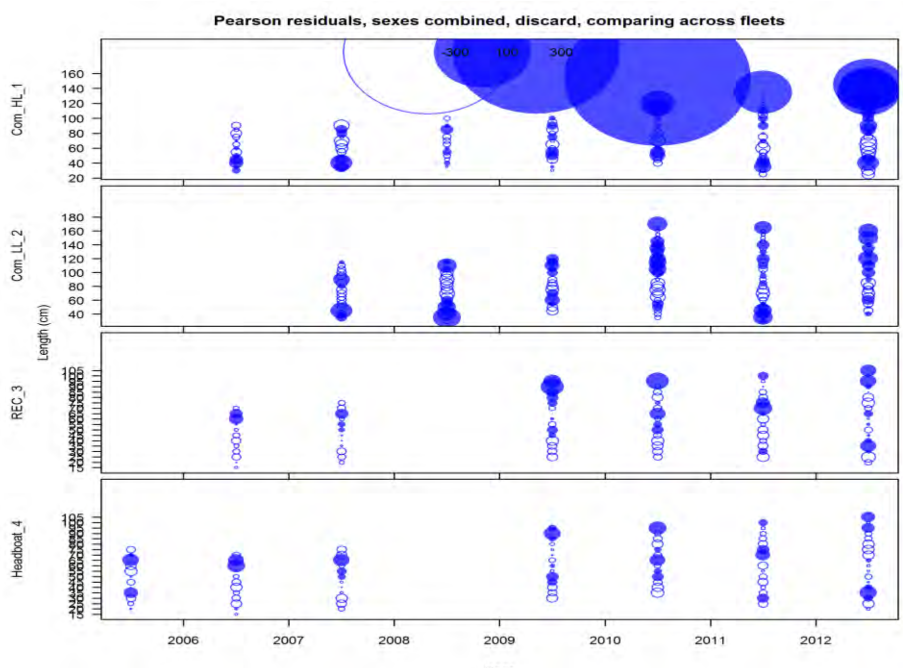


Figure 3.2.1.5.1j. Pearson residual of discarded length composition fits for Gulf of Mexico greater amberjack for four fleets for SS Base Model Run. Solid circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

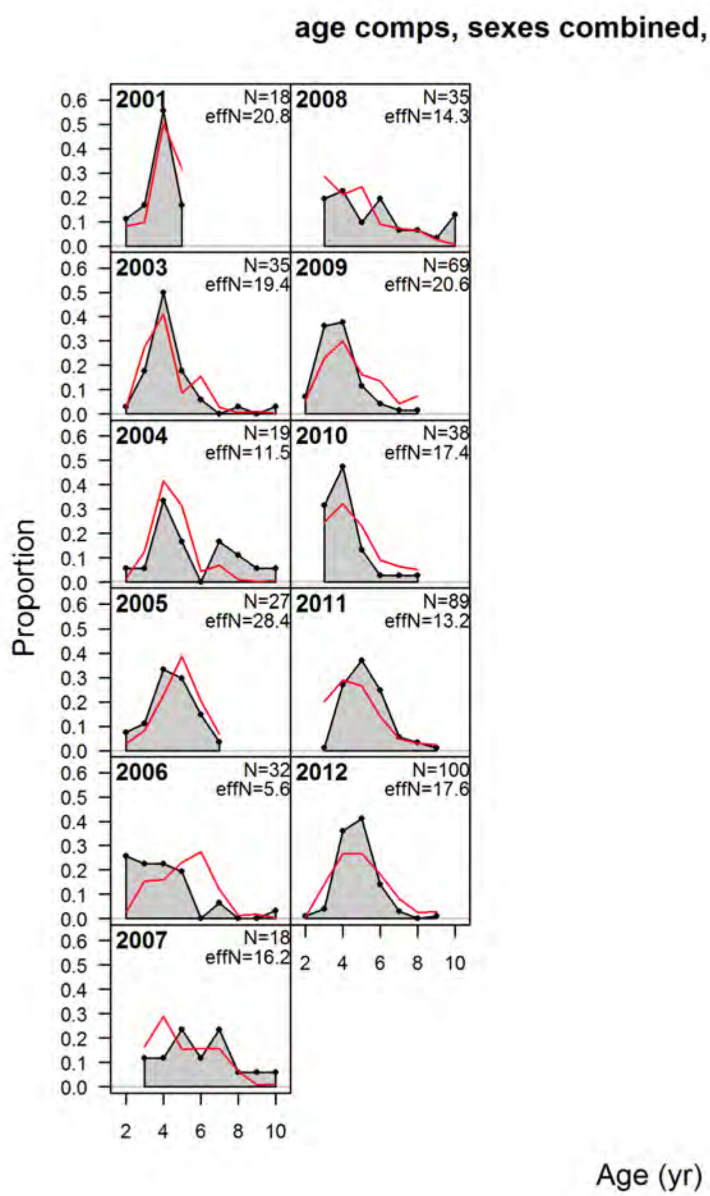


Figure 3.2.1.6.1a. Age composition fits for Gulf of Mexico greater amberjack from the SS Run Base Model Run for the commercial line fishery (COM_HL) fleet. Observed sample sizes were capped at a maximum of 200 fish.

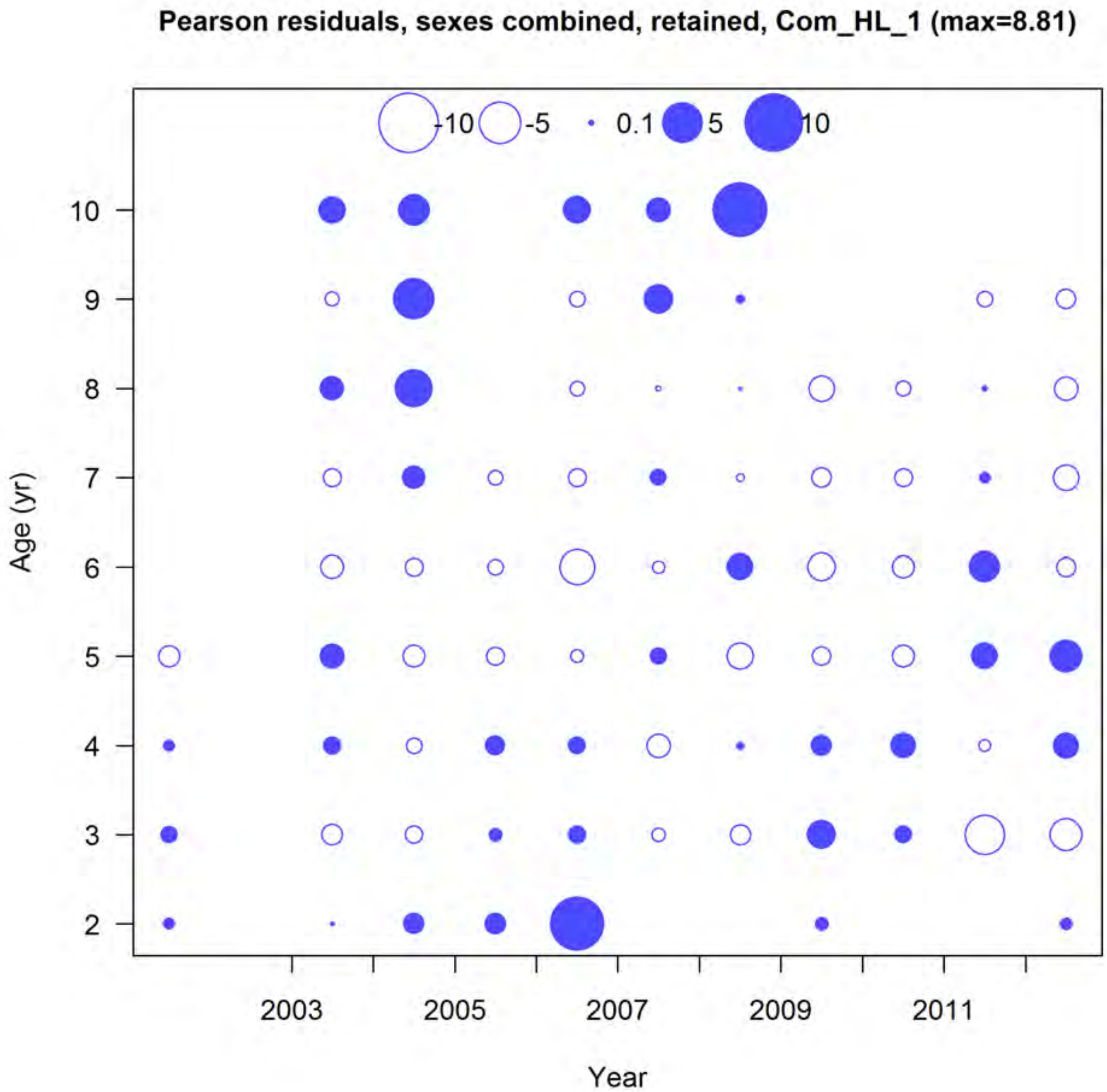


Figure 3.2.1.6.1b. Pearson residual of retained age composition fits for Gulf of Mexico greater amberjack in the commercial line fishery (COM_HL) from the SS Base Model Run. Solid circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

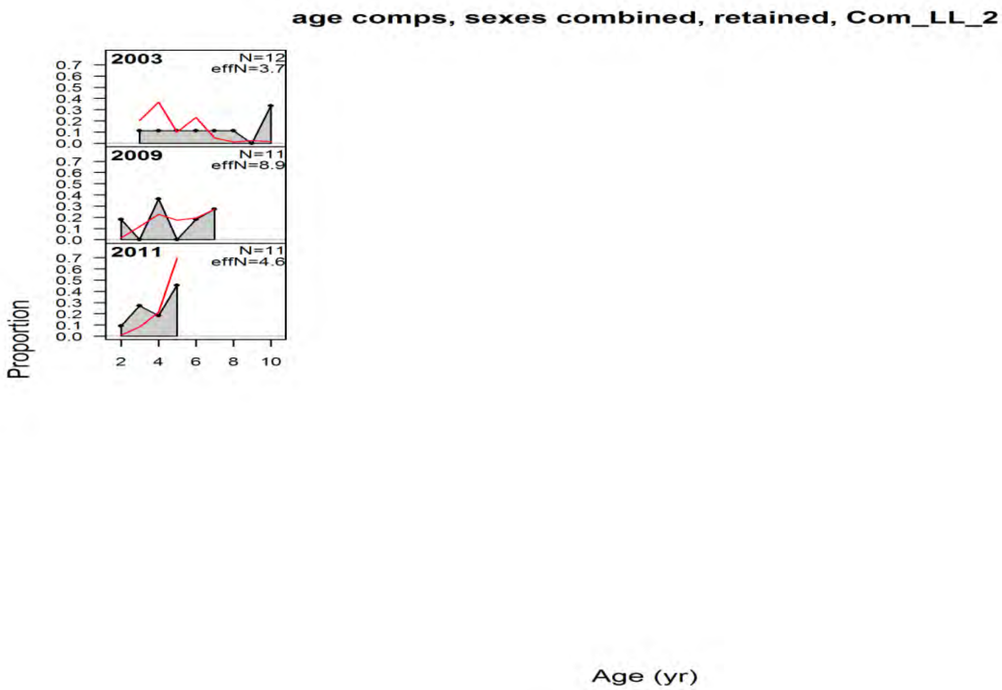


Figure 3.2.1.6.1c. Age composition fits for Gulf of Mexico greater amberjack from the SS Base Model Run for the commercial bottom longline (COM_LL) fleet. Observed sample sizes were capped at a maximum of 200 fish.

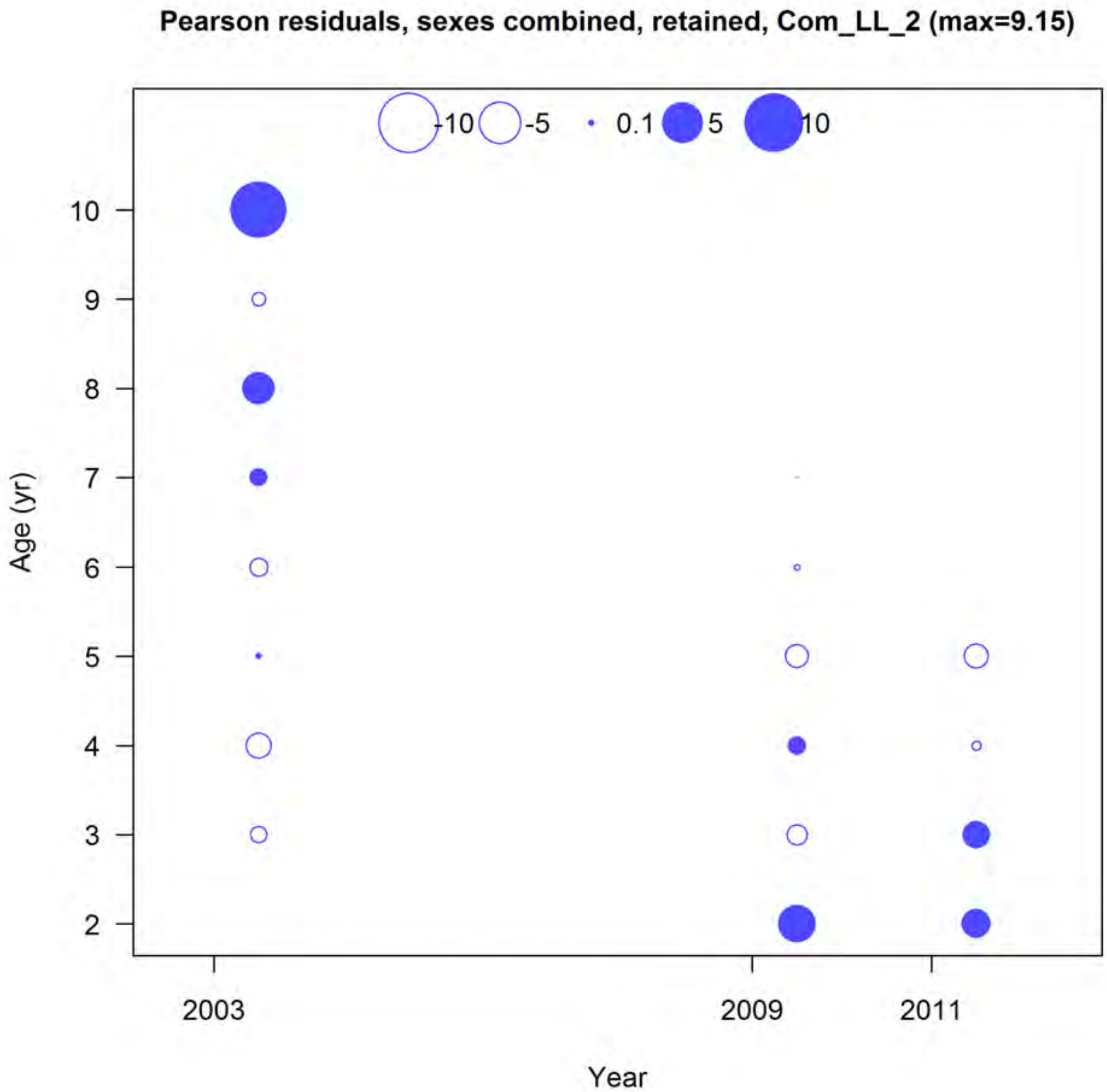


Figure 3.2.1.6.1d. Pearson residual of retained age composition fits for Gulf of Mexico greater amberjack in the commercial longline fishery (COM_LL) from the SS Base Model Run. Solid circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

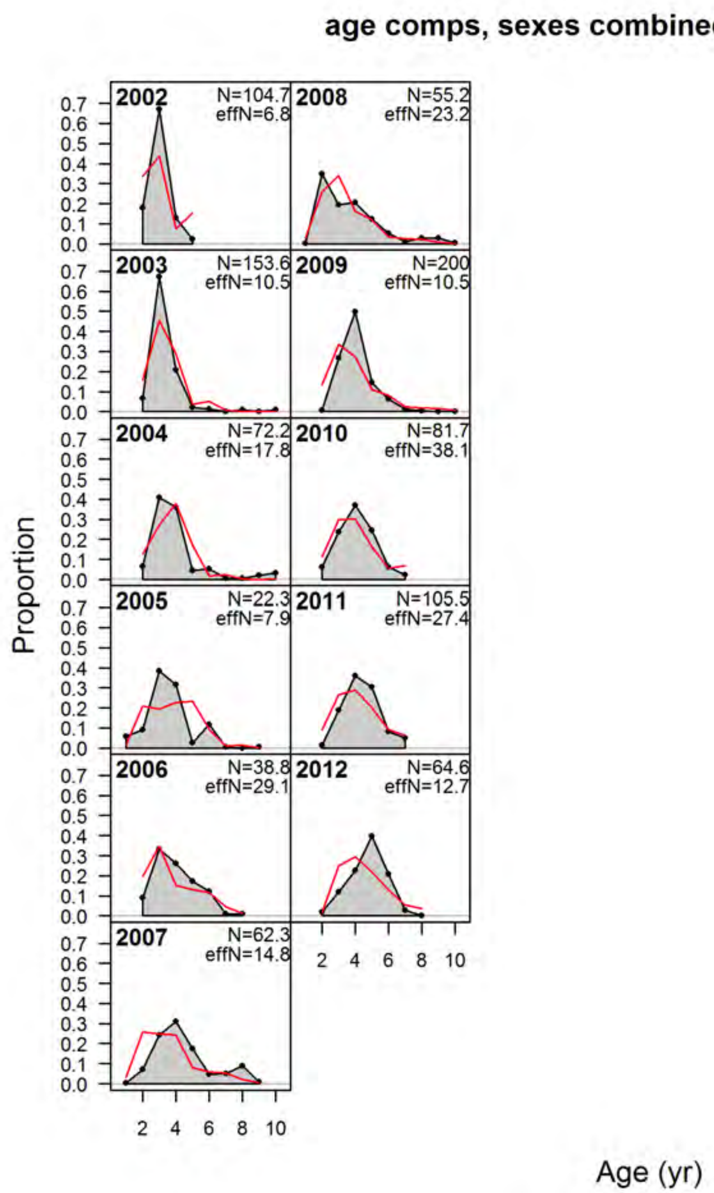


Figure 3.2.1.6.1e. Age composition fits for Gulf of Mexico greater amberjack from the SS Base Model Run for the recreational charter and private angler (REC) fleets. Observed sample sizes were capped at a maximum of 200 fish.

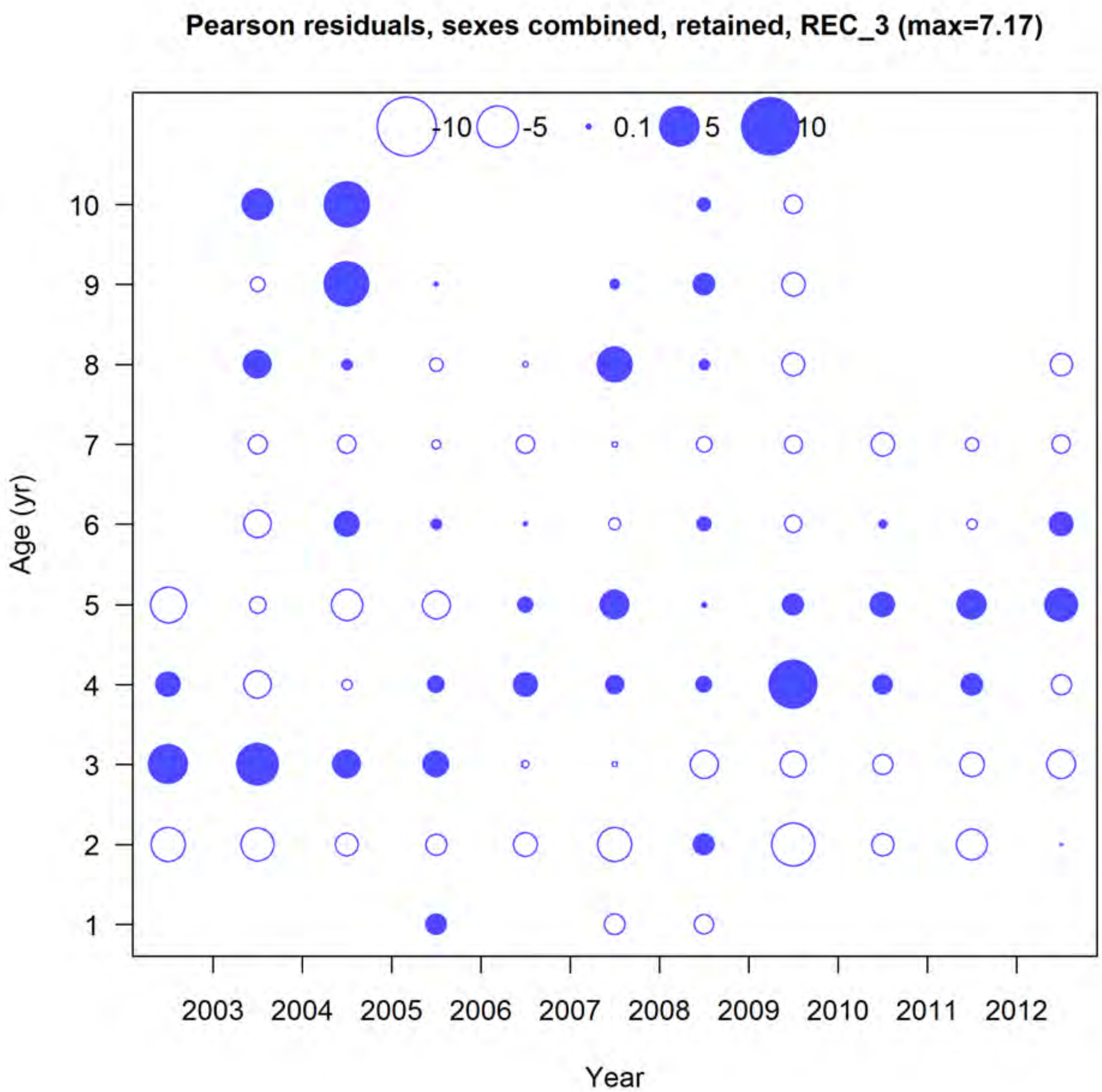


Figure 3.2.1.6.1f. Pearson residual of retained age composition fits for Gulf of Mexico greater amberjack in the recreational charter and private angler fishery (REC) from the SS Base Model Run. Solid circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

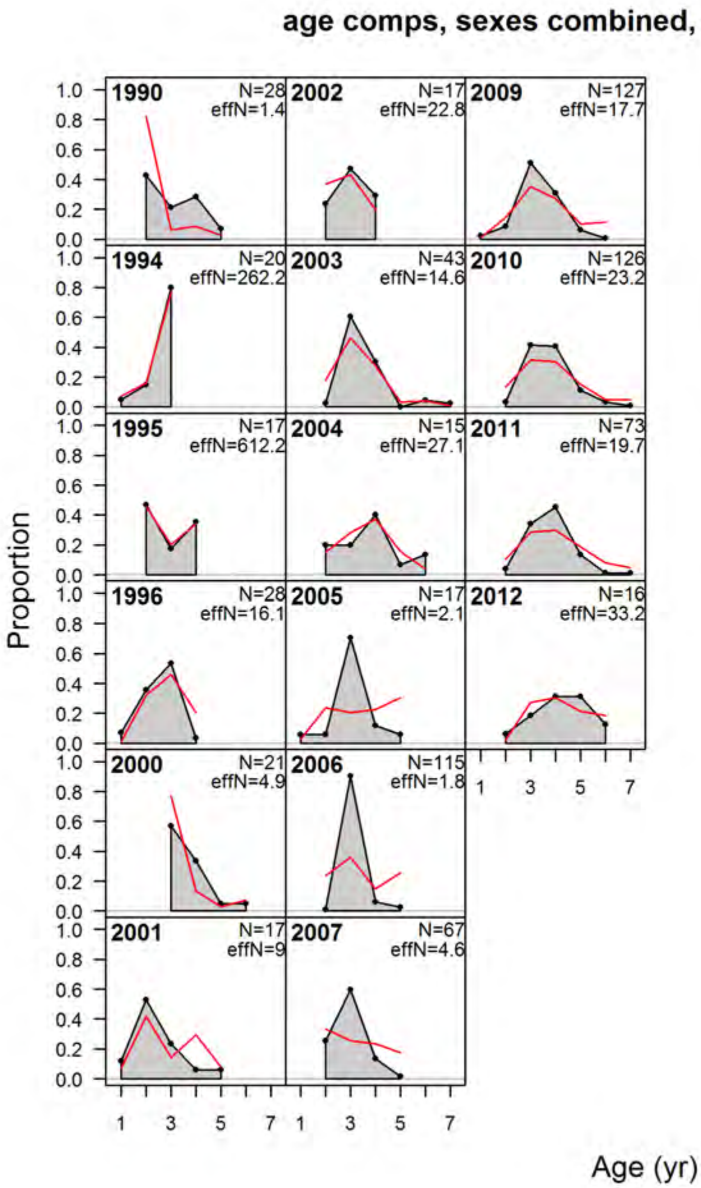


Figure 3.2.1.6.1g. Age composition fits for Gulf of Mexico greater amberjack from the SS Base Model Run for the recreational Headboat fleet. Observed sample sizes were capped at a maximum of 200 fish.

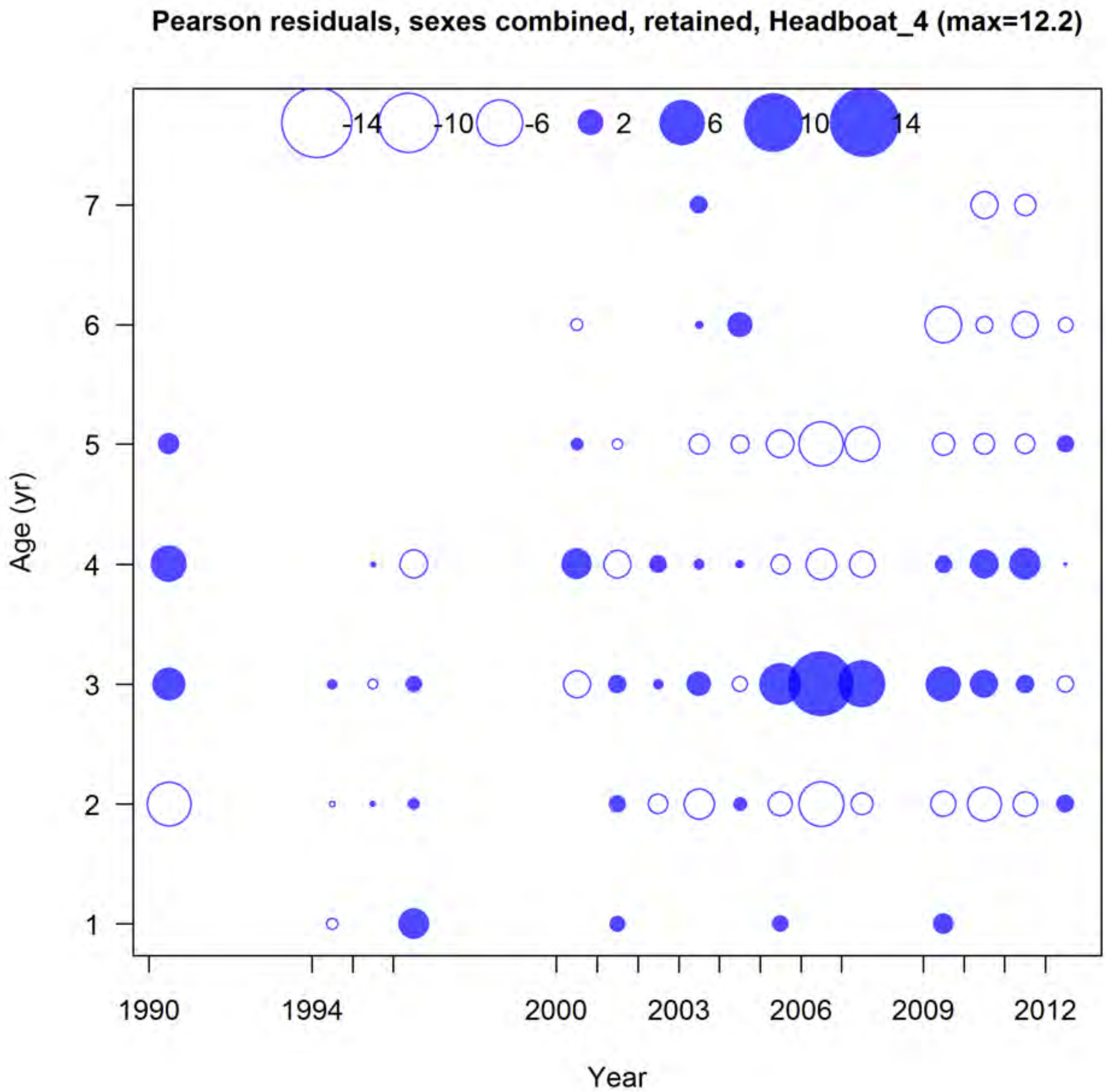


Figure 3.2.1.6.1h. Pearson residual of retained age composition fits for Gulf of Mexico greater amberjack in the Headboat fishery (Headboat) from the SS Base Model Run. Solid circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

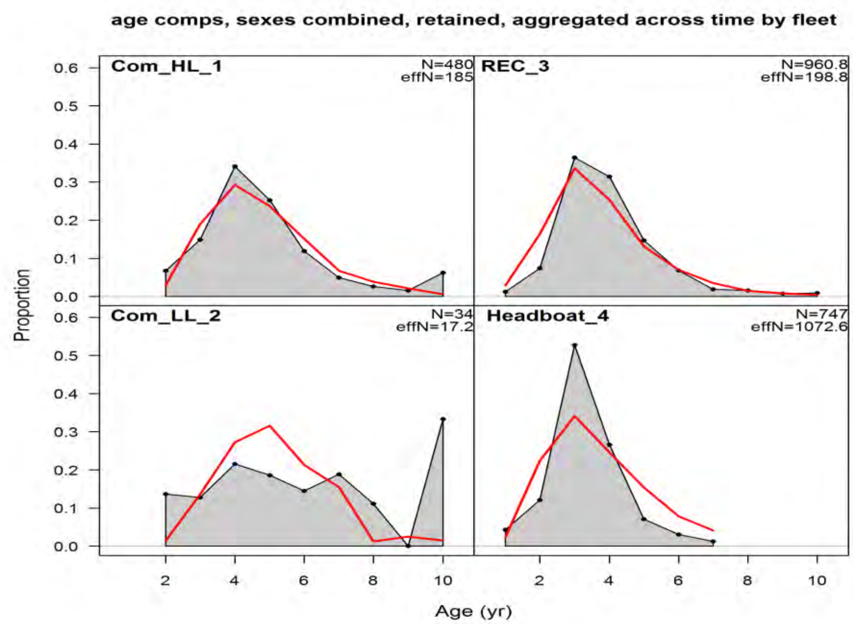


Figure 3.2.1.6.1j. Age composition fits for Gulf of Mexico greater amberjack from the SS Base Model Run for four fleets. Observed sample sizes were capped at a maximum of 200 fish.

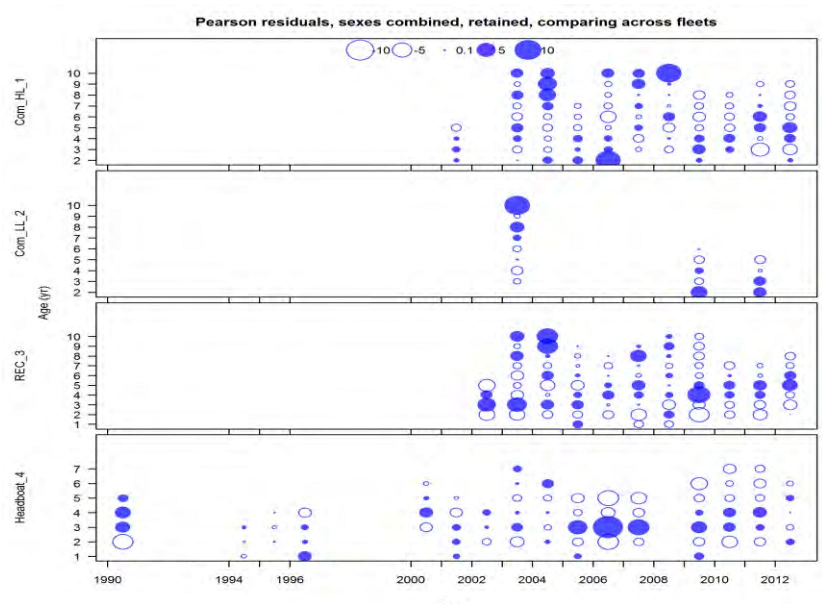


Figure 3.2.1.6.1k. Pearson residual of retained age composition fits for Gulf of Mexico greater amberjack in the Headboat fishery (Headboat) from the SS Base Model Run. Solid circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

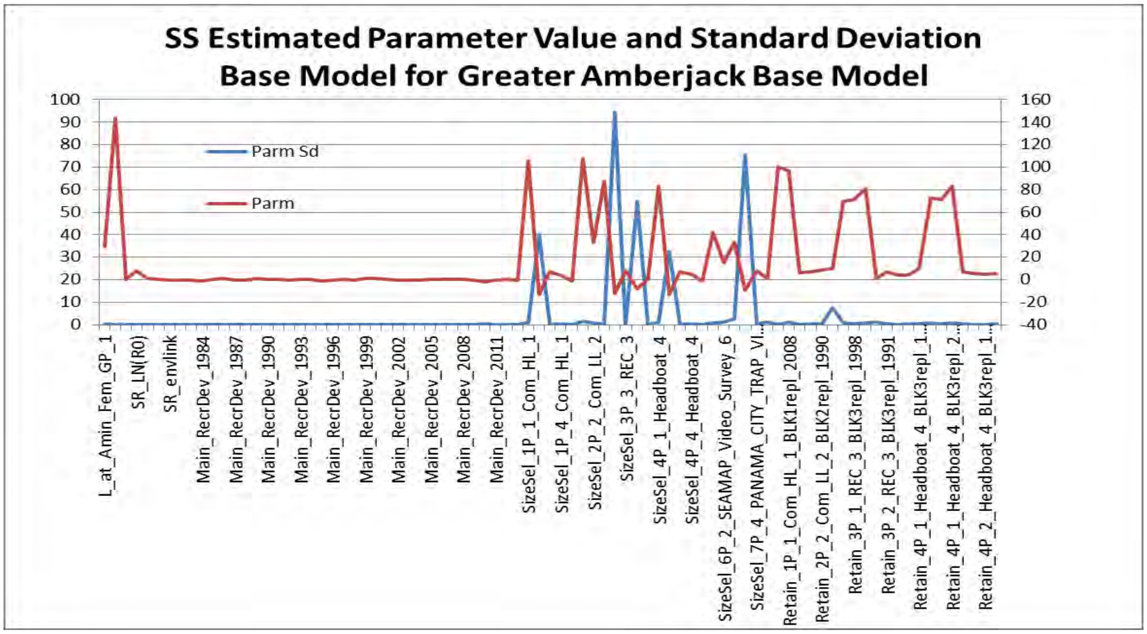


Figure 3.2.2.1a. SS estimated maximum likelihood parameter value for greater amberjack from the final Base Model run (Run 1, Table 3.3).

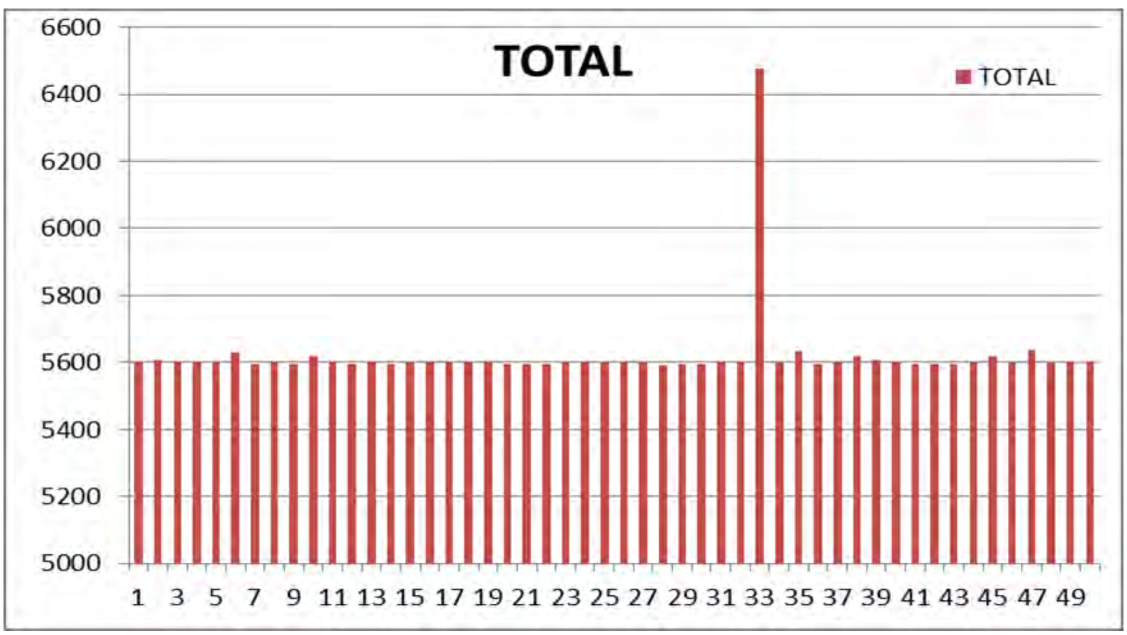
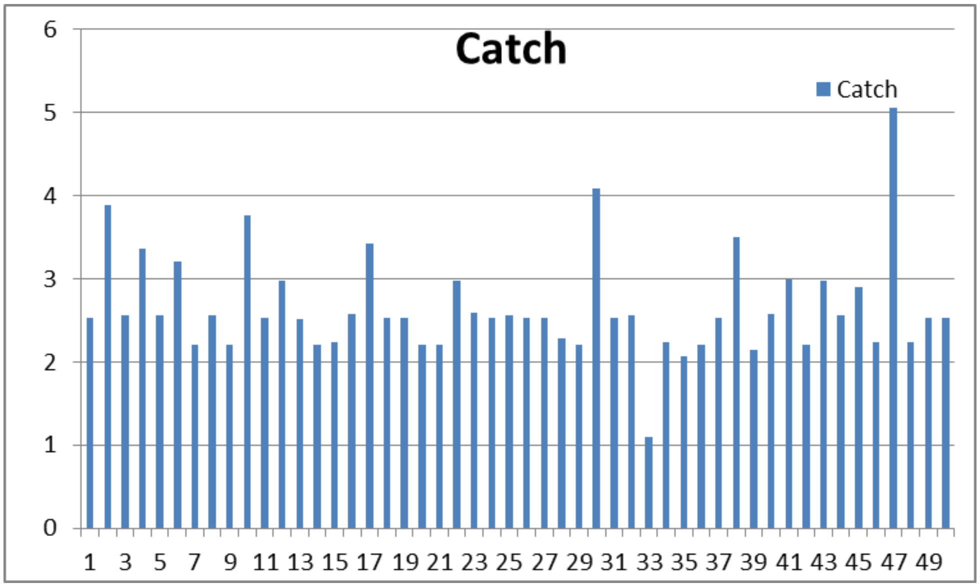


Figure 3.2.2.1b. Summary results for model likelihood estimate for total likelihood for 50 jitter runs from the SS stock assessment Base Model Run for Gulf of Mexico greater amberjack. X axis = jitter trial id. Yaxis = SS estimated likelihood value.



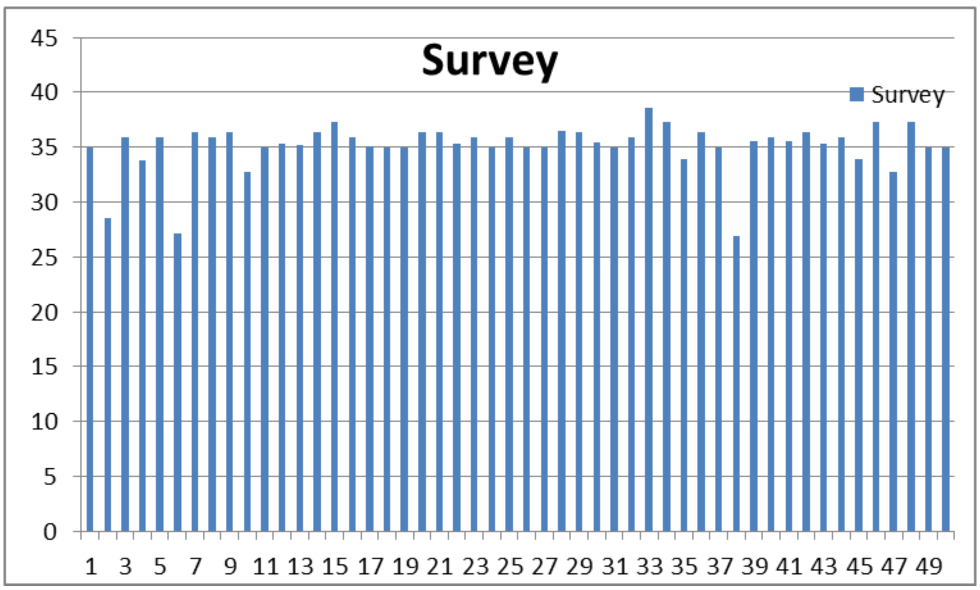
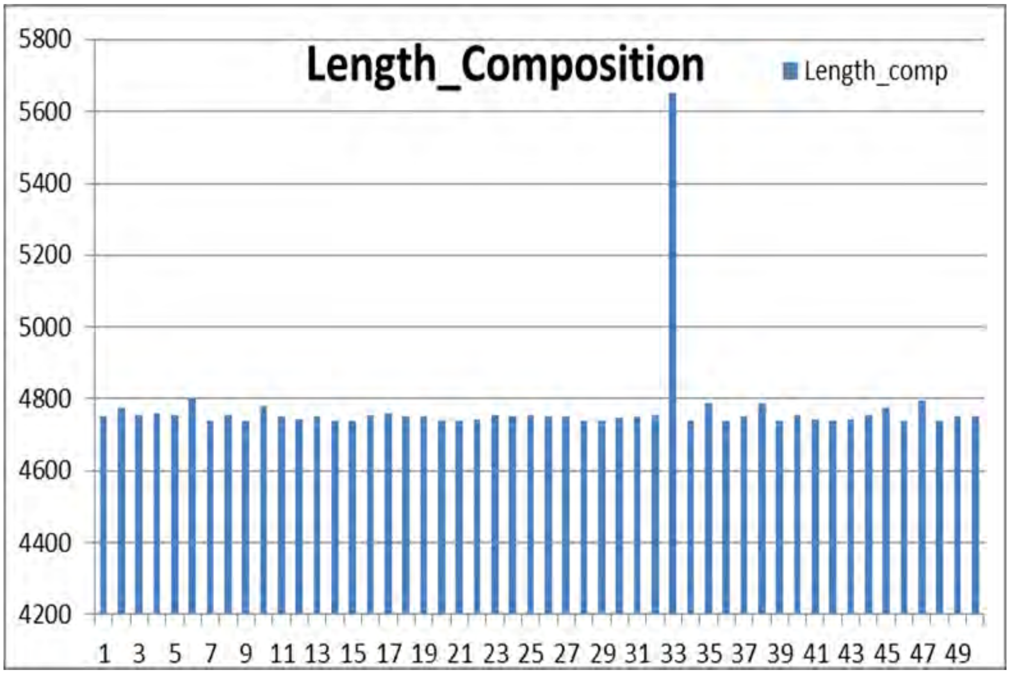


Figure 3.2.2.1c, d. Summary results for model likelihood estimate for catch likelihood and survey likelihood component for 50 jitter runs from the SS stock assessment Base Model Run for Gulf of Mexico greater amberjack. X axis = jitter trial id. Y axis = SS estimated likelihood value.



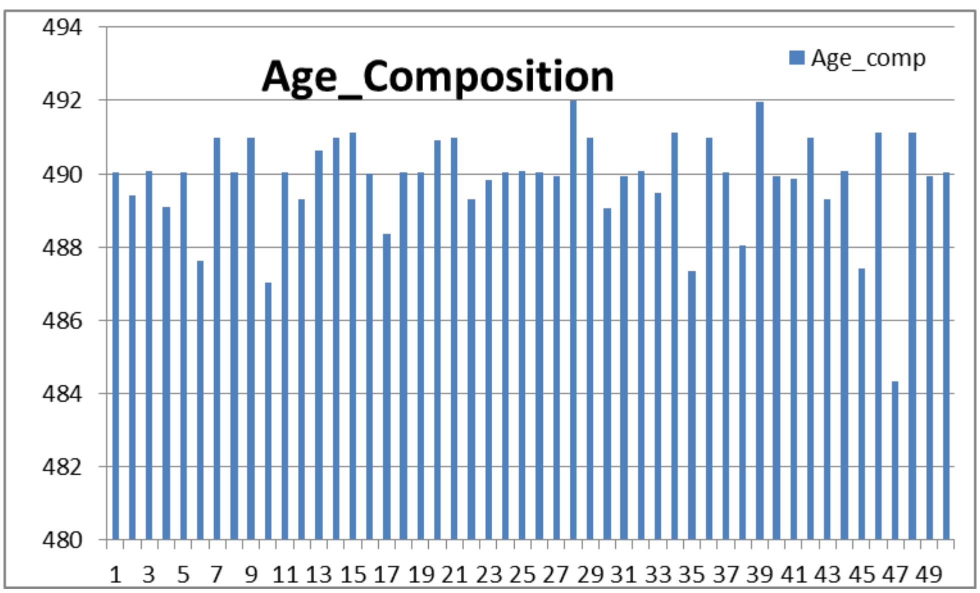


Figure 3.2.2.1e, f. Summary results for model likelihood estimate for length likelihood and age likelihood component for 50 jitter runs from the SS stock assessment Base Model Run for Gulf of Mexico greater amberjack. X axis = jitter trial id. Y axis = SS estimated likelihood value.

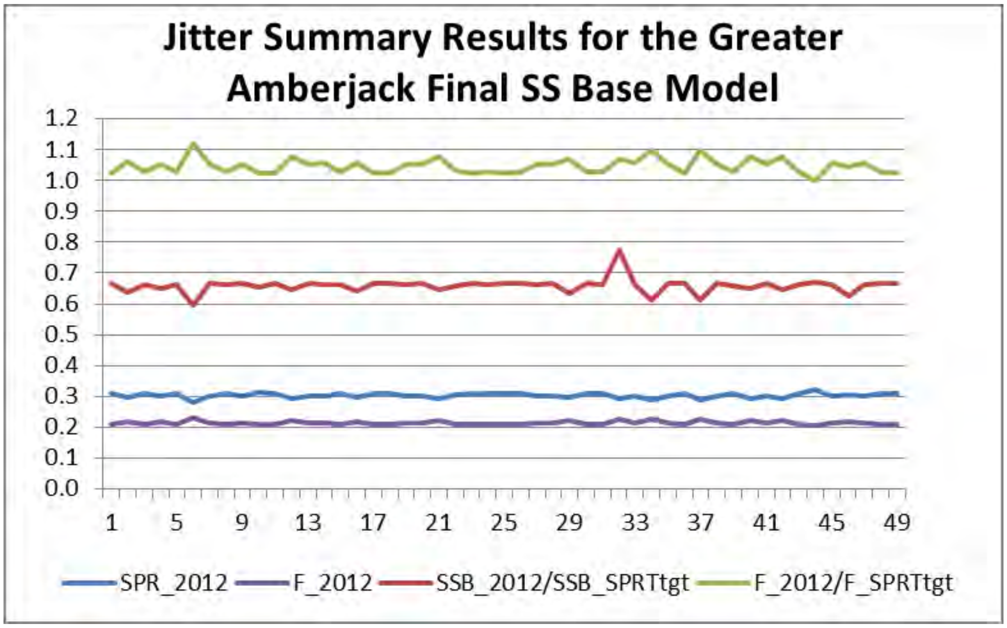


Figure 3.2.2.1g. Summary results for model likelihood estimate for 50 jitter runs from the SS stock assessment Base Model Run for Gulf of Mexico greater amberjack.

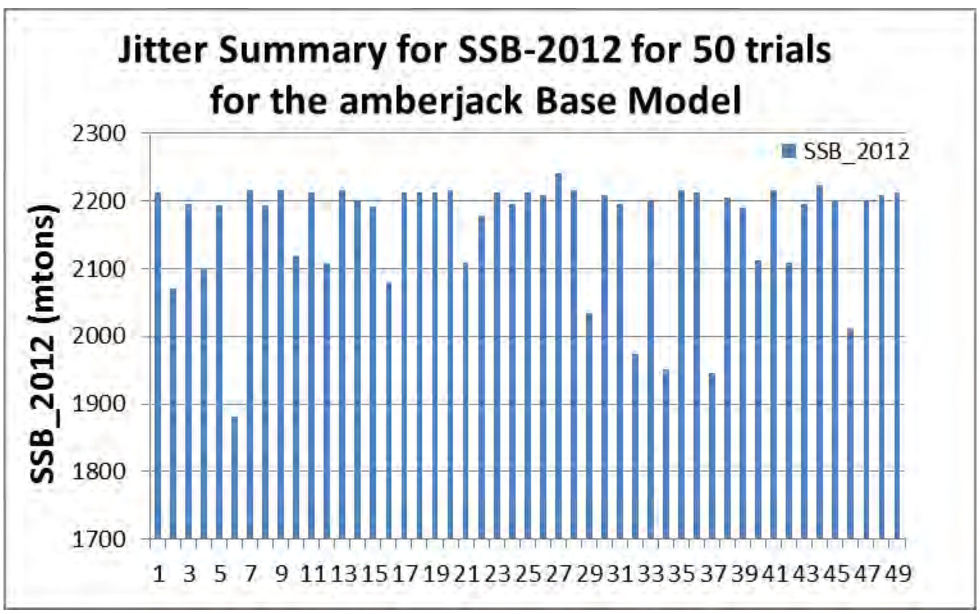
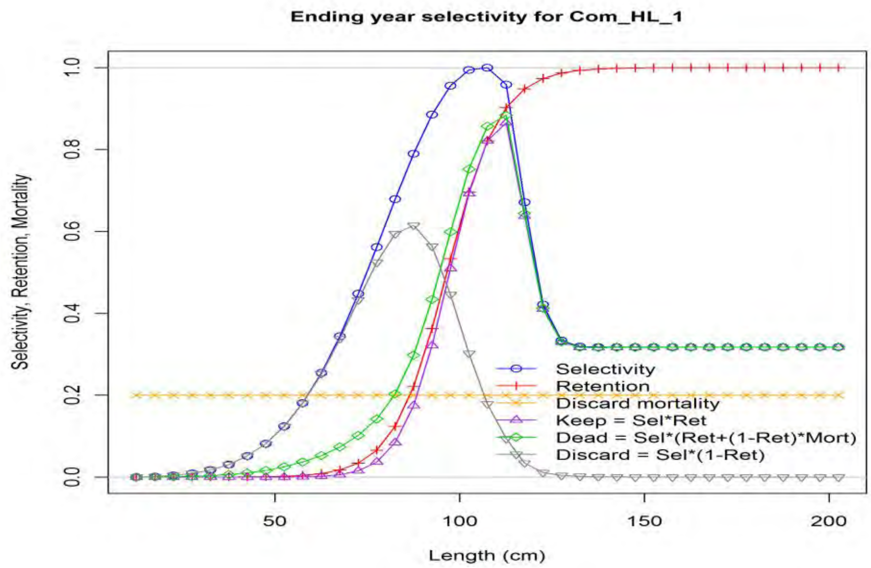


Figure 3.2.2.1h. Summary results for predicted spawning stock biomass in 2012 (SSB) for 50 jitter runs from the SS Base Model Run for Gulf of Mexico Greater amberjack. X axis = jitter trial id. Y axis = SS estimated likelihood value.



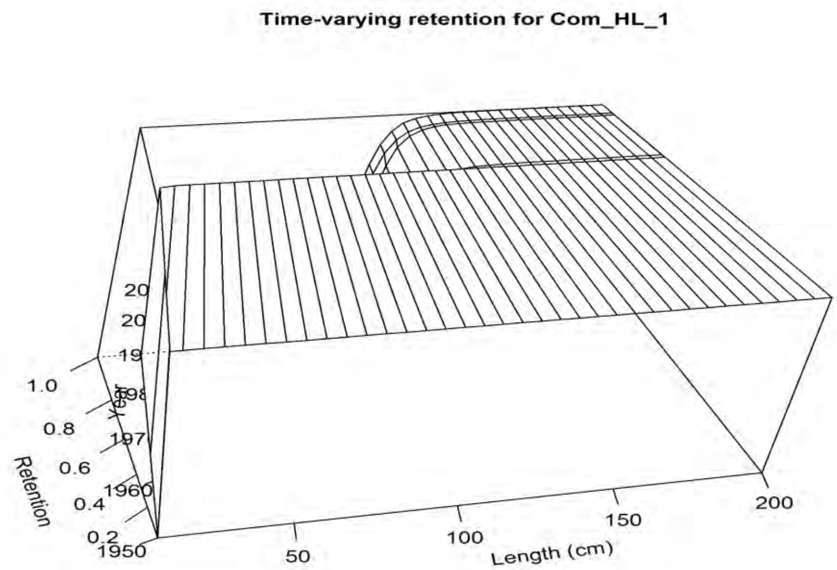


Figure 3.2.3.1a. Predicted size selectivity and time varying retention for Gulf of Mexico greater amberjack from SS for the COM_HL fishery. Model configuration = Base Model Run.

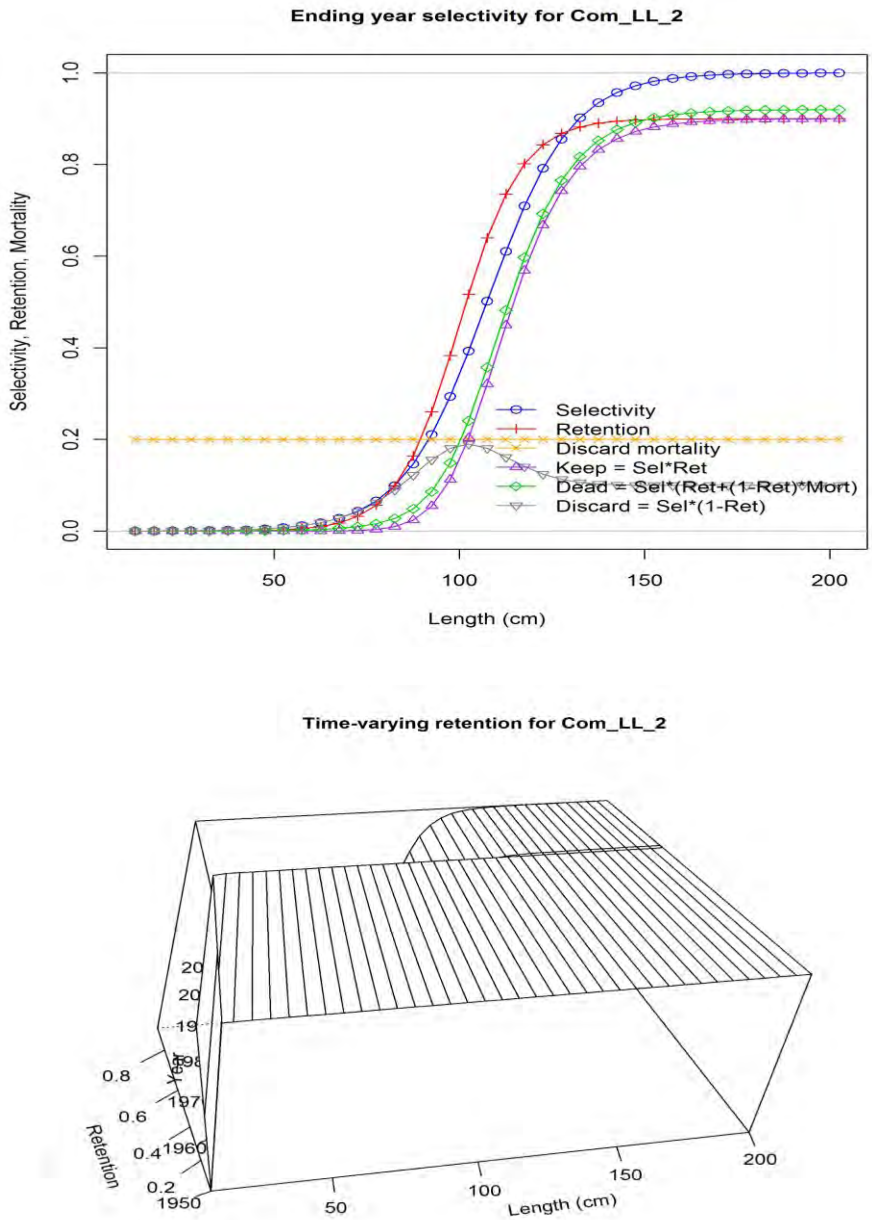
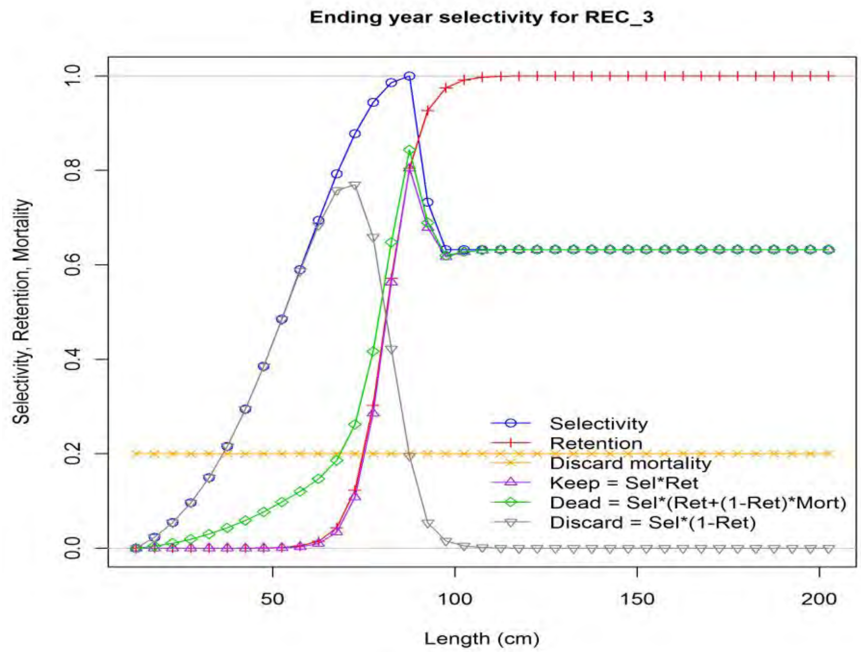


Figure 3.2.3.1b. Predicted size selectivity for Gulf of Mexico greater amberjack from SS for the COM_LL fishery. Model configuration = Base Model Run.



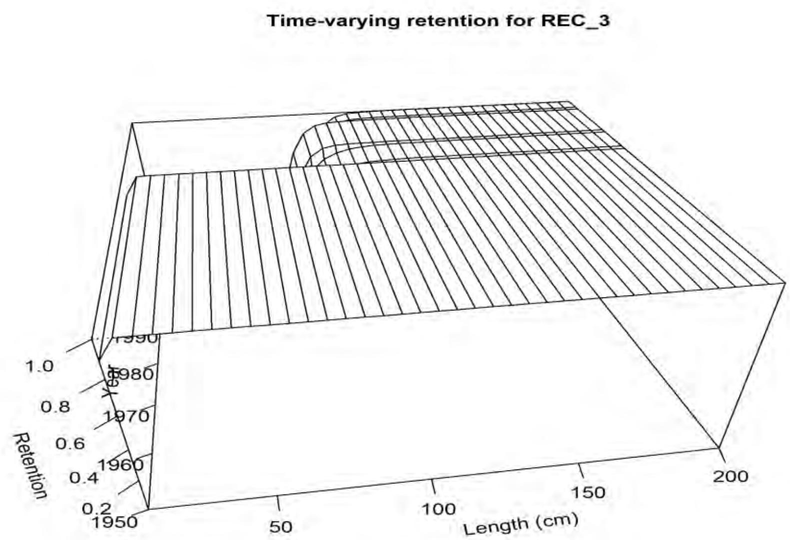
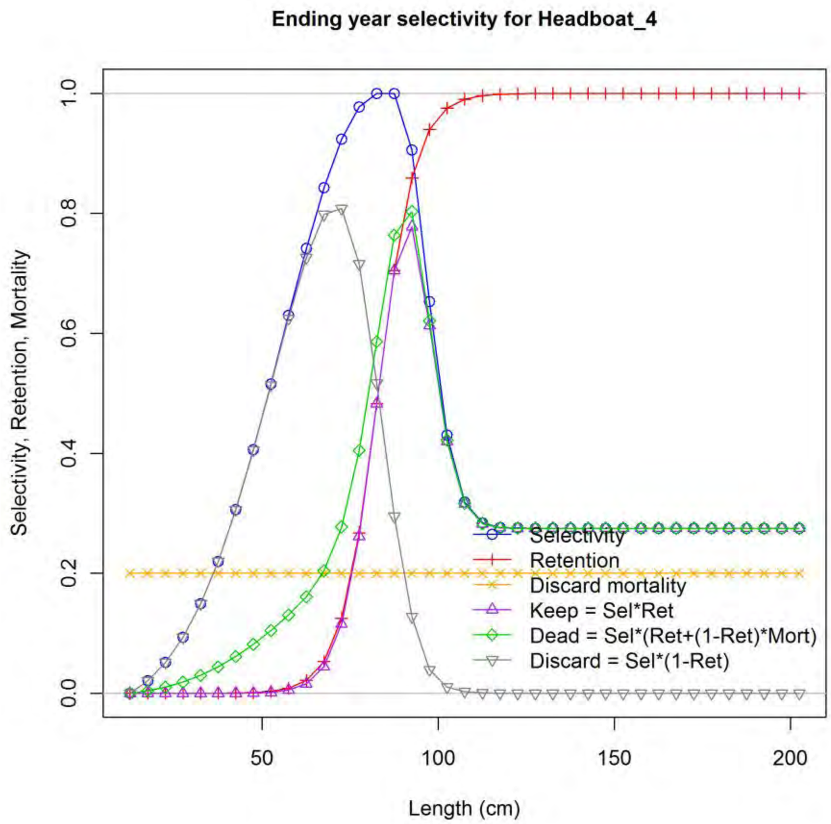


Figure 3.2.3.1c. Predicted size selectivity for Gulf of Mexico greater amberjack from SS the REC (recreational all modes). Model configuration = Base Model Run.



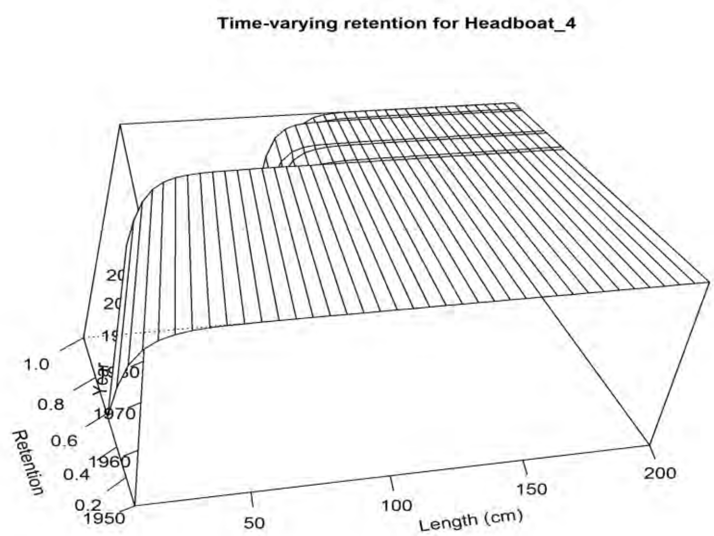


Figure 3.2.3.1d. Predicted size selectivity for Gulf of Mexico greater amberjack from SS the Headboat fleet. Model configuration = Base Model Run.

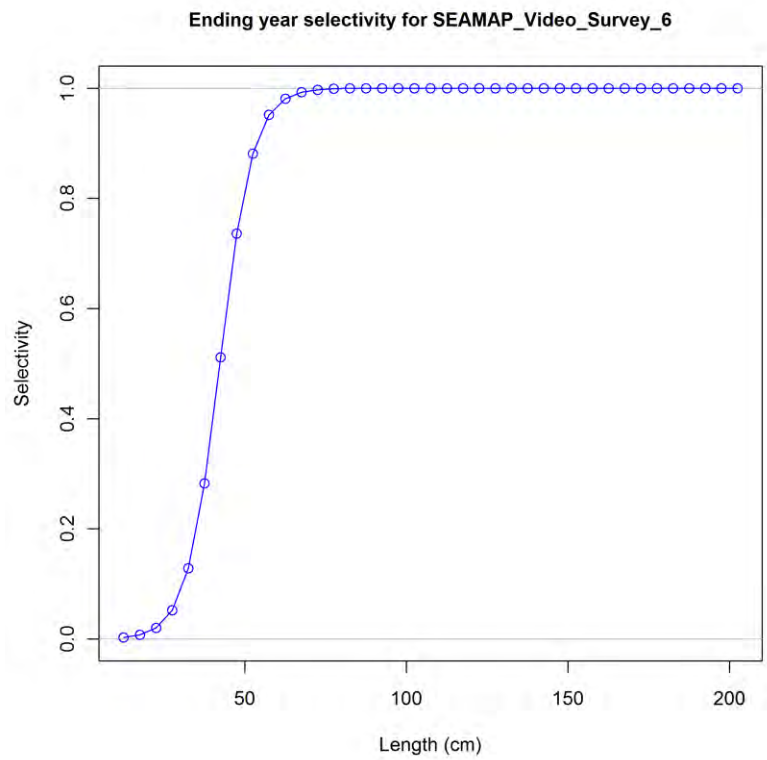


Figure 3.2.3.1e. Predicted size selectivity for Gulf of Mexico greater amberjack from the SEAMAP Video Survey. Model configuration = Base Model Run.

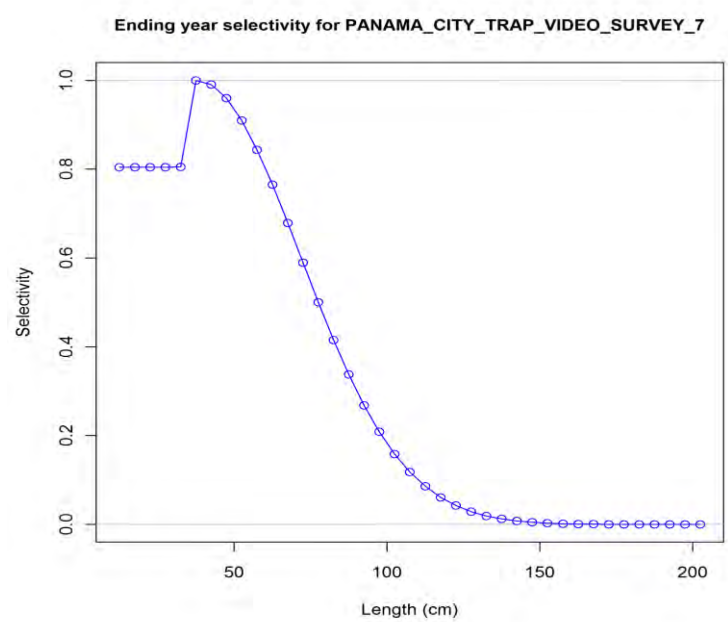


Figure 3.2.3.1f. Predicted size selectivity for Gulf of Mexico greater amberjack from the panama City Laboratory trap Video. Model configuration = Base Model Run.

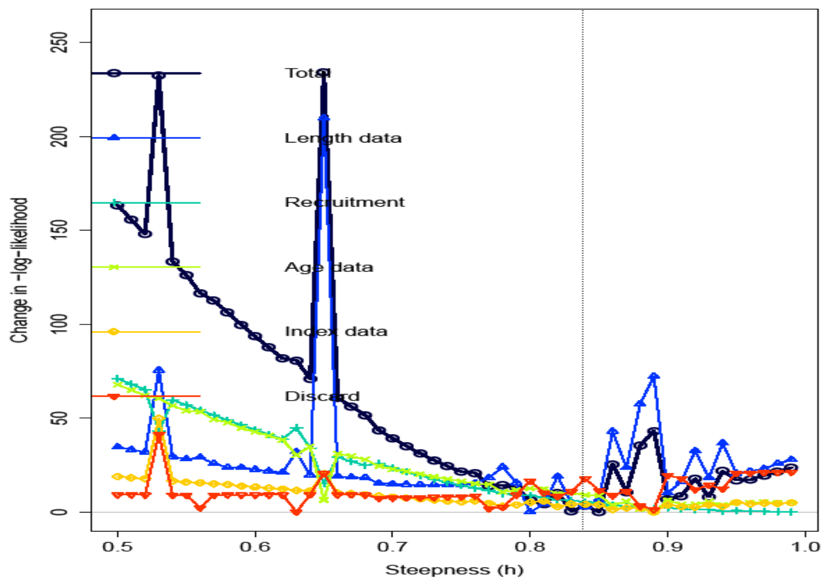


Figure 3.2.4.1. Profile of steepness for Gulf of Mexico greater amberjack for the SS Base Model run configuration. 0.837618, SD= 0.018473. Blue line is change in length data likelihood, red line = change in discard data likelihood, aqua color line = change in age likelihood.

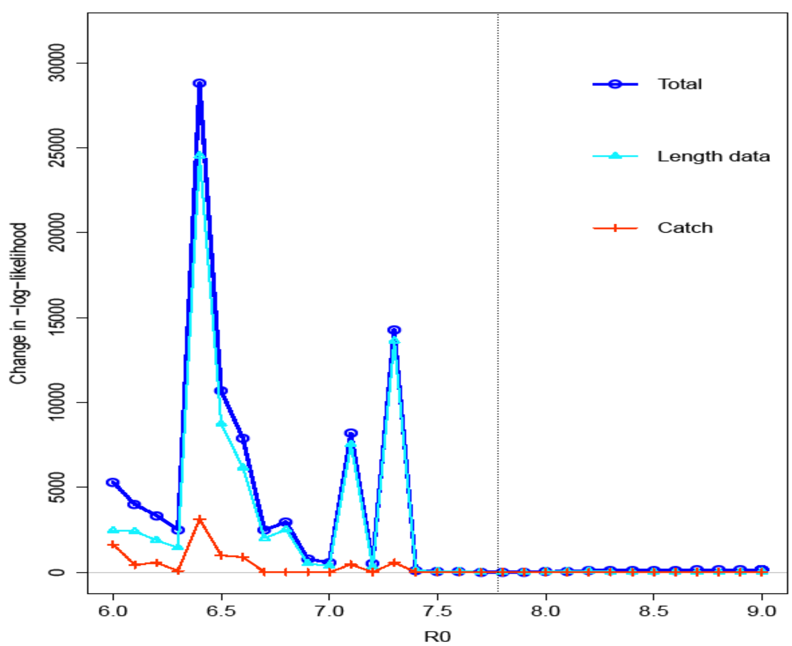


Figure 3.2.4.2. Profile of Virgin biomass (R0) for Gulf of Mexico greater amberjack for Base Model Run configuration. Model estimated ln(R0) value= 7.77614, SD = 0.030959. Blue line is change in length data likelihood, red line = change in discard data likelihood, aqua color line = change in age likelihood.

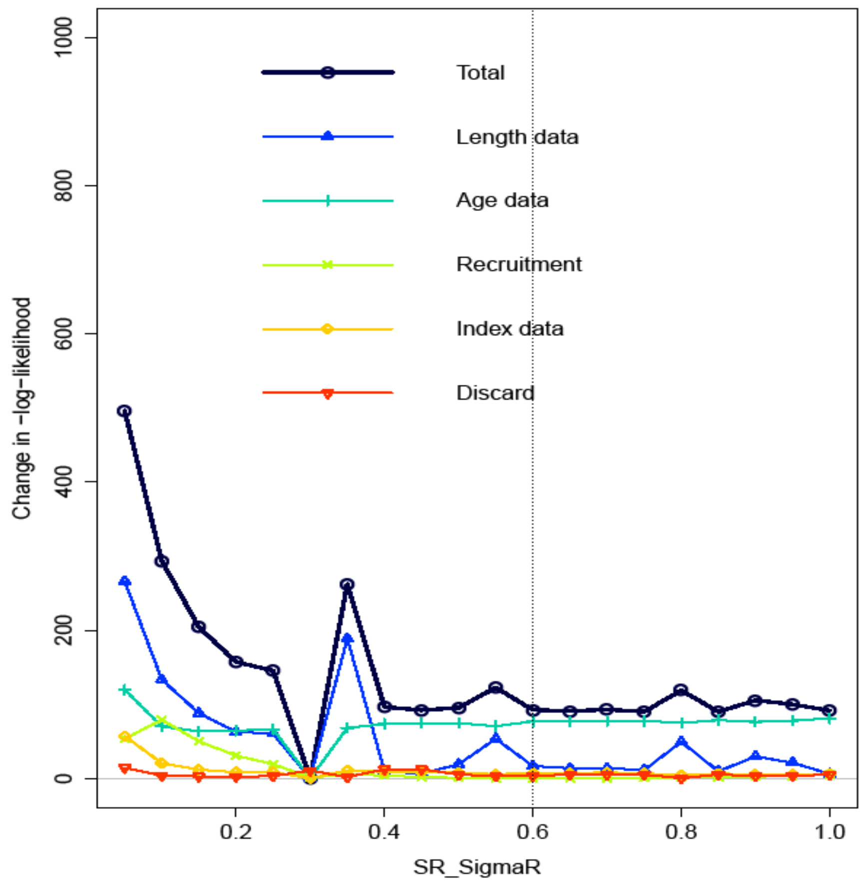


Figure 3.2.4.3. Profile of SigmaR of Gulf of Mexico greater amberjack for the Base Model Run configuration. Final Base modle value assumed 0.6=sigmaR. Blue line is change in length data likelihood, red line = change in discard data likelihood, aqua color line = change in age likelihood.

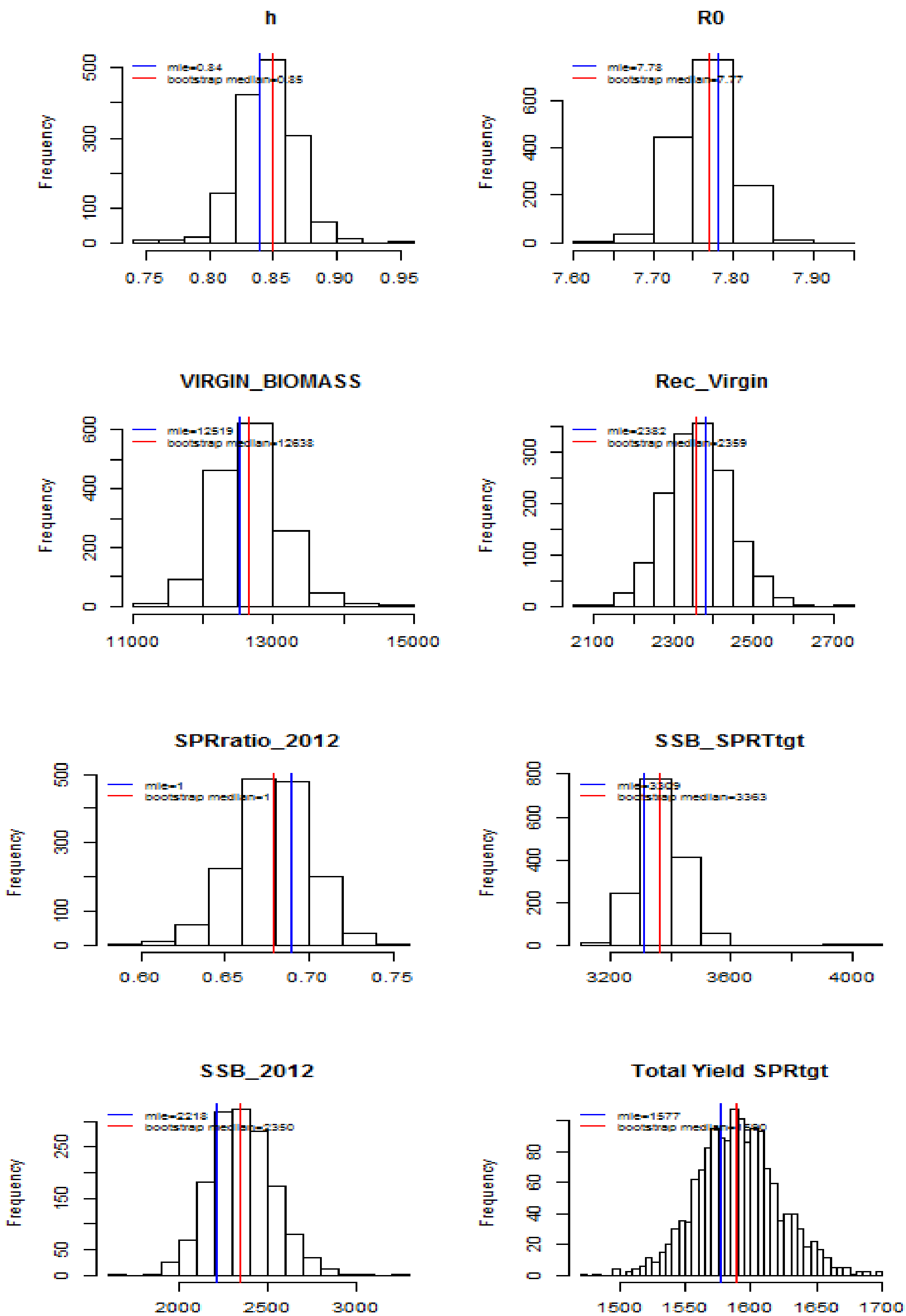


Figure 3.2.4.4a. Distribution of key parameters estimated from SS from 1,500 bootstrap samples for Base Model Run. Red lines represent mean estimates from the bootstrap samples; blue lines represent the point estimate of the parameters from the Run 1 model.

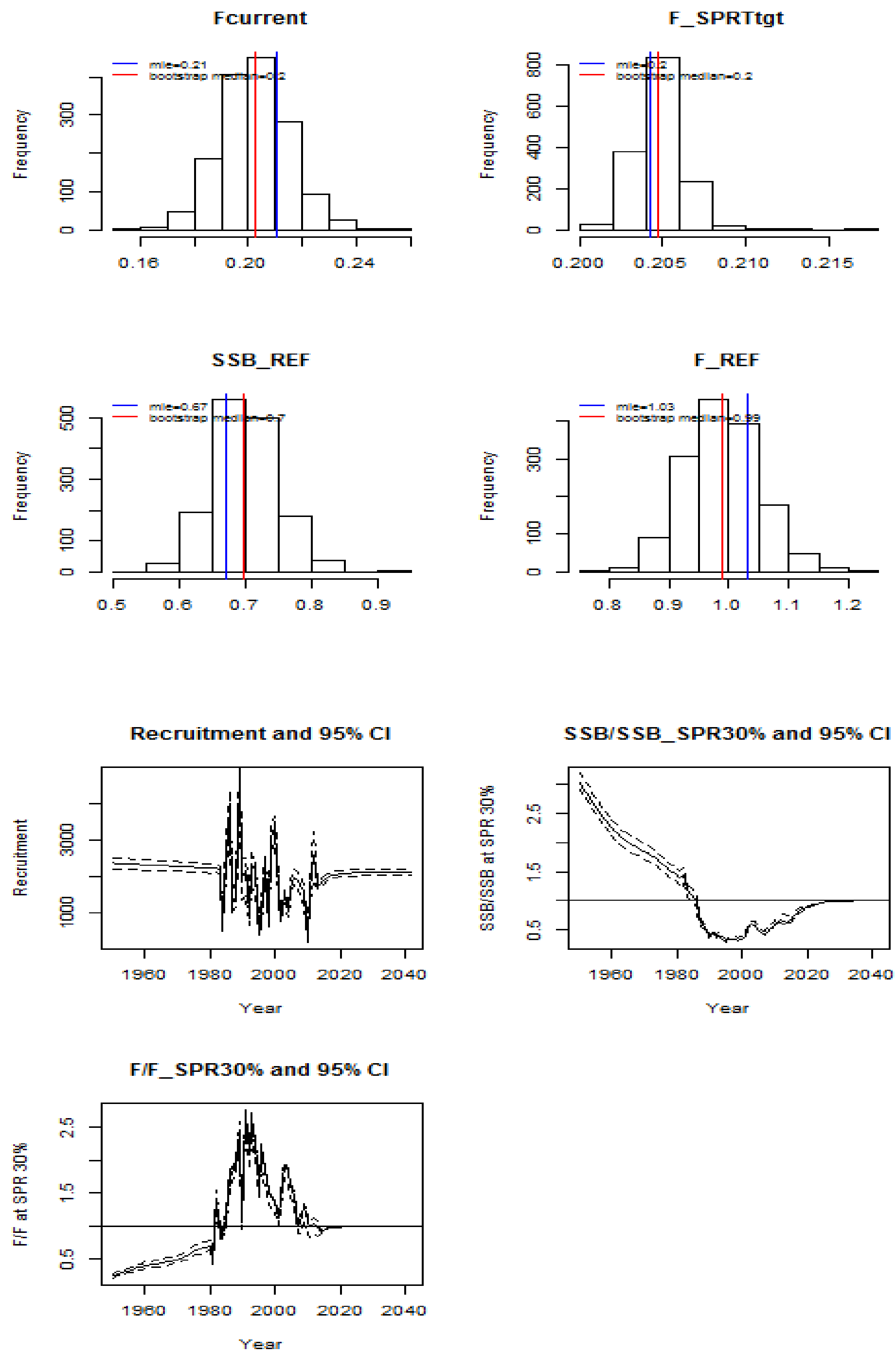


Figure 3.2.4.4b. Distribution of key parameters estimated from SS from 1,500 bootstrap samples for Base Model Run. Red lines represent mean estimates from the bootstrap samples; blue lines represent the point estimate of the parameters from the Run 1 model. The bottom three panels include the bootstrapped estimates from the data period (1950-2012) and from a projection (2013-2042) at $F_{SPR30\%}$.

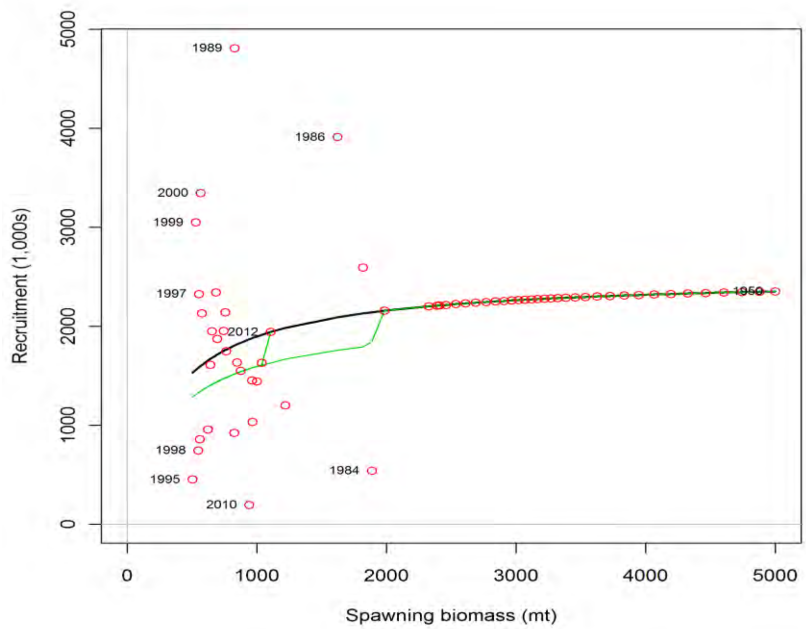


Figure 3.2.4.5. Predicted stock-recruitment relationship for Gulf of Mexico greater amberjack from SS Base Model Run configuration. Plotted are predicted annual recruitments from SS (circles), expected recruitment from the stock recruit relationship (line), and bias adjusted recruitment from the stock-recruit relationship (line with X). Labels included on first, last, and years with (log) deviations > 0.5.

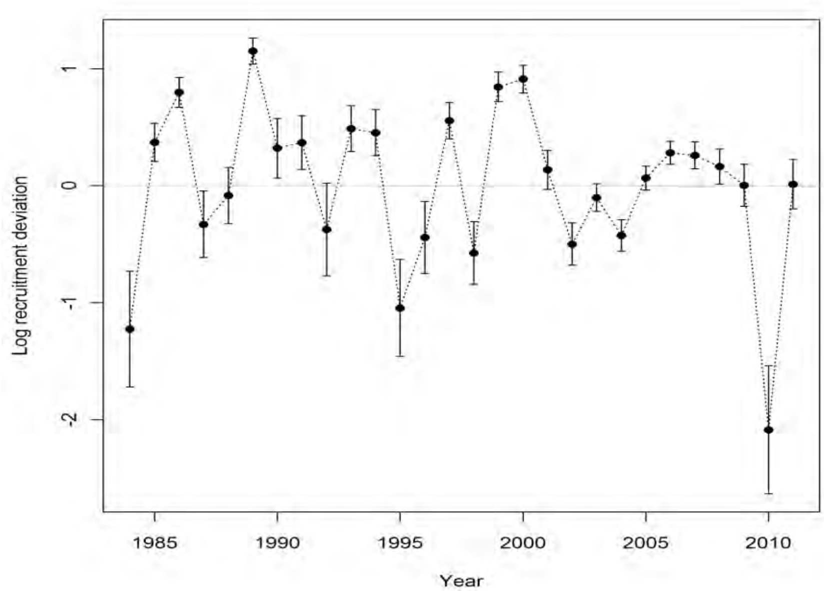


Figure 3.2.4.6. Asymptotic standard errors for recruitment deviations (1985-2010) for Gulf of Mexico greater amberjack from the SS Base Model Run.

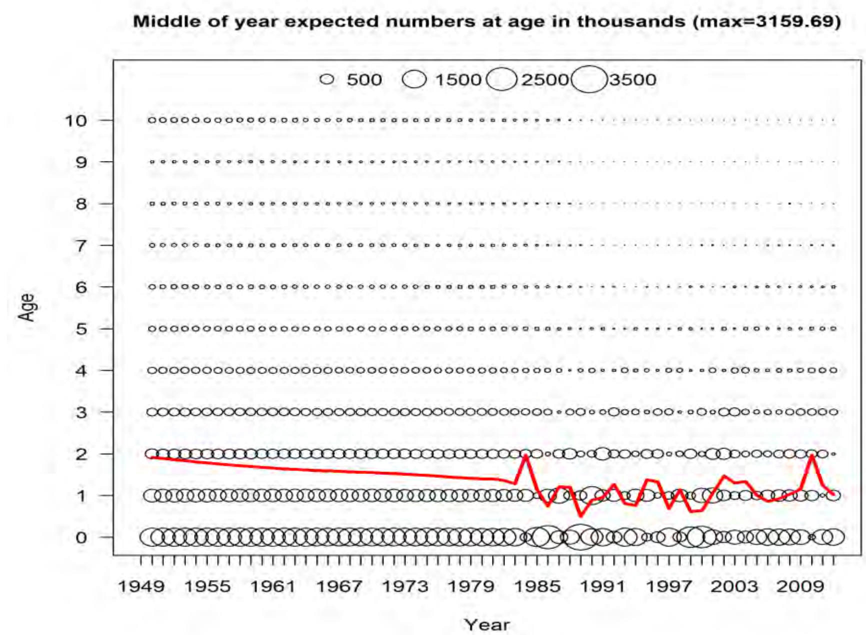


Figure 3.2.4.7. Predicted abundance at age (circles) and mean age (line) for Gulf of Mexico greater amberjack. Units are abundance in thousands of fish. Model configuration = Base Model Run.

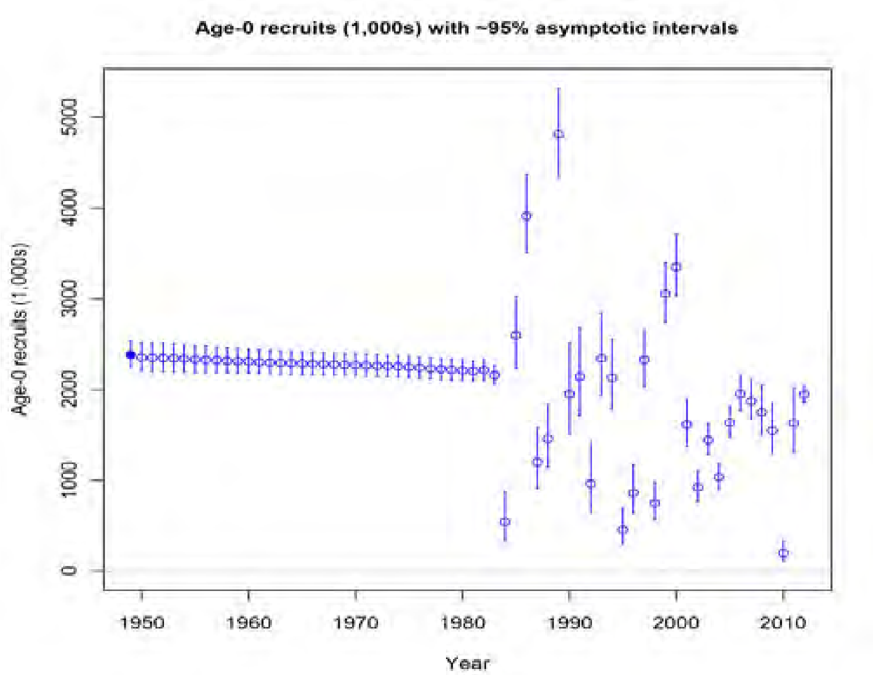


Figure 3.2.4.8. Predicted age-0 recruits in thousand fish and log recruitment deviations for Gulf of Mexico greater amberjack from SS. Model configuration = Base Model Run.

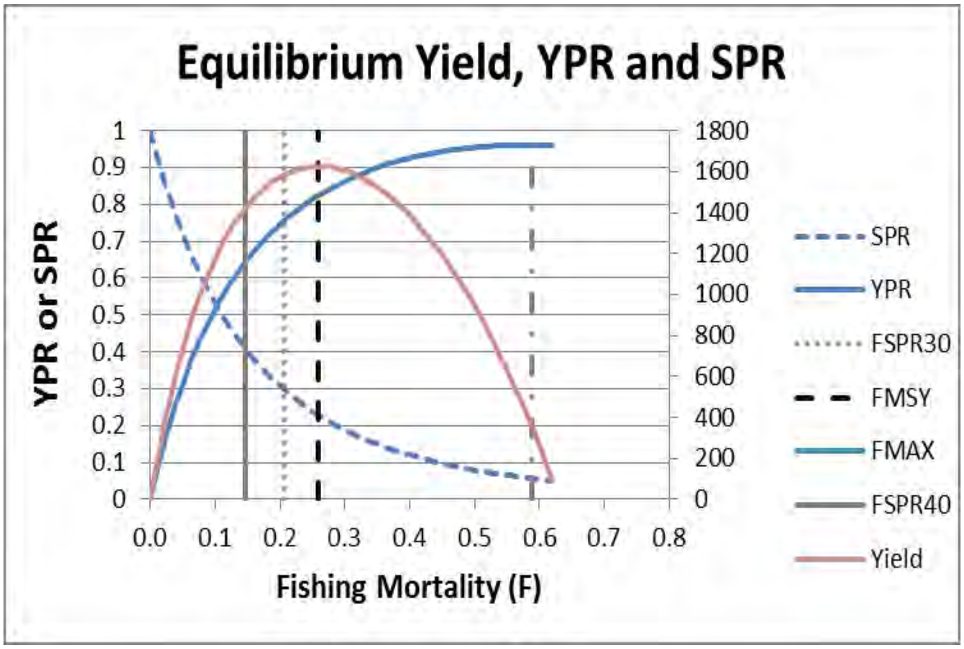


Figure 3.2.4.9. SS estimated equilibrium yield and yield and spawner per recruit and spawner per recruit as a function of fishing mortality for Gulf of Mexico Greater Amberjack for the Base Model run. Yield refers to landings (mtons) plus dead discards. Vertical lines include: $F_{30\%SPR}$ (F-0.20), F_{MSY} (F=-0.26), F_{MAX} (F=0.59), and $F_{SPR40\%}$ (F=0.15).

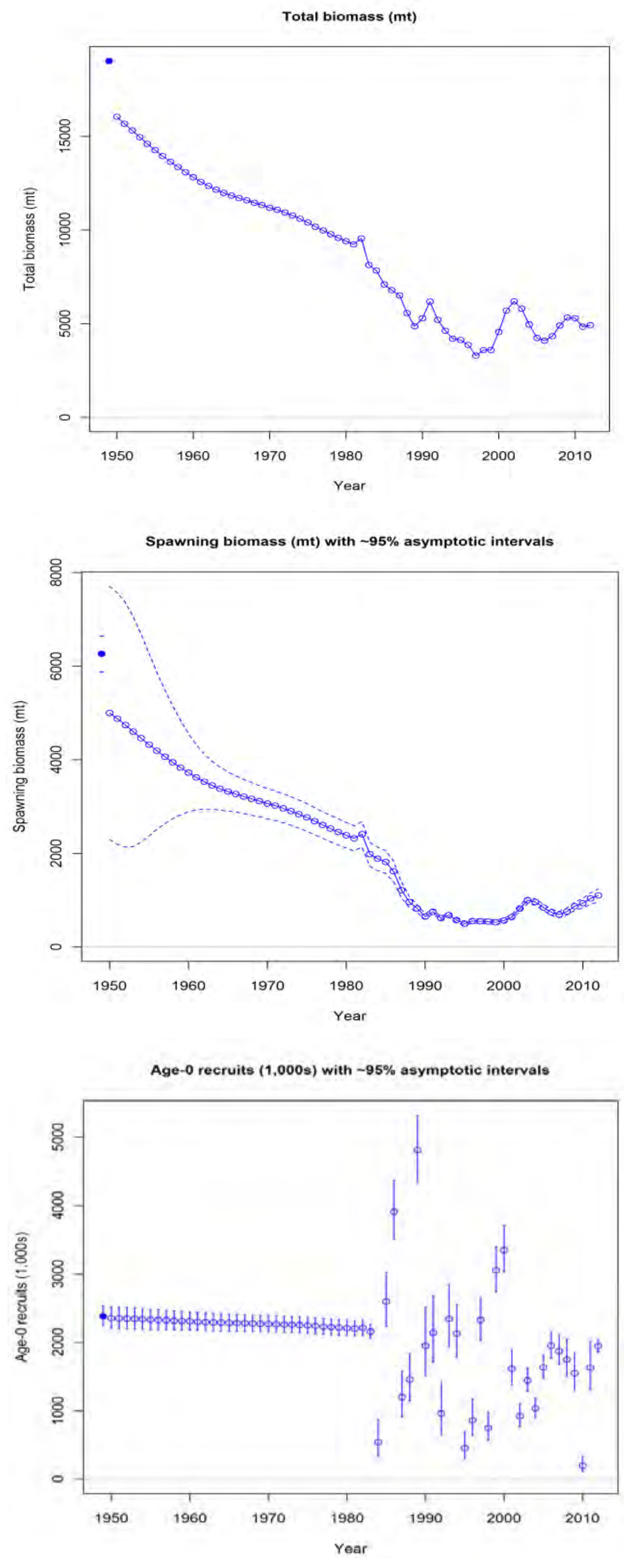


Figure 3.2.5.1. SS predicted total biomass (Top Panel), spawning biomass, and age 0 recruits for Gulf of Mexico greater amberjack Base SS model.

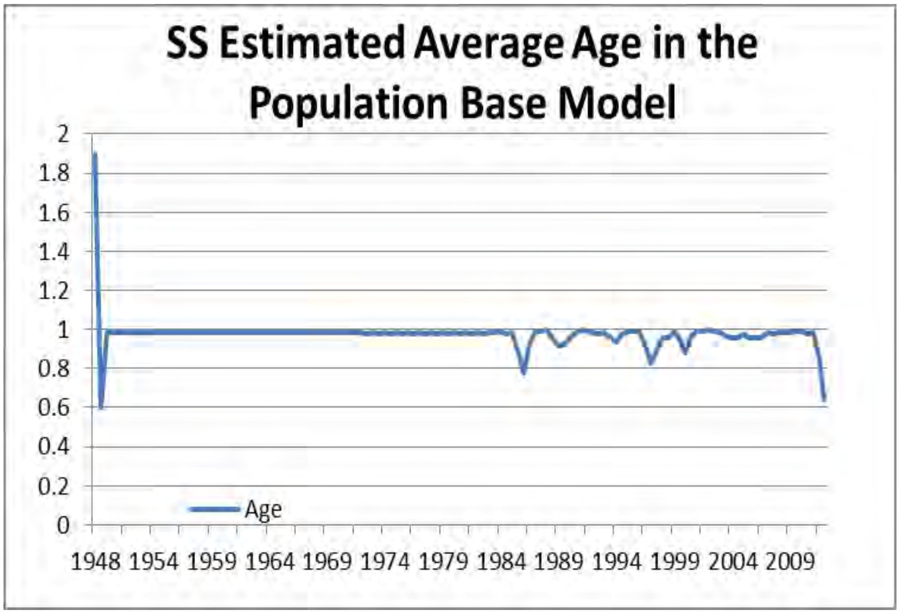


Figure 3.2.5.2. SS Estimated average age in the Greater Amberjack population from the final Base model run.

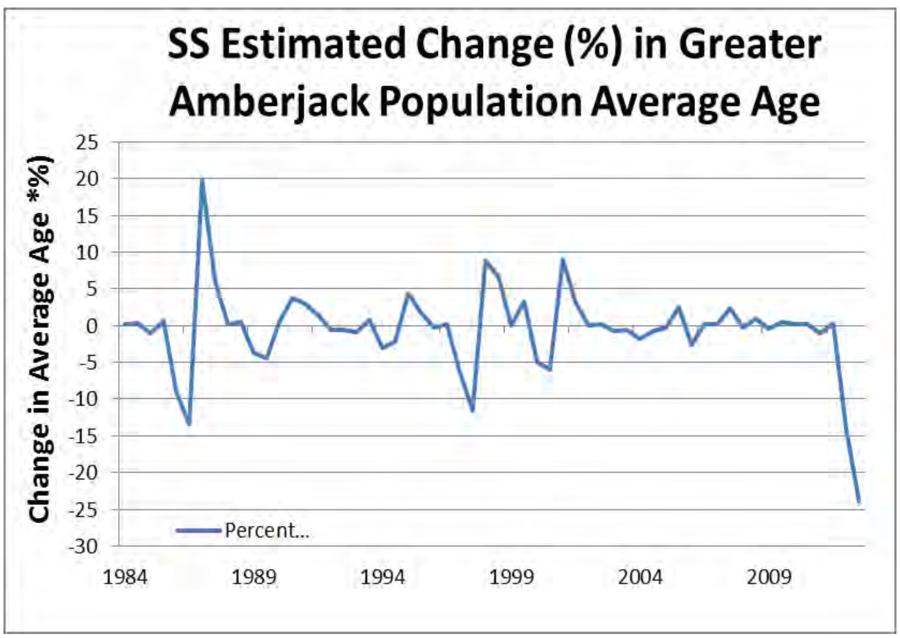
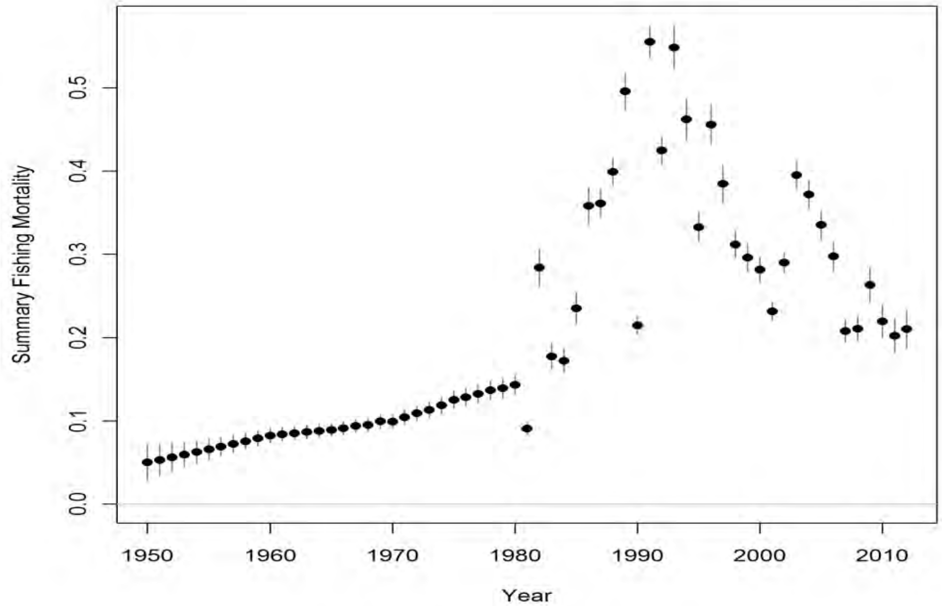


Figure 3.2.5.3. SS estimated percent change in average age in the Greater Amberjack population from the final Base model run 1984- 2012.



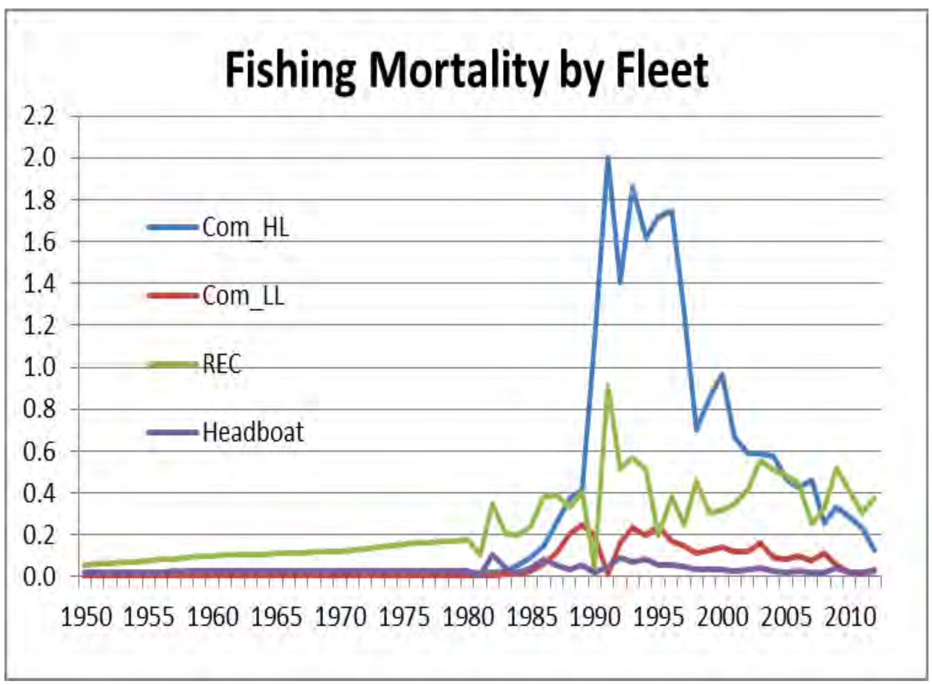


Figure 3.2.6.1. Predicted fishing mortality for Gulf of Mexico greater amberjack from SS. Model configuration = Base Model Run. Top panel is annual exploitation rate and bottom panel is fleet specific continuous fishing mortality.

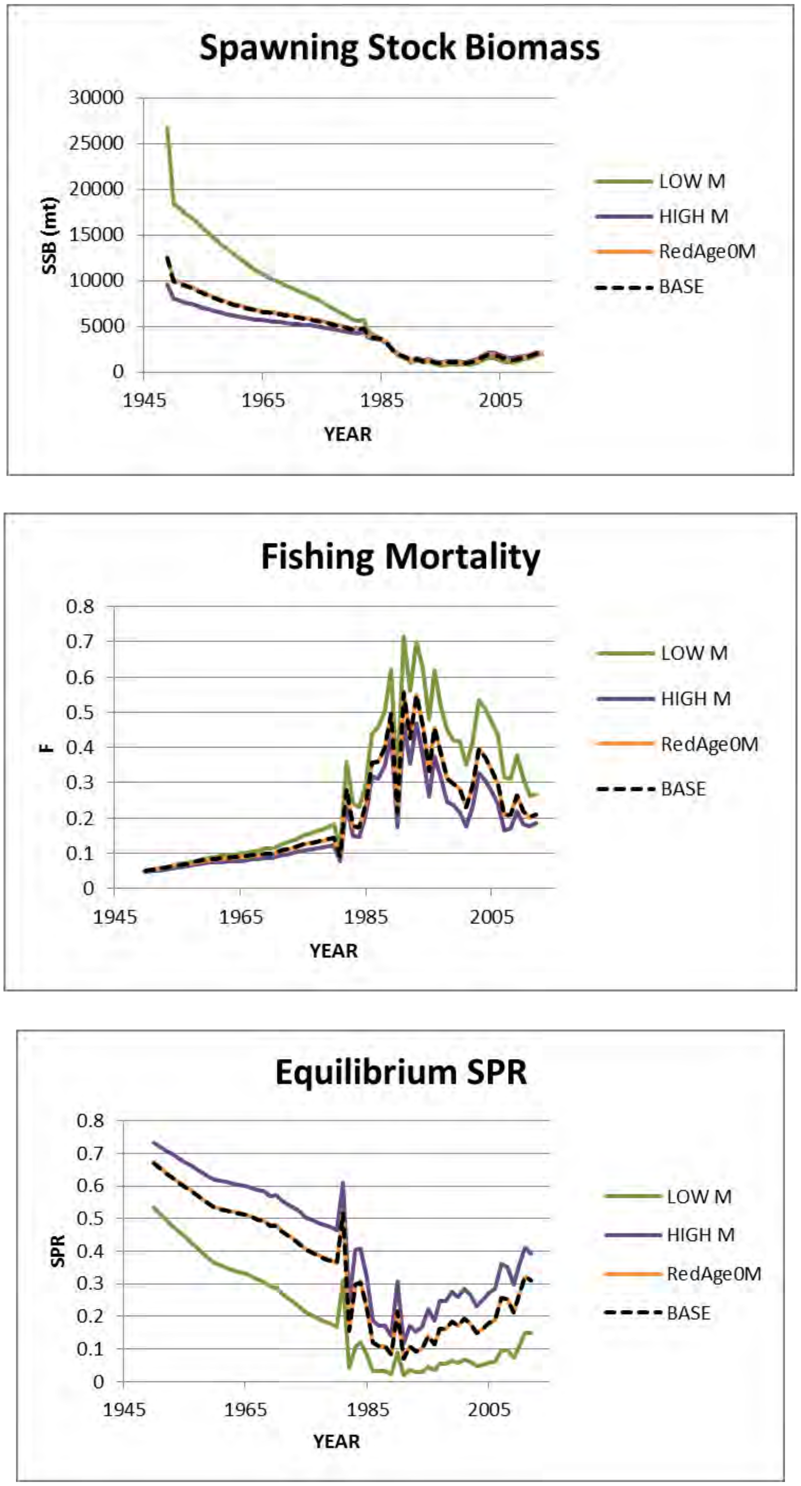
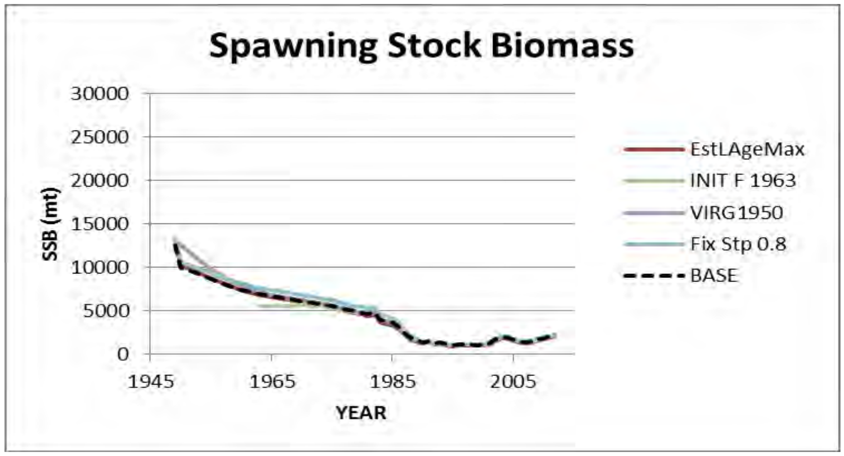
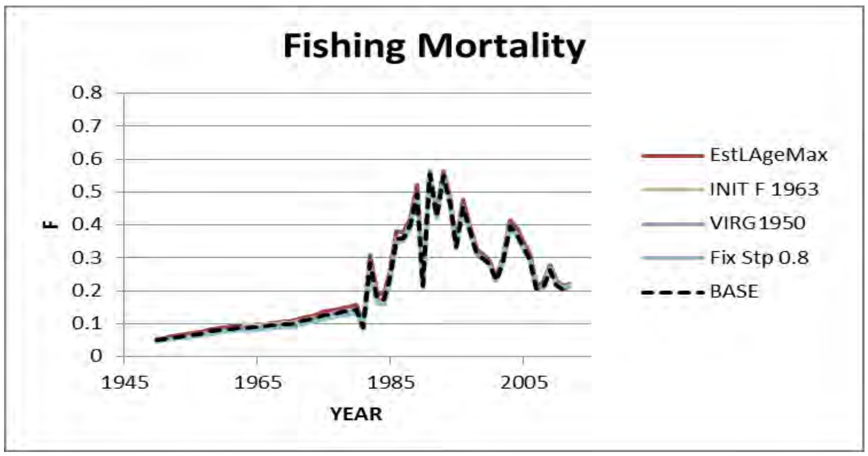


Figure 3.2.7.1. Sensitivity analyses for the Base Model Run model configuration at four alternative natural mortality scenarios (Base Model Lorenzen M = 0.28, age 0 M unadjusted, LOW M (0.,15), HIGH (0.35), and Lorenzen M at age for age 0 reduced. Top Panel = spawning biomass (SSB), Middle Panel = Recruitment, Bottom Panel = spawning potential ratio (SPR).





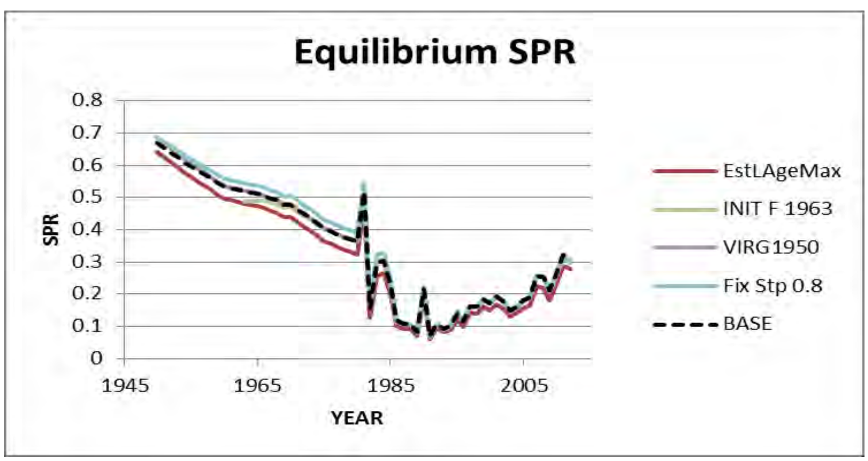


Figure 3.2.7.2. Sensitivity analysis for Gulf of Mexico greater amberjack with varying assumptions on the Beverton – Holt steepness parameter, to the growth parameter assumptions, and to the assumptions on initial conditions. Top Panel = spawning biomass (SSB), Middle Panel = Recruitment, Bottom Panel = spawning potential ratio (SPR). Metrics shown are predicted spawning biomass (SSB), recruitment and spawning potential ratio (SPR).

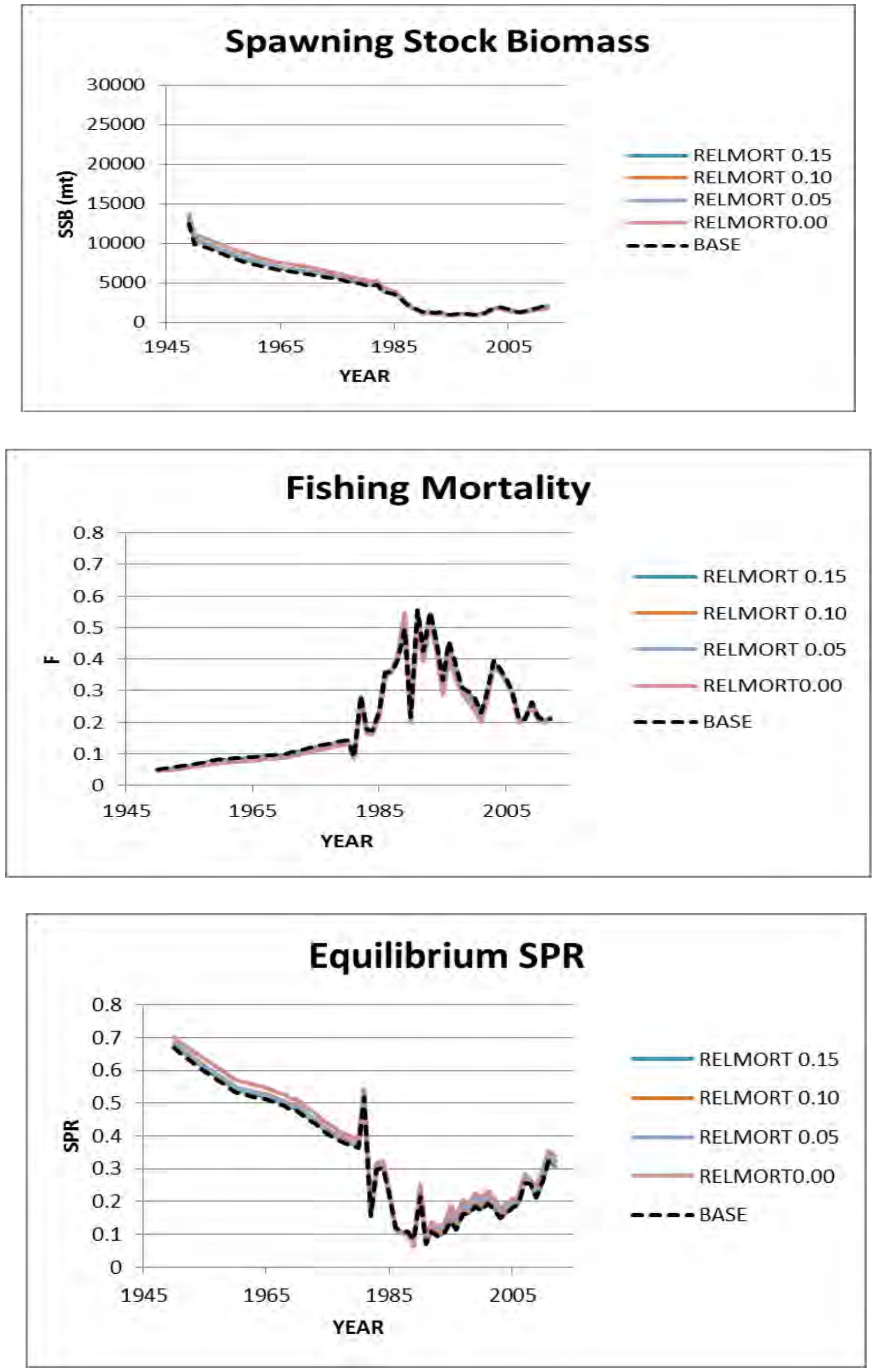
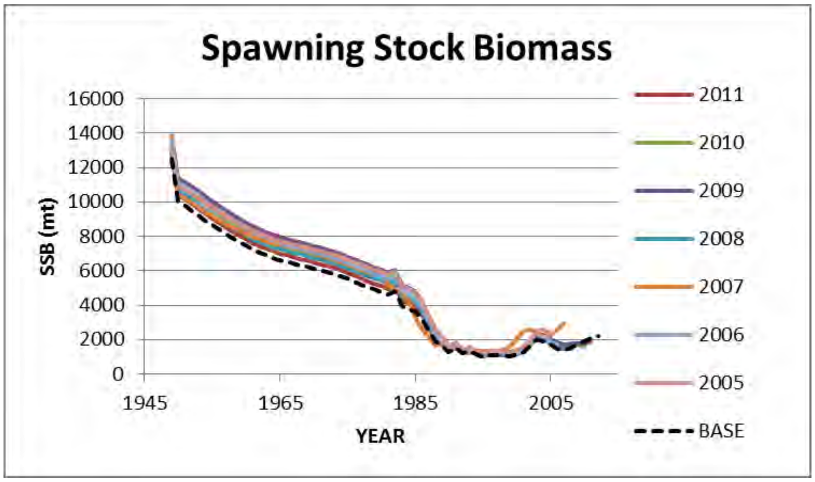
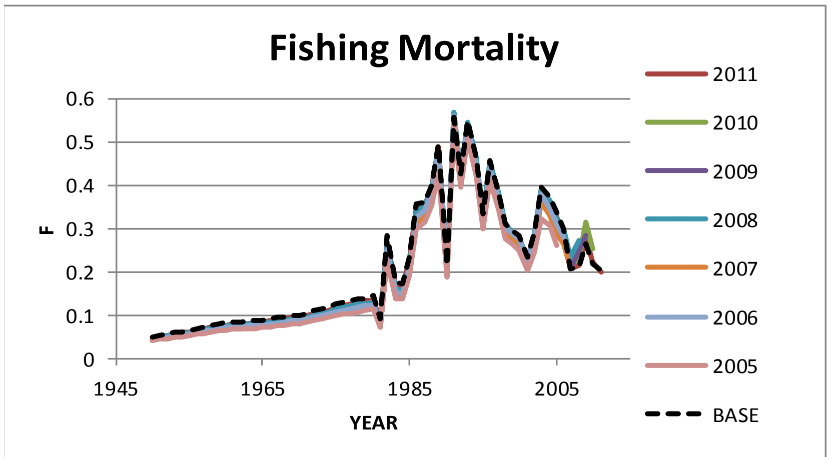


Figure 3.2.7.3. Sensitivity analysis for Gulf of Mexico greater amberjack with varying assumptions of release mortality. Top Panel = spawning biomass (SSB), Middle Panel = Recruitment, Bottom Panel = spawning potential ratio (SPR). Metrics shown are predicted spawning biomass (SSB), recruitment and spawning potential ratio (SPR).





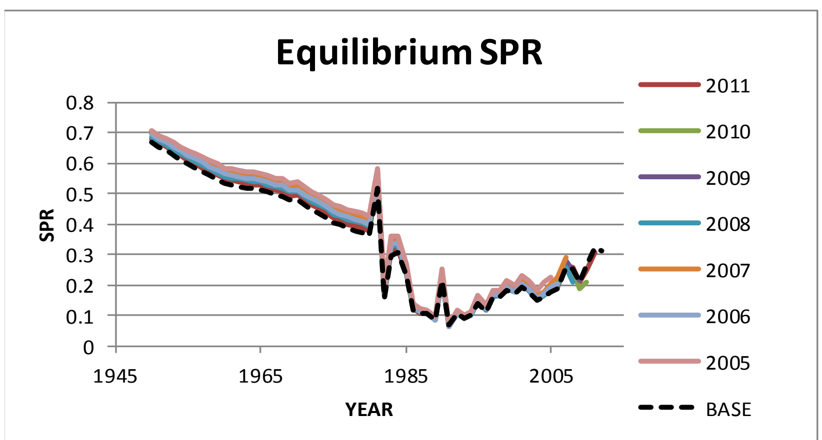


Figure 3.2.7.4. Retrospective analysis for Gulf of Mexico greater amberjack with last seven years of data sequentially dropped from SS for final Base run model. Metrics shown are predicted spawning biomass, recruitment and spawning potential ratio.

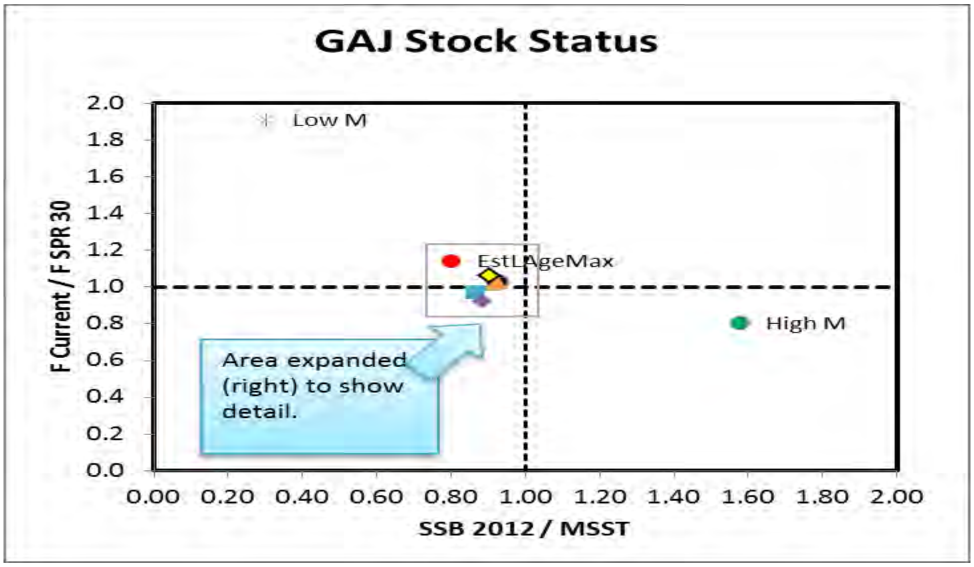


Figure 3.2.8.1a. Phase plot of Stock Synthesis (SS) estimates of SSB/MSST and F/MFMT Benchmarks for Gulf of Mexico greater amberjack SEDAR 33 stock assessment for varying assumptions for natural mortality at age (input into Lorenzen function), Beverton – Holt parameter, data inclusion, and discard release mortality. $SSB_{Ratio} = SSB_{2012}$ / MSST. MSST = (1-M) * SSB_{MSY} where $SSB_{MSY} = SSB@F_{30\%SPR}$. MFMT = F@30%SPR.

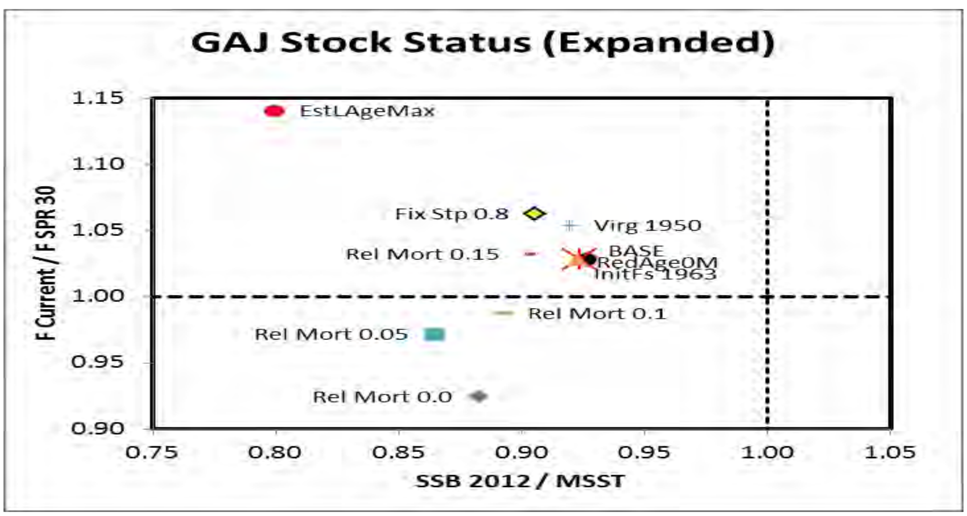


Figure 3.2.8.1b. Phase plot from above (a) expanded for of Stock Synthesis (SS) estimates of SSB/MSST and F/MFMT Benchmarks for Gulf of Mexico greater amberjack SEDAR 33 stock assessment for varying assumptions for natural mortality at age (input into Lorenzen function), Beverton – Holt parameter, data inclusion, and discard release mortality. $SSB_{Ratio} = SSB_{2012}$ / MSST. MSST = (1-M) * SSB_{MSY} where $SSB_{MSY} = SSB@F_{30\%SPR}$. MFMT = F@30%SPR.

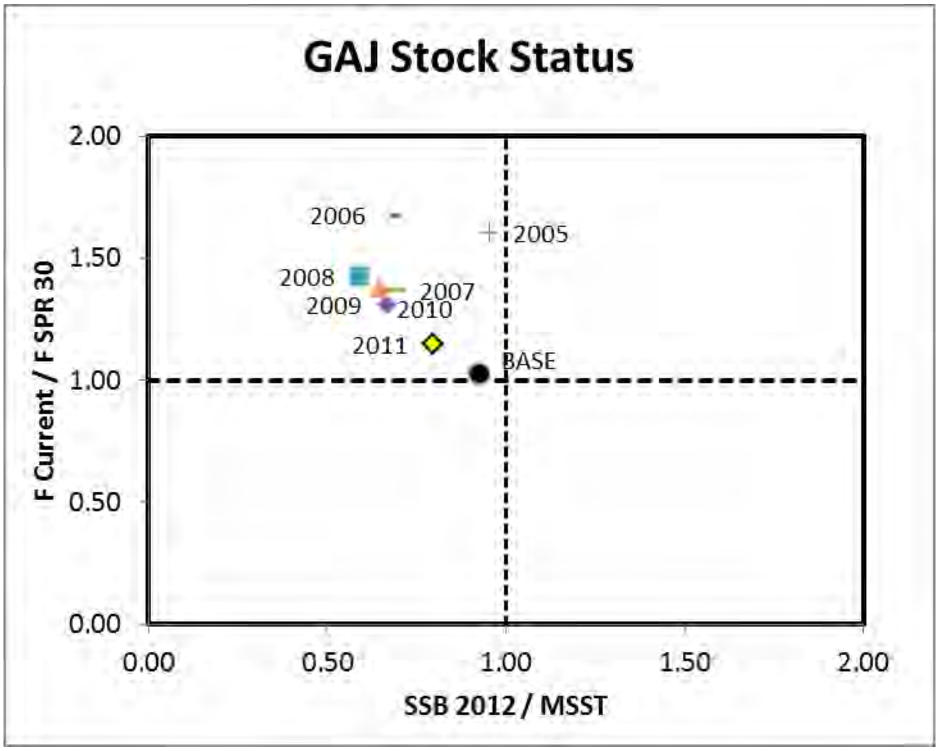


Figure 3.2.8.2. Phase plot of Stock Synthesis (SS) estimates of SSB/MSST and F/MFMT Benchmarks for Gulf of Mexico greater amberjack SEDAR 33 stock assessment for varying assumptions on retrospective analysis. $SSB_{Ratio} = SSB_{2012}$ / MSST. MSST = (1-M) * SSB_{MSY} where SSB_{MSY} = SSB@$F_{30\%SPR}$. MFMT = F@30%SPR.

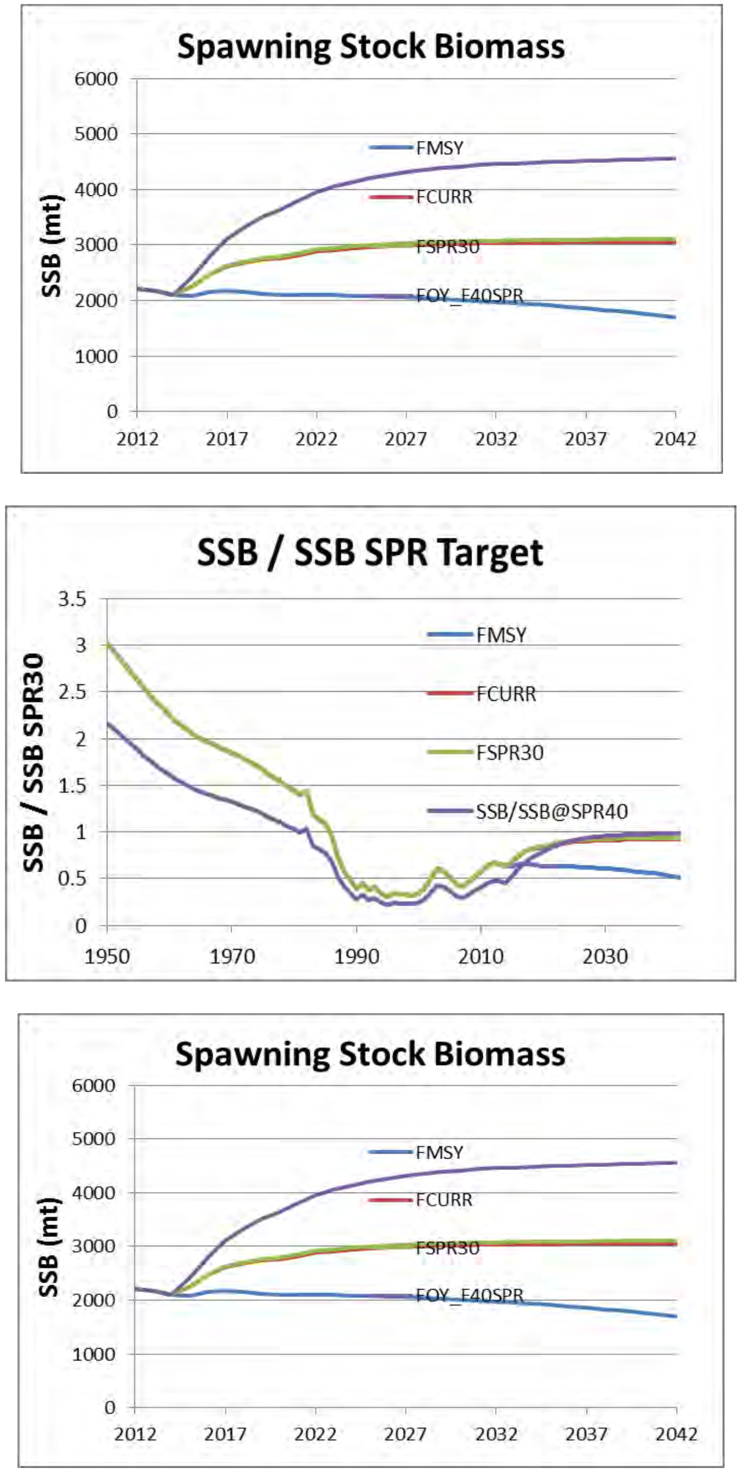
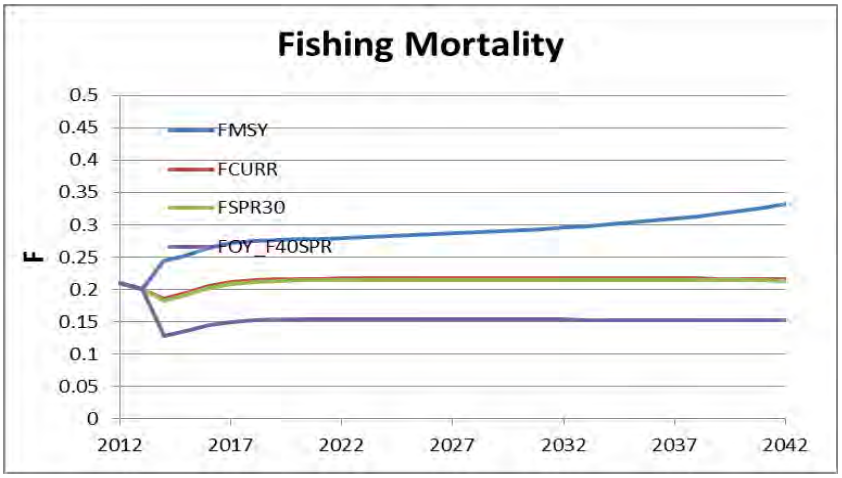
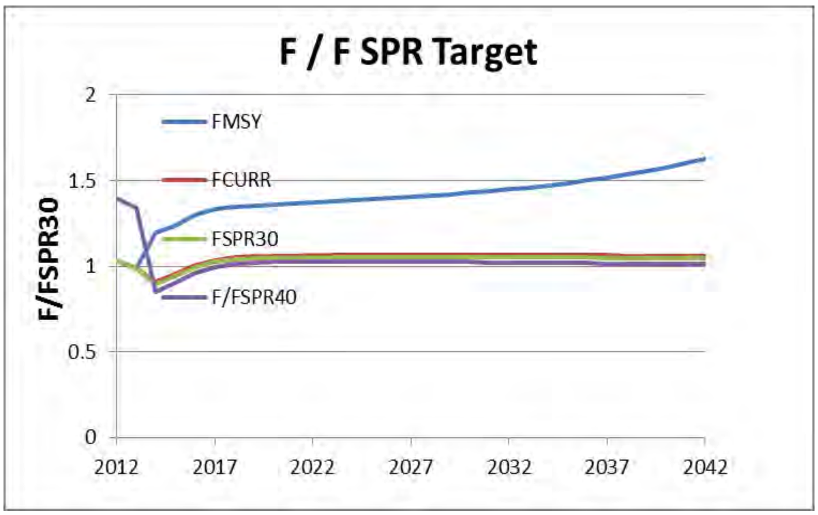


Figure 3.2.9.1.1. SS deterministic projections of spawning biomass (SSB-Top Panel) and stock status (SSB/SPR 30%-Middle Panel, SSB/SSB MSST-Bottom Panel) for the Base Model Run configuration under four fishing mortality scenarios: $F_{CURRENT}$, F_{SPR30}, F_{MSY}, and FOY=$F_{40\%SPR}$. Predictions years are 2013-2042.





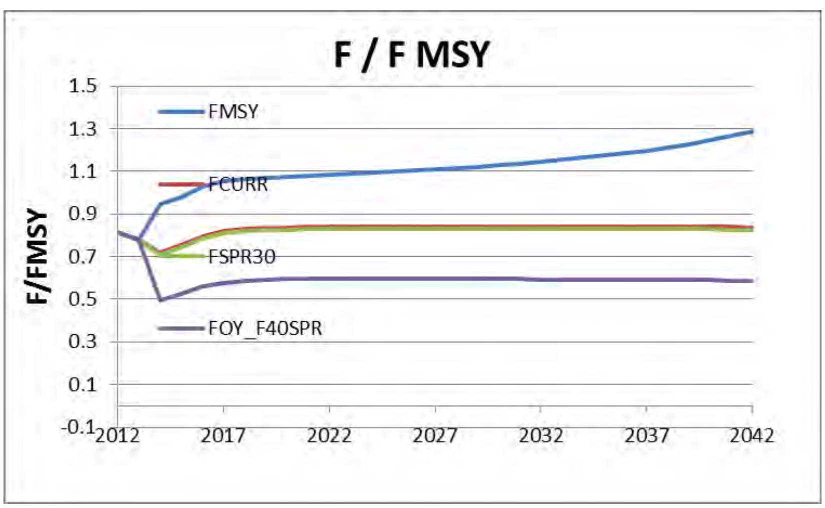


Figure 3.2.9.1.2. SS deterministic projections of fishing mortality (F-Top Panel) and stock status and stock status (F/SPR 30% -Middle Panel, F/FMSY-Bottom Panel) for the Base Model Run configuration under four fishing mortality scenarios: $F_{CURRENT}$, F_{SPR30}, and F_{MSY}. Prediction years are 2013-2042.

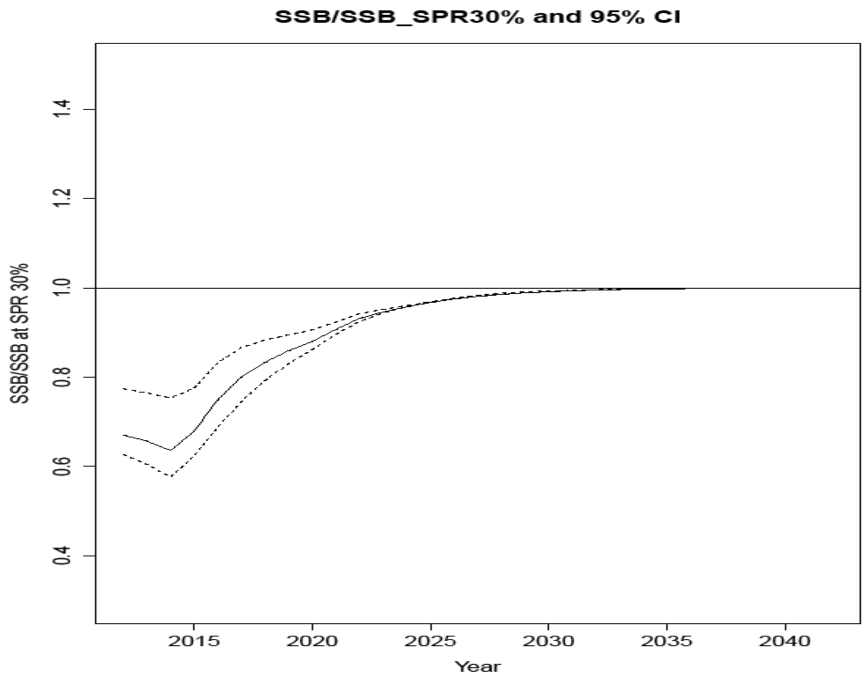


Figure 3.2.9.2.1a. SS stochastic projections of spawning stock relative to SPR 30%. Projections are 2013-2042.

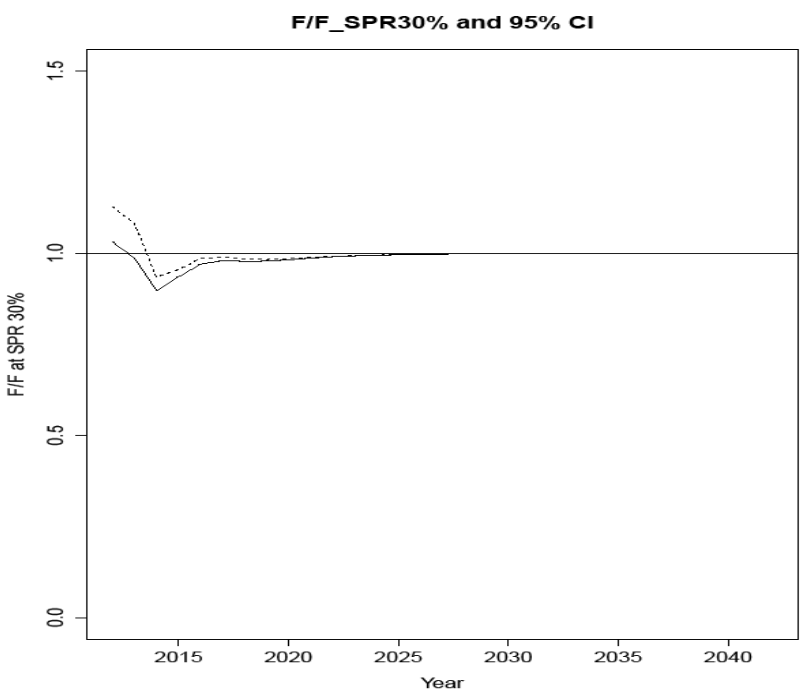


Figure 3.2.9.2.1b. SS stochastic projections of fishing mortality relative to F/SPR 30%. Projection years are 2013-2042.

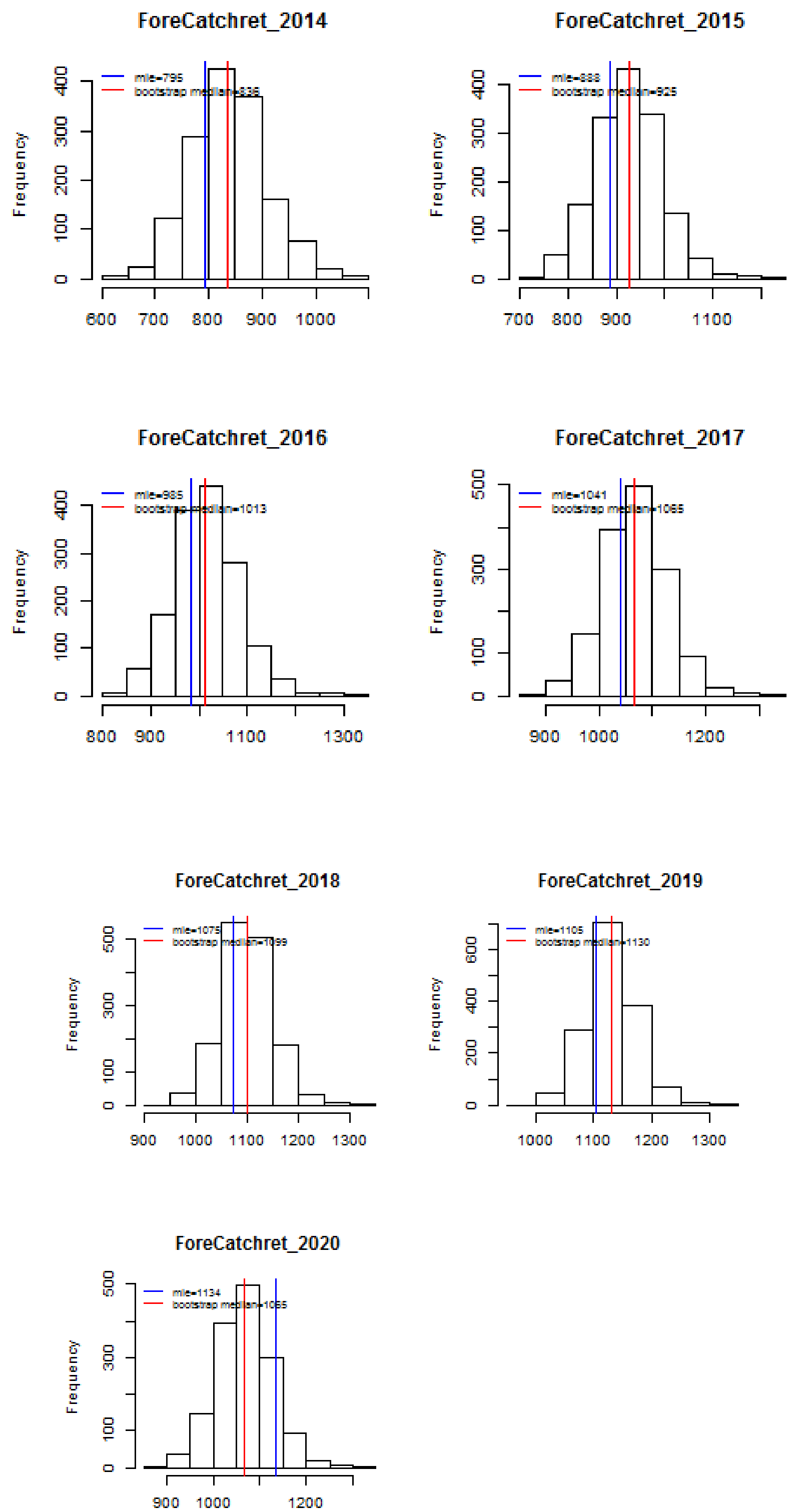


Figure 3.2.9.2.2. Distribution of SS projected catches for 2013-2020 from 1,500 bootstrap samples of the final Base model run according to $F_{30\%SPR}$ projection scenario.

3.3 ASPIC Model

3.3.1 Overview

In the current SEDAR 33 benchmark assessment, Version 5.34 of ASPIC was used to fit non-equilibrium production models conditioned on yield to the Gulf of Mexico greater amberjack data. In this report, an ASPIC model is presented for continuity with the prior 2010 stock assessment update for greater amberjack. Additionally, two ASPIC models are presented with conditions that were modified with advice from the SEDAR 33 AW Panel.

The two models with conditions that differ from the 2010 SEDAR Update are referred to as the "High Case" and the "Low Case". The names are attributed to the method that was used to develop data inputs associated with recreational fisheries (Section 2.3.2). The High Case assumed that recreationally discarded GAJ had the same average annual size as all recreationally landed GAJ. Meanwhile, the Low Case assumed that recreationally discarded GAJ had the same average size as GAJ that were below the size limit and landed prior to 1990 (prior to the implementation of the size and bag limits). As described in Section 2, this assumption affects the estimates of annual catch for each recreational fishery and also affects the indices in biomass associated with the combined charterboat and private recreational fishery.

3.3.2 Data Sources

The fishery dependent indices developed for the commercial vertical line, commercial longline, recreational headboat, and combined recreational charterboat and private fisheries, previously discussed in Section 2.6 of this report, were used to configure the ASPIC model. The recreational indices used in the High and Low Cases differed from those in the Continuity Case in that they were divided into three time periods and converted to indices in biomass (as described in Section 2.6).

Tables 3.3.2.1 – 3.3.2.3 and Figures 3.3.2.1 – 3.3.2.6 present the estimated catch (landings and discards) and indices of abundance that were used in each ASPIC model. In all models, the recreational charterboat-private boat fishery is the major contributor to the total landings of this species followed by the commercial handline fishery.

In the 2010 Update assessment, the commercial longline index showed a tendency for departure from the trends of the recreational combined charterboat and private angler index and the commercial vertical line index. Table 3.3.2.4 reproduces the pair wise correlations between the fishery dependent indices that were used in the SEADR 9 Update. This departure was no longer as pronounced among the indices developed for SEDAR 33. Tables 3.3.2.5 – 3.3.2.7 present the estimated pair wise correlations between the fishery dependent indices of abundance that were used in each model.

3.3.3 Model Configuration and Equations

For the current assessment, the Continuity Case was defined as 1) assuming the logistic (Schaefer) production model 2) applying equal index weightings, and 3) a B1/K fixed ratio equal to 0.5. The data inputs included total annual yields by fishery assuming a 20% release mortality rate and the standardized abundance indices from the updated GLM analyses. The four fisheries dependent data series were: the recreational charterboat and private angler, the recreational headboat, the commercial vertical line, and the commercial longline fisheries. As consistent with the 2010 Update, the indices associated with the recreational fisheries were left as indices in numbers.

The High and Low cases differed from the Continuity Case in three main ways. 1) The recreational indices were converted to indices in biomass and broken into three time periods (as described in Section 2.6). 2) Recreational landings were estimated using updated assumptions (as described in Section 2.3.2). 3) The B1/K ratio was fixed at 0.2688. This value of B1/K was suggested by the SS model results.

The ASPIC model requires initial values for the parameters being estimated: B1/K, MSY, K and fishery specific selectivities (q's). 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. Later runs were carried out with user input estimates based on previous runs.

3.3.4 Parameters Estimated

Using the logistic option, ASPIC estimates BMSY as K/2 and FMSY as MSY/BMSY.

3.3.5 Uncertainty and Measures of Precision

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

3.3.6 Sensitivity Analysis

Three sensitivity scenarios were considered. The first scenario evaluated the effect on ASPIC model results to the selection of initial input values for the B1/K ratio. The second scenario varied both the input B1/K ratio and also the input landings data to reflect different levels of assumed discard mortality (i.e., 0%, 20%, and 40%). The third sensitivity scenario evaluated the impact on ASPIC model results to the selection of index weighting methods applied in model fitting. The Continuity Case was developed strictly for comparing the model results using the updated model inputs. As such, sensitivities were not explored for the continuity case, and were only explored for the High and Low cases. Further details for each of the three sensitivity scenarios are presented below.

3.3.6.1 Sensitivity Analyses 1 and 2: Varying Initial Input B1/K Ratio and Level of Discard Mortality

For the current assessment, B1/K input vales considered were: 0.2, 0.5, 0.6, 0.75, and 1.0. Two additional levels of discard mortality (0% and 40%) were evaluated, given that 20% was chosen as the initial model runs.

In the previous assessment and update assessment a penalty factor equal to 10.0 was applied the objective function fitting process for B1/K ratios > 1.0 (SEDAR9-SAR RW, SEDAR9-Update Report). In the current assessment, there were no estimated B1/K ratios that were greater than 1. However, when unusually high ratios were estimated, a penalty factor equal to 1.0 was applied to the objective function. The value of 1.0 was suggested in the ASPIC user manual. The penalty term is described in Prager (1994).

3.3.6.2 Sensitivity Analysis 3: Index Weighting

The third sensitivity scenario evaluations considered the effect on ASPIC model results to the selection of index weighting methods applied in model fitting. In the initial trials and in earlier sensitivity evaluations (varying B1/K ratios and levels of discard mortality) equal index weighting was applied. Two additional weighting methods were applied. They were 1) proportional index weighting and 2) estimating weights via the ASPIC iteratively reweighted fit (IRF).

3.3.7 Sensitivity to New Data

Three additional sensitivities (all ending in 2009) were performed for the Continuity Case to elucidate the factors that were driving the observed differences between the 2010 Update and the SEDAR 33 Continuity Case results. The first analysis was simply running the SEDAR 33 Continuity Case with a final year of 2009. The second analysis was running the SEDAR 33 Continuity Case with a final year of 2009 and substituting the landings with the landings from the 2010 Update. The third analysis was running the SEDAR 33 Continuity Case substituting the indices with the indices from the 2010 Update.

3.3.8 Projection Methods

Relative biomass projections for the years 2013-2028 were obtained for 9 different scenarios of future F_{Year}/F_{2012} (multiples of 0.0, 0.5, 1.0, 1.5, 2.0, 3.0, 4.0, and 5.0 times F_{2012} were used). Nine additional projections were made to explore variation in estimated population trajectories under various multiples of constant catch (0.0, 0.5, 1.0, 1.5, and 2.0 times the 2012 Yield and 0.8, 1.0, 1.2, and 1.4 times the model estimated values of MSY were used). Projections were run on the three main ASPIC models explored in this report (Continuity Case, High Case, and Low Case).

3.3.9 Tables

Table 3.3.2.1. Fishery input yields and abundance indices for the SEDAR 33 Continuity Case. Yield is in whole weight and includes the landings and 20% discards. The commercial indices are based on catch rates in biomass and the recreational indices are based on catch rates in numbers.

	Index (bio)	Yield (ww)	Index (bio)	Yield (ww)	Index (num)	Yield (ww)	Index (num)	Yield (ww)
Year	HL	HL	LL	LL	HB	HB	CB+PR	CB+PR
1986		918,538		209,322	3.5268	763,949	2.7736	5,680,045
1987		1,279,001		259,354	1.7878	379,665	4.1456	2,257,659
1988		1,698,741		339,686	1.9151	173,964	0.7334	2,238,253
1989		1,612,718		311,943	1.4690	206,838	1.6020	5,016,198
1990	0.6654	1,128,146	0.5748	127,434	0.5795	161,378	0.1885	865,367
1991	0.7433	1,779,769	0.8185	27,499	0.7394	132,463	1.6439	3,906,353
1992	0.5526	1,163,634	1.2705	65,724	1.2103	367,442	1.6054	2,319,302
1993	0.7812	1,643,312	0.5674	95,223	0.7402	270,825	0.4672	2,748,912
1994	0.8769	1,359,078	0.4073	83,469	0.5772	246,282	0.3638	1,768,818
1995	0.8139	1,317,942	0.5972	93,571	0.6860	171,897	0.3833	817,308
1996	1.0219	1,343,354	0.5425	68,719	0.7781	169,847	0.2290	1,405,446
1997	0.9059	1,191,804	0.6230	70,289	0.6071	142,240	0.5063	1,124,847
1998	0.8610	785,693	0.6183	63,687	0.4181	128,650	0.2665	1,582,188
1999	0.8845	836,915	0.5706	73,184	0.5605	101,144	0.2120	1,044,021
2000	0.9417	936,819	0.5995	79,537	0.5349	116,689	0.6490	1,359,155
2001	0.8720	773,712	0.7296	73,936	0.9164	129,466	1.1412	3,169,985
2002	1.0973	838,246	0.9682	86,037	1.0722	199,431	1.2617	2,954,501
2003	1.9737	1,021,905	1.1111	136,532	1.4314	233,490	0.9799	3,599,358
2004	1.7301	1,023,378	1.2815	90,962	1.0825	118,191	0.7318	2,847,833
2005	1.0025	813,464	1.7578	82,243	0.4837	73,966	0.7803	2,203,956
2006	1.2384	690,231	1.3103	89,061	0.6798	88,604	0.5457	2,142,690
2007	0.7260	597,927	1.1043	68,897	0.4249	74,892	0.8246	1,447,529
2008	0.9446	647,947	1.5165	97,716	1.5129	88,996	0.7139	1,839,417
2009	0.7282	663,560	2.0343	56,261	0.7275	137,105	0.9018	1,900,766
2010	1.6388	693,463	1.9965	25,850		69,142		2,284,521
2011		557,075		21,796	0.8260	82,846	1.6399	1,558,192
2012		900,444		45,591	0.7130	119,222	0.7097	1,635,300

Table 3.3.2.2. Fishery input yields and abundance indices for the SEDAR 33 High Case. Yield is in whole weight and includes the landings and 20% discards. The commercial indices are based on catch rates in biomass and the recreational indices are based on catch rates in numbers that were converted to indices in biomass by accounting for changes in average weight.

	Index (bio)	Yield (ww)	Index (bio)	Yield (ww)	Index (bio)	Yield (ww)	Index (bio)	Yield (ww)
Year	HL	HL	LL	LL	HB	HB	CB+PR	CB+PR
1986		918,538		209,322	1.7778	763,949	1.1517	5,680,045
1987		1,279,001		259,354	0.9342	379,665	1.7192	2,257,659
1988		1,698,741		339,686	0.7601	173,964	0.3004	2,238,253
1989		1,612,718		311,943	0.5279	206,838	0.8287	5,016,198
1990	0.6654	1,128,146	0.5748	127,434	0.2199	99,441	0.1396	730,562
1991	0.7433	1,779,769	0.8185	27,499	0.6998	122,612	2.1744	3,830,591
1992	0.5526	1,163,634	1.2705	65,724	1.5216	360,728	2.1039	2,282,394
1993	0.7812	1,643,312	0.5674	95,223	0.9903	267,952	0.6360	2,714,716
1994	0.8769	1,359,078	0.4073	83,469	0.7597	243,407	0.4916	1,730,653
1995	0.8139	1,317,942	0.5972	93,571	0.8975	170,407	0.4656	796,037
1996	1.0219	1,343,354	0.5425	68,719	1.0179	168,001	0.3216	1,398,903
1997	0.9059	1,191,804	0.6230	70,289	0.8048	141,452	0.6975	1,106,016
1998	0.8610	785,693	0.6183	63,687	0.5497	126,421	0.3587	1,549,855
1999	0.8845	836,915	0.5706	73,184	0.7354	99,775	0.2892	1,015,269
2000	0.9417	936,819	0.5995	79,537	0.6702	115,344	0.8904	1,313,908
2001	0.8720	773,712	0.7296	73,936	1.2424	126,293	1.5661	2,984,206
2002	1.0973	838,246	0.9682	86,037	1.4647	196,708	1.8294	2,915,301
2003	1.9737	1,021,905	1.1111	136,532	2.0423	232,069	1.5295	3,597,252
2004	1.7301	1,023,378	1.2815	90,962	1.4868	117,771	1.1465	2,848,727
2005	1.0025	813,464	1.7578	82,243	0.6819	73,620	1.2676	2,198,202
2006	1.2384	690,231	1.3103	89,061	0.8132	87,248	0.8117	2,127,444
2007	0.7260	597,927	1.1043	68,897	0.4506	71,810	1.2133	1,379,093
2008	0.9446	647,947	1.5165	97,716	1.9512	84,860	1.0673	1,782,666
2009	0.7282	663,560	2.0343	56,261	0.7211	131,945	0.7745	1,849,522
2010	1.6388	693,463	1.9965	25,850		68,733		2,260,870
2011		557,075		21,796	1.2110	82,323	1.5371	1,542,804
2012		900,444		45,591	1.0678	118,781	0.6883	1,632,978

Table 3.3.2.3. Fishery input yields and abundance indices for the SEDAR 33 Low Case. Yield is in whole weight and includes the landings and 20% discards. The commercial indices are based on catch rates in biomass and the recreational indices are based on catch rates in numbers that were converted to indices in biomass by accounting for changes in average weight (see Section 2.6).

	Index (bio)	Yield (ww)	Index (bio)	Yield (ww)	Index (bio)	Yield (ww)	Index (bio)	Yield (ww)
Year	HL	HL	LL	LL	HB	HB	CB+PR	CB+PR
1986		918,538		209,322	1.7778	757,528	1.1688	5,661,109
1987		1,279,001		259,354	0.9342	379,276	1.7604	2,244,831
1988		1,698,741		339,686	0.7601	173,844	0.2950	2,210,332
1989		1,612,718		311,943	0.5279	206,141	0.7758	4,929,048
1990	0.6654	1,128,146	0.5748	127,434	0.2199	93,213	0.1885	677,134
1991	0.7433	1,779,769	0.8185	27,499	0.6998	108,392	2.6761	3,377,992
1992	0.5526	1,163,634	1.2705	65,724	1.5216	322,625	2.4783	1,983,701
1993	0.7812	1,643,312	0.5674	95,223	0.9903	234,393	0.7384	2,408,069
1994	0.8769	1,359,078	0.4073	83,469	0.7597	219,355	0.5911	1,526,674
1995	0.8139	1,317,942	0.5972	93,571	0.8975	149,466	0.4969	682,510
1996	1.0219	1,343,354	0.5425	68,719	1.0179	145,474	0.4089	1,266,807
1997	0.9059	1,191,804	0.6230	70,289	0.8048	128,642	0.8263	1,010,578
1998	0.8610	785,693	0.6183	63,687	0.5497	96,392	0.3706	1,342,119
1999	0.8845	836,915	0.5706	73,184	0.7354	78,935	0.2861	825,575
2000	0.9417	936,819	0.5995	79,537	0.6702	103,893	0.8307	1,042,522
2001	0.8720	773,712	0.7296	73,936	1.2424	96,804	1.0808	1,854,022
2002	1.0973	838,246	0.9682	86,037	1.4647	167,792	1.6129	2,215,638
2003	1.9737	1,021,905	1.1111	136,532	2.0423	205,563	1.5152	2,951,808
2004	1.7301	1,023,378	1.2815	90,962	1.4868	110,545	1.1690	2,414,040
2005	1.0025	813,464	1.7578	82,243	0.6819	63,653	1.0982	1,649,570
2006	1.2384	690,231	1.3103	89,061	0.8132	81,559	0.7418	1,721,955
2007	0.7260	597,927	1.1043	68,897	0.4506	62,599	0.9448	961,498
2008	0.9446	647,947	1.5165	97,716	1.9512	60,915	0.9454	1,375,911
2009	0.7282	663,560	2.0343	56,261	0.7211	109,280	0.8813	1,510,801
2010	1.6388	693,463	1.9965	25,850		55,870		1,461,723
2011		557,075		21,796	1.2110	65,625	1.3735	1,043,100
2012		900,444		45,591	1.0678	102,357	0.7452	1,303,359

Table 3.3.2.4. Estimated pair wise correlations for the Greater Amberjack indices from the SEDAR 9 Update.

Index	**HL**	**LL**	**HB**	**CB+PR**
HL	1.000			
LL	-0.629	1.000		
HB	0.193	0.349	1.000	
CB+PR	0.746	-0.507	0.691	1.000

Table 3.3.2.5. Estimated pair wise correlations for the Greater Amberjack indices from the SEDAR 33 Continuity Case.

	HL	**LL**	**HB**	**CB+PR**
HL	1.000			
LL	0.325	1.000		
HB	0.464	0.337	1.000	
CB+PR	-0.006	0.415	0.647	1.000

Table 3.3.2.6. Estimated pair wise correlations for the Greater Amberjack indices from the SEDAR 33 High Case.

	HL	LL	HB1	HB2	HB3	CBPR1	CBPR2	CBPR3
HL	1.000							
LL	0.325	1.000						
HB1	0.000	0.000	1.000					
HB2	0.560	0.435	0.000	1.000				
HB3	0.000	0.000	0.000	0.000	1.000			
CB+PR1	0.000	0.000	0.329	0.000	0.000	1.000		
CB+PR2	0.116	0.520	0.000	0.484	0.000	0.000	1.000	
CB+PR3	0.000	0.000	0.000	0.000	0.659	0.000	0.000	1.000

Table 3.3.2.7. Estimated pair wise correlations for the Greater Amberjack indices from the SEDAR 33 Low Case.

	HL	LL	HB1	HB2	HB3	CBPR1	CBPR2	CBPR3
HL	1.000							
LL	0.325	1.000						
HB1	0.000	0.000	1.000					
HB2	0.560	0.435	0.000	1.000				
HB3	0.000	0.000	0.000	0.000	1.000			
CB+PR1	0.000	0.000	0.352	0.000	0.000	1.000		
CB+PR2	0.046	0.417	0.000	0.420	0.000	0.000	1.000	
CB+PR3	0.000	0.000	0.000	0.000	0.568	0.000	0.000	1.000

3.3.10 Figures

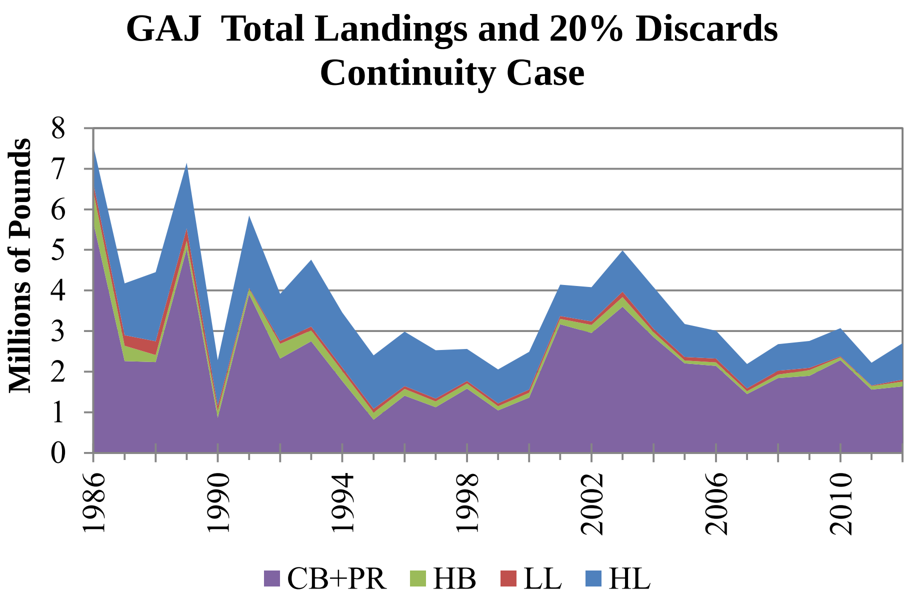


Figure 3.3.2.1. Calculated total commercial and recreational landings and discards for the Gulf of Mexico SEDAR 33 Greater Amberjack stock assessment Continuity Case, assuming 20% discard mortality rate.

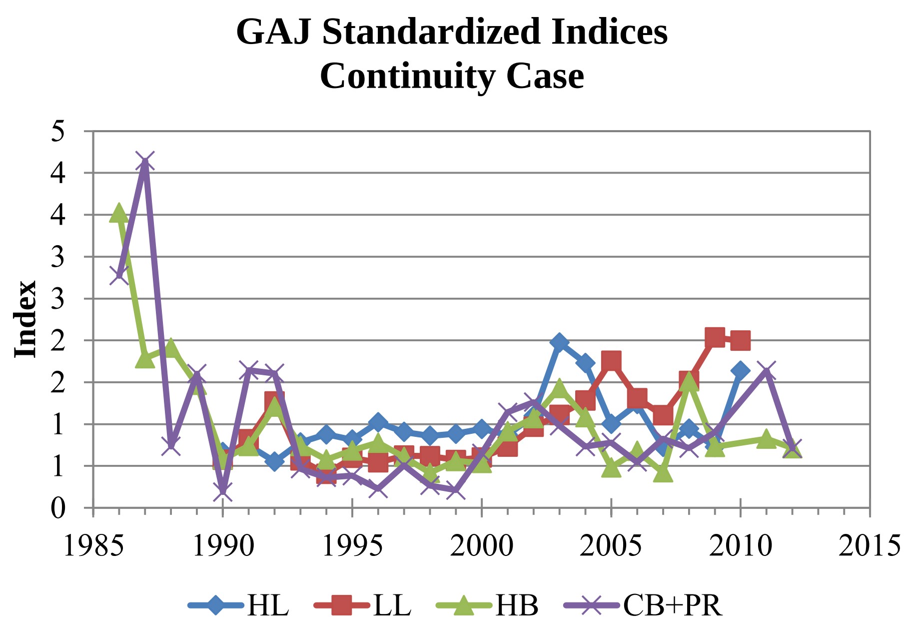


Figure 3.3.2.2. Continuity Case Gulf of Mexico Greater Amberjack standardized abundance indices for four fishery dependent data sets: MRFSS charterboat and private angler (CB+PR), NMFS Headboat Survey (HB), NMFS, SEFSC Coastal Loogbook Commercial Vertical Line (HL), and the NMFS, SEFSC, Coastal Logbook Commercial Longline fisheris (LL). The commercial indices are based on catch rates in biomass and the recreational indices are based on catch rates in numbers.

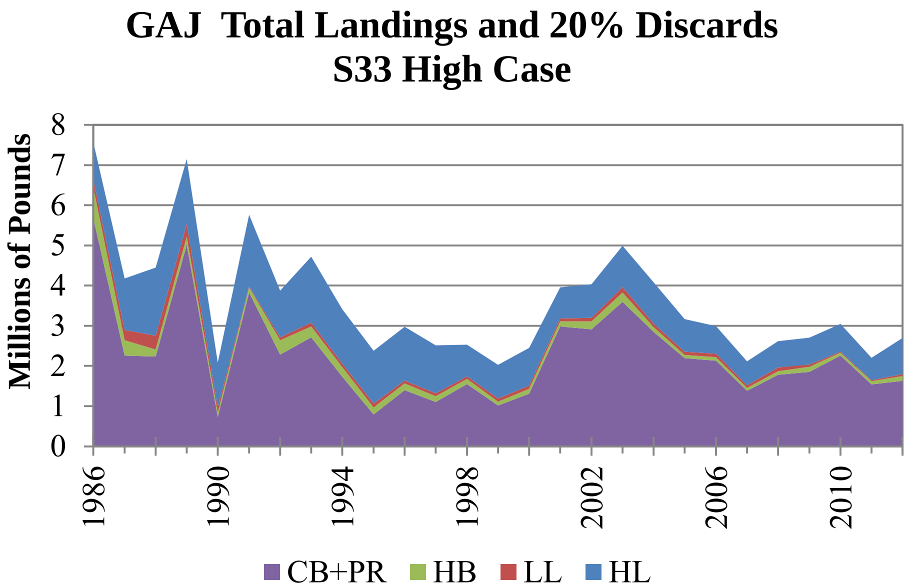


Figure 3.3.2.3. Calculated total commercial and recreational landings and discards for the Gulf of Mexico SEDAR 33 Greater Amberjack stock assessment High Case, assuming 20% discard mortality rate.

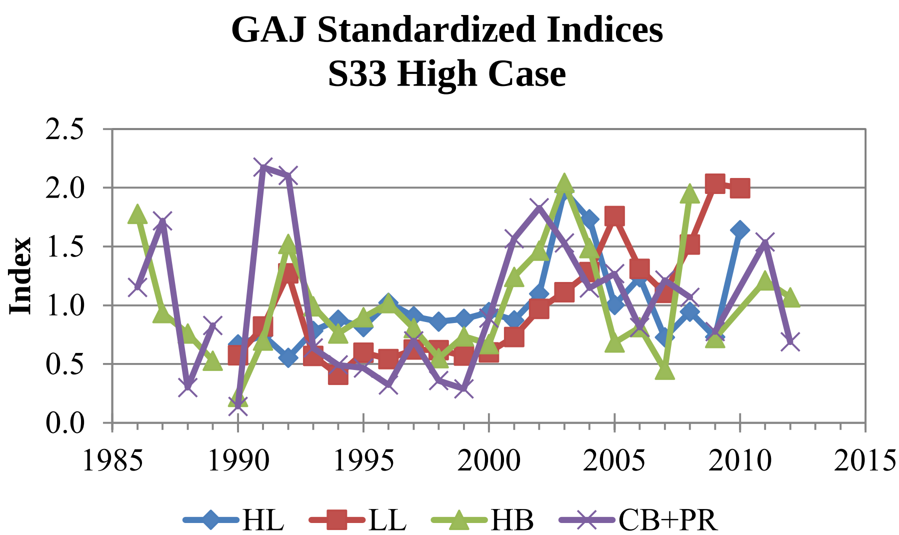


Figure 3.3.2.4. High Case Gulf of Mexico Greater Amberjack standardized abundance indices for four fishery dependent data sets: MRFSS charterboat and private angler (CB+PR), NMFS Headboat Survey (HB), NMFS, SEFSC Coastal Loogbook Commercial Vertical Line (HL), and the NMFS, SEFSC, Coastal Logbook Commercial Longline fisheris (LL). The commercial indices are based on catch rates in biomass and the recreational indices are based on catch rates in numbers that were converted to indices in biomass by accounting for changes in average weight.

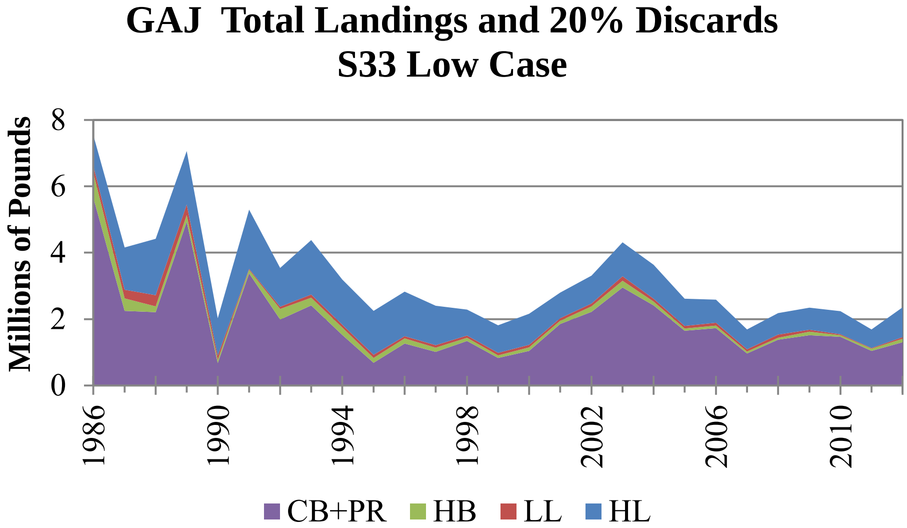


Figure 3.3.2.5. Calculated total commercial and recreational landings and discards for the Gulf of Mexico SEDAR 33 Greater Amberjack stock assessment Low Case, assuming 20% discard mortality rate.

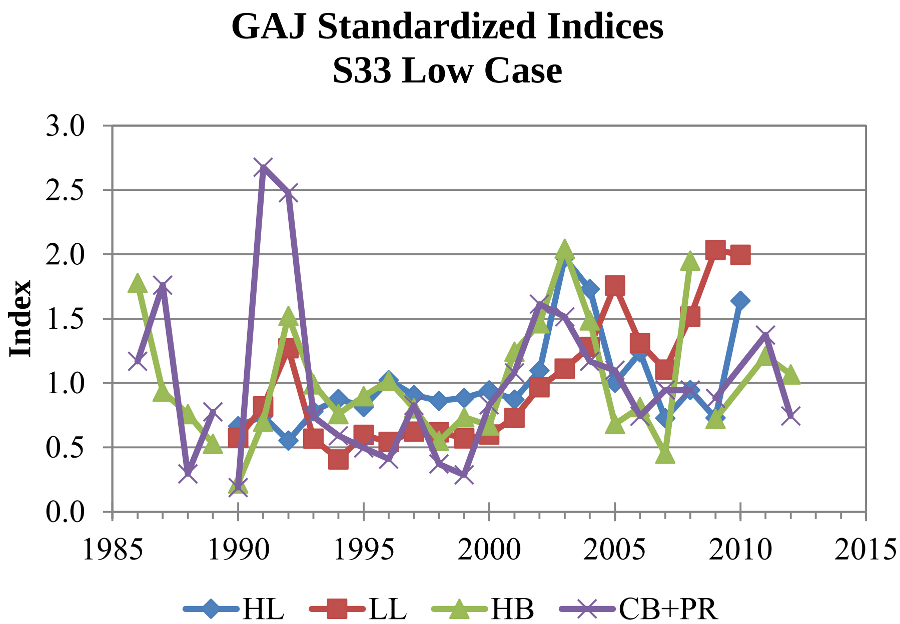


Figure 3.3.2.6. Low Case Gulf of Mexico Greater Amberjack standardized abundance indices for four fishery dependent data sets: MRFSS charterboat and private angler (CB+PR), NMFS Headboat Survey (HB), NMFS, SEFSC Coastal Loogbook Commercial Vertical Line (HL), and the NMFS, SEFSC, Coastal Logbook Commercial Longline fisheris (LL). The commercial indices are based on catch rates in biomass and the recreational indices are based on catch rates in numbers that were converted to indices in biomass by accounting for changes in average weight.

3.4 ASPIC Model Results

3.4.1 Measures of overall model fit

Most of the ASPIC runs showed no notable convergence problems. Figures 3.4.1.1 – 3.4.1.3 show the observed and predicted CPUE series for each fishery and for each model.

3.4.2 Parameter estimates

The parameters estimated by each of the three SEDAR 33 ASPIC models are summarized in Table 3.4.2.1.

For the SEDAR 33 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 4.5 million lbs, B_{MSY} 14.7 million lbs and maximum population size K 29.4 million lbs. Estimated F_{MSY} was 0.308 and the current relative F (F_{2012}/F_{MSY}) was 0.553. The current relative biomass (B_{2012}/B_{MSY}) was estimated at 1.140.

For the SEDAR 33 High Case, the B1/K ratio was set at 0.2588 which assumes the greater amberjack population was at 26% of the virgin biomass at the beginning of the time series (i.e., in 1986). MSY was estimated to be about 5.9 million lbs, B_{MSY} 54.3 million lbs and maximum population size K 108.6 million lbs. Estimated F_{MSY} was 0.109 and the current relative F (F_{2012}/F_{MSY}) was 0.450. The current relative biomass (B_{2012}/B_{MSY}) was estimated at 1.039.

For the SEDAR 33 Low Case, the B1/K ratio was set at 0.2588 which assumes the greater amberjack population was at 26% of the virgin biomass at the beginning of the time series (i.e., in 1986). MSY was estimated to be about 5.5 million lbs, B_{MSY} 54.7 million lbs and maximum population size K 109.4 million lbs. Estimated F_{MSY} was 0.101 and the current relative F (F_{2012}/F_{MSY}) was 0.485. The current relative biomass (B_{2012}/B_{MSY}) was estimated at 0.906.

In general, the High and Low ASPIC models resulted in similar parameter estimates. Compared to the Continuity Case, the High and Low ASPIC models resulted in significantly larger estimates of K and B_{MSY}. These larger values of K and B1/K can be partially attributed to the different values of B1/K. In the High and Low models, B1/K was fixed at 0.2588 while in the Continuity model B1/K was fixed at 0.5. These values of B1/K empirically suggest that that the stock was almost twice as depleted in the initial year (1986) for the High and Low models than for the Continuity model. Model sensitivity to B1/K will be further discussed in Section 3.4.6.1.

3.4.3 Stock Biomass

Figure 3.4.3.1 provides the biomass and fishing mortality trajectories for each SEDAR 33 ASPIC model and for the model from the 2010 Update assessment. Despite different initial values of B1/K and differences in recreational indices and discards, the overall trajectories for biomass were similar across all three models.

In the Continuity Case, virgin biomass (K) was estimated to be about 29.4 million lbs and B_{MSY} about 14.7 million lbs (50% of K by definition). At the beginning of the time series B_{1986} was 14.7 million lbs and relative biomass B_{1986}/B_{MSY} was 1.0 (Figure 3.4.3.1b). The initial trend in relative biomass was an overall decline from 1986 to 1995. The stock experienced a brief period of recovery between 1996 and 2001, reaching a biomass of about 9.4 million lbs in 2001 (B_{2012}/B_{MSY} = 0.642) thereafter declining through 2005. Since 2005 the stock has experienced a recovery to a level slightly above B_{MSY} in 2012 (B_{2012}/B_{MSY} = 1.140).

In the High Case, virgin biomass (K) was estimated to be about 108.6 million lbs and B_{MSY} about 54.3 million lbs (50% of K by definition). At the beginning of the time series B_{MSY} was 26.5 million lbs and relative biomass B_{1986}/B_{MSY} was 0.518 (Figure 3.4.3.1d). The initial trend in relative biomass was an overall decline from 1986 to 1994. Between 1994 and 2012, the trend is an overall increase with a period of relative stability present from 2001 to 2005. In 2012 the stock size is approximately B_{MSY} (B_{2012}/B_{MSY} = 1.039).

In the Low Case, virgin biomass (K) was estimated to be about 109.4 million lbs and B_{MSY} about 54.7 million lbs (50% of K by definition). At the beginning of the time series B_{1986} was 28.3 million lbs and relative biomass B_{1986}/B_{MSY} was 0.518 (Figure 3.4.3.1c). The initial trend in relative biomass was an overall decline from 1986 to 1995. Between 1995 and 2012, the trend is an overall increase with a period of relative stability present from 2001 to 2005. In 2012 the stock size is slightly below B_{MSY} (B_{2012}/B_{MSY} = 0.906).

3.4.4 Fishing Mortality

Figure 3.4.3.1 provides the biomass and fishing mortality trajectories for each SEDAR 33 ASPIC model and for the model from the 2010 Update assessment. Despite the different initial values of B1/K and the differences in recreational indices and discards, the overall trajectories for fishing mortality were similar across all three models.

The ASPIC estimated F_{MSY} for the Continuity case was 0.308. The trajectory of relative F (F_{Year}/F_{MSY}) is plotted in Figure 3.4.3.1b. The results show high relative F in the beginning of the time series associated with large variability in the trend of fishing mortality. After 1993, the overall all trend is a decline to 1990 where the relative F reaches levels slightly below F_{MSY} for two consecutive years. Thereafter, the results show an increase until 2003, to almost twice the rate of F_{MSY}. Since 2003, fishing mortality has declined, and in the most recent 2 years it has remained at levels that are near half of F_{MSY}. The results from this model suggest the Gulf of Mexico Greater Amberjack stock has not experienced overfishing conditions since 2006, and that the current relative F is 0.553.

The ASPIC estimated F_{MSY} for the High Case was 0.109. The trajectory of relative F (F_{Year}/F_{MSY}) is plotted in Figure 3.4.3.1b. The results show high relative F in the beginning of the time series associated with large variability in the trend of fishing mortality through 1993. After 1993 the overall all trend is a decline to 1997 after where the relative F reaches levels near to or below F_{MSY} for four consecutive years (1997-2000). Thereafter, the results show an increase until 2003, to about 1.5 times the rate of F_{MSY}. Since 2003, relative fishing mortality has declined, and in the 6 most recent years it has remained at levels that are near half of F_{MSY}. The results from this model suggest the Gulf of Mexico Greater Amberjack stock has not experienced overfishing conditions since 2004, and that the current relative F is 0.450.

The ASPIC estimated F_{MSY} for the Low Case was 0.101. The trajectory of relative F (F_{Year}/F_{MSY}) is plotted in Figure 3.4.3.1c. The results show high relative F in the beginning of the time series associated with large variability in the trend of fishing mortality through 1993. After 1993 the overall all trend is a decline to 1998 after where the relative F reaches levels either near to or below F_{MSY} for four consecutive years (1998-2001). Thereafter, the results show an increase until 2003, to about 1.5 times the rate of F_{MSY}. Since 2003, relative fishing mortality has declined and in the 6 most recent years it has remained at levels that are near half F_{MSY}. The results from this model suggest the Gulf of Mexico Greater Amberjack stock has not experienced overfishing conditions since 2004, and that the current relative F is 0.485.

3.4.5 Evaluation of Uncertainty

To quantify the uncertainty around the parameter estimates, 1,000 bootstrap runs were made for each model. Figure 3.4.3.1 shows relative F (FYear/FMSY) and relative biomass (BYear/BMSY) and the estimated 10^{th}-90^{th} percentiles for each model. Table 3.4.5.1 shows the parameter estimates from each model along with their 10^{th} and 90^{th} percentile estimates.

In general, the High and Low ASPIC models resulted in similar levels of variability associated with each estimated parameter (Table 3.4.5.1). Compared to the Continuity Case, the High and Low ASPIC models showed wider 10^{th} and 90^{th} percentiles associated with the trajectories of relative F and relative biomass (Figure 3.4.3.1).

3.4.6 Sensitivity Analyses

3.4.6.1 Sensitivity Analyses 1 and 2: Varying Initial Input B1/K Ratio and Level of Discard Mortality

Tables 3.4.6.1.1 and 3.4.6.1.2 summarize the estimated parameters for the sensitivity scenario runs with B1/K ranging from 0.2 to 1.0 for release mortalities of 0%, 20% and 40%. These tables also summarize model performance and provide the mean square error for each scenario. Most scenarios resulted in normal convergence. Scenarios without normal convergence were identified as those that converged at high values of mean square errors.

In general, estimated values of B1/K were lower in the ASPIC model runs associated with the High Case than those associated with the Low Case (Figure 3.4.6.1.1). Across all 6 values of initial B1/K and all 3 levels of discard mortality, scenarios explored the estimated value of B1/K ranged from 0.19 - 0.67 and from 0.45 - 0.77, for the High and Low sensitivity runs, respectively). The larger range in estimated B1/K that was observed for the High model can be attributed to two particular scenarios. The two runs with the highest input values of B1/K (0.8 and 1.0) for the High model with 0% discard mortality converged at similar values of MSE but had much larger values of B1/K in comparison to all other scenarios associated with the High model.

Within runs of either the High or Low ASPIC models, there were similar ranges of estimated B1/K across the different values of discard mortality. For the High model runs, the estimated values of B1/K associated with 0%, 20% and 40% discard mortality ranged from 0.27 - 0.67, 0.23 - 0.37, and 0.19 - 0.40, respectively. For the Low model runs, the estimated values of B1/K associated with 0%, 20% and 40% discard mortality ranged from 0.54-0.77, 0.48-0.63, and 0.46-0.52, respectively.

Figure 3.4.6.1.2 provides plots of model estimated B1/K versus model estimated K, MSY, F/F_{MSY}, and B/B_{MSY} for the scenarios that resulted in lowest objection function for each combination of discard mortality and High/Low model. Across both High and Low scenarios, high values of discard mortality was associated with higher estimates of MSY, K, and F/F_{MSY}, and lower estimates of B/B_{MSY} compared to lower values of discard mortality.

Figure 3.4.6.1.2 shows that the ASPIC model results are sensitive to the fixed or estimated value of B1/K. Models with higher values of B1/K assume that the stock was less depleted in the initial year (1986). Models with higher values of estimated B1/K were associated with smaller values of K, and MSY.

No single value of B1/K for the Gulf of Mexico Greater Amberjack stock was strongly suggested by these sensitivity analyses. Additionally, the ASPIC models results were not highly sensitive to the level of discard mortality. As in the previous SEDAR assessment for Greater Amberjack, the bootstraps and projections for the Continuity ASPIC model assumed a fixed B1/K = 0.5 and discard mortality of 20%. In order to explore the High and Low models using starting year conditions that are comparable to the results from the SS model, bootstraps and projections for the High and Low cases were done using a fixed B1/K that was informed by the SS model (Fixed B1/K = 0.2588). Bootstraps and projections for the High and Low models were also run using a discard mortality of 20%.

3.4.6.2 Sensitivity Analyses 3: Index Weighting

Table 3.4.6.2.1 summarizes the estimated parameters for the sensitivity runs that explored the iteratively reweighted fit (IRF) and the proportional weightings. All sensitivity 3 runs assumed a 20% discard mortality and a fixed B1/K input = 0.2588. Table 3.4.6.2.2 summarizes the ASPIC IRF estimated weights and compares them to the proportional weights estimated from the total landings.

The IRF sensitivity runs resulted in similar index weights in each the High and Low models (Table 3.4.6.2.2). Overall, the IRF models resulted in higher weights associated with the commercial indices than most recreational indices. There was one exception; the third period of the segmented headboat index resulted with an even higher weight than each commercial index. The weightings that resulted from the IRF ASPIC runs differed from the weightings that were developed based on proportions of total yield. The highest weightings in the proportionally weighted models were associated with the first and second periods of the segmented charterboat and private angler index (1986-1999 and 1990-2008) and with the commercial handline index.

Parameter estimates from the IRF and the proportionally weighted models differed slightly from that of the equally weighted models (Table 3.4.6.2.1 and Figure 3.4.6.2.1). However, almost all of the estimated values were within the 10^{th} and 90^{th} percentiles that were reported for the models with equal weightings (Table 3.4.5.1). There was one exception. The estimate of MSY in the High proportionally weighted model (6.06E+06) was slightly larger than the 90^{th} percentile (6.02E+06) associated with the equally weighted High ASPIC model.

3.4.7 Sensitivity to New Data

Table 3.4.7.1 and Figure 3.4.7.1 summarize the estimated parameters for the three sensitivity analyses that were performed on the Continuity Case. All three analyses assumed a 20% discard mortality rate, a fixed B1/K = 0.5, and a final year of 2009.

The SEDAR 33 Continuity ASPIC model with updated landing and indices and a final year of 2009, suggested lower values of K and MSY than the model run with the data inputs that were used in the previous SEDAR assessment for Greater Amberjack (Table 3.4.7.1 and Figure 3.4.7.1). Additionally, the Continuity model with the updated data inputs suggested a higher relative biomass (B_{2009}/B_{MSY}) and lower relative fishing mortality (F_{2009}/F_{MSY}). These analyses suggest that the ASPIC model results are sensitive to both the updated indices and landings. The final year estimates of relative biomass and relative fishing mortality were more sensitive to the updated indices alone than they were to the updated landings alone. The sensitivity of the ASPIC models to the updated indices was discussed during early assessment workshop webinars. This topic was partially what prompted the in-depth review of the methods used to develop the SEDAR 33 fishery independent indices (See Section 2.6.1 for details on how the methods for each index differed between the current and previous SEDAR assessment for Greater Amberjack).

3.4.8 Benchmarks/Reference points

3.4.8.1 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=0.28) of greater amberjack, and 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 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.

3.4.8.2 Overfishing Definitions

According to all of the models examined, and using the Council's preferred definition for MFMT (overfishing criterion), the Greater Amberjack resource in the U.S. Gulf of Mexico is no longer considered to be undergoing overfishing as F_{2012}/F_{MSY} does not exceeded the MFMT (High Model F_{2012}/F_{MSY} = 0.450; Low Model F_{2012}/F_{MSY} = 0.485; Continuity Model F_{2012}/F_{MSY} = 0.553). The estimate of the 90^{th} percentile for F_{2012}/F_{MSY} from each the High, Low, and Continuity models were 0.61, 0.73, and 0.70, respectively.

Across all formulations, including the sensitivity runs, the largest estimated value of F_{2012}/F_{MSY} was 0.58 and it was associated with the Low proportionally weighted run.

3.4.8.3 Overfished Definitions

Likewise, according to models examined, and using the Council's preferred definition for MSST (overfished criterion), the Greater Amberjack resource in the U.S. Gulf of Mexico is no longer considered overfished. The estimates of B_{2012}/B_{MSY} from the Continuity model (1.140), the High model (1.039), and the Low model (0.906) did not exceed the MSST = 0.75_{BMSY}. Across all formulations, including the sensitivity runs, the smallest estimated B_{2012}/B_{MSY} of 0.88 was associated with the High case, 40% discard mortality rate, and a model estimated B1/K of 0.185. The estimates of the 10^{th} percentile for B_{2012}/B_{MSY} were above MSST for both the Continuity case (0.93) and the High Case (0.81) and slightly below MSST for the Low case (0.67).

3.4.9 Projections

3.4.9.1 Fishing Mortality Projections

Figures 3.4.9.1.1 – 3.4.9.1.3 present the projections for 2013-2028 that were explored based on different levels of F_{2012} (levels of 0.0, 0.5, 0.1, 1.5, 2.0, 3.0, 4.0, and 5.0 times F_{2012}) for each model.

The ASPIC projections of relative biomass based fishing mortality suggest that the stock will grow under rates equal to or lower than each models estimated F_{2012}. This result is consistent with the fact that each models estimate of F_{2012}/F_{MSY} was less than 1. The projected declines in relative biomass that are plotted in figures 3.4.9.1.1-3.4.9.1.3 are consistent with the model values of F_{MSY}/F_{2012} that are reported in table 3.4.2.1. The estimates of F_{MSY}/F_{2012} were 1.81, 2.22, and 2.06 for the Continuity, High, and Low models, respectively. As expected, the projections with F_{2012} * values larger than the estimates of F_{MSY}/F_{2012} all show declines in relative biomass.

3.4.9.2 Catch Projections Based on 2012 and Based on Model Estimated MSY

Figures 3.4.9.2.1 – 3.4.9.2.3 present the projections for 2013-2028 based on different levels of constant catch (levels of 0.0, 0.5, 1.0, 1.5, and 2.0 times the 2012 Yield and levels of 0.8, 1.0, 1.2, and 1.4 times the each model's estimated MSY) for each model.

The ASPIC projections of relative biomass based on constant catch suggest that the stock will grow under scenarios where the yield is equal to or lower than the yield in 2012. This result is also consistent with the fact that each models estimate of F_{2012}/F_{MSY} was less than 1.

Fishing at levels of constant catch that are higher than MSY will ultimately deplete the stock. The projections of relative biomass for the continuity model show rapid declines to zero biomass when the constant catch is set as 1.2*MSY or higher (Figure 3.4.9.2.1). In comparison to the projections for the Continuity mode, the projections for the High and Low models were less sensitive to the scenarios of constant catch above MSY. Both the High and Low model projections with constant catch set as 1.2*MSY result in only gradual declines in relative biomass overtime (Figures 3.4.9.2.2h and 3.4.9.2.3h).

3.4.10 Tables

Table 3.4.5.1. Estimated parameters from each ASPIC model and estimates associated with for the 10th and 80th percentiles (landings + 20% discards, equal index weighting, and fixed values of B1/K). The q parameter corresponds to estimated selectivity's for the commercial handline (HL), commercial longline (LL), recreational headboat (HB) and the combined recreational charterboat and private angler fisheries (CBPR).

	S33 Continuity Case			S33 High Case			S33 Low Case		
Parameter	Estimate	10th Percentile	90th Percentile	Estimate	10th Percentile	90th Percentile	Estimate	10th Percentile	90th Percentile
B1/K	5.00E-01	5.00E-01	5.00E-01	2.59E-01	2.59E-01	2.59E-01	2.59E-01	2.59E-01	2.59E-01
MSY	4.52E+06	4.24E+06	4.76E+06	5.94E+06	5.44E+06	6.02E+06	5.53E+06	5.00E+06	5.65E+06
K	2.94E+07	2.39E+07	3.72E+07	1.09E+08	7.51E+07	1.88E+08	1.09E+08	8.08E+07	2.03E+08
q_HL	1.22E-07	7.89E-08	1.64E-07	3.30E-08	1.42E-08	6.30E-08	3.78E-08	1.64E-08	6.70E-08
q_LL	1.15E-07	7.74E-08	1.60E-07	3.10E-08	1.35E-08	5.85E-08	3.56E-08	1.57E-08	6.24E-08
q_HB	1.01E-07	7.08E-08	1.37E-07						
q_HB (86-89)				3.65E-08	1.78E-08	6.24E-08	3.71E-08	1.76E-08	5.97E-08
q_HB (90-08)				3.23E-08	1.38E-08	6.22E-08	3.69E-08	1.54E-08	6.54E-08
q_HB (09-12)				1.94E-08	9.77E-09	3.89E-08	2.25E-08	1.12E-08	4.38E-08
q_CBPR	8.75E-08	6.06E-08	1.18E-07						
q_CBPR (86-89)				3.38E-08	1.74E-08	5.81E-08	3.40E-08	1.72E-08	5.60E-08
q_CBPR (90-08)				2.91E-08	1.18E-08	5.46E-08	3.39E-08	1.41E-08	5.94E-08
q_CBPR (09-12)				1.86E-08	8.87E-09	3.38E-08	2.22E-08	1.19E-08	4.20E-08
BMSY	1.47E+07	1.20E+07	1.86E+07	5.43E+07	3.76E+07	9.42E+07	5.47E+07	4.04E+07	1.02E+08
FMSY	3.08E-01	2.28E-01	3.98E-01	1.09E-01	6.78E-02	1.62E-01	1.01E-01	5.86E-02	1.45E-01
B/BMST	1.14E+00	9.28E-01	1.29E+00	1.04E+00	8.12E-01	1.22E+00	9.06E-01	6.68E-01	1.06E+00
F/FMSY	5.53E-01	4.71E-01	7.02E-01	4.50E-01	3.79E-01	6.11E-01	4.85E-01	4.07E-01	7.25E-01

Table 3.4.6.1.1. ASPIC estimated parameter values from the High Model for sensitivity runs evaluating varying levels of input values of B1/K (0.2, 0.4, 0.5, 0.6, 0.8, and 1.0) for three levels of discard mortality (0%, 20%, and 40%).

High Case Discard Mortality	Estimated Parameters	Initial Input Value for B1/K Ratio 0.2	0.4	0.5	0.6	0.8	1
0%	B1/K	3.405E-01	3.659E-01	2.659E-01	2.689E-01	6.661E-01	6.484E-01
	MSY	4.335E+06	4.155E+06	5.092E+06	5.056E+06	3.265E+06	3.287E+06
	K	7.948E+07	7.290E+07	1.085E+08	1.061E+08	3.243E+07	3.351E+07
	B_{MSY}	3.974E+07	3.645E+07	5.424E+07	5.307E+07	1.622E+07	1.676E+07
	F_{MSY}	1.091E-01	1.140E-01	9.387E-02	9.528E-02	2.013E-01	1.962E-01
	B(2013) / B_{MSY}	1.172E+00	1.228E+00	9.821E-01	9.889E-01	1.541E+00	1.534E+00
	F(2012) / F_{MSY}	3.290E-01	3.270E-01	3.357E-01	3.359E-01	3.276E-01	3.270E-01
	F_{MSY} / F(2012)	3.040E+00	3.058E+00	2.979E+00	2.977E+00	3.052E+00	3.058E+00
	Contrast (Ideal = 1.0)	0.3763	0.3913	0.3189	0.3220	0.4834	0.4812
	Nearness Index (Ideal = 1.0)	1.0000	1.0000	0.9911	0.9945	1.0000	1.0000
	Objective function	1.976E+01	1.974E+01	1.981E+01	1.980E+01	1.968E+01	1.968E+01
	Model Performance	Normal Convergence	Normal Convergence	Normal Convergence	Normal Convergence	Normal Convergence	Normal Convergence

Table 3.4.6.1.1. (Continued) ASPIC estimated parameter values from the High Model for sensitivity runs evaluating varying levels of input values of B1/K (0.2, 0.4, 0.5, 0.6, 0.8, and 1.0) for three levels of discard mortality (0%, 20%, and 40%).

High Case		Initial Input Value for B1/K Ratio					
Discard Mortality	Estimated Parameters	0.2	0.4	0.5	0.6	0.8*	1
20%	B1/K	2.268E-01	3.720E-01	3.538E-01	3.480E-01	3.451E-01	3.417E-01
high	MSY	6.521E+06	4.769E+06	4.897E+06	4.940E+06	4.964E+06	4.992E+06
	K	1.276E+08	6.317E+07	6.803E+07	7.011E+07	7.070E+07	7.171E+07
	B_{MSY}	6.379E+07	3.159E+07	3.401E+07	3.505E+07	3.535E+07	3.586E+07
	F_{MSY}	1.022E-01	1.510E-01	1.440E-01	1.409E-01	1.404E-01	1.392E-01
	B(2013) / B_{MSY}	9.397E-01	1.292E+00	1.260E+00	1.250E+00	1.244E+00	1.238E+00
	F(2012) / F_{MSY}	4.545E-01	4.472E-01	4.469E-01	4.468E-01	4.469E-01	4.468E-01
	F_{MSY} / F(2012)	2.200E+00	2.236E+00	2.237E+00	2.238E+00	2.238E+00	2.238E+00
	Contrast (Ideal = 1.0)	0.3048	0.4076	0.3996	0.3959	0.3950	0.3934
	Nearness Index (Ideal = 1.0)	0.9698	1.0000	1.0000	1.0000	1.0000	1.0000
	Objective function	2.015E+01	2.017E+01	2.016E+01	2.016E+01	2.016E+01	2.015E+01
	Model Performance	Normal Convergence	Normal Convergence	Normal Convergence	Normal Convergence	Normal Convergence	Normal Convergence

* A penalty factor of 1 was applied to the objective function fitting process for B1/K

Table 3.4.6.1.1. (Continued) ASPIC estimated parameter values from the High Model for sensitivity runs evaluating varying levels of input values of B1/K (0.2, 0.4, 0.5, 0.6, 0.8, and 1.0) for three levels of discard mortality (0%, 20%, and 40%).

High Case		Initial Input Value for B1/K Ratio					
Discard Mortality	Estimated Parameters	0.2	0.4†	0.5	0.6	0.8	1
40%	B1/K	1.847E-01	3.999E-01	2.145E-01	1.980E-01	2.212E-01	2.345E-01
	MSY	8.914E+06	7.346E+06	7.568E+06	8.049E+06	7.399E+06	7.097E+06
	K	2.433E+08	9.442E+06	1.458E+08	1.658E+08	1.403E+08	1.301E+08
	B_{MSY}	1.217E+08	4.721E+06	7.292E+07	8.290E+07	7.014E+07	6.505E+07
	F_{MSY}	7.327E-02	1.556E+00	1.038E-01	9.709E-02	1.055E-01	1.091E-01
	B(2013) / B_{MSY}	8.862E-01	1.706E+00	9.695E-01	9.117E-01	9.928E-01	1.038E+00
	F(2012) / F_{MSY}	4.886E-01	2.982E-01	5.279E-01	5.283E-01	5.269E-01	5.247E-01
	F_{MSY} / F(2012)	2.046E+00	3.354E+00	1.894E+00	1.893E+00	1.898E+00	1.906E+00
	Contrast (Ideal = 1.0)	0.2701	0.7371	0.3051	0.2869	0.3114	0.3233
	Nearness Index (Ideal = 1.0)	0.9431	1.0000	0.9848	0.9559	0.9964	1.0000
	Objective function	2.046E+01	7.558E+01	2.045E+01	2.044E+01	2.046E+01	2.047E+01
	Model Performance	Normal Convergence		Normal Convergence	Normal Convergence	Normal Convergence	Normal Convergence

†Based on the value of the objective function, the ASPIC model appears to have converged on a local minimum.

Table 3.4.6.1.2. ASPIC estimated parameter values from the Low Model for sensitivity runs evaluating varying levels of input values of B1/K (0.2, 0.4, 0.5, 0.6, 0.8, and 1.0) for three levels of discard mortality (0%, 20%, and 40%).

Low Case		Initial Input Value for B1/K Ratio					
Discard Mortality	Estimated Parameters	0.2*†	0.4*†	0.5*	0.6*	0.8*	1*
0%	B1/K	7.667E-01	6.326E-01	5.990E-01	5.425E-01	6.800E-01	6.269E-01
low	MSY	4.216E+06	5.774E+06	3.292E+06	3.406E+06	3.178E+06	3.242E+06
	K	1.282E+07	6.100E+06	3.825E+07	4.316E+07	3.293E+07	3.651E+07
	B_{MSY}	6.412E+06	3.050E+06	1.913E+07	2.158E+07	1.646E+07	1.826E+07
	F_{MSY}	6.575E-01	1.893E+00	1.721E-01	1.578E-01	1.930E-01	1.776E-01
	B(2013) / B_{MSY}	2.097E-02	1.849E+00	1.428E+00	1.378E+00	1.479E+00	1.447E+00
	F(2012) / F_{MSY}	5.185E+00	1.519E-01	3.527E-01	3.541E-01	3.519E-01	3.532E-01
	F_{MSY} / F(2012)	1.928E-01	6.585E+00	2.835E+00	2.824E+00	2.842E+00	2.832E+00
	Contrast (Ideal = 1.0)	0.7562	0.7594	0.4398	0.4269	0.4535	0.4415
	Nearness Index (Ideal = 1.0)	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
	Objective function	4.858E+02	2.280E+01	1.899E+01	1.899E+01	1.901E+01	1.900E+01
	Model Performance			Normal Convergence	Normal Convergence	Normal Convergence	Normal Convergence

* A penalty factor of 1 was applied to the objective function fitting process for B1/K

†Based on the value of the objective function, the ASPIC model appears to have converged on a local minimum.

Table 3.4.6.1.2. (Continued) ASPIC estimated parameter values from the Low Model for sensitivity runs evaluating varying levels of input values of B1/K (0.2, 0.4, 0.5, 0.6, 0.8, and 1.0) for three levels of discard mortality (0%, 20%, and 40%).

Low Case Discard Mortality	Estimated Parameters	Initial Input Value for B1/K Ratio 0.2*	0.4*†	0.5	0.6	0.8	1
20%	B1/K	4.765E-01	5.411E-01	5.187E-01	5.791E-01	6.246E-01	5.683E-01
	MSY	3.916E+06	4.409E+06	3.788E+06	3.666E+06	3.589E+06	3.683E+06
	K	4.902E+07	2.316E+07	4.387E+07	3.723E+07	3.393E+07	3.840E+07
	B_{MSY}	2.451E+07	1.158E+07	2.193E+07	1.862E+07	1.696E+07	1.920E+07
	F_{MSY}	1.598E-01	3.808E-01	1.727E-01	1.969E-01	2.116E-01	1.918E-01
	B(2013) / B_{MSY}	1.332E+00	3.561E-02	1.376E+00	1.425E+00	1.451E+00	1.417E+00
	F(2012) / F_{MSY}	4.589E-01	6.104E+00	4.580E-01	4.558E-01	4.566E-01	4.567E-01
	F_{MSY} / F(2012)	2.179E+00	1.638E-01	2.183E+00	2.194E+00	2.190E+00	2.190E+00
	Contrast (Ideal = 1.0)	0.4073	0.5233	0.4174	0.4361	0.4416	0.4317
	Nearness Index (Ideal = 1.0)	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
	Objective function	1.920E+01	3.803E+01	1.921E+01	1.923E+01	1.926E+01	1.923E+01
	Model Performance	Normal Convergence		Normal Convergence	Normal Convergence	Normal Convergence	Normal Convergence

* A penalty factor of 1 was applied to the objective function fitting process for B1/K

†Based on the value of the objective function, the ASPIC model appears to have converged on a local minimum.

Table 3.4.6.1.2. (Continued) ASPIC estimated parameter values from the Low Model for sensitivity runs evaluating varying levels of input values of B1/K (0.2, 0.4, 0.5, 0.6, 0.8, and 1.0) for three levels of discard mortality (0%, 20%, and 40%).

Low Case		Initial Input Value for B1/K Ratio					
Discard Mortality	Estimated Parameters	0.2*	0.4	0.5	0.6	0.8	1
40%	B1/K	4.604E-01	5.078E-01	4.785E-01	4.757E-01	5.236E-01	5.056E-01
	MSY	4.299E+06	4.152E+06	4.237E+06	4.239E+06	4.111E+06	4.160E+06
	K	4.844E+07	4.170E+07	4.571E+07	4.668E+07	3.987E+07	4.179E+07
	B_{MSY}	2.422E+07	2.085E+07	2.286E+07	2.334E+07	1.993E+07	2.089E+07
	F_{MSY}	1.775E-01	1.991E-01	1.854E-01	1.816E-01	2.062E-01	1.991E-01
	B(2013) / B_{MSY}	1.339E+00	1.384E+00	1.357E+00	1.353E+00	1.395E+00	1.382E+00
	F(2012) / F_{MSY}	5.412E-01	5.404E-01	5.410E-01	5.422E-01	5.407E-01	5.400E-01
	F_{MSY} / F(2012)	1.848E+00	1.851E+00	1.849E+00	1.844E+00	1.849E+00	1.852E+00
	Contrast (Ideal = 1.0)	0.4065	0.4199	0.4116	0.4071	0.4231	0.4208
	Nearness Index (Ideal = 1.0)	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
	Objective function	1.941E+01	1.944E+01	1.942E+01	1.942E+01	1.946E+01	1.944E+01
	Model Performance	Normal Convergence	Normal Convergence	Normal Convergence	Normal Convergence	Normal Convergence	Normal Convergence

* A penalty factor of 1 was applied to the objective function fitting process for B1/K

Table 3.4.6.2.1. ASPIC estimated parameters for the ASPIC sensitivity runs that explored the iteratively reweighted fit (IRF) and the proportional weightings.

Parameter	High Case Equal Weights Estimate	High Case IRF Estimate	High Case Proportional Estimate	Low Case Equal Weights Estimate	Low Case IRF Estimate	Low Case Proportional Estimate
B1/K	2.59E-01	2.59E-01	2.59E-01	2.59E-01	2.59E-01	2.59E-01
MSY	5.94E+06	5.95E+06	6.06E+06	5.53E+06	5.57E+06	5.34E+06
K	1.086E+08	1.15E+08	1.46E+08	1.094E+08	1.17E+08	1.26E+08
q_HL	3.30E-08	2.98E-08	2.12E-08	3.78E-08	3.21E-08	3.34E-08
q_LL	3.10E-08	2.81E-08	2.00E-08	3.56E-08	3.02E-08	3.15E-08
q_HB (86-89)	3.65E-08	3.41E-08	2.59E-08	3.71E-08	3.43E-08	3.17E-08
q_HB (90-08)	3.23E-08	2.92E-08	2.06E-08	3.69E-08	3.14E-08	3.23E-08
q_HB (09-12)	1.94E-08	1.79E-08	1.37E-08	2.25E-08	1.89E-08	2.24E-08
q_CBPR (86-89)	3.38E-08	3.16E-08	2.40E-08	3.40E-08	3.15E-08	2.91E-08
q_CBPR (90-08)	2.91E-08	2.63E-08	1.86E-08	3.39E-08	2.88E-08	2.96E-08
q_CBPR (09-12)	1.86E-08	1.71E-08	1.31E-08	2.22E-08	1.87E-08	2.22E-08
BMSY	5.43E+07	5.75E+07	7.32E+07	5.47E+07	5.83E+07	6.31E+07
FMSY	1.09E-01	1.03E-01	8.27E-02	1.01E-01	9.56E-02	8.46E-02
B/BMST	1.04E+00	1.06E+00	1.06E+00	9.06E-01	9.96E-01	7.72E-01
F/FMSY	4.50E-01	4.40E-01	4.30E-01	4.85E-01	4.36E-01	5.86E-01
FMSY/F2009	2.22E+00	2.27E+00	2.33E+00	2.06E+00	2.29E+00	1.71E+00

Table 3.4.6.2.2. ASPIC IRF estimated weights and the proportional weights estimated from the total landings + 20% discards.

		IRF Estimated Weights				Proportional Weights			
Model	Years/Fishery	HL	LL	HB	CB+PR	HL	LL	HB	CB+PR
High	All years	1.590	1.630			0.292	0.029		
	1986-1989			0.506	0.196			0.016	0.157
	1990-2008			0.547	0.315			0.030	0.396
	2009-2010			2.010	0.416			0.040	0.075
Low	All years	1.520	1.650			0.324	0.033		
	1986-1989			0.520	0.184			0.017	0.173
	1990-2008			0.530	0.328			0.029	0.359
	2009-2010			2.090	0.677			0.004	0.061

Table 3.4.7.1. ASPIC estimated parameters for the three retrospective analyses that were performed on the Continuity Case. All retrospective analyses assumed a 20% discard mortality rate and a fixed B1/K = 0.5.

Parameter	SEDAR 9 Indices and SEDAR 9 Landings Estimate	SEDAR 9 Indices and SEDAR 33 Landings Estimate	SEDAR 33 Indices and SEDAR 9 Landings Estimate	SEDAR 33 Indices and SEDAR 33 Landings Estimate
B1/K	5.00E-01	5.000E-01	5.000E-01	5.000E-01
MSY	4.90E+06	4.455E+06	4.665E+06	4.835E+06
K	2.95E+07	3.085E+07	3.415E+07	2.231E+07
q_HL	1.87E-07	1.398E-07	1.212E-07	1.809E-07
q_LL	1.76E-07	1.327E-07	1.146E-07	1.711E-07
q_HC	1.43E-07	1.140E-07	1.006E-07	1.499E-07
q_CBPR	8.70E-08	6.852E-08	8.639E-08	1.287E-07
Bmsy	1.47E+07	1.543E+07	1.707E+07	1.115E+07
Fmsy	3.33E-01	2.888E-01	2.732E-01	4.334E-01
B/BMSY	3.11E-01	3.598E-01	7.559E-01	8.356E-01
F/FMSY	1.83E+00	1.704E+00	8.225E-01	7.533E-01
FMSY/F2012	5.46E-01	5.869E-01	1.216E+00	1.328E+00

3.4.11 Figures

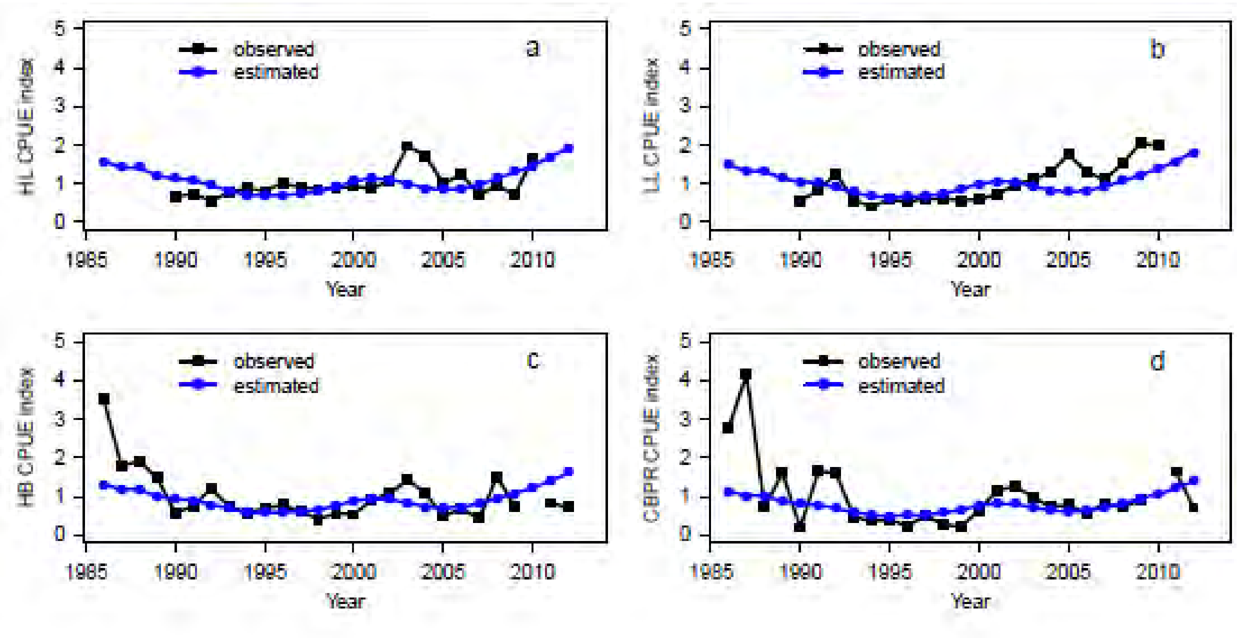


Figure 3.4.1.1. ASPIC estimated and observed CPUE series for the SEDAR 33 Continuity Case (B1/K = 0.5, equal index weighting). Each frame shows a different fishery dependent index: a) NMFS, SEFSC, Coastal Logbook Commercial Vertical Line (HL), b) NMFS, SEFSC, Coastal Logbook Commercial Longline Fleet (LL), c) NMFS Headboat Survey (HB), d) MRFSS charterboat and private fishery (CBPR).

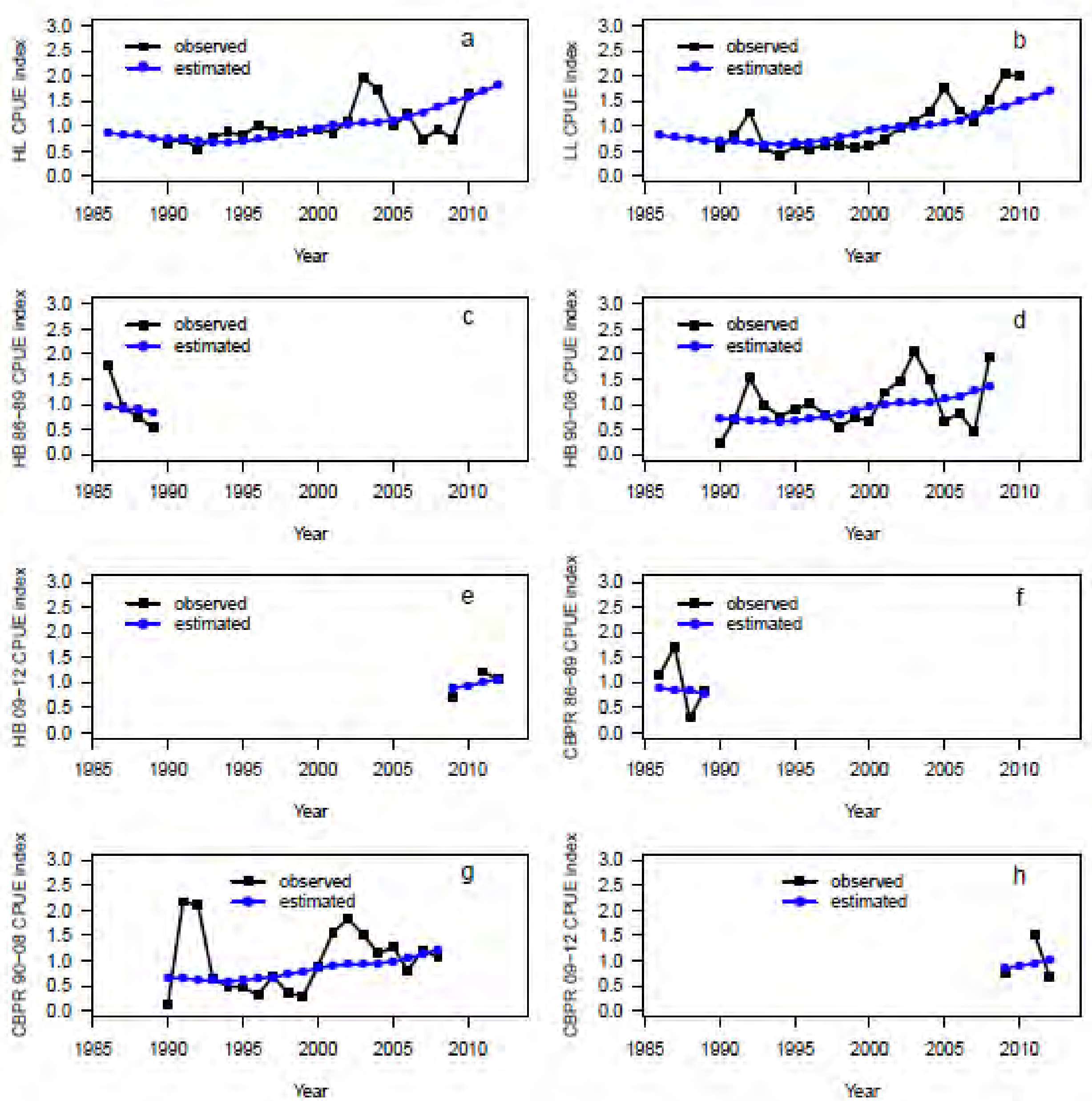


Figure 3.4.1.2. ASPIC estimated and observed CPUE series for the SEDAR 33 High Case (B1/K = 0.2588, equal index weighting). Each frame shows a different fishery dependent index: a) NMFS, SEFSC, Coastal Logbook Commercial Vertical Line (HL), b) NMFS, SEFSC, Coastal Logbook Commercial Longline Fleet (LL), c-e) NMFS Headboat Survey (HB), f-h) MRFSS charterboat and private fishery (CBPR).

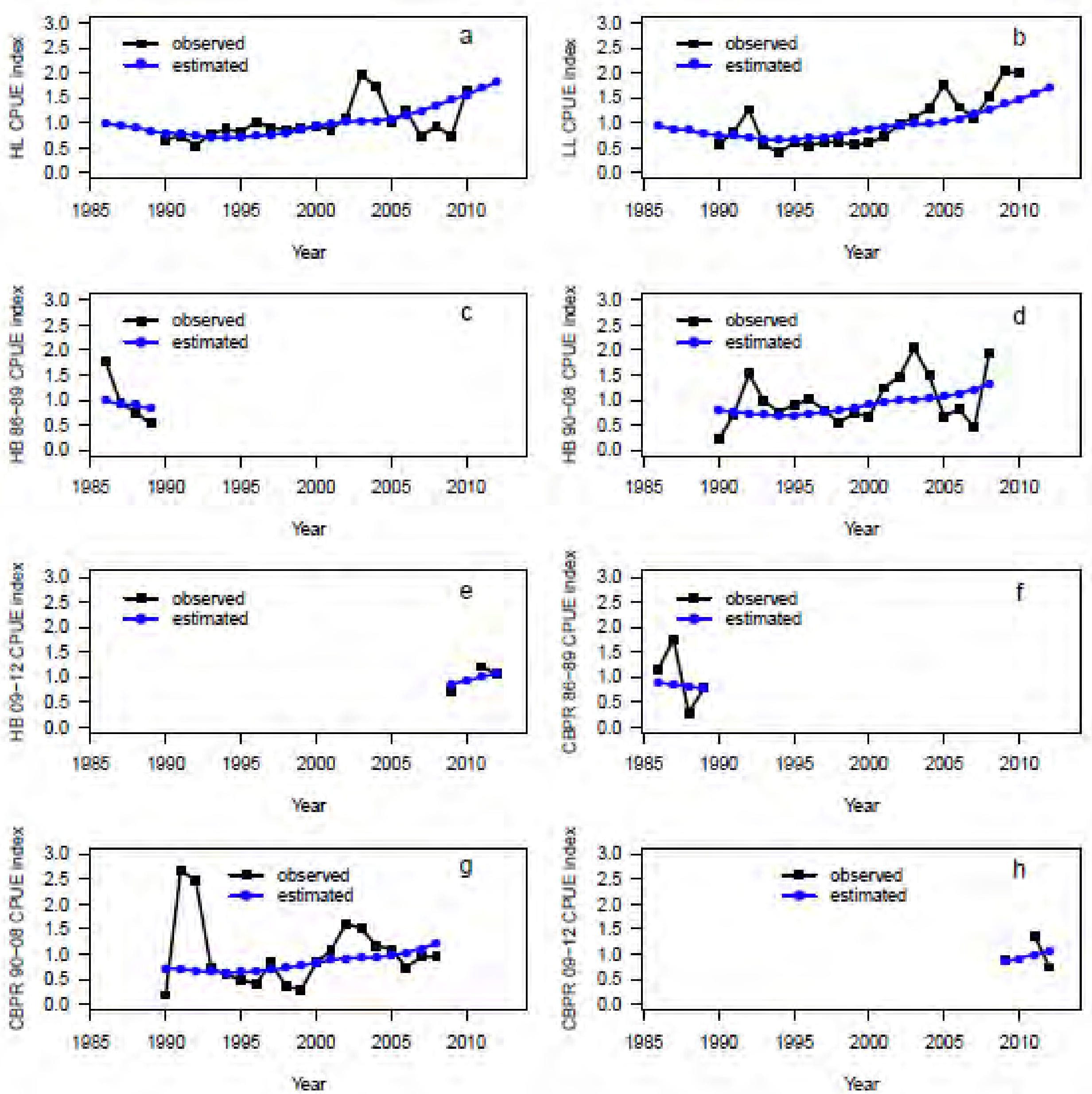


Figure 3.4.1.3. ASPIC estimated and observed CPUE series for the SEDAR 33 Low Case (B1/K = 0.2588, equal index weighting). Each frame shows a different fishery dependent index: a) NMFS, SEFSC, Coastal Logbook Commercial Vertical Line (HL), b) NMFS, SEFSC, Coastal Logbook Commercial Longline Fleet (LL), c-e) NMFS Headboat Survey (HB), f-h) MRFSS charterboat and private fishery (CBPR).

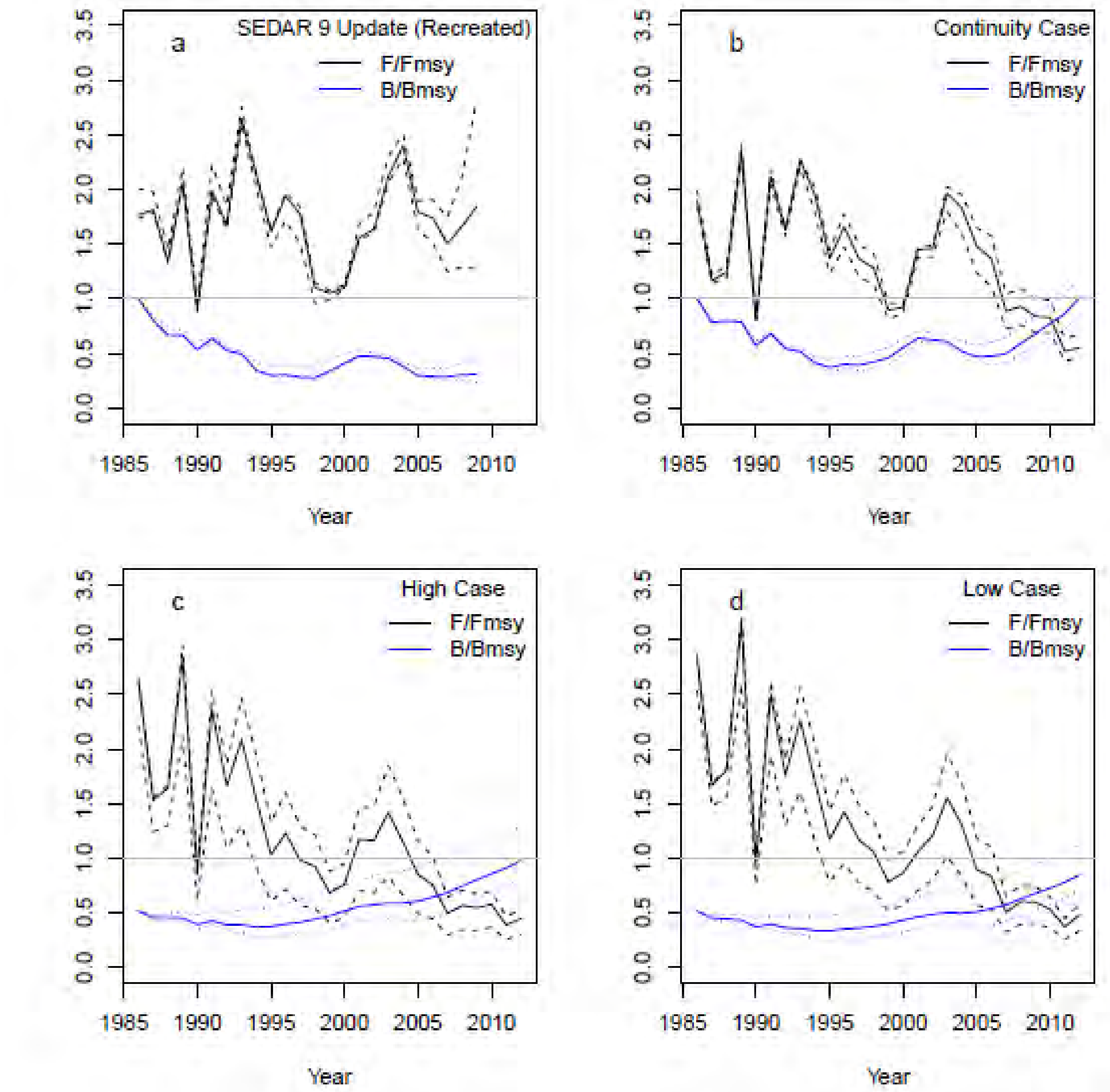


Figure 3.4.3.1. ASPIC estimated relative biomass (B/BMSY) and relative F (F/FMSY) trajectories for a) A recreated run of the SEDAR 9 Update ASPIC model, b) the SEDAR 33 Continuity Case, c) the SEDAR 33 High Case and d) the SEDAR 33 Low Case. Dashed lines correspond to the 10-90th percentiles.

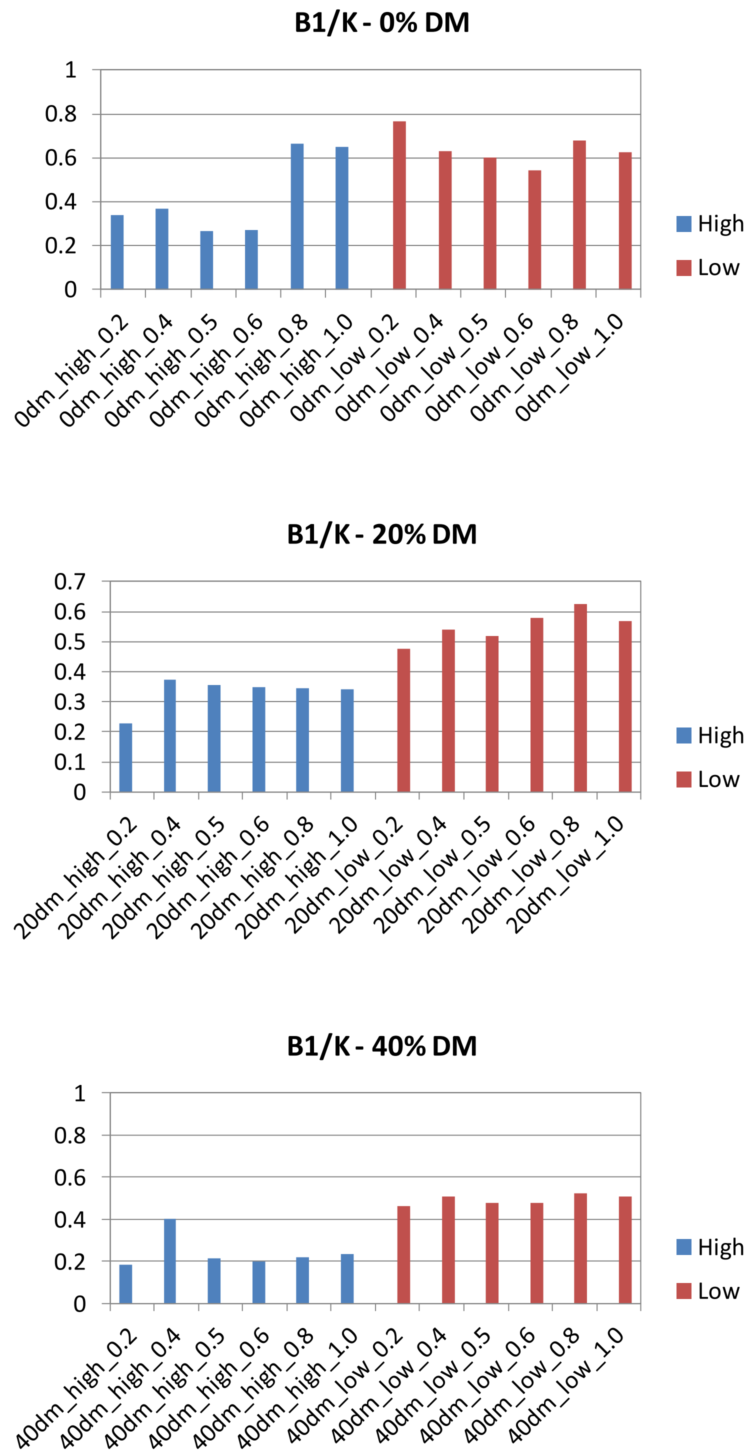


Figure 3.4.6.1.1. Plots of the ASPIC estimated values of B1/K for various levels of discard mortality (0%, 20%, and 40%) and various levels of input B1/K (0.2, 0.4, 0.6, 0.8, and 1.0) for each the High and Low models.

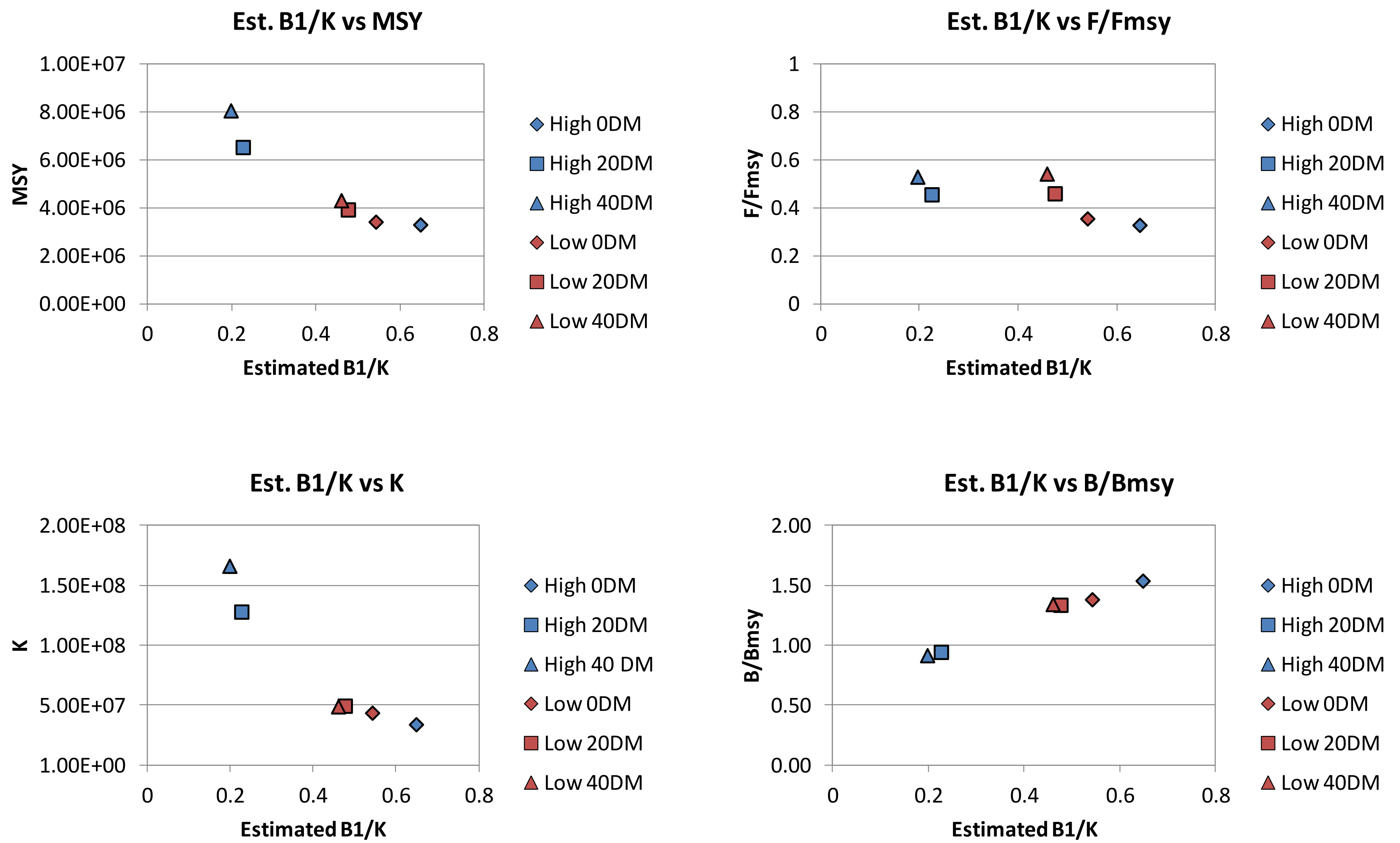


Figure 3.4.6.1.2. Plots of the ASPIC estimated B1/K versus other ASPIC estimated parameters from the sensitivity analyses exploring various levels of discard mortality (0%, 20%, and 40%) for each the High and Low models. Only scenarios with the lowest objective function for each model type (High and Low) and level of discard mortality, as detailed in Tables 3.4.6.1.1 and 3.4.6.1.2, are included.

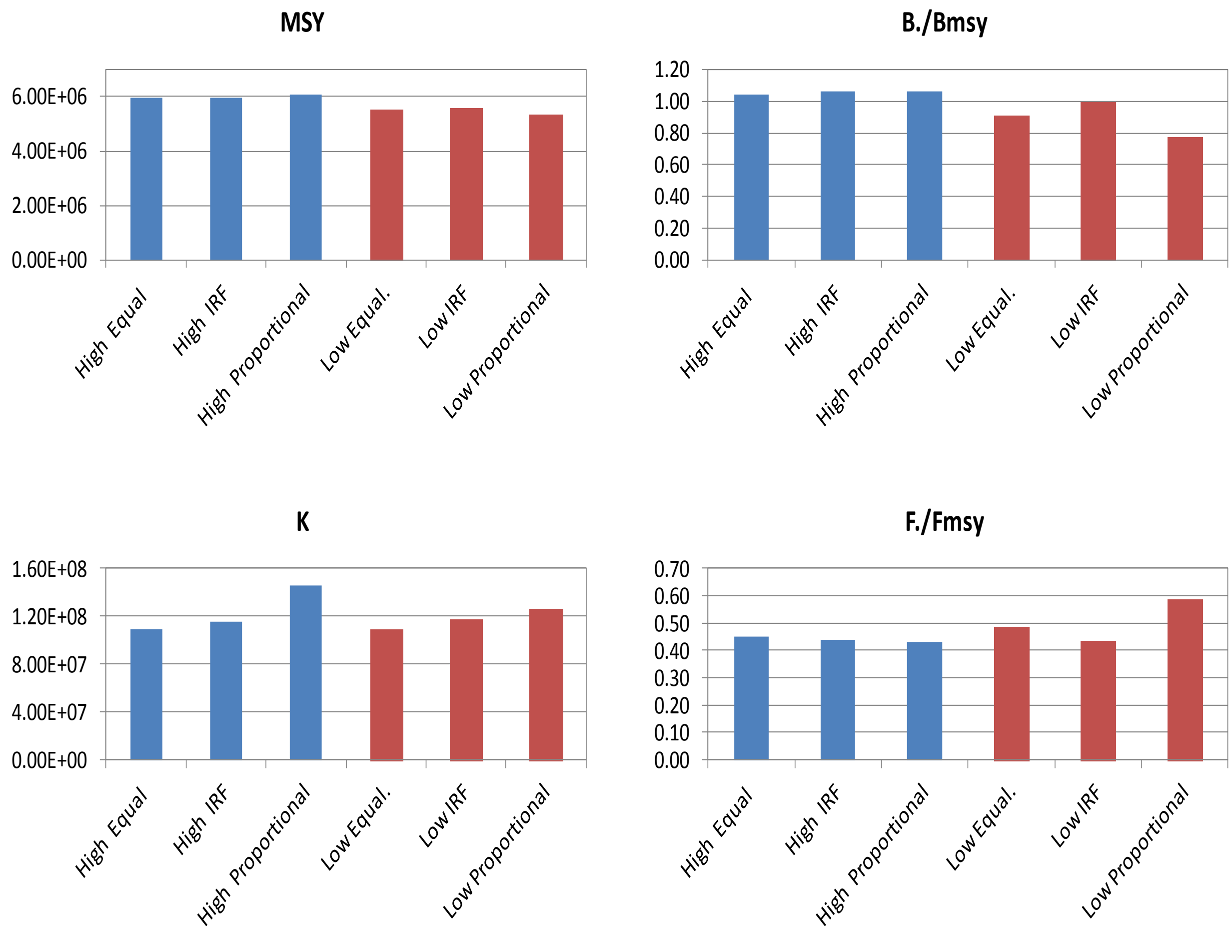


Figure 3.4.6.2.1. Plots of ASPIC estimated parameters from the sensitivity analyses exploring different index weightings (equal weightings, iteratively refit weightings, and weightings proportional to observed fishery yield).

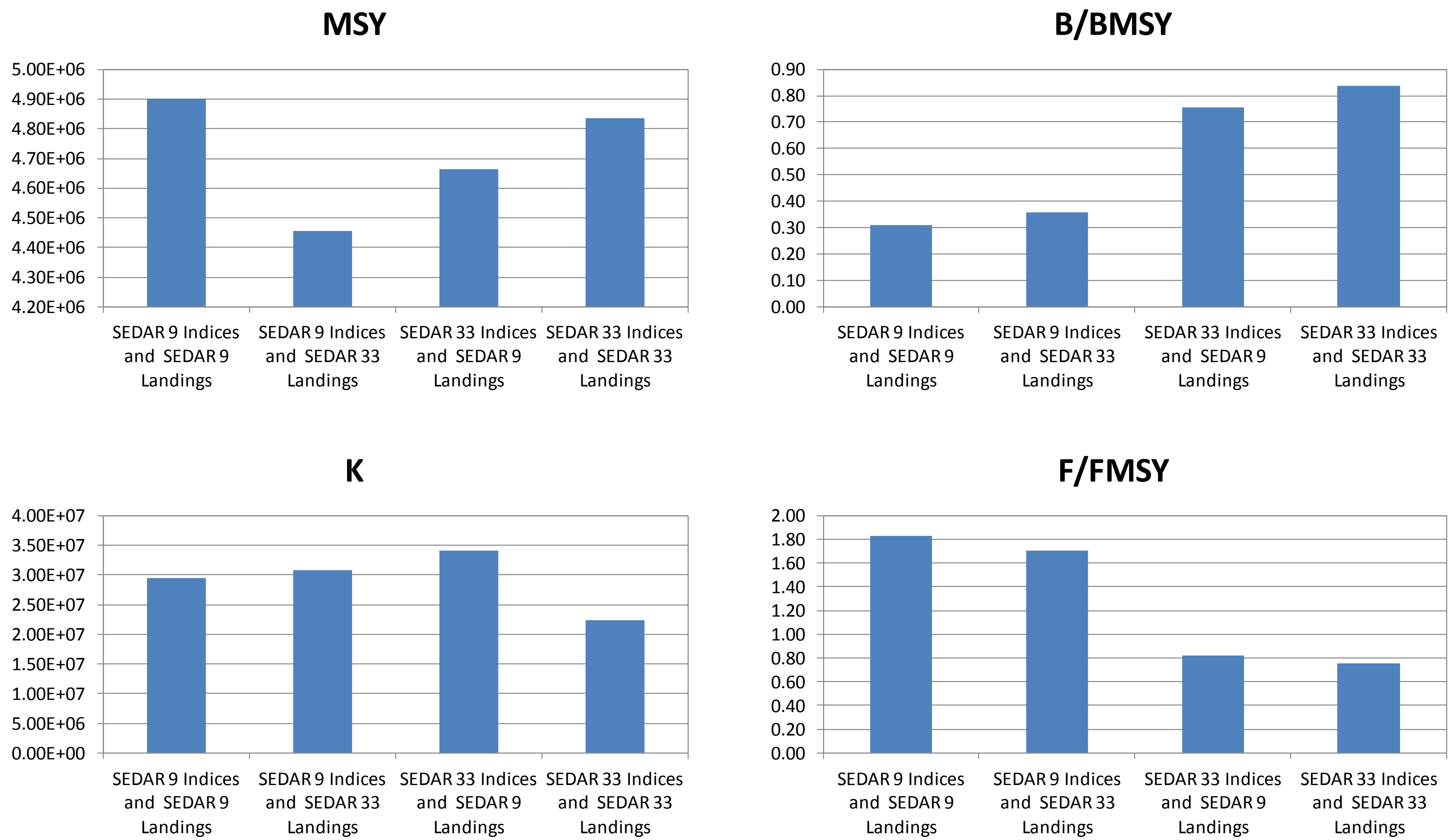


Figure 3.4.7.1. Plots of ASPIC estimated parameters from the sensitivity analyses to new data (equal weights, 20% discard mortality, fixed B1/K = 0.5, and final year set as 2009).

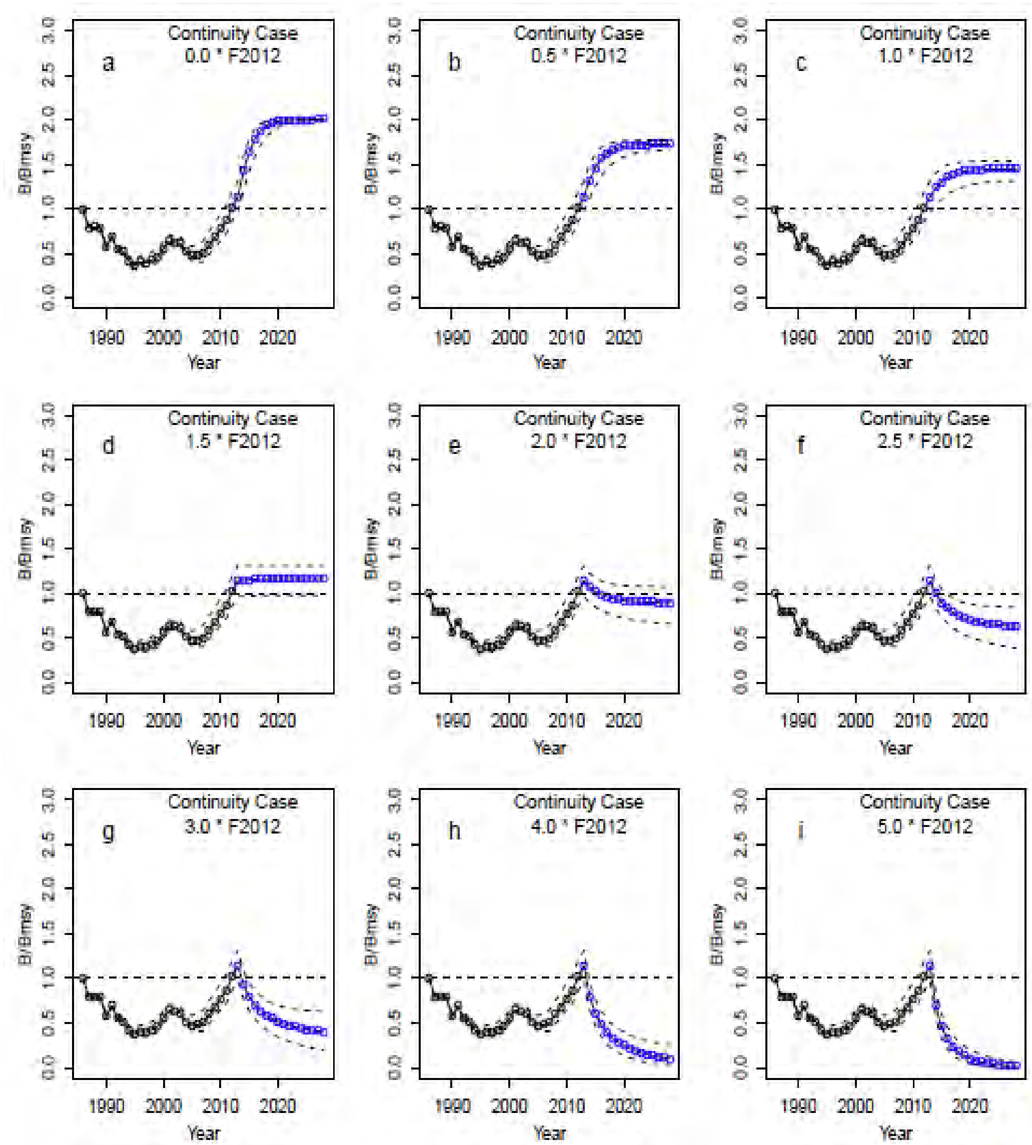


Figure 3.4.9.1.1. Projections for 2013-2028 that were explored based on different multiples of F_{2012} (0.0, 0.5, 0.1, 1.5, 2.0, 3.0, 4.0, and 5.0 times F_{2012}) for the Continuity ASPIC Model Case. Dashed lines correspond to 10^{th} -90^{th} percentiles of bootstrap.

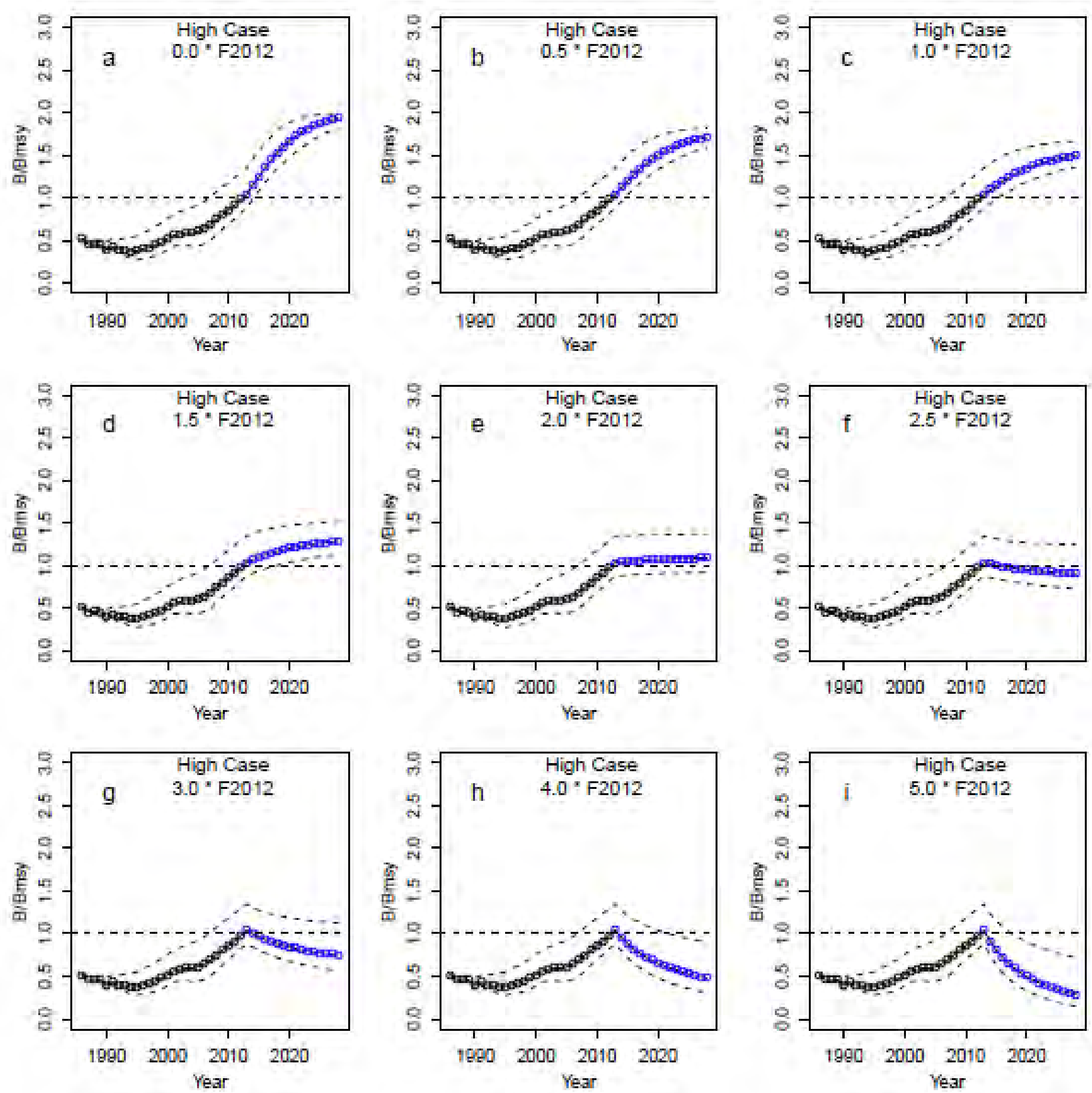


Figure 3.4.9.1.2. Projections for 2013-2028 that were explored based on different multiples of F_{2012} (0.0, 0.5, 0.1, 1.5, 2.0, 3.0, 4.0, and 5.0 times F_{2012}) for the High ASPIC Model Case. Dashed lines correspond to 10^{th} -90^{th} percentiles of bootstrap.

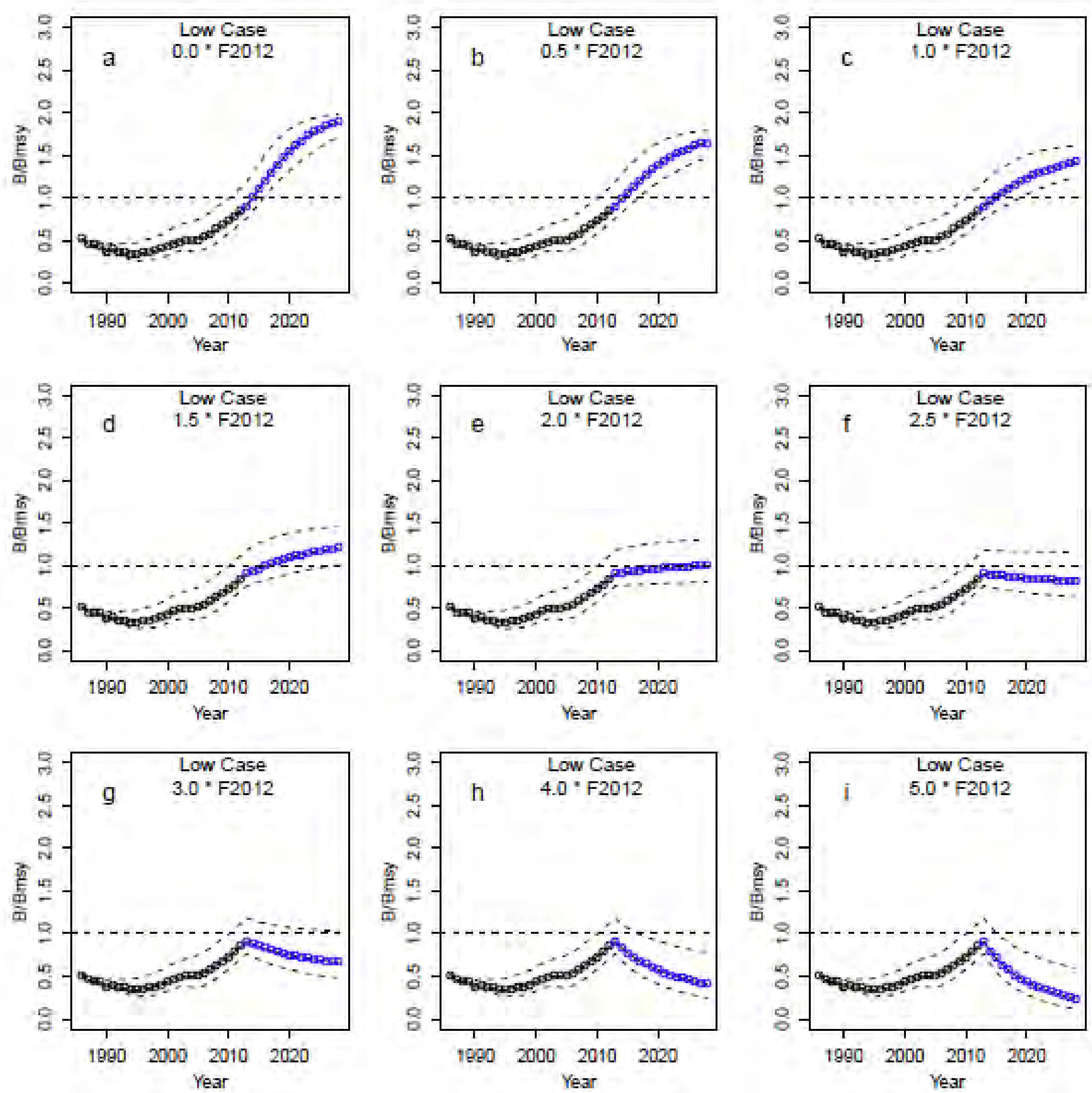


Figure 3.4.9.1.3. Projections for 2013-2028 that were explored based on different multiples of F_{2012} (0.0, 0.5, 0.1, 1.5, 2.0, 3.0, 4.0, and 5.0 times F_{2012}) for the Low ASPIC Model Case. Dashed lines correspond to 10^{th} -90^{th} percentiles of bootstrap.

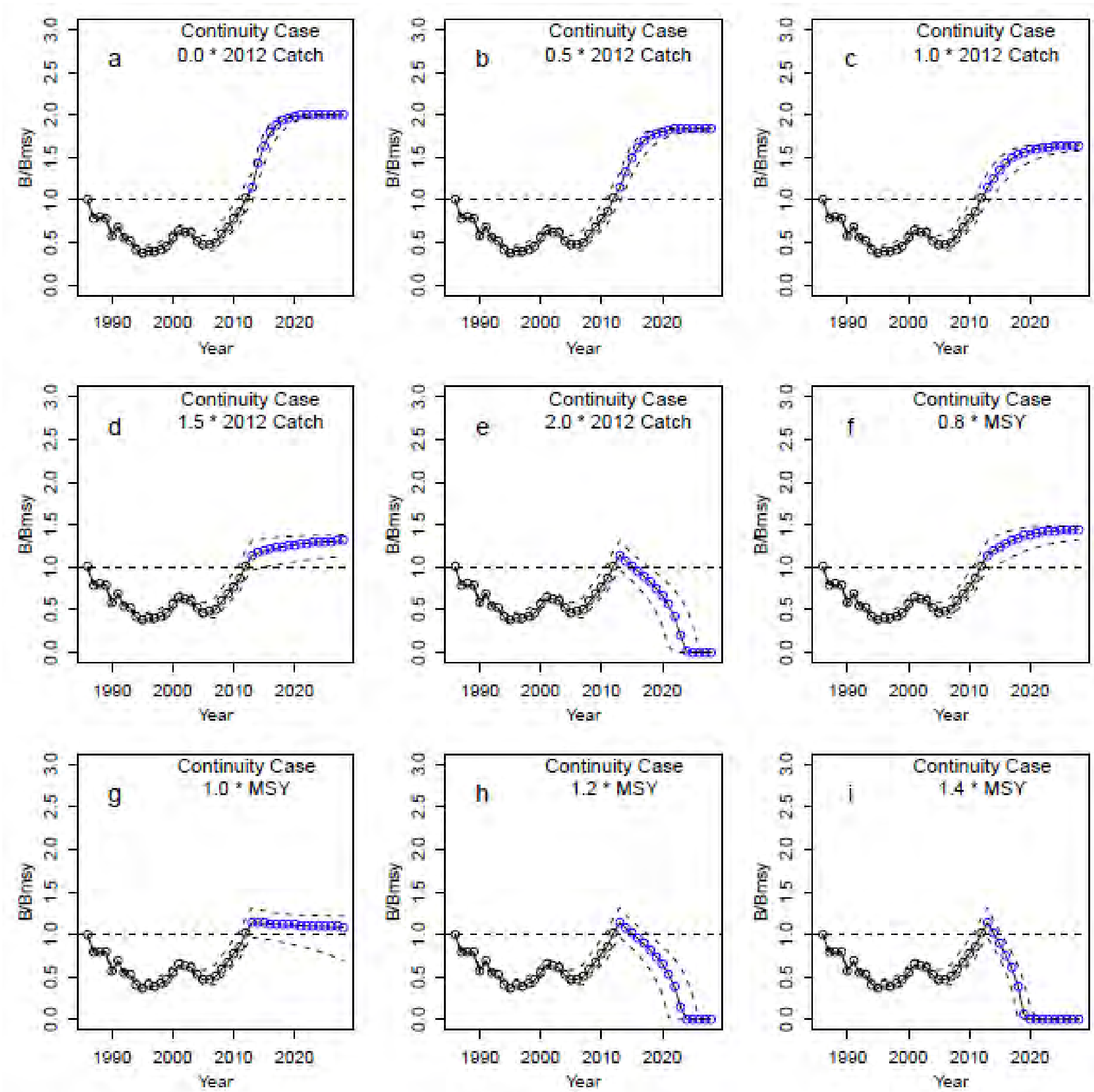


Figure 3.4.9.2.1. Projections for 2013-2028 that were explored based on different multiples of constant catch (0.0, 0.5, 1.0, 1.5, and 2.0 times the 2012 Yield and 0.8, 1.0, 1.2, and 1.4 times the model estimated MSY) for the Continuity ASPIC Model Case. Dashed lines correspond to 10^{th} -90^{th} percentiles of bootstrap.

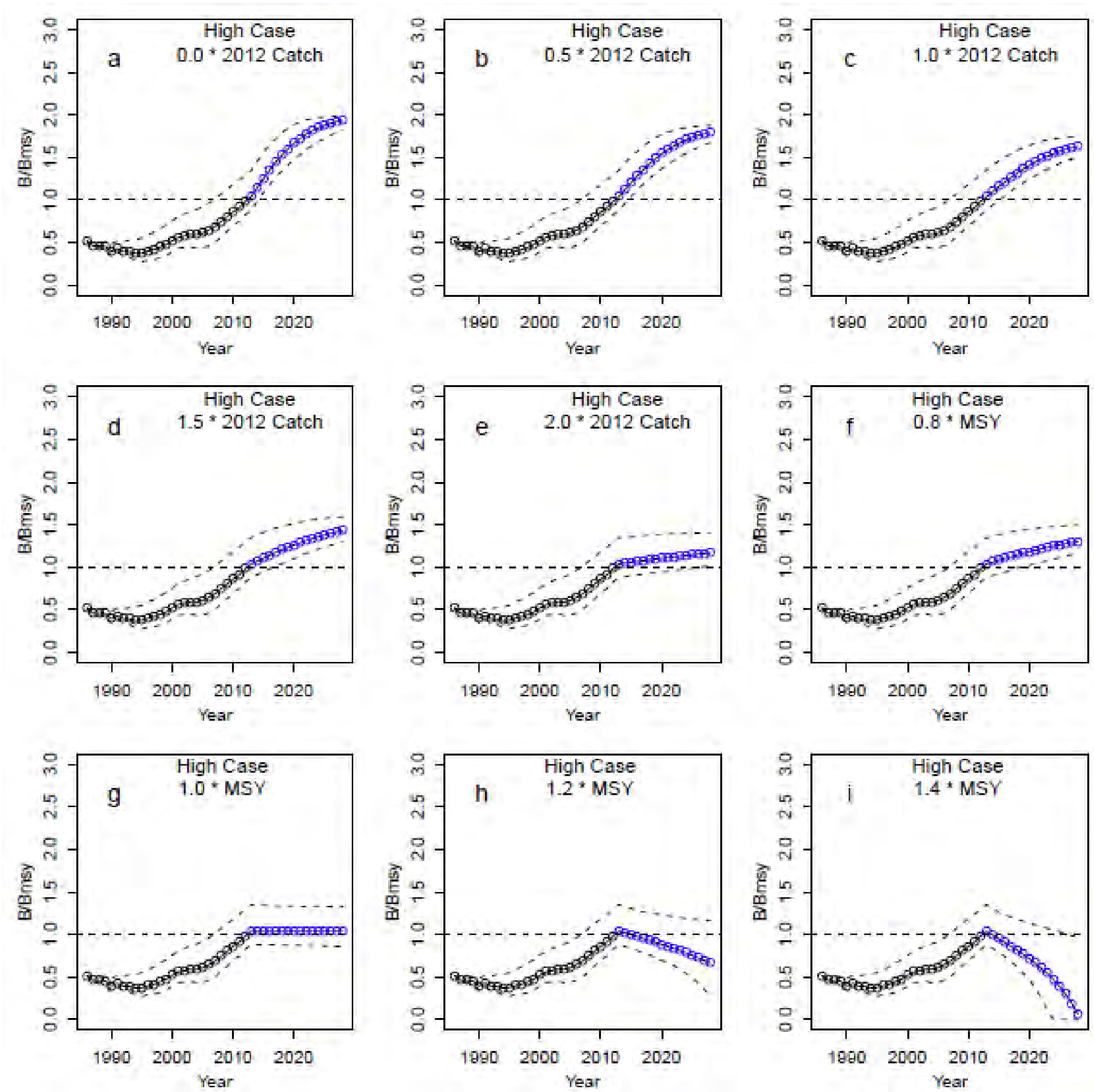


Figure 3.4.9.2.2. Projections for 2013-2028 that were explored based on different multiples of constant catch (0.0, 0.5, 1.0, 1.5, and 2.0 times the 2012 Yield and 0.8, 1.0, 1.2, and 1.4 times the model estimated MSY) for the High ASPIC Model Case. Dashed lines correspond to 10^{th} - 90^{th} percentiles of bootstrap.

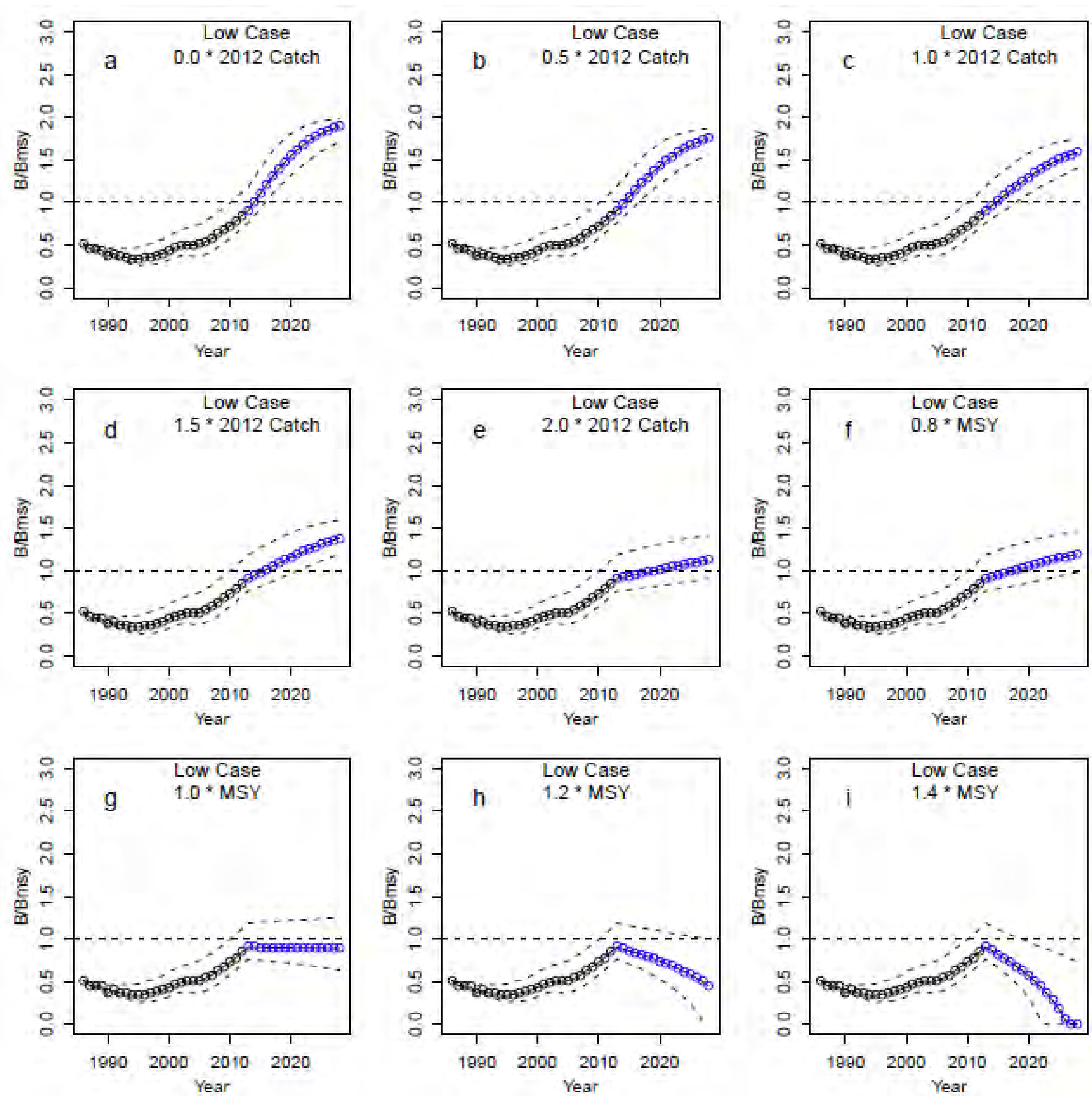


Figure 3.4.9.2.3. Projections for 2013-2028 that were explored based on different multiples of constant catch (0.0, 0.5, 1.0, 1.5, and 2.0 times the 2012 Yield and 0.8, 1.0, 1.2, and 1.4 times the each model's estimated MSY) for the Low ASPIC Model Case. Dashed lines correspond to 10^{th} -90^{th} percentiles of bootstrap.

3.5 Discussion and Recommendations

1. Review fishery dependent length and age sampling intensity protocols for Greater Amberjack. This is needed to optimize sampling coverage across the entire geographical area of catch.
2. Review fishery independent video surveys sampling design to determine if there are practical changes which could be implemented that would increase reliability in the indices. In particular, the Panama City trap video survey should be enhanced as this survey provides information on small Greater Amberjack. Improvements in the index could potentially yield more reliable estimates of size composition of recruits.
3. Develop fishery independent sampling programs for size/age composition. This research is needed to improve more reliable and accurate estimation of selectivity unaffected by fishery dependent data collections, the latter which are affected by management regulations
4. Evaluate method used to develop historical recreational effort.
5. Develop program/procedures to allow increased sampling of discarded fish for all fleets and initiate a program to collect size composition of discards from the private angler fleets. A program similar to the North Carolina Division of Marine Resources (i.e., the “Board Survey”) used to obtain size compositor of discarded recreational fish) could be evaluated to obtain self-reported size composition form private anglers and other recreational components also.

3.6 Acknowledgements

Contributions by numerous researchers lead to the completion of this stock assessment. The contents of the Assessment report were improved by input from Jeff Isley, Mandy Karnauskas, Shannon Cass-Calay, Clay Porch, and Kai Lorenzen.

3.7 References

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3.8 Appendices.

Appendix A. Starter File used in SS base model for greater amberjack "Starter.SS"

```
#Starter  file for greater amberjack Base model;
#Stock Synthesis Version 3.24j
GAJ_2012_dat.ss
GAJ_2012_ctl.ss
0 # 0=use init values in control file; 1=use ss3.par
1 # run display detail (0,1,2)
1 # detailed age-structured reports in REPORT.SSO (0,1)
1 # write detailed checkup.sso file (0,1)
1 # write parm values to ParmTrace.sso
2 # report level in CUMREPORT.SSO (0,1,2)
0 # Include prior_like for non-estimated parameters (0,1)
1 # Use Soft Boundaries to aid convergence
1 # Number of bootstrap datafiles to produce
7 # Turn off estimation for parameters entering after this phase
1000 # MCMC burn interval
100  # MCMC thin interval
0  # jitter initial parm value by this fraction
-1 # min yr for sdreport outputs (-1 for styr)
-2 # max yr for sdreport outputs (-1 for endyr; -2 for endyr+Nforecastyrs
0 # N individual STD years
0.0001 # final convergence criteria
0 # retrospective year relative to end year
1 # min age for calc of summary biomass
1 # Depletion basis:  denom is: 0=skip; 1=rel X*B0; 2=rel X*Bmsy; 3=rel X*B_styr
1 # Fraction (X) for Depletion denominator
4 # (1-SPR)_reporting:  0=skip; 1=rel(1-SPR); 2=rel(1-SPR_MSY); 3=rel(1-SPR_Btarget); 4=notrel
1 # F_std reporting: 0=skip; 1=exploit(Bio); 2=exploit(Num); 3=sum(frates)
0 # F_report_basis: 0=raw; 1=rel Fspr; 2=rel Fmsy ; 3=rel Fbtgt
999
```

Appendix B. Input Forecast File used in SS base model for greater amberjack "Forecast.SS"

#C generic forecast file
#V3.20b
for all year entries except rebuilder; enter either: actual year, -999 for styr, 0 for endyr, neg number for rel.endyr
1 # Benchmarks: 0=skip; 1=calc F_spr,F_btgt,F_msy
#it calculates targets at MSY, SPR, and biomass targets all independently during model run
2 # MSY: 1= set to F(SPR); 2=calc F(MSY); 3=set to F(Btgt); 4=set to F(endyr)
0.3 # SPR target (e.g. 0.40)
0.3 # Biomass target (e.g. 0.40)
2009 2011 2009 2011 2009 2011 #_Bmark_years: beg_bio, end_bio, beg_selex, end_selex, beg_relF, end_relF (enter actual year, or values of 0 or -integer to be rel. endyr) - use range of year where there was not change in any time varying processies, i.e. time varying change in selectivity, chagne in R0, etc.
1 #Bmark_relF_Basis: 1 = use year range; 2 = set relF same as forecast below
0 # Forecast: 0=none; 1=F(SPR); 2=F(MSY) 3=F(Btgt); 4=Ave F (uses first-last relF yrs); 5=input annual F scalar
10 # N forecast years
0.2 # F scalar (only used for Do_Forecast==5)
2009 2011 2009 2011 #_Fcast_years: beg_selex, end_selex, beg_relF, end_relF (enter actual year, or values of 0 or -integer to be rel.endyr) # the last years to use F - typically use the last three years!
2 # Control rule method (1=catch=f(SSB) west coast; 2=F=f(SSB)) # leave alone
0.01 # Control rule Biomass level for constant F (as frac of Bzero, e.g. 0.40) - leave this alone, this is west coast thing
0.001 # Control rule Biomass level for no F (as frac of Bzero, e.g. 0.10) - leave this alone, this is west coast thing
1.0 # Control rule target as fraction of Flimit (e.g. 0.75) # this is to do the F at OY - i.e. the 75 percent of Fmsy
3 #_N forecast loops (1-3) (fixed at 3 for now) # leave alone
3 #_First forecast loop with stochastic recruitment # leave alone
0 #_Forecast loop control #3 (reserved for future bells&whistles) # leave alone
0 #_Forecast loop control #4 (reserved for future bells&whistles) # leave alone
0 #_Forecast loop control #5 (reserved for future bells&whistles) # leave alone
#get final 2012 landings info from data: commecial get from REFIK, recreation may not be final and may have to do some hole filling - get with Vivian on this.
2013 #FirstYear for caps and allocations (should be after years with fixed inputs) # thsi is the year when to start the projections - remember triggefish, when we added the landings from the last year sicne they wanted manamagement advice from current year

0 # stddev of log(realized catch/target catch) in forecast (set value>0.0 to cause active impl_error)
0 # Do West Coast gfish rebuilder output (0/1)
2013 # Rebuilder: first year catch could have been set to zero (Ydecl)(-1 to set to 1999)
2012 # Rebuilder: year for current age structure (Yinit) (-1 to set to endyear+1)
#this is how we allocate fishing effort and mortality with the fleets - i.e we want a fixed effort for the shrimp fleets and constant level of closed season discards in the projections going forward - talk with Jake about how to do this
1 # fleet relative F: 1=use first-last alloc year; 2=read seas(row) x fleet(col) below
Note that fleet allocation is used directly as average F if Do_Forecast=4
this will just give you retained biomass and won't have to back out the discards
3 # basis for fcast catch tuning and for fcast catch caps and allocation (2=deadbio; 3=retainbio; 5=deadnum;6=retainnum)
Conditional input if relative F choice = 2
Fleet relative F: rows are seasons, columns are fleets
#_Fleet: FISHERY1
1
max totalcatch by fleet (-1 to have no max)
-1 -1 -1 -1
max totalcatch by area (-1 to have no max)
-1
fleet assignment to allocation group (enter group ID# for each fleet, 0 for not included in an alloc group)
0 0 0 0
#_Conditional on >1 allocation group
allocation fraction for each of: 0 allocation groups
no allocation groups
0 # Number of forecast catch levels to input (else calc catch from forecast F)
3 # basis for input Fcast catch: 2=dead catch; 3=retained catch; 99=input Hrate(F) (units are from fleetunits; note new codes in SSV3.20)
#Year Seas   Fleet   Catch(or_F)
999 # verify end of input

Appendix C. Control File used in the SS Base model run for greater amberjack. "Control.ss"

#C generic forecast file
#V3.20b
for all year entries except rebuilder; enter either: actual year, -999 for styr, 0 for endyr, neg number for rel.endyr
1 # Benchmarks: 0=skip; 1=calc F_spr,F_btgt,F_msy
#it calculates targets at MSY, SPR, and biomass targets all independently during model run
2 # MSY: 1= set to F(SPR); 2=calc F(MSY); 3=set to F(Btgt); 4=set to F(endyr)
0.3 # SPR target (e.g. 0.40)
0.3 # Biomass target (e.g. 0.40)
2009 2011 2009 2011 2009 2011 #_Bmark_years: beg_bio, end_bio, beg_selex, end_selex, beg_relF, end_relF (enter actual year, or values of 0 or -integer to be rel. endyr) - use range of year where there was not change in any time varying processies, i.e. time varying change in selectivity, chagne in R0, etc.
1 #Bmark_relF_Basis: 1 = use year range; 2 = set relF same as forecast below
0 # Forecast: 0=none; 1=F(SPR); 2=F(MSY) 3=F(Btgt); 4=Ave F (uses first-last relF yrs); 5=input annual F scalar
10 # N forecast years
0.2 # F scalar (only used for Do_Forecast==5)
2009 2011 2009 2011 #_Fcast_years: beg_selex, end_selex, beg_relF, end_relF (enter actual year, or values of 0 or -integer to be rel.endyr) # the last years to use F - typically use the last three years!
2 # Control rule method (1=catch=f(SSB) west coast; 2=F=f(SSB)) # leave alone
0.01 # Control rule Biomass level for constant F (as frac of Bzero, e.g. 0.40) - leave this alone, this is west coast thing
0.001 # Control rule Biomass level for no F (as frac of Bzero, e.g. 0.10) - leave this alone, this is west coast thing
1.0 # Control rule target as fraction of Flimit (e.g. 0.75) # this is to do the F at OY - i.e. the 75 percent of Fmsy
3 #_N forecast loops (1-3) (fixed at 3 for now) # leave alone
3 #_First forecast loop with stochastic recruitment # leave alone
0 #_Forecast loop control #3 (reserved for future bells&whistles) # leave alone
0 #_Forecast loop control #4 (reserved for future bells&whistles) # leave alone
0 #_Forecast loop control #5 (reserved for future bells&whistles) # leave alone
#get final 2012 landings info from data: commecial get from REFIK, recreation may not be final and may have to do some hole filling - get with Vivian on this.
2013 #FirstYear for caps and allocations (should be after years with fixed inputs) # thsi is the year when to start the projections - remember triggefish, when we added the landings from the last year sicne they wanted manamagement advice from current year

0 # stddev of log(realized catch/target catch) in forecast (set value>0.0 to cause active impl_error)
0 # Do West Coast gfish rebuilder output (0/1)
2013 # Rebuilder: first year catch could have been set to zero (Ydecl)(-1 to set to 1999)
2012 # Rebuilder: year for current age structure (Yinit) (-1 to set to endyear+1)
#this is how we allocate fishing effort and mortality with the fleets - i.e we want a fixed effort for the shrimp fleets and constant level of closed season discards in the projections going forward - talk with Jake about how to do this
1 # fleet relative F: 1=use first-last alloc year; 2=read seas(row) x fleet(col) below
Note that fleet allocation is used directly as average F if Do_Forecast=4
this will just give you retained biomass and won't have to back out the discards
3 # basis for fcast catch tuning and for fcast catch caps and allocation (2=deadbio; 3=retainbio; 5=deadnum;6=retainnum)
Conditional input if relative F choice = 2
Fleet relative F: rows are seasons, columns are fleets
#_Fleet: FISHERY1
1
max totalcatch by fleet (-1 to have no max)
-1 -1 -1 -1
max totalcatch by area (-1 to have no max)
-1
fleet assignment to allocation group (enter group ID# for each fleet, 0 for not included in an alloc group)
0 0 0 0
#_Conditional on >1 allocation group
allocation fraction for each of: 0 allocation groups
no allocation groups
0 # Number of forecast catch levels to input (else calc catch from forecast F)
3 # basis for input Fcast catch: 2=dead catch; 3=retained catch; 99=input Hrate(F) (units are from fleetunits; note new codes in SSV3.20)
#Year Seas Fleet Catch(or_F)
999 # verify end of input

Appendix D. Data file used in the SS Base model run for greateramberjack. "Dat.ss"

#C Gulf of Mexico Greater Amberjack 2012
#C bootstrap file: 1
1950 #_styr
2012 #_endyr
1 #_nseas
12 #_months/season
1 #_spawn_seas
4 #_N_Fishing_fleet
3 #_Nsurveys
1 #_N_areas
Com_HL_1%Com_LL_2%REC_3%Headboat_4%MRFSS_5%SEAMAP_Video_Survey_6%PANAMA_CITY_TRAP_VIDEO_SURVEY_7
#
0.5 #_surveytiming_in_season
0.5 #_surveytiming_in_season
0.5 #_surveytiming_in_season
0.5 #_surveytiming_in_season
0.5 #_surveytiming_in_season
0.5 #_surveytiming_in_season
0.5 #_surveytiming_in_season
#
1 1 1 1 1 1 1 #_area_assignments_for_each_fishery_and_survey
1 1 2 2 #_units of catch: 1=bio; 2=num
#
0.05 0.05 0.05 0.05 #_se of log(catch) used for init_eq_catch and for Fmethod 2 and 3
1 #_Ngenders
10 # Accumulator age per the manual not the number of ages (Nages)
0 0 50 15 #_init_equil_catch_for_each_fishery
63 # Number of Catch Observations
#COM_HL COM_LL REC HEADBOAT YEAR TYPE

0 0 88.85 34.521 1950 1
0 0 94.06 34.521 1951 1
0 0 99.27 34.521 1952 1
0 0 104.48 34.521 1953 1
0 0 109.69 34.521 1954 1
0 0 114.9 34.521 1955 1
0 0 120.11 34.521 1956 1
0 0 125.33 34.521 1957 1
0 0 130.54 34.521 1958 1
0 0 135.75 34.521 1959 1
0 0 140.96 34.521 1960 1
0 0 142.07 34.521 1961 1
0 0 143.18 34.521 1962 1
3.9747 0 144.29 34.521 1963 1
2.9701 0 145.4 34.521 1964 1
2.446 0 146.52 34.521 1965 1
3.4506 0 149.19 34.521 1966 1
13.6277 0 151.87 34.521 1967 1
5.3725 0 154.55 34.521 1968 1
34.0255 0 157.22 34.521 1969 1
6.3771 0 159.9 34.521 1970 1
17.9519 0 166.89 34.521 1971 1
19.4369 0 173.88 34.521 1972 1
13.1909 0 180.87 34.521 1973 1
19.4806 0 187.86 34.521 1974 1
36.4715 0 194.84 34.521 1975 1
40.3589 0 196.79 34.521 1976 1
55.95 0 198.74 34.521 1977 1
70.3268 0 200.68 34.521 1978 1
69.4082 1.2875 202.63 34.521 1979 1
80.9911 2.2715 204.58 34.521 1980 1
99.2262 10.5151 125.616 10.7798 1981 1

86.167 18.3626 388.8785 116.5301 1982 1
108.8901 21.2777 217.6948 43.3027 1983 1
218.0949 28.7633 181.8931 17.7757 1984 1
305.1138 53.9045 212.2562 34.9038 1985 1
416.917 95.0095 379.1736 86.024 1986 1
588.4908 119.3333 360.4039 52.892 1987 1
784.8037 156.932 265.1117 29.66 1988 1
747.8648 144.6571 381.7245 52.521 1989 1
512.9492 60.3879 48.1673 24.26 1990 1
805.0641 3.2893 239.5108 9.852 1991 1
456.7364 25.1394 137.1139 19.747 1992 1
695.4868 41.0095 130.0275 14.053 1993 1
549.9423 33.9318 94.5314 13.116 1994 1
525.6994 38.1652 39.0612 8.67 1995 1
538.4548 26.8099 80.8511 10.511 1996 1
459.1756 25.8661 43.947 7.538 1997 1
274.1078 23.3461 61.181 5.11 1998 1
303.7795 27.9257 46.8869 5.286 1999 1
351.5364 30.2803 55.5762 6 2000 1
283.5733 28.1397 74.6073 6.009 2001 1
304.7499 33.7592 123.2375 10.689 2002 1
377.3752 55.994 163.1155 11.976 2003 1
391.3733 34.8357 118.9632 6.242 2004 1
291.1188 32.9288 90.5926 3.993 2005 1
230.5702 35.6909 75.7393 4.726 2006 1
235.327 26.6065 45.3744 4.462 2007 1
169.3001 40.8255 70.1147 4.823 2008 1
245.6784 22.5427 69.0586 5.239 2009 1
238.8034 10.4618 59.16 2.571 2010 1
226.1311 7.6668 47.6178 2.992 2011 1
137.0449 19.9423 57.1556 3.836 2012 1
Abundance Indices

116 # Number of Survey Observations
Fleet Units(0=num, 1=bio, 2=F) error dist(-1=normal, 0=lognorm, >0=df_T)
1 1 0 # COM_RR
2 1 0 # COM_LL
3 0 0 # REC
4 0 0 # HEADBOAT
5 0 0 # MRFSS_CH+PR
6 0 0 # SEAMAP VIDEO SURVEY
7 0 0 # Panama City Lab Trap Video Survey
#Year Season FLEET EFFORT SD Label
1990 1 1 0.665373301 0.373822498 #COM_HL Index_lbs/hook hour
1991 1 1 0.743299614 0.342059794 #COM_HL Index_lbs/hook hour
1992 1 1 0.552604661 0.370760314 #COM_HL Index_lbs/hook hour
1993 1 1 0.781163913 0.326572332 #COM_HL Index_lbs/hook hour
1994 1 1 0.876914467 0.324847962 #COM_HL Index_lbs/hook hour
1995 1 1 0.813911694 0.331482875 #COM_HL Index_lbs/hook hour
1996 1 1 1.021887403 0.323786037 #COM_HL Index_lbs/hook hour
1997 1 1 0.905882834 0.322656704 #COM_HL Index_lbs/hook hour
1998 1 1 0.861017028 0.327060532 #COM_HL Index_lbs/hook hour
1999 1 1 0.88454832 0.32609762 #COM_HL Index_lbs/hook hour
2000 1 1 0.941737658 0.33247648 #COM_HL Index_lbs/hook hour
2001 1 1 0.871963859 0.336052277 #COM_HL Index_lbs/hook hour
2002 1 1 1.09727164 0.332671419 #COM_HL Index_lbs/hook hour
2003 1 1 1.973697942 0.318145106 #COM_HL Index_lbs/hook hour
2004 1 1 1.730147917 0.325897881 #COM_HL Index_lbs/hook hour
2005 1 1 1.00253901 0.330651537 #COM_HL Index_lbs/hook hour
2006 1 1 1.238399623 0.322090588 #COM_HL Index_lbs/hook hour
2007 1 1 0.726048465 0.339148577 #COM_HL Index_lbs/hook hour
2008 1 1 0.944621253 0.343889299 #COM_HL Index_lbs/hook hour
2009 1 1 0.728169176 0.372036923 #COM_HL Index_lbs/hook hour
2010 1 1 1.638800223 0.386612604 #COM_HL Index_lbs/hook hour
1990 1 2 0.57481133 0.254079148 #COM_LL Index_lbs/hook hour

1991 1 2 0.818476624 0.197153706 #COM_LL Index_lbs/hook hour
1992 1 2 1.270537766 0.211240088 #COM_LL Index_lbs/hook hour
1993 1 2 0.567376262 0.180972329 #COM_LL Index_lbs/hook hour
1994 1 2 0.407292572 0.172722959 #COM_LL Index_lbs/hook hour
1995 1 2 0.597242478 0.174886372 #COM_LL Index_lbs/hook hour
1996 1 2 0.542501991 0.191430461 #COM_LL Index_lbs/hook hour
1997 1 2 0.623033657 0.169543066 #COM_LL Index_lbs/hook hour
1998 1 2 0.618307503 0.175236033 #COM_LL Index_lbs/hook hour
1999 1 2 0.570568637 0.172638733 #COM_LL Index_lbs/hook hour
2000 1 2 0.599485257 0.176114178 #COM_LL Index_lbs/hook hour
2001 1 2 0.729640079 0.171216367 #COM_LL Index_lbs/hook hour
2002 1 2 0.968151091 0.170660154 #COM_LL Index_lbs/hook hour
2003 1 2 1.111147877 0.162155217 #COM_LL Index_lbs/hook hour
2004 1 2 1.281544099 0.16908306 #COM_LL Index_lbs/hook hour
2005 1 2 1.757812784 0.168331425 #COM_LL Index_lbs/hook hour
2006 1 2 1.310319502 0.167324538 #COM_LL Index_lbs/hook hour
2007 1 2 1.104332518 0.175070731 #COM_LL Index_lbs/hook hour
2008 1 2 1.516536795 0.168923293 #COM_LL Index_lbs/hook hour
2009 1 2 2.034333165 0.177827619 #COM_LL Index_lbs/hook hour
2010 1 2 1.996548011 0.227792019 #COM_LL Index_lbs/hook hour
1986 1 5 2.773623145 0.291976596 #MRFSS CH+PR Index_fish/1000 angler hours
1987 1 5 4.145559492 0.303739321 #MRFSS CH+PR Index_fish/1000 angler hours
1988 1 5 0.733429056 0.345044007 #MRFSS CH+PR Index_fish/1000 angler hours
1989 1 5 1.601979891 0.337115408 #MRFSS CH+PR Index_fish/1000 angler hours
1990 1 5 0.188512721 0.415356928 #MRFSS CH+PR Index_fish/1000 angler hours
1991 1 5 1.643904039 0.319266895 #MRFSS CH+PR Index_fish/1000 angler hours
1992 1 5 1.605394114 0.29495039 #MRFSS CH+PR Index_fish/1000 angler hours
1993 1 5 0.46720322 0.341210927 #MRFSS CH+PR Index_fish/1000 angler hours
1994 1 5 0.363770156 0.341284488 #MRFSS CH+PR Index_fish/1000 angler hours
1995 1 5 0.383296904 0.349248899 #MRFSS CH+PR Index_fish/1000 angler hours
1996 1 5 0.228978207 0.363683416 #MRFSS CH+PR Index_fish/1000 angler hours
1997 1 5 0.506320986 0.344759445 #MRFSS CH+PR Index_fish/1000 angler hours

1998 1 5 0.266514505 0.335934266 #MRFSS CH+PR Index_fish/1000 angler hours
1999 1 5 0.211952373 0.34002048 #MRFSS CH+PR Index_fish/1000 angler hours
2000 1 5 0.649032289 0.329731095 #MRFSS CH+PR Index_fish/1000 angler hours
2001 1 5 1.141233801 0.297684187 #MRFSS CH+PR Index_fish/1000 angler hours
2002 1 5 1.261742476 0.28867341 #MRFSS CH+PR Index_fish/1000 angler hours
2003 1 5 0.979854169 0.290939237 #MRFSS CH+PR Index_fish/1000 angler hours
2004 1 5 0.731825674 0.293887642 #MRFSS CH+PR Index_fish/1000 angler hours
2005 1 5 0.780259943 0.301490602 #MRFSS CH+PR Index_fish/1000 angler hours
2006 1 5 0.545717214 0.317354856 #MRFSS CH+PR Index_fish/1000 angler hours
2007 1 5 0.824600525 0.306807556 #MRFSS CH+PR Index_fish/1000 angler hours
2008 1 5 0.713914825 0.304531057 #MRFSS CH+PR Index_fish/1000 angler hours
2009 1 5 0.901830368 0.303027732 #MRFSS CH+PR Index_fish/1000 angler hours
2011 1 5 1.639877416 0.310798453 #MRFSS CH+PR Index_fish/1000 angler hours
2012 1 5 0.709672493 0.320426944 #MRFSS CH+PR Index_fish/1000 angler hours
1986 1 4 3.526841615 0.221804168 #Headboat Index_fish/angler hour
1987 1 4 1.787783023 0.242129444 #Headboat Index_fish/angler hour
1988 1 4 1.91506681 0.23495725 #Headboat Index_fish/angler hour
1989 1 4 1.468980642 0.242644935 #Headboat Index_fish/angler hour
1990 1 4 0.57948875 0.283291491 #Headboat Index_fish/angler hour
1991 1 4 0.739363768 0.2708747 #Headboat Index_fish/angler hour
1992 1 4 1.210324426 0.243136241 #Headboat Index_fish/angler hour
1993 1 4 0.740171157 0.251982152 #Headboat Index_fish/angler hour
1994 1 4 0.577163932 0.264752995 #Headboat Index_fish/angler hour
1995 1 4 0.685955405 0.260890739 #Headboat Index_fish/angler hour
1996 1 4 0.778071342 0.255873018 #Headboat Index_fish/angler hour
1997 1 4 0.607128911 0.278325453 #Headboat Index_fish/angler hour
1998 1 4 0.418102174 0.291631561 #Headboat Index_fish/angler hour
1999 1 4 0.560540931 0.304947491 #Headboat Index_fish/angler hour
2000 1 4 0.53488233 0.301049013 #Headboat Index_fish/angler hour
2001 1 4 0.916410527 0.266617417 #Headboat Index_fish/angler hour
2002 1 4 1.07217839 0.275597948 #Headboat Index_fish/angler hour
2003 1 4 1.431357309 0.261324333 #Headboat Index_fish/angler hour

2004 1 4 1.082519472 0.261257826 #Headboat Index_fish/angler hour
2005 1 4 0.483661602 0.292060926 #Headboat Index_fish/angler hour
2006 1 4 0.679759484 0.29552426 #Headboat Index_fish/angler hour
2007 1 4 0.424897986 0.301169932 #Headboat Index_fish/angler hour
2008 1 4 1.512879419 0.30676535 #Headboat Index_fish/angler hour
2009 1 4 0.727517853 0.277673226 #Headboat Index_fish/angler hour
2011 1 4 0.825981675 0.331365178 #Headboat Index_fish/angler hour
2012 1 4 0.712971069 0.329519241 #Headboat Index_fish/angler hour
1993 1 6 1.1483 0.125046632 #SEAMAP VIDEO Survey_frequency of occurrence P/A
1994 1 6 1.2123 0.118005646 #SEAMAP VIDEO Survey_frequency of occurrence P/A
1995 1 6 1.113 0.11600397 #SEAMAP VIDEO Survey_frequency of occurrence P/A
1996 1 6 0.6971 0.103048937 #SEAMAP VIDEO Survey_frequency of occurrence P/A
1997 1 6 0.6103 0.119999264 #SEAMAP VIDEO Survey_frequency of occurrence P/A
2002 1 6 1.8357 0.071482943 #SEAMAP VIDEO Survey_frequency of occurrence P/A
2004 1 6 0.965 0.101230162 #SEAMAP VIDEO Survey_frequency of occurrence P/A
2005 1 6 1.0185 0.070548728 #SEAMAP VIDEO Survey_frequency of occurrence P/A
2006 1 6 0.7384 0.090638291 #SEAMAP VIDEO Survey_frequency of occurrence P/A
2007 1 6 0.8944 0.078381441 #SEAMAP VIDEO Survey_frequency of occurrence P/A
2008 1 6 0.7416 0.101243111 #SEAMAP VIDEO Survey_frequency of occurrence P/A
2009 1 6 1.0723 0.072377759 #SEAMAP VIDEO Survey_frequency of occurrence P/A
2010 1 6 0.8353 0.084336331 #SEAMAP VIDEO Survey_frequency of occurrence P/A
2011 1 6 1.1819 0.075628743 #SEAMAP VIDEO Survey_frequency of occurrence P/A
2012 1 6 0.936 0.065854895 #SEAMAP VIDEO Survey_frequency of occurrence P/A
2006 1 7 0.9468 0.282022067 #Panama City Video Trap Video Survey_frequency
2007 1 7 0.8611 0.241879645 #Panama City Video Trap Video Survey_frequency
2008 1 7 1.0916 0.224567008 #Panama City Video Trap Video Survey_frequency
2009 1 7 1.7134 0.12922521 #Panama City Video Trap Video Survey_frequency
2010 1 7 0.7564 0.164829535 #Panama City Video Trap Video Survey_frequency
2011 1 7 0.1627 0.247266408 #Panama City Video Trap Video Survey_frequency
2012 1 7 1.468 0.120860515 #Panama City Video Trap Video Survey_frequency
#
4 #_N_fleets with discard_obs

Fleet Units Error (1=biomass or numbers according to selection made for retained catch, 2= fraction (biomass or numbers) of total catch discarded, 3= numbers of fish discarded, even if retained catch has units of biomass)
Discard Error Structure (>=1 degrees of freedem for students T, 0=normal and value interperted as CV of observation, -1 normal and value interperted as SE of observation)
#Fleet Disc_units err_type
1 3 1 #Com_RR
2 3 1 #Com_LL
3 1 1 #REC
4 1 1 #Headboat
76 # number of discard observations
year season fleet discard error
2007 1 1 46.4178 0.25 #COM_HL
2008 1 1 144.9098 0.25 #COM_HL
2009 1 1 67.4119 0.25 #COM_HL
2010 1 1 97.2824 0.25 #COM_HL
2011 1 1 38.3515 0.25 #COM_HL
2012 1 1 306.7235 0.25 #COM_HL
2007 1 2 2.7268 0.25 #COM_LL
2008 1 2 2.6847 0.25 #COM_LL
2009 1 2 1.7846 0.25 #COM_LL
2010 1 2 0.9257 0.25 #COM_LL
2011 1 2 1.2715 0.25 #COM_LL
2012 1 2 0.9941 0.25 #COM_LL
1981 1 3 17.5357 0.25 #REC
1982 1 3 61.3991 0.25 #REC
1983 1 3 92.6632 0.25 #REC
1984 1 3 26.6458 0.25 #REC
1985 1 3 8.4912 0.25 #REC
1986 1 3 55.7091 0.25 #REC
1987 1 3 33.1208 0.25 #REC
1988 1 3 77.296 0.25 #REC
1989 1 3 124.6045 0.25 #REC

1990 1 3 79.4045 0.25 #REC
1991 1 3 247.2505 0.25 #REC
1992 1 3 161.4858 0.25 #REC
1993 1 3 157.5203 0.25 #REC
1994 1 3 110.9463 0.25 #REC
1995 1 3 66.737 0.25 #REC
1996 1 3 63.5903 0.25 #REC
1997 1 3 48.6287 0.25 #REC
1998 1 3 105.0886 0.25 #REC
1999 1 3 95.3392 0.25 #REC
2000 1 3 134.3783 0.25 #REC
2001 1 3 548.751 0.25 #REC
2002 1 3 316.2959 0.25 #REC
2003 1 3 261.7869 0.25 #REC
2004 1 3 175.1149 0.25 #REC
2005 1 3 211.5526 0.25 #REC
2006 1 3 180.3188 0.25 #REC
2007 1 3 188.0846 0.25 #REC
2008 1 3 178.1431 0.25 #REC
2009 1 3 137.7299 0.25 #REC
2010 1 3 305.1132 0.25 #REC
2011 1 3 179.0983 0.25 #REC
2012 1 3 112.2326 0.25 #REC
1981 1 4 0.8395 0.25 #HEADBOAT
1982 1 4 5.1588 0.25 #HEADBOAT
1983 1 4 3.581 0.25 #HEADBOAT
1984 1 4 0.488 0.25 #HEADBOAT
1985 1 4 0.5034 0.25 #HEADBOAT
1986 1 4 1.371 0.25 #HEADBOAT
1987 1 4 0.64 0.25 #HEADBOAT
1988 1 4 0.381 0.25 #HEADBOAT
1989 1 4 3.053 0.25 #HEADBOAT

1990 1 4 25.655 0.25 #HEADBOAT
1991 1 4 9.407 0.25 #HEADBOAT
1992 1 4 7.268 0.25 #HEADBOAT
1993 1 4 14.056 0.25 #HEADBOAT
1994 1 4 0.283 0.25 #HEADBOAT
1995 1 4 9.022 0.25 #HEADBOAT
1996 1 4 9.706 0.25 #HEADBOAT
1997 1 4 5.429 0.25 #HEADBOAT
1998 1 4 12.856 0.25 #HEADBOAT
1999 1 4 8.948 0.25 #HEADBOAT
2000 1 4 5.212 0.25 #HEADBOAT
2001 1 4 12.149 0.25 #HEADBOAT
2002 1 4 11.8 0.25 #HEADBOAT
2003 1 4 10.249 0.25 #HEADBOAT
2004 1 4 2.929 0.25 #HEADBOAT
2005 1 4 3.911 0.25 #HEADBOAT
2006 1 4 2.748 0.25 #HEADBOAT
2007 1 4 5.215 0.25 #HEADBOAT
2008 1 4 10.505 0.25 #HEADBOAT
2009 1 4 9.232 0.25 #HEADBOAT
2010 1 4 4.043 0.25 #HEADBOAT
2011 1 4 4.23 0.25 #HEADBOAT
2012 1 4 4.059 0.25 #HEADBOAT
#
0 #_N_meanbodywt_obs
30 #degrees of freedom (must be here)
#
Population length bins are needed even if there are no size data
These define the resolution at which the mean weight-at-length, maturity-at-length and size-selectivity are based. Calculations use the mid-length of the population bins.
2 # length bin method: 1=use databins; 2=generate from binwidth,min,max below; 3=read vector
5 # binwidth for population size comp

10 # minimum size in the population (lower edge of first bin and size at age 0.00)
200 # maximum size in the population (lower edge of last bin)
#
0 #_-0.0001 #0 #_comp_tail_compression note, set to 0 for tail compress and set to - value for no tail compressing
1.00E-07 #_add_to_comp
#
0 #_combine males into females at or below this bin number
39 #_N_LengthBins
10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110 115 120 125 130 135 140 145 150 155 160 165 170 175 180 185 190 195 200
161 #_N_Length_obs
#length composition data go next
Year Season Fleet Gender Partition Nsamp data_vector
#Partition indicates discard vs. retained (0=combined; 1=discard; 2=retained)
#_year season fleet gender part nsamp 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110 115 120 125 130 135 140 145 150 155 160 165 170 175 180 185 190 195 200
1984 1 1 0 2 119 0 0 0 0 0 3 2 2 3 4 7 18 17 19 13 9 4 5 5 2 3 0 0 2 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0
1985 1 1 0 2 164 0 0 0 0 0 0 2 3 8 6 8 13 17 16 17 24 11 16 4 8 6 3 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1986 1 1 0 2 109 0 0 0 0 0 0 1 3 4 2 6 8 6 7 8 15 14 7 12 5 8 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1987 1 1 0 2 25 0 0 0 0 0 2 3 1 0 1 2 3 1 4 2 3 2 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1988 1 1 0 2 49 0 0 0 0 0 7 10 3 4 4 4 1 6 4 2 1 0 2 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1989 1 1 0 2 150 0 0 0 0 0 10 10 12 15 16 15 4 1 8 2 3 6 5 17 15 4 5 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1990 1 1 0 2 200 0 0 0 0 0 0 4 16 28 21 36 29 15 19 12 21 46 57 88 95 45 29 15 6 4 2 0 0 0 0 0 0 0 0 0 0 0 0 0
1991 1 1 0 2 200 0 0 0 0 5 22 12 9 6 2 3 7 4 9 13 26 68 65 103 62 69 40 35 11 7 4 0 2 0 1 1 0 0 0 0 0 0 0 0
1992 1 1 0 2 200 0 0 0 1 2 8 3 3 9 4 7 5 14 14 21 100 212 198 94 55 52 31 16 4 3 1 0 1 1 0 0 0 0 0 0 0 0 0 0
1993 1 1 0 2 200 0 0 0 0 0 1 1 3 0 0 1 5 6 6 14 71 149 125 161 69 43 25 13 10 4 3 4 3 0 0 0 0 1 0 0 0 1 0 0
1994 1 1 0 2 200 0 0 0 0 0 2 1 1 0 0 0 5 3 10 27 98 203 185 148 107 89 34 23 13 13 6 2 2 1 1 0 0 0 0 0 0 0 0 0
1995 1 1 0 2 200 0 0 0 0 0 0 0 0 6 0 2 1 4 11 40 62 162 142 144 68 48 21 7 6 4 0 2 1 0 0 0 0 0 0 0 0 0 0 0
1996 1 1 0 2 200 0 0 0 0 0 0 1 0 1 0 1 5 6 7 19 51 108 113 74 58 24 19 10 4 5 0 1 1 1 2 0 0 0 0 0 0 0 0 0
1997 1 1 0 2 200 0 0 0 0 2 0 0 0 1 0 0 0 2 5 1 52 157 112 72 64 55 23 10 7 1 0 1 0 1 1 0 0 0 0 0 0 0 0 0
1998 1 1 0 2 200 0 0 0 0 0 0 0 0 1 0 0 1 0 3 8 29 66 116 122 108 28 7 10 5 1 1 0 0 1 0 0 0 0 0 0 0 0 0 0
1999 1 1 0 2 200 0 0 0 0 0 0 0 0 0 0 1 0 7 13 14 22 54 71 90 187 141 52 25 5 4 0 0 1 0 0 0 0 0 0 0 0 0 0 0

2000 1 1 0 2 200 0 0 0 0 0 0 0 0 0 0 0 0 1 0 3 12 118 231 152 52 52 29 30 10 10 6 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2001 1 1 0 2 200 0 0 0 0 0 0 1 0 0 0 0 1 3 3 4 10 30 28 58 82 71 37 34 15 3 2 3 2 0 0 0 0 0 0 0 0 0 0 0
2002 1 1 0 2 200 0 0 0 0 1 0 0 0 0 0 0 0 2 0 6 43 171 123 72 90 117 59 26 7 5 3 2 1 0 0 0 0 0 0 0 0 0 0 0
2003 1 1 0 2 200 0 0 0 0 0 0 0 0 0 0 0 0 1 1 5 34 73 106 111 63 50 13 4 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2004 1 1 0 2 200 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 7 96 45 39 27 13 9 3 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0
2005 1 1 0 2 131 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 2 12 21 29 37 19 8 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2006 1 1 0 2 53 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 14 16 10 4 4 2 1 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0
2007 1 1 0 2 119 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 3 19 15 22 20 17 7 5 6 2 1 0 0 0 0 0 0 0 0 0 0 0 0 0
2008 1 1 0 2 33 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 3 18 4 5 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2009 1 1 0 2 104 0 0 0 0 0 0 0 0 0 0 0 0 0 2 3 6 13 48 19 10 2 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2010 1 1 0 2 50 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3 0 22 15 7 1 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2011 1 1 0 2 76 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 4 21 21 9 11 5 4 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2012 1 1 0 2 127 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 1 4 29 40 20 19 8 3 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2006 1 1 0 1 19 0 0 0 0 2 1 3 3 2 0 2 1 2 1 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2007 1 1 0 1 107 0 0 0 0 6 9 16 12 9 7 5 5 3 9 12 11 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2008 1 1 0 1 81 0 0 0 0 0 6 4 4 5 10 9 7 7 6 7 9 4 2 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2009 1 1 0 1 30 0 0 0 0 0 1 1 1 0 5 6 2 0 3 5 2 0 3 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2010 1 1 0 1 46 0 0 0 0 0 0 0 1 1 8 9 6 4 0 3 2 3 3 1 1 0 1 1 1 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0
2011 1 1 0 1 114 0 0 0 1 2 8 5 5 3 5 3 9 16 11 13 11 11 5 4 0 1 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0
2012 1 1 0 1 200 0 0 0 1 2 7 30 23 7 5 4 4 10 24 34 44 39 13 11 6 5 1 0 1 0 2 1 1 0 0 0 0 0 0 0 0 0 0 0
1984 1 2 0 2 27 0 0 0 0 0 0 0 2 0 0 0 1 0 0 1 1 1 0 2 3 8 2 2 1 1 1 0 0 0 1 0 0 0 0 0 0 0 0 0 0
1985 1 2 0 2 96 0 0 0 2 1 0 0 0 1 0 6 3 8 7 7 10 5 8 16 17 4 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1986 1 2 0 2 15 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 2 1 2 2 2 3 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1987 1 2 0 2 12 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 2 3 3 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1988 1 2 0 2 17 0 0 0 0 0 0 0 0 2 1 0 0 0 0 1 0 0 0 1 0 2 3 3 2 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0
1990 1 2 0 2 52 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 1 2 7 8 6 12 4 7 1 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1991 1 2 0 2 35 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 3 3 3 12 3 6 2 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0
1992 1 2 0 2 73 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 9 8 14 20 11 5 1 2 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0
1993 1 2 0 2 61 0 0 0 0 0 0 0 0 1 0 0 0 0 0 1 6 6 6 4 7 5 2 4 6 8 2 2 1 0 0 0 0 0 0 0 0 0 0 0
1994 1 2 0 2 41 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 8 13 7 4 3 2 0 1 0 0 1 0 0 0 0 0 0 0 0 0 0 0
1995 1 2 0 2 54 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 6 10 18 6 5 2 1 2 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0
1996 1 2 0 2 43 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 4 4 13 4 4 4 1 1 3 1 0 0 1 0 0 0 0 0 0 0 0 0 0

1997 1 2 0 2 52 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 3 8 5 6 5 12 2 3 3 0 1 2 0 0 0 0 0 0 0 0 0 0 0 0
1998 1 2 0 2 103 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 2 3 5 15 15 20 21 9 4 4 1 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1999 1 2 0 2 146 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 2 9 20 20 29 27 10 17 4 3 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2000 1 2 0 2 116 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 3 11 1 8 21 23 27 9 3 4 2 2 0 0 0 0 0 0 0 0 0 0 0 0 0
2001 1 2 0 2 58 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 1 5 7 13 8 10 4 4 0 2 2 0 0 0 0 0 0 0 0 0 0 0 0
2002 1 2 0 2 62 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 3 9 6 15 8 8 4 5 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2003 1 2 0 2 86 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3 7 7 7 13 20 9 11 3 3 1 2 0 0 0 0 0 0 0 0 0 0 0 0
2004 1 2 0 2 77 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 17 21 8 7 6 6 5 2 2 0 1 0 0 0 0 0 0 0 0 0 0 0 0
2005 1 2 0 2 37 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 6 8 5 6 5 3 2 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2006 1 2 0 2 20 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 3 1 3 1 3 2 1 1 1 0 1 1 0 0 0 0 0 0 0 0 0 0 0
2007 1 2 0 2 24 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 9 2 1 3 3 4 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2008 1 2 0 2 10 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 3 0 2 1 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
-2009 1 2 0 2 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 2 2 2 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
-2010 1 2 0 2 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2011 1 2 0 2 12 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 2 1 0 1 0 0 2 2 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
-2006 1 2 0 1 7 0 0 0 0 3 3 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2007 1 2 0 1 15 0 0 0 0 0 2 1 4 0 0 0 0 0 0 2 0 5 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2008 1 2 0 1 110 0 0 0 0 2 13 8 5 12 9 10 3 2 5 5 5 3 4 2 6 10 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2009 1 2 0 1 50 0 0 0 0 0 0 0 1 0 3 7 2 7 1 2 3 3 4 5 3 4 2 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2010 1 2 0 1 147 0 0 0 0 0 1 1 2 7 9 6 2 7 5 9 8 15 13 15 16 9 8 5 2 2 2 1 1 0 0 0 0 1 0 0 0 0 0 0
2011 1 2 0 1 138 0 0 0 0 4 6 3 5 4 4 4 4 4 8 12 19 14 16 10 5 7 1 4 1 1 0 1 0 0 0 0 1 0 0 0 0 0 0 0
2012 1 2 0 1 57 0 0 0 0 0 0 4 0 1 0 4 0 0 2 3 1 8 6 9 3 5 2 5 1 0 1 0 0 1 0 1 0 0 0 0 0 0 0 0
1981 1 3 0 2 34.74 0.00 0.10 0.00 0.10 1.65 32.95 5.44 5.14 0.20 0.89 1.95 3.29 1.65 1.65 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
1982 1 3 0 2 95.41 0.00 0.00 0.00 7.99 6.85 7.84 4.41 3.42 16.45 20.71 7.32 1.77 6.44 3.17 2.02 1.14 0.88 1.14 0.00 0.88 0.00 1.14
2.28 0.00 1.14 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
1983 1 3 0 2 89.96 0.00 0.00 1.61 1.61 4.82 0.00 1.52 1.52 3.05 3.05 2.28 13.96 8.55 20.14 8.55 7.02 12.70 7.19 2.28 2.37 0.00 0.76
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
1984 1 3 0 2 62.04 0.00 0.00 0.00 4.83 2.42 0.00 6.01 8.32 4.13 8.32 17.76 7.84 10.20 5.96 3.01 2.95 3.01 0.00 0.59 2.42 0.00 2.42
2.42 0.00 2.42 2.42 0.00 0.00 0.59 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
1985 1 3 0 2 141.56 0.00 0.86 0.86 35.02 25.04 19.36 7.65 2.96 6.16 2.46 2.59 4.69 7.52 1.23 3.33 1.23 6.65 2.96 0.86 4.19 0.86 4.32
0.86 0.00 2.59 0.86 0.86 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00

1986 1 3 0 2 200.00 0.00 5.97 23.87 28.89 11.83 16.12 18.53 14.13 26.74 19.68 21.67 1.57 9.11 11.04 14.60 19.31 5.13 7.07 7.85 4.71 3.93 1.57 2.36 1.99 2.36 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
1987 1 3 0 2 200.00 0.00 0.00 0.00 17.20 26.08 80.15 101.06 101.43 156.99 71.65 83.34 55.42 29.78 19.11 17.23 21.01 3.27 3.27 0.93 5.12 3.24 3.70 0.46 4.19 1.39 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
1988 1 3 0 2 137.55 0.00 0.00 0.00 3.24 10.98 7.76 8.41 14.22 18.12 26.52 36.89 39.38 22.63 5.83 5.17 2.58 5.16 4.52 1.30 0.00 0.00 0.00 0.00 0.65 0.65 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
1989 1 3 0 2 53.91 0.00 0.00 7.30 7.74 19.58 20.48 1.78 13.99 10.42 14.88 9.00 3.12 1.78 2.68 6.33 3.12 5.88 0.45 0.45 2.23 0.45 0.45 0.45 0.00 0.00 0.00 0.00 0.00 0.00 0.45 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
1990 1 3 0 2 29.73 0.00 0.00 0.00 0.00 2.20 3.87 2.20 6.08 6.68 0.00 2.20 2.20 1.60 2.14 0.53 4.41 1.07 2.14 0.00 1.67 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
1991 1 3 0 2 200.00 0.00 2.22 3.53 0.74 2.95 1.77 7.94 0.00 0.00 5.14 9.71 70.57 110.98 45.14 10.74 5.14 6.17 4.12 1.03 0.00 1.03 0.00 3.09 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
1992 1 3 0 2 200.00 0.00 0.00 0.00 5.24 0.00 0.00 0.72 0.72 2.89 10.30 6.69 67.43 230.18 171.58 94.89 46.45 13.92 11.75 11.75 4.34 7.23 0.72 3.62 2.17 5.06 1.45 2.17 0.00 0.72 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
1993 1 3 0 2 94.08 0.00 0.00 0.00 3.35 2.59 0.00 0.00 0.00 1.52 2.59 3.35 17.98 27.72 19.63 14.00 16.73 12.93 3.04 2.28 0.76 0.00 0.76 0.76 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
1994 1 3 0 2 176.25 0.00 0.00 2.49 2.49 1.87 3.43 0.00 0.00 3.73 0.00 1.24 10.61 53.37 40.55 24.32 12.77 7.48 2.81 1.87 0.00 1.24 0.00 6.55 2.18 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
1995 1 3 0 2 57.69 0.00 0.00 0.00 0.00 1.41 0.00 0.00 1.41 1.41 1.41 2.82 3.87 23.96 17.74 9.68 1.05 2.82 0.00 0.00 0.00 1.41 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
1996 1 3 0 2 150.98 0.00 0.00 0.00 0.00 1.20 0.00 1.20 1.20 0.00 0.87 0.87 10.36 58.59 51.18 11.96 6.21 6.55 2.41 2.41 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
1997 1 3 0 2 135.34 0.00 1.31 1.31 1.31 3.94 2.63 3.49 0.00 0.00 0.00 1.31 11.80 25.25 17.84 20.47 26.06 12.13 7.80 2.60 0.87 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.87 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
1998 1 3 0 2 31.64 0.00 0.00 0.00 0.00 0.00 14.07 1.12 0.00 0.00 7.03 0.84 23.91 24.17 29.80 15.74 37.98 9.28 0.56 1.12 1.68 1.40 0.28 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
1999 1 3 0 2 195.69 0.00 5.13 5.13 5.13 0.00 5.70 0.57 2.86 1.14 1.14 11.97 54.79 235.07 96.42 41.08 18.82 12.55 22.81 4.00 2.29 4.00 2.29 1.71 1.14 0.57 0.57 5.13 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
2000 1 3 0 2 200.00 0.00 0.00 0.00 0.00 0.00 0.00 0.65 8.03 16.06 18.00 27.32 20.32 133.58 148.45 165.03 100.84 75.35 2.59 3.24 9.97 1.94 0.65 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
2001 1 3 0 2 152.49 0.00 0.00 0.00 0.00 0.00 0.00 4.69 0.00 4.69 9.39 6.79 66.96 158.29 76.48 59.46 10.50 20.73 15.62 18.21 8.89 11.91 5.53 0.42 0.00 0.00 0.42 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00

2002 1 3 0 2 200.00 0.00 0.00 0.00 0.00 0.00 0.00 0.64 5.57 0.64 5.57 17.99 86.10 330.95 238.84 172.62 139.20 54.62 16.28 3.21 3.21 3.21 4.92 2.57 0.00 0.00 0.00 0.64 0.64 1.29 0.00 0.00 0.00 0.00 0.64 0.00 0.64 0.00 0.00 0.00
2003 1 3 0 2 200.00 0.00 0.00 0.00 0.00 0.00 4.98 4.98 0.46 0.46 0.00 0.91 40.50 261.56 330.40 241.28 107.56 74.83 40.95 40.81 8.63 3.20 1.83 0.46 0.00 0.00 0.00 0.91 0.91 0.00 0.00 0.00 5.43 4.98 0.00 0.00 0.00 4.98 0.00 0.00
2004 1 3 0 2 200.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.51 1.53 26.10 106.96 146.40 148.49 128.02 74.21 74.73 21.50 4.09 17.93 16.91 7.17 12.29 0.51 0.00 0.00 5.12 0.00 0.00 0.51 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
2005 1 3 0 2 133.33 0.00 0.00 0.00 0.00 0.00 0.00 3.87 0.00 0.30 7.75 4.18 17.09 109.23 105.50 56.06 32.66 20.74 15.04 16.18 5.70 0.91 4.48 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.30 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
2006 1 3 0 2 161.90 0.00 0.00 0.00 0.00 0.00 0.00 0.62 0.62 4.33 0.00 8.12 9.90 84.34 84.41 73.35 59.05 45.99 34.17 39.81 12.99 29.91 18.70 2.47 7.50 0.62 6.88 0.62 0.00 0.62 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
2007 1 3 0 2 200.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.68 2.04 20.44 116.52 113.11 62.69 36.80 34.07 40.88 35.43 16.35 19.08 7.50 2.04 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 1.36 0.00 0.00 0.00
2008 1 3 0 2 120.06 0.45 0.00 0.00 4.00 4.00 0.45 5.80 4.07 7.99 0.00 8.44 23.60 52.85 45.23 36.19 27.74 15.23 35.73 13.42 17.41 7.16 1.81 1.36 0.45 0.45 0.00 0.45 0.00 1.36 0.00 0.00 0.45 0.00 0.00 0.90 0.00 0.00 0.00 0.00
2009 1 3 0 2 200.00 0.00 0.00 0.00 0.00 0.57 0.57 2.97 2.97 2.97 0.00 2.97 0.00 23.45 93.30 127.40 146.62 101.77 74.79 56.96 9.72 12.12 5.83 4.00 1.14 1.71 0.57 0.00 0.57 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
2010 1 3 0 2 200.00 0.00 0.00 0.00 0.00 0.00 0.43 0.00 0.43 0.00 0.43 0.00 4.91 31.69 159.21 127.88 96.46 112.11 71.90 46.24 12.66 23.77 2.15 0.00 0.00 0.43 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.43 0.43 0.43 0.00 0.00 0.00 0.00
2011 1 3 0 2 200.00 0.00 0.00 0.00 4.78 9.56 0.00 0.00 0.00 0.00 0.00 0.00 0.72 28.68 212.71 164.67 124.30 42.06 48.76 34.66 44.70 17.69 6.93 6.93 10.28 0.00 0.72 0.00 0.72 0.00 0.00 0.00 2.15 0.00 0.00 0.00 0.00 0.00 0.00 0.00
2012 1 3 0 2 200.00 0.00 0.00 0.00 0.00 0.00 0.00 0.50 6.05 6.05 0.00 0.00 0.00 7.49 111.83 156.88 150.26 130.43 121.64 90.06 90.13 43.82 28.21 8.05 6.05 6.05 0.50 0.00 0.00 0.00 0.50 0.00 0.00 0.00 0.00 0.00 0.50 0.00 0.00 0.00
2006 1 3 0 1 34.32 0.00 0.15 2.14 3.29 7.62 7.88 4.17 6.65 8.65 9.10 16.33 11.08 3.05 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
2007 1 3 0 1 24.24 0.00 0.00 0.81 1.95 3.02 6.30 6.74 7.45 10.39 10.31 4.87 10.29 0.35 0.10 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
2009 1 3 0 1 34.58 0.00 0.00 0.00 0.55 1.91 1.91 0.00 7.35 10.29 4.36 6.75 5.64 3.16 5.47 3.81 2.13 2.62 0.81 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
2010 1 3 0 1 56.47 0.00 0.00 0.00 0.14 0.00 1.33 3.57 17.69 47.35 41.02 26.11 61.11 16.88 19.92 0.28 0.00 0.00 5.12 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
2011 1 3 0 1 53.39 0.00 0.00 0.00 3.68 22.39 4.88 4.44 0.75 5.02 13.85 8.48 23.25 47.14 28.43 2.57 0.75 0.62 0.00 0.45 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00

2012 1 3 0 1 88.77 0.00 0.00 2.54 2.54 22.36 36.09 18.94 17.41 12.52 15.47 12.41 17.33 9.19 2.28 1.40 2.28 1.05 1.68 0.00 0.43 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
-1981 1 4 0 2 4 0 0 0 0 0 0 0 0 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1982 1 4 0 2 30 0 0 0 0 0 0 0 4 1 0 2 3 2 0 4 5 5 3 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1983 1 4 0 2 50 0 0 0 1 0 1 3 2 3 11 3 4 0 7 0 4 1 2 4 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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1988 1 4 0 2 200 0 0 2 5 7 48 26 14 22 64 81 36 16 16 11 7 4 1 1 3 0 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1989 1 4 0 2 200 0 2 38 150 353 227 129 55 24 28 26 31 42 76 51 18 15 6 9 6 3 1 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1990 1 4 0 2 200 0 0 0 0 46 82 14 14 9 3 5 8 9 11 16 6 1 4 4 2 3 1 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1991 1 4 0 2 200 0 0 2 5 2 5 0 9 1 13 27 49 92 56 59 61 17 6 11 2 2 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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1995 1 4 0 2 200 0 0 0 0 0 2 1 0 1 5 6 23 71 64 40 27 9 11 11 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1996 1 4 0 2 164 0 0 0 0 0 1 0 0 1 0 0 9 63 50 19 10 5 2 3 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1997 1 4 0 2 115 0 0 0 2 2 1 0 0 0 0 2 5 21 20 35 15 7 4 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1998 1 4 0 2 128 0 1 0 0 0 0 0 0 0 0 0 3 29 37 21 17 8 5 5 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1999 1 4 0 2 130 0 0 0 1 0 1 0 0 0 1 0 7 69 27 13 4 3 1 1 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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2002 1 4 0 2 173 0 0 0 0 2 1 0 0 0 0 1 6 27 31 35 37 16 6 6 2 2 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0
2003 1 4 0 2 200 0 0 0 1 0 1 1 0 1 1 4 26 67 89 31 22 19 13 8 2 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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2010 1 4 0 2 200 0 0 0 0 0 0 0 0 2 1 0 0 6 29 52 60 64 54 13 7 5 3 2 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

2011 1 4 0 2 160 0 0 0 0 0 0 0 0 0 0 0 0 0 5 32 44 37 15 8 5 8 3 1 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2012 1 4 0 2 200 1 0 0 0 0 2 0 1 0 2 0 2 10 33 49 42 40 57 33 40 18 10 3 2 4 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2005 1 4 0 1 32.43 0 0 0.93 1.86 1.86 7.78 2.93 2 3.96 0.64 1.22 7.38 1.79 0.07 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2006 1 4 0 1 80.1 0 0.15 2.14 3.29 7.62 7.88 4.17 6.65 8.65 9.1 16.33 11.08 3.05 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2007 1 4 0 1 62.57 0 0 0.81 1.95 3.02 6.3 6.74 7.45 10.39 10.31 4.87 10.29 0.35 0.1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2009 1 4 0 1 13.75 0 0 0 0 0.11 0.11 0 2.59 3.58 1.35 1.89 0.75 1.08 0.68 0.22 0.43 0.86 0.11 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2010 1 4 0 1 44.53 0 0 0 0 0 0.22 0.63 2.88 8.87 7.52 4.58 11.57 3.03 4.16 0 0 0 1.07 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2011 1 4 0 1 30.69 0 0 0 0.83 5.28 1.05 0.94 0.11 1.16 2.8 1.48 3.75 7.81 4.95 0.33 0.11 0 0 0.11 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2012 1 4 0 1 52.91 0 0 1.01 1.01 8.07 13.12 6.15 5.26 3.73 4.21 3.55 4.39 0.87 0.35 0 0.35 0 0.67 0 0.17 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0
1995 1 6 0 0 60 0 0 0 0 0 0 1 13 20 16 3 1 0 1 1 2 1 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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2004 1 6 0 0 200 0 0 0 0 13 68 28 15 38 30 44 32 24 14 11 17 13 11 12 2 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2005 1 6 0 0 200 0 0 0 0 6 16 15 19 38 29 26 15 10 8 5 11 13 7 6 5 3 2 1 1 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0
2006 1 6 0 0 200 1 0 1 2 10 17 78 134 90 47 21 14 19 8 8 17 7 4 6 3 2 4 5 3 7 1 0 1 0 1 0 0 0 0 0 0 0 0 0 0
2007 1 6 0 0 200 7 0 0 0 5 12 29 37 31 40 62 39 33 25 28 24 26 39 30 22 12 11 4 4 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0
2009 1 6 0 0 149 0 0 0 5 63 42 10 16 6 5 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2010 1 7 0 0 17 0 0 0 0 1 3 3 2 5 2 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2011 1 7 0 0 15 0 0 0 1 1 2 3 1 1 1 0 2 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2012 1 7 0 0 46 9 5 5 4 11 3 2 2 1 1 0 1 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
#
10 #_N_age_bins Here age' refers to OBSERVED age - SEE SECTION 8.3.7 IN MANUAL, not TRUE age. Age' is estimated taking into accoutn ageing bias and imprecision. Note if using a random walk for age selex- #paramaters is nages+1
following vector is the lower edge of the integer age' for each age' bin; by starting at age' = 0
1 2 3 4 5 6 7 8 9 10
2 #_N_ageerror_definitions
0.5 1.5 2.5 3.5 4.5 5.5 6.5 7.5 8.5 9.5 10.5
0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001

0.5 1.5 2.5 3.5 4.5 5.5 6.5 7.5 8.5 9.5 10.5
0.1 0.2 0.21 0.29 0.40 0.51 0.63 0.63 0.63 0.63 0.63 # values from L.Lombardi
64#_N_Agecomp_obs
2 #_Lbin_method: 1=poplenbins_index; 2=datalenbins_index; 3=lengths
0 #_combine males into females at or below this bin number
#_Year season Fleet Gender Partition Age_err_df L_binLo L_Bin_Hi Nsamp 1 2 3 4 5 6 7 8 9 10
-1990 1 1 0 2 1 -1 -1 2 0 2 0 0 0 0 0 0 0 0
-1997 1 1 0 2 1 -1 -1 2 0 0 0 0 0 1 1 0 0 0
-1998 1 1 0 2 1 -1 -1 2 0 0 1 1 0 0 0 0 0 0
-1999 1 1 0 2 1 -1 -1 1 0 0 1 0 0 0 0 0 0 0
2001 1 1 0 2 1 -1 -1 18 0 2 3 10 3 0 0 0 0 0
-2002 1 1 0 2 1 -1 -1 4 0 0 4 0 0 0 0 0 0 0
2003 1 1 0 2 1 -1 -1 35 0 1 6 17 6 2 0 1 0 1
2004 1 1 0 2 1 -1 -1 19 0 1 1 6 3 0 3 2 1 1
2005 1 1 0 2 1 -1 -1 27 0 2 3 9 8 4 1 0 0 0
2006 1 1 0 2 1 -1 -1 32 0 8 7 7 6 0 2 0 0 1
2007 1 1 0 2 1 -1 -1 18 0 0 2 2 4 2 4 1 1 1
2008 1 1 0 2 1 -1 -1 35 0 0 6 7 3 6 2 2 1 4
2009 1 1 0 2 1 -1 -1 69 0 5 25 26 8 3 1 1 0 0
2010 1 1 0 2 1 -1 -1 38 0 0 12 18 5 1 1 1 0 0
2011 1 1 0 2 1 -1 -1 89 0 0 1 24 33 22 5 3 1 0
2012 1 1 0 2 1 -1 -1 100 0 1 4 36 41 14 3 0 1 0
-1997 1 2 0 2 1 -1 -1 1 0 0 1 0 0 0 0 0 0 0
2003 1 2 0 2 1 -1 -1 12 0 0 1 1 1 1 1 1 0 3
-2004 1 2 0 2 1 -1 -1 1 0 0 0 1 0 0 0 0 0 0
-2005 1 2 0 2 1 -1 -1 1 0 0 0 1 0 0 0 0 0 0
-2006 1 2 0 2 1 -1 -1 1 0 0 0 0 1 0 0 0 0 0
-2007 1 2 0 2 1 -1 -1 5 0 1 0 2 0 1 0 0 1 0
2009 1 2 0 2 1 -1 -1 11 0 2 0 4 0 2 3 0 0 0
-2010 1 2 0 2 1 -1 -1 3 0 0 0 2 1 0 0 0 0 0
2011 1 2 0 2 1 -1 -1 11 0 1 3 2 5 0 0 0 0 0
-1990 1 3 0 2 1 -1 -1 1.76 0.00 1.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00

-1991 1 3 0 2 1 -1 -1 2.30 0.00 1.00 1.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
-2000 1 3 0 2 1 -1 -1 4.13 0.00 1.00 2.00 1.00 0.00 0.00 0.00 0.00 0.00 0.00
-2001 1 3 0 2 1 -1 -1 2.32 0.00 4.00 1.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
2002 1 3 0 2 1 -1 -1 104.67 0.00 20.32 75.66 14.57 2.46 0.00 0.00 0.00 0.00 0.00
2003 1 3 0 2 1 -1 -1 153.60 0.00 15.55 161.66 49.98 5.53 2.79 0.00 2.24 0.00 2.24
2004 1 3 0 2 1 -1 -1 72.18 0.00 6.46 39.97 35.40 4.49 5.20 0.63 0.63 1.97 3.23
2005 1 3 0 2 1 -1 -1 22.26 4.13 6.52 27.22 22.49 1.80 8.25 0.30 0.00 0.30 0.00
2006 1 3 0 2 1 -1 -1 38.80 0.00 5.64 21.00 16.48 10.84 7.68 0.68 0.68 0.00 0.00
2007 1 3 0 2 1 -1 -1 62.33 0.68 10.88 37.80 48.20 26.92 7.48 7.68 14.00 1.36 0.00
2008 1 3 0 2 1 -1 -1 55.22 0.43 73.48 40.77 43.28 26.31 11.05 2.13 6.35 5.92 1.28
2009 1 3 0 2 1 -1 -1 200.00 0.00 2.37 97.12 180.61 52.71 22.90 4.93 1.18 0.59 0.59
2010 1 3 0 2 1 -1 -1 81.67 0.00 13.02 50.08 78.63 52.34 13.16 4.79 0.00 0.00 0.00
2011 1 3 0 2 1 -1 -1 105.46 0.00 2.86 42.90 82.43 69.57 18.69 11.55 0.00 0.00 0.00
2012 1 3 0 2 1 -1 -1 64.64 0.00 6.71 45.53 86.12 151.77 79.50 10.40 0.96 0.00 0.00
-1989 1 4 0 2 1 -1 -1 1 0 0 1 0 0 0 0 0 0 0
1990 1 4 0 2 1 -1 -1 28 0 12 6 8 2 0 0 0 0 0
-1991 1 4 0 2 1 -1 -1 4 1 3 0 0 0 0 0 0 0 0
-1992 1 4 0 2 1 -1 -1 1 0 0 0 1 0 0 0 0 0 0
-1993 1 4 0 2 1 -1 -1 1 0 1 0 0 0 0 0 0 0 0
1994 1 4 0 2 1 -1 -1 20 1 3 16 0 0 0 0 0 0 0
1995 1 4 0 2 1 -1 -1 17 0 8 3 6 0 0 0 0 0 0
1996 1 4 0 2 1 -1 -1 28 2 10 15 1 0 0 0 0 0 0
-1997 1 4 0 2 1 -1 -1 8 0 3 4 1 0 0 0 0 0 0
-1998 1 4 0 2 1 -1 -1 2 0 1 1 0 0 0 0 0 0 0
-1999 1 4 0 2 1 -1 -1 1 0 1 0 0 0 0 0 0 0 0
2000 1 4 0 2 1 -1 -1 21 0 0 12 7 1 1 0 0 0 0
2001 1 4 0 2 1 -1 -1 17 2 9 4 1 1 0 0 0 0 0
2002 1 4 0 2 1 -1 -1 17 0 4 8 5 0 0 0 0 0 0
2003 1 4 0 2 1 -1 -1 43 0 1 26 13 0 2 1 0 0 0
2004 1 4 0 2 1 -1 -1 15 0 3 3 6 1 2 0 0 0 0
2005 1 4 0 2 1 -1 -1 17 1 1 12 2 1 0 0 0 0 0
2006 1 4 0 2 1 -1 -1 115 0 1 104 7 3 0 0 0 0 0

2007 1 4 0 2 1 -1 -1 67 0 17 40 9 1 0 0 0 0 0
-2008 1 4 0 2 1 -1 -1 1 0 0 1 0 0 0 0 0 0 0
2009 1 4 0 2 1 -1 -1 127 3 11 65 39 8 1 0 0 0 0
2010 1 4 0 2 1 -1 -1 126 0 4 52 51 14 4 1 0 0 0
2011 1 4 0 2 1 -1 -1 73 0 3 25 33 10 1 1 0 0 0
2012 1 4 0 2 1 -1 -1 16 0 1 3 5 5 2 0 0 0 0
#
0 #_N_MeanSize-at-Age_obs
0 #_N_environ_variables
0 #_N sizefreq methods to read
0 #_N super periods
0 #_no tag data
0 #_ no morphcomp data
#
999
ENDDATA

Appendix E
Continuity Case ASPIC Data Input File
“bot_s33_cont_2012.inp”

```
BOT  ## Run type (FIT, BOT, or IRF)
"S33 Cont. 2012"
LOGISTIC  YLD    SSE
112  ## Verbosity
1000  50  ## Number of bootstrap trials, <= 1000
0  100000  ## 0=no MC search, 1=search, 2=repeated srch; N
trials
1.0000E-08  ## Convergence crit. for simplex
3.0000E-08  6  ## Convergence crit. for restarts, N restarts
1.0000E-04  12  ## Conv. crit. for F; N steps/yr for gen. model
8.0000  ## Maximum F when cond. on yield
0.0  ## Stat weight for B1>K as residual (usually 0 or 1)
4  ## Number of fisheries (data series)
1.0000E-04  1.0000E-04  1.0000E-04  1.0000E-04    ## Statistical
weights for data series
0.5000  ## B1/K (starting guess, usually 0 to 1)
4.0000E+06  ## MSY (starting guess)
2.0000E+07  ## K (carrying capacity) (starting guess)
1.9000E-07  1.8000E-07  1.4000E-07  8.7000E-08    ## q (starting
guesses -- 1 per data series)
0  1  1  1  1  1  1    ## Estimate flags (0 or 1)
(B1/K,MSY,K,q1...qn)
4.0000E+05  9.0000E+06  ## Min and max constraints -- MSY
1.0000E+07  9.0000E+07  ## Min and max constraints -- K
4120359  ## Random number seed
27  ## Number of years of data in each series
"HL"
CC
   1986    -1.000000E+00     9.185380E+05
   1987    -1.000000E+00     1.279001E+06
   1988    -1.000000E+00     1.698741E+06
   1989    -1.000000E+00     1.612718E+06
   1990     6.654000E-01     1.128146E+06
   1991     7.433000E-01     1.779769E+06
   1992     5.526000E-01     1.163634E+06
   1993     7.812000E-01     1.643312E+06
   1994     8.769000E-01     1.359078E+06
   1995     8.139000E-01     1.317942E+06
   1996     1.021900E+00     1.343354E+06
   1997     9.059000E-01     1.191804E+06
   1998     8.610000E-01     7.856930E+05
```

```
   1999     8.845000E-01     8.369150E+05
   2000     9.417000E-01     9.368190E+05
   2001     8.720000E-01     7.737120E+05
   2002     1.097300E+00     8.382460E+05
   2003     1.973700E+00     1.021905E+06
   2004     1.730100E+00     1.023378E+06
   2005     1.002500E+00     8.134640E+05
   2006     1.238400E+00     6.902310E+05
   2007     7.260000E-01     5.979270E+05
   2008     9.446000E-01     6.479470E+05
   2009     7.282000E-01     6.635600E+05
   2010     1.638800E+00     6.934630E+05
   2011    -1.000000E+00     5.570750E+05
   2012    -1.000000E+00     9.004440E+05
"LL"
CC
   1986    -1.000000E+00     2.093220E+05
   1987    -1.000000E+00     2.593540E+05
   1988    -1.000000E+00     3.396860E+05
   1989    -1.000000E+00     3.119430E+05
   1990     5.748000E-01     1.274340E+05
   1991     8.185000E-01     2.749900E+04
   1992     1.270500E+00     6.572400E+04
   1993     5.674000E-01     9.522300E+04
   1994     4.073000E-01     8.346900E+04
   1995     5.972000E-01     9.357100E+04
   1996     5.425000E-01     6.871900E+04
   1997     6.230000E-01     7.028900E+04
   1998     6.183000E-01     6.368700E+04
   1999     5.706000E-01     7.318400E+04
   2000     5.995000E-01     7.953700E+04
   2001     7.296000E-01     7.393600E+04
   2002     9.682000E-01     8.603700E+04
   2003     1.111100E+00     1.365320E+05
   2004     1.281500E+00     9.096200E+04
   2005     1.757800E+00     8.224300E+04
   2006     1.310300E+00     8.906100E+04
   2007     1.104300E+00     6.889700E+04
   2008     1.516500E+00     9.771600E+04
   2009     2.034300E+00     5.626100E+04
   2010     1.996500E+00     2.585000E+04
   2011    -1.000000E+00     2.179600E+04
   2012    -1.000000E+00     4.559100E+04
"HB"
CC
```

```
   1986     3.526800E+00     7.639490E+05
   1987     1.787800E+00     3.796650E+05
   1988     1.915100E+00     1.739640E+05
   1989     1.469000E+00     2.068380E+05
   1990     5.795000E-01     1.613780E+05
   1991     7.394000E-01     1.324630E+05
   1992     1.210300E+00     3.674420E+05
   1993     7.402000E-01     2.708250E+05
   1994     5.772000E-01     2.462820E+05
   1995     6.860000E-01     1.718970E+05
   1996     7.781000E-01     1.698470E+05
   1997     6.071000E-01     1.422400E+05
   1998     4.181000E-01     1.286500E+05
   1999     5.605000E-01     1.011440E+05
   2000     5.349000E-01     1.166890E+05
   2001     9.164000E-01     1.294660E+05
   2002     1.072200E+00     1.994310E+05
   2003     1.431400E+00     2.334900E+05
   2004     1.082500E+00     1.181910E+05
   2005     4.837000E-01     7.396600E+04
   2006     6.798000E-01     8.860400E+04
   2007     4.249000E-01     7.489200E+04
   2008     1.512900E+00     8.899600E+04
   2009     7.275000E-01     1.371050E+05
   2010    -1.000000E+00     6.914200E+04
   2011     8.260000E-01     8.284600E+04
   2012     7.130000E-01     1.192220E+05
"CB+PR"
CC
   1986     2.773600E+00     5.680045E+06
   1987     4.145600E+00     2.257659E+06
   1988     7.334000E-01     2.238253E+06
   1989     1.602000E+00     5.016198E+06
   1990     1.885000E-01     8.653670E+05
   1991     1.643900E+00     3.906353E+06
   1992     1.605400E+00     2.319302E+06
   1993     4.672000E-01     2.748912E+06
   1994     3.638000E-01     1.768818E+06
   1995     3.833000E-01     8.173080E+05
   1996     2.290000E-01     1.405446E+06
   1997     5.063000E-01     1.124847E+06
   1998     2.665000E-01     1.582188E+06
   1999     2.120000E-01     1.044021E+06
   2000     6.490000E-01     1.359155E+06
   2001     1.141200E+00     3.169985E+06
```

2002	1.261700E+00	2.954501E+06
2003	9.799000E-01	3.599358E+06
2004	7.318000E-01	2.847833E+06
2005	7.803000E-01	2.203956E+06
2006	5.457000E-01	2.142690E+06
2007	8.246000E-01	1.447529E+06
2008	7.139000E-01	1.839417E+06
2009	9.018000E-01	1.900766E+06
2010	-1.000000E+00	2.284521E+06
2011	1.639900E+00	1.558192E+06
2012	7.097000E-01	1.635300E+06

Appendix F
Continuity Case ASPIC Data Input File
"bot_s33_rec_bio_high_1000_b1_k_0.2588.inp"

```
BOT  ## Run type (FIT, BOT, or IRF)
"Bot Broken Rec Bio High 1000 B1/K 0.2588"
LOGISTIC  YLD    SSE
112  ## Verbosity
1000  90  ## Number of bootstrap trials, <= 1000
0  100000  ## 0=no MC search, 1=search, 2=repeated srch; N
trials
1.0000E-08  ## Convergence crit. for simplex
3.0000E-08  6  ## Convergence crit. for restarts, N restarts
1.0000E-04  12  ## Conv. crit. for F; N steps/yr for gen. model
8.0000  ## Maximum F when cond. on yield
0.0  ## Stat weight for B1>K as residual (usually 0 or 1)
8  ## Number of fisheries (data series)
1.0000E-04  1.0000E-04  1.0000E-04  1.0000E-04  1.0000E-04
1.0000E-04  1.0000E-04  1.0000E-04    ## Statistical weights for
data series
0.2588  ## B1/K (starting guess, usually 0 to 1)
9.4203E+06  ## MSY (starting guess)
9.4203E+07  ## K (carrying capacity) (starting guess)
1.9000E-07  1.8000E-07  1.4000E-07  1.4000E-07  1.4000E-07
8.7000E-08  8.7000E-08  8.7000E-08    ## q (starting guesses --
1 per data series)
0  1  1  1  1  1  1  1  1  1  1    ## Estimate flags (0 or 1)
(B1/K,MSY,K,q1...qn)
9.4203E+05  1.8841E+08  ## Min and max constraints -- MSY
9.4203E+06  1.8841E+09  ## Min and max constraints -- K
4120359  ## Random number seed
27  ## Number of years of data in each series
"HL"
CC
   1986    -1.000000E+00     9.185380E+05
   1987    -1.000000E+00     1.279001E+06
   1988    -1.000000E+00     1.698741E+06
   1989    -1.000000E+00     1.612718E+06
   1990     6.654000E-01     1.128146E+06
   1991     7.433000E-01     1.779769E+06
   1992     5.526000E-01     1.163634E+06
   1993     7.812000E-01     1.643312E+06
   1994     8.769000E-01     1.359078E+06
   1995     8.139000E-01     1.317942E+06
```

```
   1996     1.021900E+00     1.343354E+06
   1997     9.059000E-01     1.191804E+06
   1998     8.610000E-01     7.856930E+05
   1999     8.845000E-01     8.369150E+05
   2000     9.417000E-01     9.368190E+05
   2001     8.720000E-01     7.737120E+05
   2002     1.097300E+00     8.382460E+05
   2003     1.973700E+00     1.021905E+06
   2004     1.730100E+00     1.023378E+06
   2005     1.002500E+00     8.134640E+05
   2006     1.238400E+00     6.902310E+05
   2007     7.260000E-01     5.979270E+05
   2008     9.446000E-01     6.479470E+05
   2009     7.282000E-01     6.635600E+05
   2010     1.638800E+00     6.934630E+05
   2011    -1.000000E+00     5.570750E+05
   2012    -1.000000E+00     9.004440E+05
"LL"
CC
   1986    -1.000000E+00     2.093220E+05
   1987    -1.000000E+00     2.593540E+05
   1988    -1.000000E+00     3.396860E+05
   1989    -1.000000E+00     3.119430E+05
   1990     5.748000E-01     1.274340E+05
   1991     8.185000E-01     2.749900E+04
   1992     1.270500E+00     6.572400E+04
   1993     5.674000E-01     9.522300E+04
   1994     4.073000E-01     8.346900E+04
   1995     5.972000E-01     9.357100E+04
   1996     5.425000E-01     6.871900E+04
   1997     6.230000E-01     7.028900E+04
   1998     6.183000E-01     6.368700E+04
   1999     5.706000E-01     7.318400E+04
   2000     5.995000E-01     7.953700E+04
   2001     7.296000E-01     7.393600E+04
   2002     9.682000E-01     8.603700E+04
   2003     1.111100E+00     1.365320E+05
   2004     1.281500E+00     9.096200E+04
   2005     1.757800E+00     8.224300E+04
   2006     1.310300E+00     8.906100E+04
   2007     1.104300E+00     6.889700E+04
   2008     1.516500E+00     9.771600E+04
   2009     2.034300E+00     5.626100E+04
   2010     1.996500E+00     2.585000E+04
   2011    -1.000000E+00     2.179600E+04
```

```
   2012    -1.000000E+00     4.559100E+04
"HB1"
CC
   1986     1.777800E+00     7.639490E+05
   1987     9.342000E-01     3.796650E+05
   1988     7.601000E-01     1.739640E+05
   1989     5.279000E-01     2.068380E+05
   1990    -1.000000E+00     0.000000E+00
   1991    -1.000000E+00     0.000000E+00
   1992    -1.000000E+00     0.000000E+00
   1993    -1.000000E+00     0.000000E+00
   1994    -1.000000E+00     0.000000E+00
   1995    -1.000000E+00     0.000000E+00
   1996    -1.000000E+00     0.000000E+00
   1997    -1.000000E+00     0.000000E+00
   1998    -1.000000E+00     0.000000E+00
   1999    -1.000000E+00     0.000000E+00
   2000    -1.000000E+00     0.000000E+00
   2001    -1.000000E+00     0.000000E+00
   2002    -1.000000E+00     0.000000E+00
   2003    -1.000000E+00     0.000000E+00
   2004    -1.000000E+00     0.000000E+00
   2005    -1.000000E+00     0.000000E+00
   2006    -1.000000E+00     0.000000E+00
   2007    -1.000000E+00     0.000000E+00
   2008    -1.000000E+00     0.000000E+00
   2009    -1.000000E+00     0.000000E+00
   2010    -1.000000E+00     0.000000E+00
   2011    -1.000000E+00     0.000000E+00
   2012    -1.000000E+00     0.000000E+00
"HB2"
CC
   1986    -1.000000E+00     0.000000E+00
   1987    -1.000000E+00     0.000000E+00
   1988    -1.000000E+00     0.000000E+00
   1989    -1.000000E+00     0.000000E+00
   1990     2.199000E-01     9.944100E+04
   1991     6.998000E-01     1.226120E+05
   1992     1.521600E+00     3.607280E+05
   1993     9.903000E-01     2.679520E+05
   1994     7.597000E-01     2.434070E+05
   1995     8.975000E-01     1.704070E+05
   1996     1.017900E+00     1.680010E+05
   1997     8.048000E-01     1.414520E+05
   1998     5.497000E-01     1.264210E+05
```

```
   1999     7.354000E-01     9.977500E+04
   2000     6.702000E-01     1.153440E+05
   2001     1.242400E+00     1.262930E+05
   2002     1.464700E+00     1.967080E+05
   2003     2.042300E+00     2.320690E+05
   2004     1.486800E+00     1.177710E+05
   2005     6.819000E-01     7.362000E+04
   2006     8.132000E-01     8.724800E+04
   2007     4.506000E-01     7.181000E+04
   2008     1.951200E+00     8.486000E+04
   2009    -1.000000E+00     0.000000E+00
   2010    -1.000000E+00     0.000000E+00
   2011    -1.000000E+00     0.000000E+00
   2012    -1.000000E+00     0.000000E+00
"HB3"
CC
   1986    -1.000000E+00     0.000000E+00
   1987    -1.000000E+00     0.000000E+00
   1988    -1.000000E+00     0.000000E+00
   1989    -1.000000E+00     0.000000E+00
   1990    -1.000000E+00     0.000000E+00
   1991    -1.000000E+00     0.000000E+00
   1992    -1.000000E+00     0.000000E+00
   1993    -1.000000E+00     0.000000E+00
   1994    -1.000000E+00     0.000000E+00
   1995    -1.000000E+00     0.000000E+00
   1996    -1.000000E+00     0.000000E+00
   1997    -1.000000E+00     0.000000E+00
   1998    -1.000000E+00     0.000000E+00
   1999    -1.000000E+00     0.000000E+00
   2000    -1.000000E+00     0.000000E+00
   2001    -1.000000E+00     0.000000E+00
   2002    -1.000000E+00     0.000000E+00
   2003    -1.000000E+00     0.000000E+00
   2004    -1.000000E+00     0.000000E+00
   2005    -1.000000E+00     0.000000E+00
   2006    -1.000000E+00     0.000000E+00
   2007    -1.000000E+00     0.000000E+00
   2008    -1.000000E+00     0.000000E+00
   2009     7.211000E-01     1.319450E+05
   2010    -1.000000E+00     6.873300E+04
   2011     1.211000E+00     8.232300E+04
   2012     1.067800E+00     1.187810E+05
"CB+PR1"
CC
```

```
   1986    1.151700E+00    5.680045E+06
   1987    1.719200E+00    2.257659E+06
   1988    3.004000E-01    2.238253E+06
   1989    8.287000E-01    5.016198E+06
   1990   -1.000000E+00    0.000000E+00
   1991   -1.000000E+00    0.000000E+00
   1992   -1.000000E+00    0.000000E+00
   1993   -1.000000E+00    0.000000E+00
   1994   -1.000000E+00    0.000000E+00
   1995   -1.000000E+00    0.000000E+00
   1996   -1.000000E+00    0.000000E+00
   1997   -1.000000E+00    0.000000E+00
   1998   -1.000000E+00    0.000000E+00
   1999   -1.000000E+00    0.000000E+00
   2000   -1.000000E+00    0.000000E+00
   2001   -1.000000E+00    0.000000E+00
   2002   -1.000000E+00    0.000000E+00
   2003   -1.000000E+00    0.000000E+00
   2004   -1.000000E+00    0.000000E+00
   2005   -1.000000E+00    0.000000E+00
   2006   -1.000000E+00    0.000000E+00
   2007   -1.000000E+00    0.000000E+00
   2008   -1.000000E+00    0.000000E+00
   2009   -1.000000E+00    0.000000E+00
   2010   -1.000000E+00    0.000000E+00
   2011   -1.000000E+00    0.000000E+00
   2012   -1.000000E+00    0.000000E+00
"CB+PR2"
CC
   1986   -1.000000E+00    0.000000E+00
   1987   -1.000000E+00    0.000000E+00
   1988   -1.000000E+00    0.000000E+00
   1989   -1.000000E+00    0.000000E+00
   1990    1.396000E-01    7.305620E+05
   1991    2.174400E+00    3.830591E+06
   1992    2.103900E+00    2.282394E+06
   1993    6.360000E-01    2.714716E+06
   1994    4.916000E-01    1.730653E+06
   1995    4.656000E-01    7.960370E+05
   1996    3.216000E-01    1.398903E+06
   1997    6.975000E-01    1.106016E+06
   1998    3.587000E-01    1.549855E+06
   1999    2.892000E-01    1.015269E+06
   2000    8.904000E-01    1.313908E+06
   2001    1.566100E+00    2.984206E+06
```

```
   2002     1.829400E+00     2.915301E+06
   2003     1.529500E+00     3.597252E+06
   2004     1.146500E+00     2.848727E+06
   2005     1.267600E+00     2.198202E+06
   2006     8.117000E-01     2.127444E+06
   2007     1.213300E+00     1.379093E+06
   2008     1.067300E+00     1.782666E+06
   2009    -1.000000E+00     0.000000E+00
   2010    -1.000000E+00     0.000000E+00
   2011    -1.000000E+00     0.000000E+00
   2012    -1.000000E+00     0.000000E+00
"CB+PR3"
CC
   1986    -1.000000E+00     0.000000E+00
   1987    -1.000000E+00     0.000000E+00
   1988    -1.000000E+00     0.000000E+00
   1989    -1.000000E+00     0.000000E+00
   1990    -1.000000E+00     0.000000E+00
   1991    -1.000000E+00     0.000000E+00
   1992    -1.000000E+00     0.000000E+00
   1993    -1.000000E+00     0.000000E+00
   1994    -1.000000E+00     0.000000E+00
   1995    -1.000000E+00     0.000000E+00
   1996    -1.000000E+00     0.000000E+00
   1997    -1.000000E+00     0.000000E+00
   1998    -1.000000E+00     0.000000E+00
   1999    -1.000000E+00     0.000000E+00
   2000    -1.000000E+00     0.000000E+00
   2001    -1.000000E+00     0.000000E+00
   2002    -1.000000E+00     0.000000E+00
   2003    -1.000000E+00     0.000000E+00
   2004    -1.000000E+00     0.000000E+00
   2005    -1.000000E+00     0.000000E+00
   2006    -1.000000E+00     0.000000E+00
   2007    -1.000000E+00     0.000000E+00
   2008    -1.000000E+00     0.000000E+00
   2009     7.745000E-01     1.849522E+06
   2010    -1.000000E+00     2.260870E+06
   2011     1.537100E+00     1.542804E+06
   2012     6.883000E-01     1.632978E+06
```

Appendix G
Low Case ASPIC Data Input File
“bot_s33_rec_bio_low_1000_b1_k_0.2588.inp”

```
BOT  ## Run type (FIT, BOT, or IRF)
"Bot Broken Rec Bio Low B1/K 2.588"
LOGISTIC  YLD    SSE
112  ## Verbosity
1000  90  ## Number of bootstrap trials, <= 1000
0  100000  ## 0=no MC search, 1=search, 2=repeated srch; N
trials
1.0000E-08  ## Convergence crit. for simplex
3.0000E-08  6  ## Convergence crit. for restarts, N restarts
1.0000E-04  12  ## Conv. crit. for F; N steps/yr for gen. model
8.0000  ## Maximum F when cond. on yield
0.0  ## Stat weight for B1>K as residual (usually 0 or 1)
8  ## Number of fisheries (data series)
1.0000E-04  1.0000E-04  1.0000E-04  1.0000E-04  1.0000E-04
1.0000E-04  1.0000E-04  1.0000E-04    ## Statistical weights for
data series
0.2588  ## B1/K (starting guess, usually 0 to 1)
8.48385E+06  ## MSY (starting guess)
8.48385E+07  ## K (carrying capacity) (starting guess)
1.9000E-07  1.8000E-07  1.4000E-07  1.4000E-07  1.4000E-07
8.7000E-08  8.7000E-08  8.7000E-08    ## q (starting guesses --
1 per data series)
0  1  1  1  1  1  1  1  1  1  1    ## Estimate flags (0 or 1)
(B1/K,MSY,K,q1...qn)
8.48385E+05  1.69677E+08  ## Min and max constraints -- MSY
8.48385E+06  1.69677E+09  ## Min and max constraints -- K
4120359  ## Random number seed
27  ## Number of years of data in each series
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```

SEDAR

Southeast Data, Assessment, and Review

SEDAR 33
Gulf of Mexico Greater Amberjack

SECTION IV: Research Recommendations
March 2014

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

Section IV: Research Recommendations

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Data Workshop Research Recommendations:
Gulf of Mexico Greater Amberjack

Life History

Natural Mortality

- Expand sampling in the commercial fishery to try and obtain larger/older individuals since most ages to date are from the recreational fishery.
- Use fishery-independent surveys to sample YOY greater amberjack over the entire first year of life.

Age

- Continue annual ageing workshops and reference collection exchanges among laboratories to standardize methods. As a group, decide how to deal with fish that form an opaque zone late in the year (i.e., to count last opaque zone or not).
- Due to the difficulty in distinguishing the first annulus from the core region, measurements should be taken on a subset of young-of-the-year to age one greater amberjack otoliths to use as a reference.
- Since there is large variation in length-at-age and Murie and Parkyn (2008) found a significant relationship between otolith weight and body weight, examine the relationship between otolith weight and age.
- Cross-reference trip tickets and log book data to Biological Sampling Database to complete spatial records (depth, grid, etc.) to allow for increased analysis of spatial demographics.
- Expand sampling of commercial and recreational spear landing and long-line landings, as these are under-represented in the dataset.
- Expand sampling in the Western Gulf of Mexico, in particular off Texas, as this region is under-represented in the dataset.
- A general recommendation of the LHW is to expand design-based fishery-independent sampling to elucidate regional (i.e., eastern and western GOM) and sub-regional differences in the demographics of greater amberjack.

Reproduction

- There is a lack of information on spawning frequency and fecundity with size and age for greater amberjack in the Gulf of Mexico. Given the observed differences in sexual maturity, peak spawning season, and potential growth differences between the South Atlantic and Gulf of Mexico stocks of greater amberjack, it should be a research priority to obtain information on spawning frequency and fecundity with size and age for Gulf of Mexico greater amberjack.
- Given that sex ratios are skewed to females for fish > 1 m fork length (Smith et al. 2013 SEDAR33-DW27), if release mortality is low (Murie and Parkyn 2013b SEDAR33-DW29), then a slot size limit could be explored as a means of rebuilding female SSB.

Movement and Migration

- More tagging information is necessary to understand seasonal movements of greater amberjack in the Gulf of Mexico (see Stock ID section). Satellite tags may provide better habitat and seasonal information compared to conventional dart tags that cannot provide serial location information on the fish throughout the year.

Commercial Fishery Statistics

Landings

-Improved dockside sampling for catch composition

-Improved dealer reporting to species

Discards

-Increased observer coverage.

-More representative observer coverage.

-Most appropriate method for incorporation of IFQ data into discard estimations

Recreational Fishery Statistics

1) Evaluate the technique used to apply sample weights to landings.
2) Develop methods to identify angler preference and targeted effort.
3) Continue and expand fishery dependent at sea observer surveys to collect discard information. This would help to validate self-reported headboat discard rates.
4) Track Texas commercial and recreational discards.
6) Evaluate existing and new methods to estimate historical landings

Measures of Population Abundance

- Expand the use of molecular genetics to identify the amberjack larvae in SEAMAP samples that cannot be positively identified as greater amberjack because diagnostic morphological characters are not yet developed.

- The IWG made note that the delta-lognormal index may not be the most appropriate distribution with some of the data presented. However, the lack of adequate diagnostics for different distributions prelude their use. The recommendation is that addition work be done with these other distribution (i.e. Poisson, negative binomial) in order to fully vet the methodology.

- A calibration study is needed between the FWRI/NMFS video survey.

- An exploration of the effects of the IFQ on the fishery dependent indices, specially the commercial handline and longline is needed. During the workshop, fisherman indicated that since the implementation of the IFQ, there has been a drastic change in fisheries behavior. There is also the possibility that dealers can directly influence this behavior. The need is to find a way to incorporate these years into the overall timer series or a recommendation to split the time series when the IFQ began.

Discard Mortality Rate

Future studies reporting discard mortality estimates should provide data tables that report the number of fish by discard condition (e.g. dead or alive), the number of fish by depth and by length bin, complete descriptions of gear (reel and hook type), and whether fish were properly vented. In addition, analyses of long-term mortality estimates from tag-recapture studies should account for effects of variable fishing effort over spatial and temporal scales.

Assessment Workshop Research Recommendations:
Gulf of Mexico Greater Amberjack

1. Review fishery dependent length and age sampling intensity protocols for Greater Amberjack. This is needed to optimize sampling coverage across the entire geographical area of catch.

2. Review fishery independent video surveys sampling design to determine if there are practical changes which could be implemented that would increase reliability in the indices. In particular, the Panama City trap video survey should be enhanced as this survey provides information on small Greater Amberjack. Improvements in the index could potentially yield more reliable estimates of size composition of recruits.

3. Develop fishery independent sampling programs for size/age composition. This research is needed to improve more reliable and accurate estimation of selectivity unaffected by fishery dependent data collections, the latter which are affected by management regulations

4. Evaluate method used to develop historical recreational effort.

5. Develop program/procedures to allow increased sampling of discarded fish for all fleets and initiate a program to collect size composition of discards from the private angler fleets. A program similar to the North Carolina Division of Marine Resources (i.e., the “Board Survey”) used to obtain size compositor of discarded recreational fish) could be evaluated to obtain self-reported size composition form private anglers and other recreational components also.

Review Workshop Research Recommendations:
Gulf of Mexico Greater Amberjack

Below, the RW Panel highlights research recommendations they feel should be emphasized, and provides new recommendations partly based on assessment methodology and results.

A. Panel recommendations for other research needs and new suggestions partly based on assessment methodology and results:

1. Need more assessment analyses to determine whether it is best to use either female or sexes-combined biomass estimates

2. Improving discard mortality estimates should be considered

3. Species identification has the potential to be problematic. More studies using genetic approaches may be beneficial

B. Panel recommendations to improve the SEDAR Process:

1. Due to the inherent complexity of highly parameterized statistical catch at age models (i.e. stock synthesis) and the relative scarcity of expert users, the review panel recommends that each SEDAR assessment workshop panel include at least one nationally recognized expert in the model used. This expert could participate in person or by electronic means and would greatly facilitate the review process.

There is concern over a variety of issues that emerge as a result of the Assessment Workshop largely or even exclusively performed via webinars. The Review Panel emphasizes the importance of face-to-face meetings for improving the model development during the assessment phase. The panel feels that many of the issues uncovered during the review process could have been avoided and may have enabled the assessment team to provide a more polished product for review and in the end resulting in the best model possible.

SEDAR

Southeast Data, Assessment, and Review

SEDAR 33

Section V: Review Workshop Report

Gulf of Mexico Greater Amberjack

March 2014

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1. Review Workshop Proceedings

1.1 Introduction

1.1.1 Method of Review

The SEDAR 33 stock assessment Review Workshop for Gulf of Mexico Greater Amberjack (*Seriola dumerili*) was conducted as an in-person review workshop at the Doubletree Grand Hotel in Miami Florida from February 24-27, 2014.

1.1.2 Terms of Reference

1. Evaluate the data used in the assessment, addressing the following:
   - Are data decisions made by the Data and Assessment Workshops sound and robust?
   - Are data uncertainties acknowledged, reported and within normal or expected levels?
   - Are data applied properly within the assessment model?
   - Are input data series reliable and sufficient to support the assessment approach and findings?
2. Evaluate the methods used to assess the stock, accounting for only the available data:
   - Are the methods scientifically sound, robust, and appropriate for the available data?
   - Are assessment models properly configured and used consistent with standard practices?
3. Evaluate the assessment findings with respect to the following:
   - Are abundance, exploitation, and biomass estimates reliable, consistent with input data and population biological characteristics, and useful to support inferences on stock status?
   - Is the stock overfished? What information helps you reach this conclusion?
   - Is the stock undergoing overfishing? What information helps you reach this conclusion?
   - Is there an informative stock recruitment relationship? Is the stock recruitment curve reliable and useful for evaluation of productivity and future stock conditions?
   - Are quantitative estimates of status determination criteria for this stock reliable? If not, are there other indicators that may be used to inform managers about stock trends and conditions?
4. Evaluate the stock projections, addressing the following:
   - Are the methods consistent with accepted practices and available data?
   - Are the methods appropriate for the assessment model and outputs?
   - Are results informative and robust, and useful to support inferences of probable future conditions?

- Are key uncertainties acknowledged, discussed, and reflected in the projection results?

5. Consider how uncertainties in the assessment, and their potential consequences, are addressed.
    - Comment on the degree to which methods used to evaluate uncertainty reflect and capture the significant sources of uncertainty in the population, data sources, and assessment methods
    - Ensure that the implications of uncertainty in technical conclusions are clearly stated.
6. Consider the research recommendations provided by the Data and Assessment workshops and make any additional recommendations or prioritizations warranted.
    - Clearly denote research and monitoring that could improve the reliability of, and information provided by, future assessments with particular emphasis on the Deepwater Horizon Oil Spill
    - Provide recommendations on possible ways to improve the SEDAR process
7. Provide guidance on key improvements in data or modeling approaches which should be considered when scheduling the next assessment.
8. Prepare a Peer Review Summary Report summarizing the Panel's evaluation of the stock assessment and addressing each Term of Reference. Develop a list of tasks to be completed following the workshop. Complete and submit the Peer Review Summary Report in accordance with the project guidelines.

1.1.3 Participants

Analytical Team		
Nancie Cummings	Lead Analyst- GAJ	SEFSC
Meaghan Bryan	Analyst- GAJ	SEFSC
Jake Tetzlaff	Lead Analyst- Gag	SEFSC
Meaghan Bryan	Analyst- Gag	SEFSC
Shannon Cass-Calay	Analyst	SEFSC
Jeff Isely	Analyst	SEFSC
Review Panel		
Sean Powers	Chair	Gulf SSC
Ben Blount	Panelist	Gulf SSC
Greg Stunz	Panelist	Gulf SSC
Neil Klaer	Panelist	CIE
Mike Armstrong	Panelist	CIE
Anders Nielsen	Panelist	CIE

Observers

Skyler Sagarese	SEFSC	Jessica Stephen	SEFSC
John Froeschke	GMFMC	Katyana Vert	UF

Justin Grubiche	PEG	Mike Murphy	FWC-FWRI

Staff

Ryan Rindone	SEDAR Coordinator	SEDAR
Charlotte Schiaffo	Administrative Support	GMFMC

1.1.4 Review Workshop Working Documents

Review Workshop Documents			
SEDAR33-RW01	Gag	Linking an environmental index to natural mortality within the stock synthesis integrated assessment model framework: A case study for Gulf of Mexico gag grouper (*Mycteroperca microlepis*) and red tide	Sagarese, Tetzlaff, Bryan, Walter, and Schirripa

2. Review Workshop Panel Report

2.1 Executive Summary

Overall the Panel was impressed with the quality of work done by the assessment team and commends the analyst team. Two models were presented to the review panel, the ASPIC model and a newly developed SS model. The Panel agreed that the ASPIC model provides continuity with previous assessments, but is no longer the preferred method for determination of stock status and management advice for Greater Amberjack. ASPIC is a surplus production model, and as such, it cannot deal with selectivity or use composition data. In the panel's opinion, the SS model is the preferred framework to advance the stock assessment; however, the panel had several concerns with the current SS model configuration and performance. The review panel's main concern is the jitter analysis, which is used to verify model convergence by starting all the model parameters in numerous different initial values and then examining the end results in terms of the of objective function, model parameters, and important output metrics is unchanged. After 50 runs large changes were evident in several key outputs when the starting point was changed (e.g., the F[2012]/F[SPR_{Target}] showed that it varied about 10% when nothing except the starting point was changed). Another place where the convergence problem is evident is in the profile likelihood with respect to the steepness parameter, where sudden inexplicable high values occur in several places on otherwise convex curves. For Gulf of Mexico Greater Amberjack it is the view of the Panel that the optimal configuration of Stock Synthesis has not yet been found. Addressing the issues identified by the Review Workshop is needed before the assessment model could be accepted as properly configured and consistent with standard practices. The panel offered several suggestions to further develop the model. At the end of the workshop, the panel did not recommend a specific base model. Hence, the panel made no assessment of overfishing or overfished status.

2.2 Terms of Reference Addressed

1. Evaluate the data used in the assessment.

A. Are data decisions made by the Data and Assessment Workshops sound and robust?

The Review Panel concludes that the data decisions made at the SEDAR 33 Data Workshop and Assessment Workshop are mostly sound and robust. Data decisions from previous assessments were given careful and thorough consideration and were accepted, modified, or rejected on the basis of more recent data and analysis. The decisions made were mostly appropriate given the information available. The Panel however disagrees with the Assessment Workshop decision to treat recreational catches as exact (as they are estimated from surveys with known precision), or to use numbers of fish measured or aged, capped at 200, as input effective sample sizes to weight the fishery size and age composition data rather than more appropriate proxies for effective sample size such as numbers of fishing trips sampled. These approaches degrade the ability of the model to appropriately weight data according to their precision. Additional assessment model runs were requested at the Review Meeting to examine sensitivity to including CVs for the recreational survey estimates of catches and to using trips sampled as input effective sample sizes. However, it was not possible in the time available to determine true or proxy effective sample sizes for length and age data, such as numbers of trips sampled. Suitable estimates or proxies should be developed for future assessments, and appropriate CVs for recreational catches identified.

B. Are data uncertainties acknowledged, reported and within normal or expected levels?

The Panel considers that data uncertainties have been explored and reported, although would have found it more helpful to see a clearer summary of the relative quality of the different data sets. Where they could be quantified, uncertainties appeared to be within normal or expected levels given the design of data collection schemes and the amount of sampling that has taken place. Fishery data limitations were due, in part, to greater amberjack not being a major directed fishery and therefore present in a relatively small fraction of trips. The workshop reports indicate clearly where sample sizes are small or where data are absent. Procedures for imputing missing data for years, fleets or areas are well described, although potential biases caused by the imputations are not clearly indicated. Discussions about uncertainty were mostly detailed and thorough, and data updates and additions were made when needed and appropriate. Those considerations included, among others, uncertainties related to estimation of life history parameters, fishery landings, discards, length and age composition, converting estimates of commercial and recreational discards from numbers to weights, re-standardization of the abundance indices for all fleets, and conversion of ASPIC abundance indices from numbers to weight. Recreational fisheries take a large fraction of the catches, and the catch estimates are based on statistically-sound sampling designs that have been improved in the recent MRIP surveys to reduce bias and allow more accurate estimates of precision. In general, a clearer framework for documenting known or potential data quality issues (bias and precision) in relation to design, implementation, achievement and analysis of data over different periods would be very helpful for assessment analysts and reviewers.

C. Are data applied properly within the assessment model?

Overall, the Review Panel is in agreement that the Assessment Workshop applied data properly within the assessment model. Deficiencies and uncertainty in the data were explored. Consideration was given to appropriate fitting of data to SS3 and, for comparison, to ASPIC Version 5.34. ASPIC was used to fit non-equilibrium production models conditioned on yield to the Gulf of Mexico greater amberjack data, and it was presented for continuity with the prior 2010 stock assessment update for greater amberjack. Some of the fishery dependent indices developed during SEDAR 33 and recommended in the SEDAR 33 DW differ in trend from the indices from previous evaluations of the Greater Amberjack stock (i.e. MRFSS and the COM HL). Because ASPIC model results can be sensitive to changes in the indices, the methods used to develop the SEDAR 33 indices for Greater Amberjack were explored in depth during various SEDAR 33 assessment workshop webinars. The indices were recomputed in terms of weight to accommodate the production model, which is cast in terms of biomass. When changes in size occur, an increase or decline in the catch rates in numbers does not necessarily imply a corresponding change in the catch rates in biomass. Previous SEDAR 9 and SEDAR 9 Update assessments for Greater Amberjack used indices developed in numbers per unit effort to reference abundance, which in the context of a biomass production model implies that average size/weight of individuals did not vary over time, even with the imposition of size limits. The SEDAR 33 assessment panelists reviewed and rejected that assumption.

D) Are input data series reliable and sufficient to support the assessment approach and findings?

The Review Panel considers that the input data series are not, at present, of sufficient quality to support a stable and reliable implementation of the proposed Stock Synthesis model at the level of complexity and parameterization configured by the SEDAR 33 Assessment Workshop. However, further development should be carried out after the review meeting to identify a simpler Stock Synthesis model formulation appropriate to the information content of the available data.

That conclusion is contingent on the changes that were made in the Data and the Assessment workshops, and on the Panel's review of model performance in a range of Stock Synthesis sensitivity runs. The Data and Assessment teams are commended for their work in compiling and evaluating the wide range of data and parameters used in the assessment, but the nature of Greater Amberjack and its fisheries means that data quality is patchy and in places insufficient to support the estimation of the many selectivity and other parameters in the SS model as presented. Further development is needed to identify a simpler model formulation appropriate to the information content of the available data. At the same time, well-targeted improvements in data are needed to facilitate development of models that can adequately account for the large changes in discard practices following changes in size limits. The current data series are also problematic for input to the continuity ASPIC model, which cannot account for changes in size structure of catches or fishery-dependent indices of abundance following changes in fishery selectivity or retention.

2. Evaluate the methods used to assess the stock, accounting for only the available data.

The main method applied for both stocks is Stock Synthesis 3 (Methot 2013). Stock Synthesis (SS) is not a single model, but a modelling framework for full parametric stock assessments, and many configurations have also been simulation-tested. It is well tested, as it has been applied to numerous thoroughly reviewed assessments. It can be configured to match almost any situation in terms of stock dynamics and observational likelihoods. In terms of data sources it can be configured to use many different data sources from highly processed indices of abundances to fairly raw length and age data. An additional advantage of using such a widely used framework (in combination with graphics from the R-package r4ss) is that reviewers are familiar with it and the associated standard diagnostics. Stock Synthesis is a sound and robust choice, which can be configured to be appropriate for the available data.

For Gulf of Mexico Greater Amberjack it is the view of the Panel that the optimal configuration for Stock Synthesis has not yet been found. It is the reviewers collected opinion however, that addressing the issues identified below is needed before the assessment model could be accepted as properly configured and consistent with standard practices.

In addition to the Stock Synthesis, the model ASPIC (A Stock-Production model Incorporating Covariates) was configured for greater amberjack. ASPIC is part of the NOAA Fisheries toolbox, and the model is scientifically sound and robust. It is however not an obvious choice given the data available for amberjack. ASPIC is a surplus production model, and as such, it cannot deal with selectivity or use composition data.

The ASPIC model is supplied by the assessment team mainly as a continuity run, as it was the method used in the previous SEDAR 9 benchmark and update assessment. The current implementation gives a different result (more optimistic) than the previous update assessment. According to the assessment team, this is mainly due to changing the recreational fishery abundance indices from numbers to weights.

For the SS analysis the Review Panel's main concern is the so-called jitter analysis. In a jitter analysis it is the intention to verify model convergence by starting all the model parameters at numerous different initial values (within some range) and then see that the end result in terms of the of objective function, estimated model parameters, and important output metrics is unchanged. For Amberjack 100 runs were presented where the starting points had been randomly shifted by 10%. The result of this was not as expected. All 100 runs were reported as converged by the model. Of the 100 runs only one (run 33) gave a very different total likelihood (AW Fig. 3.2.2.1b), but the scale of the figure made it difficult to judge if other runs were all the same, or noticeable different. Even if the total likelihood is the same the following is problematic. For the individual likelihood contributions of catch (AW Fig. 3.2.2.1c), survey (AW Fig. 3.2.2.1d) and the length and age compositions (AW Fig. 3.2.2.1e,f) it was clear that the model did not converge to one unique solution. Looking further at the important output metrics over the 100 runs (AW Fig. 3.2.2.1g) revealed that they too were changing when the starting point was changed. For example, the important ratio $F[2012]/F[SPR_{Target}]$ varied about 10% when nothing except the starting point was changed (also 10%).

Another place where the convergence problem is evident is in the profile likelihood with respect to the steepness parameter (AW Fig. 3.2.4.1), where sudden inexplicable high values occur in several places on otherwise convex curves.

It is important to note that the reviewers are not particularly worried about occasional lack of convergence, which could be solved in each individual case by choosing different starting points until convergence. The problem here is that the presented model reports convergence, but the point of convergence is highly dependent on the arbitrary starting values.

The SS model, in its current configuration, is not finding a unique minimum, which normally occurs if the model is non-identifiable (i.e. over-parameterized), which means that a change in some model parameters can compensate for a change in other model parameters. To solve such an issue it is often necessary to fix some parameters, or assign priors to them. When looking for which model parameters to restrict it can be useful to look at correlations between model parameters, and to see if standard deviations from a parametric bootstrap are similar to those derived from the inverse Hessian approximation. If they are very different it could be an indication of over-parameterization. Some of these methods were tried during the review, and some results were improved. Some selectivity parameters were identified as problematic. The review panel and the assessment team are optimistic that the issue can be resolved.

Another issue raised was the small sample sizes in the composition data. The reviewers were concerned that the composition data were given too much influence (as the sample sizes don't reflect independent samples) and recommended further down weighting.

The results for the important output metrics are not consistent between Stock Synthesis and ASPIC. This is not in itself surprising as Stock Synthesis uses more data (on age and length compositions) and is able to account for the different selectivities of the abundance indices and fisheries, but in this case the review panel cannot simply recommend the more advanced and detailed method using the most data. It is however the review panel impression, that relative minor adjustments to the Stock Synthesis configuration would make it identifiable and suitable as basis for management of Greater Amberjack.

3. Evaluate the assessment findings with respect to the following:

A. Are abundance, exploitation, and biomass estimates reliable, consistent with input data and population biological characteristics, and useful to support inferences on stock status?

Amberjack ASPIC

Abundance indices. An important feature of the index data available for amberjack is that the selectivity is widely different among those indices. For example, the size range of catches associated with the MRFSS index suggests a broad selection pattern, while the narrow and small range of catches associated with the headboat survey suggests a dome shaped pattern. A biomass dynamic model such as ASPIC is unable to allow selectivity differences across indices, with all applying equally to the total biomass. Experience with an age structured model for Greater

Amberjack shows that the different trends shown by the indices can be more appropriately followed by expected values determined via appropriate size selection.

The assessment WG concluded that factors that significantly change the size selectivity of an index (e.g. the implementation of a new retention size limit) affects the index catchability and therefore necessitate that the index be broken at that point. A long index showing potentially useful trend information such as MRFSS is therefore reduced to smaller segments that no longer show any significant trend. As management change is a common feature for the amberjack indices, an assessment that can deal with those changes in more appropriate manner is preferred. As a model that can deal with the issues outlined is available (SS), the Panel agreed that the ASPIC model provides continuity with previous assessments, but is no longer the preferred method for determination of stock status and management advice for amberjack.

Amberjack SS

Both of the commercial fishery-dependent indices apply to older fish in the population – handline mainly ages 4-10 and longline ages 10 and older. The fit of the longline index was best overall, influenced by the relatively low CV for that index. The handline index was also reasonably well fitted by the model, although not as closely as for longline as allowed by the greater CV.

Given the broad selectivity of the MRFSS index and the dome shape of the headboat index, the expected annual exploitable biomass patterns for those varied considerably – particularly from 1985-1990. These indices with such broadly different annual patterns were reasonably well fitted by the model, although both indices showed observations at similarly high levels in 1986 and 1987.

Of the fishery-independent indices, both PC Video and SEAMAP Video both had observations that were variable but mostly flat, with expected fits also showing no strong trends.

Index weighting within the model was according to the CV determined by the standardization. The weighting for the commercial handline and longline was similar to that which would have resulted from an iterative reweighting procedure. All other indices had expected values well outside the range suggested by the CV, showing that those indices were more heavily weighted than iterative reweighting would have produced. It is not optimal to use error estimates from a standardization as the weighting for an index within a population model. Recent papers (e.g. Francis, 2011) give improved objective procedures for determining such weighting for abundance, and also composition data that should be investigated.

B. Is the stock overfished? What information helps you reach this conclusion?

Because a base model configuration was not identified during the Review workshop, the Panel was unable to make this determination. Continuity runs for ASPIC found the stock to be at or slightly above the overfished status. The current ASPIC assessment shows substantial improvement of stock condition from the 2009 Update - although this improvement was likely caused by changes to the calculation of the indices. SS model runs were highly variable in their evaluation of the stock condition although most runs indicated an overfished stock.

C. Is the stock undergoing overfishing? What information helps you reach this conclusion?

Because a base model configuration was not identified during the Review workshop, the Panel was unable to make this determination. While showing highly variable results with regard to the question of overfished, ASPIC and most SS runs presented to the panel did not indicate current overfishing.

D. Is there an informative stock recruitment relationship? Is the stock recruitment curve reliable and useful for evaluation of productivity and future stock conditions?

Because a base model configuration was not identified during the Review workshop, the Panel was unable to make this determination. However, as the stock has likely undergone a single long depletion followed perhaps by a recent increase, with virgin biomass poorly estimated, the shape of the stock-recruitment relationship is poorly characterized. In such a situation it is best to investigate the effect of a plausible range of steepness values, perhaps informed by similar species or a meta-analysis.

E. Are quantitative estimates of status determination criteria for this stock reliable? If not, are there other indicators that may be used to inform managers about stock trends and conditions?

Because a base model configuration was not identified during the Review workshop, the Panel was unable to make this determination.

The Review Panel made recommendations for improving the base case model in SS, and it was discussed at the RW that this could potentially be done in time for the forthcoming fishery management meetings. Indicators to improve are the jitter convergence and the likelihood profiles – these should better indicate that the model converges to stable solutions – e.g. the likelihood profile for steepness should be smooth. Some ways to do this are:

- Investigate correlations among model parameters (particularly for selectivity and retention), and either fix or provide informative priors for one at values that have some supportable evidence. If supportable evidence is unavailable and the parameter has a strong influence on the results, then a range of alternative fixed values should be investigated.
- For individual jitter starting points that resulted in different likelihood solutions, investigate which parameter estimates were affected that may also be fixed or provided with informative priors.
- Examine the CVs of parameter estimates. If the CV is large and the value has little influence on results, then choose a fixed value.
- Examine the time blocking of retention and selectivity for the fleets that converge at very high F values – consider very high to be values greater than 1.0, but preferably less than that. Consider adjusting the configuration of selectivity and retention of those fleets around the period of high F to see if the problem can be alleviated.

4. Evaluate the stock projections, addressing the following:

A. Are the methods consistent with accepted practices and available data?

Projection methodology is consistent with accepted practices. Because a base model configuration was not identified during the Review workshop, the Panel was unable to evaluate the projections.

B. Are the methods appropriate for the assessment model and outputs?

Projection methodology is consistent with accepted practices. Because a base model configuration was not identified during the Review workshop, the Panel was unable to evaluate the projections.

C. Are results informative and robust, and useful to support inferences of probable future conditions?

Because a base model configuration was not identified during the Review workshop, the Panel was unable to evaluate the projections.

D. Are key uncertainties acknowledged, discussed, and reflected in the projection results?

Because a base model configuration was not identified during the Review workshop, the Panel was unable to evaluate the projections

5. Consider how uncertainties in the assessment, and their potential consequences, are addressed.

Uncertainties generally play an important role in assessment models. If a likelihood approach is applied, which it is for both Gag and greater amberjack stocks, the uncertainties determine the relative weighting of the different information sources entering the assessment. Furthermore it is important to correctly quantify the uncertainties on important output metrics to evaluate the risks of future fishing scenarios.

The Greater Amberjack assessment supplies standard deviations derived from the inverse Hessian matrix of the objective function at its minimum. This is a standard output from most model fitting software, but it requires two things for these numbers to represent the uncertainty of our estimates: 1) The objective function should be well approximated by a quadratic function and 2) The model should correctly describe the observations including their observation uncertainties. Item (1) is less of a concern, as standard approaches are available to circumvent this issue. For the assessment a parametric bootstrap is provided. An alternative could be to use an MCMC approach. The review panel debated the difference, so a brief summary of the difference is described here. Parametric bootstrap simulates multiple independent data sets according to the assumptions in the model and the parameters estimated from the real observations. Estimation is then carried out for each data set. Parametric bootstrap is useful to obtain a simulation-based, but otherwise exact, error propagation. It is also useful for revealing biases in the estimation procedure, as estimates can be compared to the assumed truth used when simulating the datasets. An MCMC approach simulates a Markov chain, such that its equilibrium distribution is the Bayesian posterior distribution of the model parameters (assuming flat priors where no prior is specified). The MCMC approaches are useful for error propagation, but not for identifying biases, as no truth is assumed with which the estimates can be compared.

For the ASPIC model for Gulf of Mexico Greater Amberjack a major part of the uncertainty originates from the inability of the model to interpret trends in landings and indices caused by changes in fishery retention and discarding. In recent years discards are a large proportion (75%) of the total recreational catch (AW Fig 2.3.2.1). The size of the discarded fish is based on the landings, but the size distribution of landed fish has changed due to regulations (AW Fig. 2.3.2.2). This raises uncertainty as to how this changed the size distribution of the discarded fish. Three methods were considered (details in AW section 2.3.2): "update", "low" (discard weights calculated from only the fish landed below the size limit before it was changed), and "high" (discard weights calculated from all sizes of fish landed before the size limit changed). Results are reported for all three scenarios.

For the ASPIC model the reported uncertainties within each scenario are based on 1000 bootstrap runs. This is a reasonable way to ensure that the uncertainties are correctly propagated in a non-linear model. These uncertainties are clearly stated w.r.t. important output metrics in AW Figure 3.4.3.1 and Table 3.3.5.1.

In addition, sensitivities to the B1/K input ratio, discard mortality, and index weighting were conducted for the ASPIC results. These showed expected differences, but also that most conclusions about important output metrics were relatively stable (AW Fig. 3.4.6.1.2 and 3.4.6.2.1). The important output metrics from the ASPIC model are however sensitive to the new data compilation in SEDAR 33 compared to the SEDAR 9 update (AW Section 2.6.1). When 2009 is considered to be the final year and the new indices are used, the current B/B_{MSY} doubles, and F/F_{MSY} halves (AW Fig. 3.4.7.1 and Tab. 3.4.7.1).

For the Stock Synthesis model the uncertainty about all model parameters is summarized by the estimated (Hessian based) standard deviations (AW Table 3.1.4.1). These standard deviations are however not likely to be reliable because the model with the present configuration is not identifiable (see description of this issue under TOR2). The quadratic approximation used when calculating these standard deviations is not appropriate if the objective function does not have a unique minimum.

Standard deviations based on 1500 parametric bootstrap runs are also given (AW Tab. 3.2.2.1), and these have the advantage that they include all aspects of the implemented model when propagating uncertainties from observations to estimates of model parameters. This means that even if this model is not strictly identifiable (as some model parameters can compensate for others) this will, to some extent, be captured in bootstrapped uncertainties. Hence, if the currently configured model were to be used as the basis for advice (which is not recommended) then it would be very important to use bootstrapped uncertainties and not the hessian-based ones.

In addition to the main concern, which is that the model appears to be non-identifiable, a number of minor concerns were identified. For Amberjack it was chosen to fix uncertain parameters for different data sources, to cap sample sizes, and to assign data weighting constants. These choices will directly influence estimated uncertainties on derived model parameters, and therefore all uncertainty estimates are conditioned on those choices.

The residual plots and plots of fitted lines and observations (AW Fig. 3.2.1.3-3.2.1.6) indicate that some fits are close (compared to the data standard deviations) to the observations and others are far off. Many of the composition residuals systematically show positive residuals near the center of the distribution. Seeing residuals, which are less than perfect is however not uncommon in assessment models combining many different data sources.

Many sensitivity analyses were performed, some in the report, others requested by the review. The model was shown to be robust in the recent period, but more sensitive in the first period.

A final issue related to uncertainty was the steepness parameter. The configuration in the AW report estimated the steepness, and the profile likelihood (vaguely) suggested that estimation was possible (AW Fig. 3.2.4.1). Model improvements made during the review meeting however changed this, and the conclusion of the reviewers was that estimating steepness is very uncertain, and that fixed values should be chosen. If fixed values for steepness are used, it may be possible to estimate other highly influential parameters such as natural mortality.

6. Consider the research recommendations provided by the Data and Assessment workshops and make any additional recommendations or prioritizations warranted.

Following the Terms of Reference, the Review Workshop Panelists considered the research recommendations provided by both the Data and Assessment workshops and provided additional recommendations. These research and monitoring recommendation were also made while considering improving the information and reliability of future assessments with particular emphasis on the Deepwater Horizon Oil Spill. Finally, this report provides recommendations on possible ways to improve the SEDAR process.

A. Panel recommendations for other research needs and new suggestions partly based on assessment methodology and results:

1. Need more assessment analyses to determine whether it is best to use either female or sexes-combined biomass estimates

2. Improving discard mortality estimates should be considered

3. Species identification has the potential to be problematic. More studies using genetic approaches may be beneficial

B. Panel recommendations to improve the SEDAR Process:

1. Due to the inherent complexity of highly parameterized statistical catch at age models (i.e. stock synthesis) and the relative scarcity of expert users, the review panel

recommends that each SEDAR assessment workshop panel include at least one nationally recognized expert in the model used. This expert could participate in person or by electronic means and would greatly facilitate the review process.

2. There is concern over a variety of issues that emerge as a result of the Assessment Workshop largely or even exclusively performed via webinars. The Review Panel emphasizes the importance of face-to-face meetings for improving the model development during the assessment phase. The panel feels that many of the issues uncovered during the review process could have been avoided and may have enabled the assessment team to provide a more polished product for review and in the end resulting in the best model possible.

7. Provide guidance on key improvements in data or modelling approaches which should be considered when scheduling the next assessment.

The Panel considers that for greater amberjack, the Stock Synthesis modelling framework still remains appropriate for the type of data available, and allows flexibility to account for changes in size limits that affect patterns of discarding in commercial and recreational fisheries. If it is agreed to continue with this approach, more work is needed to: i) more clearly express the relative quality of the different data inputs in relation to weighting, ii) to identify the minimum sufficient complexity of the model to provide robust advice on stock status, including identifying correlated parameters and applying fixed values, iii) to set appropriate priors to constrain model fits within bounds, and iv) to target work on improving the quality of the key data sets.

Improving the quality of length and age compositions for retained and discarded fish would help in fitting year class strength, selectivity and retention. However the Panel recognises that this is a challenge for greater amberjack due to the nature of the fisheries, and it is important to understand how improvements in precision of composition data translate into improvements in the quality of assessment outputs and advice, and the costs of sampling schemes that achieve this amount of sampling. Simulation modelling could be helpful in this regard.

Currently, the most influential relative abundance indices are from recreational and commercial fisheries, i.e. the same data sets used for estimating catch compositions and recreational catches, but filtered using information on species guilds in catches to try and identify trips where amberjack have a probability of being caught. The Panel considers that further work may be needed to identify potential biases in these approaches, for example where amberjack were initially targeted in a recreational trip but zero or low catch rates led to a switch to other areas or methods that do not catch amberjack. Other factors affecting catch rates in hook fisheries, particularly longlines (e.g. gear saturation, competition with other species) should be considered in evaluating if the commercial index series are reliable. Further investigation into the robustness of the design of the video surveys should also be carried out in relation to coverage of the stock. Problems associated with poor identification of small amberjacks in observer programmes and self-reporting of discards by recreational fishers need to be addressed.

2.3 Tables

Table 1. Summary of sensitivities examined by the Review Workshop for the SS model for Greater Amberjack.

Run	Name	Category of Run	Description
1	Base Model	Base Model Run	Estimated K, M=0.28 input into Lorenzen scaled to reference age 2, estimate steepness, estimate virgin stock (R0), estimate virgin biomass offset, estimate recruitment deviations (1984-2011), input discards as discards, 3 time varying selectivity/retention blocks COM_HL (pre 1990, 1990-2007, 2008-2012); two blocks COM_LL (pre 1990, 1990-2012); and four time varying blocks recreational charterboat and private angler modes (REC) and four time blocks Headboat: pre 1990, 1991-1997, 1998-2008, 2009-2012. All indices and composition (age, length) inputs equally weighted. Standard error on fleet catch assumed 0.05.
2	DOWNWEIGHT AGE COMP	Composition Weighting	Run 1 Configuration, Age composition model lambda component set to 0.5x default
3	DOWNWEIGHT AGE_LENGTH COMP	Composition Weighting	Run 1 Configuration, Age and Length composition lambda component set to 0.5x default
4	DOWNWEIGHT LENGTH COMP	Composition Weighting	Run 1 Configuration, Length compositing model lambda set to 0.5x default
5	NO AGE COMP	Composition Weighting	Run 1 Configuration, Age composition excluded from sensitivity run
6	UPWEIGHT INDICES	Indices weighting	Run 1 Configuration, All indices lambdas set to 5x default
7	NO COM	Index exclusion effect	Run 1 Configuration, COM_HL and Com_LL indices excluded from sensitivity run
8	NO COM_HL	Index exclusion effect	Run 1 Configuration, COM_HL index excluded from sensitivity run
9	NO COM_LL	Index exclusion effect	Run 1 Configuration, COM_LL index excluded from sensitivity run

10	NO DEPEND INDICES	Index exclusion effect	Run 1 Configuration, all fishery dependent indices (COM_HL, COM_LL, MRFSS, HEADBOAT) excluded from sensitivity run
11	NO FISHERY INDEP INDICES	Index exclusion effect	Run 1 Configuration, All fishery independent survey indices (SEAMAP, Panama City) excluded from sensitivity run
12	NO HEADBOAT	Index exclusion effect	Run 1 Configuration, Headboat index excluded from sensitivity run
13	NO INDICES	Index exclusion effect	Run 1 Configuration, All indices excluded from sensitivity run
14	NO MRFSS	Index exclusion effect	Run 1 Configuration, MRFSS index excluded from sensitivity run
15	NO PANAMA CITY	Index exclusion effect	Run 1 Configuration, Panama City survey index excluded from sensitivity run
16	NO REC CHPR	Index exclusion effect	Run 1 Configuration, MRFSS Recreational Charter and Private angler (REC CHPR) index excluded from sensitivity run
17	NO SEAMAP	Index exclusion effect	Run 1 Configuration, SEAMAP survey index excluded from sensitivity run
18	EARLY RECRUIT DEVS_and DW_LENCOMP0.1_lambda	Review Workshop Sensitivity	Run 1 Configuration, Recruitment Deviations estimated for early period also (1970-1983) and data rich period (1984-2012), and length composition model lambda downweighted (lambda set to 0.1xdefault)
19	EARLY_RECRUIT_DEVS_No DownWeighting of length comp	Review Workshop Sensitivity	Same as 18, with no downweighting of length composition
20	GROW_CV_0.1	Review Workshop Sensitivity	Same as Base Model run (run 1 this table) with coefficient of variation on growth parameter k set to 0.1
21	RecCatch_SE Adjusted	Review Workshop Sensitivity	Same as Base model run (run 1 this table), and standard error on recreational catch fleets (fleet=REC, HEADBOAT) Adjusted (REC SE = 0.25, Headboat SE = 0.20)
22	RemBelowMSL	Review Workshop Sensitivity	Same as Base model run (Run 1 this table), with length composition samples below minimum size limit removed for COM_HL and recreational fleets (REC, HEADBOAT)

23	RemBelowMSL_allowDiscAboveMSL	Review Workshop Sensitivity	Same as Base model run (Run 1 this table), with length composition samples below minimum size limit removed for COM_HL and recreational fleets (REC, HEADBOAT), and retention function adjusted to allow discarding above the minimum size limit
24	RW Base1	Review Workshop Sensitivity	Same as run 18 this table and also downweighting the length composition by setting model lambda to 0.1xdefault lambda, and adjusting the standard error on the catch of the recreational fleets by 0.25 (REC) and 0.20 (Headboat)
25	TVaring Selectivity	Review Workshop Sensitivity	Same as Run 1 this table, with time varying selectivity block set for COM_HL (Pre 1990, 1990-20120

Table 2. Summary of SS results from sensitivity and retrospective analysis runs for Gulf of Mexico Greater Amberjack. Results include steepness; virgin recruitment (thousand fish, R_0), virgin total biomass (B_0), virgin spawning biomass (SSB_0), 2012 spawning biomass ($SSB_{Current}$), and ratios for select benchmarks. Weight units are whole weight mtons. See Table 1 for description of model parameters.

Run #	Run	R0	B0	Bcurrent	SSB0	SSBcurrent	Fcurr	SSBcurr	Fref_spr	SSBref_spr	Fratio_spr	SSBratio_spr	Fref_msy	SSBref_msy	Fratio_msy	SSBratio_msy
1	Base Model	2383	19017	4920	12532	2210	0.21	2210	0.20	3313	1.03	0.67	0.26	2366	0.81	0.93
2	DOWNWEIGHT AGE COMP	2355	19263	5097	12795	2334	0.21	2175	0.21	3355	1.01	0.65	0.25	2501	0.82	0.87
3	DOWNWEIGHT AGE_LENGTH COMP	2299	18446	4620	12208	2067	0.22	1930	0.21	3249	1.04	0.59	0.27	2249	0.81	0.86
4	DOWNWEIGHT LENGTH COMP	2316	18273	4482	12106	1986	0.23	1875	0.21	3264	1.09	0.57	0.28	2151	0.82	0.87
5	NO AGE COMP	2289	20544	5283	14113	2629	0.20	2384	0.21	3495	0.94	0.68	0.23	3095	0.86	0.77
6	UPWEIGHT INDICES	2268	18288	4413	12117	1935	0.22	1759	0.21	3241	1.08	0.54	0.27	2201	0.82	0.80
7	NO COM	2411	19189	4848	12634	2145	0.215	2010	0.205	3322	1.050	0.605	0.256	2422	0.840	0.830
8	NO COM_HL	2329	18553	4832	12224	2159	0.217	2026	0.205	3260	1.056	0.622	0.263	2292	0.825	0.884
9	NO COM_LL	2441	19407	4775	12777	2095	0.220	1964	0.204	3355	1.077	0.585	0.252	2480	0.871	0.792
10	NO DEPEND INDICES	2429	19258	4488	12661	1934	0.238	1834	0.204	3328	1.170	0.551	0.251	2470	0.949	0.743
11	NO FISHERY INDEP INDICES	2371	18898	6306	12465	2876	0.171	2614	0.205	3369	0.834	0.776	0.277	2198	0.617	1.189
12	NO HEADBOAT	2410	19150	4687	12601	2054	0.223	1931	0.205	3318	1.088	0.582	0.256	2411	0.869	0.801
13	NO INDICES	2439	19118	4660	12481	1996	0.221	1853	0.205	3272	1.077	0.566	0.255	2397	0.866	0.773
14	NO MRFSS	2388	19063	4869	12570	2200	0.212	2071	0.205	3318	1.037	0.624	0.258	2386	0.822	0.868
15	NO PANAMA CITY	2396	19099	5034	12606	2219	0.215	2094	0.204	3372	1.056	0.621	0.262	2356	0.820	0.889
16	NO RECHB	2410	19158	4619	12602	2032	0.225	1920	0.204	3312	1.102	0.580	0.254	2424	0.885	0.792
17	NO SEAMAP	2368	18947	5818	12522	2733	0.184	2507	0.204	3376	0.902	0.743	0.271	2268	0.681	1.105
18	EARLY RECRUIT DEVS_and DW_LENCOMP0.1_lambda	2558	20939	3981	15669	2076	0.264	1986	0.222	4293	1.187	0.463	0.312	2766	0.846	0.718
19	EARLY_RECRUIT_DEVS_No DownWeighting of length comp	2094	16671	4917	10994	2202	0.216	2069	0.204	3120	1.059	0.663	0.329	1578	0.657	1.311
20	GROW_CV_0.1	2124	19945	7051	13599	3708	0.145	3479	0.188	3869	0.772	0.899	0.286	2109	0.508	1.650

21	RecCatch_SE Adjusted	2386	19041	4918	12557	2210	0.211	2072	0.205	3321	1.028	0.624	0.260	2369	0.810	0.875
22	RemBelowMSL	2228	18994	4761	12798	2319	0.199	2176	0.212	3301	0.939	0.659	0.260	2481	0.766	0.877
23	RemBelowMSL_allowDiscAboveMSL	2383	20026	5141	13394	2436	0.196	2277	0.209	3503	0.937	0.650	0.265	2516	0.740	0.905
24	RW Base1	2443	20079	3900	15042	2126	0.265	1936	0.230	4161	1.152	0.465	0.337	2527	0.784	0.766
25	TVaring Selectivity	2288	18281	5014	12069	2284	0.212	2140	0.204	3303	1.037	0.648	0.284	2074	0.746	1.032