SEDAR
Southeast Data, Assessment, and Review

SEDAR 38
Stock Assessment Report

South Atlantic King Mackerel

September 2014

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

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SECTION I: Introduction

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EXECUTIVE SUMMARY

SEDAR 38 addressed the stock assessment for Gulf of Mexico and South Atlantic king mackerel. The assessment process consisted of three in-person workshops, as well as a series of webinars. The Data Workshop was held December 9-13, 2013 in Charleston, SC, the Assessment Workshop was held March 24-28, 2014 in Miami, FL, and the Review Workshop took place August 12-14, 2014 in Miami, FL.

The Stock Assessment Report is organized into 6 sections. Section I – Introduction contains a brief description of the SEDAR Process, Assessment and Management Histories for the species of interest, and the management specifications requested by the Cooperator. The Data Workshop Report can be found in Section II. It documents the discussions and data recommendations from the Data Workshop Panel. Section III is the Assessment Process report. This section details the assessment model, as well as documents any changes to the data recommendations that may have occurred after the data workshop. Consolidated Research Recommendations from all three stages of the process (data, assessment, and review) can be found in Section IV for easy reference. Section V documents the discussions and findings of the Review Workshop (RW). Finally, Section VI – Addenda and Post-Review Workshop Documentation consists of any analyses conducted during or after the RW to address reviewer concerns or requests. It may also contain documentation of the final RW-recommended base model, should it differ from the model put forward in the Assessment Report for review.

The final Stock Assessment Reports (SAR) for the South Atlantic and Gulf of Mexico king mackerel were disseminated to the public in September 2014. Each Council's Scientific and Statistical Committee (SSC) will review the SAR for its stock. The SSCs are tasked with recommending whether the assessments represent Best Available Science, whether the results presented in the SARs are useful for providing management advice and developing fishing level recommendations for the Council. An SSC may request additional analyses be conducted or may use the information provided in the SAR as the basis for their Fishing Level Recommendations (e.g., Overfishing Limit and Acceptable Biological Catch). The South Atlantic Council's SSC will review the assessment at its October 2014 meeting, with the Council reviewing those recommendations at its meeting in December 2014. The Gulf of Mexico's SSC will review the assessment at its January 2015 meeting, followed by the Council receiving that information at its January 2015. Documentation on SSC recommendations is not part of the SEDAR process and is handled through each Council.

During the assessment process several data and modeling topics received a lot of discussion. Those topics included:

- Changing the winter mixing zone definitions: The recommendation of the Panel decreased the size of the winter mixing zone. The recommended winter mixing zone included the area south of the Florida Keys and Dry Tortugas, then south from the Dry

Tortugas (the Gulf of Mexico/South Atlantic Council boundary) to the shelf edge, and in the east from the Dade-Monroe county line to the shelf edge.

- Growth model fitting: The growth models did not fit the ends of the size ranges (smallest and largest fish) well. The fitting issue was never completely resolved, and this represents a potential source of uncertainty in the assessment.

- Inclusion of tournament caught fish in the South Atlantic: There were concerns about growth model fitting and the modeling of the selectivity of that component of the recreational fishery. Otoliths from tournament-caught fish were excluded from the growth models used as to develop parameter starting values for estimating growth internally in the model. Tournament landings and age and length compositions were included in the model.

- Estimation of shrimp bycatch in the South Atlantic: A shrimp-effort data stream did not exist for the South Atlantic and was produced for use in this assessment. This topic was not as much of an issue for the Gulf of Mexico group. Shrimp bycatch estimates were included in both assessments.

- The strongly dome shaped selectivity pattern implemented for most fleets in both the Gulf and South Atlantic models received much discussion during the review workshop because of the potential for a sizeable cryptic biomass. This issue represents a potential source of uncertainty in the model results.

- Inclusion of environmental variables as a means to possibly explain variability in catch rates or recruitment: While these efforts were not incorporated in the current assessment model, they show promise for future assessments.

- Recent history of low recruitment in the South Atlantic: was discussed at several stages of the process, particularly with regards to possible approaches for projection analyses. How the current history of low recruitment in the South Atlantic may affect future stock status, projection analyses, and abundance is uncertain.

- Assumption of a stock-recruitment function, and whether to estimate or fix steepness: The Review Panel recommended fixing steepness at 0.99, to indicate the data available does not support a clear stock-recruitment relationship. Fixing h = 0.99 should not be interpreted as a measure of very high stock productivity, but is merely a method for implementing a forecast going forward with random recruitment.

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. SEDAR seeks improvements in the scientific quality of stock assessments and the relevance of information available to address fishery management issues. SEDAR emphasizes constituent and stakeholder participation in assessment development, transparency in the assessment process, and a rigorous and independent scientific review of completed stock assessments.

SEDAR is managed by the Caribbean, Gulf of Mexico, and South Atlantic Regional Fishery Management Councils in coordination with NOAA Fisheries and the Atlantic and Gulf States Marine Fisheries Commissions. 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; a representative from the Highly Migratory Species Division of NOAA Fisheries, and Interstate Commission representatives: Executive Directors of the Atlantic States and Gulf States Marine Fisheries Commissions.

SEDAR is normally organized around two workshops and a series of webinars. First is the Data Workshop, during which fisheries, monitoring, and life history data are reviewed and compiled. The second stage is the Assessment Process, which is conducted via a workshop and/or a series of webinars, during which assessment models are developed and population parameters are estimated using the information provided from the Data Workshop. The final step 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 stages 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 Cooperator. Workshop participants are drawn from state and federal agencies, non-government organizations, Council members, Council advisors, and the fishing industry with a goal of including a broad range of disciplines and perspectives. All participants are expected to contribute to the process by preparing working papers, contributing, providing assessment analyses, and completing the workshop report.

2. MANAGEMENT OVERVIEW

2.1. *Fishery Management Plan and Plan Amendments*

The following summary describes only those management actions that likely affect king mackerel fisheries and harvest.

Original FMP:

The Fishery Management Plan for Coastal Migratory Pelagic Resources of the Gulf of Mexico and South Atlantic (FMP) and Environmental Assessment (EA), approved in 1982 and implemented by regulations effective in February of 1983, treated king and Spanish mackerel each as one U.S. stock. Allocations were established for recreational and commercial fisheries, and the commercial allocation was divided between net and hook-and-line fishermen.

FMP Amendments affecting king mackerel:

Description of Action	FMP/Amendment	Effective Date
Provided a framework procedure for pre-season adjustment of total allowable catch (TAC), revised the estimate of king mackerel maximum sustainable yield (MSY) downward, recognized separate Atlantic and Gulf migratory groups of king mackerel, and established fishing permits and bag limits for king mackerel. Eliminated commercial allocations among gear users except purse seines, which were allowed 6% of the commercial allocation of TAC. Divided the Gulf commercial allocation for king mackerel into Eastern and Western Zones for the purpose of regional allocation, with 69% of the remaining allocation provided to the Eastern Zone and 31% to the Western Zone.	Amendment 1	1985
Required charterboat permits. TAC for overfished stocks must be set below the upper range of acceptable biological catch (ABC). Prohibited using purse seines on overfished stocks.	Amendment 2	1987
Prohibited drift gillnets for coastal pelagic species and purse seines for the overfished migratory groups of mackerels.	Amendment 3	1990
Extended the management area for Atlantic migratory groups of mackerels through the Mid-Atlantic Council's jurisdiction. Revised the definition of "overfishing". Provided that the South Atlantic	Amendment 5	1990

Council will be responsible for pre-season adjustments of TACs and bag limits for the Atlantic migratory groups of mackerels while the Gulf Council will be responsible for Gulf migratory groups. Continued to manage the two recognized Gulf migratory groups of king mackerel as one until management measures appropriate to the eastern and western migratory groups can be determined. Re-defined recreational bag limits as daily limits, and deleted a provision specifying that bag limit catch of mackerel may be sold. Provided guidelines for corporate commercial vessel permits. Specified that Gulf migratory group king mackerel may be taken only by hook-and-line and run-around gillnets. Established a minimum size of 12" FL or 14" TL for king mackerel and included a definition of "conflict" to provide guidance to the Secretary.		
Provided for rebuilding overfished stocks of mackerels within specific periods, and provided for biennial assessments and seasonal adjustments. Allowed for Gulf migratory group king mackerel stock identification and allocation when appropriate. Changed commercial permit requirements to allow qualification in one of three preceding years. Discontinued the reversion of the bag limit to zero when the recreational quota is filled. Modified the recreational fishing year to the calendar year, changed the minimum size limit for king mackerel to 20" FL, and changed all size limit measures to fork length only	Amendment 6	1992
Equally divided the Gulf commercial allocation in the Eastern Zone at the Dade-Monroe County line in Florida. The sub-allocation for the area from Monroe County through Western Florida is equally divided between commercial hook-and-line and net gear users.	Amendment 7	1994
Allowed only hook-and-line and run-around gillnets for the Gulf migratory group king mackerel fishery; however, catch by permitted, multi-species vessels and bycatch allowances for purse seines were maintained. Established the Councils' intent to evaluate the impacts	Amendment 8	1998

of permanent jurisdictional boundaries between the Gulf and South Atlantic Councils and development of separate FMPs for coastal pelagic species in these areas. Established a moratorium on commercial king mackerel permits until no later than October 15, 2000, with a qualification date for initial participation of October 16, 1995. Increased the income requirement for a king or Spanish mackerel permit to 25% of earned income or $10,000 from commercial sale of catch or charter or head boat fishing in one of the three previous calendar years, but allowed for a one-year grace period to qualify under permits that are transferred. Legalized retention of up to five cut-off (damaged) king mackerel on vessels with commercial trip limits. Set an optimum yield (OY) target at 30% static spawning potential ratio (SPR) for the Gulf and 40% static SPR for the Atlantic. Provided the SAFMC with authority to set gear restrictions for Gulf migratory group king mackerel in the North Area of the Eastern Zone (Dade/Monroe to Volusia/Flagler County lines).		
Reallocated the percentage of the commercial allocation of TAC for the North Area (Florida east coast) and South/West Area (Florida west coast) of the Eastern Zone to 46.15% North and 53.85% South/West and retained the recreational and commercial allocations of TAC at 68% recreational and 32% commercial. Subdivided the commercial hook-and-line king mackerel allocation for the Gulf migratory group, Eastern Zone, South/West Area (Florida west coast) by establishing two subzones with a dividing line between the two subzones at the Collier/Lee County line. Established regional allocations for the west coast of Florida based on the two subzones with 7.5% of the Eastern Zone allocation of TAC being allowed from Subzone 2 and the remaining 92.5% being allocated as follows: 50% - Florida east coast 50% - Florida west coast that is further subdivided:	Amendment 9	2000

50% - Net Fishery 50% - Hook-and-Line Fishery Established a trip limit of 3,000 lb per vessel per trip for the Western Zone. Established a moratorium on the issuance of commercial king mackerel gillnet endorsements and allow re-issuance of gillnet endorsements to only those vessels that: 1) had a commercial mackerel permit with a gillnet endorsement on or before the moratorium control date of October 16, 1995 (Amendment 8), and 2) had landings of king mackerel using a gillnet in one of the two fishing years, 1995-1996 or 1996-1997, as verified by the NMFS or trip tickets from Florida. Allowed transfer of gillnet endorsements to immediate family members (son, daughter, father, mother, or spouse) only, and prohibited the use of gillnets or any other net gear for the harvest of Gulf migratory group king mackerel north of an east/west line at the Collier/Lee County line. Increased the minimum size limit for Gulf migratory group king mackerel from 20" to 24" FL.		
Incorporated the essential fish habitat (EFH) provision for SAFMC.	Amendment 10	2000
Included proposals for mackerel in the SAFMC's Comprehensive Amendment Addressing Sustainable Fishery Act Definitions and other Provisions in Fishery Management Plans of the South Atlantic Region.	Amendment 11	1999
Extended the commercial king mackerel permit moratorium from its current expiration date of October 15, 2000, to October 15, 2005, or until replaced with a license limitation, limited access, and/or individual fishing quota or individual transferable quota system, whichever occurs first.	Amendment 12	2000
Established two marine reserves in the EEZ of the Gulf in the vicinity of the Dry Tortugas, Florida known as Tortugas North and Tortugas South in which fishing for coastal migratory pelagic species is prohibited.	Amendment 13	2002

Established a three-year moratorium on the issuance of charter vessel and head boat Gulf migratory group king mackerel permits in the Gulf unless sooner replaced by a comprehensive effort limitation system. The control date for eligibility was established as March 29, 2001. Included provisions for eligibility, application, appeals, and transferability.	Amendment 14	2002
Established an indefinite limited access program for the commercial king mackerel fishery in the EEZ under the jurisdiction of the Gulf, South Atlantic, and Mid-Atlantic Councils. Changed the fishing season to March 1 through February 28/29 for the Atlantic groups of king and Spanish mackerel. Beginning the fishing year on March 1 ensures the mackerel fisheries in the Atlantic are open when other fisheries are closed.	Amendment 15	2005
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. There will be a periodic review at least every 10 years on the effectiveness of the limited access system.	Amendment 17	2006
Established annual catch limits and accountability measures for Gulf and Atlantic migratory groups for cobia, king mackerel, and Spanish mackerel.	Amendment 18	2012

GMFMC Regulatory Amendments:

May 1986:

Allowed charter boats to obtain commercial permits. For the 1986/87 season (July 1 - June 30) the amendment set TAC for Gulf group king mackerel at 2.9 MP with 0.93 MP commercial quota and 1.97 MP recreational allocation. The king mackerel bag limit was set at 2 fish for persons fishing from boats without a captain and crew and 3 fish for persons fishing from boats with a captain and crew (i.e., for-hire boats), the crew excluded. The commercial quota was allocated 6% for purse-seines, 64.5% for eastern zone (Florida) and 29% for western zone (AL-TX). The amendment also provided that the recreational and commercial fisheries would be closed when their allocation was taken.

May 1987:

For the 1987/88 season (July 1 - June 30) the amendment reduced TAC for Gulf group king mackerel to 2.2 MP with commercial quota of 0.7 MP and recreational allocation of 1.5 MP. The purse-seine allocation was set at zero.

May 1988:

For the 1988/89 season the amendment set TAC for Gulf group king mackerel at 3.4 MP with commercial quota of 1.1 MP and recreational allocation 2.3 MP. The commercial quota was allocated 69% to eastern zone (FL) and 31% to western zone (AL-TX).

May 1989:

For the 1989/1990 season the amendment increased TAC for Gulf group king mackerel to 4.25 MP with commercial quota 1.36 MP and recreational allocation 2.89 MP. The bag limit remained unchanged.

May 1990:

For the 1990/91 season the amendment left the TAC (4.25 MP) and bag limit for Gulf group king mackerel unchanged.

May 1991:

For the 1991/92 season the amendment increased TAC for Gulf group king mackerel to 5.75 MP with a 1.84 MP commercial quota and 3.91 MP recreational allocation. The king mackerel bag limit was modified to 2 fish off Florida and 2/3 AL-TX (See 1986/87 regulatory amendment for description). The amendment also set the overfishing thresholds at 30% SPR (SSBR).

May 1992:

For the 1992/93 season the amendment increased TAC for Gulf group king mackerel to 7.8 MP with commercial quota of 2.50 MP and recreational allocation of 5.3 MP. The king mackerel bag limit was reduced to 2 fish per person including captain and crew of charter and head boats for the entire Gulf

EEZ. The amendment deleted the requirement that the bag limits for Gulf group king and Spanish mackerels revert to zero when the allocations were projected to be harvested and the fisheries be closed. Emergency action added 259,000 pounds under 25-fish trip limit.

May 1993:

For the 1993/94 season the TAC and bag limits remained the same for Gulf group king mackerel. For the eastern zone (FL) commercial hook-and-line fisheries the trip limit for the FL east coast zone (FECZ) was set at 50 fish until 50% of the sub-quota was taken and then was reduced to 25 fish until the quota was taken. For the FL west coast zone (FWCZ) there was no trip limit until 75% of the sub-quota was taken then was reduced to 50 fish.

May 1994:

For the 1994/95 season the TAC and bag limits remained unchanged for Gulf group king mackerel. Commercial gill net boats fishing king mackerel in the eastern zone were limited to 25,000 pounds per trip. Emergency action added 300,100 pounds under 125-fish trip limit.

May 1995:

For the 1995/96 season the TAC and bag limits remained unchanged for Gulf group king mackerel. The hook-and-line trip limit for the FWCZ of the eastern zone was set at 125 fish until 75% of the sub-quota was taken, then it became 50 fish.

May 1996:

For the 1996/97 season the TAC and bag limits remained unchanged for Gulf group king mackerel, except that the bag limit for captain and crew of charter and head boats was set at zero. The commercial hook-and-line trip limit for the FWCZ was set at 1,250 pounds per trip until 75% of the sub-quota was taken and then changed to 500 pounds per trip. FECZ set at 750 pounds then to 500 pounds when 75% taken.

May 1997:

For the 1997/98 season the TAC was increased to 10.6 MP for Gulf group king mackerel. The zero bag limit for captain and crew of charter and head boats was rescinded. The commercial hook-and-line trip limit for the FECZ was changed to 50 fish until the sub-quota was taken.

July 1998:

For the 1998/99 season the amendment proposes to retain the TAC for the Gulf group king mackerel, but to set the bag limit for captain and crew of charter and head boats at zero. The size limit for king mackerel would increase to 24 inches (FL). The commercial king mackerel hook-and-line trip limit for the western zone (AL-TX) would be set at 3,000 pounds per trip.

July 1999:

For the 1999-2000 season, proposed to retain TAC for Gulf group king mackerel at 10.6 million pounds. It also proposed to establish a 2-fish per person per day bag limit on Gulf group king mackerel for the captain and crew of for-hire vessels and retain this 2-fish bag limit for all other recreational fishermen; however, the captain and crew bag limit was rejected by NMFS. The fishing season for the commercial gill net fishery for Gulf group king mackerel was changed to open at 6 a.m. eastern standard time (EST) on the Tuesday following the Martin Luther King, Jr. holiday, with the following weekend open as long as the quota has not been taken and all subsequent weekends and holidays would be closed as long as the season remains open. Weekend and holiday closures would be from 6 a.m. Saturday to 6 a.m. Monday EST (or Tuesday if a Monday holiday is involved), and during this period boats with a net on board must be tied to the dock.

July 2000:

Implemented in 2001, it reduced TAC from 10.6 MP to 10.2 MP, provided a 2-fish bag limit for the captain and crew of for-hire vessels, and revised the trip limit for Gulf migratory group king mackerel in the northern area of the Eastern Zone (Miami-Dade through Volusia Counties, Florida) to remain at 50 fish until February 1. If the quota is not 75% filled as of February 1, then the trip limit will increase to 75 fish; if the quota is 75% filled or greater, then the trip limit will remain at 50 fish.

July 2003:

Establishes definitions of maximum sustainable yield (MSY), optimum yield (OY), the overfishing threshold, and the overfished condition for Cobia and Gulf group king and Spanish mackerel.

SAFMC Regulatory Amendments:

May 7, 1990:

Letter from Gulf Council Chair to Andrew Kemmerer with Regulatory Impact Review prepared by GMFMC and NMFS (May 1990): Atlantic migratory group king mackerel: ABC = 6.5 – 15.7 MP, TAC = 8.3 MP, commercial allocation (37.1%) = 3.08 MP, recreational allocation (62.9%) = 5.22 MP = 601,000 fish; and bag limit of 2 per person per trip off FL and 3 fish per person per trip off GA, SC & NC. The definition of overfishing was set at 40% Spawning Stock Biomass for king mackerel.

May 17, 1991:

Letter from Gulf and South Atlantic Council Chairs to Andrew Kemmerer with Regulatory Impact Review prepared by GMFMC and NMFS (May 1991): Atlantic migratory group king mackerel: ABC = 9.6 – 15.5 MP, TAC = 10.5 MP, commercial allocation (37.1%) = 3.9 MP, recreational allocation (62.9%) = 6.6 MP = 735,000 fish ; and bag limit of 5 fish per person per day throughout the range.

May 1994:
Framework Seasonal Adjustment of Harvest Levels and Procedures under the Fishery Management Plan for Coastal Pelagics in the Gulf of Mexico and South Atlantic includes Environmental Assessment and Regulatory Impact Review) - For the 1994/1995 season, Atlantic Migratory Group king mackerel: ABC = 7.6-10.3 MP; TAC is lowered from 10.5 to 10 MP; bag limit remains unchanged at 5/person/day off GA-NY and 2/person/day off FL; commercial allocation (37.1%) = 3.71 MP and recreational allocation (62.9%) = 6.29 MP /8.87 pounds per fish = 709,100 fish.

February 1995:
Revised Final Regulatory Amendment (Including Regulatory Impact Review and Environmental Assessment) for the Fishery management Plan for the Coastal Migratory Pelagic Resources (Mackerels) in the Gulf of Mexico and South Atlantic Regions - Set trip limits for Atlantic Migratory Group King Mackerel: (a) 4/1 thru 3/31 from Volusia/Flagler to NY/CT = 3,500 pounds; (b) 4/1 thru 10/31 from Brevard/Volusia to Volusia/Flagler = 3,500 pounds; and (c) 4/1 thru 10/31 from Collier/Monroe to Brevard/Volusia = 50 fish.

June 1995:
Framework Seasonal Adjustment of Harvest Levels and Procedures under the Fishery Management Plan for the Coastal Migratory Pelagic Resources (Mackerels) in the Gulf of Mexico and South Atlantic Region (Including Regulatory Impact Review, Social Impact Assessment and Environmental Assessment) - For fishing year 1995/96 for Atlantic Migratory Group king mackerel: ABC = 7.3-15.5 MP; TAC is lowered from 10 to 7.3 MP; bag limit is reduced from 5 to 3 fish per person per day off NY through GA effective 1/1/96 while the bag limit remains unchanged at 2/person/day off FL; commercial allocation (37.1%) = 2.7 MP and recreational allocation (62.9%) = 4.6 MP/10.11 pounds per fish = 454,995 fish.

September 1996:
Framework Seasonal Adjustment of Harvest Levels and Procedures under the Fishery Management Plan for the Coastal Migratory Pelagic Resources (Mackerels) in the Gulf of Mexico and South Atlantic Region (Including Regulatory Impact Review, Social Impact Assessment and Environmental Assessment) - For fishing year 1996/97 for Atlantic Migratory Group king mackerel: ABC = 4.1-6.8 MP; TAC is lowered from 7.3 to 6.8 MP; bag limit remains unchanged at 3 fish per person per day off NY through GA and 2/person/day off FL; commercial allocation (37.1%) = 2.52 MP and recreational allocation (62.9%) = 4.28 MP/9.76 pounds per fish (from 1995 stock assessment) = 438,525 fish.

May 1997:
Framework Seasonal Adjustment of Harvest Levels and Procedures under the Fishery Management Plan for the Coastal Migratory Pelagic Resources (Mackerels) in the Gulf of Mexico and South Atlantic Region (Including Regulatory Impact Review, Social Impact Assessment and Environmental Assessment) - For fishing year 1997/98 for Atlantic Migratory Group king mackerel – no change to ABC or bag limits: ABC = 4.1-6.8 MP; TAC is lowered from 7.3 to 6.8 MP; bag limit remains unchanged at 3 fish per person per day off NY through GA and 2/person/day off FL; commercial allocation (37.1%) = 2.52 MP and recreational allocation

(62.9%) = 4.28 MP /9.76 pounds per fish (from 1995 stock assessment) = 438,525 fish. Revised trip limits for Atlantic migratory group king mackerel: (a) 4/1 through 3/31 from Volusia/Flagler to NY/CT = 3,500 pounds (NO CHANGE); (b) 4/1 through 10/31 from Brevard/Volusia to Volusia/Flagler = 3,500 pounds (NO CHANGE); (c) 4/1 through 10/31 from DADE/Monroe to Brevard/Volusia = 50 fish; AND (d) 4/1 through 10/31 MONROE COUNTY = 125 FISH. (Note: new trip limits shown in all caps.)

August 1998:
Framework Seasonal Adjustment of Harvest Levels and Procedures under the Fishery Management Plan for the Coastal Migratory Pelagic Resources (Mackerels) in the Gulf of Mexico and South Atlantic Region (Including Regulatory Impact Review, Social Impact Assessment/Fishery Impact Statement and Environmental Assessment) - For fishing year 1998/99 for Atlantic Migratory Group king mackerel: ABC = 8.4-11.9 MP; TAC is increased from 6.8 to 8.4 MP; bag limit remains unchanged at 3 fish per person per day off NY through GA and 2/person/day off FL; commercial allocation (37.1%) = 3.12 MP and recreational allocation (62.9%) = 5.28 MP/10.46 pounds per fish (from 1998 stock assessment) = 504,780 fish. Atlantic migratory group king mackerel size limit increased from 20” FL to 24” FL. Revised trip limits for Gulf migratory group king mackerel in the northern area of the eastern subzone (Dade through Volusia Counties, Florida): the trip limit is increased from 50 fish to 75 fish throughout the entire season (Nov. – Mar. 31). Revised trip limits for Atlantic migratory group king mackerel: (a) 4/1 through 3/31 from Volusia/Flagler to SC/NC = 3,500 pounds (NO CHANGE); (b) NORTH OF THE SC/NC LINE = 2,000 POUNDS YEAR-ROUND UNLESS 80% OF THE COMMERCIAL ALLOCATION IS TAKEN PRIOR TO FEBRUARY 1, THEN IT WOULD BR REDUCED TO 1,000 POUNDS; (c) 4/1 through 10/31 from Brevard/Volusia to Volusia/Flagler = 3,500 pounds (NO CHANGE); (d) 4/1 through 10/31 from DADE/Monroe to Brevard/Volusia = 50 fish; and (e) 4/1 through 10/31 Monroe County = 125 fish. (Note: new trip limits shown in all caps.) NOTE: THE PROPOSED RULE FOR THE SPECIFICATIONS WAS NOT PUBLISHED UNTIL JUNE 1999, AND AT THE JUNE 1999 MEETING, THE SOUTH ATLANTIC COUNCIL REQUESTED THAT THE PROPOSED CHANGE IN THE TRIP LIMIT NORTH OF THE SC/NC LINE BE WITHDRAWN AND THE PROPOSED CATCH SPECIFICATIONS IN THIS FRAMEWORK ADJUSTMENT BE REPLACED BY THE RECOMMENDED SPECIFICATIONS IN THE JULY 1999 FRAMEWORK ADJUSTMENT. NMFS DID NOT ALLOW THIS DUE TO SUFFICIENT TIME FOR THE PUBLIC TO REVIEW THE JULY 1999 SPECIFICATIONS. THE FINAL RULE FOR THE AUGUST 1998 FRAMEWORK AJUSTMENT WAS PUBLISHED IN AUGUST 1999 WITH THE CATCH SPECIFICATIONS (TAC=8.4 MP) AND INCREASE IN THE MINIMUM SIZE, BUT NO TRIP LIMIT CHANGE.

July 1999:
South Atlantic Fishery Management Council Framework Seasonal Adjustment of Harvest Levels and Related Measures under the Fishery Management Plan for the Coastal Migratory Pelagic Resources (Mackerels) in the Gulf of Mexico and South Atlantic Region (Including Regulatory Impact Review, Social Impact Assessment/Fishery Impact Statement and Environmental Assessment)- For fishing year 1999/2000 for Atlantic Migratory Group king mackerel: ABC = 8.9-13.3 MP; increase TAC to 10 MP; bag limit remains unchanged at 3 fish per person per day off NY through GA and 2/person/day off FL; commercial allocation (37.1%) = 3.71 MP and

recreational allocation (62.9%) = 6.29 MP/10.46 pounds per fish (from 1999 stock assessment) = 601,338 fish. Revised trip limits for Atlantic migratory group king mackerel: (a) 4/1 through 3/31 from Volusia/Flagler to NY/CT = 3,500 pounds (NO CHANGE); (b) 4/1 through 10/31 from Brevard/Volusia to Volusia/Flagler = 3,500 pounds (NO CHANGE); (c) YEAR-ROUND FROM DADE/MONROE TO BREVARD/VOLUSIA = 75 FISH; and (e) 4/1 through 10/31 Monroe County = 125 fish (NO CHANGE). (Note: new trip limits shown in all caps.)

January 2000:

South Atlantic Fishery Management Council Framework Seasonal Adjustment of Harvest Levels and Related Measures under the Fishery Management Plan for the Coastal Migratory Pelagic Resources (Mackerels) in the Gulf of Mexico and South Atlantic Region (Including Regulatory Impact Review, Social Impact Assessment/Fishery Impact Statement and Environmental Assessment) - For fishing year 2000/2001 for Atlantic Migratory Group king mackerel: ABC = 8.9-13.3 MP; TAC is increased from 8.4 to 10.0 MP; bag limit remains unchanged at 3 fish per person per day off NY through GA and 2/person/day off FL; commercial allocation (37.1%) = 3.71 MP and recreational allocation (62.9%) = 6.29 MP/10.46 pounds per fish (from 1999 stock assessment) = 601,338 fish. Revised trip limits for Atlantic migratory group king mackerel: (a) 4/1 through 3/31 from Volusia/Flagler to NY/CT = 3,500 pounds (NO CHANGE); (b) 4/1 through 10/31 from Brevard/Volusia to Volusia/Flagler = 3,500 pounds (NO CHANGE); (c) 4/1 through 10/31 FROM DADE/MONROE TO BREVARD/VOLUSIA = 75 FISH; and (e) 4/1 through 10/31 Monroe County = 125 fish. (Note: new trip limits shown in all caps.) MSY and status determination criteria were also revised to reflect the new biomass-based values. NOTE: THE FINAL RULE FOR THE JUNE 1999 FRAMEWORK ADJUSTMENT ALSO RECOMMENDED TAC=10 MP, BUT THIS HAD NOT PUBLISHED WHEN THIS FRAMEWORK ADJUSTMENT WAS DEVELOPED.

2.2. Emergency and Interim Rules

GMFMC:

1986:

Reduced TAC for Gulf group king mackerel from 14.4 million pounds to 5.2 million pounds.

1992:

Added 259,000 lbs to the commercial Gulf group king mackerel TAC.

1993:

The commercial quota for Eastern Zone Gulf group king mackerel (1.73 million pounds) be divided equally at the Dade-Monroe County line, with sub-quotas of 865,000 pound north, and the same amount south and west of the line. NMFS approved and implemented for the fishing season begun in 11/93.

1994:

Added 300,000 lbs. to the commercial Gulf group King mackerel TAC.

2.3. 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.

October 16, 1995:

Date of requirement of having a commercial king mackerel permit in order to qualify for a moratorium permit.

March 29, 2001:

Date of requirement of having a for-hire coastal migratory pelagics permit for the Gulf to qualify for a moratorium permit.

June 15, 2004:

Established control date for participation in the commercial sector of the Gulf and Atlantic king mackerel fishery for future qualification, if necessary.

2.4. Management Parameters and Projection Specifications

Table 2.4.1. General Management Information

Species	King Mackerel
Management Unit	King Mackerel
Management Unit Definition	Gulf of Mexico and Atlantic migratory groups
Management Entity	GMFMC/SAFMC
Management Contacts SERO / Council	GMFMC: Ryan Rindone SAFMC: Kari Maclauchlin SERO: Sue Gerhart
Current stock exploitation status: Gulf and Atlantic	Not overfished, uncertain if undergoing overfishing (SEDAR 16)
Current spawning stock biomass status: Gulf and Atlantic	3166.46 billion hydrated eggs (SEDAR 16)

Table 2.4.2. Specific Management Criteria

Criteria	Gulf of Mexico - Current (SEDAR 16- 2009)		Gulf of Mexico - Proposed	
	Definition	Value	Definition	Value
MSST	$(1-M)*SSB_{MSY}$: M=0.174	2615.5 billion hydrated eggs	$(1-M)*SSB_{MSY}$	SEDAR 38
MFMT	$F_{SPR30\%}$	0.25	$F_{SPR30\%}$	SEDAR 38
MSY	Yield @ F_{MSY}	9.10 mp	Yield @ F_{MSY}	SEDAR 38
F_{MSY}	$F_{SPR30\%}$	0.25	$F_{SPR30\%}$	SEDAR 38
OY	Equilibrium Yield @ F_{OY}	8.61 mp	Equilibrium Yield @ F_{OY}	SEDAR 38
F_{OY}	75% of F_{MSY}	0.19	F_{OY} = 65%,75%, 85% F_{MSY}	SEDAR 38
M	n/a	0.174	M	SEDAR 38
Probability value for evaluating status	50% Fcurr> Fmsy = overfishing 50% Bcurr < MSST = overfished			SEDAR 38

Criteria	South Atlantic – Current	
	Definition	Value
MSST	Value from the most recent stock assessment based on MSST = [(1-M) or 0.5 whichever is greater]*B_{MSY}	1,827.5 billion hydrated eggs
MFMT	Fmsy = F30%SPR	
MSY	Yield at F_{MSY} from the most recent stock assessment	9.357-12.836MP
F_{MSY}	F_{MSY} or proxy from the most recent stock assessment	$F_{30\%SPR}$ = 0.256
OY	ACL = OY = ABC	10.46 mp
F_{OY}	65%, 75% OR 85% F_{MSY}	0.17, 0.19 or 0.22
M	Base of Lorenzen M	0.1603
Probability value for evaluating status	50% Fcurr> Fmsy = overfishing 50% Bcurr < MSST = overfished	

Criteria	South Atlantic - Proposed		
	Definition	Base Run Values	Median of Base Run MCBS
MSST[1]	Value from the most recent stock assessment based on MSST = [(1-M) or 0.5 whichever is greater]*BMSY		
MFMT[2]	FMSY or proxy from the most recent stock assessment		
F_{MSY}			
MSY	Yield at F_{MSY}, landings and discards, pounds and numbers		
Bmsy[1]	Total or spawning stock, to be defined		
Rmsy	Recruits @ MSY		

F Target	75% Fmsy		
Yield at Ftarget (Equilibrium)	landings and discards, pounds and numbers		
M	Natural Mortality, average across ages		
Terminal F	Exploitation		
Terminal Biomass[1]	Biomass		
Exploitation Status	F/MFMT		
Biomass Status[1]	B/MSST B/Bmsy		
Generation Time			
$T_{rebuild}$ (if appropriate)			

1. Biomass values reported for management parameters and status determinations should be based on the biomass metric recommended through the Assessment process and SSC. This may be total, spawning stock or some measure thereof, and should be applied consistently in this table.

2. Fmsy was not available from the prior assessment. A proxy of F30%SPR was used. This should be replaced with Fmsy if a reliable estimate is provided from this assessment.

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

None- Gulf and Atlantic migratory group king mackerel are not currently overfished.

Table 2.4.4. General projection information

Requested Information	Value
First Year of Management	2015 Fishing Year
Interim basis	ACL, if ACL is met average exploitation, if ACL is not met
Projection Outputs - By migratory group and Fishing Year	
Landings	pounds and numbers
Discards	pounds and numbers
Exploitation	F & Probability F>MFMT
Biomass (total or SSB, as	B & Probability B>MSST

appropriate)	(and Prob. B>Bmsy if under rebuilding plan)
Recruits	number

Table 2.4.5. Base Run Projections Specifications. Long Term and Equilibrium conditions.

Criteria	Definition	If overfished	if overfishing	Neither overfished nor overfishing
Projection Span	Years	Trebuild	10	10
Projection Values	Fcurrent	X	X	X
	Fmsy (proxy)	X	X	X
	75% Fmsy	X	X	X
	Frebuild	X		
	F=0	X		

NOTE: Exploitation rates for projections may be based upon point estimates from the base run (current process) or upon the median of such values from the MCBS evaluation of uncertainty. The critical point is that the projections be based on the same criteria as the management specifications.

Table 2.4.6. P-Star Projections. Short term specifications for OFL and ABC recommendations. Additional P-Star projections may be requested by the SSC once the ABC control rule is applied.

Criteria		Overfished	Not overfished
Projection Span	Years	10	10
Probability Values	50%	Probability of stock rebuild	Probability of overfishing
	27.5%[1]		

1. Based on the SA SSC recommended P*, December 2008.

Table 2.4.5. Quota Calculation Details

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

Quota Detail	**Gulf of Mexico Value**	**South Atlantic Value**
Current Quota Value	ACL=11.9 mp	ACL=10.46 mp
Next Scheduled Quota Change	2013/2014	After assessment
Annual or averaged quota?	Annual	Average of 2011-15
If averaged, number of years to average	-	2011-2015
Does the quota include bycatch/discard?	No	No

Table 2.5.1. Annual Commercial King Mackerel Regulatory Summary

Year	Fishing Year Atlantic	Fishing Year Gulf	Size Limit	Trip Limit Atlantic	Trip Limit Gulf
1983[1]			None	--	--
1984[1]			None	--	--
1985[2]	4/1 - 3/31	7/1 - 6/30	None	--	--
1986	4/1 - 3/31	7/1 - 6/30	None	--	--
1987	4/1 - 3/31	7/1 - 6/30	None	--	--
1988	4/1 - 3/31	7/1 - 6/30	None	--	--
1989	4/1 - 3/31	7/1 - 6/30	None	--	--
1990[3]	4/1 - 3/31	7/1 - 6/30	12 in FL or 14 in TL	--	--
1991	4/1 - 3/31	7/1 - 6/30	12 in FL or 14 in TL	--	--
1992	4/1 - 3/31	7/1 - 6/30	20 in FL	--	--
1993	4/1 - 3/31	7/1 - 6/30	20 in FL	--	i, j, k
1994	4/1 - 3/31	7/1 - 6/30	20 in FL	--	k, l, m, n
1995	4/1 - 3/31	7/1 - 6/30	20 in FL	a, b	l, m, n, o
1996	4/1 - 3/31	7/1 - 6/30	20 in FL	c, d, e	l, p, q
1997	4/1 - 3/31	7/1 - 6/30	20 in FL	c, d, f, g	l, q, r
1998	4/1 - 3/31	7/1 - 6/30	20 in FL	"	"
1999	4/1 - 3/31	7/1 - 6/30	24 in FL	"	"
2000	4/1 - 3/31	7/1 - 6/30	24 in FL	c, d, g, h	l, q, s, t
2001	4/1 - 3/31	7/1 - 6/30	24 in FL	"	"
2002	4/1 - 3/31	7/1 - 6/30	24 in FL	"	"
2003	4/1 - 3/31	7/1 - 6/30	24 in FL	"	"
2004	4/1 - 3/31	7/1 - 6/30	24 in FL	"	"
2005	3/1 - 2/28-29	7/1 - 6/30	24 in FL	"	"
2006	3/1 - 2/28-29	7/1 - 6/30	24 in FL	"	"
2007	3/1 - 2/28-29	7/1 - 6/30	24 in FL	"	"
2008	3/1 - 2/28-29	7/1 - 6/30	24 in FL	"	"
2009	3/1 - 2/28-29	7/1 - 6/30	24 in FL	"	"
2010	3/1 - 2/28-29	7/1 - 6/30	24 in FL	"	"
2011	3/1 - 2/28-29	7/1 - 6/30	24 in FL	"	"
2012	3/1 - 2/28-29	7/1 - 6/30	24 in FL	"	"

[1]One stock
[2]Two management groups (Atlantic & Gulf migratory) from this point forward
[3]Management area expands from TX through NC to TX through NY

Key to trip limit codes

a	Brevard/Volusia to NY -> 3,500 lb/trip (year round)
b	Brevard/Volusia to Monroe/Collier -> 50 fish/trip (4/1 - 10/31)
c	Volusia/Flagler to NY ->3,500lb/trip (year-round)
d	Volusia County -> 3,500lb/trip (4/1 - 10/31)
e	Brevard/Volusia to Collier/Monroe -> 50 fish/trip (4/1 - 10/31)
f	Brevard/Volusia to Miami-Dade/Monroe -> 50 fish/trip (4/1 - 10/31)
g	Monroe County -> 1,250 lb/trip (4/1 - 10/31)
h	Brevard/Volusia to Miami-Dade/Monroe -> 75 fish/trip (4/1 - 10/31)
i	FECZ -> 25 fish/trip limit under emergency addition of 259K lbs
j	FECZ -> 50 fish/vessel until 50% of suballocation, then 25 fish/vessel until quota taken (11/1-3/31)
k	FWCZ -> hook and line: no trip limit until 75% of subquota taken then 50 fish/trip
l	25,000 lb trip limit for gillnets
m	FECZ -> hook and line: 50 fish/vessel until 25% of sub-allocation, then 25 fish/vessel until quota taken (11/1-3/31)
n	FWCZ -> 125 fish/trip (Emergency addition of 300,100 lbs - additional poundage was intended for the southern area)
o	FWCZ -> hook-and-line trip limit is 125 fish until 75% of subquota taken then 50 fish
p	FECZ -> hook and line: 750 lbs/trip until 75% of sub allocation taken, then 500 lbs/trip (11/1 - 3/31)
q	FWCZ -> hook and line: 1,250 lbs/trip until 75% of suballocation taken, then 500 lbs/trip
r	FECZ -> hook and line: 50 fish/trip (11/1 - 3/31)
s	FECZ -> 50 fish/trip until Feb 1; if quota not 75% filled by 2/1, then 75 fish; if quota 75% or greater, then stay at 50 fish
t	Gulf WZ -> 3,000 lb trip limit

FWCZ	Florida west coast subzone: AL/FL border to Collier/Monroe line (4/1-10/31) or Monroe/Miami-Dade line (11/1- 3/31)
FECZ	Florida east coast subzone: Monroe/Miami-Dade line to Volusia/Flagler line ((11/1 - 3/31)
Gulf WZ	Gulf western zone: US/Mexico border to Alabama/Florida border (7/1 - 6/30)

Table 2.5.2. King mackerel commercial closure dates.

Fishing Year	Western Gulf Close	Western Gulf Reopen	Western Gulf Reclose	FL East Coast increase 75 fish	FL East Coast 50-> 25 fish	FL East Coast Close	FL East Coast Reopen	FL East Coast Reclose	FL West Coast 500lbs	FL West Coast 50 fish	FL West Coast Close	FL West Coast Reopen	FL West Coast Reclose	FL West Coast, N 500lbs	FL West Coast, N Close	FL West Coast, S - HL 500lbs	FL West Coast, S - HL Close	FL West Coast, S - Gill Open	FL West Coast, S - Gill Close	FL West Coast, S - Gill Reopen	FL West Coast, S - Gill Reclose	FL West Coast, S - Gill # day	Atlantic Close
85-86						12-Mar					12-Mar												
86-87	4-Feb					4-Feb					4-Feb												
87-88	2-Nov					29-Dec					29-Dec												
88-89	3-Dec					31-Dec					31-Dec												23-Nov
89-90	25-Oct					9-Jan					9-Jan												
90-91	18-Oct					4-Jan																	
91-92	29-Sep					31-Jan																	
92-93	18-Oct					13-Jan	18-Feb	27-Mar															
93-94	1-Oct									29-Dec	27-Jan												
94-95	24-Sep										20-Dec	7-Feb	22-Feb						3-Feb				
95-96	5-Sep				15-Mar					24-Jan	21-Feb								12-Feb				
96-97	26-Aug				1-Mar					1-Jan	22-Jan								7-Jan				
97-98	2-Aug	20-Feb	29-Mar			29-Mar			28-Nov		7-Jan	20-Feb	5-Mar						3-Feb	20-Feb	24-Feb		29-Mar
98-99	25-Aug					13-Mar			30-Jan		16-Mar								20-Jan				
99-00	25-Aug								24-Jan		6-Mar								15-Feb				
00-01	26-Aug													12-Nov	19-Nov	20-Feb	2-Mar	15-Jan	19-Jan				
01-02	19-Nov			1-Feb		none								none	10-Nov	11-Mar	23-Mar	21-Jan	28-Jan				
02-03	25-Oct			1-Feb		none								30-Nov	5-Dec	5-Mar	none	20-Jan	4-Feb				
03-04	24-Sep			1-Feb		none								30-Oct	13-Nov	20-Mar	9-Apr	19-Jan	none				
04-05	20-Oct			1-Feb		none									none	25-Feb	none	17-Jan	28-Jan			11	
05-06	17-Nov			1-Feb		none									none	25-Feb	12-Mar	16-Jan	7-Mar			51	
06-07	6-Oct			1-Feb		none								27-Nov	none	3-Mar	10-Apr	15-Jan	25-Jan			10	none
07-08	3-Nov			1-Feb		21-Feb								27-Dec	none	22-Mar	none	21-Jan	5-Feb			15	none
08-09	27-Mar			none		6-Mar								none	none	28-Feb	none	19-Jan	30-Jan			10	none
09-10	4-Sep			none		4-Feb	3-Mar	8-Mar						none	24-Oct	7-Feb	15-Feb	18-Jan	23-Jan			5	none
10-11	11-Feb			none		26-Feb								26-Oct	4-Apr	8-Mar	23-Mar	17-Jan	2-Feb			15	none
11-12	16-Sep			1-Feb		14-Mar								none	7-Oct	none	26-Feb	16-Jan	21-Jan			4	none
12-13	22-Aug			1-Feb		none								30-Aug	5-Oct	12-Mar	17-Mar	22-Jan	none				none
13-14	20-Sep	1-Nov	3-Nov											25-Sep	12-Oct								

Closure Times

Colour	Closure time
purple	1am
cyan	6am
yellow	noon
green	6pm
orange	don't know
all others	12:01 am

Grey: period during which those regulations were not in effect

Table 2.5.3. Annual Recreational King Mackerel Regulatory Summary

	Fishing Year			Bag Limit		Closures	
Year	**Atlantic**	**Gulf**	**Size Limit**	**Atlantic**	**Gulf**	**Atlantic**	**Gulf**
1983-1984[1]			--	--	--	--	--
1984-1985[1]			--	--	--	--	--
1985-1986[2]							
1986-1987	4/1 - 3/31	7/1 - 6/30	--	Private = 2/person/trip; Charterboat = greater of 2/person incl capt&crew or 3/person excl capt&crew		--	--
1987-1988	4/1 - 3/31	7/1 - 6/30	--	3/person/trip	"		Closed 12/16/87
1988-1989	4/1 - 3/31	7/1 - 6/30	--	2/person/trip FL & 3 GA to SC	"	Closed 10/17/88	Closed 12/17/88
1989-1990	4/1 - 3/31	7/1 - 6/30	--	2/person/trip FL & 3 GA to SC	"		
1990-1991[3]	4/1 - 3/31	7/1 - 6/30	12 in FL or 14 in TL	2 FL; 3 GA-NY	Same as above[4]		Closed12/20/90
1991-1992	4/1 - 3/31	7/1 - 6/30	12 in FL or 14 in TL	5 FL-NY	"		Closed 01/13/92
1992-1993	4/1 - 3/31	7/1 - 6/30	20 in FL	2 FL; 5 GA-NY	2 / person including captain & crew		--
1993	Calendar Year		20 in FL	"	"		--
1994	Calendar Year		20 in FL	"	"		--
1995	Calendar Year		20 in FL	2 FL; 3 GA-NY	"		--
1996	Calendar Year		20 in FL	"	"		--
1997	Calendar Year		20 in FL	"	2 per person, 0 capt&crew as of 6-97		--
1998	Calendar Year		20 in FL	"	2 per person, 2 capt&crew as of 2-98		--
1999	Calendar Year		24 in FL	"	2 per person, 0 capt&crew as of 9-99		--
2000	Calendar Year		24 in FL	"	2 per person, 2 capt&crew as of 6-00		--
2001	Calendar Year		24 in FL	"	"		--
2002	Calendar Year		24 in FL	"	"		--
2003	Calendar Year		24 in FL	"	"		--
2004	Calendar Year		24 in FL	"	"		--
2005	Calendar Year		24 in FL	"	"		--
2006	Calendar Year		24 in FL	"	"		--
2007	Calendar Year		24 in FL	"	"		--
2008	Calendar Year		24 in FL	"	"		--
2009	Calendar Year		24 in FL	"	"		--
2010	Calendar Year		24 in FL	"	"		--
2011	Calendar Year		24 in FL	"	"		--
2012	Calendar Year		24 in FL	"	"		--

[1]One stock
[2]Two management groups (Atlantic & Gulf migratory) from this point forward

[3]Management area expands from TX through NC to TX through NY
[4]Redefined as daily bag limits; 1-day possession except for-hire on multi-day can have 2-day possession

Table 2.5.4. Summary of quota management and harvest for the Gulf of Mexico migratory group of king mackerel.

						Annual Harvest Levels		
Fishing Year	ABC Range[1] (lbs)	TAC (lbs)	Recreational Allocation/Quota[2] (lbs. /numbers)	Commercial Allocation	East/West-EC/WC-North-South[3,4]	Com	Rec	Total[5]
1986/87	1.2-2.9	2.9	1.97	0.93	0.60/0.27+PS=0.06	1.473	3.269	4.742
1987/88	0.6-2.7	2.2	1.5	0.70	0.48/0.22	0.868	2.145	3.013
1988/89	0.5-4.3	3.4	2.31	1.09	0.75/0.34	1.405	5.276	6.681
1989/90	2.7-5.8	4.25	2.89/298,000	1.36	0.94/0.42	1.954	3.36	5.314
1990/91	3.2-5.4	4.25	2.89/301,000	1.36	0.94/0.42	1.816	3.951	5.767
1991/92	4.0-7.0	5.75	3.91/574,000	1.84	1.27/0.57	2.117	4.773	6.89
1992/93	4.0-10.79	7.8	5.3/715,000	2.50+0.259	1.73+0.259/0.77[6]	3.599	6.258	9.857
1993/94	1.9-8.1[7]	7.8	5.3/759,000	2.5	1.73/0.77	2.572	6.146	8.718
1994/95	1.9-8.1[7]	7.8	5.3/768,000	2.05+0.300	1.73+0.300/0.77[7]	2.901	7.948	10.849
1995/96	1.9-8.1[7]	7.8	5.3/629,000	2.5	1.73/0.77	2.645	6.265	8.91
1996/97	4.7-8.8	7.8	5.3/629,000	2.5	1.73/0.77	2.864	6.933	9.797
1997/98	6.0-13.7	10.6	7.21	3.39	2.34/1.05	3.445	6.6341	10.08
1998/99	7.1-10.8	10.6	7.21	3.39	2.34/1.05	3.895	5.235	9.13
1999/00	8.0-12.5	10.6	7.21	3.39	2.34/1.05	2.953	4.067	7.02
2000/01	5.5-8.8	10.2	6.94	3.26	3.25/1.01-1/04/1.21-0.169/1.04	3.079	5.061	8.14
2001/02	5.3 - 9.6	10.2	6.94	3.26	3.25/1.01-1/04/1.21-0.169/1.04	2.932	5.163	8.095
2002/03	5.3 - 9.6	10.2	6.94	3.26	3.25/1.01-1/04/1.21-0.169/1.04	3.126	4.764[8]	7.89
2003/04	5.3 - 9.6	10.2	6.94	3.26	3.25/1.01-1/04/1.21-0.169/1.04	2.758	4.296	7.054
2004/05	5.3 - 9.6	10.2	6.94	3.26	3.25/1.01-1/04/1.21-0.169/1.04	2.904	3.26	6.164
2005/06	5.3 - 9.6	10.2	6.94	3.26	3.25/1.01-1/04/1.21-0.169/1.04	2.687	3.317	6.004
2006/07	5.3 - 9.6	10.8	7.344	3.456	3.25/1.01-1/04/1.21-0.169/1.04	3.232	4.459	7.691
2007/08	5.3 - 9.6	10.8	7.344	3.456	3.25/1.01-1/04/1.21-0.169/1.04	3.489	3.471	6.96
2008/09	5.3 - 9.6	10.8	7.344	3.456	3.25/1.01-1/04/1.21-0.169/1.04	3.855	3.146	7.001

2009/10	5.3 - 9.6	10.8	7.344	3.456	3.25/1.01-1/04/1.21-0.169/1.04	3.399	2.391	5.79
2010/11	5.3 - 9.6	10.8	7.344	3.456	3.25/1.01-1/04/1.21-0.169/1.04	3.539	2.183	5.722
2011/12	5.3 - 9.6	10.8	7.344	3.456	3.25/1.01-1/04/1.21-0.169/1.04	3.343[9]	[10]	[10]

[1] The range has been defined in terms of acceptable risk of achieving the FMP's fishing mortality rate target: the Panel's best estimate of ABC has been intermediate to the end-point of this range

[2] Recreational quota in numbers is the allocation divided by an estimate of annual weight (not used prior to fishing year 1989).

[3]East/West commercial allocations apply to all legal gears except purse seine in fishing year 1986 and are divided at the AL/FL border

[4]East zone allocations are divided into East Coast FL and West Coast FL, and West Coast FL is divided into North and South subzones.

[5]Sums within rows may not appear to equal the total value shown due to rounding of numbers before printing.

[6]0.25 million pound allocation added to commercial allocation for L East only, opened 2/18/93-3/26/93.

[7]0.3 million pounds added to hook and line quota for Florida West Coast subzone.

[8]2002-03 recreational landings, in pounds, were estimated from the average of 1999-2001 landings.

[9]2011-12 commercial landings, in pounds, were estimated from the Quota Monitoring System. Final landings will need to be updated with ALS estimates when available (09/30/2013).

[10]Data not available at time of request. Will need to be updated prior to DW (10/01/2013).

Table 2.5.5. Summary of quota management and harvest for the South Atlantic migratory group of king mackerel.

Fishing Year	ABC Range[1] (lbs)	TAC (lbs)	Recreational Allocation/Quota[2] (lbs. /numbers)	Commercial Allocation	Annual Harvest Levels Com	Rec	Total
1986/87	6.9-15.4	9.68		3.59 (PS=0.40)	2.84	5.98	8.82
1987/88	6.9-15.4	9.68	6.09	3.59 (PS=0.40)	3.453	3.905	7.358
1988/89	5.5-10.7	7.00	4.4	2.6 (PS=0.40)	3.091	4.881	7.972
1989/90	6.9-15.4	9.00	5.66/666,000	3.34	2.635	3.4	6.035
1990/91	6.5-15.7	8.30	5.22/601,000	3.08	2.676	3.718	6.394
1991/92	9.6-15.5	10.50	6.60/735,000	3.9	2.516	5.822	8.338
1992/93	8.6-12.0	10.50	6.60/834,000	3.9	2.227	6.251	8.478
1993/94	9.9-14.6	10.50	6.60/854,000	3.9	2.018	4.438	6.456
1994/95	7.6-10.3	10.00	6.29/709,000	3.71	2.197	3.728	5.925
1995/96	7.3-15.5	7.30	4.60/454,000	2.7	1.87	4.153	6.023
1996/97	4.1-6.8	6.80	4.28/438,525	2.52	2.702	3.99	6.692
1997/98	4.1-6.8	6.80	4.28/438,525	2.52	3.002	5.158	8.16
1998/99	8.4-11.9	8.40	5.28/504,780	3.12	2.675	4.268	6.943
1999/00	8.9-13.3	10.00	6.30/601,338	3.71	2.225	3.424	5.649
2000/01	8.9-13.3	10.00	6.30/601,338	3.71	2.102	6.185	8.287
2001/02	8.9-13.3	10.00	6.30/601,338	3.71	2.017	5.035	7.052
2002/03	8.9-13.3	10.00	6.30/601,338	3.71	1.738	4.574	6.312
2003/04	8.9-13.3	10.00	6.30/601,338	3.71	1.708	4.980	6.688
2004/05	8.9-13.3	10.00	6.30/601,338	3.71	2.734	5.321	8.055
2005/06	8.9-13.3	10.00	6.30/601,338	3.71	2.251	4.458	6.709
2006/07	8.9-13.3	10.00	6.30/601,338	3.71	2.995	5.127	8.122
2007/08	8.9-13.3	10.00	6.30/601,338	3.71	2.667	7.129	9.493
2008/09	8.9-13.3	10.00	6.30/601,338	3.71	3.108	4.228	9.796

2009/10	8.9-13.3	10.00	6.30/601,338	3.71	3.564	4.394	7.958
2010/11[3]	8.9-13.3	10.00	6.30/601,338	3.7	3.406	2.693	6.099
2011/12[3]	10.46	10.46	6.58/???????	3.88	2.102	6.185	8.287

[1]The range has been defined in terms of acceptable risk of achieving the FMP's fishing mortality rate target: the Panel's best estimate of ABC has been intermediate to the end-point of this range

[2]Recreational quota in numbers is the allocation divided by an estimate of annual average weight. Need to get the average weight for 2011/12 from SEFSC or from stock assessment.

[3]Mackerel Amendment 18 regulations were implemented effective 1/30/12 and the new ABC/ACL/Quotas applied to the 2011/12 fishing year. In addition, there is a recreational ACT = 6.11 million pounds. Landings from 1986/87 through 1999/2000 are from Table 2.13.4.1 in Amendment 18. Landings from 2000-2001 onwards are from Tables 3.1.1.1 and 3.1.1.2 in Amendment 20a (SEFSC, MRFSS, HBS, and TPW databases)

3. ASSESSMENT HISTORY AND REVIEW

Gulf of Mexico and south Atlantic king mackerel have been previously assessed under the SEDAR process (Southeast Data, Assessment and Review) in 2004 (SEDAR 5) and 2008. (SEDAR 16). Both the 2004 and 2008 stock assessments were benchmark assessments. Prior to the institution of the SEDAR process, stock assessments for king mackerel were conducted very frequently. Gulf of Mexico and south Atlantic king mackerel were previously assessed in 1990, 1992, 1994, 1996, 1998, 2000 and 2002 (MSAP 1990, 1992, 1994, 1996, 1998, 2000, 2002) using variations of Gavaris' (1988) ADAPT model, a method for calibrating a VPA to relative abundance data in a least-squares framework.

The 2004 assessment used VPA methods (Porch et al., 2001) incorporating information on landings and discards from 1981 primarily through 2001, size composition, size at age and sex, and catch rate information from multiple recreational and commercial fisheries. The assessment produced a wide range of values for current fishing mortality and stock status criteria under a specific stock structure with a previously determined mixing zone. Due to uncertainty in the stock-recruitment relationship, reference points were based on MSY proxies.

The 2008 (SEDAR 16) assessment considered both the VPA model (VPA-2Box; Porch et al. 2001) and a Statistical Catch at Age model (SS2; Methot 2005). As recommended by the SEDAR 16 panels, management advice was developed using the results of the VPA Model. Data sources included abundance indices, recorded landings and catch estimates, and calculated total annual sex-specific size and age composition from the fisheries. The assessment time series was 1981 through 2006. The Assessment Panel determined that the Gulf of Mexico migratory group of king mackerel was not overfished and overfishing was not occurring. They also concluded the South Atlantic migratory group of king mackerel was also not overfished; however, there was some indication that a small amount of overfishing may have been occurring.

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Porch, C. E., S. C. Turner and J. E. Powers. 2001. Virtual population analyses of Atlantic bluefin tuna with alternative models of trans-Atlantic migration: 1970-1997. ICCAT Coll. Vol. Sci. Pap. 52:1022-1045.

SEDAR. 2004. Complete Stock Assessment Report of SEDAR 5: Atlantic and Gulf of Mexico king mackerel.

SEDAR. 2008. Complete Stock Assessment Report of SEDAR 16: Atlantic and Gulf of Mexico king mackerel.

4. REGIONAL MAPS

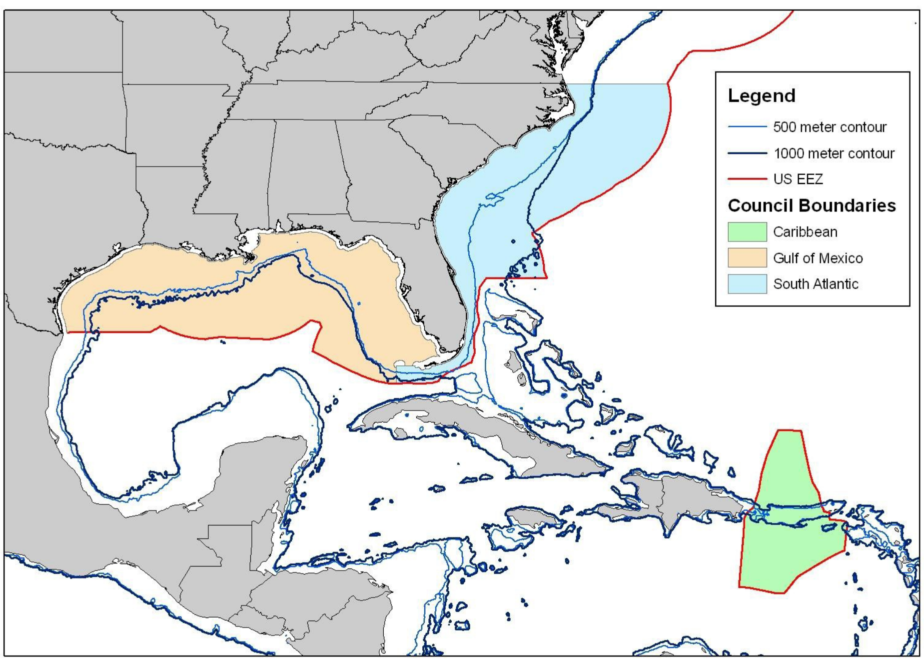

Figure 4.1 Southeast Region including Council and EEZ Boundaries.

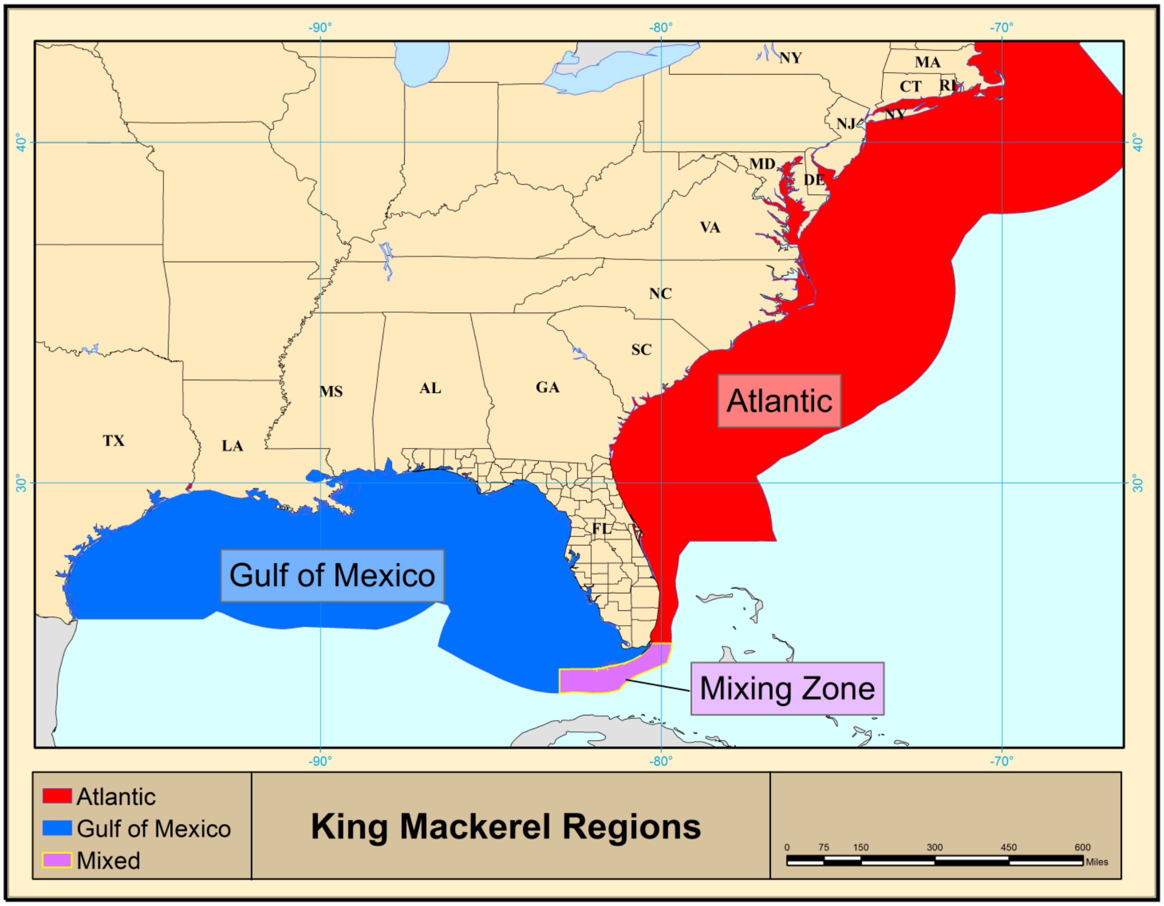

Figure 4.2 Regions used to aggregate landings for stock assessment of king mackerel in the GMFMC and SAFMC management areas (*Figure 3.1 from the Data Workshop Report*).

5. 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
AMRD	Alabama Marine Resources Division
ASMFC	Atlantic States Marine Fisheries Commission
B	stock biomass level
BAM	Beaufort Assessment Model
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 that will result 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
F0	a fishing mortality close to, but slightly less than, Fmax
FL FWCC	Florida Fish and Wildlife Conservation Commission
FWRI	(State of) Florida Fish 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
HMS	Highly Migratory Species
LDWF	Louisiana Department of Wildlife and Fisheries
M	natural mortality (instantaneous)
MARMAP	Marine Resources Monitoring, Assessment, and Prediction
MDMR	Mississippi Department of Marine Resources
MFMT	maximum fishing mortality threshold, a value of F above which overfishing is deemed to be occurring
MRFSS	Marine Recreational Fisheries Statistics Survey
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
SEAMAP	Southeast Area Monitoring and Assessment Program
SEDAR	Southeast Data, Assessment and Review
SEFIS	Southeast Fishery-Independent Survey
SEFSC	Fisheries Southeast Fisheries Science Center, National Marine Fisheries Service
SERO	Fisheries 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
SS	Stock Synthesis
SSC	Science and Statistics Committee
TIP	Trip Incident Program; biological data collection program of the SEFSC and Southeast States.
TPWD	Texas Parks and Wildlife Department
Z	total mortality, the sum of M and F

SEDAR

Southeast Data, Assessment, and Review

SEDAR 38

Gulf of Mexico and South Atlantic King Mackerel

SECTION II: Data Workshop Report

March 2014

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

This information is distributed solely for the purpose of pre-dissemination peer review. It does not represent and should not be construed to represent any agency determination or policy.

Table of Contents

1. INTRODUCTION

1.1 WORKSHOP TIME AND PLACE

The SEDAR 38 Data Workshop was held December 9-13, 2014 in Charleston, South Carolina.

1.2 TERMS OF REFERNCE

1. Review stock structure and unit stock definitions and consider 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 these species as well as similar species from the southeastern United States and 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 benchmark or other prior assessment.
4. Provide measures of population abundance that are appropriate for stock assessment.
   - Consider and discuss all available and relevant 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.
   - Discuss the degree to which available indices adequately represent fishery and population conditions.
   - Recommend which data sources are considered adequate and reliable for use in assessment modeling.
   - Complete the SEDAR index evaluation worksheet for each index considered.
   - Rank the available indices with regard to their reliability and suitability for use in assessment modeling.
5. Describe any environmental covariates or episodic events that would be reasonably expected to affect population abundance.

6. Provide commercial catch statistics, including both landings and discards in both pounds and number.
   - Evaluate and discuss the adequacy of available data for accurately characterizing harvest and discard by species and fishery sector or gear.
   - Provide length and age distributions for both landings and discards if feasible.
   - Provide maps of fishery effort and harvest.
7. Provide recreational catch statistics, including both landings and discards in both pounds and number.
   - Evaluate and discuss the adequacy of available data for accurately characterizing harvest and discard by species and fishery sector or gear.
   - Provide length and age distributions for both landings and discards if feasible.
   - Provide maps of fishery effort and harvest.
8. Provide recommendations for future research in areas such as sampling, fishery monitoring, and stock assessment. Include specific guidance on sampling intensity (number of samples including age and length structures) and appropriate strata and coverage.
9. Prepare the Data Workshop report providing complete documentation of workshop actions and decisions in accordance with project schedule deadlines (Section II of the SEDAR assessment report).

1.3 LIST OF PARTICIPANTS

Workshop Panel

Matt Lauretta, Lead Analyst................................NMFS Miami
Michael Schirripa, Lead Analyst................................NMFS Miami
John Walter, Lead Analyst................................NMFS Miami
Jason Adriance................................Gulf SSC
Neil Baertlein................................NMFS Miami
Peter Barile................................Marine Resources & Consulting
Donna Bellais................................GSMFC
Jeanne Boylan................................SEAMAP
Ken Brennan................................NMFS Beaufort
Steve Brown................................FL FWC
Mary Christman................................Gulf SEDAR AP
Julie Defilippi................................ACCSP
Doug Devries................................NMFS Panama City
Amy Dukes................................SC DNR
Kelly Fitzpatrick................................NMFS Beaufort
Dave Glockner................................NMFS Miami
David Hanisko................................NMFS Pascagoula
Eric Hiltz................................SC DNR
Rusty Hudson................................DSF, Inc.
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Ed Martino.. ACCSP
Vivian Matter ....NMFS Miami
Kevin McCarthy..NMFS Miami
Stephanie McInerny ....NC DMF
Refik Orhun...NMFS Miami
Chris Palmer ....NMFS Panama City
Will Patterson..Gulf SSC
Jon Richardson ....SEAMAP
Beverly Sauls...FL FWC
Tracy Smart .... MARMAP
Bob Zales II .... Gulf CMP AP

Council Representation
Anna Beckwith ....SAFMC
Ben Hartig ....SAFMC

Attendees
Mark Brown .... SAFMC SG AP
Matt Nuttall ....RSMAS
Skyler Sagarese ....RSMAS/SEFSC
Andrew Shuler... NMFS/JHT

Staff
Julie Neer..SEDAR 38 Coordinator
Craig Brown ....NMFS Miami
Julia Byrd ....SEDAR
Tyree Davis ....NMFS Miami
Mike Errigo ....SAFMC
Clay Porch ....NMFS Miami
Ryan Rindone .... GMFMC

Additional Participants via Webinars
Adam Pollack .... NMFS Pascagoula
Marcel Reichert ....SA SSC
Jim Tolan.. Gulf SSC
Chris Wilson...NC DMF

1.4 LIST OF DATA WORKSHOP WORKING PAPERS & REFERNCE DOCUMENTS

Document #	Title	Authors	Date Submitted
Documents Prepared for the Data Workshop			
SEDAR38-DW-01	King mackerel (*Scomberomorus cavalla*) larval indices of relative abundance from SEAMAP Fall	David S. Hanisko and Joanne	10 Dec 2013

	Plankton Surveys, 1986 to 2012	Lyczkowski-Shultz	
SEDAR38-DW-02	King mackerel abundance indices from SEAMAP groundfish surveys in the Northern Gulf of Mexico	Adam G. Pollack and G. Walter Ingram, Jr.	10 Dec 2013 Addendum – 30 Dec 2013
SEDAR38-DW-03	King mackerel abundance indices from NMFS small pelagics trawl surveys in the Northern Gulf of Mexico	Adam Pollack and G. Walter Ingram, Jr.	10 Dec 2013
SEDAR38-DW-04	Standardized catch indices of king mackerel from the U.S. Marine Recreational Fisheries Statistics Survey, 1981 to 2012	Matthew Lauretta and John F. Walter	22 Nov 2013
SEDAR38-DW-05	SEDAR standardized report cards used for review of indices of abundance for Atlantic and Gulf of Mexico king mackerel	SEDAR 38 Indices Working Group	7 January 2014
SEDAR38-DW-06	Standardized catch rates of Atlantic king mackerel (*Scomberomorus cavalla*) from the North Carolina Commercial fisheries trip tickets 1994-2013	John Walter and Stephanie McInerny	22 Nov 2013
SEDAR38-DW-07	Analysis of environmental factors affecting king mackerel landings along the east coast of Florida	Peter J. Barile	22 Nov 2013
SEDAR38-DW-08	Analysis of annual, monthly and weekly king mackerel landings in the east FL "mixing zone" : evidence of stock migrations and a "resident" population on the east coast of FL	Peter J. Barile	22 Nov 2013
SEDAR38-DW-09	Sampling History of the King Mackerel Commercial Fisheries in the Southeastern United States by the Federal Trip Interview Program (TIP)	Courtney R. Saari	22 Nov 2013
SEDAR38-DW-10	Standardized catch rates of from commercial logbook data for king mackerel from the United States Gulf of Mexico, South Atlantic, and Mixing Zone, 1993-2013	John F. Walter and Kevin J. McCarthy	6 January 2014
SEDAR38-DW-11	King mackerel index of abundance in coastal US South Atlantic waters	Tracey I. Smart	22 Nov 2013

	based on a fishery-independent trawl survey	and Jeanne Boylan	Addendum – 30 Dec 2013
SEDAR38-DW-12	Trends from Non-CPUE Standardized King mackerel Landing Logs from Long Bay, South Carolina Recreational Pier Fishery	Christian Johnson	22 Nov 2013
SEDAR38-DW-13	King Mackerel Historical Pictures Summary	Rusty Hudson	22 Nov 2013
SEDAR38-DW-14	SEDAR 16 King Mackerel Review Panel Information Provided by Ben Hartig	Ben Hartig	29 Nov 2013
SEDAR38-DW-15	A review of Gulf of Mexico and Atlantic king mackerel *(Scomberomorus cavalla)* age data, 1986 – 2013, from the Panama City Laboratory, Southeast Fisheries Science Center, NOAA Fisheries Service	Chris Palmer, Doug DeVries, Carrie Fioramonti, and Hannah Lang	3 Dec 2013 Addendum: 7 January 2014
SEDAR38-DW-16	Updated standardized catch rates of king mackerel (*Scomberomorus cavalla*) from the headboat fishery in the U.S. Gulf of Mexico and U.S. South Atlantic	Matt Lauretta and Shannon L. Cass-Calay	6 Dec 2013 Addendum: 3 January 2014
SEDAR38-DW-17	Historical For-Hire Fishing Vessels South Atlantic Fishery Management Council 1930s to 1985	Rusty Hudson	3 January 2014
SEDAR38-DW-18	Historical photographs of For-Hire Fishing Vessels 1930s to 1985	Rusty Hudson	3 January 2014
Reference Documents			
SEDAR38-RD01	Spatial and temporal variability in the relative contribution of king mackerel (*Scomberomorus cavalla*) stocks to winter mixed fisheries off South Florida	Todd R. Clardy, William F. Patterson III, Douglas A. DeVries, and Christopher Palmer	
SEDAR38-RD02	King mackerel population dynamics and stock mixing in the United States Atlantic Ocean and Gulf of Mexico	Katherine E. Shepard	

SEDAR38-RD03	A Cooperative Research Approach to Estimating Atlantic and Gulf of Mexico: King Mackerel Stock Mixing and Population Dynamics Parameters	William F. Patterson III and Katherine E. Shepard
SEDAR38-RD04	Contemporary versus historical estimates of king mackerel (*Scomberomorus cavalla*) age and growth in the U.S. Atlantic Ocean and Gulf of Mexico	Katherine E. Shepard, William F. Patterson III, Douglas A. DeVries, and Mauricio Ortiz
SEDAR38-RD05	Trends in Atlantic contribution to mixed-stock king mackerel landings in South Florida inferred from otolith shape analysis	Katherine E. Shepard, William F. Patterson III, and Douglas A. DeVries
SEDAR38-RD06	Coastal upwelling in the South Atlantic Bight: A revisit of the 2003 cold event using long term observations and model hindcast solutions	Kyung Hoon Hyun and Ruoying He
SEDAR38-RD07	FishSmart: An Innovative Role for Science in Stakeholder-Centered Approaches to Fisheries Management	Thomas J. Miller , Jeff A. Blair , Thomas F. Ihde , Robert M. Jones, David H. Secor & Michael J. Wilberg
SEDAR38-RD08	FishSmart: Harnessing the Knowledge of Stakeholders to Enhance U.S. Marine Recreational Fisheries with Application to the Atlantic King Mackerel Fishery	Thomas F. Ihde, Michael J. Wilberg, David H. Secor, and Thomas J. Miller
SEDAR38-RD09	SEDAR 16 Final Document List	SEDAR 16 Panels
SEDAR38-RD10	History of fishing in Ponce Inlet	The Quarterly Newsletter of the Ponce de Leon Inlet Lighthouse Preservation Association, Inc.
SEDAR38-RD11	Biological-Statistical Census of the Species Entering Fisheries in the Cape Canaveral Area	William W. Anderson and Jack W. Gehringer

2. LIFE HISTORY

2.1 OVERVIEW

The life history working group (LHG) reviewed information on stock structure and mixing, natural mortality, age, growth, reproduction, movements and migration, age sampling, and size and age composition of the fisheries. Discard mortality was addressed by an ad hoc group.

The primary issue discussed by the LHG were the implications on stock and mixing zone boundaries based on analyses of new information on the temporal progression of landings and CPUE southward along the Florida Peninsula in late fall and then northward in late winter in both commercial and recreational fisheries, as well as the same progression among the Gulf states of Mexico. There were also discussions on the increasing contributions of age samples from the Gulf States Marine Fisheries Commission partners and the shifting spatial distribution of age sampling in the Gulf, specifically significant increases in Louisiana and Texas. Overall, there was very little discussion on most of the topics the LHG was responsible for because of the lack of any new research or information on king mackerel since SEDAR16.

2.1.1. Group leader and membership

Doug DeVries (Leader) …………………………………………………….NMFS-Panama City
Jason Adriance ……………………………………………………………………LA LDWF
Chris Palmer …………………………………………………………….NMFS-Panama City
Will Patterson (GMFMC SSC) ………………………………………………U. South Alabama
Clay Porch (Intermittent) ……………………………………………………………NMFS-Miami
Ben Hartig (Intermittent) ……………………………………SAFMC/Commercial fisherman
Peter Barile (Intermittent)…………………………………………………….......Consultant
Tracey Smart (Day 1 only) ………………………………………………………. SC DNR
Beverly Sauls (ad hoc discard mortality group)……………………………………...FL FWC
Kevin McCarthy (ad hoc discard mortality group) ……………………………….. NMFS-Miami
Linda Lombardi (not present but calculated all growth equations)………....NMFS-Panama City

2.2 REVIEW OF WORKING PAPERS

SEDAR38-DW-07: Analysis of environmental factors affecting king mackerel landings along the east coast of Florida.

In winter king mackerel from both the Gulf and Atlantic stocks migrate to warmer southeast and south Florida waters, an area known as the "mixing zone", where water and air temperature are moderated by the Florida current. Changes in temperature regimes within this mixing zone may have measurable and predictable effects on the composition of stocks within the mixing zone along with the migration and persistence of Atlantic and GOM stocks into the southeast and south Florida. Several environmental drivers could influence the temperature regimes, including meteorologically significant seasonal weather patterns such as historically cold winters as well as regionally significant climatological (e.g. El Nino & La Nina) and summer upwelling events; and such information should be considered for incorporation into fisheries models. A comparison of mean Dec. and Jan. surface water temperatures off Cape Canaveral, FL with monthly king mackerel landings suggested a positive relationship. The author noted that the intensity and frequency of ENSO events increased in the last 2 decades of the past century but presented conflicting evidence on the relationships of such events to winter king mackerel landings in recent years. The author also speculated that persistent summer cold water upwelling events off east Florida, such as occurred in 2003, likely reduce king mackerel landings, but again he presented conflicting evidence.

The latter portion of SEDAR38-DW-07 began with a review of the tagging evidence used to justify the original stock designations, boundaries, and mixing zone. The author correctly noted that the characterization of two distinct migratory groups of king mackerel in a south Florida mixing zone during Nov- Mar and the assignment of all fish in that zone during those months to the GOM migratory group was a management tool to support the conservation and recovery of that long-overfished stock. Lastly, the author reviewed the more recent studies of king mackerel stock structure using otolith shape, micro-constituent and stable isotope analyses, and more in-depth reanalysis of all earlier tagging studies. He correctly noted that 1) those studies supported his contention that the winter mixing zone off of SE Florida is dominated by Atlantic stock, whereas Gulf stock pre-dominates stock composition along the SW Florida coast, and 2) that in their report the SEDAR 16 DW Life History group stated “A consistent pattern of greater estimates of Gulf group contribute to stock off of SW Florida, and greater estimates of the Atlantic group contribute off of SE Florida has been observed among studies.”

SEDAR38-DW-08: Analysis of annual, monthly and weekly king mackerel landings in the east FL "mixing zone": evidence of stock migrations and a "resident" population on the east coast of FL

This document presents highly resolved landings data from the east coast of Florida at explicit time and spatial scales which the author contends can provide an understanding of latitudinal migrations of king mackerel. Seasonal and geographic shifts and patterns in landings and trip data from Florida’s trip ticket database, 1995-2011, were examined to characterize Atlantic king mackerel stock migrations into and out of the east Florida “mixing zone”. Plots by county of total annual landings, long-term monthly landings proportions, nominal CPUE annual means and CPUEs for significant landings months were presented in a latitudinal gradient (north to south) for Volusia, Brevard, Indian River, St, Lucie, Martin and Palm Beach counties. Weekly landings data for April 2009 and 2010 were also presented in an attempt to resolve migration patterns in the historically cold winter of 2010, when the king mackerel mixing zone was thought to be spatially constricted. Monthly landings data from that portion of the mixing zone north of Broward County revealed peak landings (north to south) for Volusia Co. in November, Brevard Co. in December, Indian River Co. in January; and for St. Lucie Co., Martin Co., and Palm Beach Co. all in May. The author noted an apparent sinusoidal pattern in landings peaks at ~ 10 year intervals, with the most recent peak in 2008-2010. The author also concluded there was evidence for a “resident” summer population (July-August, during the Atlantic stock fishing season) in all east Florida counties.

SEDAR38-DW-015: A review of Gulf of Mexico and Atlantic king mackerel *(Scomberomorus cavalla)* age data, 1986 – 2013, from the Panama City Laboratory, Southeast Fisheries Science Center, NOAA Fisheries Service

This report primarily provides an overview of the temporal and spatial distributions, as well as distributions by fishery and gear, of king mackerel age samples from 1986 through 2013 aged by the Panama City Laboratory of the Southeast Fisheries Science Center, NOAA Fisheries Service. It also provides sex-, stock-, and, in some cases, fishing sector-specific information on size and age distributions and sizes at age of those data. Besides an overview of the age data, the report also details data sources, ageing protocols, and quality control and sub-sampling procedures. A total of 60,672 king mackerel from fishing year (FY) 1985-1986 through early in FY 2013-2014 (25,390 from the Gulf of Mexico (GOM) migratory group, 22,300 from the Atlantic group, and 12,982 from the winter mixing zone) were aged by the Panama City Laboratory and those data are being made available for SEDAR 38. Ages ranged from 0 to 26 yr in the Atlantic, 0 to 24 yr in the GOM, and 0 to 17 yr in the winter mixing zone. The primary reader (C. Palmer) aged various overlapping subsets of whole or sectioned otoliths from 2007 or 2012 with three other readers, and in each case precision rates were high (i.e., average percent error (APE) of 2.3-5.1%). Of all aged samples, 46% were from the commercial sector, 24% from the non-tournament recreational sector, and 24% from tournaments. The vast majority of commercial samples fish, over 88%, were collected with hook and line gear.

2.3 STOCK DEFINITION AND DESCRIPTION

King mackerel range in the western Atlantic Ocean from the northeastern US to Brazil, including waters of the Gulf of Mexico (Gulf) and Caribbean Sea (Collette and Nauen 1983). King mackerel have been managed as a single stock in US waters since the inception of the Coastal Pelagics Management Plan (CPMP), which was jointly created by the Gulf of Mexico and South Atlantic Fishery Management Councils in 1983 (GMFMC and SAFMC 1983). While a single stock is still assumed, the first amendment to the CPMP instituted the premise that fish in US Atlantic and Gulf waters constitute two separate migratory groups (GMFMC and SAFMC 1985). The two migratory group approach was supported at the time by tag recapture data that indicated Gulf and Atlantic fish undertook separate seasonal migrations (Powers and Eldridge 1983; Sutter et al. 1991). While later genetic analyses confirmed Gulf and Atlantic fish are genetically distinct (Gold et al. 1997; Gold et al. 2002), other evidence exists that two distinct migratory groups may exist within the Gulf alone. That evidence, as well as results from various studies examining broader issues of king mackerel population structure and connectivity, is reviewed in this section. Data sources from which inference is drawn with respect to population structure include tagging studies, analysis of regional differences in population demographics, population genetics analyses, estimates of population mixing computed from natural tags derived from otolith shape and chemistry, and the temporal and spatial progression of fisheries landings as Atlantic, eastern Gulf, and western Gulf migratory groups undertake annual migrations.

Fishermen and scientists alike have long known that king mackerel, like many other scombrids, undertake seasonal migrations. For example, catch per unit of effort is correlated with water temperature in the eastern Gulf and Atlantic waters of the US southeast and fishery-dependent data clearly demonstrate an increase in fish availability in winter off south Florida (Fable et al. 1981; Trent et al. 1987). Perhaps the greatest information on seasonal migrations has come from mark-recapture studies conducted off the southeastern US in the Atlantic and Gulf of Mexico. While that information is reviewed more extensively in Section 2.9 below, some of it also will be discussed here in the context of king mackerel population structure.

Several tagging studies have been conducted to examine movement and mixing in king mackerel in US waters. Tagging studies conducted in the 1970s and 1980s demonstrated that king mackerel in the eastern GOM and Atlantic migrate along the Florida peninsula in late fall and overwinter off south Florida where large gillnet and troll fisheries are prosecuted on the mixed stock. As water temperatures warm in spring, fish migrate northward and return to summer spawning grounds (Powers and Eldridge 1983; Sutter et al. 1991; Schaefer and Fable 1994). Fishery-dependent data from winter fisheries off Louisiana, North Carolina, and Florida suggest most of the seasonal migrants are small, young fish (e.g., < 6 years old), which is also supported by tagging data. Fable et al. (1987) reported larger fish tagged in summer off south Louisiana tended to remain resident in the northern Gulf in winter, while smaller individuals tended to be recaptured either off south Florida or in Mexican waters in winter. Fish tagged off Vera Cruz, Mexico in winter subsequently were mostly recaptured in the northern Gulf of Mexico. Therefore, not only do tagging data corroborate the inference that Gulf and Atlantic fish mix in winter off south Florida, but recaptures in the western Gulf indicate winter mixing may also occur between fish from the western US Gulf and fish resident in Mexican waters (Arreguin-Sanchez et al.1995).

Differences in population demographics among regions in US waters provide further evidence that distinct Atlantic, eastern Gulf, and western Gulf populations (or migratory groups) of king mackerel exist. Little reproductive biology information is available with which to examine inter-populational differences (e.g., Finucane et al. 1986; Fitzhugh et al. 2008), but there is some evidence that spawning seasonality is distinct among regions (Collins et al. 1987; DeVries et al. 1990; Grimes et al.1990; Johnson et al. 1994). The most compelling evidence for inter-populational differences in demographic patterns comes from age and growth estimates derived from examination of otolith microstructure. DeVries et al. (1997) reported interregional differences existed in population growth rate estimates among fish sampled in the south Atlantic, eastern Gulf, and western Gulf, which they concluded supported the suggestion made by Johnson et al. (1994) that eastern and western Gulf fish constituted separate stocks. Shepard et al. (2010b) also reported significant differences in growth and size at age between eastern Gulf and Atlantic migratory group fish, as well as between males and females. However, Shepard et al. (2010b) also reported that size at age was significantly different for both sexes and stock among time stanzas in the 1980s, 1990s, and 2000s, with Atlantic fish being approximately 5% larger at age and eastern Gulf fish approximately 5% smaller at age during the most recent time period. They attributed this finding to density dependent growth effects as the Atlantic spawning stock biomass was estimated to decline and the Gulf stock biomass to increase since the 1990s.

Genetic differences reported between fish sampled in the eastern and western Gulf were among the evidence cited by Johnson et al. (1994) that fish in those regions constituted separate stocks. In their work on protein allozymes, they reported allelic variability of one polymorphic dipeptidase locus was significantly different between eastern and western Gulf fish. However, Gold et al. (1997) later showed that difference was confounded by correlations with age and sex. Furthermore, Gold et al. (1997, 2002) reported results from mitochondrial (mtDNA) and nuclear microsatellite DNA analyses did not indicate genetic differences existed between eastern and western Gulf fish. Results of Gold et al.'s (1997, 2002) studies did demonstrate that eastern Gulf and Atlantic fish are genetically distinct, although differences between the populations, while statistically significant, are weak. It should be noted, however, that any finding of significantly different genetic variability between king mackerel populations is remarkable given the amount of straying demonstrated among regions with tagging data. Furthermore, a lack of a significant genetic difference in selectively neutral markers, such as mtDNA or nuclear DNA microsatellites, is not definitive evidence that interregional population structure does not exist (Nolan et al. 1991; Pruett et al. 2005).

Gold et al. (2002) attempted to use the nuclear microsatellite library they developed for king mackerel to distinguish Gulf from Atlantic fish around the Florida peninsula, a feat that tagging data repeatedly have been found to be ill-suited to perform. They reported that estimates of the stock composition of their samples rarely deviated from a 50:50 split (± 10%) of Gulf to Atlantic fish regardless of where along the coast of Florida samples were collected. This finding may indicate equal proportions of Gulf and Atlantic fish were present, or that natural tags derived from inter-stock genetic variability were too weak to distinguish Gulf from Atlantic fish effectively.

Stock markers based on otolith shape and otolith chemistry have proven to be the most effective natural tags yet found to distinguish eastern Gulf from Atlantic king mackerel, with the principle goal being to distinguish the two stocks as they mix off south Florida in winter. DeVries et al. (2002) reported differences in sagittal otolith shape parameters were significant between Atlantic and Gulf females in summer 1996 (when stocks were separate), and that discriminant function analysis of shape data classified 71% of Atlantic and 78% of Gulf fish accurately. The authors then parameterized a maximum likelihood mixing model with the same set of variables to estimate the stock composition of females sampled during winter 1996/97 off southeast Florida in the region near Cape Canaveral. They estimated 99.8% (SE = 3.4%) of winter samples belonged to the Atlantic migratory group. Furthermore, the authors concluded that otolith shape analysis suggested the migratory groups effectively did not mix in their winter sampling area in 1996/97. In a similar approach, Clardy et al. (2008) were able to distinguish female and male mackerel between Gulf and Atlantic groups sampled in summer 2001 and 2002 with between 65 and 82% accuracy with otolith shape characteristics. Maximum likelihood estimates of the stock identity of fish collected in three zones around southern Florida in winter 2001/02 and 2002/03 indicated fish off southwest Florida (north of the Florida Keys and Dry Tortugas) were up to 85% Gulf group, while fish off southeast Florida (most samples were from Jupiter inlet to Cape Canaveral) were up to 84% Atlantic group.

Shepard et al. (2010a) took a similar approach as Clardy et al. (2008) to estimate winter mixing off south Florida in winter 2006/07 and 2007/08 with otolith shape analysis. However, they also examined the temporal variability in mixing in their eastern-most sampling zone off southeast Florida by collecting monthly samples from December through March in that zone. They reported estimated Gulf group contribution was >80% off southwest Florida (north of the Florida Keys and Dry Tortugas), while off southeast Florida (most samples were from Jupiter inlet to Cape Canaveral) the estimated Gulf contribution was typically <30%, and <20% in February and March. Both Clardy et al. (2008) and Shepard et al. (2010) reported that winter samples collected in their zone II, which was south of the Florida Keys, were estimated to be approximately 50% Gulf stock.

Results of studies in which otolith chemical signatures were employed to examine winter mixing between king mackerel stocks are consistent with those produced with otolith shape analysis, although higher stock-specific classification success was achieved, thus tighter confidence intervals for winter mixing estimates. Patterson et al. (2004) examined differences in king mackerel migratory group-specific otolith elemental signatures with the same samples for which Clardy et al. (2008) examined otolith shape parameters. Classification accuracies computed from sex-specific linear discriminant functions (LDFs) with elemental concentrations (Ba, Mn, Mg, and Sr) as dependent variables ranged from 69 – 91%. Otolith chemistry-based maximum likelihood estimates of the stock identity of fish collected in the three south Florida winter zones mirrored results from otolith shape analysis: fish in the southwestern zone were mostly Gulf fish and fish in the southeastern zone were predominantly Atlantic fish. More recently, Shepard et al. (2008a) and Patterson and Shepard (2008) examined stock mixing among winter sampling zones off south Florida with otolith shape and otolith stable isotope ($\delta^{13}C$ and $\delta^{18}O$) analysis, respectively. They reported successful discrimination between eastern Gulf and Atlantic fish sampled in summer 2006 (mean success of 66% with otolith shape data and 81% with stable isotopes). Estimates of the Atlantic migratory group's contribution to south Florida winter landings were consistent between otolith-based approaches, with a higher percentage of Gulf fish estimated to have been landed off southwestern Florida (as high as 73% for males) and a higher percentage of Atlantic fish estimated to have been landed off southeastern Florida (as high as 93% for females). Overall, results from all otolith-based (shape or chemistry) studies of king mackerel population mixing have suggested that mixing is spatially variable around the tip of southern Florida, as well as temporally variable within a given winter and among winters. However, a consistent pattern has been observed among studies with higher estimates (>80%) of Gulf group contribution off southwest Florida, greater estimates (>90%) of Atlantic group contribution off southeastern Florida, and a near even mix between the stocks in winter landings sampled in Monroe County from fish caught south of the Florida Keys.

New information was presented at the Data Workshop about the temporal progression of king mackerel recreational landings along the east coast of Florida among months within recent fishing years. That approach was extended throughout the year and along both the east and west coasts of Florida but with recreational CPUE and commercial landings data (Barile 2013). Similarly, monthly king mackerel landings for Mexican states that border on the Gulf of Mexico were plotted to examine the temporal and spatial distribution of landings across the winter months. In the case of Florida landings, deciphering patterns is problematic given the various fishing sector seasons and the potential for little effort to be expended when local abundance of king mackerel is high. However, it is apparent in results from both the commercial landings and recreational CPUE monthly composites (**Figures 2.15.1 and 2.15.2**) that a progression of landings moving southward along both the west and east coasts of Florida occur in fall and then a return south-north trend occurs starting in late winter. That should not be surprising given historic landings and tagging data were utilized to inform the original winter mixing zone. However, what is also apparent in the commercial landings plots is that almost no winter landings are taken in the commercial fishery off SE Florida between Palm Beach County and the Monroe (the Florida Keys)/Dade County line. Greater recreational CPUE exists in winter months off Brevard to Broward Counties, but a clear progression of elevated CPUE from north to south from fall into winter suggests a large percentage of that rise in CPUE is likely contributed by the Atlantic, not Gulf stock. That inference is also supported by tagging and otolith shape and chemistry results.

Monthly progressions of Mexican landings of king mackerel also indicate a seasonal component to that fishery. King mackerel landings were reported from all Mexican states throughout the year, but there is a clear peak in winter when a north-south progression of landings is apparent in late fall, and then a south-north progression of landings occurs in late winter (**Figure 2.15.3**). This pattern is similar to what is seen in the Florida data as well as what is known from tagging and otolith-based mixing studies in Florida. Therefore, it is likely that king mackerel from US western Gulf waters make seasonal migrations into Mexico where they are subjected to a robust Mexican fishery (Chavez and Arreguin-Sanchez 1995). However, no data exist to estimate the percentage of Mexican winter landings contributed by the western Gulf migratory group, or the percentage of western Gulf fish that actually migrate into Mexican waters in winter.

In summary, a distinct picture of king mackerel population structure begins to come into focus when results of tagging, population demographics, population genetics, and otolith-based stock mixing studies are viewed in total. **Figure 2.15.1** depicts the hypothesized population structure of king mackerel in U.S. waters, as first proposed during SEDAR 16. Tagging data clearly show that relatively small, young fish from the eastern Gulf and Atlantic mix off south Florida in winter; fish from the eastern Gulf and western Gulf mix in the north central Gulf in summer; and at least some young migrants from the western Gulf migrate into Mexican waters in winter. Population demographic patterns, such as they are known, among eastern Gulf, western Gulf, and Atlantic regions are consistent with the interpretation that distinct migratory groups, or populations, exist among those regions. Genetics data confirm differences exist between eastern Gulf and Atlantic fish, but mixing between eastern and western Gulf populations during summer when spawning occurs likely precludes genetic divergence between those groups. Otolith-based analyses of stock mixing off south Florida in winter have consistently resulted in greater estimates of Gulf group contribution to winter southwest Florida landings, while the converse is true of estimates from southeastern Florida. To gain a more complete understanding of population structure, future work should be aimed at estimating mixing between eastern Gulf and western Gulf populations, as well as attempting to estimate the vulnerability of western Gulf fish to overfished Mexican fisheries in winter (Chavez and Arreguin-Sanchez 1995).

While some of the mixing dynamics among king mackerel migratory contingents remain unknown, the LHG carefully considered historic estimates of stock mixing and new information on the temporal progression of landings southward along the Florida Peninsula in late fall and then northward in late winter, as well as the same progression among the Gulf states of Mexico, and concluded that a refinement of the what is considered the winter mixing zone off south Florida should be made. The data suggest that the best approach is to establish the management mixing zone in the area south of the Florida Keys and Dry Tortugas, demarcated in the west by a line west from Key West to the Dry Tortugas at 24°35' N. lat, then south at 83º W from the Dry Tortugas (the Gulf of Mexico/South Atlantic Council boundary) to the shelf edge, and in the east from the Dade-Monroe county line to the shelf edge (see Figure 3.1 in Commercial Fishery Statistics section). King mackerel captured in this zone from November 1 to March 31 should be assigned 50:50 to Gulf and Atlantic stocks.

The issue of what impact Mexican fisheries have on western Gulf king mackerel, and potential implications for estimates of Gulf stock productivity and status, was raised by the LHG during SEDAR 16, and those concerns persist. Analysis of the temporal progression of king mackerel landings among Mexican states (**Figure 2.15.3**) suggests a north-south movement of fish during late fall and early winter, and then movement from south to north in late winter and early spring. If those landings trends do in fact reflect season movement of fish, then they would be consistent with the movement observed in the Atlantic and eastern Gulf migratory groups as they move to south Florida in winter. Furthermore, exploration of satellite surface temperature data during the Data Workshop indicated similar temperature regimes occurred in the western Gulf from Texas into Mexican waters as they did in the eastern Gulf along peninsular Florida. While no age composition or fishery indices exist to fully incorporate Mexican landings into a multi-stock assessment model, the LHG recommends two sensitivity analyses to gauge the potential impact of Mexican landings and Gulf stock productivity and biomass estimates:

1) Conduct a sensitivity analysis which examines the effect of removing data from the western Gulf (defined as west or northwest of the mouth of the Mississippi River, i.e., Southwest Pass) under the assumption that these data reflect the dynamics of a distinct migratory unit that is shared with Mexico, and understanding that this is a simple approach which ignores any sort of mixing zone.

2) Conduct a sensitivity analysis in which king mackerel landings in U.S. waters of the western Gulf along with those made in Mexican waters are contributed by a single western Gulf stock.

2.4 NATURAL MORTALITY

Given that the estimates of maximum age have not changed since SEDAR16 (SEDAR38-DW-15) (**Figures 2.15.5, 2.15.6, and 2.15.7**), and there have been no new studies examining natural mortality rates in king mackerel, the LHG recommends using the same values and methods recommended in SEDAR16. The LHG does recommend that the new growth equations generated for SEDAR38 be used in calculating the new Lorenzen curve, so those curves may differ slightly from those generated for SEDAR16. The following is quoted from SEDAR 16 – SAR – Section II: "Application of Hoenig's (1983) regression based on fish data only to these maximum age estimates (26 yr for the Atlantic, 24 yr for the Gulf) suggests average M values of 0.17 yr^{-1} and 0.16 yr^{-1} for the Gulf and Atlantic, respectively.

Consistent with the recommendations of previous SEDAR panels for other species, the group recommends modeling the natural mortality rate of king mackerel as a declining 'Lorenzen' function of size (translated to age by use of a growth curve) (Lorenzen 1996). The Lorenzen curve should be scaled such that the average value of M over the range of fully-selected ages (in this case age 2 up to the maximum age) is the same as the point estimate from Hoenig's (1983) regression – 0.17 for the Gulf and 0.16 for the Atlantic. Separate functions should be developed for the Gulf and Atlantic migratory units owing to differences in the observed maximum age and growth. Preliminary calculations of M based on the growth information available at the data workshop are shown in **Figure 2.15.2**. It should be noted that a consequence of scaling the Lorenzen curve to ages 2 and older is that the cumulative natural mortality rate on ages 1 and older is slightly higher than in previous assessments. However, inasmuch as Hoenig's paper was based primarily on catch curve analyses of fully-selected age classes, it would seem more appropriate to apply the resulting estimates of M only to fully selected ages. In any case, the impact of this change is likely to be small as age 1 fish constitute a small fraction of the catch.

The value of M for the plus-group should be computed as a weighted average of the natural mortality rates for the age classes from the first age in the plus-group to the maximum age. In principle, the weights should reflect the declining relative abundance of older age classes, but the results are usually relatively insensitive to the discount rate selected as long as the plus-group is reasonably large. It is considered sufficient to compute the weights based on the expected decline in abundance with age under equilibrium conditions without fishing. This exercise, however, does not address the larger question that natural mortality is poorly known."

LHG Recommendations for the AW:

1) Model the natural mortality rate of king mackerel as a declining Lorenzen function of size, incorporating the new growth equations generated for SEDAR38 in calculating the function.

2.5 DISCARD MORTALITY

(Provided by Beverly Sauls, leader of ad-hoc discard mortality work group)

This section summarizes the results of an ad-hoc meeting that was convened during the SEDAR 38 Data Workshop (DW) and was open to all DW participants. Representatives from the recreational and commercial fisheries were present and contributed to the discussion. Recommendations were presented to all participants of the DW and approved during plenary on December 12.

Discard Mortality Sources

In hooked gear fisheries for king mackerel, the primary sources of discard mortality include predation, gill injuries, hook injuries, and handling time. Barotrauma is not a concern for pelagic mackerels. Shrimp trawl by-catch was also identified as a source of discard mortality for king mackerel in SEDAR16.

Recreational Hook-and-Line Fisheries

The SEDAR16 Data Workshop recommended 20% mortality for recreational hook-and-line discards from private angling and charter trips (MRIP estimates) and 33% mortality from headboats (SEHBS estimates). These percentages were based on one telemetry study for king mackerel which reported a discard mortality rate of 19.4% (95% CI 7.4-37.8%; Edwards, 1996), and observations from headboats in Florida and Alabama where 33.5% of king mackerel were in fair, poor, or dead condition when observed at the surface immediately following release (SEDAR16-DW19). The telemetry study was also cited during SEDAR28, and 20% discard mortality was recommended for all recreational Spanish mackerel discards (MRIP and SEHBS).

A literature review and request for new data sources prior to the Data Workshop for SEDAR38 did not yield any new studies since the previous assessment, with the exception of fishery observer data collection programs in Florida that were modified in 2009 to collect more detailed release condition data. The observer programs were expanded to include both headboat and charter vessels that target reef fishes, but many of the observed trips also target pelagic species during portions of sampled trips. Hook location was recorded for all king mackerel observed (harvested and released), which provided a large sample size to assess the incidence of potentially lethal hook injuries. Of 698 king mackerel that were observed (**Figure 2.15.8**), 85.8% were hooked in the lip, 6.6% were hooked inside the mouth, 5.3% were externally foul hooked, 1.3% were hooked inside the throat, and approximately 1% were hooked in the gills or gut (0.85% and 0.14%, respectively). Of 44 fish that were not harvested, 5 (11.6%) suffered immediate mortality. Of the remaining 39 live discards observed, 80% were hooked in the lip or mouth and immediately submerged (i.e., in good condition, **Figure 2.15.9**). While the sample sizes for discarded fish is low, these data are in agreement with estimated discard mortality percentages that were recommended for the recreational fishery during SEDAR16.

Commercial Hooked Gear Fisheries

The SEDAR16 DW estimated that approximately 25% of king mackerel discarded in commercial hooked gear fisheries suffer immediate or latent discard mortality. After examining the magnitude of discards, SEDAR16 DW participants concluded that the amount of removals attributed to discard mortality in the commercial hooked gear fisheries was negligible.

For SEDAR38, estimates of discard mortality provided by commercial fishers reporting to the discard logbook program were summarized. Each year a 20% random sample of the vessels with South Atlantic snapper-grouper, Gulf of Mexico reef-fish, king mackerel, Spanish mackerel or shark permits was selected to report species specific discard information from commercial fishing trips. To assure that the sample was representative of vessels with these Federal permits, the universe of permitted vessels was stratified by region and gear fished. A random sample was selected from each stratum. Region was defined as the Gulf of Mexico (Gulf-side of the Florida Keys-Dry Tortugas to the Texas-Mexican border) and the South Atlantic (which extends from the North Carolina - Virginia border to the ocean-side of the Florida Keys- Dry Tortugas). Fishing gear strata included handline, electric reel (bandit rig), trolling, longline, trap, gillnet, and diving. Complete calendar years of data were available for the period 2002-2012. The release condition and reason for discarding were reported for a total of 18,714 king mackerel over all years.

Reported data included the numbers of discards by species, estimated condition of the fish when released, reason for release (due to regulations or unmarketable/unwanted), and the fishing area where the animal was discarded. There are six options for the condition of released fish: all animals are dead, majority of the animals are dead, all animals are alive when released, majority of animals are alive, the fish are kept but not sold, and the condition of the released animal was unknown.

The fisher reported release conditions of discarded king mackerel in percent per year are provided in **Table 2.14.3**. In most cases less than 15% of king mackerel were reported as dead or “majority dead” when released. The category “kept” also accounted for a low percentage of king mackerel in the discard reports. The number of king mackerel reported as “all alive” or “majority alive” included 92% of discarded fish over all years. The pattern of region specific king mackerel release condition was similar to those seen in the combined data (**Table 2.14.4**) with the exception of a few region/year combinations (e.g., Gulf of Mexico 2005, 2006 and South Atlantic 2003, 2004). Such differences are likely due to few reported discards within those region/year combinations that differed from patterns observed in the combined data.

The size composition of discarded fish is not reported on discard logbook forms. Fishers have, however, reported the reason king mackerel were discarded – most because they were smaller than the minimum size limit. Those data are summarized in **Table 2.14.5**. Beginning in 2008, fishers could report “under size limit” or “out of season” as reasons for discarding caught fish. Reports of discards in those categories in 2007 were likely due to early use of 2008 reporting forms. Since 2008, with the exception of 2010, > 85 percent of all discarded king mackerel were reported as discarded because the fish were under the legal size limit. Prior to 2008 only the categories of “due to regulations" or "due to market conditions" appeared on the reporting forms. During that period most (85% or more in 4 of 6 years) king mackerel were discarded "due to regulations" (shown as "other regulations" in **Table 2.14.5**). Unless a fundamental change in the size composition of discards coincided with the introduction of new reporting forms (in 2008), most of the discarded king mackerel during 2002-07 were likely fish under the size limit. Similar patterns were seen in each region (**Table 2.14.6**).

Recommendations

Available data reviewed during the SEDAR38 DW supports the recommendations for discard mortality put forth during SEDAR 16. Note that discard mortality percentages for recreational fisheries should only be applied to live discards, since immediate discard mortalities are already counted in harvest estimates generated by MRIP and the SEHBS (through 2012).

The following recommendations represent no change from SEDAR 16:

- Recreational hook-and line fisheries:
  - 20% mortality applied to live discards in private and charter segments
  - 22% mortality applied to live discards in the headboat segment
- Commercial hooked gear fisheries:
  - 25% mortality applied to all discards
  - Represents a negligible amount of total removals
- Shrimp trawl by-catch
  - 100% discard mortality

2.6 AGE

The Panama City Laboratory of the Southeast Fisheries Science Center, NOAA Fisheries Service has conducted annual production ageing of king mackerel since 1986, ageing over 60,000 during those years (**Figures 2.15.10, 2.15.11, and 2.15.12**). A description of the methods, information on quality control and sub-sampling procedures, and the distribution of age samples by year, geographical location, gear, fishery, and collecting agency or program are presented in SEDAR38-DW-15 (with Jan. 7 addendum). The otolith sampling methods used in the Federal Trip Interview Program, the source of almost all commercial king mackerel samples, evolved from non-random quota sampling by size intervals for the development of age-length keys along with random length sampling (RLS) during the 1990's to primarily random otolith and random length sampling by the mid-2000's (Saari 2013). Chih (2009) determined that for king mackerel, sampling efficiency of the non-random age-length key sampling method and a new method she explored called the reweighting method was much higher than with random otolith sampling, especially when using two stage cluster sampling as is normally done. As in SEDAR16, the group noted the continued complete absence of data from Mexico since 1994 in the Panama City database. On a positive note, collections of Texas fish, still small, have increased since 2009, and that state has recently become a major contributor to the GSMFC database. Any attempt to assess a potential western Gulf stock would be severely limited without significant age data from both Texas and Mexico. The paucity of age data from South Carolina (none since 2003) and Georgia (none since 1998) was again noted but the group did not feel that would cause any major problems given the large sample sizes from North Carolina and NE Florida. The huge increase in TIP sampling in Louisiana was the biggest spatial shift in king mackerel age sampling since SEDAR16. In 2012, during July and August only, 2,743 samples were collected in Louisiana, and they composed over 65% of all TIP otolith samples sent to the Panama City NMFS lab that year (SEDAR38-DW-15). To prevent this very large, temporally limited sample from having an overwhelming effect on the Gulf age structure analyses for 2012, a random subsample of only 1000 of the 2012 Louisiana otoliths were aged.

In 2007 the NMFS Panama City Laboratory began distributing a king mackerel otolith reference collection composed of 100 whole and 100 sectioned otolith samples to member states of the Gulf States Marine Fisheries Commission (GSMFC). The states of Alabama, Florida, Louisiana, and Texas read the reference collection every few years and send those ages to the Panama City lab, where three indices of precision - average percent error (APE), precision (D), and coefficient of variation (CV), are determined. The Mississippi Department of Marine Resources does not read the reference collection, as it collects very few king mackerel otoliths and those are sent to either Alabama or Louisiana for ageing.

Overall, estimates of average precision at age (D) were high and average percent error (APE) by year were low for sectioned otoliths for all four states (**Fig. 2.15.13**). Precision (D) and APE estimates for whole otolith readings remain consistent for Florida, Alabama, and Texas with marked improvement for Louisiana (**Fig. 2.15.14**). Within Panama City lab indices of precision have remained good (**Table 2.14.7**). Refer to SEDAR38-DW-15 for a more information regarding reader precision and ageing procedures of sectioned versus whole otoliths.

The LHG discussed the evidence in the Panama City lab age data of likely strong year classes in both Gulf and Atlantic stocks of king mackerel. Although representative of only the annual age structure of the non-randomly-sampled king mackerel age samples, not the population, the repeated, easily identified, stock-specific patterns of sequential one year increases in modal age over several years (**Figure 2.15.15**), provided fairly convincing evidence of periodic strong cohorts recruiting to the population. Because the otolith sampling was not random, the actual strength of those dominant cohorts cannot be estimated. In the Atlantic, the 1979, 1989, and 1998 cohorts, and possibly the 2001, appear to have been strong. In the Gulf, 1982, possibly 1990 and 2004, and definitely 2007 were strong cohorts (**Figure 2.15.15**).

LHG Recommendations for the AW:

1) Ages contributed by the GSMFC to SEDAR38 should be included in the assessment. Although Texas had a somewhat higher reading error of the reference collection versus the other three states, the LHG agreed that any ages supplied by that state should be included in this assessment given the overall small sample size from there**.**

2) Age-specific indices of precision for the various groups contributing age data for SEDAR38 should be incorporated into the assessment models where possible.

2.7 GROWTH

The LHG is unaware of any new growth studies on king mackerel in the Gulf of Mexico or S.E. U. S. Atlantic waters since SEDAR16, but presents the following background information from SEDAR5 and SEDAR16 for information purposes:

– Begin SEDAR5 "Growth of king mackerel in the Gulf of Mexico and the Atlantic has been documented in several studies. Early studies utilized age determinations from whole otoliths to model growth (Beaumariage 1973, Johnson et al. 1983, Manooch et al. 1987). Subsequent studies documented the underageing of older fish (>80 cm FL males, 90 cm FL females) from whole otoliths (Collins et al. 1988, DeVries and Grimes 1997. The life history group considered a report, SEDAR Doc.-6, which was a literature review of the growth of king mackerel in the southeastern U.S. Information presented in this report included a summary of available formulae for transforming from individual length to weight, length to age and length to length.

The group noted that sexual dimorphism was very significant in the length to age relationship, in the weight to length relationship and also the body size – otolith size relationship, and should be taken into account when modeling growth of king mackerel. In addition DeVries and Grimes (1997) documented spatial differences. The group noted that the information on sex ratio at size used in the most recent assessment included observations available through 1994 (Restrepo 1996). The group recommended the sex ratio at length curves be updated to include data collected subsequent to the Restrepo (1996) study. Currently the assessment assumes that the sex ratio of fish size 50 cm FL and smaller is 1:1 however little data exist to verify this assumption. The group recommended as a long term research object to conduct a histological study to evaluate this assumption.

The group also reviewed a report providing a summary of the updated king mackerel otolith observations through fishing year 2002/2003 (SEDAR 5 Doc-7). The group reviewed the existing formulae for converting individual length to age and felt that the von Bertalanffy growth equations of DeVries and Grimes (1997) were most current. " **– End SEDAR5**

– Begin SEDAR16: SEDAR16-DW-12 provided updated von Bertalanffy growth parameters by sex for Gulf and Atlantic migratory groups both with and without samples from the mixing zone as defined in the FMP. The group discussed which growth estimates should be used. Age-length keys are to be used to age most of the catch samples. Growth curves are to be used to age catch data for which no age length keys are available (1981 – 1985) and for specific cells in subsequent years for which there were no appropriate age data. The group also discussed the new age length key data provided by Dr. Will Patterson and Kate Shepard which includes significant numbers of age 0 and 1 fish collected in fishery independent surveys. These data help address the selectivity issues of fishery dependent samples subject to size limits. **– End SEDAR16**

The LHG discussed the findings by Linda Lombardi, who generated growth curves for the SEDAR38 LHG, that the recommendation by the SEDAR16 LHG to include juvenile fish (age 0-3, n = 160) from Patterson and Shepard (SEDAR16-DW-27) in computing growth curves was not followed by the SEDAR16 assessment panel, who chose to remove these fish from the final growth curves. The reason given for not using the Patterson and Shepard data was that fish from the mixing zone could be from either migratory group. However Dr. Lombardi was able to confirm that all the fish were collected May – Nov., 2006-07 in the northern Gulf of Mexico during fishery independent SEAMAP summer and fall groundfish surveys, so in fact could be confidently assigned to the Gulf stock.

The LHG reviewed both the SCDNR trawl data, which is mainly age zero fish and a few age 1's (n = 159), and the GSMFC age data, and concluded both data sets were suitable for use and should be used in SEDAR38 growth calculations.

Modeling Growth (the following paragraph was provided by Dr. Linda Lombardi, who conducted the growth modeling as well as proofed and corrected the data sets used in those calculations)

Growth, based on fractional ages and observed fork lengths at capture, was modeled using the von Bertalanffy growth model and was executed in ADMB (Auto Differentiate Model Builder; **Tables 2.14.1. and 2.14.2**). Since the majority of the data were derived from commercial and recreational samples, a size-modified von Bertalanffy model was used to predict growth parameters that take into account the non-random sampling due to minimum size restrictions (Diaz et al., 2004). This model uses either constant standard deviations or constant coefficients of variation. The latter was chosen to better model the linear increase in variation of size-at-age with age. The model also uses a restrictive maximum likelihood estimation procedure with minimum size (for both commercial and recreational records: 1986-1989, no minimum size; 1990-1991 , 30.48 mm, 12 inches; 1992-1998, 50.8 mm, 20 inches; 1999-2013, 60.96 mm, 24 inches) as the left truncation limit for fisheries dependent observations. Fishery independent data were used to aid the model in predicting growth at smaller sizes not collected in fishery dependent sampling. This is the same method as was used in the previous assessment (Ortiz and Palmer, 2008). Stock- and sex-specific size-modified growth curves were compared using a likelihood ratio test for coincident curves (Kimura, 1980; Haddon, 2001). The results of this analysis are presented in SEDAR38-AW-01 (Lombardi, 2013). Chih (2009) recommended when modeling growth in king mackerel to incorporate a reweighing factor based on length, due to the biases associated with sampling. The size-modified growth models generated by the LHG for SEDAR38 do not include a reweighing factor but do incorporate the effect of non-random sampling due to minimum size limits in fishery dependent data.

LHG Recommendations for the AW:

1) Represent growth in the king mackerel population by sex and migratory group (required for the Stock Synthesis 2 assessment algorithm) following the methods of Lombardi (SEDAR38-AW-01). The size-age data used should include the Panama City lab, GSMFC, SCDNR trawl survey, and Patterson and Shepard (SEDAR16-DW-27) data sets. All data should come from outside the mixing zone as newly defined by the LHG in SEDAR38 (Section 2.3 this document) to ensure that each curve uniquely represents either the Atlantic or Gulf migratory group.

2.8 REPRODUCTION

Given that there have been no new studies examining reproduction in king mackerel since SEDAR16, the LHG recommends using the same values and methods recommended in SEDAR16. The following is quoted from <u>SEDAR 16 – SAR – Section II</u>: "Until very recently, few studies on reproduction of king mackerel in the U.S. have been conducted – one in the Gulf only (Beaumariage 1973), one in the Gulf and Atlantic (Finucane et al. 1986) and two in the Atlantic only (Waltz 1986; Noble et al. 1992). Only Finucane et al. (1986) provide fecundity estimates (by length, weight, and age). These estimates were derived from 65 fish 446-1,489 mm FL, 0.681-25.610 kg, and ages 1-13 yr. Fecundity samples came from North Carolina (n=12), Texas (n=12), Louisiana (n=24), and northwest Florida (n=17). One caveat with the Finucane et al. (1986) results is that the fish were all aged with whole otoliths, which have been shown to underage older fish (Collins et al. 1989; DeVries and Grimes 1997). Besides the ageing issue, the method Finucane et al. (1986) used presumed that king mackerel were determinate spawners, an approach known to underestimate fecundity in fishes that actually exhibit indeterminate oocyte development reflected in multiple spawnings over a season (Murua et al. 2003). They also estimated fecundity by counting yolked eggs >=0.20 mm (Hunter and Goldberg 1980) as opposed to the current widely used technique of counting hydrated oocytes.

To address these issues with the Finucane et al. (1986) study, and responding to SEDAR5 research recommendations to develop batch fecundity, spawning frequency, and age specific fecundity estimates, including size and age at maturity, Fitzhugh et al. (SEDAR16-DW-06) used the hydrated oocyte method to estimate batch fecundities for 178 king mackerel collected in the Gulf (n=32) and Atlantic (n= 146) during 2005-2007.

Because Finucane et al. (1986) included all vitellogenic eggs (which would certainly contribute to more than one batch) in their counts, those counts could not be considered estimates of batch fecundity, as they would be overestimates. Based upon the fecundity-length relationship for NW Florida (Table 4 in Finucane et al., 1986), the expected annual fecundity of an 800 mm FL female would be 1,644,805 ova. However, Fitzhugh et al. (SEDAR16-DW-06) estimated that a single batch for a female this size should equal 560,000 ova. Because of these differences in methods and the overestimation problem, the group concluded it would be inappropriate to merge the fecundity estimates of Finucane et al. (1986) with the new data presented in SEDAR16-DW-06. The group also concluded that the new fecundity data in SEDAR16-DW-06 should be used in the upcoming assessment, but that it should be fit with a power function and that all months (Apr-Aug) should be included for the Atlantic.

The group also agreed that given the high frequency (88%) of hydrated females exhibiting old and recent POFs, the small sample sizes, especially in the Atlantic, the small spatial coverage of the study, and the reliance on macro staging for spawning frequency estimates, spawning frequencies of Fitzhugh et al. (2008) should be considered only as rough estimates, and especially for the Atlantic, are very likely underestimates. There was also discussion regarding the need to determine if spawning frequency varies by age (currently the data are insufficient for this), in which case the use of batch fecundity alone may not adequately represent the relative reproductive contribution of each age class.

No new size or age at maturity data is available so the same relationships from Finucane et al. (1986) used in SEDAR5 will have to be used in SEDAR16."

LHG Recommendations for the AW (Same as for SEDAR16):

1) Use the batch fecundity relationships, whether length or age-related, from Fitzhugh et al. (SEDAR16-DW-06) to estimate female reproductive potential until age-based spawning frequency estimates can be incorporated. The group recognizes the possibility that annual differences in population reproductive potential may occur even at equivalent levels of stock biomass (see Marshall et al. 2003), but the available data represent only a few years and therefore do not allow the detection of annual variations.

2) Use size or age at maturity data from Finucane et al. (1986)."

2.9 MOVEMENTS AND MIGRATIONS (inferred from tagging data)

Given that there have been no new studies examining movements and migrations in king mackerel, for information purposes, the following is quoted from <u>SEDAR 16 – SAR – Section II</u>:
"This section addresses stock mixing and migration patterns that are apparent from the tagging data described in S16-DW-10. Additional data on stock mixing off Florida, based on otolith shape analysis and otolith isotope chemistry, contributed to the discussion below but are described in the report section on stock structure.

Working Group Consensus regarding migration and movement based on tagging data:

Two issues can be potentially addressed based on the tagging data summarized in S16-DW-10. The first is the issue of migration into and out of the mixing zone by fish from the two migratory units (Atlantic and Gulf of Mexico, hereafter GOM). The second is the issue of whether the GOM migratory unit is a single unit or comprised of two overlapping migratory units (eastern and western). The life history working group examined the tagging data for each of these issues.

The region delimited by the Flagler-Volusia and Monroe-Collier county lines on the Florida coast is commonly referred to as the mixing zone. Current allocation rules state that all king mackerel caught in this region between November and March are taken from the GOM migratory unit. Tagging data suggest that at least some of these fish are in fact from the Atlantic unit. Of the 12,896 fish tagged and released in the mixing zone between November and March (GOM fish), 527 were recaptured. Most of these recaptures occurred in the mixing zone, however 90 (17.1%) were recaptured somewhere on the Atlantic coast north of the Flagler-Volusia county line. In contrast, only 20 (3.8%) were recaptured in the Gulf of Mexico outside the mixing zone. Of the 1,288 fish tagged and released in the mixing zone between April and October (Atlantic fish), 116 were recaptured. All but three of these recaptures occurred in the mixing zone or along the Atlantic coast north of the Flagler-Volusia county line. These data strongly suggest that fish present in the mixing zone in the winter may be from either the GOM or Atlantic migratory unit. It was the consensus of the working group that tagging data are not sufficient to accurately quantify unit mixing in the Florida mixing zone, but they do suggest that 100% percent allocation of catch to the GOM unit in the winter is not supported by the data.

Of the 7,878 fish tagged and released in the GOM no-mix zone that stretches from Florida's Monroe-Collier county line to the Texas-Mexican border, 460 were recaptured in that same zone. **Figure 2.15.16** (from S16-DW-10) gives straight line distances between individual release and recapture locations for the subset of these 460 fish recaptured in a different season. These data suggest that migration pathways occur in an easterly direction towards Florida and in a westerly direction towards Mexico. These data are consistent with two possible scenarios: the GOM migratory unit is contiguous from Florida to Mexico or the existence of two migratory units in the Gulf of Mexico separated between eastern and western zones. Figure 1 (not included in SEDAR38 report) below summarizes the hypothesized unit structure of the king mackerel stock that the working group considered most supported by the tagging data. The workgroup felt that limitations with these data outlined below make the exact structure of the GOM migratory unit inconclusive. Further study is needed to more clearly determine the existence of an east and west portion of the GOM unit, delineate these portions if they exist in terms of a dividing line, and measure the amount of mixing between eastern and western portions of the unit. It was also the consensus of the group that identification techniques currently being employed to characterize unit mixing in the Florida mixing zone may be useful for clarifying the east/west structure of the GOM unit and the level of connectivity between the US GOM unit and king mackerel stocks off the coast of Mexico. The magnitude of the Mexican landings in comparison to US landings from the GOM unit indicates clarification of this issue should be a priority for future assessments (see SEDAR16-DW-31).

It should be emphasized that the tagging programs conducted to date were not designed to evaluate levels of mixing. As noted by the SEDAR5 RW Panel, tagging fish in a concentrated area (as done in the tagging studies off southeast Florida) does not lend itself to estimation of mixing rates. Moreover, tag recoveries in these programs were fishery-dependent. Thus, the numbers of tags recovered in different locations were dependent not only on fish movements, but on local fishing effort and reporting rates as well. Finally, while the data set covers a period from 1961 to 2005, the vast majority of the releases and recaptures occurred between 1983 and 1996. This may limit the utility of these data for describing current conditions of the stock. Accordingly, even qualitative interpretations regarding stock definition and mixing must be viewed with some caution."

LHG Recommendations for the AW (Same as for SEDAR16): none

2.10 MERISTICS AND CONVERSION FACTORS

Updated length-weight relationships (fork lengths and whole and gutted weights) by sex, sexes combined, and stock (including separate equations for mixing zone fish) were calculated by NMFS Miami lab (Eric Orbesen) using data from the Southeast Regional Headboat Survey (SRHS 1996-2013), the Marine Recreational Statistics Survey (MRFSS 1999-2013), and the Trip Interview Program (TIP 1983-2013). Fish were assigned to the mixing zone using the definition in place prior to the SEDAR38 data workshop, i.e., the area between the Collier-Monroe and the Flagler-Volusia County lines from Nov 1st to Mar 31st. Examination of the various length-weight plots (**Figures 2.15.17 and 2.15.18**) showed there was very little difference in the relationships between the sexes or between stocks. At 150 cm there was a 7% difference between the Gulf and the Atlantic for the all sexes relationship, while at 100 cm the difference was 5%. Atlantic and mixing zone relationships were almost exactly the same for females and for sexes combined, but did show some difference for males. Based on these very small differences, even at quite large sizes, and after discussion within the LHG and during a plenary session, the LHG recommended that only two length-weight relationships, one for whole weights and one for gutted weights, be used in SEDAR38 – each equation to be calculated using data sets in which both sexes and both stocks (including mixing zone) are pooled (**Table 2.14.8 and Figure 2.15.18**).

Equations for converting total length to fork length and standard length to fork length were estimated by Ching-Ping Chih (SEFSC Miami Lab) from the same data set used by Mauricio Ortiz in SEDAR16, although for SEDAR38 some outliers were removed based on 99% confidence intervals (**Table 2.14.9**).

LHG Recommendations for the AW:

1) Use the updated, pooled sexes and stocks (including mixing zone) length-weight relationships, one for whole weights and one for gutted weights (**Table 2.14.8**).

2) Use the length-length relationships used in SEDAR16 as slightly updated for SEDAR38 by removal of outliers by Ching-Ping Chih (**Table 2.14.9**), to convert total and standard lengths to fork lengths.

2.11 COMMENTS ON ADEQUACY OF DATA FOR ASSESSMENT ANALYSES

Comments were included in individual sections above.

2.12 RESEARCH RECOMMENDATIONS

1) Examine population connectivity throughout the Gulf and S. Atlantic using otolith elemental and stable isotope signatures of age-0 fish as natural tags of various regions. Otolith signatures of juvenile king mackerel collected in various resource surveys should first be examined to determine if population- or region-specific differences exist in otolith signatures, although success seems likely given the degree of classification success seen in adult mackerel whose otolith chemical signatures are integrated over several years of life, which adds greater variance to their signatures. Once otolith chemical signatures are determined, the chemistry of adult cores could be sampled to examine interregional mixing between purported migratory groups (populations) in the Atlantic, eastern Gulf, western Gulf, and even Mexico. **From SEDAR16**

2) Investigate and quantify mixing between eastern Gulf and western Gulf populations using the new next-generation DNA sequencing techniques and/or otolith elemental and stable isotope analyses. The magnitude of the Mexican landings in comparison to U.S. landings from the GOM unit (annually 3-4 times higher during last 20 yr) indicates clarification of this issue should be a priority for future assessments (see SEDAR38_com_DW_Day4-2 presentation). **Modified from SEDAR16 recommendation.**

3) Further investigate/estimate the vulnerability of the western Gulf migratory group to overfished Mexican fisheries in winter (Chavez and Arreguin-Sanchez 1995). **From SEDAR16**

4) Conduct studies and monitoring that will allow estimation of natural mortality. **From SEDAR16**

5) Continue holding ageing workshops and training to standardize techniques and increase the ageing precision among laboratories. **From SEDAR16**

6) Increase age sampling in South Carolina and Georgia and length sampling north of Florida in the Atlantic. **From SEDAR16**

7) Try to recover and include age and size data from Collins et al. (1989) Atlantic age and growth study in the next stock assessment of Atlantic king mackerel. **From SEDAR16**

8) Establish clear priorities for added reproductive information as expanded work would involve considerable costs for a long-term sampling program. **From SEDAR16**

9) If made a priority, more precisely determine 1) the extent of hydration that can be determined via routine observations in the field and 2) the timing of this phase relative to final oocyte maturation and

spawning and 3) calibration of the degeneration of post-ovulatory follicles. This is needed to account for and correct a likely bias in spawning frequency estimates. **From SEDAR16**

10) If made a priority, design and implement a reproductive sampling program (in concert with age sampling) on an annual basis that expands and intensifies spatial and temporal coverage (particularly adding the western Gulf of Mexico). A goal would be to provide annual estimates of spawning frequency. This would include regular training of port agents and scientific observers in macroscopic methods and additionally include a quality control component of random sub-sampling for histological comparisons. **From SEDAR16**

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2.14 TABLES

Table 2.14.1. King mackerel von Bertalanffy growth parameters (± standard deviations) from each stock, sexes combined and by sex. Observed fork lengths and fractional ages were fit to a size-modified von Bertalanffy growth model that used a constant coefficient of variation (see Lombardi SEDAR38-AW-01 for complete information on the growth model). Growth models were computed multiple times testing a range of initial growth parameters (L_∞ = 90%* L_∞, 95% *L_∞; k = 0.20,0.25; t_0 =0.00, -0.25, -1.00) and coefficients of variation (CV = 10%, 30%, 50%) for each stock, sexes combined and by sex. Each of the models (with alternative initial values) converged with the same growth parameters, model objective function values and model CVs. King mackerel caught in the winter months (January, February, March, November and December) in the mixing zone (State = SF, County = Monroe) were not used in this analysis.

	n	L_∞	k	t_0	CV	Model objective function
Atlantic						
Combined	32710	112.08 ± 0.3326	0.2470 ± 0.0037	-1.8340 ± 0.0437	11.9% ± 0.05%	116649
Female	20581	122.35 ± 0.4508	0.2039 ± 0.0033	-2.2950 ± 0.0495	10.3% ± 0.06%	72418
Male	12404	92.86 ± 0.2090	0.4646 ± 0.0051	-0.6077 ± 0.0153	11.5% ± 0.09%	41715
Gulf						
Combined	32887	115.41 ± 0.5936	0.1879 ± 0.0038	-2.5955 ± 0.0590	13.2% ± 0.06%	118444
Female	21393	125.18 ± 0.7376	0.1887 ± 0.0039	-2.1606 ± 0.0518	12.4% ± 0.07%	76560
Male	12079	87.57 ± 0.2079	0.5111 ± 0.0083	-0.5600 ± 0.0235	11.6% ± 0.09%	41138

Table 2.14.2. Resulting male king mackerel von Bertalanffy growth parameters (± standard deviations) for each stock. In attempt to better fit the observed data, a higher range (k = 0.30-0.35) of initial growth coefficient values was explored (L_∞ = 95% asymptotic length, t_0 =0.00, -1.00, CV = 30%).

Stock and Sex	n	L_∞	k	t_0	CV	Model objective function
Atlantic						
Male	12404	88.78 ± 0.9123	0.3450 ± 0.0168	-1.2918 ± 0.1412	20.1% ± 0.05%	43623
Gulf						
Male	12079	91.61 ± 0.2576	0.3511 ± 0.0038	-0.8487 ± 0.0164	15.6% ± 0.25%	42152

Table 2.14.3. Fisher-reported condition of king mackerel discards from commercial vertical line and trolling vessels.

Gulf of Mexico	**all dead**	**majority dead**	**all alive**	**majority alive**	**kept not sold**	**unable to determine**	**unreported**
2002	4%	10%	46%	36%	3%	0%	0%
2003	3%	6%	55%	20%	9%	7%	0%
2004	21%	13%	39%	13%	13%	0%	0%
2005	5%	1%	36%	18%	1%	1%	37%
2006	8%	6%	42%	38%	1%	0%	4%
2007	9%	7%	65%	14%	4%	0%	1%
2008	5%	3%	58%	24%	4%	6%	0%
2009	1%	3%	62%	27%	0%	6%	0%
2010	3%	4%	60%	19%	2%	0%	11%
2011	7%	1%	53%	35%	1%	2%	0%
2012	1%	7%	79%	13%	1%	0%	0%
2013	4%	4%	79%	12%	2%	0%	0%
Total	5%	5%	59%	23%	3%	3%	3%

Table 2.14.4. Fisher-reported condition of king mackerel discards from commercial vertical line and trolling vessels by region.

Gulf of Mexico	all dead	majority dead	all alive	majority alive	kept not sold	unable to determine	unreported
2002	3%	2%	42%	49%	3%	0%	0%
2003	0%	9%	23%	24%	9%	34%	0%
2004	1%	3%	56%	0%	39%	0%	0%
2005	55%	4%	11%	20%	1%	8%	0%
2006	52%	26%	4%	14%	4%	0%	0%
2007	9%	13%	75%	3%	0%	0%	0%
2008	1%	3%	11%	49%	2%	34%	0%
2009	3%	2%	54%	41%	0%	0%	0%
2010	0%	36%	47%	17%	1%	0%	0%
2011	14%	0%	45%	41%	0%	0%	0%
2012	1%	5%	87%	7%	0%	0%	0%
2013	1%	13%	42%	45%	0%	0%	0%
Total	6%	6%	50%	30%	2%	7%	0%
Mixing Zone	**all dead**	**majority dead**	**all alive**	**majority alive**	**kept not sold**	**unable to determine**	**unreported**
2002	3%	2%	62%	28%	5%	0%	0%
2003	4%	5%	64%	20%	7%	0%	0%
2004	27%	16%	37%	16%	4%	0%	0%
2005	0%	1%	28%	21%	1%	0%	48%
2006	1%	3%	46%	44%	0%	0%	5%
2007	10%	7%	70%	7%	5%	0%	1%
2008	6%	4%	67%	19%	4%	0%	0%
2009	0%	3%	63%	24%	0%	9%	0%
2010	3%	0%	59%	21%	3%	0%	14%
2011	1%	1%	60%	31%	3%	4%	0%
2012	0%	8%	72%	18%	2%	0%	0%
2013	5%	2%	88%	3%	2%	0%	0%
Total	4%	4%	62%	21%	3%	2%	4%
South Atlantic	**all dead**	**majority dead**	**all alive**	**majority alive**	**kept not sold**	**unable to determine**	**unreported**
2002	7%	32%	23%	38%	1%	0%	0%
2003	6%	0%	44%	0%	50%	0%	0%
2004	0%	0%	0%	0%	100%	0%	0%
2005	5%	0%	87%	6%	2%	0%	0%
2006	12%	0%	76%	0%	12%	0%	0%
2007	3%	0%	27%	70%	0%	0%	0%
2008	10%	0%	77%	13%	0%	0%	0%
2009	14%	0%	78%	7%	0%	1%	0%
2010	6%	0%	94%	0%	0%	0%	0%
2011	11%	28%	61%	0%	0%	0%	0%
2012	13%	0%	87%	0%	0%	0%	0%
2013	5%	0%	95%	0%	0%	0%	0%
Total	7%	8%	57%	24%	3%	0%	0%

Table 2.14.5. Fisher-reported reason for discarding king mackerel from commercial vertical line and trolling vessels. Prior to 2007 the categories 'under size limit' and 'out of season' could not be reported on discard logbooks.

Year	under size limit	out of season	other regulations	market conditions	unreported
2002	0%	0%	85%	12%	3%
2003	0%	0%	95%	3%	2%
2004	0%	0%	88%	10%	2%
2005	0%	0%	61%	2%	37%
2006	0%	0%	88%	5%	7%
2007	18%	0%	77%	4%	1%
2008	87%	0%	7%	2%	3%
2009	88%	9%	3%	0%	0%
2010	78%	4%	3%	2%	13%
2011	89%	3%	0%	7%	1%
2012	95%	1%	3%	1%	0%
2013	90%	3%	7%	1%	0%
Total	62%	2%	28%	3%	4%

Table 2.14.6. Fisher-reported reason for discarding king mackerel from commercial vertical line and trolling vessels by region. Prior to 2007 the categories 'under size limit' and 'out of season' could not be reported on discard logbooks.

Gulf of Mexico	under size limit	out of season	other regulations	market conditions	unreported
2002	0%	0%	77%	20%	3%
2003	0%	0%	96%	3%	1%
2004	0%	0%	100%	0%	0%
2005	0%	0%	96%	4%	0%
2006	0%	0%	48%	24%	28%
2007	55%	0%	45%	0%	0%
2008	92%	2%	5%	0%	0%
2009	53%	41%	6%	1%	0%
2010	82%	17%	1%	1%	0%
2011	85%	5%	0%	11%	0%
2012	92%	2%	5%	1%	0%
2013	78%	13%	9%	0%	0%
Total	67%	8%	20%	5%	1%
Mixing Zone	**under size limit**	**out of season**	**other regulations**	**market conditions**	**unreported**
2002	0%	0%	90%	7%	3%
2003	0%	0%	96%	1%	2%
2004	0%	0%	86%	12%	3%
2005	0%	0%	51%	1%	49%
2006	0%	0%	94%	1%	5%
2007	12%	0%	81%	6%	1%
2008	87%	0%	6%	2%	4%
2009	100%	0%	0%	0%	0%
2010	76%	3%	3%	3%	15%
2011	93%	1%	1%	5%	1%
2012	97%	1%	2%	0%	0%
2013	93%	0%	6%	1%	0%
Total	63%	0%	28%	3%	6%
South Atlantic	**under size limit**	**out of season**	**other regulations**	**market conditions**	**unreported**
2002	0%	0%	84%	10%	5%
2003	0%	0%	44%	56%	0%
2004	0%	0%	58%	42%	0%
2005	0%	0%	93%	7%	0%
2006	0%	0%	88%	12%	0%
2007	0%	0%	100%	0%	0%
2008	75%	0%	24%	0%	0%
2009	72%	0%	28%	0%	0%
2010	95%	0%	5%	0%	0%
2011	100%	0%	0%	0%	0%
2012	100%	0%	0%	0%	0%
2013	95%	0%	5%	0%	0%
Total	35%	0%	58%	5%	1%

Table 2.14.7. Indices of precision from NMFS Panama City Lab reader comparisons. See SEDAR38-DW-15 for details. APE = average percent error, CV = coefficient of variation, and D = index of precision.

Reader pair	Data years	Ageing method	APE	CV	D
1 and 2	2012	Whole	5.07%	7.16%	3.58%
1 and 3	2007	Sectioned	2.34%	3.31%	1.66%
1 and 4	2012	Sectioned	2.84%	4.02%	2.01%

Table 2.14.8. Meristic regressions for king mackerel derived from the Southeast Regional Headboat Survey (SRHS 1996-2013) the Marine Recreational Statistics Survey (MRFSS 1999-2013), and the Trip Interview Program (TIP 1983-2013) data. For these equations sexes and stocks, including mixing zone fish, were combined. Model fit criteria: linear regression models r^2 and non-linear regression models residual square error (RSE).

Conversion and units	Equation	Sample Size	R^2 or RSE values	Data Ranges
FL (cm) to W. Wt (kg)	W. Wt = 7.31 x 10^{-06} * (FL^$^{3.009}$)	53224	0.9606	FL (cm): 25-176.7 W. Wt (kg): 0.15-44.25
FL (cm) to G. Wt (kg)	G. Wt = 4.34 x 10^{-06} * (FL^$^{3.119}$)	22491	0.9542	FL (cm): 33.8 - 156.4 G. Wt (kg): 0.35 - 29.48

Table 2.14.9. Total length (TL) / fork length (FL) and standard length (SL) / fork length regression equations for king mackerel. These were derived from the same data sets used for deriving conversions for SEDAR16 with the exception that data points outside the 99% confidence limits were excluded.

Conversion and units	Equation	Sample Size	R^2 or RSE values
TL (cm) to FL (cm)	FL= -4.28 +0.963 * TL	n=2034	R^2=0.99
SL (cm) to FL (cm)	FL= 0.663 + 1.051 * SL	n=2083	R^2=0.99

2.15 FIGURES

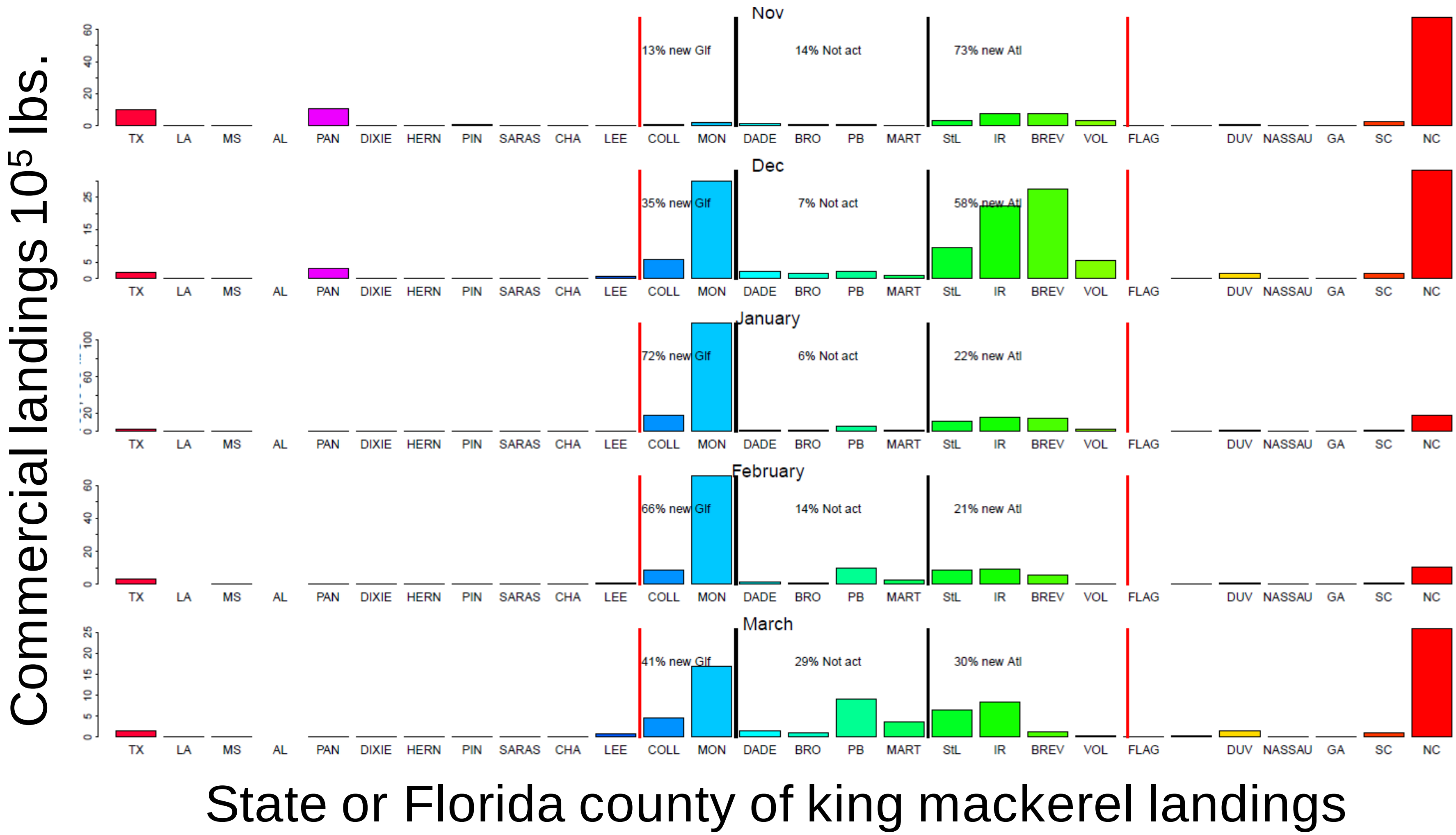


Figure 2.15.1. Composite of the temporal progression of commercial king mackerel landings among Gulf states (far left), Atlantic states (far right), and Florida counties from 1986-2012. Current (prior to SEDAR38 data workshop) mixing zone borders are shown as red bars.

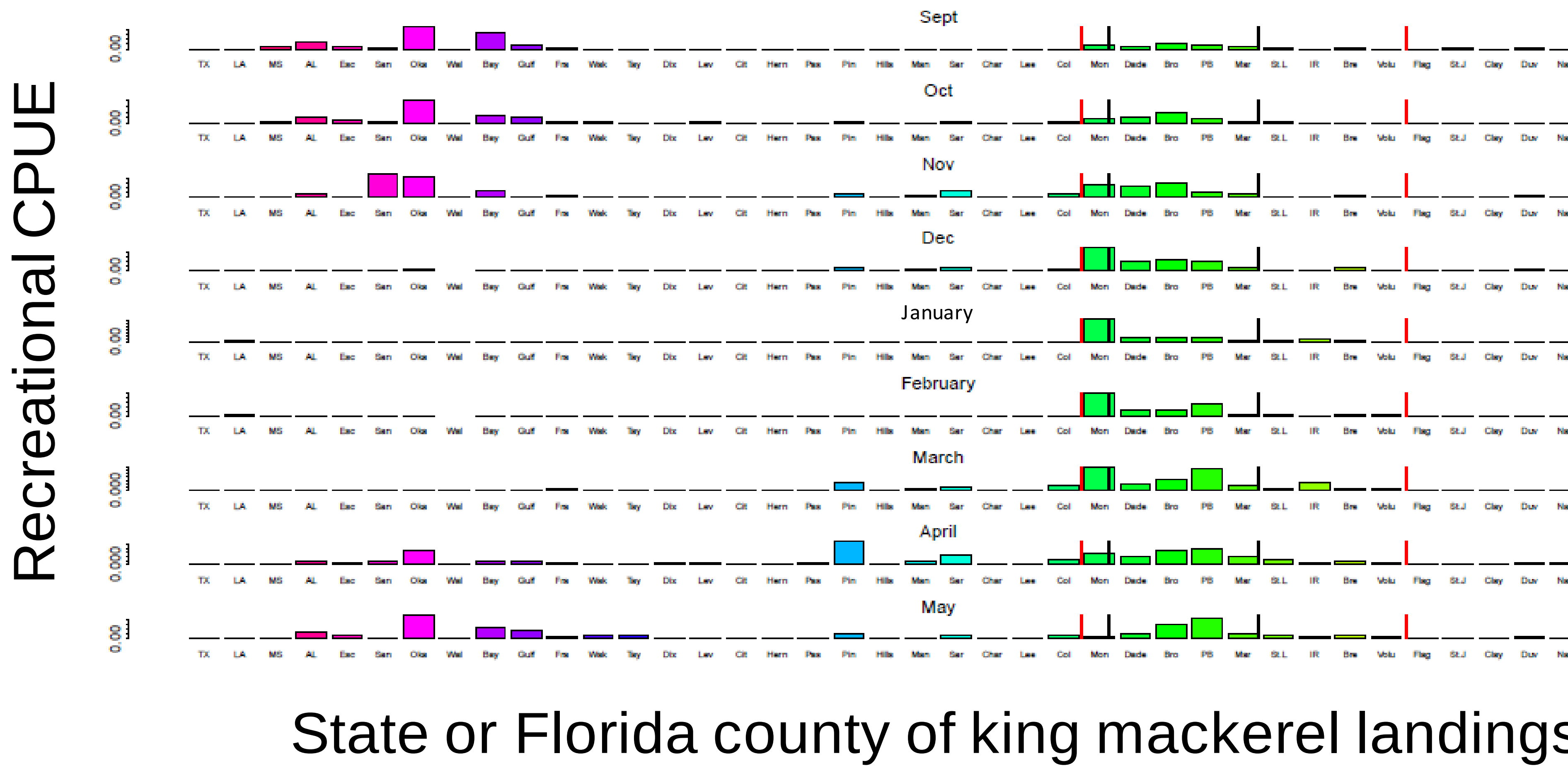


Figure 2.15.2. Composite of the temporal progression of recreational catch per unit effort (CPUE) for king mackerel among Gulf states (far left), Atlantic states (far right), and Florida counties from 1986-2012. Current (prior to SEDAR38 data workshop) mixing zone borders are shown as red bars.

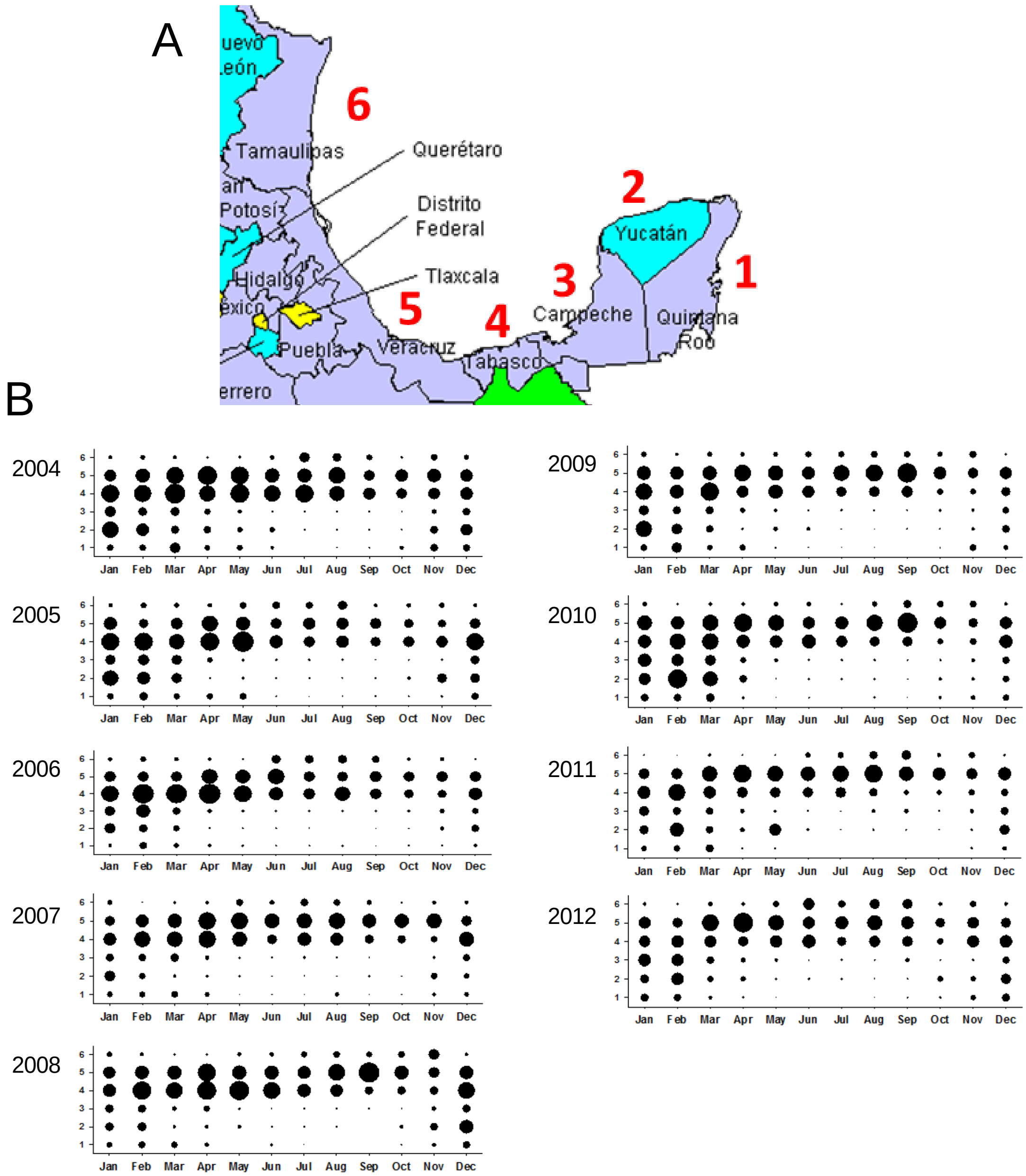


Figure 2.15.3. Temporal progression of commercial king mackerel landings among Mexican Gulf states 2002-2012. The scale of bubble sizes is the same among all figures, with the area of the bubbles indicating relative landings. The A) map indicates state number codes that appear on the y-axis in panel B.

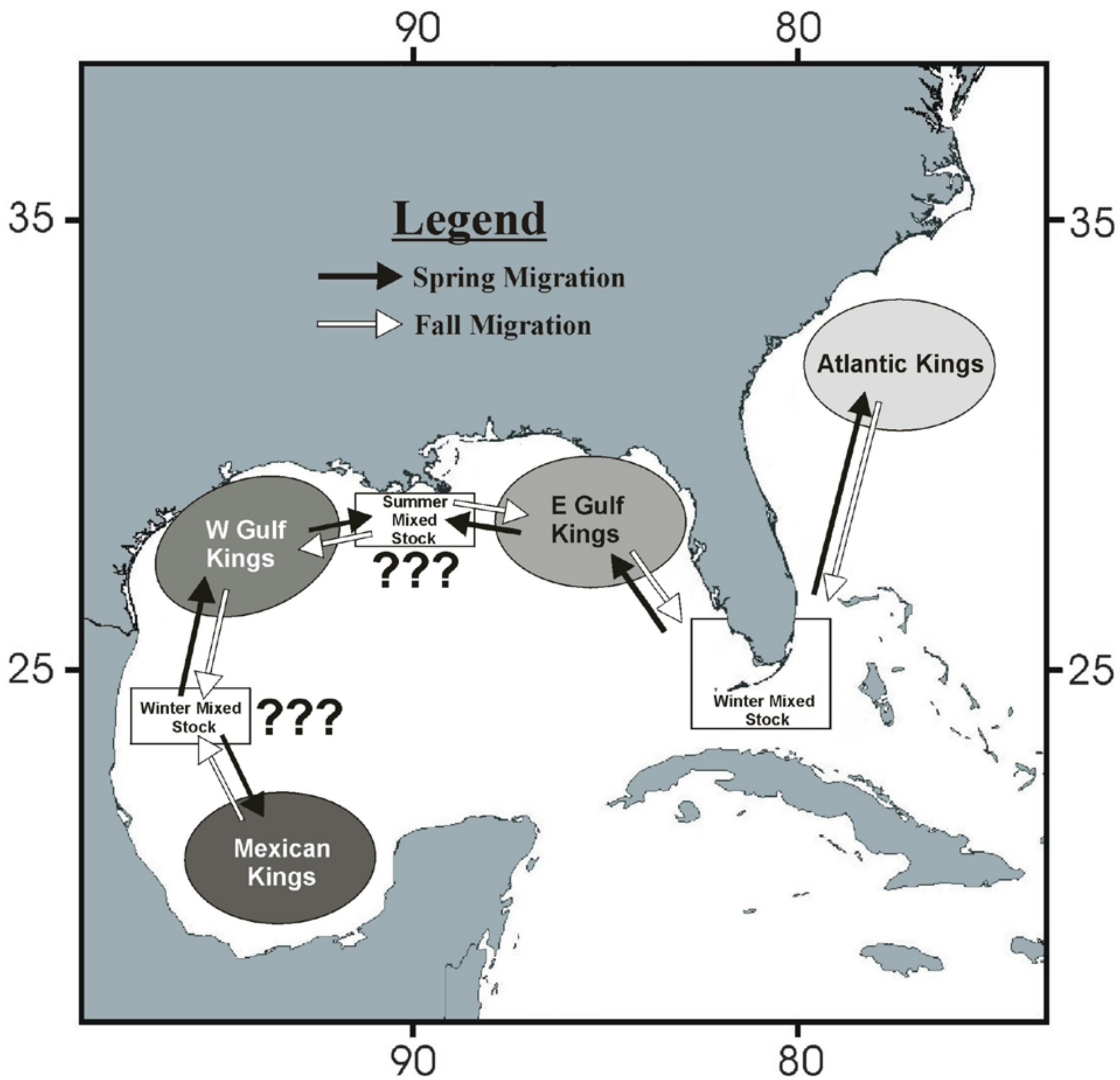


Figure 2.15.4. (from SEDAR 16 – SAR – Section II) Hypothesized population structure and migratory pathways of king mackerel in U.S. waters and Mexican waters in the western and southern Gulf of Mexico. All migratory pathways have been documented with tagging data, but the degree of mixing among migratory groups is estimated to vary among years. Furthermore, the extent to which the western Gulf migratory group migrates into Mexican waters of the southern Gulf is unknown.

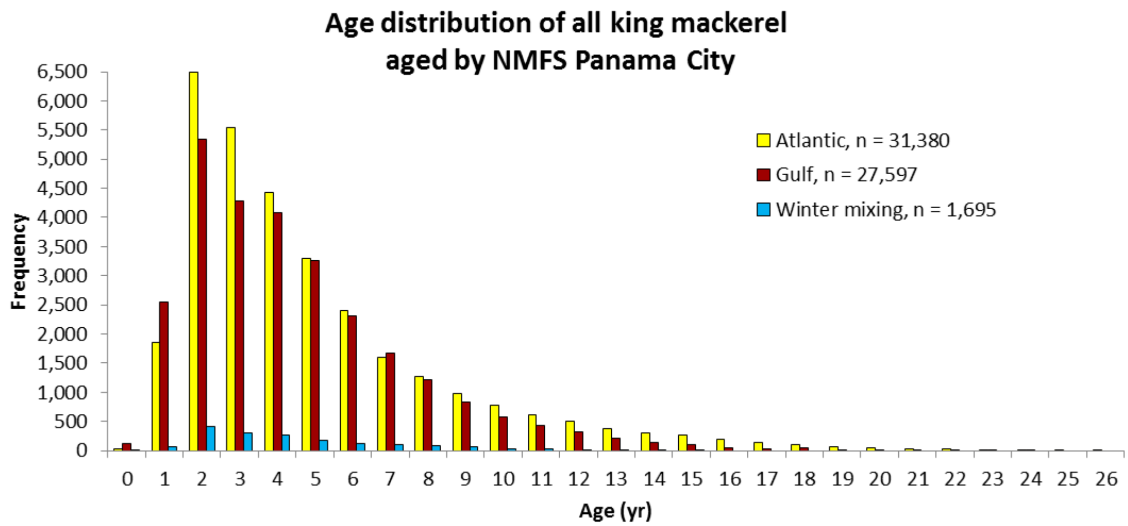


Figure 2.15.5. Age frequency distribution of all king mackerel, sexes combined, aged by NMFS Panama City, 1986-2013, using new (SEDAR38 DW) mixing zone definition.

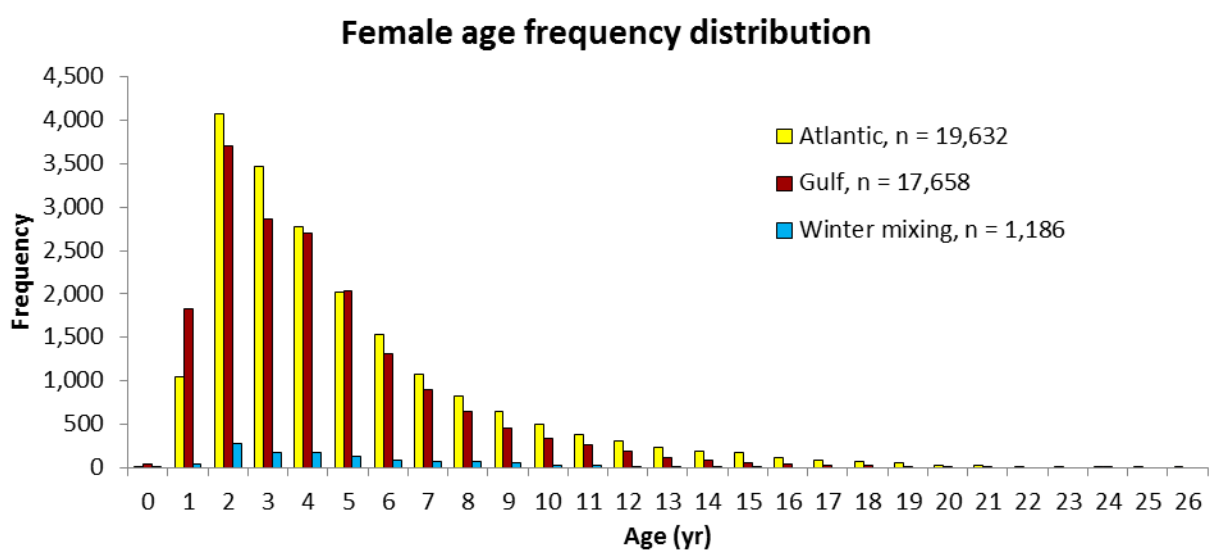


Figure 2.15.6. Age frequency distribution by stock (using new SEDAR38 DW mixing zone definition) of all female king mackerel, fishing years 1985-86 (incomplete) through 2013-14 (incomplete), aged by NMFS Panama City.

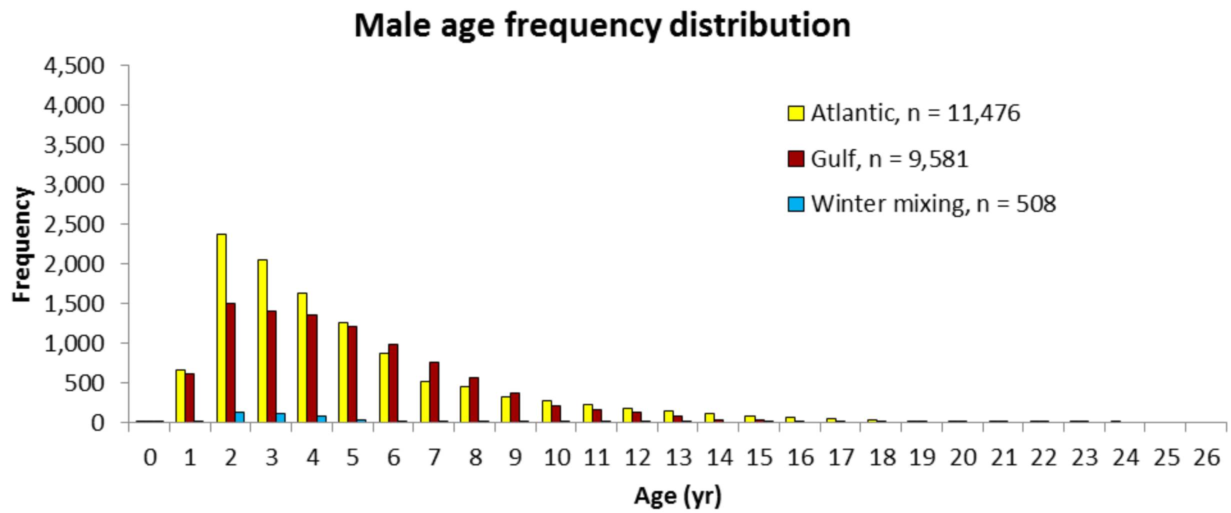


Figure 2.15.7. Age frequency distribution by stock (using new SEDAR38 DW mixing zone definition) of all male king mackerel, fishing years 1985-86 (incomplete) through 2013-14 (incomplete), aged by NMFS Panama City.

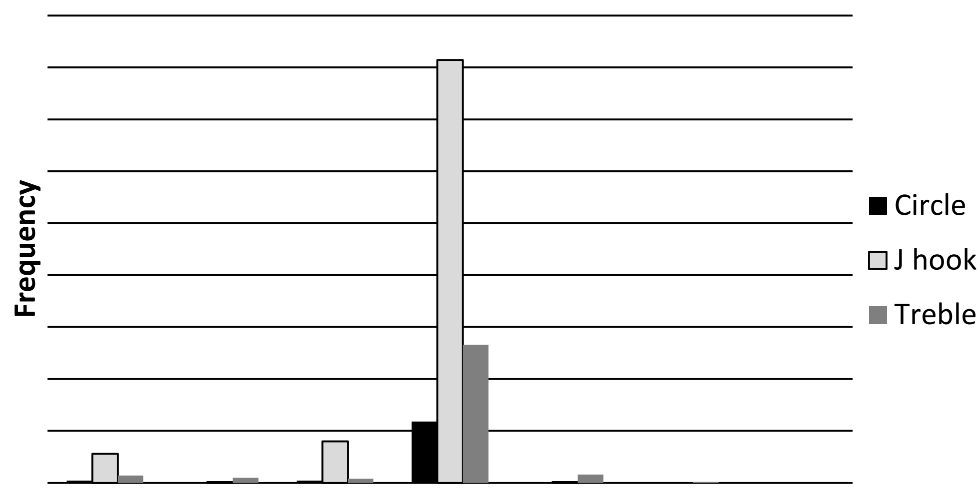


Figure 2.15.8. Numbers of king mackerel (harvested and released) observed on charter boats and headboats from the Gulf of Mexico and Atlantic coasts of Florida (combined) that were hooked externally (foul), in the gill, inside the mouth, in the lip, inside the throat, inside the gut, and in the eye by hook type.

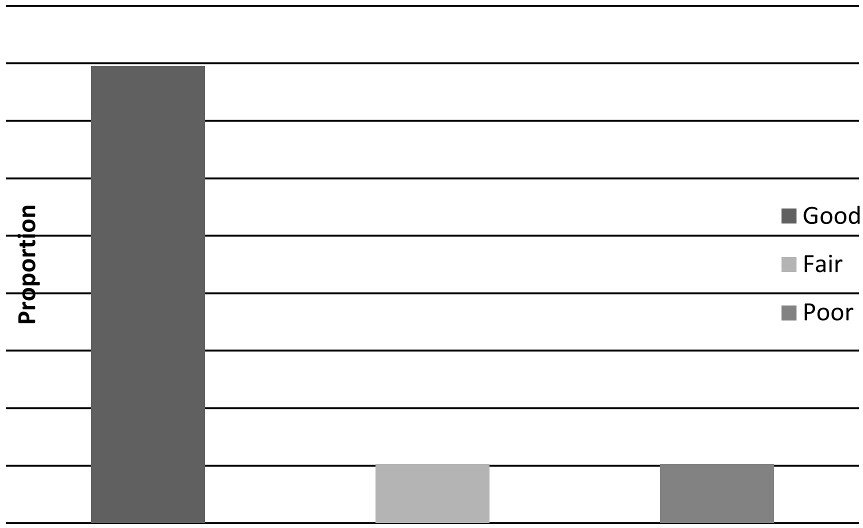


Figure 2.15.9. Proportion of live king mackerel discards observed from headboats and charter boats on the Gulf and Atlantic coasts of Florida, combined, that were released in good condition (hooked in the lip or mouth and submerged immediately), fair condition (hooked in the lip or mouth and initially disoriented before submerging), and poor condition (hooked in a location other than the lip or mouth, and/or did not submerge).

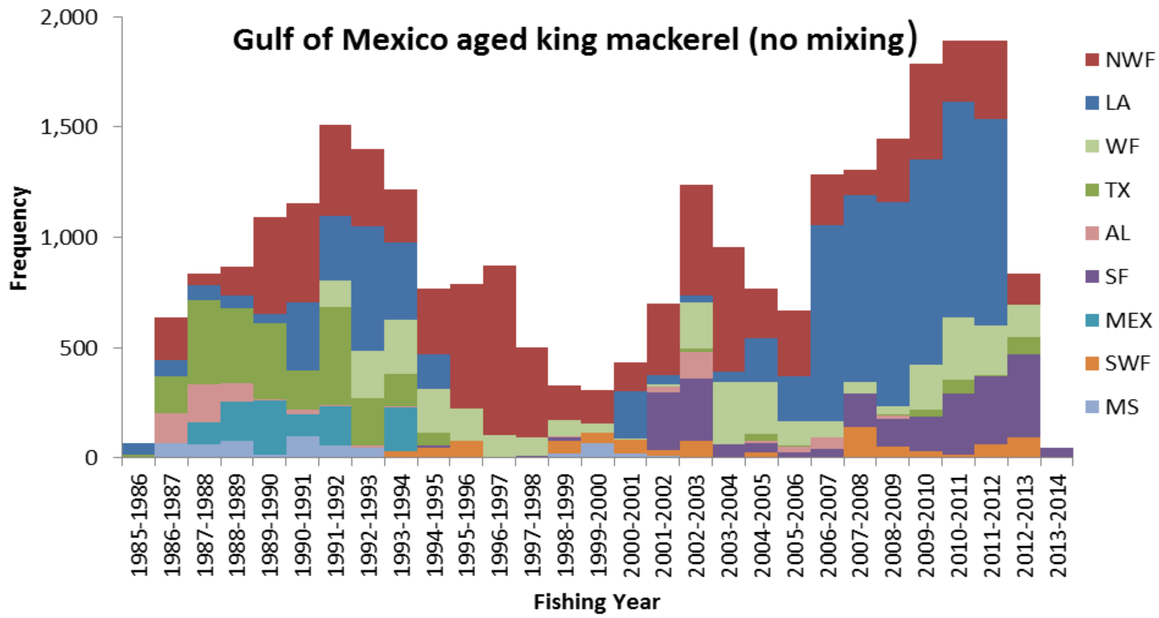


Figure 2.15.10. Annual frequencies of aged king mackerel from the Gulf of Mexico by state or region (excluding the winter mixing zone as defined in the SEDAR38 data workshop) , 1986-2013, in the Panama City NMFS lab data set: SF (South Florida), SWF (Southwest Florida), WF (West Florida), NWF (Northwest Florida), AL (Alabama), MS (Mississippi), LA (Louisiana), TX (Texas), MEX (Mexico).

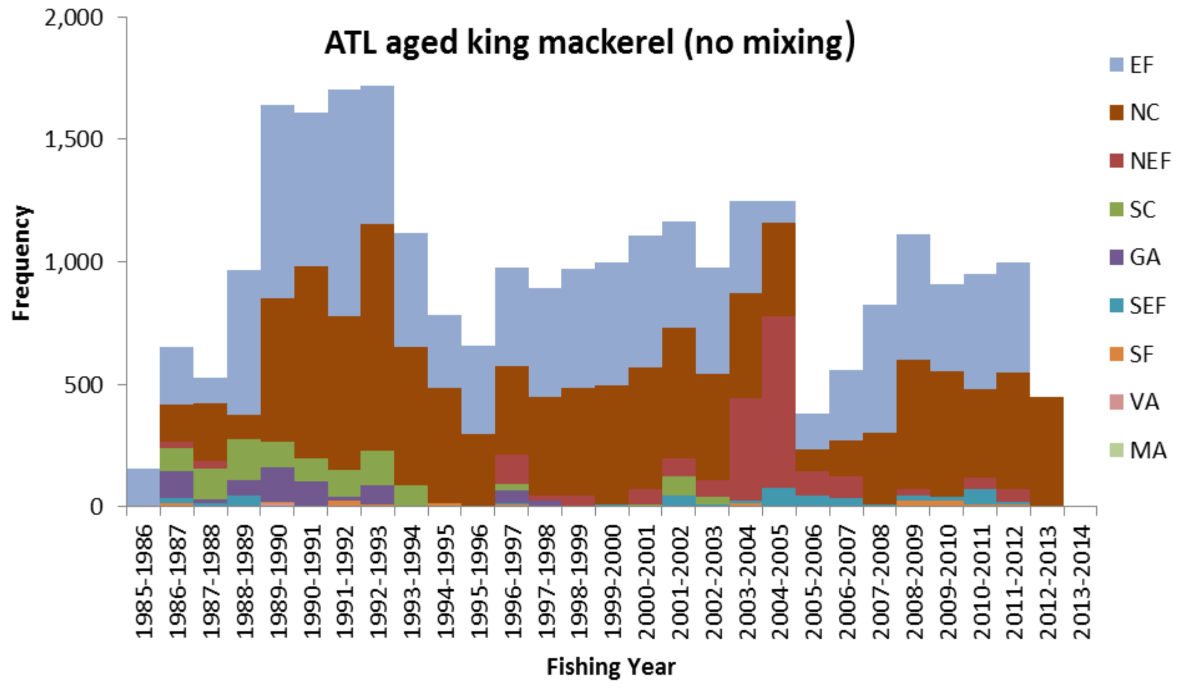


Figure 2.15.11. Annual frequencies of aged king mackerel from the Atlantic Ocean by state or region (excluding the winter mixing zone as defined in the SEDAR38 data workshop), 1986-2013, in the Panama City NMFS lab data set: MA (Massachusetts), VA (Virginia), NC (North Carolina), SC (South Carolina), GA (Georgia), NEF (Northeast Florida), EF (Northeast Florida), SEF (Southeast Florida), SF (South Florida).

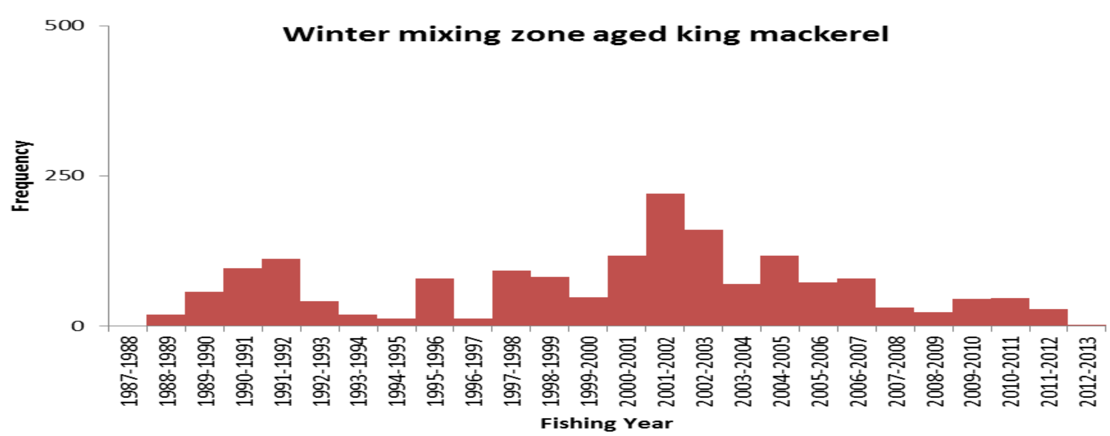


Figure 2.15.12. Annual frequencies of aged king mackerel, 1987-2013, from the winter mixing zone (Monroe County, FL) as defined in the SEDAR38 data workshop, in the Panama City NMFS lab data set.

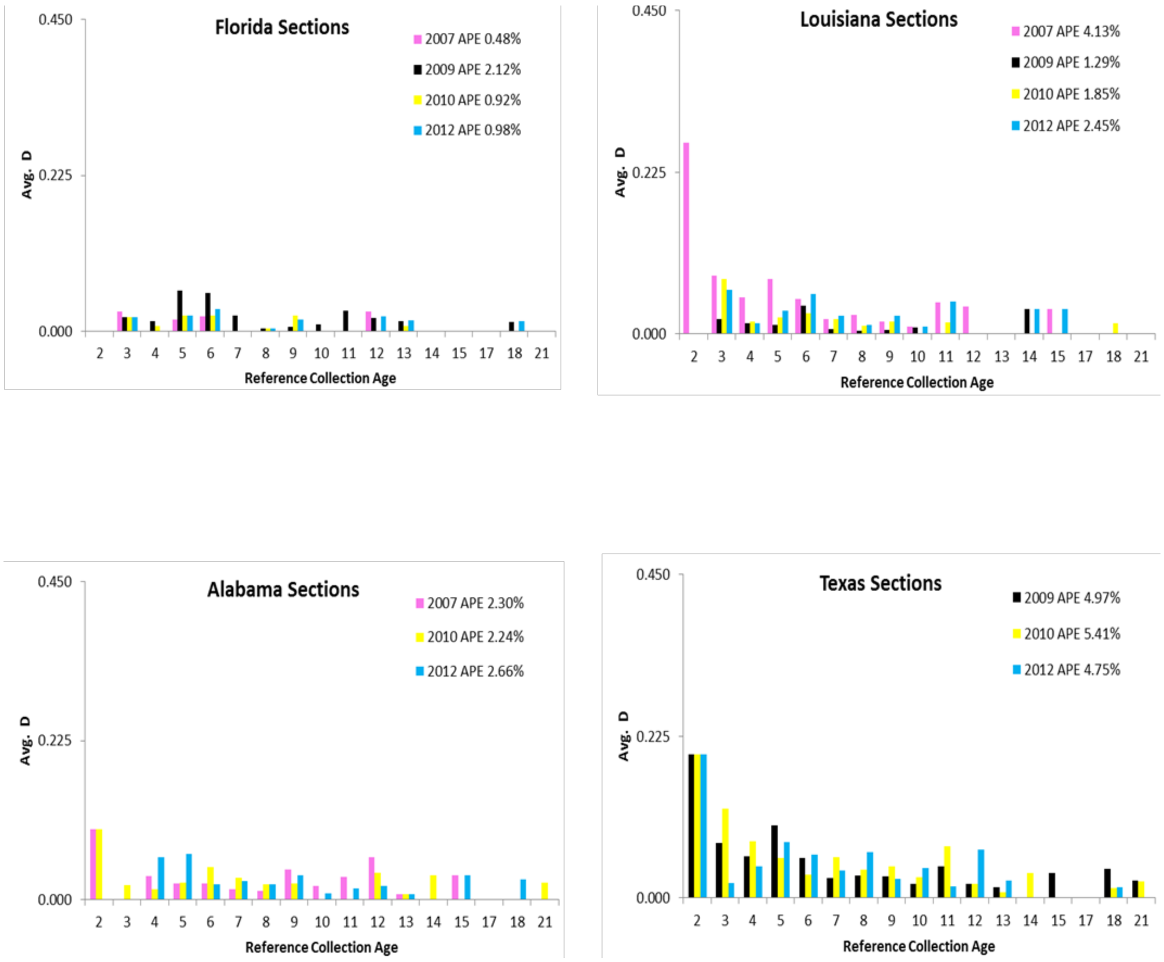


Fig 2.15.13. Yearly average precision (D) by age, and yearly average percent error or APE (shown in the legend) of king mackerel reference collection sectioned otolith readings from member states of the Gulf States Marine Fisheries Commission.

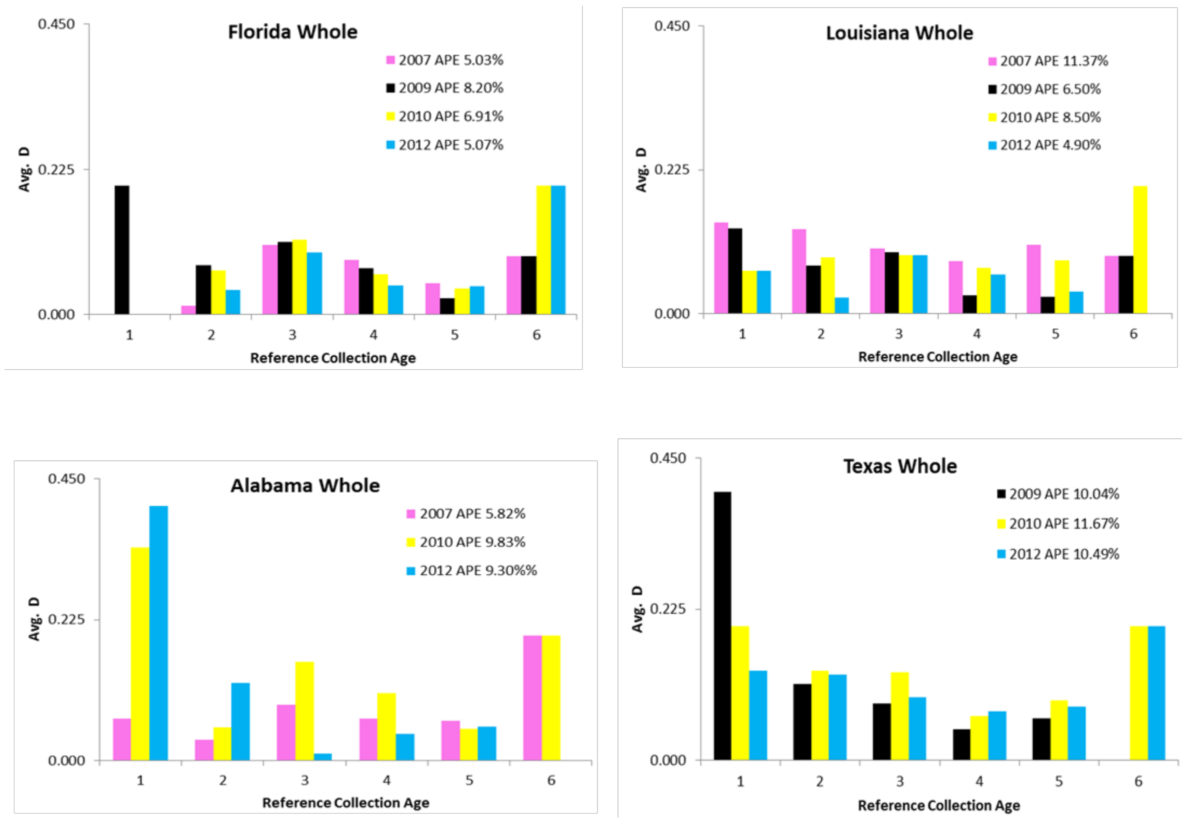


Fig 2.15.14. Yearly average precision (D) by age, and yearly average percent error or APE (shown in the legend) of king mackerel reference collection whole otolith readings from member states of the Gulf States Marine Fisheries Commission.

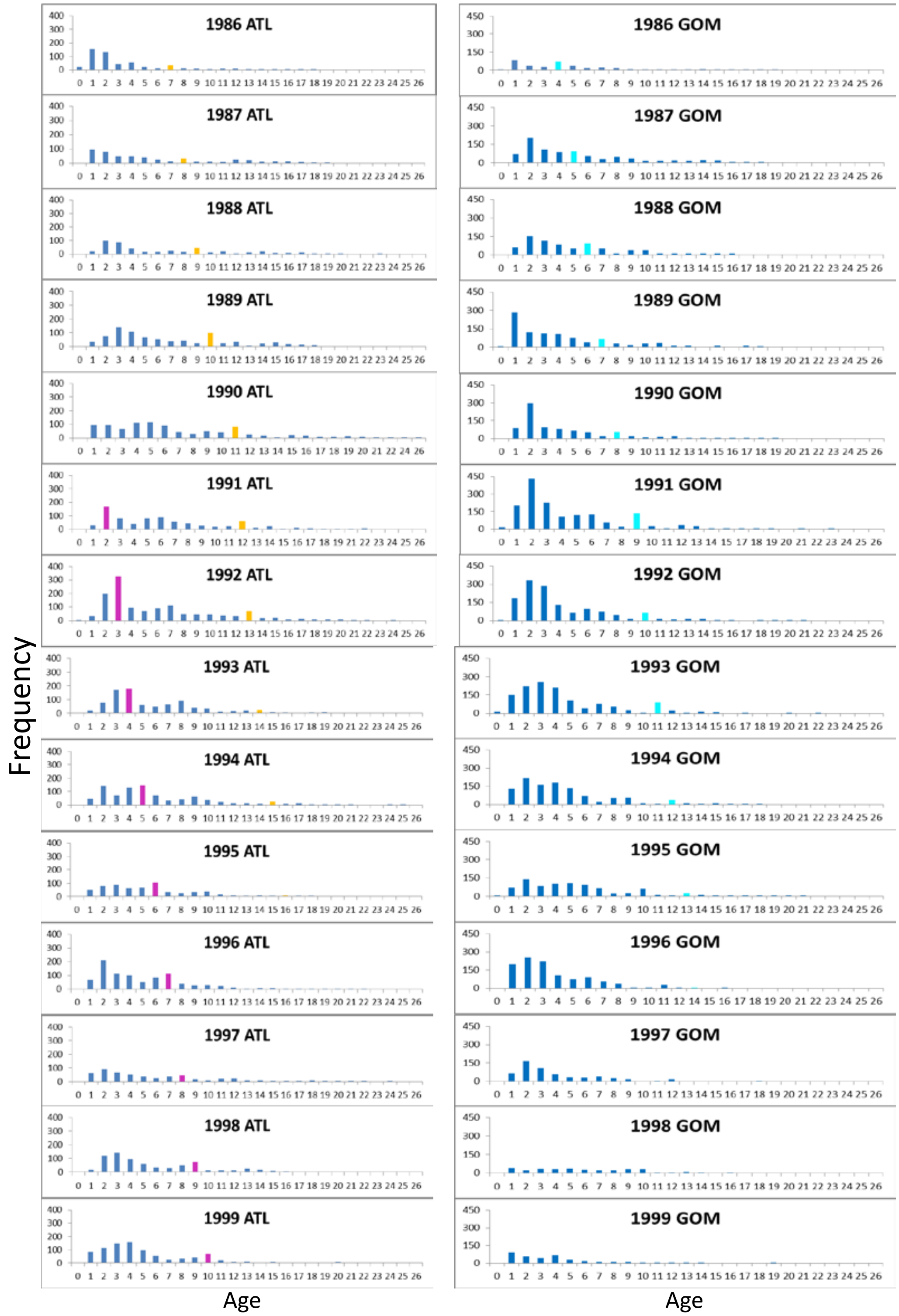


Figure 2.15.15. Annual stock-specific age composition of Panama City lab king mackerel age samples. Likely strong year classes easily identified as stock-specific, sequential one year increases in modal ages over several years are indicated by uniquely colored bars. In the Atlantic, the 1979, 1989, and 1998 cohorts, and possibly the 2001, appear to have been strong. In the Gulf, 1982, possibly 1990 and 2004, and definitely 2007 were strong cohorts. (Continued on following page)

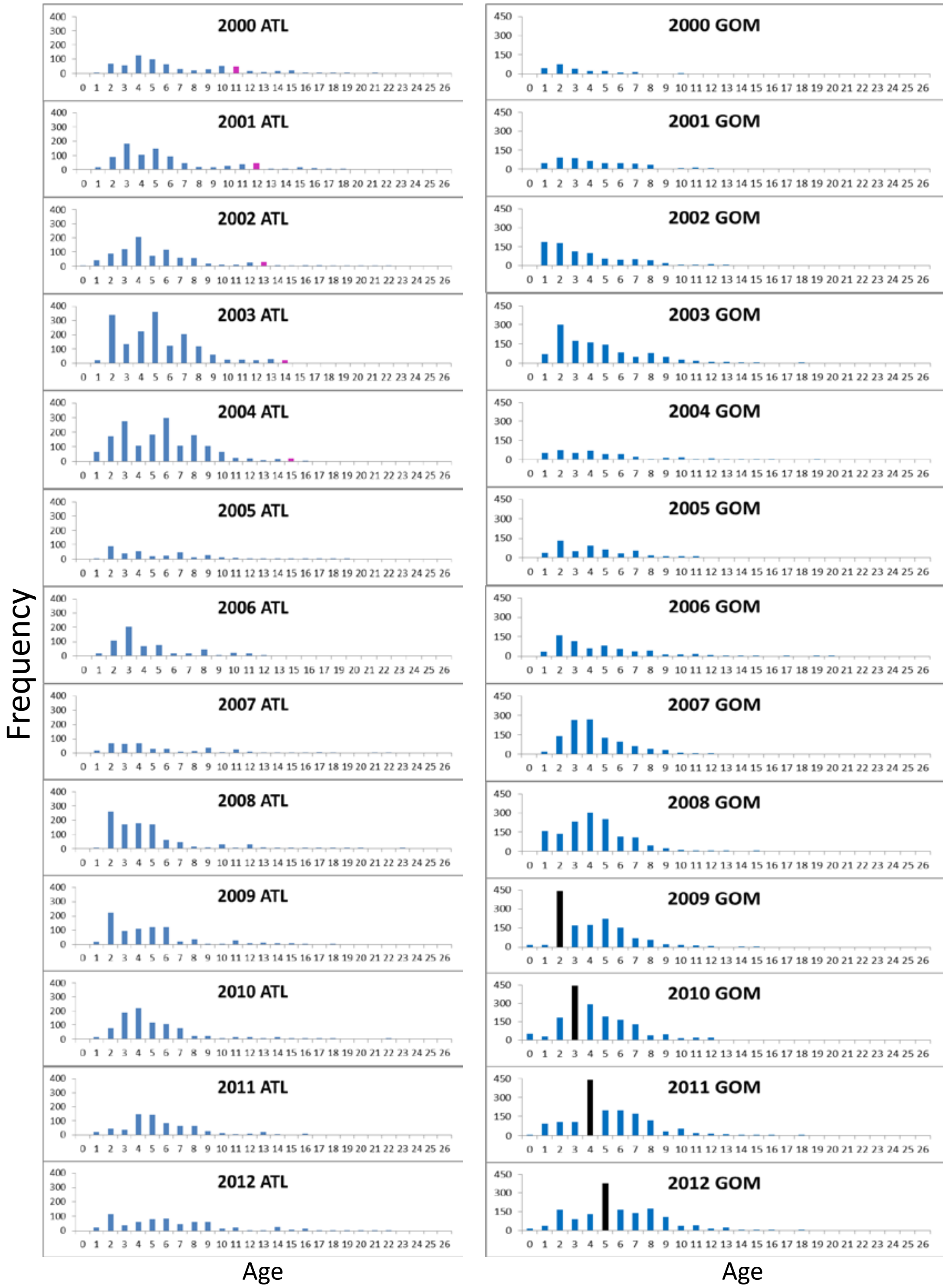


Figure 2.15.15 (cont.). Annual stock-specific age composition of Panama City lab king mackerel age samples. Likely strong year classes easily identified as stock-specific, sequential one year increases in modal ages over several years are indicated by uniquely colored bars. In the Atlantic, the 1979, 1989, and 1998 cohorts, and possibly the 2001, appear to have been strong. In the Gulf, 1982, possibly 1990 and 2004, and definitely 2007 were strong cohorts.

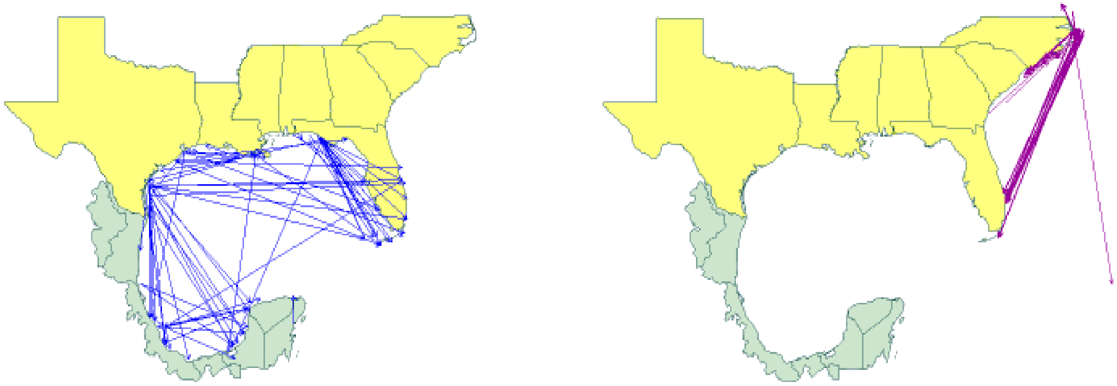


Figure 2.15.16. (Fig. 17 in S16-DW-10). Vector displacement maps of king mackerel tag recoveries from the non-mixing areas of the Gulf of Mexico (left) and Atlantic (right) regions.

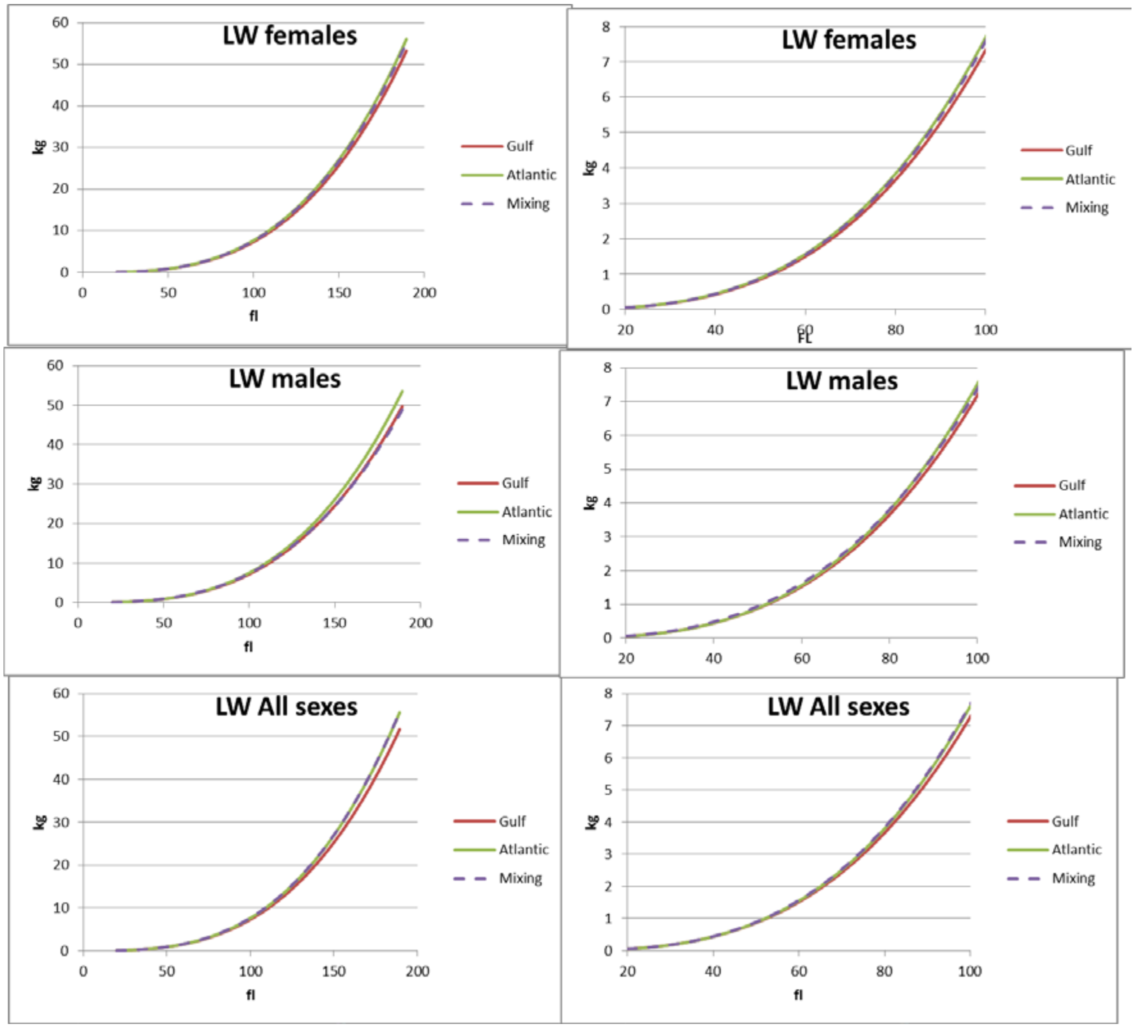
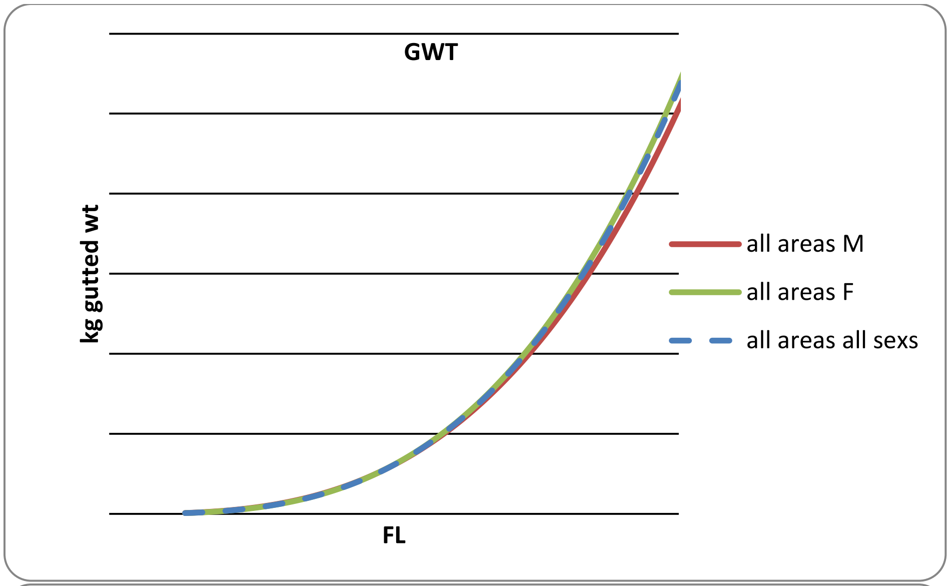


Figure 2.15.17. Fork length-gutted weight relationships developed for females, males and all sexes by region. Mixing zone (as defined prior to SEDAR38 data workshop) is defined as the Collier-Monroe to the Flagler-Volusia County line during the winter (Nov 1st to Mar 31st). **Both columns show the same data – the only difference is the scale covered.** The graphs on the left cover lengths to almost 200 cm FL, while those on the right range only to 100 cm to better show the differences at the smaller, more abundant sizes. At 150 cm there is a 7% difference between the Gulf and the Atlantic for the all sexes relationship. At 100 cm the difference is 5%. Atlantic and mixing zone relationships are almost exactly the same for females and for both sexes, but show some difference for males.



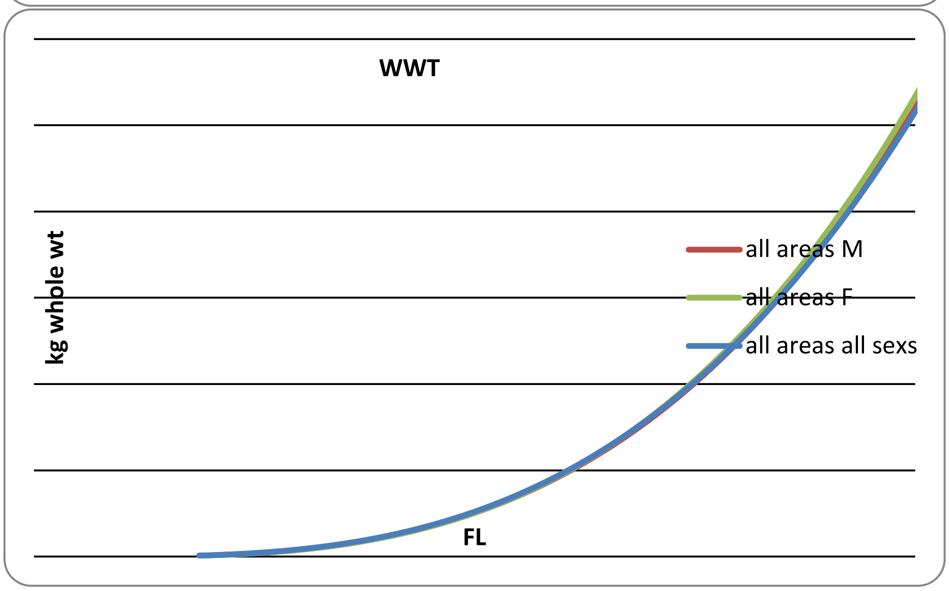


Figure 2.15.18. Fork length (cm) - gutted weight (kg) and fork length - whole weight relationships for all areas combined, by sex. GWT = gutted weight, WWT = whole weight. The all areas all sexes (i.e., sexes combined) regressions were recommended for use in the SEDAR38 assessment by the LHG based on the very slight differences between males and females.

3. COMMERCIAL FISHERY STATISTICS

3.1 OVERVIEW

Commercial landings of king mackerel were developed using data from multiple state and federal databases for three regions in the US: Atlantic, Gulf of Mexico and a newly defined ‘mixing zone’. These landings were provided in whole pounds from 1880-2013 and were also split into three primary gear groups: handline, gillnet, and other. In addition to the US commercial landings, Gulf of Mexico landings from Mexico were obtained from International Commission for Conservation of Atlantic Tunas (ICCAT) statistics.

Commercial discards were calculated from vessels fishing in the US South Atlantic and Gulf of Mexico using data from the Coastal Fisheries Logbook Program (CFLP) from 1998 through June 2013. Discards were estimated using methodologies used in SEDAR16.

Commercial lengths samples were obtained from the Trip Interview Program (TIP) databases. Sampling intensity for lengths by region, year, and gear were considered and appeared to be adequate for most strata from 1984 onward.

3.1.1. Commercial Workgroup Participants

Neil Baertlein	*Workgroup Leader*	NMFS-SEFSC
Stephanie McInerny	Rapporteur/Data Provider	NCDMF
Kevin McCarthy	Data Provider	NMFS-SEFSC
Dave Gloeckner	Data Provider	NMFS-SEFSC
Omar Rodriguez*	Data Provider	NMFS-SEFSC
Refik Orhun	Data Provider	NMFS-SEFSC
Steve Brown	Data Provider	FL FWC
Amy Dukes	Data Provider	SC DNR
Julie DeFilippi	Data Provider	ACCSP
Ed Martino	Data Provider	ACCSP
Donna Bellais	Data Provider	GSMFC
Ching-Ping Chih*	Data Provider	NMFS-SEFSC
Rusty Hudson	Commercial Fisherman	Florida
David Krebs	Commercial Fisherman	Florida

*Not present at Data Workshop

3.1.2 Issues Discussed at the Data Workshop

Issues discussed by the commercial workgroup concerning king mackerel landings included region assignments, gear groupings, calendar vs. fishing year, historical and Mexican landings. For discards, the workgroup discussed the discard estimation methodologies employed as well as the usefulness of the limited number of discards in the stock assessment.

3.2 REVIEW OF WORKING PAPERS

No SEDAR 38 working papers were provided or reviewed.

3.3 COMMERCIAL LANDINGS

Commercial landings of king mackerel were compiled from 1880 through 2012 for the US Atlantic Coast and US Gulf of Mexico. Historical landings of king mackerel for 1880 through 1949 were obtained from NOAA Fisheries' Office of Science and Technology. From 1950 onward, sources for landings in the US South Atlantic (Florida through North Carolina) included the Florida Fish and Wildlife Conservation Commission trip ticket program (FWC), South Carolina Department of Natural Resources (SCDNR), North Carolina Division of Marine Fisheries (NCDMF), and the Atlantic Coastal Cooperative Statistics Program (ACCSP). Landings from the Mid and North Atlantic (north of the NC-VA border) were solely from ACCSP. Sources for landings in the US Gulf of Mexico (Texas through the west coast of Florida) included the Florida FWC, Gulf of Mexico Fisheries Information Network (GulfFIN), the Accumulated Landings System (ALS), and ACCSP. Further discussion of how landings were compiled from the above sources can be found below. Detailed descriptions of historical federal and state data collections can be found in Appendix A.

King mackerel landings were provided in whole pounds up through June 2013. For landings reported as gutted, they will be converted to whole pounds using a conversion of 1.04. This conversion is used consistently in the South Atlantic and Gulf states. No other conversion factor was available. The terminal year was determined to be calendar year 2012/fishing year 2013. Fishing year in the Gulf runs from July 1-June30 for 1985 through present. Fishing years in the Atlantic are April 1-March 31 for years 1985 to 2005. From 2005 to present, fishing year is March1-February 28(29). However, many states do not yet have data available for 2013, so 2013 data should be considered incomplete. Because fishing year changed over time, landings data will be provided to assessment scientists by region, state, calendar year, month, and gear. Monthly landings can be split into fishing years if needed.

Landings will also be provided for only those landings reported as king mackerel. Unclassified mackerel landings were not considered as there were relatively small amount of landings and industry representatives felt these were Spanish mackerel.

3.3.1 Stock Regions

Landings of king mackerel were aggregated into three regions for assessment: Gulf of Mexico, Atlantic, and the “mixing zone” (**Figure 3.13.1**). Commercial landings were assigned to one of those regions based on area fished (**Figures 3.13.2 – 3.13.4**). A history of the Florida Trip Ticket program’s area codes for Key West and the Dry Tortuga can be found in **Table 3.12.1**.

The mixing zone is defined as dynamic, seasonally shifting boundaries of the Gulf of Mexico Fishery Management Council (GMFMC) and South Atlantic Fishery Management Council (SAFMC) fishery management areas. Regions were defined using the following convention:

- North of US 1 in the Key West and Marathon areas (Area 1.1, 1.8, 748.1) will be considered Gulf stock. South of US 1 in the Key West and Marathon areas (Area 1.0, 1.9, 748.0, 748.9) during the winter (Nov-Mar) will be designated as mixing zone. South of US 1 in the Keys and Marathon areas during the summer (Apr-Oct) will be considered South Atlantic stock. (**Figures 3.13.3 and 3.13.4)**
- Atlantic side of the Tortugas (Area 2.2, 2.9) will be designated as mixing zone during the winter (Nov-Mar) and considered South Atlantic stock during the summer (Apr-Oct).

Gulf of Mexico side of the Tortugas (Area 2.0, 2.8) will be considered Gulf stock (**Figure 3.13.4**).

- Landings in Florida Bay (Area 744.1) will also be considered Gulf (**Figure 3.13.3**).
- Winter mixing zone (areas 1.0, 1.9, 2.2, 2.9, 748.0, 748.9) landings will be split evenly between Gulf of Mexico and South Atlantic.

These geographic strata reflected the general stock structure and movement patterns described in the report of the life history working group: that separate management units exist in the Gulf of Mexico and in the Atlantic and that these management units overlap geographically in the mixing zone. Mixing zone definitions are different from those described in SEDAR16 based on recommendations from the Life History Workgroup. Landings by year, month, and region can be found in **Table 3.12.4** and **Figure 3.13.5**.

3.3.2 Commercial Landings by State and Gear

Commercial landings were grouped into three gear categories; Handline, Gillnet, and Other. Since 1978 handline which includes hook and line, electric/hydraulic bandit reels, and trolling was the dominant gear. In the 1960s and 1970s, gillnet landings usually accounted for more than half of the landings, however, since the mid1980s gillnet landings have accounted for 10-20% of the landings.

Statistics on commercial landings (1950 to present) for all species on the Atlantic coast are maintained in the Atlantic Coastal Cooperative Statistics Program (ACCSP) Data Warehouse. The Data Warehouse is an online database of fisheries dependent data provided by the ACCSP state and federal partners. Data sources and collection methods are illustrated by state in **Figure 3.13.5**. The Data Warehouse was queried in December 2013 for all king mackerel landings (monthly summaries by gear and category) from 1950−2012 from Florida through Maine (ACCSP 2013). Data to the county level are only provided for Florida. Data are presented using the gear categories as determined at the Data Workshop. The specific ACCSP gears in each category are listed in **Table 3.12.2** Commercial landings in pounds (whole weight) were developed based on methodologies for gear as defined by the Workgroup for each state as available for 1950−2013. 2013 data were not available to ACCSP at the time of the data workshop. Landings by calendar year and gear can be found in **Table 3.12.5**.

Decision #1: The workgroup recommends three gear groupings, handline, gillnet, and other. Handline includes hook and line, rod and reel, handline, electric/hydraulic bandit reels, and trolling.

<u>Gulf States (non-Florida)</u>

Gulf of Mexico landings for Alabama, Mississippi, Louisiana and Texas were compiled from the NOAA Fisheries Services' Accumulated Landing System (ALS) starting in 1982. Only

Louisiana showed any significant landings in 1982 and Texas landings started 1984. The ALS data were aggregated monthly and are available by county code and name, state code and name, NMFS area code, water body, gear code, gear description and aggregated gear groups (handline, gillnet, and other). The data can also be aggregated by calendar year and fishing year as well as for winter and summer months, where winter includes the months of November through March.

During the SEDAR38 DW it was agreed to use the gear information provided by the fishermen's logbook rather than the dealer assigned gear information of the ALS to assign gears to landings for the years from 1998 to 2012 for Louisiana. This was done by creating gear group proportions from gear specific logbook landings data for the three gear groups (handline, gillnet, and other) and applying those proportions to the ALS reported landings. The logbook landings database for king mackerel in the Gulf states started in 1998.

Gear information was not available for Louisiana from 1991 to 1999 or for Texas from 1993 to the present (2012-2013). For Louisiana in those years 1991-1997, the average annual gear group proportions of the three following years (i.e. 1998-2000) were calculated using logbook data and used to assign gear. The average annual gear group proportions of the years 1998-2000 was also used to assign gear to the Texas landings from 1994-1997.

In order to get monthly landings, needed to compile landings by fishing year, monthly gear proportions were calculated for Louisiana and Texas from the ALS landings and applied to the ALS landings with average annual gear group information for logbook (see above).

Texas:
Annual landings of king mackerel from the Texas Trip Ticket program from 2007-2012 were compared to TX landings from ALS and GulfFIN. Landings differed by data source therefore, the Commercial Workgroup suggested using data from ALS because TX trip ticket didn't start until 2007 and data provided were not a comprehensive depiction of the king mackerel fishery in TX. Landings of king mackerel in TX will be provided by year, month, and gear from ALS (1963-2013) or from historical databases of NOAA's Science and Technology division (prior to 1963).

Louisiana:
The Fisheries Information Network (FIN) is a state/federal cooperative program among agencies to collect, manage, and disseminate statistical data and information on the commercial fisheries of the Southeast Region. Beginning in 1999, through the GulfFIN and RecFIN line items, FIN received funding to conduct operational activities related to data collection and management of commercial and recreational data in the Gulf of Mexico. GulfFIN started receiving Louisiana trip ticket data beginning in 2000 and provided king mackerel landings data for LA in whole pounds from 2000-2013 (2013 being preliminary) by year, month, and gear. Landings prior to 2000 were extracted from ALS (1963-1999) or from historical databases of NOAA's Science and Technology division (prior to 1963). Unclassified landings of "mackerel" in the Gulf were determined to be Spanish mackerel so were not included.

Mississippi:
Mississippi landings of king mackerel through 2013 were extracted from ALS or from historical databases of NOAA's Science and Technology division prior to 1963. 2013 data are preliminary.

Alabama:
Similar to Louisiana, GulfFIN started receiving Alabama trip ticket data beginning in 2002 and provided king mackerel landings data for AL in whole pounds from 2002-2013 (2013 being preliminary) by year, month, and gear. Landings prior to 2002 were extracted from ALS (1963-2001) or from historical databases of NOAA's Science and Technology division (prior to 1963).

Florida

Comparisons were made between Florida's commercial trip ticket data (1985-2013) to both the NMFS general canvas (1976-1996) and logbook data (1998-2013). All three datasets were very similar in landings trends for matching years, and the level of landings reported by general canvass and Florida trip ticket were very similar for matching years as well. Landings levels from logbook data were much lower than Florida trip ticket. It was decided to use the landings from the Florida trip ticket data over the general canvas and logbook since general canvas data are Florida trip ticket data since 1997, and trip ticket data were more complete and are of a longer time series than the logbook data.

Florida trip ticket did not collect gear data prior to the latter part of 1991. Also, while gear specific landings trends in Monroe County from 1996-2012 reported through Florida trip tickets and NMFS logbooks were very similar, the distribution of landings between logbook and trip ticket by gear and area for Monroe County were different for both hook and line and gill net gears. Florida trip ticket showed a shift towards the Gulf after 2003 while NMFS logbook gear landings were more consistent by area. Given that effort was more consistent in the area and the logbook is generally regarded as having more reliable effort data, it was decided to use 1996-2012 Monroe County landings proportions by month, gear, and area from the NMFS logbook data, and apply those proportions to Monroe County trip ticket landings by year and month from 1986-2012. Additionally, because area fished was not required on trip tickets until 1995, month, county, area and gear proportions were calculated from non-Monroe trip ticket data from 1996-2012. These proportions were then applied to non-Monroe trip ticket data for years 1986-1995 by year and month. Monroe County and non-Monroe data were then combined into final Florida king mackerel landings summarized by year, month, region (Gulf of Mexico or South Atlantic), county landed, area fished, and gear from 1986-2012.

Monroe County proportions from the NMFS logbook data by month, region and gear were applied to landings from 1978-1985. Proportions by region and gear were applied to the annual landings from Monroe County from 1962-1977. Prior to 1962, county of landing was not available and only east vs. west coast (includes Monroe County) of Florida was reported. To apportion these landings to the mixing zone a mean proportion of mixing zone landings to west coast landings from 1962 through 1971 was applied.

Atlantic States (non-Florida)

Georgia:

Georgia DNR staff examined ACCSP landings and compared them to state held versions. It was determined that ACCSP landings were a match and would be used in place of state provided data for the entire time series (1950– 2013).

South Carolina:

SCDNR provided monthly landings data for king mackerel from 1972– June 2013 in appropriate gear categories. Data from 1972–2003 were provided as monthly totals through collaborative efforts by SCDNR and the NMFS Cooperative Statistics Program and all data were correlated and confirmed with the ACCSP data warehouse. Data provided from 2004– June 2013 were more comprehensive, as SCDNR instituted a mandatory Trip Ticket Program in late 2003. SCDNR data from 1972–2012 were compared to data from ACCSP and were found to be the same for most years. 1972–1977 data by month were provided by SCDNR because monthly data were not available from ACCSP for those years. 2001–2003 data were also provided by SCDNR since annual totals were slightly higher than ACCSP. SC landings will be provided by ACCSP for all remaining years between 1950 and 2012.

King mackerel were landed primarily gutted with a minimal amount landed in whole pounds. For finfish reported in gutted weights, a conversion factor of 1.04 was used to calculate whole weight, which was a consistent conversion factor among all the Southeast states. Additionally, all landings throughout this time period were associated with gears used; therefore, landings data were partitioned by year/month/gear combinations. Gear combinations provided in this assessment were Handline, Gillnet, and Other and these same gear groupings were used in the last king mackerel SEDAR16 assessment.

North Carolina:

NCDMF provided landings data for king mackerel from 1972–1977 and 1994–2013. Data from 1972–1977 were provided from NMFS General Canvass and are also stored in the NCDMF database; data from 1994–2013 were provided by the NC Trip Ticket Program. 2013 data were still considered preliminary and were only provided complete through June. Up to three gears can be listed on a trip ticket therefore, landings were analyzed to look at gear combinations and gear1 was reassigned where necessary (**Table 3.12.3**). Data from NCDMF is also stored in the ACCSP data warehouse. Data were provided by NCDMF to capture all three gears and would contain the most recent edits to the data. ACCSP will provide NC landings for all remaining years between 1950 and 1993.

The majority of king mackerel landed in NC are in gutted condition. Those reported as gutted were converted to whole weight using a conversion of 1.04 which is the currently accepted conversion for king mackerel in the South Atlantic. Landings reported as whole were not modified. There were no landings of unclassified mackerels. Gear groupings provided in SEDAR16 for king mackerel were Handline, Gillnet, and Other and match the gear groupings recommended by the Commercial Workgroup.

North of North Carolina:
Landings in the Atlantic north of North Carolina were provided by ACCSP from 1950-2012 by year, state, and gear. Monthly data were provided when available. Sparse landings were reported from Virginia through New Hampshire (less than 1% of total Atlantic landings).

3.3.3 Historic Landings

Historic landings were obtained from NOAA Fisheries' Office of Science and Technology which has available landings from 1880-1949. While reported landings are available back to 1880, no appreciable landings are seen until 1918, and consistent reporting began in 1926. Between 1926 and 1949, several years have no landings available, most noticeably the years during World War II, 1941-1944. Since it is possible these years had no landings, due to wartime port closures, attempts to interpolate landings were not made. Reported historical landings can be found in **Table 3.12.6** and **Figure 3.13.7**.

Decision #2: Provide historic landings as reported. No interpolation for missing years

3.4 MEXICAN COMMERCIAL LANDINGS

The Commercial Workgroup compared Mexican king mackerel (i.e. "Peto" in Spanish) from ICCAT to reported landings from the Mexican Secretaria de Agricultura for 1980–2012 (ICCAT 2013; Secretaria de Agricultura 2013). In some years, ICCAT landings were lower than those extracted from the Secretaria de Agricultura. Secretaria de Agricultura landings were adjusted by removing landings from Yucatan and Quintana Roo. ICCAT landings were still lower than the adjusted Secretaria de Agricultura reported landings but matched more closely (**Figure 3.13.8**). The Commercial Workgroup recommended using ICCAT landings over data from the Secretaria de Agricultura because ICCAT is a peer reviewed data source. Total Mexican commercial catches from 1960-2012 were compiled using the landings from the ICCAT database (**Table 3.12.7** and **Figure 3.13.9**). A comparison of Mexican landings to US landings can be seen in **Figure 3.13.10**.

Decision #3: Accept Mexican king mackerel landings from ICCAT in preference to those reported by the Mexican Secretaria de Agricultura.

3.5 COMMERCIAL DISCARDS

Historically the commercial discards have been divided into two major categories for each regional fisheries management council, one each for the commercial finfish fishery fleet and one each for the shrimp fishing fleet. They are then analyzed separately for the SAFMC and for the GMFMC.

For this assessment, discards from the handline fishery will be calculated for three regions as defined for commercial landings data: Gulf of Mexico, South Atlantic, and mixing zone. Logbook reporting of coastal pelagics such as king mackerel became required in 1998.

3.5.1 U.S. Finfish Fishery Discards

The data set for calculating commercial vessel king mackerel discards included trips from vessels that reported discards to the coastal discard logbook program between January 1, 2002 and June 30, 2013 in the US South Atlantic, Gulf of Mexico, and king mackerel mixing zone. Only discard reports from hook and line gear (handline, electric reel, and trolling gears) were included in the calculations. The available data for other gears were too few for discard rates to be calculated. The data were stratified using new regional breakdowns as described in Section 3.3.1, but otherwise followed methods used in SEDAR 16 (McCarthy, K. J. 2008) where strata included: Gulf of Mexico = hooks/line (1 or 2+) and gear (vertical line and trolling), South Atlantic = hooks/line(1 or 2+) and vessel length (<30, 30-35, and 35+ feet), and Mixing Zone = hooks/line (1 or 2+) and number of lines fished (1-2, 3, and 4+). Mean discard rates (discards per hook hour fished) were calculated for each stratum. Those mean rate calculations included all hook and line discard trips within each stratum; i.e., trips with no king mackerel discards reported were included in the discard rate calculations to produce a mean nominal discard rate. Total hook and line effort (hook hours) was tabulated from the coastal logbook data set for each of those region specific strata for each year and month combination from January 1998-June 2013. Total discards for each stratum were then calculated as: ***stratum mean discard rate*stratum specific monthly effort***. Calculated king mackerel discards are reported for each region (as defined for SEAR16)/year/month in **Table 3.12.8**. Discards were not calculated for years prior to 1998 because the reporting of fishing effort in the coastal pelagic fishery, including the king mackerel fishery, was not mandatory before that year.

Calculated king mackerel discards from the commercial hook and line fishery by year, month, and region as defined in the SEDAR 38 data workshop are provided in **Table 3.12.9**. Other than following the new region definitions, discards were calculated using the methods from SEDAR 16. Total discards summed across regions were similar to those calculated using the SEDAR 16 region definitions. The combination of higher discard rates and greater fishing effort under the new definition of the South Atlantic region resulted in much higher calculated king mackerel discards compared to those calculated for the South Atlantic using regional definitions from SEDAR 16. Conversely, discard rates and total effort in the newly defined Mixing Zone were much lower and resulted in many fewer discards calculated in that region compared to the

SEDAR 16 defined Mixing Zone. Discard rates in the Gulf of Mexico differed very little from discard rates calculated using the SEDAR 16 region definitions, but more effort was assigned to that region resulting in slightly higher calculated discards compared initial results using the SEDAR 16 defined regions.

Based on recommendations from the data workshop, commercial discard totals should be included in VPA models, but not Stock Synthesis (SS) models. Variation in calculated commercial discards among years, due to the method used for calculating those discards, does not represent changes in recruitment. In order to avoid providing the model (SS) with misleading data, it was recommended in plenary session that the commercial discards not be included in the SS data inputs. It was further recommended that dead discard totals be included as an input for any VPA model runs, although it is believed that commercial discard totals are so low as to have little effect on model results.

Decision #4: Total discards will be provided by month and region to assessment biologists for use in appropriate models.

3.5.2. U.S. Shrimp Fishery Bycatch

Efforts to construct king mackerel bycatch estimates from the shrimp fishery are ongoing. These will available for the SEDAR38 assessment workshop.

3.6 COMMERCIAL EFFORT

The distribution of commercial effort in trips landing king mackerel by year was compiled from the Coastal Fisheries Logbook Program (CFLP) for 1998-2012 and supplied here for informational purposes. These data are presented in **Figure 3.13.11**. The distribution of harvest, as reported to the CFLP, is also displayed in **Figure 3.13.12**.

3.7 BIOLOGICAL SAMPLING

Commercial length samples were obtained from the Trip Interview Program (TIP) databases. However, due to changes in the mixing zone definition, sampling intensity for lengths by region, year, and gear were not available for the data workshop.

3.8 COMMERCIAL CATCH-AT-AGE/LENGTH: DIRECTED AND DISCARD

Due to changes in the mixing zone definition catch at age and length for directed fisheries were not available for the data workshop. These will be made available for the SEDAR38 Assessment workshop. There were little to no samples available from observer programs to develop catch at age or length distributions of discarded king mackerel.

3.9 COMMENTS ON ADEQUACY OF DATA FOR ASSESSMENT ANALYSES

The working group considered the majority of landings data from the United States to be adequate for assessment analyses. Data appeared to be most accurate and reliable from the various state data bases in the most recent years. This is likely due to the implementation of state trip ticket programs, beginning with Florida in 1986. Prior to 1986, areas fished were not available to assign mixing zone landings. Mean proportions were therefore developed to apportion Monroe County landings to the mixing zone. Reliable monthly landings data can be found back to 1978. Historic landings prior to 1950 were found to be the least reliable, as there appears to be missing data for various years and states. The working group was unable to evaluate the adequacy of the Mexican landings statistics due to the absence of scientists and fishermen familiar with that fishery.

Discards calculated from the hook and line fishery were found to be inappropriate for some assessment models. As discussed in Section 3.5, the variation in calculated commercial discards does not represent changes in recruitment. King mackerel bycatch from the shrimp fishery was not available for any comments on adequacy to be made.

Length samples appeared to be adequate for assessment analyses. There were a relatively high number of samples for most years and strata.

3.10 RESEARCH RECOMMENDATIONS

- Consistent and sufficient levels of observers are needed in both the Gulf of Mexico and the South Atlantic. The South Atlantic shrimp fishery has especially been under sampled.
- Increase Biological Sampling efforts to better define mixing zone boundaries in the South Atlantic and Gulf of Mexico.
- Increase cooperative research with Mexican scientists to understand the relationships between king mackerel exploited in Mexican and U.S. waters. Additionally, participation of Mexican scientists is needed in the assessment process (both accumulation and interpretation of data as well as assessment) to better understand the Mexican fisheries and possible connectivity of Gulf stocks.

3.11 LITERATURE CITED

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3.12 TABLES

Table 3.12.1 History of Florida Trip Ticket area codes used to define the boundary between Gulf of Mexico and mixing zone regions.

Area	Description	Year Created
1.0	Key West, S. Atlantic State Waters	1984
1.1	Key West, Gulf State Waters	1984
2.0	Tortugas, All State Waters	1984 (2008 - Gulf only)
1.9	Key West, All Fed. Waters	1990 (1996 - S. Atlantic only)
2.9	Tortugas, All Fed. Waters	1990 (1996 – S. Atlantic only)
1.8	Key West, Gulf Fed. Waters	1996
2.8	Tortugas, Gulf Fed. Waters	1996
2.2	Tortugas, S. Atlantic State Waters	2008

Table 3.12.2 Specific ACCSP gears in each gear category for king mackerel commercial landings.

HANDLINE			
GEAR CODE	**GEAR NAME**	**TYPE CODE**	**GEAR TYPE**
300	HOOK AND LINE	007	HOOK AND LINE
301	HOOK AND LINE, MANUAL	007	HOOK AND LINE
302	HOOK AND LINE, ELECTRIC	007	HOOK AND LINE
303	ELECTRIC/HYDRAULIC, BANDIT REELS	007	HOOK AND LINE
304	HOOK AND LINE, CHUM	007	HOOK AND LINE
305	HOOK AND LINE, JIG	007	HOOK AND LINE
306	HOOK AND LINE, TROLL	007	HOOK AND LINE
307	HOOK AND LINE, CAST	007	HOOK AND LINE
308	HOOK AND LINE, DRIFTING EEL	007	HOOK AND LINE
309	HOOK AND LINE, FLY	007	HOOK AND LINE
310	HOOK AND LINE, BOTTOM	007	HOOK AND LINE
320	TROLL LINES	007	HOOK AND LINE
321	TROLL LINE, MANUAL	007	HOOK AND LINE
322	TROLL LINE, ELECTRIC	007	HOOK AND LINE
323	TROLL LINE, HYDRAULIC	007	HOOK AND LINE
324	TROLL LINE, GREEN-STICK	007	HOOK AND LINE
330	HAND LINE	013	HAND LINE
331	TROLL & HAND LINE CMB	013	HAND LINE
340	AUTO JIG	013	HAND LINE
700	HAND LINE	013	HAND LINE
701	TROLL AND HAND LINES CMB	013	HAND LINE
702	HAND LINES, AUTO JIG	013	HAND LINE
GILLNET			
GEAR CODE	**GEAR NAME**	**TYPE CODE**	**GEAR TYPE**
200	GILL NETS	006	GILL NETS
201	GILL NETS, FLOATING DRIFT	006	GILL NETS
202	GILL NETS, SINK DRIFT	006	GILL NETS
203	GILL NETS, FLOATING ANCHOR	006	GILL NETS
204	GILL NETS, SINK ANCHOR	006	GILL NETS
205	GILL NETS, RUNAROUND	006	GILL NETS
206	GILL NETS, STAKE	006	GILL NETS
207	GILL NETS, OTHER	006	GILL NETS
208	GILL NETS, SMALL MESH	006	GILL NETS
209	GILL NETS, LARGE MESH	006	GILL NETS
210	TRAMMEL NETS	006	GILL NETS
211	TRAMMEL NETS, FLOATING DRIFT	006	GILL NETS
212	TRAMMEL NETS, SINK DRIFT	006	GILL NETS
213	TRAMMEL NETS, FLOATING ANCHOR	006	GILL NETS
214	TRAMMEL NETS, SINK ANCHOR	006	GILL NETS
215	TRAMMEL NETS, RUNAROUND	006	GILL NETS
216	TRAMMEL NETS, OTHER	006	GILL NETS

Table 3.12.3 North Carolina Trip Ticket Program gear code reassignments for king mackerel (1994–2013).

NEW GEAR		GEAR1		GEAR2		GEAR3
610	Rod-n-Reel	330	Crab Pot	610	Rod-n-Reel	
660	Trolling	330	Crab Pot	660	Trolling	
480	Gill Net Set (sink)	345	Fish Pot	480	Gill Net Set (sink)	
610	Rod-n-Reel	345	Fish Pot	610	Rod-n-Reel	
660	Trolling	345	Fish Pot	660	Trolling	
660	Trolling	760	Gigs	660	Trolling	
660	Trolling	676	Bottom Longline	660	Trolling	
480	Gill Net Set (sink)	677	Longline Shark	480	Gill Net Set (sink)	
610	Rod-n-Reel	677	Longline Shark	610	Rod-n-Reel	
610	Rod-n-Reel	675	Longline Surface	610	Rod-n-Reel	
660	Trolling	675	Gill Net Set (sink)	660	Trolling	
610	Rod-n-Reel	215	Shrimp Trawl	610	Rod-n-Reel	

Table 3.12.4 US Commercial landings in whole pounds of king mackerel by year, month, and region for 1950-2012. Mixing zone landings have been removed due to confidentiality rules governing low sample size (number of vessels or dealers reporting).

Year	Month	Atlantic	Gulf of Mexico	Mixing Zone
2012	12	365,743	191,087	*
2012	11	81,910	20,127	*
2012	10	101,215	23,282	*
2012	9	46,089	102,558	*
2012	8	91,781	205,823	*
2012	7	73,577	543,113	*
2012	6	104,187	1,983	*
2012	5	506,425	4,588	*
2012	4	216,181	6,164	*
2012	3	120,437	4,777	*
2012	2	220,991	241,996	*
2012	1	518,398	556,964	*
2011	12	349,164	104,400	*
2011	11	269,455	1,797	*
2011	10	44,574	31,195	*
2011	9	40,529	274,758	*
2011	8	125,350	423,197	*
2011	7	142,186	514,068	*
2011	6	262,913	355	*
2011	5	628,006	1,286	*
2011	4	427,464	8,416	*
2011	3	11,832	80,019	*
2011	2	303,456	676,820	*
2011	1	432,060	278,538	*
2010	12	384,229	78,531	*
2010	11	171,319	356,223	*
2010	10	122,604	347,544	*
2010	9	35,132	87,607	*
2010	8	566,160	119,564	*
2010	7	188,534	72,126	*
2010	6	547,012	572	*
2010	5	633,306	1,026	*
2010	4	964,410	162,425	*
2010	3	229,061	1,681	*
2010	2	42,385	114,947	*
2010	1	333,803	883,303	*

Year	Month	Atlantic	Gulf of Mexico	Mixing Zone
2009	12	644,563	48,287	*
2009	11	423,748	5,580	*
2009	10	225,081	155,935	*
2009	9	149,535	209,523	*
2009	8	575,712	390,734	*
2009	7	368,391	590,148	*
2009	6	424,944	31,637	*
2009	5	856,299	30,167	*
2009	4	417,432	21,716	*
2009	3	143,753	35,888	*
2009	2	249,231	249,388	*
2009	1	371,867	1,027,403	*
2008	12	534,640	128,022	*
2008	11	486,666	236,595	*
2008	10	260,821	253,120	*
2008	9	54,256	82,788	*
2008	8	425,939	174,914	*
2008	7	358,120	286,286	*
2008	6	375,080	17,707	*
2008	5	678,147	7,395	*
2008	4	315,027	29,765	*
2008	3	83,602	163,690	*
2008	2	343,215	410,765	*
2008	1	428,775	376,318	*
2007	12	748,551	87,534	*
2007	11	381,484	115,363	*
2007	10	166,466	184,508	*
2007	9	91,252	109,425	*
2007	8	353,036	290,735	*
2007	7	213,025	448,244	*
2007	6	217,412	15,967	*
2007	5	384,978	8,533	*
2007	4	484,304	32,429	*
2007	3	156,678	123,977	*
2007	2	314,794	150,442	*
2007	1	311,613	500,849	*
2006	12	587,941	47,832	*
2006	11	318,861	69,653	*
2006	10	255,629	108,159	*

Year	Month	Atlantic	Gulf of Mexico	Mixing Zone
2006	9	108,882	271,458	*
2006	8	367,320	377,347	*
2006	7	155,472	379,778	*
2006	6	247,626	12,416	*
2006	5	555,345	20,790	*
2006	4	391,293	80,288	*
2006	3	318,284	99,429	*
2006	2	221,773	226,265	*
2006	1	255,282	392,325	*
2005	12	383,705	87,201	*
2005	11	452,338	139,058	*
2005	10	156,756	146,985	*
2005	9	49,481	64,898	*
2005	8	204,105	234,408	*
2005	7	133,150	274,107	*
2005	6	176,775	9,306	*
2005	5	468,745	18,218	*
2005	4	157,320	27,618	*
2005	3	423,653	64,441	*
2005	2	174,003	230,752	*
2005	1	331,580	556,271	*
2004	12	316,740	35,497	*
2004	11	376,271	46,033	*
2004	10	185,011	168,499	*
2004	9	13,585	79,972	*
2004	8	306,166	209,689	*
2004	7	226,362	492,837	*
2004	6	221,208	1,854	*
2004	5	560,785	1,692	*
2004	4	415,663	13,285	*
2004	3	226,132	342,445	*
2004	2	136,867	194,693	*
2004	1	305,005	145,993	*
2003	12	322,550	35,597	*
2003	11	338,610	43,269	*
2003	10	100,437	191,162	*
2003	9	157,101	157,695	*
2003	8	306,418	348,328	*
2003	7	81,144	454,494	*

Year	Month	Atlantic	Gulf of Mexico	Mixing Zone
2003	6	90,392	3,180	*
2003	5	374,714	3,028	*
2003	4	169,522	16,320	*
2003	3	478,297	76,343	*
2003	2	180,376	161,779	*
2003	1	261,440	376,584	*
2002	12	304,820	15,703	*
2002	11	306,568	82,814	*
2002	10	203,307	230,834	*
2002	9	63,436	117,975	*
2002	8	122,124	341,134	*
2002	7	141,844	392,532	*
2002	6	106,332	2,879	*
2002	5	236,567	3,756	*
2002	4	273,170	19,746	*
2002	3	259,834	106,185	*
2002	2	139,173	164,231	*
2002	1	341,606	317,357	*
2001	12	396,528	79,360	*
2001	11	218,974	232,773	*
2001	10	167,708	194,872	*
2001	9	97,888	155,969	*
2001	8	183,268	248,382	*
2001	7	179,030	304,308	*
2001	6	161,611	2,396	*
2001	5	296,498	1,091	*
2001	4	300,044	38,910	*
2001	3	185,492	9,111	*
2001	2	271,593	221,093	*
2001	1	239,921	465,999	*
2000	12	151,502	46,906	*
2000	11	479,406	66,466	*
2000	10	278,688	87,142	*
2000	9	102,389	18,055	*
2000	8	179,959	387,131	*
2000	7	146,118	653,857	*
2000	6	162,069	1,472	*
2000	5	330,073	2,476	*
2000	4	323,695	6,731	*

Year	Month	Atlantic	Gulf of Mexico	Mixing Zone
2000	3	358,250	62,234	*
2000	2	208,003	219,066	*
2000	1	257,373	291,148	*
1999	12	431,831	60,625	*
1999	11	288,818	166,451	*
1999	10	121,050	119,002	*
1999	9	68,470	21,805	*
1999	8	151,412	450,674	*
1999	7	109,887	682,687	*
1999	6	146,108	4,324	*
1999	5	446,667	1,006	*
1999	4	367,530	6,408	*
1999	3	258,294	52,870	*
1999	2	393,759	71,605	*
1999	1	429,108	1,067,819	*
1998	12	305,808	95,486	*
1998	11	776,411	114,380	*
1998	10	284,082	54,179	*
1998	9	109,718	13,778	*
1998	8	139,165	354,351	*
1998	7	158,781	606,622	*
1998	6	161,112	975	*
1998	5	300,262	939	*
1998	4	287,765	80,749	*
1998	3	245,131	191,758	*
1998	2	186,071	340,866	*
1998	1	294,427	303,549	*
1997	12	426,752	48,599	*
1997	11	576,660	116,843	*
1997	10	308,967	249,765	*
1997	9	105,207	36,383	*
1997	8	207,642	84,189	*
1997	7	175,859	747,991	*
1997	6	166,165	1,560	*
1997	5	518,207	2,171	*
1997	4	415,838	5,066	*
1997	3	668,789	4,677	*
1997	2	351,371	22,244	*
1997	1	267,327	386,718	*

Year	Month	Atlantic	Gulf of Mexico	Mixing Zone
1996	12	331,355	123,300	*
1996	11	293,630	47,461	*
1996	10	253,438	94,607	*
1996	9	87,539	62,759	*
1996	8	203,927	289,947	*
1996	7	108,636	451,307	*
1996	6	208,947	3,285	*
1996	5	407,099	1,675	*
1996	4	245,056	139,359	*
1996	3	101,187	17,060	*
1996	2	254,279	569,857	*
1996	1	236,244	73,844	*
1995	12	409,068	63,767	*
1995	11	319,411	62,818	*
1995	10	204,695	27,438	*
1995	9	62,200	84,446	*
1995	8	87,521	211,086	*
1995	7	122,383	499,507	*
1995	6	152,376	5,101	*
1995	5	360,352	8,300	*
1995	4	243,183	25,409	*
1995	3	306,479	61,408	*
1995	2	131,918	357,559	*
1995	1	243,786	289,735	*
1994	12	406,057	50,113	*
1994	11	297,075	89,836	*
1994	10	191,007	80,490	*
1994	9	113,439	270,477	*
1994	8	174,360	216,340	*
1994	7	139,850	456,949	*
1994	6	138,469	5,059	*
1994	5	357,661	8,256	*
1994	4	319,553	67,770	*
1994	3	189,128	28,497	*
1994	2	128,934	64,989	*
1994	1	159,120	191,361	*
1993	12	246,663	365,639	*
1993	11	292,925	45,720	*
1993	10	133,641	70,084	*

Year	Month	Atlantic	Gulf of Mexico	Mixing Zone
1993	9	70,655	277,422	*
1993	8	188,900	267,962	*
1993	7	125,266	394,916	*
1993	6	113,955	2,652	*
1993	5	512,921	7,674	*
1993	4	301,503	21,635	*
1993	3	240,829	40,266	*
1993	2	225,313	39,886	*
1993	1	174,438	900,314	*
1993	Unk	2		*
1992	12	458,158	237,014	*
1992	11	244,870	30,350	*
1992	10	242,835	358,956	*
1992	9	136,663	236,810	*
1992	8	190,395	235,948	*
1992	7	145,342	422,999	*
1992	6	214,108	4,170	*
1992	5	218,382	4,735	*
1992	4	307,751	38,272	*
1992	3	136,021	9,266	*
1992	2	98,656	15,802	*
1992	1	293,401	419,274	*
1991	12	579,633	116,775	*
1991	11	329,017	48,712	*
1991	10	238,230	53,777	*
1991	9	149,608	229,123	*
1991	8	249,869	274,146	*
1991	7	166,251	146,337	*
1991	6	134,606	3,678	*
1991	5	376,525	6,936	*
1991	4	322,273	19,189	*
1991	3	113,196	6,064	*
1991	2	82,078	7,145	*
1991	1	223,042	84,434	*
1990	12	476,089	137,522	*
1990	11	491,163	98,766	*
1990	10	152,147	173,245	*
1990	9	170,898	170,276	*
1990	8	221,043	179,897	*

Year	Month	Atlantic	Gulf of Mexico	Mixing Zone
1990	7	138,213	185,943	*
1990	6	160,474	4,361	*
1990	5	494,590	9,366	*
1990	4	390,319	46,378	*
1990	3	224,852	3,860	*
1990	2	17,056	20,222	*
1990	1	70,339	467,856	*
1989	12	218,902	84,087	*
1989	11	311,380	169,505	*
1989	10	174,896	218,118	*
1989	9	85,666	158,833	*
1989	8	351,731	154,201	*
1989	7	199,879	109,338	*
1989	6	147,725	4,535	*
1989	5	544,421	9,795	*
1989	4	408,777	45,989	*
1989	3	27,356	3,333	*
1989	2	39,043	2,969	*
1989	1	48,685	10,751	*
1989	Unk	8,500		*
1988	12	316,707	337,431	*
1988	11	302,109	199,417	*
1988	10	236,343	71,191	*
1988	9	201,210	66,932	*
1988	8	295,769	84,797	*
1988	7	122,598	123,477	*
1988	6	136,510	3,744	*
1988	5	777,978	15,399	*
1988	4	722,774	72,967	*
1988	3	92,380	2,584	*
1988	2	35,582	1,436	*
1988	1	58,424	3,536	*
1988	Unk	15,100		*
1987	12	498,749	75,423	*
1987	11	424,432	22,117	*
1987	10	390,817	126,136	*
1987	9	290,939	89,054	*
1987	8	340,948	72,319	*
1987	7	295,851	91,042	*

Year	Month	Atlantic	Gulf of Mexico	Mixing Zone
1987	6	276,701	7,289	*
1987	5	640,114	12,387	*
1987	4	374,715	41,055	*
1987	3	100,784	22,936	*
1987	2	73,789	273,299	*
1987	1	168,335	332,087	*
1987	Unk	11,800		*
1986	12	257,639	80,964	*
1986	11	234,140	66,627	*
1986	10	327,106	65,120	*
1986	9	282,197	57,402	*
1986	8	422,421	54,738	*
1986	7	249,335	49,459	*
1986	6	134,964	2,815	*
1986	5	605,478	9,263	*
1986	4	357,904	18,574	*
1986	3	212,130	163,873	*
1986	2	194,605	779,137	*
1986	1	200,260	421,867	*
1986	Unk	3,500		*
1985	12	326,347	474,993	*
1985	11	429,268	100,994	*
1985	10	145,918	63,790	*
1985	9	90,612	6,656	*
1985	8	256,846	46,862	*
1985	7	229,178	56,561	*
1985	6	138,919	53,876	*
1985	5	736,976	41,838	*
1985	4	291,730	17,005	*
1985	3	529,804	224,708	*
1985	2	192,022	186,822	*
1985	1	281,980	200,641	*
1985	Unk	6,300		*
1984	12	473,608	493,197	*
1984	11	233,913	68,222	*
1984	10	236,771	49,030	*
1984	9	266,754	13,672	*
1984	8	342,789	45,387	*
1984	7	116,484	65,526	*

Year	Month	Atlantic	Gulf of Mexico	Mixing Zone
1984	6	141,541	19,335	*
1984	5	318,968	8,339	*
1984	4	150,151	19,080	*
1984	3	347,520	12,161	*
1984	2	539,227	160,191	*
1984	1	202,150	601,737	*
1984	0	3,300		*
1983	12	284,251	114,952	*
1983	11	394,348	21,605	*
1983	10	258,254	57,726	*
1983	9	198,372	79,599	*
1983	8	237,365	164,603	*
1983	7	100,655	68,931	*
1983	6	196,898	27,050	*
1983	5	675,031	53,331	*
1983	4	217,894	31,765	*
1983	3	816,116	447,757	*
1983	2	215,402	813,890	*
1983	1	537,011	470,099	*
1983	Unk	6,100		*
1982	12	431,658	15,166	*
1982	11	443,930	8,208	*
1982	10	389,783	8,392	*
1982	9	249,281	11,731	*
1982	8	578,545	1,633	*
1982	7	372,890	4,779	*
1982	6	183,303	3,906	*
1982	5	1,089,461	602	*
1982	4	439,142	3,149	*
1982	3	1,152,379	240,924	*
1982	2	253,481	269,423	*
1982	1	461,237	832,241	*
1982	Unk	12,700		*
1981	12	1,481,494	59,364	*
1981	11	314,576	6,684	*
1981	10	379,002	10,958	*
1981	9	172,325	8,779	*
1981	8	416,239	2,462	*
1981	7	214,003	12,929	*

Year	Month	Atlantic	Gulf of Mexico	Mixing Zone
1981	6	175,638	5,985	*
1981	5	438,889	11,054	*
1981	4	255,279	64,731	*
1981	3	684,421	464,182	*
1981	2	559,292	836,466	*
1981	1	648,337	543,785	*
1981	Unk	3,100		*
1980	12	691,160	93,713	*
1980	11	415,601	6,507	*
1980	10	300,379	15,383	*
1980	9	377,480	70,480	*
1980	8	559,882	12,317	*
1980	7	154,686	9,474	*
1980	6	194,143	2,903	*
1980	5	566,208	5,056	*
1980	4	161,848	162,575	*
1980	3	126,425	762,866	*
1980	2	164,831	601,231	*
1980	1	353,861	489,417	*
1980	Unk	20,100		*
1979	12	522,909	97,272	*
1979	11	159,098	15,642	*
1979	10	215,705	22,530	*
1979	9	71,540	33,079	*
1979	8	333,769	42,782	*
1979	7	174,596	6,995	*
1979	6	253,406	5,568	*
1979	5	477,651	31,825	*
1979	4	179,455	26,437	*
1979	3	566,713	58,646	*
1979	2	729,595	660,240	*
1979	1	139,464	188,836	*
1979	Unk	11,300		*
1978	12	355,807	69,693	59,145
1978	11	201,970	2,872	640
1978	10	143,953	16,001	369
1978	9	129,213	9,474	297
1978	8	268,460	3,399	41
1978	7	134,626	4,791	606

Year	Month	Atlantic	Gulf of Mexico	Mixing Zone
1978	6	203,557	2,093	455
1978	5	501,208	2,582	2,156
1978	4	144,509	379,012	1,607
1978	3	531,147	73,089	63,615
1978	2	651,632	326,637	154,058
1978	1	355,656	425,536	147,023
1978	Unk	8,800		
1977	All	4,170,664	4,245,150	990,023
1976	All	5,002,873	2,458,906	346,480
1975	All	3,815,259	2,467,071	159,802
1974	All	4,275,102	5,665,474	526,066
1973	All	3,748,215	1,898,327	326,806
1972	All	3,482,247	1,312,336	84,563
1971	All	2,915,564	2,621,041	130,695
1970	All	4,338,563	2,172,089	217,849
1969	All	2,930,467	2,869,392	404,041
1968	All	2,578,197	3,494,211	128,192
1967	All	2,672,761	3,197,134	228,705
1966	All	1,869,406	2,501,420	149,474
1965	All	2,663,592	1,852,575	76,333
1964	All	2,089,308	1,154,416	215,876
1963	All	2,136,258	2,581,658	339,684
1962	All	2,029,889	1,866,639	260,573
1961	All	2,140,600	1,320,867	362,233
1960	All	1,904,400	1,464,019	396,281
1959	All	2,231,700	960,813	277,987
1958	All	1,867,700	1,090,648	315,552
1957	All	2,502,700	691,856	199,044
1956	All	2,434,400	935,429	268,171
1955	All	1,411,200	921,645	266,655
1954	All	921,700	842,908	240,492
1953	All	1,314,200	992,380	287,120
1952	All	1,540,100	626,529	181,271
1951	All	1,994,000	890,793	257,707
1950	All	1,219,400	324,123	93,777

Table 3.12.5 US commercial landings in whole pounds of king mackerel by calendar year and gear for 1950-2012.

Year	Handline	Gillnet	Other
2012	4,006,203	499,514	27,420
2011	5,150,525	568,991	45,846
2010	5,841,537	771,324	17,024
2009	6,816,927	970,773	24,158
2008	5,866,381	801,400	19,444
2007	5,350,113	704,541	112,473
2006	5,550,673	647,130	40,260
2005	4,540,805	843,458	29,016
2004	4,631,637	589,818	131,559
2003	4,459,587	474,314	245,587
2002	4,005,854	336,153	317,551
2001	4,274,077	545,000	131,880
2000	4,513,179	511,143	69,620
1999	5,022,353	1,041,798	94,971
1998	5,043,309	599,028	179,152
1997	5,286,560	755,848	102,677
1996	4,208,355	793,683	106,783
1995	4,099,188	513,881	40,984
1994	3,968,650	299,932	26,594
1993	4,708,621	894,810	68,371
1992	4,546,513	444,468	33,469
1991	3,905,312	131,169	18,785
1990	4,209,699	504,591	45,493
1989	3,541,494	65,767	16,476
1988	4,360,543	146,381	22,465
1987	4,849,923	327,289	34,095
1986	4,980,402	727,367	64,280
1985	4,307,970	1,047,147	45,252
1984	3,757,162	1,398,493	64,580
1983	5,420,484	1,473,694	75,075
1982	5,143,436	2,761,925	120,227
1981	6,027,938	2,628,682	158,980
1980	4,934,741	2,037,336	116,129
1979	3,803,031	1,634,431	88,998
1978	3,561,128	1,734,229	80,372
1977	3,473,740	5,910,110	21,988
1976	3,318,846	4,431,152	58,261
1975	3,243,807	3,103,327	94,998
1974	3,649,096	6,768,753	48,794

1973	2,947,824	2,935,129	90,395
1972	2,529,177	2,300,698	49,271
1971	1,628,979	3,979,254	59,066
1970	2,422,094	4,205,158	101,248
1969	1,788,964	4,231,200	183,736
1968	1,381,068	4,403,077	416,455
1967	1,479,659	4,255,517	363,424
1966	1,365,177	3,092,070	63,053
1965	2,045,269	2,471,223	76,008
1964	1,938,493	1,442,885	78,222
1963	2,415,773	2,608,297	33,530
1962	2,775,062	1,315,308	66,730
1961	3,688,200	77,800	57,700
1960	3,591,900	71,500	101,300
1959	3,438,300	23,800	8,400
1958	3,203,600	54,700	15,600
1957	3,202,700	156,300	34,600
1956	3,299,700	333,600	4,700
1955	2,533,400	52,100	14,000
1954	1,709,300	295,200	600
1953	2,540,200	43,000	10,500
1952	2,336,200	200	11,500
1951	2,981,300	57,500	103,700
1950	1,574,800	3,600	58,900

Table 3.12.6 Historical commercial landings in whole pounds of king mackerel from 1880-1949. Mixing landings have been derived from the west coast of Florida landings.

Year	Atlantic	Gulf of Mexico	Mixing Zone
1949		1,102,194	316,806
1948		3,388	112
1945	2,781,000	888,138	249,862
1940	1,506,000	1,530,711	441,289
1939	2,442,000	1,219,715	351,285
1938	2,803,000	671,006	192,994
1937	1,983,000	1,068,598	307,402
1936	2,942,000	780,661	224,339
1934	1,977,000	536,008	147,992
1932	2,706,000	463,128	131,872
1931	2,671,000	582,425	166,575
1930	2,282,000	1,091,881	314,119
1929	2,400,000	1,532,383	440,617
1928	2,653,000	1,032,583	294,417
1927	3,356,000	982,465	280,535
1923	1,965,500	437,725	126,275
1918	2,484,000	361,667	104,333
1908	500		
1902	77,000		
1897	500		
1890	500		
1889	500		
1888	500		
1887	1,000	888	112
1880	1,000	888	112

Table 3.12.7 Mexican Gulf of Mexico landings king mackerel in metric tons and pounds obtained from ICCAT. Original data were in metric tons and have been converted to pounds here (1 mt = 2,204.62262 pounds).

Year	Metric Tons	Pounds
2012	3,090	6,812,284
2011	3,130	6,900,469
2010	3,040	6,702,053
2009	3,186	7,023,928
2008	3,113	6,862,990
2007	3,526	7,773,499
2006	4,201	9,261,620
2005	3,447	7,599,334
2004	4,564	10,061,898
2003	4,369	9,631,996
2002	4,453	9,817,185
2001	4,200	9,259,415
2000	3,688	8,130,648
1999	4,121	9,085,250
1998	3,583	7,899,163
1997	4,661	10,275,746
1996	4,661	10,275,746
1995	3,214	7,085,657
1994	3,097	6,827,716
1993	3,289	7,251,004
1992	3,014	6,644,733
1991	2,147	4,733,325
1990	2,689	5,928,230
1989	2,300	5,070,632
1988	3,100	6,834,330
1987	3,067	6,761,578
1986	2,643	5,826,818
1985	2,303	5,077,246
1984	2,164	4,770,803
1983	2,874	6,336,085
1982	4,409	9,720,181
1981	2,740	6,040,666
1980	1,946	4,290,196
1979	2,249	4,958,196
1978	1,535	3,384,096
1977	1,331	2,934,353

1976	1,497	3,300,320
1975	1,354	2,985,059
1974	1,531	3,375,277
1973	2,189	4,825,919
1972	1,520	3,351,026
1971	1,300	2,866,009
1970	907	1,999,593
1969	1,100	2,425,085
1968	700	1,543,236
1967	1,000	2,204,623
1966	900	1,984,160
1965	1,000	2,204,623
1964	900	1,984,160
1963	1,000	2,204,623
1962	1,000	2,204,623
1961	1,000	2,204,623
1960	1,000	2,204,623

Table 3.12.8 Calculated discards from commercial vertical line and trolling vessels. Discards are in numbers of fish and include fish kept as bait. Monthly discards were calculated as: *stratum specific discard rate*stratum specific monthly effort*. Regions are as redefined during the SEDAR16 assessment.

Year	Month	South Atlantic	Mixing Zone	Gulf of Mexico
1998	1	293	3,370	623
	2	83	2,641	1,537
	3	270	2,455	1,853
	4	233	3,258	1,994
	5	307	4,488	1,823
	6	279	4,147	1,529
	7	167	2,990	2,872
	8	142	2,449	2,196
	9	205	1,995	1,301
	10	448	2,539	2,122
	11	518	3,463	1,384
	12	157	2,974	1,432
1999	1	302	3,383	750
	2	175	4,438	2,442
	3	121	3,510	2,207
	4	136	4,253	2,170
	5	196	4,634	1,383
	6	122	3,581	1,522
	7	196	2,730	3,664
	8	133	2,549	2,898
	9	89	1,739	2,066
	10	206	1,377	2,246
	11	292	1,495	2,452
	12	289	3,079	1,203
2000	1	169	3,157	814
	2	138	3,321	2,124
	3	122	3,933	2,033
	4	181	3,323	1,835
	5	238	4,467	1,786
	6	167	3,162	1,416
	7	175	3,132	2,860
	8	163	2,590	2,091
	9	140	2,096	974
	10	260	1,801	2,348
	11	311	2,878	1,485
	12	165	2,393	1,205
2001	1	143	3,268	801
	2	196	3,310	1,519
	3	147	3,188	1,424
	4	365	3,045	1,760
	5	239	3,513	1,825
	6	245	3,516	1,559
	7	159	3,003	2,538
	8	148	3,363	1,962
	9	116	1,931	1,454
	10	211	1,432	2,078
	11	208	1,688	2,085
	12	234	2,598	1,080

Table 3.12.8 Continued.

Year	Month	South Atlantic	Mixing Zone	Gulf of Mexico
2002	1	125	3,762	1,026
	2	138	2,181	1,477
	3	232	2,811	1,453
	4	153	2,944	1,503
	5	103	2,625	1,384
	6	191	2,819	1,777
	7	164	2,815	2,513
	8	116	2,326	2,429
	9	83	1,222	1,095
	10	197	2,136	2,370
	11	363	2,075	1,550
	12	193	2,331	1,324
2003	1	114	3,000	826
	2	107	2,778	1,504
	3	180	3,364	1,851
	4	148	2,433	1,794
	5	117	3,316	1,732
	6	123	2,596	1,751
	7	99	2,184	2,922
	8	132	2,205	2,251
	9	86	1,478	1,486
	10	157	1,371	1,817
	11	343	1,379	1,583
	12	158	1,958	963
2004	1	101	2,723	1,015
	2	60	2,108	1,157
	3	126	1,870	1,887
	4	197	2,476	1,890
	5	140	2,762	1,445
	6	74	2,959	1,243
	7	137	2,314	2,965
	8	86	1,743	1,888
	9	43	357	767
	10	197	1,122	1,705
	11	331	1,231	1,093
	12	230	1,215	1,181
2005	1	157	2,095	928
	2	30	2,114	1,283
	3	130	2,648	1,357
	4	102	1,537	1,340
	5	206	2,858	1,514
	6	151	1,923	1,469
	7	152	1,848	1,718
	8	118	1,756	1,841
	9	60	851	1,111
	10	126	645	1,000
	11	372	860	1,137
	12	284	1,901	1,255

Table 3.12.8 Continued.

Year	Month	South Atlantic	Mixing Zone	Gulf of Mexico
2006	1	93	1,734	621
	2	58	1,936	868
	3	164	2,213	1,326
	4	131	2,488	1,456
	5	173	2,816	1,210
	6	169	1,906	1,341
	7	143	1,523	2,355
	8	126	1,948	2,215
	9	74	1,222	2,047
	10	210	900	1,531
	11	314	1,164	1,545
	12	389	1,601	1,929
2007	1	129	2,178	804
	2	69	2,476	1,094
	3	125	1,746	1,271
	4	207	2,100	924
	5	287	1,606	733
	6	286	2,282	1,345
	7	188	2,041	2,109
	8	208	2,097	1,671
	9	147	1,147	1,509
	10	241	798	1,349
	11	313	1,271	1,828
	12	449	2,337	1,460
2008	1	145	2,233	682
	2	94	2,430	869
	3	149	1,477	1,130
	4	165	2,148	1,253
	5	227	3,169	1,173
	6	194	2,605	1,481
	7	191	2,636	1,725
	8	171	2,278	1,615
	9	78	934	1,076
	10	196	917	1,456
	11	392	1,511	1,504
	12	326	2,514	993
2009	1	92	2,753	1,092
	2	111	2,108	722
	3	216	1,223	1,204
	4	247	2,642	774
	5	268	3,497	1,356
	6	332	3,133	1,348
	7	186	2,932	2,477
	8	134	2,495	2,021
	9	130	1,747	1,800
	10	215	1,520	1,556
	11	263	1,674	971
	12	201	2,688	744

Table 3.12.8 Continued

Year	Month	South Atlantic	Mixing Zone	Gulf of Mexico
2010	1	160	2,659	919
	2	89	1,333	772
	3	158	1,795	945
	4	177	3,483	1,026
	5	225	3,097	1,000
	6	156	2,776	495
	7	197	1,606	423
	8	182	2,327	655
	9	124	651	814
	10	213	1,000	1,522
	11	143	1,045	1,072
	12	114	2,042	837
2011	1	108	2,831	633
	2	62	2,556	552
	3	63	1,791	765
	4	74	2,665	890
	5	265	3,551	1,131
	6	128	2,049	946
	7	129	1,711	1,889
	8	114	1,495	1,937
	9	138	1,291	1,661
	10	143	807	860
	11	342	1,055	441
	12	234	2,255	931
2012	1	142	3,276	1,054
	2	118	2,638	947
	3	93	1,664	1,089
	4	80	2,054	773
	5	203	3,013	1,150
	6	214	1,440	703
	7	256	1,657	2,600
	8	175	1,272	1,881
	9	190	1,446	1,393
	10	192	917	1,051
	11	119	1,275	1,044
	12	121	2,767	899
2013	1	232	2,704	850
	2	128	1,874	603
	3	34	1,695	780
	4	123	1,853	757
	5	294	2,098	891
	6	189	1,642	629

Table 3.12.9 Calculated discards from commercial vertical line and trolling vessels. Discards are in number of fish and include fish kept as bait. Monthly discards were calculated as: *stratum specific discard rate*stratum specific monthly effort*. Regions are as redefined during the SEDAR 38 data workshop.

Year	Month	South Atlantic	Mixing Zone	Gulf of Mexico
1998	1	2,811	113	734
1998	2	2,136	79	1,608
1998	3	2,463	72	2,013
1998	4	3,078	81	2,193
1998	5	4,620	92	1,960
1998	6	4,167	78	1,595
1998	7	3,230	61	3,150
1998	8	2,505	43	2,417
1998	9	2,470	29	1,314
1998	10	3,371	39	2,140
1998	11	4,553	54	1,478
1998	12	2,718	66	1,737
1999	1	2,983	88	1,188
1999	2	2,971	121	2,670
1999	3	2,133	127	2,374
1999	4	3,346	86	2,224
1999	5	3,912	123	1,431
1999	6	2,845	76	1,647
1999	7	2,871	57	4,056
1999	8	2,702	26	3,285
1999	9	1,763	28	2,062
1999	10	2,127	35	2,301
1999	11	2,538	50	2,486
1999	12	3,123	72	1,546
2000	1	2,289	82	1,201
2000	2	2,478	94	2,398
2000	3	2,959	104	2,161
2000	4	3,259	66	1,849
2000	5	4,197	78	1,879
2000	6	3,120	84	1,466
2000	7	3,158	76	3,029
2000	8	2,824	39	2,178
2000	9	2,060	44	1,025
2000	10	2,459	66	2,369
2000	11	3,220	63	1,582
2000	12	2,070	46	1,428
2001	1	2,475	78	1,250
2001	2	2,698	89	1,930
2001	3	2,414	90	1,440
2001	4	3,273	57	1,864
2001	5	4,004	82	1,814
2001	6	3,796	61	1,553
2001	7	3,021	57	2,621
2001	8	3,891	45	2,013
2001	9	2,373	57	1,530
2001	10	2,230	38	2,098
2001	11	2,114	50	2,158
2001	12	2,900	60	1,330

Table 3.12.9 Continued.

Year	Month	South Atlantic	Mixing Zone	Gulf of Mexico
2002	1	2,717	113	1,245
2002	2	1,583	109	1,668
2002	3	2,545	101	1,598
2002	4	2,898	64	1,513
2002	5	2,860	52	1,356
2002	6	2,989	52	1,769
2002	7	2,850	50	2,636
2002	8	2,627	31	2,466
2002	9	1,661	20	1,194
2002	10	2,482	56	2,431
2002	11	2,926	39	1,537
2002	12	2,433	46	1,357
2003	1	2,083	87	987
2003	2	2,092	110	1,594
2003	3	2,865	97	1,945
2003	4	2,609	57	1,831
2003	5	3,825	64	1,684
2003	6	3,160	59	1,703
2003	7	2,592	47	2,986
2003	8	2,992	27	2,306
2003	9	1,924	25	1,525
2003	10	1,974	30	1,838
2003	11	2,275	33	1,561
2003	12	2,351	32	1,009
2004	1	2,457	74	1,049
2004	2	1,586	80	1,200
2004	3	1,942	61	2,034
2004	4	2,755	58	1,923
2004	5	3,259	51	1,427
2004	6	2,880	53	1,238
2004	7	2,424	54	2,965
2004	8	2,164	28	1,957
2004	9	569	17	779
2004	10	1,790	33	1,760
2004	11	2,114	37	1,142
2004	12	1,794	41	1,181
2005	1	2,080	72	1,010
2005	2	1,556	72	1,368
2005	3	2,275	74	1,532
2005	4	1,655	39	1,336
2005	5	3,436	55	1,526
2005	6	2,278	41	1,443
2005	7	2,329	39	1,758
2005	8	2,301	30	1,855
2005	9	1,129	22	1,107
2005	10	1,183	18	999
2005	11	2,049	22	1,124
2005	12	2,118	60	1,297

Table 3.12.9 Continued.

Year	Month	South Atlantic	Mixing Zone	Gulf of Mexico
2006	1	1,896	48	713
2006	2	1,820	64	926
2006	3	2,303	75	1,308
2006	4	2,662	56	1,467
2006	5	3,501	65	1,226
2006	6	2,540	43	1,325
2006	7	2,313	27	2,399
2006	8	2,762	29	2,220
2006	9	1,638	22	2,092
2006	10	1,803	22	1,516
2006	11	2,272	31	1,594
2006	12	2,832	22	1,972
2007	1	2,305	55	918
2007	2	2,391	57	1,225
2007	3	2,008	38	1,422
2007	4	2,897	37	947
2007	5	2,700	39	744
2007	6	3,260	47	1,315
2007	7	2,943	34	2,169
2007	8	3,272	21	1,681
2007	9	1,937	21	1,503
2007	10	2,044	23	1,341
2007	11	2,490	37	1,844
2007	12	3,648	44	1,554
2008	1	2,613	40	765
2008	2	2,210	54	1,066
2008	3	1,277	47	1,349
2008	4	2,771	42	1,303
2008	5	4,286	45	1,154
2008	6	3,532	49	1,454
2008	7	3,593	36	1,738
2008	8	3,338	44	1,563
2008	9	1,442	22	1,059
2008	10	2,151	21	1,452
2008	11	2,953	22	1,515
2008	12	3,441	31	1,087
2009	1	2,742	45	1,278
2009	2	2,378	39	828
2009	3	1,746	48	1,169
2009	4	3,543	58	817
2009	5	4,756	61	1,345
2009	6	4,313	60	1,333
2009	7	3,882	46	2,463
2009	8	3,484	29	1,983
2009	9	2,374	38	1,780
2009	10	2,373	39	1,538
2009	11	2,520	34	955
2009	12	2,921	38	792

Table 3.12.9 Continued.

Year	Month	South Atlantic	Mixing Zone	Gulf of Mexico

2010	1	2,942	53	1,026
2010	2	1,368	47	860
2010	3	1,836	65	926
2010	4	3,484	50	1,167
2010	5	3,897	68	990
2010	6	3,637	43	514
2010	7	2,608	27	433
2010	8	3,581	30	665
2010	9	1,545	20	825
2010	10	1,967	23	1,537
2010	11	1,622	24	1,069
2010	12	2,368	21	819
2011	1	3,078	43	725
2011	2	2,431	53	822
2011	3	1,364	58	930
2011	4	2,434	50	898
2011	5	4,312	69	1,112
2011	6	2,509	43	934
2011	7	2,186	41	1,917
2011	8	1,939	31	1,947
2011	9	1,797	34	1,719
2011	10	1,243	29	848
2011	11	1,982	31	449
2011	12	2,619	38	988
2012	1	3,522	57	1,144
2012	2	2,610	60	1,120
2012	3	1,551	49	1,075
2012	4	1,938	42	776
2012	5	3,525	66	1,150
2012	6	2,313	39	690
2012	7	2,429	47	2,639
2012	8	1,974	27	1,890
2012	9	1,860	38	1,473
2012	10	1,322	28	1,050
2012	11	1,101	34	1,050
2012	12	2,263	40	1,049
2013	1	3,342	37	965
2013	2	1,914	41	708
2013	3	1,347	45	855
2013	4	1,515	46	853
2013	5	2,716	55	890
2013	6	2,011	50	643

3.13 FIGURES

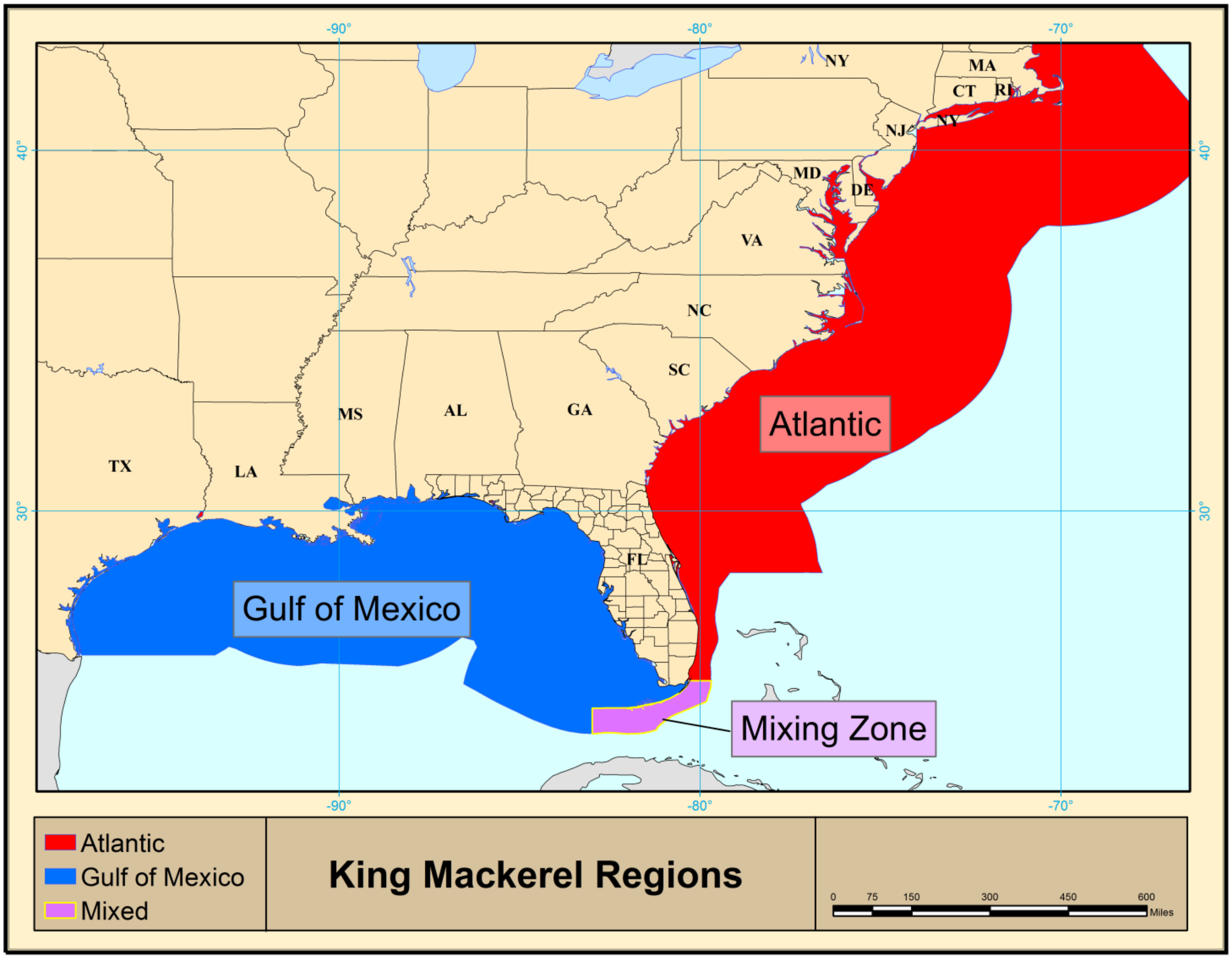

Figure 3.13.1 Regions used to aggregate landings for stock assessment of king mackerel in the GMFMC and SAFMC management areas.

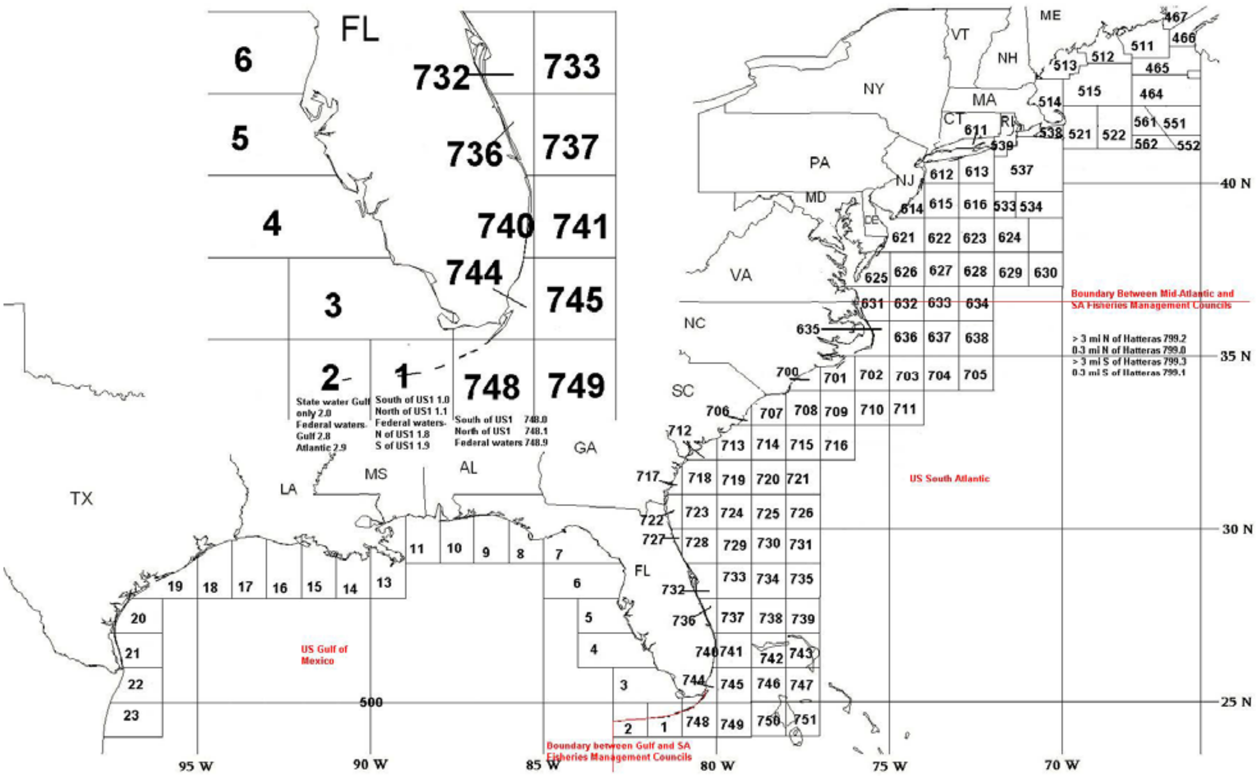

Figure 3.13. Fishing areas map of the US Gulf of Mexico and Atlantic coastline. Area codes used for region assignment of landings.

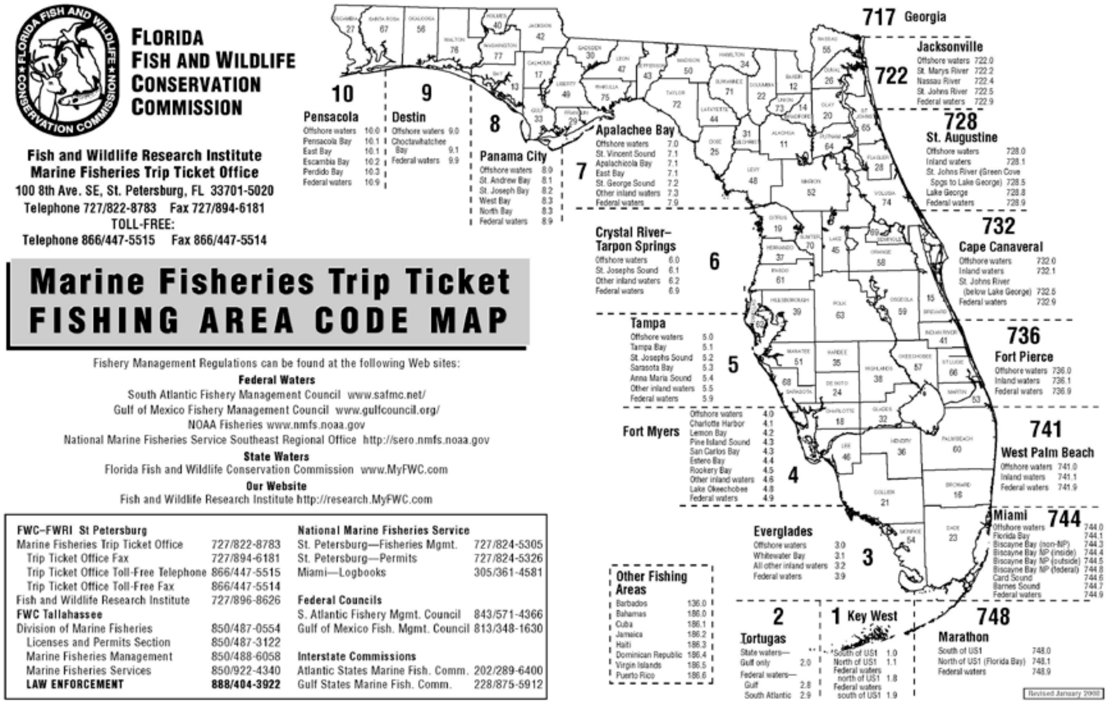

Figure 3.13.3 Marine fisheries trip ticket fishing area code map for Florida. Area codes used for region assignment of landings.

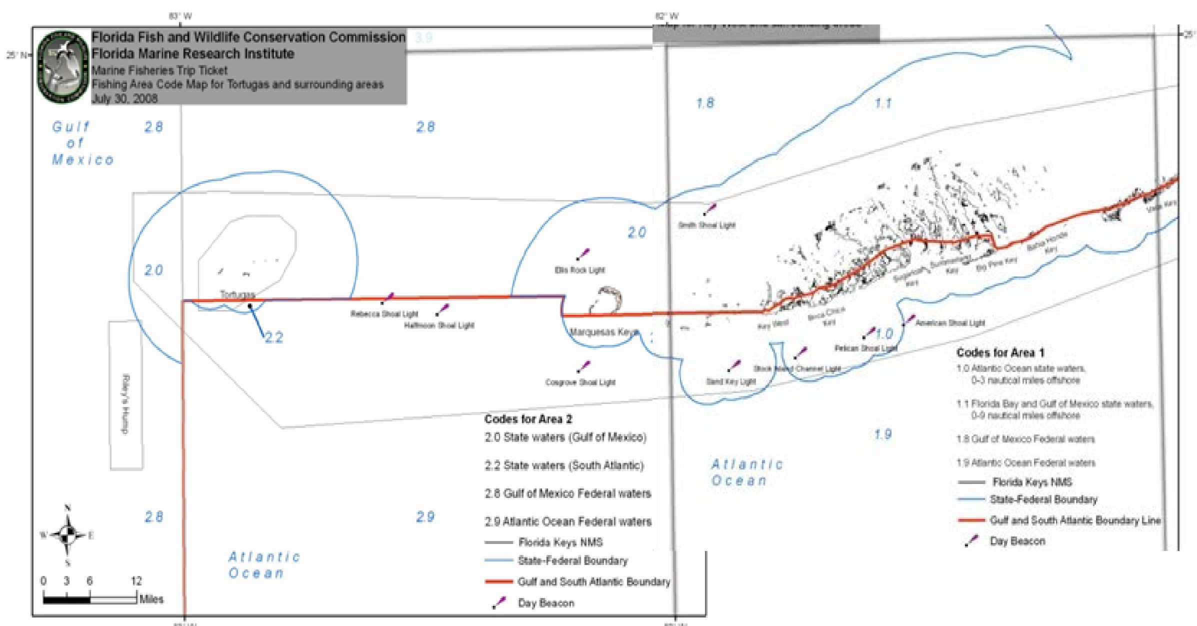

Figure 3.13.4 Close-up of the Gulf of Mexico/mixing zone boundary (in red) for areas surrounding Key West and the Dry Tortugas. Boundary also divides GMFMC and SAFMC council jurisdictions. Area codes used for region assignment of landings.

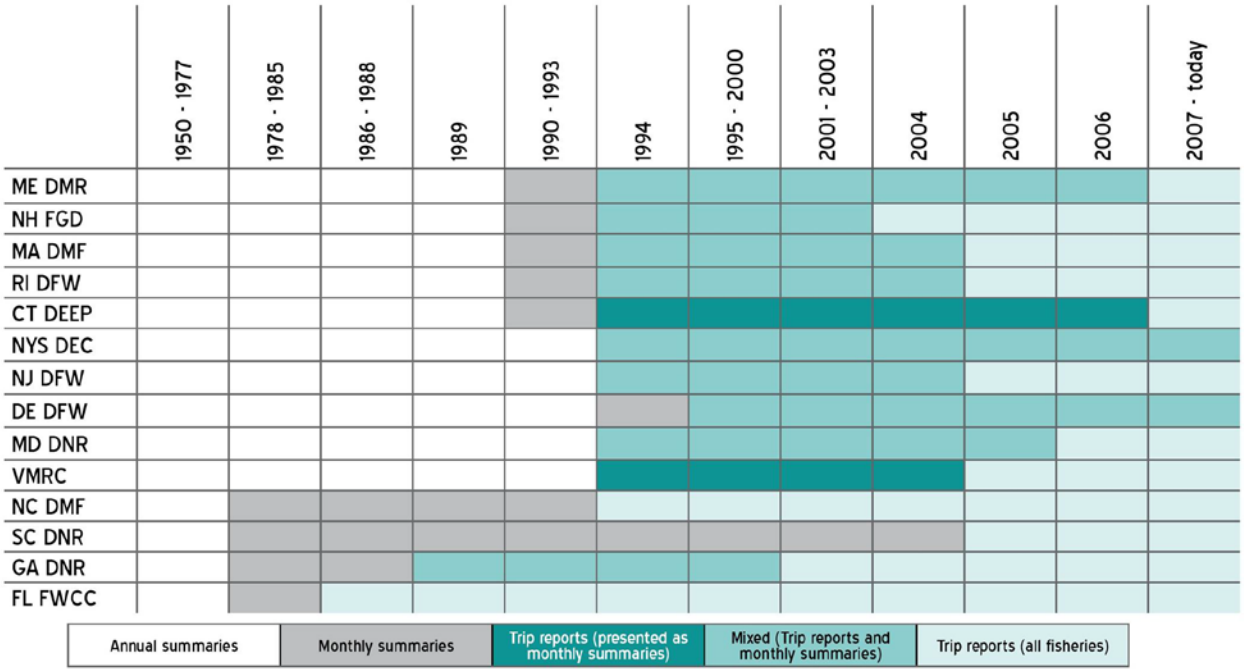

Figure 3.13.5 Atlantic Coastal Cooperative Statistics Program (ACCSP) Data Warehouse – data sources and collection methods by state. Early summaries provided by NMFS.

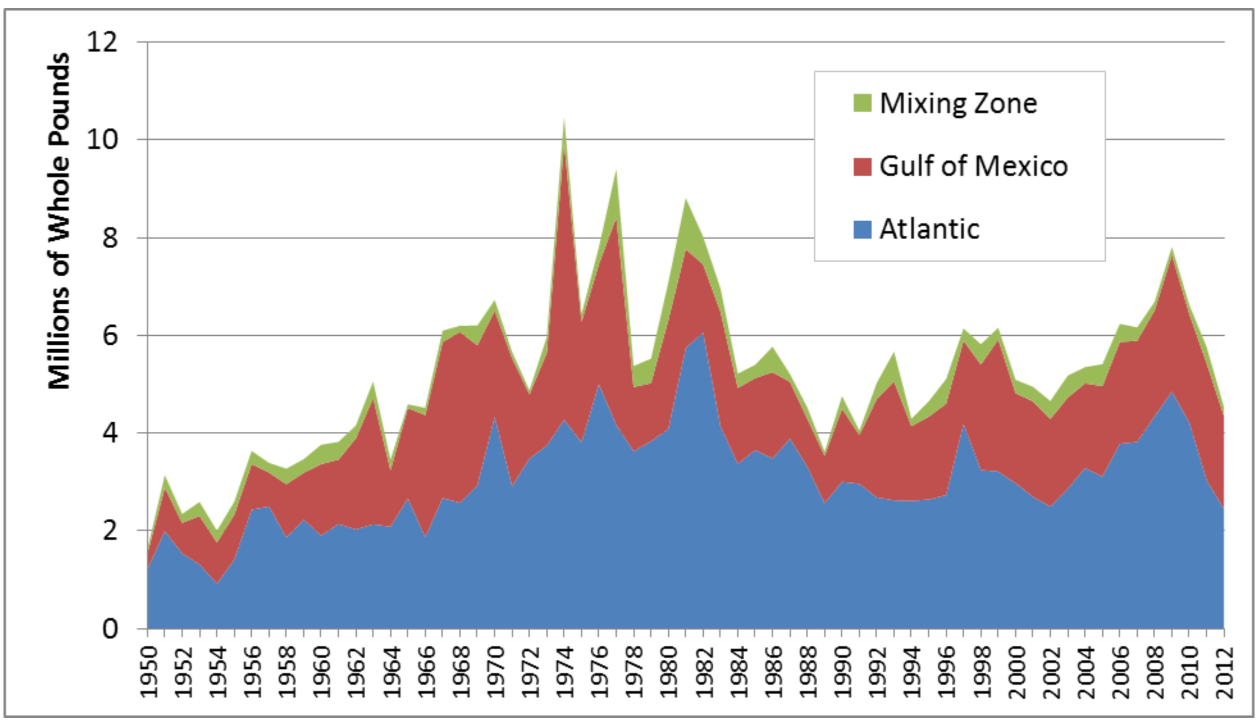

Figure 3.13.6 US commercial landings in whole pounds of king mackerel on record from 1950 through 2012. Mixing zone landings here are for all months.

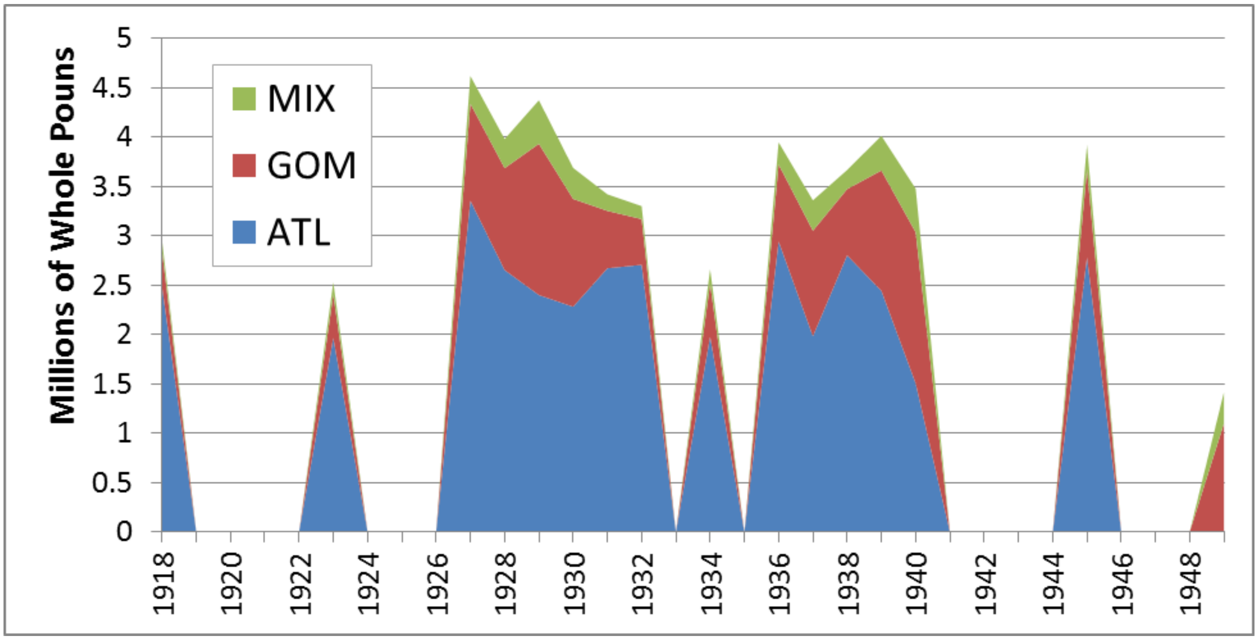

Figure 3.13.7 Historic landings in whole pounds of king mackerel on record from 1918 through 1949.

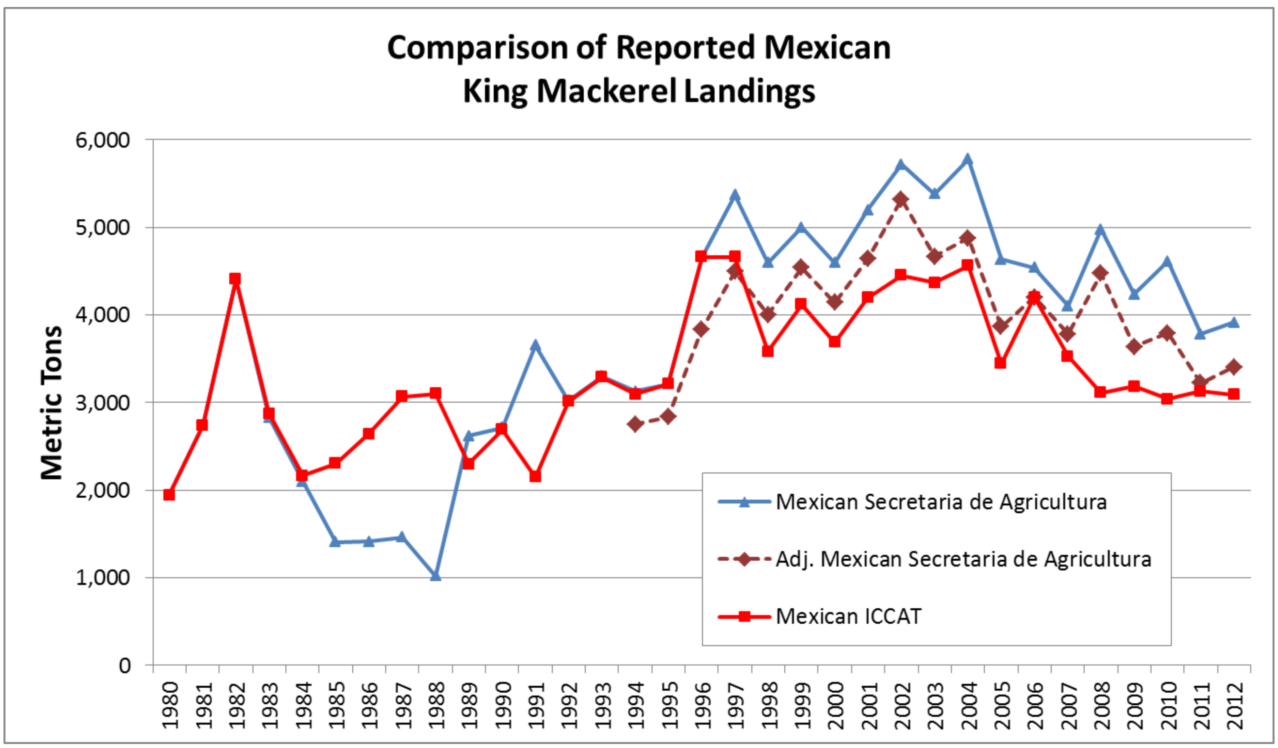

Figure 3.13.8 Comparison of reported landings of king mackerel by Mexico. Landings from the Mexican Secretaria de Agricultura were not classified to region, i.e. Gulf of Mexico. Adjusted Secretaria de Agricultura landings therefore excluded the two eastern most states of Yucatan and Quintana Roo in an attempt to match landings reported to ICCAT.

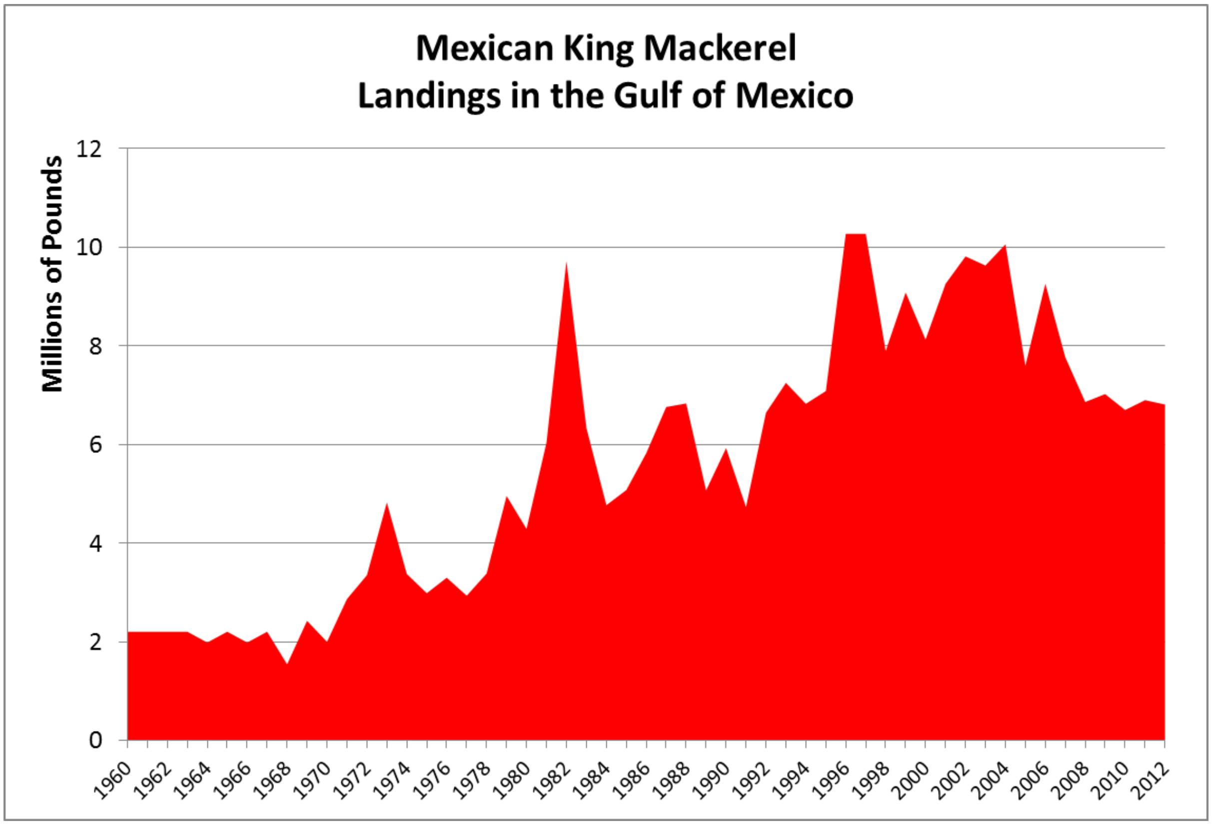

Figure 3.13.9 Mexican landings of king mackerel in the Gulf of Mexico as reported to ICCAT. ICCAT landings were provided in metric tons and were converted to pounds here (1 mt = 2,204.62262 pounds).

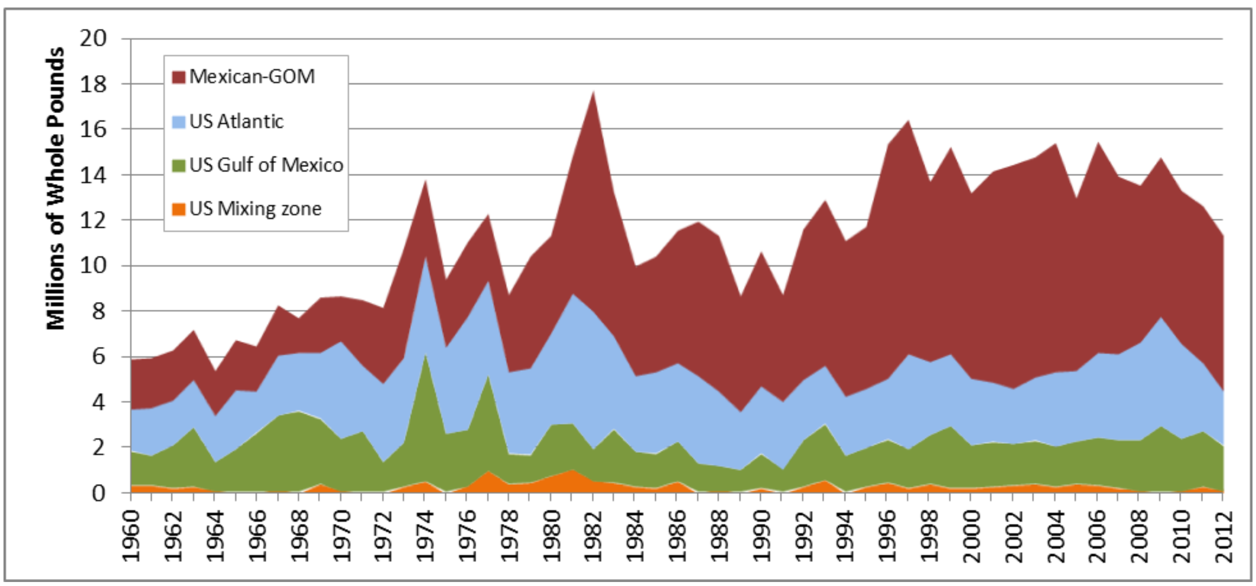

Figure 3.13.10 Comparison of U.S. and Mexican landings of king mackerel.

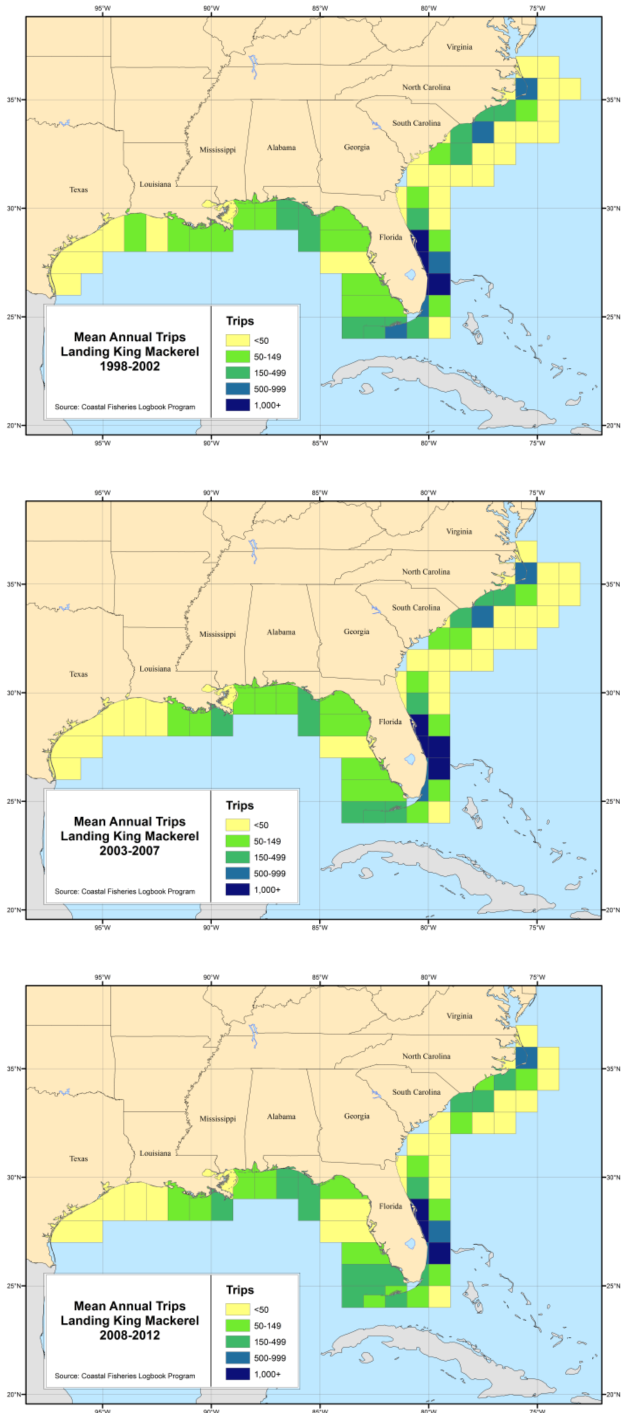

Figure 3.13.11 Maps of king mackerel effort (number of trips reporting king mackerel landings) as reported to the CFLP for 1998-2012.

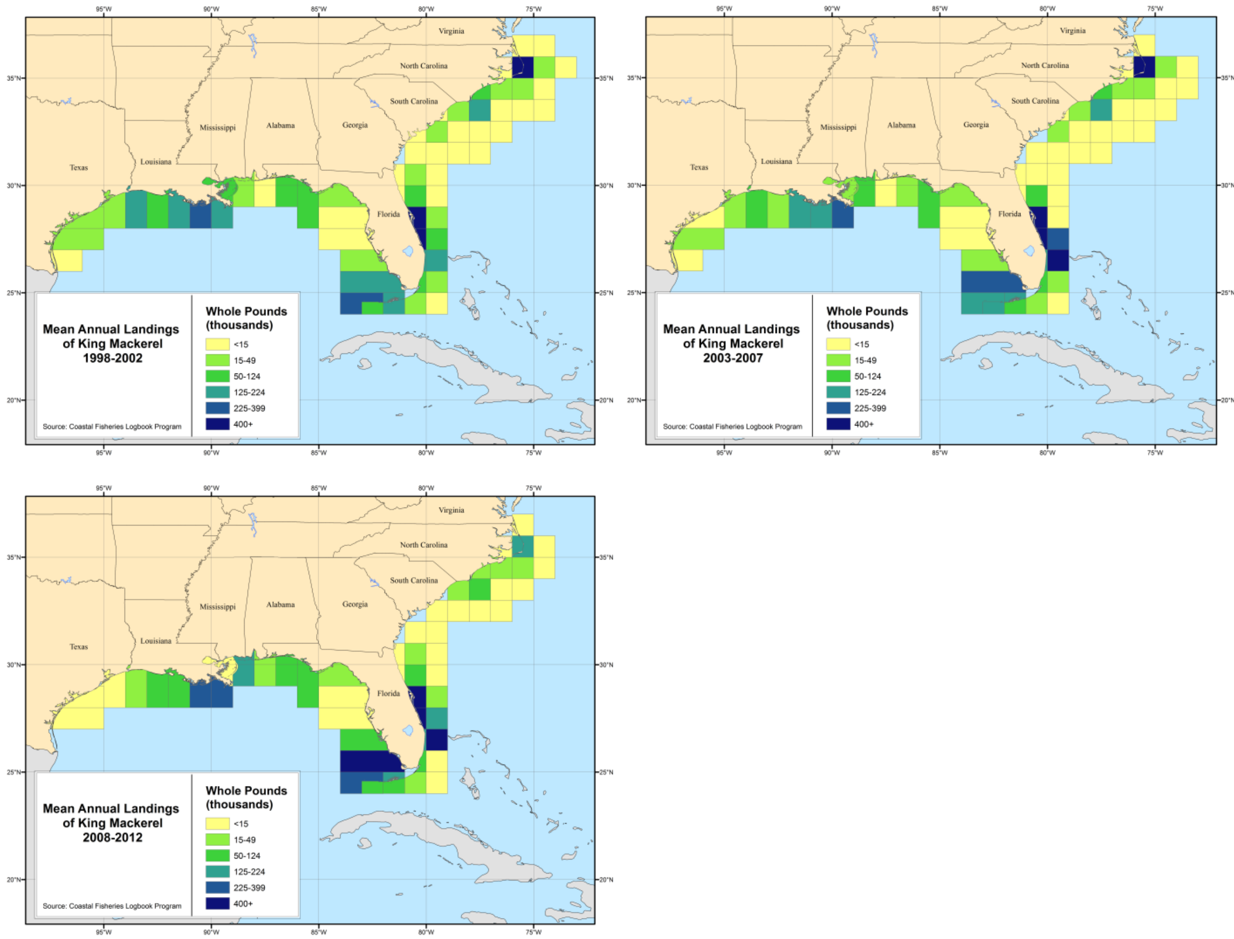

Figure 3.13.12 Maps of king mackerel harvest as reported to the CFLP

3.14 APPENDIX A

NMFS SECPR Accumulated Landings (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. 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

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

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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
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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

King mackerel (*Scomberomorus cavalla*) represent an important recreational fishery resource in the South Atlantic and Gulf of Mexico. Recreational landings of king mackerel during the most recent 5 years have averaged over 600,000 fish annually, with an average of over 200.000 more discarded. This report represents the best scientific judgment of the SEDAR 38 Data Workshop. Data were first vetted in the SEDAR 38 Recreational Fishery Statistics Group, but final decisions on data anomalies were left to the full SEDAR 38 Data Workshop panel. A summary of findings are presented here along with discussion of controversies that arose during the workshop.

Recreational landings and discards of king mackerel in the South Atlantic and 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 South Atlantic and Gulf of Mexico king mackerel. A summary of the issues discussed and data presented at the data workshop is included here.

4.1.1. Recreational Workgroup (RWG) Members

The Recreational Fishery Statistics Group leader was Jeff Isely, NOAA Fisheries. Participants included: Vivian Matter, NOAA Fisheries; Ken Brennan, NOAA Fisheries, Beaufort, NC; Kelly Fitzpatrick, NOAA Fisheries, Beaufort, NC; Eric Hiltz, South Carolina Department of Natural Resources; Beverly Sauls, Florida Fish and Wildlife Conservation Commission; Russell Hudson, Daytona FL; and Bob Zales II, Panama City, 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. Historic headboat and charterboat catch per unit effort and effort
2. Calibration of Marine Recreational Fisheries Statistics Survey (MRFSS) to Marine Recreational Information Program (MRIP) 1981-2003.
3. Calibration of MRFSS charterboat estimates to the For-Hire Survey (Gulf 1981-1997, FLE 1981-2002, Atlantic 1981-2003).
4. Evaluation of outliers, adjustments and substitutions (1981-1985)
5. Estimating recreational landings in weight
6. Estimating discards for the Southeast Region Headboat Survey
7. Estimating discards for the Texas Parks and Wildlife Department
8. Allocating the recreational survey estimates to the mixing zone.

4.1.3 South Atlantic and Gulf of Mexico Fishery Management Council Jurisdictional Boundaries

Gulf of Mexico Fishery Management Council Jurisdictional Boundaries are presented in **Figure 4.12.1**. South Atlantic Fishery Management Council Jurisdictional Boundaries are presented in **Figure 4.12.2**.

4.2 REVIEW OF WORKING PAPERS

No working papers relevant to recreational data were submitted for SEDAR38.

4.3 RECREATIONAL LANDINGS

A map summarizing all recreational landings of king mackerel in the Atlantic and Gulf of Mexico is provided in **Figure 4.12.3**.

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

<u>*Introduction:*</u>

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, NOAA Beaufort Laboratory, NC.

The MRFSS/MRIP survey covers coastal Atlantic and Gulf of Mexico states from Maine 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. Sampling is not conducted in Wave 1 (Jan/Feb) north of Florida because fishing effort is very low or non-existent, with the exception of NC, where wave 1 has been sampled since 2006.

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 officially adopted in the Gulf states in 2000, in East Florida in 2003, and in Georgia through Maine in 2005. The FHS was pilot tested in the Gulf of Mexico in 1998 and 1999 and in Georgia through Maine in 2004. 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 five distinct regions bordering the Atlantic and Gulf of Mexico coasts: NW Florida panhandle from Escambia to Dixie counties (sub-region 1), SW Florida peninsula from Levy to Collier counties (sub-region 2), Monroe county (sub-region 3), SE Florida from Dade through Indian River counties (sub-region 4), and NE Florida from Martin through Nassau counties (sub-region 5). 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), 1986-2003 in the South Atlantic (SEDAR16-DW-15, Sminkey, 2008), and for 1981-2003 in the mid-Atlantic (SEDAR17-Data Workshop Report, 2008). Atlantic calibration factors were updated in 2011 (SEDAR25-Data Workshop Report, 2011). 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 South Atlantic and 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 4.11.1**. Most of the calibration have been updated or developed since SEDAR 16.

Separation of SA combined charter/headboat mode:

In the South Atlantic, 1981-1985 charter and headboat modes were combined into one single mode for estimation purposes. Since the NMFS Southeast Region Headboat Survey (SRHS) began in this region in 1981, the MRFSS combined charter/headboat mode must be split in order to not double estimate the headboat mode for these years. MRFSS charter/headboat mode was split in these years by using a ratio of SRHS headboat angler trip estimates to MRFSS charter boat angler trip estimates for 1986-1990. This method has been used in the past (SEDAR 28-

Spanish mackerel and cobia). The mean ratio was calculated by state (or state equivalent to match SRHS areas to MRFSS states) and then applied to the 1981-1985 estimates to strip out the headboat component. These headboat estimates were then eliminated from the MRFSS estimates. This was not done in SEDAR 16 but is consistent with recent SEDARs (SEDAR 28 spanish mackerel and cobia, SEDAR 32 gray triggerfish and blueline tilefish).

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 4.11.2** shows the differences between the Atlantic and Gulf of Mexico king mackerel 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 Atlantic and Gulf of Mexico king mackerel 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 4.11.3** shows the ratio estimators used in the calibration. **Figure 4.12.4** shows the MRFSS versus MRIP adjusted AB1 estimates for Atlantic and Gulf of Mexico king mackerel 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 ($W=0.00000731410*(L^{3.0087053})$) was used to convert king mackerel sample lengths into weights, when no weight was recorded. W is whole weight in kilograms and L is fork length in centimeters. Weight estimates were not provided by the recreational workgroup in SEDAR 16 but this method has been consistently used in SEDARs since 2012.

The mixing zone and Monroe county estimates:

The LHWG has recommended a mixing zone in the area south of the Florida Keys and Dry Tortugas, demarcated in the west by a line from Key West to the Dry Tortugas, then south from the Dry Tortugas to the shelf edge, and in the east from the Dade-Monroe county line to the shelf edge. This mixing zone most closely corresponds to the Monroe county estimates in the MRFSS/MRIP data set. *Monroe County* MRFSS estimates 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.

1981, wave 1:

MRFSS began in 1981, wave 2. In the east coast of Florida and 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 migratory group, state, fishing mode and area. This methodology is consistent with SEDAR 16, except for the inclusion of migratory group in in calculating the ratios.

Texas:

Texas data from the MRFSS are 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. Shore mode estimates from Texas are retained except for an anomalous estimate in 1981. This methodology is consistent with SEDAR 16. However, we have not used a relic wave 4 estimates from 1984 that was used in SEDAR 16. This estimate (ab1=828, b2=0) is no longer a part of the MRFSS estimates.

MRIP landings in numbers of fish and in whole weight in pounds are presented by year and wave for the Atlantic migratory group in **Table 4.11.4**; for the mixing zone in **Table 4.11.5**; and for the Gulf of Mexico in **Table 4.11.6**. CVs associated with estimated landings in numbers are also shown. Atlantic king mackerel estimates includes all Atlantic coast states north through Maine. Estimates from 2013 are preliminary and are only included through June in order to complete the 2012/2013 fishing year.

4.3.2 Southeast Region Headboat Survey

Introduction:

The Southeast Region Headboat Survey (SRHS) estimates landings and effort for headboats in the South Atlantic and Gulf of Mexico. The SRHS began in the South Atlantic in 1972 and Gulf of Mexico in 1986 and extends from the NC\VA border 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 SRHS incorporates two components for estimating catch and effort. (1) Information about the size of fishes landed is 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 (in number and weight) by species, area, and time strata. The SRHS does not generate variances of the landings estimates.

The SRHS was inconsistent in LA in 2002-2005. 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 2005 there were no trip reports or fish sampled, and no substitutes were used, so there are no estimates or samples from 2004 to 2005 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. Headboats from Mississippi were included for the first time in the SRHS in 2010.

The LHWG has recommended a mixing zone in the area south of the Florida Keys and Dry Tortugas, demarcated in the west by a line from Key West to the Dry Tortugas, then south from the Dry Tortugas to the shelf edge, and in the east from the Dade-Monroe county line to the shelf edge. This mixing zone corresponds to the Florida Keys (headboat area 12) and the Dry Tortugas- Atlantic based vessels (area 17) in the SRHS data set.

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 is consistent with SEDAR 16.

SRHS landings in numbers of fish and in whole weight in pounds for the Atlantic migratory group are presented in **Table 4.11.7**; for the winter mixing zone in **Table 4.11.8**; and for the Gulf of Mexico in **Table 4.11.9**.

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). In SEDAR 16 TPWD seasonal data was disaggregated into months. Since then SEFSC personnel has 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 king mackerel (W=10^(-5.495 +(3.070*log10(L))) where W is whole 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 in 4.3.1) was applied to the TPWD landings to obtain estimated landings in weight. Weight estimates were not provided by the recreational workgroup in SEDAR 16 but this method has been consistently used in SEDARs since 2012.

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. This method differs from that in SEDAR 16 but has been consistently used in SEDARs since 2009. TPWD landings in numbers of fish and in whole weight in pounds for Texas are presented in **Table 4.11.10.**

4.3.4 Estimating Historical Recreational Landings

The historic time period for king mackerel landings in the South Atlantic and Gulf of Mexico is defined as pre-1981, and prior to the start of the Marine Recreational Fisheries Statistics Survey (MRFSS). Historic landing estimates were developed using methodology outlined in SEDAR31-RD46, modified to follow the recommendations of the RWG during the data meeting. The RWG recommended using the headboat universe from 1971 through present in

North Carolina as a suroget for the development of effort in both the charterboat and headboat sectors in the Atlantic and Gululf of Mexico. Effort estimates prior to 1971 were based on historic records of effort in the same area, as presented in SEDAR38-DW17 and SEDAR38-DW18.

4.3.5 Potential Sources for Additional Landings Data

SCDNR Charter boat Logbook Program Data, 1993 – 2012:

The Recreational Fisheries Working Group discussed the possibility of replacing the MRFSS charter mode estimates for South Carolina from 1993 to 2012 with the SCDNR Charter boat Logbook Program estimates. The SCDNR Charter boat Logbook Program is a mandatory logbook program and is a complete census. However, the data is self-reported and no field validation is done on catch or effort. SCDNR charter boat logbook data were compared with MRFSS/MRIP charter mode estimates (**Figure 4.12.5**). The Recreational Fisheries Working Group recommended not replacing the MRFSS/MRIP charter boat estimates with the SCDNR Charter boat Logbook Program estimates for 1993 – 2012. The MRFSS estimates represent a longer time series and switching from the MRFSS dataset (1981 – 1992) to the SCDNR Charter boat logbook dataset (1993-2012) would artificially reduce the total catch potentially due to the change in methodology that would not necessarily be indicative of a change in the gray triggerfish population which could affect the stock assessment model. Concern was also expressed about replacing the MRFSS/MRIP dataset with the SCDNR Charter boat logbook dataset because the data would only be replaced for one state (SC) and one mode (charter). Additionally since MRFSS/MRIP estimates are currently used to monitor annual catch limits (ACL’s), the group thought it would be appropriate to use these estimates for the recreational landings data.

4.4 RECREATIONAL DISCARDS

A map summarizing all recreational discards of king mackerel in the South Atlantic and Gulf of Mexico is provided in **Figure 4.12.6**.

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. Lengths and weights of discarded fish are not sampled or estimated by the MRFSS/MRIP.

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 for the Atlantic migratory group in **Table 4.11.4**; for the mixing zone in **Table 4.11.5**; and for the Gulf of Mexico in **Table 4.11.6**.

Atlantic king mackerel estimates includes all Atlantic coast states north through Maine. Estimates from 2013 are preliminary and are only included through June in order to complete the 2012/2013 fishing year.

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”. As of Jan 1, 2013 the SRHS started collecting logbook data electronically through a secure website and mobile app via personal computers, tablets, or smart phones. Changes to the trip report were also made at this time, one of which removed the condition category for discards i.e., released alive vs. released dead. The new form now collects only the total number of fish released regardless of condition. These self-reported data are currently not validated within the Headboat Survey. Consequently, the SRHS discard rates were compared with the At-Sea Observer Data discard rates 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 and SEDAR 16 as a proxy to estimate the headboat discards. After analyzing the different discard rates and ratios, the working group chose to use the SRHS discard estimates for 2004 – 2013 and the MRIP charterboat discard ratio as a proxy for 1981 – 2003. MRIP does not sample in Texas. Because the Texas Parks and Wildlife Department survey does not collect discards it was decided that a Gulf-wide (FLW-LA) MRIP CH discard ratio would be used as proxy to extimate the TX headboat discards 1981-2003. Because of the change in the collection of discards beginning in 2013 (i.e. b whereas before b1 and b2 were collected) the MRIP CH discard ratios applied were b1b2/a. This is different from SEDAR 16 where b2/ab1 was used.

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. In the Gulf of Mexico, observer surveys were conducted in Alabama from 2004 to 2007, and in West Florida from 2005-2007 and 2009-present. In the South Atlantic, observer coverage on headboats was launched in NC and SC in 2004 and in GA and FL in 2005 and have been continuous since . 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 a sub-sample ofanglers 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.

SRHS discard estimates for the Atlantic migratory group are presented in **Table 4.11.11**; for the winter mixing zone in **Table 4.11.12**; and for the Gulf of Mexico in **Table 4.11.13**.

4.4.4 Texas Parks and Wildlife Department Discards

The TPWD recreational survey does not estimate discards. The recreational workgroup evaluated the available data and recommended that the Gulf wide discard ratios (LA-FLW, not including the Keys) from MRFSS/MRIP by year, wave, and mode (charter and private) be applied to the TPWD landings to estimate discards from Texas. This method is consistent with SEDAR 16. TPWD discards (number of fish) are presented in **Table 4.11.10**.

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.

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 not 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 king mackerel measured in the Atlantic and Gulf of Mexico (ME-TX) from MRFSS/MRIP by year, mode, and migratory group are summarized in **Table 4.11.14**. The number of angler trips with king mackerel measured in the Atlantic and Gulf of Mexico (ME-TX) from MRFSS/MRIP by year, mode, and migratory group are summarized in **Table 4.11.15.**

Headboat Survey Biological Sampling:

Lengths were collected from 1978 to 2013 by headboat dockside samplers in the South Atlantic. Lengths were collected in the Gulf states beginning in 1986.Louisiana was not sampled in 2004-2005 due to Hurricane Katrina. Mississippi was added to the SRHS 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 king mackerel measured for length (either total or fork length) and the number of trips from which king mackerel were measured in the headboat fleet by year in the South Atlantic is presented in **Table 4.11.16**. Number of king mackerel measured for length (either total or fork length) and the number of trips from which king mackerel were measured in the winter mixing zone are presented in **Table 4.11.17**. Number of king mackerel measured for length (either total or fork length) and the number of trips from which king mackerel were measured in the Gulf of Mexico are presented in **Table 4.11.18**.

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 king mackerel measured in the TPWD charter and private-rental modes are summarized by year in **Table 4.11.19**. The number of trips with measured king mackerel in the TPWD charter and private-rental modes are summarized by year in **Table 4.11.20**.

4.5.2 Length and Age Distributions

Length frequencies from recreational headboat landings were calculated by year (1992 to 2012). Length frequency histograms for the headboat fishery are presented in **Figures 4.12.7**. King mackerel length frequency distributions for samples collected from recreational charter boat and private boat fisheries located in the South Atlantic and Gulf of Mexico from 1981 to 2012 are presented in **Figure 4.12.8**.

Reweighted age frequencies from recreational headboat landings were calculated by year (1992 to 2012). Reweighted age frequencies histograms for the headboat fishery are presented in **Figures 4.12.9**. King mackerel reweighted age frequencies distributions for samples collected from recreational charter boat and private boat fisheries located in the South Atlantic and Gulf of Mexico from 1981 to 2012 are presented in **Figure 4.12.10**.

4.6 RECREATIONAL CATCH-AT-AGE/LENGTH: DIRECTED AND DISCARD

Due to changes in the mixing zone definition catch at age and length for directed fisheries were not available for the data workshop. These will be made available for the SEDAR38 Assessment workshop.

4.7 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 summarizing MRFSS/MRIP and TPWD effort in angler trips is included in **Figure 4.12.11**. A map summarizing SRHS effort in angler days is included in **Figure 4.12.12**.

4.7.1 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 for a single angler in the specified mode, not to exceed 24 hours. Atlantic, mixing zone and Gulf of Mexico (ME-TX) estimated number of angler trips for MRFSS (1981-2003) and MRIP (2004-2013) by year and migratory group are presented in **Table 4.11.21**.

4.7.2 Headboat Effort

Headboats report catch and effort data for each trip via the SHRS logbooks. 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 for the Atlantic migratory group in **Table 4.11.22**; for the winter mixing zone in **Table 4.11.23**; and for the Gulf of Mexico in Table **4.11.24**.

Estimated headboat angler days have decreased in the South Atlantic and Gulf of Mexico in recent years. The most obvious factor which impacted the headboat fishery in both the Atlantic and South 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 South Atlantic and 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 South Atlantic and Gulf of Mexico in 2010, the year of the Deepwater Horizon oil spill.

4.7.3 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 bay/pass because these represent most of the fishing effort, but all trips (private, charterboat, ocean, bay/pass) are sampled. Charterboat trips in ocean waters are the least encountered in the survey. Estimates of TPWD angler trips are shown in **Table 4.11.25** by year, season, and mode.

4.8 COMMENTS ON ADEQUACY OF DATA FOR ASSESSMENT ANALYSES

The RWG discussed the adequacy of the available recreational data for assessment analyses. Recreational landings of king mackerel are high in all areas. MRFSS/MRIP coverage of recreational catch, effort, and king mackerel size and age composition are adequate for assessment purposes. Size distribution of discards is a matter of concern. Data are available for a short time period, but are used for the entire time period. As king mackerel discards have historically been low, this has not presented a problem for assessment. However, as regulations become more restrictive, characterization of discards will be important.

4.9 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

4.10 LITERATURE CITED

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SEDAR38-DW17 Historical For-Hire Fishing Vessels South Atlantic Fishery Management Council 1930s to 1985.

SEDAR38-DW18 Historical photographs of For-Hire Fishing Vessels 1930s to 1985.

4.11 TABLES

Table 4.11.1 Atlantic and Gulf of Mexico MRFSS charterboat conversion factors and standard errors (in parentheses).

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

	WAVE					
STATE	1	2	3	4	5	6
NC	-	2.151 (0.12)	2.294 (0.12)	1.444 (0.12)	1.763 (0.12)	0.857 (0.12)
SC	-	1.035 (0.04)	1.085 (0.04)	1.437 (0.04)	0.891 (0.04)	0.750 (0.04)
GFE	0.845 (0.02)	0.951 (0.02)	0.985 (0.02)	1.016 (0.02)	0.811 (0.02)	0.696 (0.02)
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)

d) Apply to 1986- 2002 charterboat mode in FLE

	WAVE					
Area	1	2	3	4	5	6
Inshore	1.600 (0.65)	2.786 (0.65)	2.201 (0.65)	2.894 (0.65)	1.630 (0.65)	2.386 (0.65)
Ocean	0.664 (0.10)	0.852 (0.10)	0.828 (0.10)	1.006 (0.10)	0.478 (0.10)	0.549 (0.10)

e) Apply to 1986- 2003 charterboat mode in GA and SC

	WAVE					
Area	1	2	3	4	5	6
Inshore	-	1.635 (0.90)	3.100 (0.90)	2.092 (0.90)	0.931 (0.90)	0.757 (0.90)
Ocean	-	0.939 (0.36)	1.272 (0.33)	2.161 (0.32)	0.835 (0.33)	0.638 (0.36)

f) Apply to 1986- 2003 charterboat mode in NC

	WAVE					
Area	1	2	3	4	5	6
Inshore	-	11.850 (3.48)	10.026 (2.63)	6.616(2.84)	3.766 (2.84)	9.415 (3.11)
Ocean	-	2.188 (0.58)	2.504 (0.58)	1.565 (0.60)	2.102 (0.60)	0.661 (0.60)

g) Apply to 1981- 2003 charterboat/headboat mode in the mid-Atlantic

*originally only said to apply to 1986-2003 data, but the cbt/hbt combined mode in sub_reg=5 was consistent from 1981-2003 and there is no HBS data providing headboat estimates in this sub-region.

	WAVE					
STATE	1	2	3	4	5	6
NY	-	1.187 (0.48)	2.048 (0.54)	2.665 (0.48)	1.210 (0.51)	0.617 (0.48)
NJ	-	1.289 (0.36)	1.179 (0.34)	1.644 (0.34)	0.809 (0.34)	1.115 (0.36)
DE/MD	-	1.294 (0.52)	1.599 (0.54)	1.930 (0.54)	0.861 (0.52)	1.171 (0.56)
VA	-	0.770 (0.25)	0.680 (0.21)	0.761 (0.21)	0.324 (0.22)	0.313 (0.22)

Table 4.11.2 King mackerel MRIP vs. MRFSS estimates of landings (number of fish) for the Atlantic and 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)	KING MACKEREL	670,352	749,104	78,752	11.7%	7.3
FULL YEAR	2005	Calendar Year (Jan 1 - Dec 31)	KING MACKEREL	664,360	624,883	-39,477	-5.94%	7.1
FULL YEAR	2006	Calendar Year (Jan 1 - Dec 31)	KING MACKEREL	959,113	896,148	-62,966	-6.56%	7.1
FULL YEAR	2007	Calendar Year (Jan 1 - Dec 31)	KING MACKEREL	1,123,270	1,156,831	33,562	2.99%	7.0
FULL YEAR	2008	Calendar Year (Jan 1 - Dec 31)	KING MACKEREL	717,240	696,966	-20,274	-2.83%	7.3
FULL YEAR	2009	Calendar Year (Jan 1 - Dec 31)	KING MACKEREL	870,174	929,576	59,403	6.83%	8.1
FULL YEAR	2010	Calendar Year (Jan 1 - Dec 31)	KING MACKEREL	449,833	435,360	-14,473	-3.22%	8.0
FULL YEAR	2011	Calendar Year (Jan 1 - Dec 31)	KING MACKEREL	379,497	333,576	-45,921	-12.1%	9.7

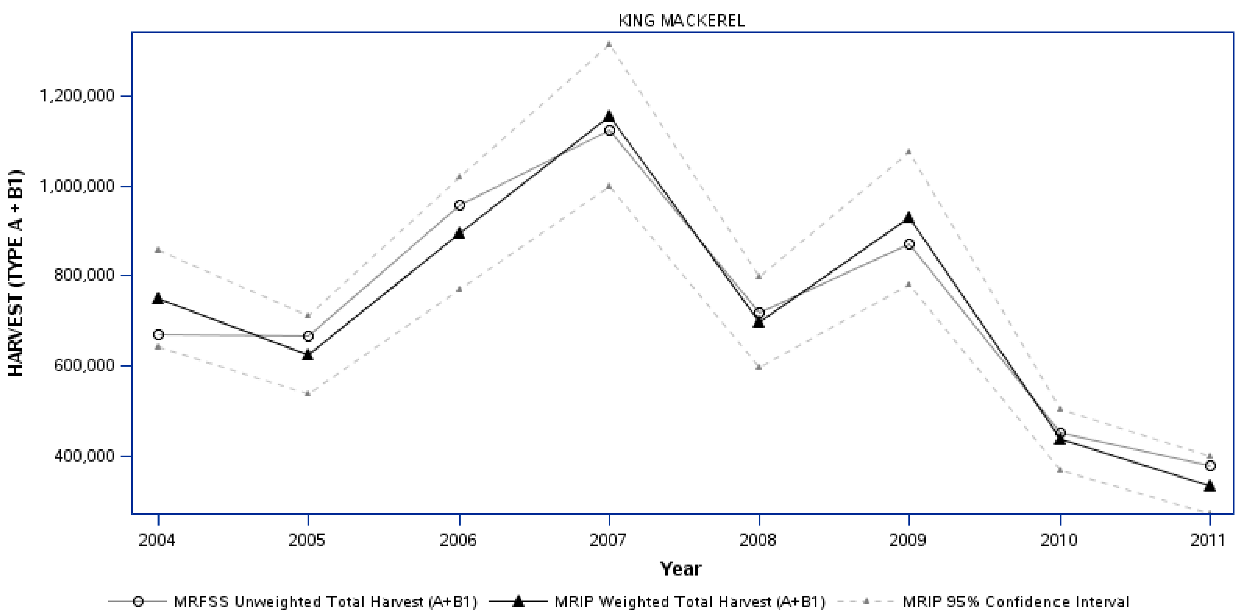

Table 4.11.3. King mackerel ratio estimators for adjusting MRFSS numbers and variance estimates (AB1 and B2) to MRIP numbers and variances for 1981-2003. The variances of the numbers ratio estimators are also shown.

a) Gulf of Mexico king mackerel

	Numbers Ratio Estimator		Variance Ratio Estimator		Variance of Numbers Ratio Estimator	
MODE	AB1	B2	AB1	B2	AB1	B2
Charterboat	1.053690177	0.989855026	4.272640143	3.238970836	0.000625352	0.008741804
Private	1.09042251	1.13962879	2.148520909	3.586798467	0.007342324	0.001393132
Shore	0.633903677	0.712802205	0.746197957	2.178680029	0.002828162	0.002516295
All	1.002494472	0.970024101	1.866482085	2.617041859	0.002336685	0.00308149

b) South Atlantic king mackerel

	Numbers Ratio Estimator		Variance Ratio Estimator		Variance of Numbers Ratio Estimator	
MODE	AB1	B2	AB1	B2	AB1	B2
Charterboat	0.940122976	0.838452124	1.615349394	1.030008707	0.002034259	0.005762587
Private	1.007138965	1.047338372	2.354325521	2.637812083	0.000818125	0.003480336
Shore	0.77512446	0.818661796	0.789074967	1.66549399	0.010365001	0.121711536
All	0.990141717	1.020808978	2.231840278	2.532968117	0.000379627	0.004249595

c) Mid- Atlantic king mackerel

	Numbers Ratio Estimator		Variance Ratio Estimator		Variance of Numbers Ratio Estimator	
MODE	AB1	B2	AB1	B2	AB1	B2
Cbt/Hbt	0.730647208		0.755358265		0.018490286	
Private	0.556644398	0.667260182	0.39488338	0.477271196	0.043001214	0.012067111
All	0.618590097	0.667260182	0.430516661	0.477271196	0.012926002	0.012067111

Table 4.11.3. cont.

d) King mackerel- all regions

	Numbers Ratio Estimator		Variance Ratio Estimator		Variance of Numbers Ratio Estimator	
MODE	AB1	B2	AB1	B2	AB1	B2
All	0.994479119	0.993271926	2.057678322	2.590894767	0.000548182	0.002628973

Table 4.11.4. Atlantic migratory group (ME-FLE, Dade) king mackerel landings (numbers of fish and whole weight in pounds) and discards (numbers of fish) from MRIP by year and wave. Each wave is a two month period (wave=1 Jan-Feb, wave=2 Mar-Apr, etc). 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.

		Atlantic MRIP landings			**Atlantic MRIP discards**	
YEAR	WAVE	Number	CV_num	Weight (lbs)	Number	CV_num
1981	1	4,705	1.12	57,656	0	0.00
	2	56,072	0.52	688,208	0	0.00
	3	49,641	0.40	531,838	0	0.00
	4	63,985	0.61	783,222	2,286	1.62
	5	393,696	0.05	2,967,487	0	0.00
	6	17,588	0.96	216,037	0	0.00
1981 Total		585,687	0.10	5,244,447	2,286	1.62
1982	1	12,561	0.00	105,720	0	0.00
	2	295,950	0.06	1,762,558	986	0.00
	3	106,054	0.31	1,051,893	0	0.00
	4	206,976	0.35	2,035,288	0	0.00
	5	122,483	0.22	955,573	0	0.00
	6	32,418	0.15	283,262	0	0.00
1982 Total		776,441	0.11	6,194,294	986	0.00
1983	1	3,729	0.99	54,845	0	0.00
	2	866	0.00	5,676	0	0.00
	3	447,999	0.09	3,565,830	105	0.00
	4	233,792	0.44	2,984,877	0	0.00
	5	138,403	0.53	1,781,077	0	0.00
	6	7,789	0.74	118,641	0	0.00
1983 Total		832,578	0.16	8,510,946	105	0.00
1984	1	11,036	0.63	113,397	0	0.00
	2	21,679	0.43	223,900	0	0.00
	3	128,398	0.20	1,311,704	89	0.00
	4	358,932	0.40	3,642,518	0	0.00
	5	130,072	0.05	1,264,340	339	0.00
	6	44,420	0.46	478,064	0	0.00
1984 Total		694,538	0.21	7,033,923	428	0.00
1985	1	5,924	1.42	62,797	0	0.00
	2	16,255	0.68	172,327	16,761	1.62
	3	158,256	0.16	1,571,842	2,669	1.62
	4	80,771	0.33	879,890	0	0.00
	5	687,415	0.09	6,120,184	0	0.00
	6	10,464	0.58	99,701	0	0.00
1985 Total		959,084	0.08	8,906,741	19,430	1.42
1986	1	11,531	0.66	107,921	1,777	1.62
	2	43,170	0.34	404,936	5,249	1.22
	3	360,764	0.52	3,069,620	0	0.00
	4	300,871	0.22	2,844,343	9,258	0.82
	5	96,257	0.25	979,750	215	0.86
	6	42,193	0.49	430,893	2,543	0.98

1986 Total		854,785	0.24	7,837,462	19,042	0.56
1987	1	5,951	0.71	71,789	0	0.00
	2	141,124	0.57	1,160,386	56,496	0.99
	3	203,659	0.24	1,441,936	1,344	1.62
	4	117,574	0.21	1,229,409	6,680	1.15
	5	165,872	0.20	1,286,812	4,563	0.96
	6	39,933	0.38	424,999	0	0.00
1987 Total		674,113	0.15	5,615,330	69,083	0.82
1988	1	2,952	1.24	28,968	2,428	1.62
	2	24,813	0.43	225,966	11,783	0.68
	3	163,761	0.17	1,152,487	2,063	1.18
	4	204,673	0.19	2,195,257	11,952	0.77
	5	183,195	0.30	1,593,097	4,408	0.75
	6	84,047	0.36	721,561	8,418	0.79
1988 Total		663,440	0.12	5,917,335	41,051	0.37
1989	1	13,228	0.62	118,426	3,301	1.49
	2	80,521	0.45	688,616	1,864	1.62
	3	84,732	0.21	731,594	3,893	0.86
	4	147,116	0.23	1,378,656	7,577	0.53
	5	74,872	0.30	697,850	12,337	1.16
	6	42,380	0.30	398,668	705	1.03
1989 Total		442,849	0.13	4,013,810	29,677	0.55
1990	1	20,785	0.41	166,770	0	0.00
	2	89,681	0.30	641,234	1,921	1.62
	3	74,075	0.26	551,266	193	1.62
	4	207,925	0.16	1,406,369	5,516	0.92
	5	77,639	0.27	574,601	4,529	0.66
	6	103,279	0.23	791,109	5,507	0.84
1990 Total		573,384	0.10	4,131,348	17,666	0.46
1991	1	3,687	0.85	30,738	1,222	1.62
	2	24,582	0.37	211,631	4,480	1.22
	3	173,139	0.17	1,360,453	23,741	0.62
	4	261,888	0.21	2,321,499	10,808	0.55
	5	143,399	0.23	1,288,582	14,042	0.92
	6	83,338	0.30	706,985	10,436	0.64
1991 Total		690,031	0.11	5,919,888	64,729	0.34
1992	1	17,182	0.36	164,772	6,990	0.68
	2	102,193	0.61	758,131	4,147	0.70
	3	123,212	0.16	1,098,774	4,964	1.04
	4	311,877	0.14	3,207,870	16,484	0.53
	5	193,459	0.26	1,932,355	3,468	0.75
	6	34,190	0.28	358,622	14,747	0.78
1992 Total		782,113	0.12	7,520,525	50,799	0.32
1993	1	65,620	0.23	593,654	11,075	0.78
	2	36,968	0.27	333,459	2,784	1.01
	3	85,074	0.18	788,763	1,190	1.24
	4	104,636	0.15	998,982	17,326	0.50
	5	93,729	0.17	1,005,674	10,937	0.59
	6	56,099	0.35	556,575	4,790	1.06
1993 Total		442,127	0.09	4,277,107	48,103	0.31

1994	1	18,422	0.27	162,323	4,012	0.90
	2	66,572	0.35	606,334	1,648	0.98
	3	91,229	0.14	841,099	9,111	0.67
	4	110,763	0.14	1,009,691	5,940	0.55
	5	106,804	0.18	979,010	2,282	0.78
	6	54,458	0.21	555,426	5,489	1.05
1994 Total		448,248	0.09	4,153,883	28,481	0.35
1995	1	23,944	0.38	207,017	2,389	0.98
	2	48,087	0.33	457,890	6,909	0.90
	3	117,546	0.21	1,130,682	19,718	0.50
	4	157,188	0.17	1,424,106	5,066	0.58
	5	136,405	0.24	1,206,987	9,503	0.53
	6	84,944	0.25	802,992	26,616	0.74
1995 Total		568,114	0.10	5,229,673	70,200	0.34
1996	1	16,061	0.37	160,028	1,174	1.62
	2	61,990	0.25	694,113	5,443	0.77
	3	115,426	0.15	1,151,459	8,764	0.64
	4	113,335	0.18	1,179,821	28,531	0.40
	5	81,125	0.28	737,604	9,811	0.64
	6	41,105	0.28	416,734	8,757	1.04
1996 Total		429,043	0.09	4,339,759	62,481	0.28
1997	1	45,258	0.33	477,896	3,193	0.95
	2	134,830	0.31	1,636,207	2,869	0.89
	3	149,990	0.16	1,514,568	36,521	0.39
	4	161,894	0.16	1,591,433	25,684	0.34
	5	176,180	0.22	1,541,761	20,111	0.61
	6	68,884	0.22	720,063	12,150	0.66
1997 Total		737,037	0.10	7,481,927	100,527	0.22
1998	1	33,122	0.26	302,934	9,390	0.86
	2	111,976	0.28	1,207,755	3,463	0.68
	3	199,846	0.20	2,080,174	43,823	0.44
	4	88,914	0.19	835,484	9,273	0.42
	5	66,114	0.22	643,966	15,844	0.49
	6	63,523	0.27	581,120	16,493	0.81
1998 Total		563,495	0.10	5,651,432	98,286	0.27
1999	1	36,663	0.24	332,045	6,796	0.59
	2	73,300	0.19	640,570	5,082	0.40
	3	115,081	0.16	1,208,588	19,598	0.45
	4	109,778	0.15	997,490	48,704	0.42
	5	44,232	0.25	399,895	12,296	0.54
	6	57,091	0.26	476,344	16,034	0.53
1999 Total		436,145	0.08	4,054,932	108,510	0.23
2000	1	26,219	0.26	255,950	10,756	0.57
	2	56,241	0.23	568,721	14,233	0.48
	3	135,120	0.17	1,286,814	22,774	0.30
	4	223,263	0.14	2,137,890	35,275	0.38
	5	111,526	0.18	1,351,923	9,340	0.36
	6	35,750	0.32	437,784	7,558	0.59
2000 Total		588,119	0.08	6,039,083	99,937	0.18
2001	1	24,080	0.25	201,969	4,195	0.79

	2	59,984	0.29	700,384	11,999	0.52
	3	142,843	0.17	1,361,200	42,173	0.38
	4	97,566	0.15	1,089,670	31,692	0.31
	5	61,629	0.31	1,409,150	7,467	0.50
	6	25,213	0.35	325,383	4,714	0.60
2001 Total		411,314	0.10	5,087,755	102,239	0.20
2002	1	13,925	0.44	208,887	6,334	0.64
	2	33,240	0.21	391,867	6,540	0.50
	3	91,950	0.15	929,798	33,269	0.37
	4	78,039	0.16	796,170	15,980	0.35
	5	38,820	0.24	383,383	16,395	0.45
	6	96,769	0.34	912,787	19,108	0.41
2002 Total		352,743	0.11	3,622,892	97,625	0.18
2003	1	86,642	0.20	775,688	85,822	0.39
	2	122,080	0.17	1,117,830	68,386	0.40
	3	127,535	0.17	1,290,560	40,876	0.32
	4	165,167	0.15	1,502,814	46,128	0.34
	5	51,708	0.43	444,987	5,928	0.79
	6	59,147	0.29	508,038	15,725	0.58
2003 Total		612,280	0.08	5,639,916	262,866	0.19
2004	1	30,235	0.27	341,848	22,943	0.55
	2	26,087	0.28	294,767	15,995	0.63
	3	114,199	0.17	1,301,081	46,029	0.25
	4	164,924	0.18	1,899,490	74,415	0.28
	5	71,725	0.23	821,820	36,566	0.42
	6	53,110	0.39	586,534	31,181	0.63
2004 Total		460,281	0.10	5,245,541	227,129	0.17
2005	1	18,126	0.25	160,004	4,644	0.41
	2	44,633	0.25	416,508	16,963	0.39
	3	119,957	0.16	1,072,028	46,278	0.35
	4	145,742	0.15	1,191,068	42,496	0.23
	5	45,521	0.30	415,967	54,780	0.42
	6	24,328	0.20	222,539	30,972	0.48
2005 Total		398,307	0.09	3,478,115	196,131	0.17
2006	1	25,799	0.27	286,318	17,297	0.43
	2	56,108	0.22	529,660	8,636	0.39
	3	155,057	0.16	1,504,153	48,321	0.33
	4	124,681	0.16	1,221,113	70,204	0.38
	5	61,812	0.22	686,221	26,472	0.34
	6	66,996	0.23	622,990	28,248	0.51
2006 Total		490,452	0.08	4,850,455	199,178	0.18
2007	1	59,716	0.31	529,386	33,354	0.44
	2	86,608	0.39	679,679	11,418	0.46
	3	279,025	0.16	2,215,286	101,293	0.39
	4	203,262	0.14	1,799,690	75,207	0.24
	5	120,403	0.20	966,075	37,807	0.33
	6	71,014	0.24	614,821	42,851	0.36
2007 Total		820,027	0.09	6,804,937	301,929	0.17
2008	1	61,880	0.33	506,092	19,862	0.54
	2	49,102	0.42	427,975	17,313	0.57

	3	122,143	0.13	1,208,364	36,186	0.26
	4	121,064	0.14	1,005,898	45,103	0.30
	5	48,041	0.23	416,543	22,210	0.39
	6	81,633	0.30	519,159	28,430	0.31
2008 Total		483,864	0.10	4,084,031	169,103	0.15
2009	1	35,328	0.25	347,142	7,632	0.41
	2	67,243	0.22	557,146	14,413	0.21
	3	96,619	0.17	1,033,281	28,752	0.24
	4	159,827	0.15	1,594,372	33,538	0.49
	5	29,744	0.20	281,244	2,882	0.39
	6	31,326	0.31	312,306	9,460	0.46
2009 Total		420,087	0.08	4,125,490	96,678	0.20
2010	1	15,747	0.35	151,236	2,137	0.46
	2	32,280	0.28	364,428	17,597	0.37
	3	79,942	0.18	817,870	32,159	0.36
	4	68,767	0.22	685,802	18,110	0.38
	5	18,875	0.22	191,967	3,183	0.52
	6	18,148	0.35	189,774	2,309	0.55
2010 Total		233,759	0.10	2,401,078	75,495	0.20
2011	1	15,023	0.43	162,999	1,849	1.04
	2	13,547	0.31	144,513	6,506	0.45
	3	64,695	0.35	714,346	26,734	0.61
	4	32,320	0.25	352,357	5,816	0.64
	5	15,724	0.57	173,271	3,678	0.71
	6	11,759	0.31	127,171	2,636	0.61
2011 Total		153,069	0.18	1,674,658	47,218	0.37
2012	1	18,193	0.26	170,826	5,089	0.42
	2	27,571	0.36	350,120	1,980	0.62
	3	23,586	0.23	258,231	7,532	0.47
	4	33,136	0.28	347,392	6,152	0.36
	5	38,102	0.26	440,663	986	0.75
	6	8,438	0.35	91,453	5,565	0.65
2012 Total		149,026	0.12	1,658,686	27,304	0.22
2013	1	16,318	0.48	189,637	4,014	0.77
	2	3,189	0.65	37,157	0	0.00
	3	18,371	0.37	208,020	3,667	0.67
2013 Total		37,878	0.28	434,813	7,681	0.51
Grand Total Atlantic MRIP		17,764,459	0.02	167,182,213	2,742,382	0.05

Table 4.11.5. Mixing zone (Monroe county, FL) king mackerel landings (numbers of fish and whole weight in pounds) and discards (numbers of fish) from MRIP by year and wave. Each wave is a two month period (wave=1 Jan-Feb, wave=2 Mar-Apr, etc). 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.

		Mixing MRIP landings			**Mixing MRIP discards**	
YEAR	WAVE	Number	CV_num	Weight (lbs)	Number	CV_num
1981	1	94,679	1.56	795,051	0	0.00
	2	167,272	1.46	1,404,639	0	0.00
1981 Total		261,951	1.09	2,199,691	0	0.00
1982	1	29,205	0.14	260,484	0	0.00
	2	3,462	1.22	30,880	0	0.00
	3	928	1.06	8,280	0	0.00
1982 Total		33,596	0.18	299,644	0	0.00
1983	1	15,037	0.00	95,982	0	0.00
	3	3,099	0.90	19,783	0	0.00
	4	357	0.00	2,277	0	0.00
1983 Total		18,493	0.15	118,042	0	0.00
1984	1	21,570	0.50	139,552	0	0.00
	2	5,734	0.74	41,621	235	0.00
	3	311	0.00	2,193	0	0.00
	6	15,001	1.46	105,848	0	0.00
1984 Total		42,615	0.58	289,215	235	0.00
1985	1	7,779	0.00	59,040	0	0.00
	6	8,048	0.00	61,084	0	0.00
1985 Total		15,827	0.00	120,124	0	0.00
1986	1	8,040	1.08	87,973	0	0.00
	2	1,465	1.46	16,025	0	0.00
	5	4,556	0.82	50,061	5,083	1.36
	6	24,440	0.51	272,208	0	0.00
1986 Total		38,501	0.41	426,267	5,083	1.36
1987	1	0	0.00	0	0	0.00
	2	15,405	0.63	106,650	0	0.00
	3	3,886	0.72	23,634	0	0.00
	4	0	0.00	0	820	1.89
	5	584	1.37	4,118	0	0.00
	6	3,625	1.15	25,552	0	0.00
1987 Total		23,500	0.46	159,953	820	1.89
1988	1	0	0.00	0	4,439	1.71
	2	0	0.00	0	5,871	1.43
	4	4,852	0.84	37,515	0	0.00
	5	310	1.65	3,334	706	1.51
	6	0	0.00	0	0	0.00
1988 Total		5,162	0.80	40,850	11,017	1.03
1989	1	6,275	0.85	57,231	31,464	0.95
	2	2,023	1.04	18,452	0	0.00
	4	875	2.07	8,579	0	0.00
1989 Total		9,173	0.66	84,261	31,464	0.95

1990	1	2,783	1.20	20,311	0	0.00
	2	5,607	0.69	36,801	0	0.00
	5	5,220	0.42	34,141	0	0.00
	6	22,164	0.51	152,057	20,630	0.88
1990 Total		35,774	0.35	243,310	20,630	0.88
1991	1	53,208	0.57	413,124	50,460	0.66
	2	18,806	0.69	150,469	12,435	0.99
	3	3,095	0.86	25,020	0	0.00
	4	13,301	0.86	107,519	0	0.00
	5	6,515	0.60	52,107	0	0.00
	6	1,450	1.05	11,725	4,694	1.42
1991 Total		96,375	0.37	759,964	67,590	0.53
1992	1	17,112	0.73	156,563	23,083	0.80
	2	353	1.54	3,086	0	0.00
	4	2,280	0.85	22,237	0	0.00
	5	7,079	0.61	57,189	1,114	1.19
	6	43,828	0.50	405,149	1,948	1.13
1992 Total		70,653	0.36	644,223	26,144	0.71
1993	1	62,044	0.53	518,793	1,952	1.79
	2	9,281	0.70	87,625	594	1.79
	4	832	1.04	7,785	0	0.00
	5	5,504	0.66	41,800	398	1.79
	6	8,771	0.59	60,482	1,081	1.10
1993 Total		86,433	0.40	716,485	4,025	0.97
1994	1	80,172	0.45	701,482	6,858	0.84
	2	27,123	0.45	217,504	961	1.89
	3	753	1.46	7,822	1,573	1.34
	5	2,764	0.94	25,805	0	0.00
	6	31,749	0.41	342,697	8,402	0.71
1994 Total		142,560	0.28	1,295,310	17,794	0.49
1995	1	101,077	0.33	937,799	6,615	1.04
	2	98,786	0.35	1,047,631	7,433	0.96
	4	1,332	0.92	12,943	0	0.00
	5	7,095	0.69	69,667	0	0.00
	6	16,644	0.55	131,519	17,552	1.80
1995 Total		224,934	0.22	2,199,559	31,600	1.05
1996	1	61,641	0.60	755,856	29,337	1.44
	2	67,505	0.57	660,721	2,197	1.41
	3	1,549	1.46	11,986	0	0.00
	4	2,385	1.19	18,200	998	1.89
	5	11,345	0.69	82,791	2,588	0.90
	6	35,202	0.35	379,321	20,866	0.60
1996 Total		179,626	0.31	1,908,876	55,987	0.79
1997	1	107,898	0.36	1,336,591	17,830	0.66
	2	6,142	0.57	62,176	832	1.89
	5	8,406	0.62	63,484	818	1.61
	6	41,114	0.49	388,940	6,083	0.59
1997 Total		163,560	0.27	1,851,192	25,562	0.49
1998	1	50,248	0.26	471,617	11,368	0.35
	2	31,002	0.29	289,579	438	0.83

		3	1,434	0.79	12,694	0	0.00
		4	1,101	0.92	12,435	0	0.00
		5	1,695	0.66	11,905	0	0.00
		6	9,121	0.36	101,334	355	0.68
1998 Total		94,601	0.17	899,565	12,161	0.33
1999	1	7,191	0.35	67,480	5,270	1.04
	2	7,418	0.32	76,263	612	0.63
	3	161	0.90	1,629	69	1.29
	4	52	1.11	476	0	0.00
	5	1,139	0.57	11,039	125	1.20
	6	4,107	0.38	35,088	1,166	0.72
1999 Total		20,069	0.19	191,974	7,243	0.77
2000	1	5,621	0.33	54,774	1,043	1.38
	2	2,454	0.48	23,427	37	1.29
	3	1,899	0.79	15,305	25	1.29
	4	443	0.65	3,503	0	0.00
	5	1,476	0.55	11,268	360	0.79
	6	3,275	0.44	24,727	550	0.77
2000 Total		15,167	0.21	133,004	2,016	0.76
2001	1	14,909	0.33	174,100	1,135	0.54
	2	6,727	0.36	70,862	2,169	0.84
	3	265	0.62	2,030	0	0.00
	4	1,088	1.08	11,196	1,690	1.75
	5	5,583	0.51	47,734	312	1.79
	6	3,242	0.46	26,767	0	0.00
2001 Total		31,814	0.20	332,689	5,306	0.67
2002	1	18,271	0.39	241,876	738	0.56
	2	10,096	0.52	88,295	247	0.90
	3	2,639	0.51	27,156	0	0.00
	4	2,521	0.46	22,333	52	1.79
	5	7,835	0.45	59,949	276	1.31
	6	5,929	0.63	55,620	939	1.68
2002 Total		47,292	0.22	495,230	2,251	0.75
2003	1	10,938	0.32	120,507	435	0.53
	2	9,011	0.35	65,244	3,527	0.44
	3	710	0.94	6,997	35	1.79
	4	1,006	0.64	9,312	395	0.82
	5	1,823	0.61	14,942	0	0.00
	6	3,866	0.41	33,177	5,787	0.99
2003 Total		27,355	0.19	250,181	10,178	0.58
2004	1	15,387	0.19	151,748	5,968	0.12
	2	3,237	0.27	32,544	699	0.43
	3	0	0.00	0	207	0.00
	4	118	0.00	1,143	0	0.00
	5	1,207	0.00	8,168	201	0.00
	6	2,862	0.26	26,721	586	0.91
2004 Total		22,811	0.14	220,324	7,661	0.12
2005	1	10,253	0.50	92,791	2,480	0.31
	2	8,347	0.25	64,912	2,021	0.39
	3	170	0.00	1,271	0	0.00

	4	387	0.00	3,210	117	0.00
	6	11,678	0.09	91,546	218	0.46
2005 Total		30,835	0.18	253,729	4,836	0.23
2006	1	11,602	0.18	102,160	4,509	0.21
	2	10,965	0.38	83,091	1,552	0.47
	3	162	0.00	1,324	0	0.00
	4	1,025	0.42	8,763	561	0.78
	5	2,020	0.00	14,126	1,373	0.00
	6	2,168	0.23	16,766	595	0.49
2006 Total		27,941	0.17	226,230	8,591	0.15
2007	1	6,569	0.28	54,389	311	0.42
	2	8,926	0.29	63,905	394	0.74
	3	71	0.00	501	0	0.00
	4	2,155	0.37	17,352	1,293	0.85
	5	178	0.42	1,410	0	0.00
	6	1,598	0.13	13,337	487	1.00
2007 Total		19,497	0.17	150,893	2,485	0.50
2008	1	5,701	0.19	56,710	333	0.50
	2	2,564	0.31	20,467	653	0.40
	3	1,053	0.47	10,318	0	0.00
	4	63	0.00	519	37	0.00
	5	1,228	0.26	9,030	26	1.00
	6	6,828	0.37	53,771	1,614	0.73
2008 Total		17,438	0.17	150,815	2,664	0.46
2009	1	12,082	0.29	94,264	2,151	0.49
	2	6,031	0.43	34,188	293	1.00
	3	700	0.34	6,379	99	1.00
	4	430	0.00	3,438	0	0.00
	5	6,411	0.98	47,542	0	0.00
	6	2,187	0.23	16,043	250	0.83
2009 Total		27,842	0.28	201,854	2,794	0.40
2010	1	5,580	0.17	41,478	56	1.00
	2	3,843	0.40	29,924	2,894	0.92
	3	876	0.14	6,195	0	0.00
	4	58	0.37	457	77	0.52
	5	399	0.00	3,018	0	0.00
	6	2,008	0.37	18,639	149	0.49
2010 Total		12,763	0.15	99,711	3,176	0.84
2011	1	6,336	0.24	56,307	1,253	0.46
	2	3,010	0.22	21,263	395	0.51
	3	259	0.25	2,350	49	1.00
	4	148	0.41	1,395	0	0.00
	5	780	0.38	5,749	514	0.75
	6	3,048	0.24	25,828	256	0.76
2011 Total		13,580	0.13	112,892	2,467	0.31
2012	1	4,881	0.27	44,722	1,072	0.35
	2	1,373	0.39	10,623	1,378	0.52
	3	121	0.00	960	0	0.00
	4	619	0.00	5,896	0	0.00
	5	593	0.00	5,502	1,092	0.00

	6	2,917	0.32	18,829	2,146	1.00
2012 Total		10,503	0.16	86,532	5,689	0.40
2013	1	7,468	0.20	66,810	610	0.53
	2	4,563	0.00	41,157	0	0.00
	3	10,539	0.00	107,298	0	0.00
2013 Total		22,570	0.06	215,266	610	0.53
Grand Total Mixing MRIP		1,890,812	0.16	17,377,854	378,080	0.21

Table 4.11.6. Gulf migratory group (TX-FLW, Collier) king mackerel landings (numbers of fish and whole weight in pounds) and discards (numbers of fish) from MRIP by year and wave. Each wave is a two month period (wave=1 Jan-Feb, wave=2 Mar-Apr, etc). 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.

		Gulf MRIP landings			**Gulf MRIP discards**	
YEAR	WAVE	Number	CV_num	Weight (lbs)	Number	CV_num
1981	1	350	0.00	3,982		0.00
	3	48,324	0.00	499,919	0	0.00
	4	36,414	0.57	411,834	4,688	1.51
	5	23,930	0.56	241,206	975	1.89
1981 Total		109,018	0.23	1,156,941	5,663	1.30
1982	2	8,509	0.69	75,895	0	0.00
	3	73,350	0.13	971,704	231	1.47
	4	40,828	0.30	530,202	18,021	1.61
	5	650,068	1.14	7,755,220	0	0.00
	6	9,814	0.92	87,533	0	0.00
1982 Total		782,570	0.95	9,420,554	18,252	1.59
1983	2	4,597	0.90	50,271	0	0.00
	3	34,762	0.20	411,225	196	0.00
	4	205,709	0.62	1,493,556	0	0.00
	5	26,319	0.62	304,749	0	0.00
1983 Total		271,388	0.48	2,259,801	196	0.00
1984	1	906	0.00	9,059	0	0.00
	2	6,903	0.00	57,501	0	0.00
	3	1,283	0.30	12,825	0	0.00
	4	74,426	0.60	741,591	1,461	0.00
	5	197,018	0.73	1,433,459	0	0.00
	6	9,888	0.25	98,860	0	0.00
1984 Total		290,424	0.52	2,353,294	1,461	0.00
1985	2	26,799	0.63	204,708	3,006	1.89
	3	16,572	0.18	174,886	802	1.89
	4	60,686	0.36	640,436	0	0.00
	5	37,621	0.56	304,028	5,153	1.41
1985 Total		141,678	0.25	1,324,059	8,961	1.04
1986	2	3,584	1.21	39,678	0	0.00
	3	11,569	0.44	174,497	2,025	1.89
	4	33,577	0.46	384,147	999	1.89
	5	76,552	0.40	846,947	462	1.79
	6	6,251	0.65	70,362	5,531	1.19
1986 Total		131,533	0.27	1,515,630	9,018	0.88
1987	2	4,549	0.59	33,352	2,983	1.28
	3	149,916	0.33	990,748	5,761	0.83
	4	36,854	0.48	280,673	7,169	1.09
	5	6,691	0.66	43,493	361	1.30
	6	18,699	0.70	127,799	0	0.00
1987 Total		216,710	0.25	1,476,065	16,274	0.61
1988	2	1,873	1.46	14,302	1,957	1.89

	3	10,071	0.55	73,345	14,340	0.77
	4	151,392	0.25	1,251,498	7,342	0.92
	5	141,884	0.24	1,184,281	1,587	1.30
	6	0	0.00	0	0	0.00
1988 Total		305,220	0.17	2,523,425	25,225	0.54
1989	1	1,819	0.87	16,592	0	0.00
	2	3,079	1.01	28,368	0	0.00
	3	37,644	0.49	354,758	15,595	1.27
	4	47,420	0.45	490,748	85,869	1.19
	5	110,622	0.28	1,053,979	1,206	1.30
	6	49,285	0.36	449,246	0	0.00
1989 Total		249,869	0.18	2,393,690	102,670	1.02
1990	1	632	1.43	3,715	1,295	1.79
	2	68,302	0.35	460,422	10,676	0.87
	3	79,652	0.20	571,993	2,850	1.89
	4	59,620	0.39	465,478	51,299	1.33
	5	98,068	0.34	855,235	6,538	1.14
1990 Total		306,274	0.16	2,356,843	72,658	0.96
1991	2	19,396	0.61	150,267	0	0.00
	3	57,300	0.37	430,154	27,087	1.08
	4	226,264	0.25	1,674,317	41,731	1.02
	5	147,650	0.21	1,188,332	27,349	0.72
	6	1,497	1.46	12,103	6,092	1.07
1991 Total		452,107	0.15	3,455,173	102,259	0.54
1992	1	0	0.00	0	646	1.89
	2	12,988	0.37	135,926	28,022	0.75
	3	68,576	0.18	633,752	25,880	0.84
	4	120,171	0.24	1,100,545	21,985	0.49
	5	44,786	0.21	431,632	26,739	0.77
	6	5,667	0.52	54,663	917	1.88
1992 Total		252,188	0.13	2,356,519	104,189	0.37
1993	1	187	5.37	1,870	194	1.79
	2	35,505	0.53	334,726	1,821	1.89
	3	70,563	0.23	655,493	856	1.89
	4	40,067	0.28	378,803	9,622	0.94
	5	137,810	0.18	1,159,610	36,036	0.57
	6	26,160	0.42	204,209	1,622	1.89
1993 Total		310,292	0.13	2,734,712	50,151	0.46
1994	2	58,627	0.27	503,276	22,104	1.04
	3	69,590	0.21	652,112	20,193	1.01
	4	92,044	0.25	937,673	26,240	0.64
	5	88,645	0.24	832,324	32,176	0.62
	6	19,999	0.32	202,622	14,892	0.72
1994 Total		328,904	0.12	3,128,008	115,605	0.36
1995	2	117,237	0.29	1,217,136	61,559	0.57
	3	84,799	0.33	678,081	35,306	0.79
	4	43,021	0.44	337,373	2,180	1.21
	5	26,376	0.69	189,461	13,329	1.12
	6	8,624	0.59	72,636	924	1.89
1995 Total		280,057	0.19	2,494,687	113,298	0.42

1996	1	170	#NUM!	1,658	0	0.00
	2	40,569	0.24	322,084	77,044	0.74
	3	164,108	0.30	1,544,636	24,311	0.60
	4	81,591	0.27	729,030	25,949	0.70
	5	44,979	0.37	409,273	3,476	0.86
	6	5,651	0.71	46,793	1,606	1.89
1996 Total		337,069	0.17	3,053,473	132,386	0.47
1997	1	3,985	0.63	37,963	0	0.00
	2	47,902	0.34	436,615	17,345	0.90
	3	83,453	0.37	705,250	30,295	0.65
	4	83,710	0.25	875,220	21,421	0.82
	5	83,628	0.42	800,629	22,239	0.68
	6	12,929	0.35	133,996	2,195	1.34
1997 Total		315,608	0.17	2,989,673	93,494	0.37
1998	1	686	1.50	6,751	1,416	1.36
	2	29,256	0.29	274,889	8,714	0.72
	3	48,417	0.25	473,607	11,210	1.40
	4	61,949	0.20	617,641	16,768	0.71
	5	27,277	0.23	238,500	2,162	0.76
	6	28,816	0.22	327,896	14,610	0.72
1998 Total		196,401	0.11	1,939,284	54,881	0.42
1999	1	253	0.76	2,369	36	1.73
	2	64,244	0.20	584,659	20,432	0.58
	3	62,544	0.20	597,298	30,170	0.53
	4	45,184	0.17	383,547	9,357	0.53
	5	25,389	0.19	215,320	4,502	0.99
	6	30,912	0.25	287,148	11,773	0.67
1999 Total		228,526	0.10	2,070,340	76,270	0.30
2000	1	4,815	0.89	41,459	5,558	1.12
	2	31,341	0.24	253,737	13,998	0.51
	3	82,887	0.17	695,047	26,644	0.41
	4	111,725	0.16	891,569	40,349	0.39
	5	33,741	0.19	286,291	11,835	0.56
	6	56,807	0.33	541,378	28,909	0.49
2000 Total		321,316	0.10	2,709,481	127,294	0.21
2001	1	17	2.09	152	16	1.79
	2	45,264	0.31	498,598	39,669	0.52
	3	44,914	0.17	391,285	14,142	0.47
	4	83,484	0.16	822,057	27,474	0.53
	5	44,027	0.19	457,422	28,729	0.52
	6	41,766	0.35	503,232	128,924	1.22
2001 Total		259,472	0.10	2,672,745	238,953	0.67
2002	1	276	1.10	3,284	14,497	0.88
	2	37,082	0.22	340,053	27,243	0.42
	3	104,057	0.13	996,124	65,066	0.37
	4	67,641	0.18	574,591	28,478	0.49
	5	60,816	0.19	624,283	20,220	0.40
	6	8,687	0.38	80,405	2,828	0.96
2002 Total		278,559	0.08	2,618,740	158,332	0.21
2003	1	59	2.00	547	4,553	1.58

	2	27,798	0.25	249,670	16,916	0.55
	3	66,638	0.22	629,579	41,435	0.51
	4	70,850	0.19	703,360	33,501	0.36
	5	57,972	0.21	569,165	24,251	0.64
	6	26,652	0.38	261,221	5,856	1.34
2003 Total		249,969	0.11	2,413,542	126,511	0.25
2004	1	2,754	0.08	27,620	0	0.00
	2	22,409	0.25	194,830	15,750	0.29
	3	89,238	0.23	752,997	81,780	0.55
	4	100,310	0.16	861,453	81,141	0.18
	5	33,413	0.29	321,001	10,172	0.55
	6	17,888	0.34	180,769	8,266	0.50
2004 Total		266,012	0.11	2,338,670	197,109	0.24
2005	1	0	0.00	0	141	0.96
	2	39,226	0.41	295,834	52,904	0.48
	3	83,337	0.17	642,065	70,476	0.32
	4	63,770	0.13	500,338	20,902	0.30
	5	3,356	0.17	30,319	634	0.23
	6	6,053	0.59	45,998	328	0.81
2005 Total		195,741	0.12	1,514,553	145,384	0.24
2006	1	157	0.77	2,122	905	0.79
	2	48,870	0.11	337,809	99,110	0.03
	3	143,814	0.26	952,791	157,368	0.35
	4	116,302	0.15	907,665	108,234	0.26
	5	54,918	0.20	391,425	58,430	0.38
	6	13,693	0.27	97,242	7,061	0.12
2006 Total		377,755	0.11	2,689,053	431,108	0.15
2007	1	3,017	0.06	24,561	1,969	0.14
	2	28,553	0.15	198,722	20,987	0.40
	3	141,231	0.15	1,086,360	23,518	0.50
	4	91,225	0.16	746,802	33,081	0.34
	5	26,483	0.21	221,861	27,173	0.51
	6	26,797	0.25	224,776	10,697	0.19
2007 Total		317,307	0.09	2,503,083	117,425	0.20
2008	1	7,720	0.53	74,940	14,792	0.00
	2	27,273	0.24	205,171	21,415	0.38
	3	80,193	0.16	655,969	54,416	0.35
	4	48,034	0.25	384,524	26,470	0.55
	5	25,098	0.19	200,254	33,408	0.09
	6	7,346	0.36	60,488	8,071	0.07
2008 Total		195,664	0.10	1,581,346	158,572	0.16
2009	1	1,291	0.00	10,128	2,899	0.00
	2	50,588	0.52	289,273	23,851	0.43
	3	207,402	0.29	1,563,956	47,924	0.17
	4	149,930	0.14	1,122,900	38,448	0.31
	5	43,983	0.13	353,823	13,657	0.27
	6	28,453	0.32	221,569	34,469	0.58
2009 Total		481,647	0.15	3,561,648	161,247	0.17
2010	1	0	0.00	0	163	0.00
	2	14,939	0.52	107,819	5,101	0.66

	3	95,630	0.16	817,382	50,018	0.27
	4	17,980	0.18	157,466	8,891	0.55
	5	48,263	0.23	477,484	17,764	0.34
	6	12,026	0.63	121,014	4,350	0.37
2010 Total		188,838	0.12	1,681,165	86,287	0.19
2011	2	40,387	0.19	367,225	22,473	0.64
	3	59,656	0.15	568,766	14,581	0.30
	4	41,291	0.23	383,884	18,101	0.32
	5	21,102	0.22	206,016	6,066	0.31
	6	4,491	0.33	44,879	617	0.72
2011 Total		166,926	0.10	1,570,769	61,838	0.26
2012	1	1,177	0.01	10,809	113	0.49
	2	49,276	0.22	407,031	22,886	0.28
	3	80,486	0.15	643,373	13,766	0.37
	4	112,624	0.14	995,432	25,066	0.34
	5	23,499	0.19	197,063	8,633	0.38
	6	9,959	0.26	84,289	3,463	0.42
2012 Total		277,022	0.08	2,337,998	73,927	0.17
2013	1	5,113	0.00	46,133	4,008	0.00
	2	39,973	0.15	362,929	8,211	0.00
	3	107,079	0.15	1,041,031	52,884	0.13
2013 Total		152,165	0.11	1,450,093	65,103	0.11
Grand Total Gulf MRIP		9,234,228	0.09	82,645,057	3,252,003	0.08

Table 4.11.7 South Atlantic king mackerel landings (number and pounds) from the SRHS by year, month and area aggregate 1981-1985. 2013 data are preliminary reported data.

	NC		SC		GA/FLE		South Atlantic	
Year	Number	Pounds	Number	Pounds	Number	Pounds	Number	Pounds
1981								
1					17,798	146,828	17,798	146,828
2					11,863	61,225	11,863	61,225
3					8,256	55,769	8,256	55,769
4					5,961	38,543	5,961	38,543
5	111	1,243			7,461	69,659	7,572	70,901
6	73	723	4	50	4,088	31,221	4,165	31,993
7	76	662			8,077	74,242	8,153	74,904
8	38	309	10	124	7,598	66,250	7,646	66,683
9	35	344	10	124	2,997	25,651	3,042	26,119
10					4,690	33,149	4,690	33,149
11					7,836	59,306	7,836	59,306
12					6,290	42,835	6,290	42,835
1981 Total	333	3,281	24	298	92,915	704,678	93,272	708,257
1982								
1					3,656	22,729	3,656	22,729
2					1,849	9,579	1,849	9,579
3					9,707	63,987	9,707	63,987
4					8,380	80,227	8,380	80,227
5	7	78			8,231	76,888	8,238	76,967
6	3	34			4,773	45,279	4,776	45,312
7	34	381	1	11	3,592	33,971	3,627	34,362
8	3	34	8	84	4,508	28,708	4,519	28,825
9	84	941	4	42	2,251	14,662	2,339	15,645
10					2,467	14,859	2,467	14,859
11					2,905	17,868	2,905	17,868
12					2,196	16,509	2,196	16,509
1982 Total	131	1,467	13	137	54,515	425,266	54,659	426,870
1983								
1					1,918	12,263	1,918	12,263
2					1,076	4,993	1,076	4,993
3					1,902	12,349	1,902	12,349
4					2,885	19,271	2,885	19,271
5	16	183	2	18	9,547	96,537	9,565	96,738
6	4	49	12	108	4,152	37,832	4,168	37,989
7	102	1,251	29	261	3,323	24,588	3,454	26,099
8	66	693	7	63	5,464	38,310	5,537	39,066
9	300	3,025	172	1,547	6,119	37,435	6,591	42,007
10					7,256	37,549	7,256	37,549
11					4,364	26,554	4,364	26,554
12					2,307	12,507	2,307	12,507
1983 Total	488	5,200	222	1,997	50,313	360,188	51,023	367,385
1984								
1					6,504	37,109	6,504	37,109
2					4,400	20,953	4,400	20,953

3					1,410	9,636	1,410	9,636
4					3,573	36,446	3,573	36,446
5	92	1,112	164	1,704	5,845	53,712	6,101	56,528
6	58	685	150	1,566	4,066	35,156	4,274	37,406
7	55	647	119	1,234	4,979	40,607	5,153	42,488
8	49	578	76	793	8,279	74,193	8,404	75,563
9	79	942	162	1,670	2,862	22,439	3,103	25,051
10					1,849	11,903	1,849	11,903
11					1,004	6,054	1,004	6,054
12					1,193	8,903	1,193	8,903
1984 Total	333	3,964	671	6,966	45,964	357,110	46,968	368,041
1985								
1					563	3,917	563	3,917
2					542	3,441	542	3,441
3					566	3,978	566	3,978
4					3,034	28,820	3,034	28,820
5	59	618	65	685	4,840	50,379	4,964	51,682
6	43	435	81	848	2,576	23,016	2,700	24,299
7	125	1,276	118	1,297	3,330	26,419	3,573	28,992
8	100	1,012	33	364	2,952	26,923	3,085	28,300
9	114	1,175	80	838	2,977	14,981	3,171	16,994
10					3,477	14,418	3,477	14,418
11					2,920	14,697	2,920	14,697
12					1,266	8,853	1,266	8,853
1985 Total	441	4,516	377	4,033	29,043	219,842	29,861	228,390
1986								
1					2,090	13,689	2,090	13,689
2					2,570	20,284	2,570	20,284
3					1,986	12,929	1,986	12,929
4					6,280	67,227	6,280	67,227
5	160	1,559	104	1,128	12,000	117,856	12,264	120,543
6	250	2,532	116	1,045	5,400	50,218	5,766	53,795
7	348	3,752	226	2,068	7,686	69,119	8,260	74,939
8	376	3,983	202	1,817	12,468	110,905	13,046	116,704
9	440	4,514	252	2,163	4,508	32,479	5,200	39,156
10					5,558	32,821	5,558	32,821
11					4,584	24,396	4,584	24,396
12					3,400	18,649	3,400	18,649
1986 Total	1,574	16,339	900	8,222	68,530	570,574	71,004	595,134
1987								
1					8,663	53,705	8,663	53,705
2					9,524	42,288	9,524	42,288
3					10,851	53,131	10,851	53,131
4					6,761	44,175	6,761	44,175
5	195	1,885	111	980	7,352	76,327	7,658	79,192
6	160	1,665	218	1,905	1,983	17,459	2,361	21,029
7	286	2,933	281	2,586	2,750	22,522	3,317	28,041
8	358	3,541	221	2,026	3,101	26,462	3,680	32,030
9	329	3,471	510	4,746	2,348	19,003	3,187	27,220
10					2,464	12,859	2,464	12,859

11					1,885	9,828	1,885	9,828
12					1,396	8,285	1,396	8,285
1987 Total	1,328	13,495	1,341	12,244	59,078	386,045	61,747	411,784
1988								
1					23	156	23	156
2					107	723	107	723
3					340	2,299	340	2,299
4					3,670	25,124	3,670	25,124
5	445	3,988	379	3,086	5,536	55,396	6,360	62,469
6	116	1,077	157	1,271	1,110	9,331	1,383	11,679
7	284	2,444	184	1,498	1,056	8,039	1,524	11,980
8	444	3,462	166	1,557	3,703	32,351	4,313	37,370
9	377	3,175	199	1,918	2,586	18,857	3,162	23,949
10					1,660	10,511	1,660	10,511
11					741	6,554	741	6,554
12					894	6,827	894	6,827
1988 Total	1,666	14,145	1,085	9,329	21,426	176,167	24,177	199,641
1989								
1					769	5,754	769	5,754
2					928	5,604	928	5,604
3					1,043	6,218	1,043	6,218
4					2,818	16,623	2,818	16,623
5	883	7,320	182	1,505	2,707	24,753	3,772	33,578
6	138	1,172	100	831	1,432	11,966	1,670	13,970
7	146	1,237	104	863	2,024	15,977	2,274	18,077
8	165	1,399	30	247	3,805	29,290	4,000	30,936
9	232	1,966	85	705	3,643	19,658	3,960	22,330
10					5,528	23,187	5,528	23,187
11					3,188	14,000	3,188	14,000
12					3,440	16,366	3,440	16,366
1989 Total	1,564	13,095	501	4,151	31,325	189,396	33,390	206,642
1990								
1					3,213	18,112	3,213	18,112
2					2,269	12,401	2,269	12,401
3					2,926	15,198	2,926	15,198
4					3,722	30,755	3,722	30,755
5	284	2,648	24	224	7,182	90,400	7,490	93,271
6	196	1,826	114	1,062	2,512	29,475	2,822	32,363
7	237	1,990	160	1,491	2,861	23,821	3,258	27,302
8	211	1,780	94	876	1,608	13,244	1,913	15,900
9	253	2,026	123	1,146	2,642	20,691	3,018	23,863
10					5,642	31,595	5,642	31,595
11					3,966	19,664	3,966	19,664
12					6,468	31,870	6,468	31,870
1990 Total	1,181	10,270	515	4,799	45,011	337,227	46,707	352,296
1991								
1					2,880	11,403	2,880	11,403
2					1,677	6,640	1,677	6,640
3					2,856	11,390	2,856	11,390
4					5,480	37,788	5,480	37,788

5	151	1,226	261	2,552	5,133	50,567	5,545	54,345
6	295	2,431	482	5,165	1,924	15,341	2,701	22,936
7	587	4,474	403	4,520	2,332	16,807	3,322	25,801
8	448	3,261	323	3,725	2,798	21,157	3,569	28,142
9	714	5,330	971	11,945	6,173	36,503	7,858	53,777
10					12,821	43,028	12,821	43,028
11					5,065	27,224	5,065	27,224
12					4,460	21,622	4,460	21,622
1991 Total	2,195	16,722	2,440	27,907	53,599	299,468	58,234	344,097
1992								
1					1,335	5,242	1,335	5,242
2					2,195	13,917	2,195	13,917
3					2,129	13,536	2,129	13,536
4					2,701	12,003	2,701	12,003
5	250	1,864	146	1,098	3,016	23,518	3,412	26,481
6	318	2,421	286	2,228	1,696	14,533	2,300	19,182
7	347	2,735	555	4,159	1,814	14,238	2,716	21,133
8	459	3,827	259	2,134	2,432	16,621	3,150	22,582
9	763	7,450	608	4,635	4,064	26,103	5,435	38,188
10					3,461	15,838	3,461	15,838
11					2,631	15,800	2,631	15,800
12					2,898	14,088	2,898	14,088
1992 Total	2,137	18,297	1,854	14,254	30,372	185,438	34,363	217,989
1993								
1					2,188	12,764	2,188	12,764
2					3,556	24,068	3,556	24,068
3					2,213	10,748	2,213	10,748
4					1,693	10,924	1,693	10,924
5	319	2,467	327	1,989	2,541	18,934	3,187	23,390
6	296	2,293	207	1,341	1,568	12,379	2,071	16,013
7	308	2,493	285	3,145	1,811	13,133	2,404	18,771
8	182	1,468	102	1,062	5,174	37,504	5,458	40,033
9	254	2,043	279	2,863	2,626	14,377	3,159	19,283
10					3,550	15,354	3,550	15,354
11					2,496	15,072	2,496	15,072
12					3,304	19,427	3,304	19,427
1993 Total	1,359	10,764	1,200	10,399	32,720	204,682	35,279	225,845
1994								
1					3,189	15,587	3,189	15,587
2					2,019	12,397	2,019	12,397
3					1,957	10,933	1,957	10,933
4					2,821	22,570	2,821	22,570
5	242	1,985	157	1,346	4,850	38,027	5,249	41,358
6	89	731	291	2,564	1,779	12,353	2,159	15,647
7	142	1,153	258	2,349	2,389	16,018	2,789	19,520
8	90	726	59	482	3,113	22,470	3,262	23,679
9	350	2,752	467	4,132	1,911	11,977	2,728	18,860
10					6,081	30,140	6,081	30,140
11					2,601	14,857	2,601	14,857
12					2,035	11,660	2,035	11,660

1994 Total	913	7,347	1,232	10,874	34,745	218,988	36,890	237,209
1995								
1					2,190	11,409	2,190	11,409
2					1,916	9,935	1,916	9,935
3					3,044	16,455	3,044	16,455
4					2,921	27,748	2,921	27,748
5	183	1,732	212	2,576	3,868	27,685	4,263	31,992
6	107	1,027	201	2,190	1,118	9,440	1,426	12,657
7	293	2,740	269	2,523	1,101	9,035	1,663	14,298
8	81	734	40	394	1,118	8,676	1,239	9,804
9	400	3,594	419	4,126	2,248	10,796	3,067	18,516
10					4,128	21,145	4,128	21,145
11					2,056	12,152	2,056	12,152
12					1,236	7,104	1,236	7,104
1995 Total	1,064	9,826	1,141	11,809	26,944	171,580	29,149	193,215
1996								
1					1,523	7,414	1,523	7,414
2					1,571	7,779	1,571	7,779
3					1,207	5,684	1,207	5,684
4					2,491	11,765	2,491	11,765
5	252	2,009	161	1,367	3,850	18,771	4,263	22,147
6	59	533	135	1,199	3,378	16,290	3,572	18,022
7	98	918	111	915	2,413	11,457	2,622	13,291
8	125	1,171	92	734	3,377	16,025	3,594	17,930
9	157	1,548	268	1,961	5,624	26,730	6,049	30,239
10					9,016	42,468	9,016	42,468
11					5,771	27,176	5,771	27,176
12					5,451	25,669	5,451	25,669
1996 Total	691	6,179	767	6,177	45,672	217,227	47,130	229,583
1997								
1	4	29			2,956	16,369	2,960	16,398
2	1	7			1,891	10,450	1,892	10,457
3	14	148	1	6	2,882	16,116	2,897	16,271
4	179	1,913	50	384	4,702	26,110	4,931	28,407
5	158	1,647	81	474	3,053	25,704	3,292	27,826
6	87	934	302	2,313	779	6,935	1,168	10,182
7	166	1,813	568	3,134	1,406	12,522	2,140	17,468
8	156	1,548	386	2,028	1,131	10,195	1,673	13,771
9	232	2,262	329	1,903	1,288	9,392	1,849	13,557
10	451	3,600	585	3,273	2,354	13,324	3,390	20,197
11	56	541	189	1,097	3,235	18,567	3,480	20,206
12					5,276	27,409	5,276	27,409
1997 Total	1,504	14,442	2,491	14,613	30,953	193,093	34,948	222,148
1998								
1	10	107			1,790	8,788	1,800	8,894
2	6	64			2,098	10,066	2,104	10,130
3	15	160	6	41	3,395	16,444	3,416	16,645
4	109	969	179	1,193	2,036	12,364	2,324	14,526
5	135	1,346	552	3,950	1,574	13,671	2,261	18,967
6	212	2,276	898	7,395	1,465	11,791	2,575	21,461

7	261	3,187	476	4,301	748	5,802	1,485	13,290
8	53	654	238	2,249	1,401	11,357	1,692	14,260
9	27	288	191	2,046	2,202	12,892	2,420	15,226
10	40	427	338	2,963	2,921	17,751	3,299	21,142
11	50	534	129	1,212	2,523	16,625	2,702	18,371
12	34	363	11	89	2,834	21,589	2,879	22,041
1998 Total	952	10,374	3,018	25,439	24,987	159,140	28,957	194,953
1999								
1					1,350	9,767	1,350	9,767
2	4	27			478	3,373	482	3,400
3			1	7	815	5,769	816	5,776
4	35	346	48	333	1,321	11,639	1,404	12,318
5	209	2,291	132	915	1,854	15,018	2,195	18,224
6	160	1,781	243	2,060	711	3,805	1,114	7,646
7	202	2,646	218	1,931	515	3,453	935	8,029
8	184	2,120	175	1,410	716	5,039	1,075	8,568
9	99	1,104	110	869	8,281	47,938	8,490	49,911
10	131	1,403	197	1,493	4,163	23,438	4,491	26,334
11	100	1,075	200	1,509	2,948	15,969	3,248	18,553
12	6	68			2,400	11,391	2,406	11,458
1999 Total	1,130	12,860	1,324	10,526	25,552	156,600	28,006	179,986
2000								
1			4	28	2,294	13,796	2,298	13,824
2	30	240			2,027	12,147	2,057	12,388
3	36	288	15	106	2,202	13,430	2,253	13,824
4	49	367	56	404	2,358	25,943	2,463	26,713
5	75	538	272	2,035	2,253	15,271	2,600	17,844
6	170	1,216	672	5,015	1,244	7,801	2,086	14,032
7	162	1,454	1,030	9,115	1,257	8,964	2,449	19,533
8	166	1,518	760	6,674	1,322	8,751	2,248	16,943
9	151	1,609	315	3,207	2,846	16,805	3,312	21,621
10	95	999	389	3,984	3,788	22,111	4,272	27,093
11	65	698	314	3,289	1,457	10,133	1,836	14,120
12	21	233	42	466	2,450	18,277	2,513	18,977
2000 Total	1,020	9,162	3,869	34,323	25,498	173,428	30,387	216,912
2001								
1					2,002	12,026	2,002	12,026
2	30	272			750	3,708	780	3,980
3	11	102	41	389	886	5,637	938	6,128
4	47	443	63	597	1,533	14,329	1,643	15,369
5	18	173	186	1,849	1,288	10,569	1,492	12,590
6	43	421	538	5,327	915	6,999	1,496	12,747
7	42	425	459	4,664	773	5,662	1,274	10,750
8	66	754	379	4,577	1,731	13,358	2,176	18,690
9	47	532	196	2,367	2,367	14,934	2,610	17,833
10	57	660	166	2,005	1,323	9,035	1,546	11,699
11	27	308	172	2,077	1,291	9,187	1,490	11,572
12			14	169	384	2,615	398	2,784
2001 Total	388	4,090	2,214	24,020	15,243	108,059	17,845	136,169
2002								

	1					436	2,779	436	2,779
	2					254	1,625	254	1,625
	3	1	12	1	9	161	959	163	980
	4	10	108	92	864	1,181	9,076	1,283	10,048
	5	34	339	99	931	1,736	17,353	1,869	18,623
	6	46	470	223	2,090	805	6,696	1,074	9,256
	7	37	358	283	2,653	1,298	9,527	1,618	12,538
	8	15	164	208	1,958	1,504	13,521	1,727	15,643
	9	12	128	101	934	2,393	15,912	2,506	16,974
	10	5	51	175	1,621	1,183	6,404	1,363	8,077
	11	4	47	205	1,900	1,054	5,741	1,263	7,688
	12			10	92	720	4,288	730	4,381
2002 Total		164	1,676	1,397	13,053	12,725	93,882	14,286	108,611
	2003								
	1					656	2,773	656	2,773
	2					660	3,058	660	3,058
	3	2	14			501	3,097	503	3,110
	4	1	7	24	179	702	5,006	727	5,193
	5	22	158	165	1,228	509	4,312	696	5,698
	6	32	230	326	2,426	582	3,864	940	6,520
	7	72	527	228	1,697	1,384	10,649	1,684	12,873
	8	52	375	126	938	1,197	9,671	1,375	10,984
	9			33	246	2,173	14,496	2,206	14,742
	10	7	47	46	342	1,361	8,387	1,414	8,776
	11	4	28	25	186	1,259	10,175	1,288	10,389
	12					984	5,797	984	5,797
2003 Total		192	1,387	973	7,242	11,968	81,284	13,133	89,913
	2004								
	1					1,024	7,073	1,024	7,073
	2					409	2,863	409	2,863
	3			1	10	1,155	7,614	1,156	7,623
	4	38	356	16	155	1,437	17,229	1,491	17,741
	5	19	169	173	1,595	1,296	13,764	1,488	15,528
	6	58	526	315	2,904	1,049	9,415	1,422	12,846
	7	49	415	429	3,656	1,635	14,873	2,113	18,944
	8	27	221	193	1,645	1,002	9,525	1,222	11,391
	9	3	26	15	132	1,582	12,897	1,600	13,054
	10	157	1,356	213	1,871	2,944	19,235	3,314	22,462
	11	653	5,486	135	1,186	1,551	11,882	2,339	18,554
	12	20	175	46	404	1,767	14,098	1,833	14,677
2004 Total		1,024	8,730	1,536	13,557	16,851	140,468	19,411	162,754
	2005								
	1					3,187	18,761	3,187	18,761
	2					2,653	16,701	2,653	16,701
	3	20	98	14	71	2,175	10,455	2,209	10,624
	4	70	344	19	96	1,737	15,091	1,826	15,532
	5	54	266	172	871	3,332	33,030	3,558	34,167
	6	66	335	269	1,363	2,152	15,956	2,487	17,654
	7	240	1,205	224	1,135	1,545	9,653	2,009	11,992
	8	152	762	287	1,489	3,410	25,148	3,849	27,399

	9	21	110	56	291	3,047	16,259	3,124	16,660
	10	34	179	55	285	3,959	20,889	4,048	21,353
	11	628	3,091	82	425	1,033	6,549	1,743	10,065
	12					5,050	25,393	5,050	25,393
2005 Total		1,285	6,389	1,178	6,026	33,280	213,885	35,743	226,300
	2006								
	1	2	13			2,626	13,594	2,628	13,606
	2	1	6			2,825	15,696	2,826	15,702
	3	9	57	1	4	4,197	21,821	4,207	21,882
	4	30	191	7	72	1,117	10,245	1,154	10,508
	5	32	204	178	1,363	1,640	12,873	1,850	14,440
	6	46	388	563	5,036	2,268	18,031	2,877	23,455
	7	69	604	516	5,044	2,574	17,342	3,159	22,989
	8	71	660	442	4,469	3,360	25,039	3,873	30,168
	9	43	346	109	1,049	2,090	13,658	2,242	15,053
	10	73	577	111	886	1,531	9,714	1,715	11,177
	11	420	3,306	106	1,017	1,478	9,330	2,004	13,654
	12			12	124	1,123	6,650	1,135	6,775
2006 Total		796	6,354	2,045	19,064	26,829	173,992	29,670	199,409
	2007								
	1					1,702	10,590	1,702	10,590
	2	5	24	1	8	1,353	7,107	1,359	7,138
	3	11	52	6	48	1,667	13,610	1,684	13,710
	4	95	457	22	163	3,284	31,619	3,401	32,239
	5	70	392	295	2,546	1,577	13,258	1,942	16,197
	6	201	1,318	1,551	10,375	1,883	13,249	3,635	24,942
	7	99	818	1,036	10,687	2,052	17,780	3,187	29,285
	8	56	393	540	4,802	6,677	54,719	7,273	59,914
	9	51	248	334	1,602	2,922	21,158	3,307	23,007
	10	117	607	377	2,234	1,649	10,367	2,143	13,207
	11	56	361	292	1,907	2,234	13,987	2,582	16,255
	12			18	79	1,016	7,268	1,034	7,348
2007 Total		761	4,670	4,472	34,450	28,016	214,712	33,249	253,832
	2008								
	1					813	6,115	813	6,115
	2					1,023	5,538	1,023	5,538
	3	6	57			972	8,345	978	8,403
	4	46	508	94	968	1,115	10,670	1,255	12,146
	5	34	345	212	2,029	1,618	14,735	1,864	17,109
	6	54	561	547	5,379	1,020	7,853	1,621	13,793
	7	44	431	369	3,185	2,006	14,578	2,419	18,194
	8	29	191	324	1,932	1,460	11,186	1,813	13,309
	9	9	55	107	581	573	2,771	689	3,407
	10	17	104	195	946	708	4,234	920	5,285
	11	105	644	154	721	577	3,462	836	4,827
	12					902	4,419	902	4,419
2008 Total		344	2,897	2,002	15,740	12,787	93,907	15,133	112,544
	2009								
	1					725	4,570	725	4,570
	2					1,687	8,258	1,687	8,258

3	2	16	3	32	1,270	9,583	1,275	9,630
4	26	213	24	232	1,297	8,241	1,347	8,686
5	14	110	123	1,125	2,910	25,324	3,047	26,559
6	35	308	676	6,136	1,810	16,150	2,521	22,595
7	29	251	490	4,270	2,225	18,721	2,744	23,241
8	15	150	223	2,891	1,440	12,002	1,678	15,042
9	4	37	156	1,326	562	5,514	722	6,877
10	17	188	219	2,651	494	3,384	730	6,223
11	3	26	42	477	245	2,252	290	2,756
12			1	12	974	16,577	975	16,589
2009 Total	145	1,297	1,957	19,153	15,639	130,576	17,741	151,025
2010								
1					1,538	13,645	1,538	13,645
2					1,775	11,777	1,775	11,777
3			1	10	2,617	13,511	2,618	13,521
4	2	25			3,241	19,818	3,243	19,843
5	37	483	154	1,780	2,461	25,631	2,652	27,895
6	15	196	407	4,761	1,266	11,428	1,688	16,385
7	13	160	257	2,996	701	6,749	971	9,905
8	13	172	183	2,166	833	10,168	1,029	12,505
9	6	78	43	466	210	2,189	259	2,733
10	17	246	132	1,609	716	5,663	865	7,518
11	15	157	18	179	341	3,798	374	4,133
12			2	24	913	8,376	915	8,400
2010 Total	118	1,516	1,197	13,991	16,612	132,753	17,927	148,259
2011								
1					1,650	10,261	1,650	10,261
2					945	8,257	945	8,257
3					1,811	10,084	1,811	10,084
4	10	131	23	290	562	8,131	595	8,551
5	12	161	77	964	1,042	10,303	1,131	11,428
6	6	80	187	2,398	534	5,422	727	7,899
7	7	94	220	2,692	591	3,900	818	6,686
8	7	93	91	1,113	422	6,511	520	7,716
9	1	13	69	843	316	2,737	386	3,593
10	6	75	67	821	269	1,852	342	2,748
11	6	75	59	723	126	1,742	191	2,539
12					561	4,476	561	4,476
2011 Total	55	721	793	9,843	8,829	73,674	9,677	84,238
2012								
1					1,448	9,455	1,448	9,455
2					1,122	12,861	1,122	12,861
3					479	4,341	479	4,341
4	4	59	31	524	734	6,216	769	6,800
5	7	89	12	203	986	9,937	1,005	10,229
6	7	102	29	490	359	4,671	395	5,263
7	15	229	79	1,336	491	5,009	585	6,573
8	23	343	94	1,589	568	5,187	685	7,120
9	24	364	99	1,674	602	5,308	725	7,347
10	11	174	77	1,302	280	3,311	368	4,787

11	6	101	23	389	153	1,133	182	1,624
12			5	85	305	2,875	310	2,959
201 2Total	97	1,462	449	7,592	7,527	70,304	8,073	79,359
2013								
1					426	2,667	426	2,667
2					316	2,371	316	2,371
3	4	68			729	9,227	733	9,295
2013 Total	4	68			1,471	14,265	1,475	14,333
Grand Total	27,377	242,999	45,198	402,228	1,036,939	7,247,897	1,109,514	7,893,124

Table 4.11.8 Winter mixing zone king mackerel landings (number and pounds) from the SRHS by year, month and area aggregate 1981-2013. Only one area aggregate (GA/FLE) exists in the winter mixing zone. 2013 data are preliminary reported data.

	GA/FLE	
Year	Number	Pounds
1981		
1	1,303	9,758
2	1,533	9,463
3	1,004	6,463
11	330	2,480
12	1,818	13,663
1981 Total	5,988	41,828
1982		
1	948	5,810
2	551	3,377
3	119	729
11	590	3,616
12	754	4,621
1982 Total	2,962	18,154
1983		
1	224	1,944
2	170	1,030
3	290	1,732
11	979	5,335
12	4,134	24,197
1983 Total	5,797	34,239
1984		
1	1,519	10,274
2	584	3,059
3	498	2,600
11	278	1,443
12	874	4,670
1984 Total	3,753	22,046
1985		
1	858	6,422
2	221	1,387
3	266	1,557
11	72	409
12	398	2,345
1985 Total	1,815	12,120
1986		
1	374	2,796
2	300	2,109
3	220	1,632
11	774	4,427
12	560	3,225
1986 Total	2,228	14,190
1987		

1	848	4,997
2	532	3,506
3	216	1,436
11	291	1,448
12	399	1,962
1987 Total	2,286	13,348
1988		
1	1	10
2	5	52
3	4	42
11	51	282
12	17	101
1988 Total	78	488
1989		
1	6	33
11	169	812
12	489	2,360
1989 Total	664	3,205
1990		
1	692	3,381
2	968	5,084
3	497	2,499
11	284	1,581
12	344	2,071
1990 Total	2,785	14,616
1991		
1	6	41
2	3	20
3	3	20
11	181	1,209
12	684	4,602
1991 Total	877	5,892
1992		
1	298	1,974
2	12	63
3	25	130
11	273	1,917
12	444	3,027
1992 Total	1,052	7,111
1993		
1	1,672	10,579
2	1,037	7,158
3	956	6,703
11	309	1,754
12	1,042	6,750
1993 Total	5,016	32,943
1994		
1	1,240	9,850
2	1,682	12,212
3	866	6,802

11	265	1,731
12	581	3,991
1994 Total	4,634	34,586
1995		
1	1,024	6,953
2	906	6,377
3	634	4,557
11	158	1,108
12	186	1,363
1995 Total	2,908	20,358
1996		
1	679	3,587
2	1,080	6,435
3	1,214	7,247
11	90	471
12	970	5,084
1996 Total	4,033	22,825
1997		
1	1,559	10,040
2	1,412	9,736
3	441	3,398
11	268	1,493
12	455	2,358
1997 Total	4,135	27,024
1998		
1	1,983	11,899
2	1,056	6,082
3	444	2,582
11	195	911
12	275	1,512
1998 Total	3,953	22,986
1999		
1	404	1,635
2	385	1,556
3	53	217
11	122	498
12	242	989
1999 Total	1,206	4,894
2000		
1	348	1,813
2	163	849
3	54	281
11	105	441
12	126	529
2000 Total	796	3,914
2001		
1	239	1,359
2	457	2,613
3	693	4,430
11	198	1,154

12	146	811
2001 Total	1,733	10,368
2002		
1	285	1,709
2	521	3,319
3	660	4,182
11	277	1,590
12	119	762
2002 Total	1,862	11,561
2003		
1	377	1,753
2	72	443
3	575	3,948
11	82	638
12	737	4,225
2003 Total	1,843	11,007
2004		
1	209	1,507
2	150	1,098
3	68	458
11	131	1,169
12	261	2,244
2004 Total	819	6,476
2005		
1	587	2,826
2	506	2,436
3	447	2,152
11	130	629
12	290	1,396
2005 Total	1,960	9,439
2006		
1	545	2,793
2	258	1,392
3	370	1,894
11	110	614
12	431	2,358
2006 Total	1,714	9,051
2007		
1	209	1,312
2	65	349
3	37	281
11	54	321
12	33	197
2007 Total	398	2,460
2008		
1	68	462
2	80	488
3	125	892
11	162	1,044
12	422	2,167

2008 Total	857	5,053
2009		
1	281	1,450
2	400	2,124
3	227	1,510
11	68	448
12	106	1,003
2009 Total	1,082	6,535
2010		
1	351	2,486
2	442	2,891
3	232	1,208
11	46	340
12	190	1,444
2010 Total	1,261	8,368
2011		
1	944	5,473
2	499	4,102
3	120	1,033
11	45	526
12	90	705
2011 Total	1,698	11,838
2012		
1	329	2,151
2	66	743
3	84	984
11	98	932
12	94	907
2012 Total	671	5,718
2013 Total		
Grand Total	72,864	454,641

Table 4.11.9 Gulf of Mexico king mackerel landings (number and pounds) from the SRHS by year, month and area aggregate 1981-2013. 2013 data are preliminary reported data.

	FLW/AL		MS		LA		TX		Gulf of Mexico	
Year	Number	Pounds	Number	Pounds	Number	Pounds	Number	Pounds	Number	Pounds
1981										
5							880	4,983	880	4,983
6							1,032	5,844	1,032	5,844
7							2,818	15,957	2,818	15,957
8							2,470	13,987	2,470	13,987
9							890	5,040	890	5,040
1981 Total							8,090	45,811	8,090	45,811
1982										
5							880	4,983	880	4,983
6							1,032	5,844	1,032	5,844
7							2,818	15,957	2,818	15,957
8							2,470	13,987	2,470	13,987
9							890	5,040	890	5,040
1982 Total							8,090	45,811	8,090	45,811
1983										
5							880	4,983	880	4,983
6							1,032	5,844	1,032	5,844
7							2,818	15,957	2,818	15,957
8							2,470	13,987	2,470	13,987
9							890	5,040	890	5,040
1983 Total							8,090	45,811	8,090	45,811
1984										
5							880	4,983	880	4,983
6							1,032	5,844	1,032	5,844
7							2,818	15,957	2,818	15,957
8							2,470	13,987	2,470	13,987
9							890	5,040	890	5,040
1984 Total							8,090	45,811	8,090	45,811
1985										
5							880	4,983	880	4,983
6							1,032	5,844	1,032	5,844
7							2,818	15,957	2,818	15,957
8							2,470	13,987	2,470	13,987
9							890	5,040	890	5,040
1985 Total							8,090	45,811	8,090	45,811
1986										
3	13	103							13	103
4	8	63							8	63
5	23	192			50	774	1,234	14,437	1,307	15,403
6	83	700					1,382	16,660	1,465	17,359
7	48	405			229	3,227	2,368	29,474	2,645	33,106
8	42	355			23	355	1,956	26,147	2,021	26,858
9	55	465			115	1,777	1,165	12,110	1,335	14,351
10	2	16							2	16
11	15	119							15	119

12	23	183					23	183
1986 Total	312	2,601	417	6,133	8,105	98,828	8,834	107,562
1987								
1	8	79					8	79
2	2	20					2	20
3	10	98					10	98
4	36	354					36	354
5	82	784	60	1,512	899	9,129	1,041	11,425
6	93	882	34	857	840	10,287	967	12,026
7	161	1,517	40	932	2,823	30,017	3,024	32,465
8	170	1,561	164	3,569	2,603	27,689	2,937	32,819
9	158	1,484	536	11,664	873	8,864	1,567	22,013
10	5	49					5	49
11	41	403					41	403
12	5	49					5	49
1987 Total	771	7,280	834	18,534	8,038	85,986	9,643	111,800
1988								
5					508	7,374	508	7,374
6	1	10			875	8,176	876	8,186
7	79	821	497	10,051	3,262	34,615	3,838	45,487
8	56	562	351	5,632	2,851	31,364	3,258	37,558
9	59	567	299	3,861	631	6,870	989	11,299
10	9	90					9	90
12	5	50					5	50
1988 Total	209	2,102	1,147	19,544	8,127	88,400	9,483	110,046
1989								
1	2	20					2	20
2	5	50					5	50
3	10	101					10	101
4	6	60					6	60
5	10	104			255	2,882	265	2,987
6	86	901			959	9,347	1,045	10,248
7	61	669	64	1,395	2,934	34,320	3,059	36,384
8	63	621	73	1,510	3,840	40,189	3,976	42,321
9	113	1,091	101	1,737	1,804	18,654	2,018	21,482
10	18	181					18	181
11	16	161					16	161
12	36	363					36	363
1989 Total	426	4,323	238	4,643	9,792	105,392	10,456	114,358
1990								
1	19	205					19	205
2	146	1,543					146	1,543
3	441	4,752					441	4,752
4	321	3,472					321	3,472
5	29	266	6	23	295	3,596	330	3,884
6	22	200	36	135	829	10,106	887	10,441
7	85	755	44	165	2,725	33,233	2,854	34,153
8	68	641	24	90	4,819	58,782	4,911	59,513
9	154	1,190	185	331	978	11,912	1,317	13,434
10	9	98					9	98

11	30	273					30	273
1990 Total	1,324	13,396	295	743	9,646	117,630	11,265	131,769
1991								
2	2	13					2	13
4	13	82					13	82
5	25	157			30	300	55	457
6	69	433	2	32	414	4,101	485	4,566
7	878	4,516	148	2,088	3,900	36,277	4,926	42,881
8	438	2,650	177	2,512	3,686	39,683	4,301	44,845
9	698	5,506	296	2,853	2,031	26,101	3,025	34,460
10	19	161					19	161
11	21	179					21	179
12	13	111					13	111
1991 Total	2,176	13,806	623	7,485	10,061	106,463	12,860	127,754
1992								
3	7	48					7	48
4	10	68					10	68
5	97	664			1,324	10,398	1,421	11,062
6	150	1,027	6	67	1,721	13,472	1,877	14,566
7	403	2,947	629	7,233	6,040	53,302	7,072	63,482
8	227	1,896	315	4,717	4,585	41,040	5,127	47,652
9	331	2,980	269	3,528	1,783	15,981	2,383	22,490
10	19	167					19	167
11	3	26					3	26
12	9	79					9	79
1992 Total	1,256	9,902	1,219	15,545	15,453	134,193	17,928	159,640
1993								
1	82	942					82	942
2	9	95					9	95
3	90	687					90	687
4	117	1,332					117	1,332
5	197	1,698	74	1,396	1,497	14,012	1,768	17,105
6	321	3,831	126	2,139	957	8,914	1,404	14,884
7	421	4,528	336	4,910	3,957	46,471	4,714	55,909
8	203	1,830	269	3,798	3,337	29,018	3,809	34,646
9	757	6,907	237	3,347	2,275	19,417	3,269	29,671
10	79	738					79	738
11	152	1,264					152	1,264
12	18	144					18	144
1993 Total	2,446	23,996	1,042	15,590	12,023	117,832	15,511	157,418
1994								
1	31	366					31	366
2	3	24					3	24
3	394	3,063					394	3,063
4	48	374					48	374
5	429	4,861	327	4,959	1,362	12,796	2,118	22,616
6	228	3,094	398	5,954	3,179	28,191	3,805	37,239
7	481	4,476	365	4,976	2,654	23,600	3,500	33,052
8	293	2,246	203	2,424	3,859	29,864	4,355	34,534
9	1,033	7,405	270	3,263	3,661	28,040	4,964	38,707

10	49	381					49	381
11	60	466					60	466
12	92	715					92	715
1994 Total	3,141	27,471	1,563	21,576	14,715	122,490	19,419	171,538
1995								
1	1	8					1	8
2	1	8					1	8
3	14	160					14	160
4	26	301					26	301
5	208	2,429	220	2,678	1,885	15,992	2,313	21,099
6	439	4,557	419	6,149	3,143	28,691	4,001	39,397
7	317	3,192	250	3,938	4,030	41,075	4,597	48,205
8	199	1,859	147	2,100	5,789	53,710	6,135	57,669
9	348	3,216	362	4,179	3,911	38,145	4,621	45,539
10	14	132					14	132
11	3	28					3	28
12	5	47					5	47
1995 Total	1,575	15,936	1,398	19,045	18,758	177,612	21,731	212,593
1996								
3	4	37					4	37
4	72	667					72	667
5	114	1,055	355	5,544	1,859	16,223	2,328	22,823
6	370	3,425	175	2,733	2,228	20,497	2,773	26,656
7	255	2,478	241	4,046	4,066	41,563	4,562	48,087
8	157	1,465	218	3,739	2,986	30,318	3,361	35,522
9	428	3,976	315	5,403	5,324	44,684	6,067	54,063
10	11	102					11	102
11	187	1,737					187	1,737
12	455	4,227					455	4,227
1996 Total	2,053	19,170	1,304	21,465	16,463	153,285	19,820	193,921
1997								
1	4	27			789	7,029	793	7,056
2			9	129	536	4,775	545	4,904
3	28	186	13	187	350	3,118	391	3,491
4	51	329	36	517	935	8,333	1,022	9,179
5	198	1,261	94	1,341	1,286	11,478	1,578	14,080
6	293	1,807	203	2,963	2,360	18,513	2,856	23,282
7	191	1,369	179	3,337	4,701	37,062	5,071	41,768
8	355	2,826	122	1,916	4,185	32,079	4,662	36,820
9	588	4,688	119	1,279	2,403	16,754	3,110	22,721
10	263	2,330	158	3,014	360	2,523	781	7,868
11	33	314	252	3,415	251	1,769	536	5,498
12	42	400	44	428	27	188	113	1,016
1997 Total	2,046	15,537	1,229	18,524	18,183	143,621	21,458	177,682
1998								
1	2	20	8	89	268	2,454	278	2,563
2			43	480	297	2,736	340	3,215
3	3	29	14	156	392	3,618	409	3,804
4	60	593	36	508	160	1,289	256	2,389
5	82	816	77	1,386	1,178	9,673	1,337	11,874

6	196	1,837	231	4,231	2,102	17,119	2,529	23,186
7	348	2,666	304	4,617	3,626	27,788	4,278	35,071
8	211	1,383	128	1,763	3,069	23,498	3,408	26,645
9	189	1,096	18	249	572	4,443	779	5,787
10	164	1,054	39	740	158	1,346	361	3,139
11	39	318	71	1,405	175	1,502	285	3,226
12	52	425	23	500	323	2,860	398	3,784
1998 Total	1,346	10,236	992	16,124	12,320	98,325	14,658	124,685
1999								
1					128	1,037	128	1,037
2	7	66			106	793	113	859
3	12	111	6	115	352	3,035	370	3,262
4	91	891	37	894	255	2,195	383	3,981
5	85	847	159	2,866	630	5,302	874	9,015
6	229	2,295	303	5,146	2,751	22,663	3,283	30,104
7	288	2,967	301	4,140	5,985	46,724	6,574	53,831
8	267	2,457	333	5,427	4,267	37,094	4,867	44,979
9	149	1,142	156	2,744	1,065	8,877	1,370	12,763
10	132	1,047	156	3,493	563	4,814	851	9,354
11	50	397	68	1,411	278	2,892	396	4,699
12	20	158	8	166	177	1,881	205	2,205
1999 Total	1,330	12,378	1,527	26,403	16,557	137,307	19,414	176,088
2000								
1	2	18			715	6,414	717	6,432
2	2	18			897	7,880	899	7,897
3	52	462			381	3,298	433	3,760
4	59	527	3	45	63	514	125	1,086
5	180	1,626	223	3,141	741	6,436	1,144	11,203
6	502	4,527	145	2,152	1,904	16,320	2,551	22,998
7	449	3,586	108	1,929	3,849	31,750	4,406	37,265
8	167	1,289	37	462	3,838	33,283	4,042	35,034
9	144	1,013	17	207	771	6,134	932	7,354
10	193	1,341	20	260	105	809	318	2,410
11	34	237	9	116	263	2,489	306	2,842
12	14	98			342	3,236	356	3,334
2000 Total	1,798	14,741	562	8,312	13,869	118,561	16,229	141,614
2001								
1	11	100			284	2,097	295	2,197
2	13	99	3	30	147	1,277	163	1,406
3	11	100			225	2,619	236	2,719
4	72	714	16	165	105	926	193	1,805
5	129	1,297	73	815	428	5,094	630	7,207
6	230	2,146	59	693	1,322	17,355	1,611	20,194
7	235	2,044	21	264	4,418	52,259	4,674	54,567
8	148	1,348	8	98	3,004	28,841	3,160	30,288
9	73	635	1	15	1,144	11,394	1,218	12,044
10	67	574	3	47	312	3,540	382	4,161
11	288	2,539	1	15	200	1,828	489	4,382
12	159	1,387	1	17	52	384	212	1,788
2001 Total	1,436	12,982	186	2,159	11,641	127,617	13,263	142,758

2002								
1					139	1,096	139	1,096
2	10	97	3	30	209	1,648	222	1,774
3	10	91			178	1,391	188	1,482
4	111	994	16	167	52	377	179	1,538
5	100	864	74	936	610	4,343	784	6,144
6	376	2,829	59	823	1,999	17,694	2,434	21,346
7	391	2,349	21	278	3,278	28,470	3,690	31,097
8	202	1,191	8	111	4,035	31,006	4,245	32,308
9	129	739	1	13	897	6,840	1,027	7,592
10	174	1,060	3	40	628	5,008	805	6,109
11	45	283	1	13	513	5,062	559	5,358
12	7	42	1	13	373	3,681	381	3,736
2002 Total	1,555	10,538	187	2,426	12,911	106,617	14,653	119,580
2003								
1	1	9			704	5,840	705	5,849
2	12	113	1	15	1,206	9,511	1,219	9,639
3	55	503			2,008	14,470	2,063	14,973
4	93	857	6	89	1,567	13,297	1,666	14,243
5	147	1,368	68	1,122	1,437	12,609	1,652	15,100
6	150	1,379	60	1,054	3,576	34,245	3,786	36,678
7	288	2,089	67	1,024	2,956	30,510	3,311	33,622
8	134	959	30	391	3,716	27,608	3,880	28,958
9	117	862	24	393	1,490	10,951	1,631	12,205
10	240	1,769	20	327	562	4,114	822	6,210
11	107	804	4	65	356	2,639	467	3,509
12	12	102	4	65	323	2,386	339	2,553
2003 Total	1,356	10,814	284	4,547	19,901	168,180	21,541	183,541
2004								
1	1	7			335	2,541	336	2,548
2					324	2,468	324	2,468
3	30	208			577	4,380	607	4,588
4	57	418			17	164	74	582
5	179	1,353			146	1,326	325	2,679
6	259	1,882			1,708	15,904	1,967	17,786
7	189	1,384			5,225	46,233	5,414	47,617
8	143	1,047			4,468	42,717	4,611	43,764
9	94	685			2,446	19,173	2,540	19,859
10	150	1,082			763	7,400	913	8,482
11	51	340			29	302	80	642
12	8	56			299	3,514	307	3,570
2004 Total	1,161	8,463			16,337	146,123	17,498	154,586
2005								
1	12	86			795	8,413	807	8,499
2					392	4,044	392	4,044
3	4	28			826	8,526	830	8,554
4	92	652			106	1,025	198	1,677
5	208	1,486			760	6,585	968	8,071
6	252	1,817			3,465	30,129	3,717	31,946
7	131	917			4,620	38,964	4,751	39,881

8	128	942					4,732	40,390	4,860	41,331
9	35	257					1,133	9,611	1,168	9,867
10	90	664					455	3,537	545	4,201
11	11	79					192	1,387	203	1,466
12	5	33					175	1,304	180	1,337
2005 Total	968	6,962					17,651	153,913	18,619	160,875
2006										
1	15	182					1,285	12,477	1,300	12,660
2							1,823	17,142	1,823	17,142
3	6	67					2,024	18,901	2,030	18,969
4	128	1,460					609	4,165	737	5,624
5	224	2,192					1,338	11,586	1,562	13,778
6	266	2,507					3,910	34,090	4,176	36,596
7	449	3,345					4,138	38,431	4,587	41,776
8	315	2,359					3,297	31,242	3,612	33,601
9	270	2,038					1,928	17,439	2,198	19,477
10	219	1,904					410	3,172	629	5,076
11	73	706					186	1,535	259	2,241
12	52	537					746	6,643	798	7,180
2006 Total	2,017	17,296					21,694	196,824	23,711	214,120
2007										
1	290	2,852					1,023	8,725	1,313	11,577
2	239	2,350					1,339	11,392	1,578	13,742
3	109	1,091					4,130	32,339	4,239	33,429
4	135	1,427					157	2,054	292	3,481
5	295	3,260					82	917	377	4,177
6	506	3,632			95	971	1,643	17,959	2,244	22,562
7	664	6,715			77	856	3,566	45,140	4,307	52,711
8	366	3,624			389	4,010	3,329	29,706	4,084	37,340
9	143	1,274			178	1,750	1,644	13,587	1,965	16,612
10	158	1,370			13	128	485	6,022	656	7,521
11	152	1,004			2	20	346	2,983	500	4,006
12	23	243					208	1,794	231	2,037
2007 Total	3,080	28,842			754	7,735	17,952	172,619	21,786	209,196
2008										
1	6	35					2	16	8	51
2							42	338	42	338
3	24	188					365	2,933	389	3,122
4	91	754			7	67	259	2,081	357	2,902
5	88	740			23	203	1,609	12,931	1,720	13,873
6	516	4,746			144	1,568	1,841	14,795	2,501	21,110
7	347	3,285			89	846	1,282	10,148	1,718	14,279
8	152	1,569			87	900	2,576	20,672	2,815	23,140
9	81	781					1,391	11,082	1,472	11,863
10	193	1,991					627	5,090	820	7,081
11	41	298					435	3,532	476	3,830
12	17	124					275	2,221	292	2,345
2008 Total	1,556	14,511			350	3,584	10,704	85,839	12,610	103,934
2009										
1	12	110			13	139	1,061	12,541	1,086	12,790

2	1	9			4	43	964	11,388	969	11,440
3	73	587			5	53	2,290	19,489	2,368	20,129
4	164	1,368			5	53	323	3,795	492	5,216
5	271	2,204			2	21	1,682	20,503	1,955	22,728
6	787	8,379			105	1,248	1,901	18,774	2,793	28,401
7	790	7,580			113	1,052	2,806	33,138	3,709	41,770
8	611	5,066			75	801	3,384	39,910	4,070	45,777
9	185	2,243			27	288	2,032	23,972	2,244	26,503
10	282	3,409			10	107	336	3,949	628	7,465
11	25	283			3	32	412	4,801	440	5,116
12	3	29					78	922	81	951
2009 Total	3,204	31,267			362	3,838	17,269	193,182	20,835	228,287
2010										
1							363	3,827	363	3,827
2	1	10					590	6,220	591	6,229
3	5	50			13	128	2,510	26,460	2,528	26,638
4	287	2,838					263	2,772	550	5,611
5	291	3,514	19	235			1,111	11,712	1,421	15,461
6	519	5,278	17	148			1,275	13,441	1,811	18,867
7	63	653					1,903	20,061	1,966	20,714
8	53	543					4,135	45,920	4,188	46,463
9	92	782	35	300			1,306	11,714	1,433	12,796
10	139	1,432	83	745			315	3,321	537	5,498
11	37	369	26	227			100	1,054	163	1,650
12	1	9					248	2,614	249	2,623
2010 Total	1,488	15,478	180	1,655	13	128	14,119	149,116	15,800	166,377
2011										
1							518	5,494	518	5,494
2	6	82					918	9,788	924	9,870
3	23	474					2,392	25,372	2,415	25,847
4	108	1,894	1	13			29	295	138	2,202
5	93	1,283	46	547	8	95	286	2,774	433	4,700
6	459	5,280	43	499	43	499	1,645	16,256	2,190	22,534
7	468	5,729	69	842	45	549	3,509	34,004	4,091	41,124
8	102	1,575	137	2,510	32	586	4,467	33,960	4,738	38,632
9	61	765	46	577	26	326	933	11,203	1,066	12,871
10	67	937	31	430	1	14	293	3,499	392	4,879
11	23	376					221	2,617	244	2,993
12	3	39							3	39
2011 Total	1,413	18,435	373	5,418	155	2,070	15,211	145,262	17,152	171,185
2012										
1	18	125					831	10,896	849	11,021
2	1	8					565	7,408	566	7,416
3	211	1,991	14	128	2	17	1,061	13,911	1,288	16,047
4	217	1,784	44	402			44	576	305	2,762
5	226	2,822	66	1,077			688	8,966	980	12,864
6	461	6,266	52	1,014	32	398	1,123	14,635	1,668	22,313
7	619	6,600	117	1,619	43	510	3,552	32,977	4,331	41,707
8	324	2,594	33	301	17	142	2,532	23,900	2,906	26,938
9	190	1,744	21	224	10	86	959	9,484	1,180	11,539

10	199	1,740	93	849			303	3,900	595	6,490
11	39	313					424	5,906	463	6,219
12	27	141					597	7,828	624	7,969
2012 Total	2,532	26,128	440	5,614	104	1,155	12,679	140,388	15,755	173,284
2013										
1	8	94					67	801	75	895
2	3	35					248	4,433	251	4,468
3	47	552					467	5,351	514	5,903
4	175	1,725			1	11	24	331	200	2,067
5	111	732					172	1,872	283	2,604
6	905	4,975	20	110	10	109	2,016	20,642	2,951	25,836
2013 Total	1,249	8,112	20	110	11	120	2,994	33,431	4,274	41,773
Grand Total	45,224	402,703	1,013	12,797	16,796	247,429	423,623	3,854,087	486,656	4,517,016

Table 4.11.10. Texas king mackerel landings (numbers of fish and whole weight in pounds) and discards (numbers of fish) from TPWD by year and wave. Each wave is a two month period (wave=1 Jan-Feb, wave=2 Mar-Apr, etc).

		Gulf TPWD landings		**Gulf TPWD discards**
year	WAVE	Number	Weight (lbs)	Number
1981	3	5,470	62,231	0
	4	30,429	346,184	3,855
	5	1,530	17,406	52
1981 Total		37,429	425,822	3,907
1982	3	5,470	65,513	0
	4	30,429	364,442	15,421
	5	1,530	18,325	0
1982 Total		37,429	448,280	15,421
1983	3	3,758	53,489	5
	4	37,039	434,430	0
	5	2,178	26,216	0
1983 Total		42,975	514,135	5
1984	3	4,765	49,910	0
	4	32,528	321,192	1,501
	5	1,604	16,046	0
1984 Total		38,897	387,147	1,501
1985	0	29	306	0
	3	7,887	94,256	1,762
	4	21,720	220,776	0
	5	809	8,525	90
1985 Total		30,445	323,862	1,852
1986	3	4,595	50,025	1,170
	4	12,950	144,381	481
1986 Total		17,545	194,406	1,651
1987	3	3,851	40,514	205
	4	14,364	145,214	2,427
	5	395	4,263	30
1987 Total		18,610	189,992	2,662
1988	0	81	871	0
	3	2,374	26,997	3,249
	4	12,889	141,153	667
	5	38	408	0
1988 Total		15,382	169,428	3,916
1989	2	172	1,923	0
	3	1,146	13,638	633
	4	7,581	81,220	4,327
	5	1,383	15,207	21
1989 Total		10,282	111,988	4,981
1990	3	2,795	28,630	115
	4	9,166	89,926	605
	5	1,969	20,121	120
	6	45	457	0
1990 Total		13,975	139,134	840

1991	2	128	1,246	0
	3	1,204	11,828	650
	4	19,332	189,661	5,740
	5	1,393	13,718	373
1991 Total		22,057	216,453	6,763
1992	3	4,229	38,951	2,189
	4	15,265	155,268	2,512
	5	851	8,795	552
1992 Total		20,345	203,014	5,253
1993	3	1,422	15,860	28
	4	11,754	126,567	3,960
	5	1,879	19,637	313
1993 Total		15,055	162,064	4,301
1994	2	230	2,192	101
	3	3,938	40,903	1,868
	4	11,619	113,298	6,095
	5	2,880	25,789	1,355
	6	94	870	60
1994 Total		18,761	183,052	9,479
1995	3	3,247	34,670	1,930
	4	22,624	234,440	67
	5	4,193	40,147	4,551
1995 Total		30,064	309,257	6,548
1996	3	8,281	79,290	2,317
	4	23,961	238,583	13,402
	5	4,036	32,138	653
	6	21	201	6
1996 Total		36,299	350,212	16,378
1997	2	91	949	44
	3	7,000	73,195	2,938
	4	26,191	268,789	6,983
	5	1,660	15,809	465
1997 Total		34,942	358,742	10,430
1998	0	86	873	0
	1	136	1,380	284
	2	27	274	16
	3	3,806	39,307	409
	4	23,675	239,045	8,885
	5	1,377	11,126	96
1998 Total		29,107	292,005	9,690
1999	2	81	865	0
	3	4,964	55,100	2,000
	4	25,620	271,357	5,830
	5	1,107	11,840	173
1999 Total		31,772	339,163	8,003
2000	2	155	1,665	95
	3	1,251	15,188	498
	4	15,979	166,616	6,722
	5	1,154	11,164	459

2000 Total		18,539	194,633	7,774
2001	3	4,428	53,759	1,586
	4	9,388	98,232	3,068
	5	800	8,997	265
2001 Total		14,616	160,988	4,919
2002	3	4,035	41,165	2,292
	4	10,361	105,252	2,727
	5	1,164	11,685	295
2002 Total		15,560	158,102	5,314
2003	3	9,146	96,276	7,628
	4	8,763	93,600	2,980
	5	639	6,693	334
2003 Total		18,548	196,570	10,942
2004	2	99	1,068	79
	3	3,583	34,488	3,780
	4	10,418	113,627	5,974
	5	765	9,916	261
	6	78	841	29
2004 Total		14,943	159,940	10,123
2005	3	2,665	31,214	2,386
	4	10,489	108,235	3,867
	5	704	7,528	340
	6	450	4,816	22
2005 Total		14,308	151,793	6,615
2006	1	66	653	0
	2	328	3,244	149
	3	9,981	92,201	8,307
	4	13,846	139,582	10,670
	5	4,300	40,112	6,034
2006 Total		28,521	275,792	25,160
2007	1	138	1,640	0
	3	2,649	31,506	419
	4	6,532	73,544	2,780
	5	1,263	13,548	1,255
	6	222	2,638	131
2007 Total		10,804	122,875	4,585
2008	3	1,142	13,957	597
	4	6,594	74,296	3,775
	5	541	6,161	362
	6	34	398	4
2008 Total		8,311	94,811	4,738
2009	1	9	93	0
	2	19	196	13
	3	5,345	55,013	1,122
	4	10,058	104,360	4,996
	5	488	5,063	411
	6	55	567	103
2009 Total		15,974	165,292	6,645
2010	3	2,471	28,404	1,533

	4	3,591	38,383	2,412
	5	296	3,121	133
2010 Total		6,358	69,908	4,078
2011	3	1,435	16,498	366
	4	7,635	86,116	3,855
	5	356	3,991	56
2011 Total		9,426	106,605	4,277
2012	2	638	6,643	591
	3	2,912	34,036	1,087
	4	4,332	44,058	1,349
	5	1,147	10,902	361
	6	58	604	31
2012 Total		9,087	96,243	3,419
2013	2	96	902	6
	3	144	1,353	114
2013 Total		240	2,254	120
Grand Total Gulf TPWD		686,606	7,273,963	212,290

Table 4.11.11 South Atlantic king mackerel discards (b1+b2. numbers of fish) for SRHS by year, month and area aggregate. 2013 data are preliminary reported data.

Year	NC	SC	GA/FLE	South Atlantic
1981				
1			-	-
2			-	-
3			-	-
4			-	-
5	-		-	-
6	-	1	-	1
7	-		-	-
8	-	2	-	2
9	-	2	-	2
10			-	-
11			-	-
12			-	-
1981 Total	-	5	-	5
1982				
1			-	-
2			-	-
3			-	-
4			-	-
5	-		-	-
6	-		-	-
7	1	1	-	2
8	-	5	-	5
9	1	3	-	4
10			-	-
11			-	-
12			-	-
1982 Total	2	9	-	11
1983				
1			327	327
2			183	183
3			324	324
4			491	491
5	18	-	1,626	1,644
6	5	1	707	713
7	117	3	566	686

8	76	1	931	1,008
9	344	16	1,042	1,402
10			1,236	1,236
11			743	743
12			393	393
1983 Total	560	21	8,569	9,150
1984				
1			27,428	27,428
2			18,555	18,555
3			5,946	5,946
4			15,067	15,067
5	5	28	24,649	24,682
6	3	25	17,146	17,174
7	3	20	20,997	21,020
8	3	13	34,913	34,929
9	4	27	12,069	12,100
10			7,797	7,797
11			4,234	4,234
12			5,031	5,031
1984 Total	18	113	193,832	193,963
1985				
1			505	505
2			486	486
3			508	508
4			2,721	2,721
5	-	56	4,341	4,397
6	-	69	2,310	2,379
7	-	101	2,986	3,087
8	-	28	2,647	2,675
9	-	68	2,670	2,738
10			3,118	3,118
11			2,619	2,619
12			1,135	1,135
1985 Total	-	322	26,046	26,368
1986				
1			21,433	21,433
2			26,355	26,355
3			20,366	20,366
4			64,401	64,401
5	4	65	123,060	123,129

6	7	72	55,377	55,456
7	9	140	78,820	78,969
8	10	125	127,859	127,994
9	12	156	46,230	46,398
10			56,997	56,997
11			47,009	47,009
12			34,867	34,867
1986 Total	42	558	702,774	703,374
1987				
1			4,500	4,500
2			4,947	4,947
3			5,637	5,637
4			3,512	3,512
5	78	5	3,819	3,902
6	64	10	1,030	1,104
7	115	13	1,429	1,557
8	143	10	1,611	1,764
9	132	24	1,220	1,376
10			1,280	1,280
11			979	979
12			725	725
1987 Total	532	62	30,689	31,283
1988				
1			14	14
2			64	64
3			203	203
4			2,191	2,191
5	35	9	3,305	3,349
6	9	4	663	676
7	22	4	631	657
8	35	4	2,211	2,250
9	30	5	1,544	1,579
10			991	991
11			442	442
12			534	534
1988 Total	131	26	12,793	12,950
1989				
1			-	-
2			-	-
3			-	-

4			-	-
5	2	15	-	17
6	-	8	-	8
7	-	9	-	9
8	-	2	-	2
9	-	7	-	7
10			-	-
11			-	-
12			-	-
1989 Total	2	41	-	43
1990				
1			-	-
2			-	-
3			-	-
4			-	-
5	9	-	-	9
6	6	1	-	7
7	8	2	-	10
8	7	1	-	8
9	8	2	-	10
10			-	-
11			-	-
12			-	-
1990 Total	38	6	-	44
1991				
1			-	-
2			-	-
3			-	-
4			-	-
5	2	2	-	4
6	4	5	-	9
7	7	4	-	11
8	5	3	-	8
9	9	9	-	18
10			-	-
11			-	-
12			-	-
1991 Total	27	23	-	50
1992				
1			78	78

2			129	129
3			125	125
4			159	159
5	3	-	177	180
6	4	1	100	105
7	4	1	107	112
8	6	1	143	150
9	10	1	239	250
10			203	203
11			155	155
12			170	170
1992 Total	27	4	1,785	1,816
1993				
1			211	211
2			344	344
3			214	214
4			164	164
5	4	30	246	280
6	4	19	152	175
7	4	26	175	205
8	2	9	500	511
9	3	25	254	282
10			343	343
11			241	241
12			319	319
1993 Total	17	109	3,163	3,289
1994				
1			2,185	2,185
2			1,383	1,383
3			1,341	1,341
4			1,933	1,933
5	6	-	3,323	3,329
6	2	-	1,219	1,221
7	4	-	1,637	1,641
8	2	-	2,133	2,135
9	9	-	1,309	1,318
10			4,167	4,167
11			1,782	1,782
12			1,394	1,394
1994 Total	23	-	23,806	23,829

1995				
1			-	-
2			-	-
3			-	-
4			-	-
5	1	34	-	35
6	-	32	-	32
7	1	43	-	44
8	-	6	-	6
9	1	67	-	68
10			-	-
11			-	-
12			-	-
1995 Total	3	182	-	185
1996				
1			695	695
2			716	716
3			550	550
4			1,136	1,136
5	6	31	1,756	1,793
6	1	26	1,540	1,567
7	2	22	1,100	1,124
8	3	18	1,540	1,561
9	4	52	2,565	2,621
10			4,112	4,112
11			2,632	2,632
12			2,486	2,486
1996 Total	16	149	20,828	20,993
1997				
1	-		1,078	1,078
2	-		690	690
3	2	-	1,051	1,053
4	20	5	1,714	1,739
5	18	9	1,113	1,140
6	10	33	284	327
7	19	62	513	594
8	18	42	412	472
9	26	36	470	532
10	51	64	858	973
11	6	21	1,180	1,207

12			1,924	1,924
1997 Total	170	272	11,287	11,729
1998				
1	1		-	1
2	-		-	-
3	1	2	-	3
4	8	57	-	65
5	10	175	-	185
6	16	285	-	301
7	20	151	-	171
8	4	76	-	80
9	2	61	-	63
10	3	107	-	110
11	4	41	-	45
12	3	3	-	6
1998 Total	72	958	-	1,030
1999				
1			2,181	2,181
2	1		772	773
3		-	1,317	1,317
4	12	24	2,134	2,170
5	70	65	2,995	3,130
6	53	119	1,149	1,321
7	67	107	832	1,006
8	61	86	1,157	1,304
9	33	54	13,379	13,466
10	44	97	6,726	6,867
11	33	98	4,763	4,894
12	2		3,878	3,880
1999 Total	376	650	41,283	42,309
2000				
1		1	1,471	1,472
2	2		1,300	1,302
3	3	5	1,412	1,420
4	3	20	1,512	1,535
5	5	96	1,445	1,546
6	12	237	798	1,047
7	11	364	806	1,181
8	12	268	848	1,128
9	11	111	1,825	1,947

10	7	137	2,430	2,574
11	5	111	935	1,051
12	1	15	1,571	1,587
2000 Total	72	1,365	16,353	17,790
2001				
1			927	927
2	3		347	350
3	1	12	410	423
4	4	19	710	733
5	2	56	597	655
6	4	161	424	589
7	4	138	358	500
8	6	114	802	922
9	4	59	1,096	1,159
10	5	50	613	668
11	2	52	598	652
12		4	178	182
2001 Total	35	665	7,060	7,760
2002				
1			35	35
2			20	20
3	-	-	13	13
4	2	46	95	143
5	6	49	139	194
6	8	111	65	184
7	6	141	104	251
8	2	103	121	226
9	2	50	192	244
10	1	87	95	183
11	1	102	84	187
12		5	58	63
2002 Total	28	694	1,021	1,743
2003				
1			-	-
2			-	-
3	-		-	-
4	-	3	-	3
5	-	18	-	18
6	-	36	-	36
7	1	25	-	26

8	1	14	-	15
9		4	-	4
10	-	5	-	5
11	-	3	-	3
12			-	-
2003 Total	2	108	-	110
2004				
1			141	141
2			40	40
3		-	2	2
4	-	-	1,580	1,580
5	-	87	3	90
6	-	208	-	208
7	9	305	1	315
8	5	80	13	98
9	-	-	35	35
10	-	35	311	346
11	-	5	434	439
12	-	-	1	1
2004 Total	14	720	2,561	3,295
2005				
1			115	115
2			209	209
3	-	5	360	365
4	-	-	177	177
5	-	18	13	31
6	-	84	57	141
7	2	52	9	63
8	-	66	45	111
9	-	25	675	700
10	-	2	329	331
11	-	3	-	3
12			589	589
2005 Total	2	255	2,578	2,835
2006				
1	-		38	38
2	-		38	38
3	-	-	37	37
4	-	-	59	59
5	-	72	1,726	1,798

6	-	136	16	152
7	-	107	59	166
8	-	100	1	101
9	-	4	18	22
10	-	20	58	78
11	-	-	-	-
12		-	9	9
2006 Total	-	439	2,059	2,498
2007				
1			22	22
2	-	-	29	29
3	-	-	32	32
4	-	-	69	69
5	-	9	40	49
6	96	138	48	282
7	37	169	9	215
8	7	53	4	64
9	20	132	4	156
10	28	185	30	243
11	-	54	37	91
12		-	12	12
2007 Total	188	740	336	1,264
2008				
1			153	153
2			252	252
3	-		195	195
4	2	8	244	254
5	-	10	248	258
6	1	92	73	166
7	-	192	166	358
8	-	91	80	171
9	-	27	158	185
10	-	36	231	267
11	-	49	125	174
12			151	151
2008 Total	3	505	2,076	2,584
2009				
1			150	150
2			608	608
3	-	-	315	315

4	-	8	130	138
5	-	14	63	77
6	-	96	24	120
7	-	108	23	131
8	-	46	16	62
9	-	29	33	62
10	-	16	73	89
11	-	-	12	12
12		-	48	48
2009 Total	-	317	1,495	1,812
2010				
1			174	174
2			520	520
3		-	890	890
4	-		748	748
5	-	-	69	69
6	-	83	49	132
7	-	40	13	53
8	-	1	4	5
9	1	1	3	5
10	-	-	21	21
11	-	-	4	4
12		-	58	58
2010 Total	1	125	2,553	2,679
2011				
1			340	340
2			267	267
3			173	173
4	-	-	308	308
5	-	-	89	89
6	-	23	58	81
7	1	17	18	36
8	-	3	4	7
9	-	5	46	51
10	-	-	61	61
11	-	17	10	27
12			62	62
2011 Total	1	65	1,436	1,502
2012				
1			387	387

2			287	287
3			240	240
4	-	-	40	40
5	-	-	18	18
6	-	1	19	20
7	-	29	18	47
8	-	51	18	69
9	-	11	34	45
10	-	27	18	45
11	-	13	24	37
12		-	27	27
2012 Total	-	132	1,130	1,262
2013				
1			103	103
2			113	113
3			52	52
2013 Total			268	268
Grand Total	2,402	9,640	1,117,781	1,129,823

Table 4.11.12 Winter mixing zone king mackerel discards (b1+b2. numbers of fish) for SRHS by year, month and area aggregate. Only one area aggregate (GA/FLE) exists for the winter mixing zone. 2013 data are preliminary reported data.

Year	GA/FLE
1981	
1	367
2	432
3	283
11	93
12	512
1981 Total	1,687
1982	
1	178
2	104
3	22
11	111
12	142
1982 Total	557
1983	
1	72
2	55
3	93
11	315
12	1,328
1983 Total	1,863
1984	
1	43
2	17
3	14
11	8
12	25
1984 Total	107
1985	
1	23
2	6
3	7
11	2
12	11
1985 Total	49
1986	
1	-
2	-

3	-
11	-
12	-
1986 Total	-
1987	
1	862
2	541
3	219
11	296
12	405
1987 Total	2,323
1988	
1	-
2	1
3	1
11	8
12	3
1988 Total	13
1989	
1	-
11	11
12	31
1989 Total	42
1990	
1	209
2	292
3	150
11	86
12	104
1990 Total	841
1991	
1	3
2	2
3	2
11	101
12	383
1991 Total	491
1992	
1	77
2	3
3	6
11	70

12	114
1992 Total	270
1993	
1	1,449
2	899
3	829
11	268
12	903
1993 Total	4,348
1994	
1	830
2	1,126
3	580
11	177
12	389
1994 Total	3,102
1995	
1	802
2	709
3	496
11	124
12	146
1995 Total	2,277
1996	
1	675
2	1,073
3	1,207
11	89
12	964
1996 Total	4,008
1997	
1	1,304
2	1,181
3	369
11	224
12	380
1997 Total	3,458
1998	
1	728
2	387
3	163
11	72

12	101
1998 Total	1,451
1999	
1	55
2	52
3	7
11	17
12	33
1999 Total	164
2000	
1	51
2	24
3	8
11	15
12	18
2000 Total	116
2001	
1	18
2	34
3	51
11	15
12	11
2001 Total	129
2002	
1	36
2	65
3	83
11	35
12	15
2002 Total	234
2003	
1	65
2	12
3	99
11	14
12	127
2003 Total	317
2004	
1	1
2	5
3	6
11	9

12	20
2004 Total	41
2005	
1	52
2	33
3	11
11	12
12	-
2005 Total	108
2006	
1	18
2	26
3	10
11	13
12	98
2006 Total	165
2007	
1	-
2	3
3	4
11	6
12	2
2007 Total	15
2008	
1	-
2	2
3	-
11	16
12	178
2008 Total	196
2009	
1	64
2	118
3	70
11	11
12	5
2009 Total	268
2010	
1	7
2	30
3	1
11	-

12	10
2010 Total	48
2011	
1	32
2	50
3	6
11	5
12	5
2011 Total	98
2012	
1	86
2	4
3	-
11	1
12	7
2012 Total	98
2013	
1	3
2	2
3	6
2013 Total	11
Grand Total	28,895

Table 4.11.13 Gulf of Mexico king mackerel discards (b1+b2. numbers of fish) for SRHS by year, month and area aggregate. 2013 data are preliminary reported data.

Year	FLW/AL	MS	LA	TX	Gulf of Mexico
1981					
5				2,122	2,122
6				2,489	2,489
7				6,797	6,797
8				5,957	5,957
9				2,147	2,147
1981 Total				19,512	19,512
1982					
5				236	236
6				276	276
7				755	755
8				661	661
9				238	238
1982 Total				2,166	2,166
1983					
5				512	512
6				600	600
7				1,638	1,638
8				1,436	1,436
9				517	517
1983 Total				4,704	4,704
1984					
5				341	341
6				399	399
7				1,091	1,091
8				956	956
9				344	344
1984 Total				3,131	3,131
1985					
5				66	66
6				77	77
7				211	211
8				185	185
9				67	67
1985 Total				607	607
1986					
3	28				28
4	17				17
5	50		27	1,673	1,750

6	180		1,873	2,053
7	104	124	3,210	3,438
8	91	12	2,652	2,755
9	119	62	1,579	1,760
10	4			4
11	33			33
12	50			50
1986 Total	676	225	10,987	11,888
1987				
1	5			5
2	1			1
3	6			6
4	22			22
5	51	-	379	430
6	58	-	354	412
7	100	-	1,190	1,290
8	106	-	1,098	1,204
9	98	-	368	466
10	3			3
11	26			26
12	3			3
1987 Total	479	-	3,389	3,868
1988				
5			124	124
6	-		214	214
7	15	-	796	811
8	10	-	696	706
9	11	-	154	165
10	2			2
12	1			1
1988 Total	39	-	1,983	2,022
1989				
1	-			-
2	-			-
3	1			1
4	1			1
5	1		26	27
6	8		98	106
7	6	-	299	305
8	6	-	391	397
9	11	-	184	195
10	2			2

11	2			2
12	4			4
1989 Total	42	-	997	1,039
1990				
1	6			6
2	45			45
3	137			137
4	100			100
5	9	-	89	98
6	7	-	250	257
7	26	-	823	849
8	21	-	1,455	1,476
9	48	-	295	343
10	3			3
11	9			9
1990 Total	411	-	2,912	3,323
1991				
2	2			2
4	12			12
5	23		26	49
6	63	-	358	421
7	803	6	3,376	4,185
8	401	7	3,190	3,598
9	639	12	1,758	2,409
10	17			17
11	19			19
12	12			12
1991 Total	1,991	25	8,708	10,724
1992				
3	3			3
4	5			5
5	46		553	599
6	72	1	718	791
7	193	93	2,521	2,807
8	109	47	1,914	2,070
9	158	40	744	942
10	9			9
11	1			1
12	4			4
1992 Total	600	181	6,450	7,231
1993				
1	9			9

2	1			1
3	10			10
4	13			13
5	23	29	191	243
6	37	49	122	208
7	48	130	506	684
8	23	104	427	554
9	87	92	291	470
10	9			9
11	17			17
12	2			2
1993 Total	279	404	1,537	2,220
1994				
1	31			31
2	3			3
3	393			393
4	48			48
5	428	236	1,284	1,948
6	227	288	2,998	3,513
7	480	264	2,503	3,247
8	292	147	3,639	4,078
9	1,030	195	3,452	4,677
10	49			49
11	60			60
12	92			92
1994 Total	3,133	1,130	13,876	18,139
1995				
1	-			-
2	-			-
3	4			4
4	7			7
5	53	-	408	461
6	111	-	681	792
7	80	-	873	953
8	50	-	1,254	1,304
9	88	-	847	935
10	4			4
11	1			1
12	1			1
1995 Total	399	-	4,065	4,464
1996				
3	1			1

4	21			21
5	33	-	521	554
6	107	-	624	731
7	74	-	1,140	1,214
8	46	-	837	883
9	124	-	1,492	1,616
10	3			3
11	54			54
12	132			132
1996 Total	595	-	4,614	5,209
1997				
1	1		144	145
2		-	98	98
3	4	-	64	68
4	7	-	171	178
5	27	-	235	262
6	40	-	432	472
7	26	-	860	886
8	48	-	765	813
9	79	-	439	518
10	36	-	66	102
11	4	-	46	50
12	6	-	5	11
1997 Total	278	-	3,325	3,603
1998				
1	-	3	25	28
2		18	27	45
3	-	6	36	42
4	5	15	15	35
5	7	31	108	146
6	17	94	194	305
7	31	124	334	489
8	19	52	283	354
9	17	7	53	77
10	14	16	15	45
11	3	29	16	48
12	5	9	30	44
1998 Total	118	404	1,134	1,656
1999				
1			8	8
2	-		6	6
3	1	1	21	23

4	5	5	15	25
5	5	20	38	63
6	13	38	166	217
7	17	38	361	416
8	16	42	257	315
9	9	20	64	93
10	8	20	34	62
11	3	9	17	29
12	1	1	11	13
1999 Total	78	194	998	1,270
2000				
1	-		118	118
2	-		148	148
3	9		63	72
4	10	-	10	20
5	30	-	123	153
6	83	-	315	398
7	75	-	636	711
8	28	-	635	663
9	24	-	127	151
10	32	-	17	49
11	6	-	43	49
12	2		57	59
2000 Total	299	-	2,293	2,592
2001				
1	2		61	63
2	3	70	32	105
3	2		49	51
4	15	373	23	411
5	27	1,704	93	1,824
6	48	1,377	286	1,711
7	49	490	956	1,495
8	31	187	650	868
9	15	23	247	285
10	14	70	67	151
11	60	23	43	126
12	33	23	11	67
2001 Total	299	4,340	2,518	7,157
2002				
1			26	26
2	2	1	40	43
3	2		34	36

4	22	7	10	39
5	20	35	116	171
6	74	28	380	482
7	77	10	623	710
8	40	4	767	811
9	25	-	170	195
10	34	1	119	154
11	9	-	97	106
12	1	-	71	72
2002 Total	306	86	2,453	2,845
2003				
1	-		189	189
2	3	1	324	328
3	14		539	553
4	23	8	421	452
5	37	95	386	518
6	38	84	961	1,083
7	73	93	794	960
8	34	42	998	1,074
9	30	33	400	463
10	61	28	151	240
11	27	6	96	129
12	3	6	87	96
2003 Total	343	396	5,346	6,085
2004				
1	-		-	-
2			-	-
3	8		-	8
4	-		-	-
5	-		-	-
6	1		-	1
7	-		-	-
8	-		1	1
9	4		4	8
10	3		-	3
11	1		-	1
12	1		-	1
2004 Total	18		5	23
2005				
1	-		-	-
2			-	-
3	-		-	-

4	12		-	12
5	5		-	5
6	1		1	2
7	4		-	4
8	4		174	178
9	3		-	3
10	-		20	20
11	4		-	4
12	1		-	1
2005 Total	34		195	229
2006				
1	-		15	15
2			-	-
3	-		-	-
4	8		5	13
5	3		39	42
6	-		41	41
7	-		52	52
8	4		16	20
9	-		-	-
10	-		-	-
11	8		-	8
12	6		-	6
2006 Total	29		168	197
2007				
1	2		81	83
2	-		127	127
3	2		97	99
4	9		-	9
5	-		-	-
6	2	-	1	3
7	-	-	15	15
8	-	-	4	4
9	-	-	2	2
10	-	-	3	3
11	-	-	7	7
12	1		3	4
2007 Total	16	-	340	356
2008				
1	-		-	-
2			-	-
3	1		-	1

4	3		-	5	8
5	3		-	-	3
6	7		2	2	11
7	25		1	5	31
8	11		1	32	44
9	54			6	60
10	9			12	21
11	1			14	15
12	1			1	2
2008 Total	115		4	77	196
2009					
1	1		-	30	31
2	-		-	51	51
3	-		-	36	36
4	12		-	-	12
5	1		-	14	15
6	19		1	9	29
7	19		11	21	51
8	15		3	1	19
9	4		-	6	10
10	-		1	3	4
11	3		-	48	51
12	-			-	-
2009 Total	74		16	219	309
2010					
1				-	-
2	-			-	-
3	-		-	13	13
4	14			-	14
5	-	-		10	10
6	3	-		-	3
7	1			-	1
8	-			-	-
9	-	-		-	-
10	-	7		-	7
11	3	-		-	3
12	-			7	7
2010 Total	21	7	-	30	58
2011					
1				11	11
2	-			-	-
3	-			14	14

4	1	-		-	1
5	-	1	-	-	1
6	1	-	10	4	15
7	-	10	-	1	11
8	1	1	21	1	24
9	-	1	-	-	1
10	-	-	-	-	-
11	3			13	16
12	-				-
2011 Total	6	13	31	44	94
2012					
1	5			-	5
2	1			-	1
3	12	-	-	-	12
4	10	-		-	10
5	1	1		-	2
6	60	-	-	6	66
7	3	1	1	3	8
8	3	1	-	-	4
9	2	-	-	15	17
10	-	15		-	15
11	-			25	25
12	3			1	4
2012 Total	100	18	1	50	169
2013					
3				4	4
4	42				42
5				22	22
6	5			2	7
2013 Total	47			28	75
Grand Total	10,825	38	7,437	108,862	127,162

Table 4.11.14 Number of king mackerel measured in the Atlantic and Gulf of Mexico in the MRFSS/MRIP by year, migratory group, and mode. 2013 data is preliminary and through June.

	Atlantic					Gulf					Mixing					Grand
YEAR	Cbt	Hbt	Priv	Shore	All	Cbt	Hbt	Priv	Shore	All	Cbt	Hbt	Priv	Shore	All	Total
1981	68		53		121	51	8	9	1	69			1		1	191
1982	72		275		347	4	14	53	6	77	12		3		15	439
1983	87		110		197	32	7	19	1	59	9	1	1		11	267
1984	208		109		317	54	9	23		86	56	1	3		60	463
1985	97		85		182	28	1	18		47	25	1			26	255
1986	323		358	3	684	87		23		110	19		15		34	828
1987	1,046		443	2	1,491	346		366	11	723	20		30		50	2,264
1988	806		290	6	1,102	219		93	4	316	10		1		11	1,429
1989	908		273	2	1,183	69		45	2	116	1		3		4	1,303
1990	1,124		303	20	1,447	116		86	7	209	7		10	5	22	1,678
1991	972		344	16	1,332	197		92	6	295	26		9		35	1,662
1992	1,284		419	5	1,708	191		136	4	331	63		6		69	2,108
1993	816		240	4	1,060	220		84	20	324	69		7		76	1,460
1994	794		251	14	1,059	158		107	11	276	165		12		177	1,512
1995	945		256	5	1,206	108		59	9	176	176		6		182	1,564
1996	693		210	2	905	121		90		211	200		15		215	1,331
1997	1,814	1	339	4	2,158	465		111	4	580	504		13		517	3,255
1998	1,278		234	2	1,514	669		102	1	772	1,057		10		1,067	3,353
1999	983		403	5	1,391	1,260		173	17	1,450	529		4		533	3,374
2000	1,365		409	2	1,776	2,356		240	14	2,610	305				305	4,691
2001	1,214		359	4	1,577	1,403		171	25	1,599	365				365	3,541
2002	770		290	11	1,071	1,107		168	19	1,294	393		2		395	2,760
2003	1,048	1	288	1	1,338	970		149	8	1,127	229				229	2,694
2004	641		166	1	808	809		172	6	987	142		2		144	1,939
2005	607		193	5	805	610		98	23	731	123				123	1,659
2006	763		334	6	1,103	894		184	25	1,103	182				182	2,388

2007	667		422	1	1,090	855		144	12	1,011	97		1		98	2,199
2008	617		387	1	1,005	535		101	7	643	151				151	1,799
2009	519		238	4	761	899		121	32	1,052	60				60	1,873
2010	316		154	5	475	543		75	10	628	111				111	1,214
2011	147		74	2	223	433		96	9	538	162				162	923
2012	225		107	3	335	870		127	11	1,008	148				148	1,491
2013	26		46		72	113		54	9	176	91		1		92	340
Grand Total	23,243	2	8,462	136	31,843	16,792	39	3,589	314	20,734	5,507	3	155	5	5,670	58,247

Table 4.11.15 Number of angler trips with measured king mackerel in the Atlantic and Gulf of Mexico in the MRFSS/MRIP by year, migratory group, and mode. 2013 data is preliminary and through June.

	Atlantic					Gulf					Mixing					Grand
YEAR	Cbt	Hbt	Priv	Shore	All	Cbt	Hbt	Priv	Shore	All	Cbt	Hbt	Priv	Shore	All	Total
1981	13		35		48	15	4	9	1	29			1		1	78
1982	10		93		103	4	4	27	6	41	4		3		7	151
1983	32		31		63	19	6	7	1	33	2	1	1		4	100
1984	67		56		123	18	3	8		29	12	1	1		14	166
1985	40		42		82	8	1	9		18	7	1			8	108
1986	115		168	3	286	39		17		56	5		6		11	353
1987	244		199	2	445	92		188	8	288	7		15		22	755
1988	207		158	6	371	61		51	4	116	3		1		4	491
1989	202		159	2	363	26		22	2	50	1		2		3	416
1990	236		135	10	381	37		49	7	93	4		4	1	9	483
1991	206		160	15	381	63		39	2	104	12		6		18	503
1992	272		204	5	481	57		84	4	145	30		3		33	659
1993	184		123	4	311	66		44	15	125	25		6		31	467
1994	187		150	6	343	59		65	9	133	36		8		44	520
1995	173		136	5	314	29		31	8	68	48		5		53	435
1996	207		126	2	335	31		54		85	53		9		62	482
1997	346	1	155	4	506	157		64	3	224	106		5		111	841
1998	273		144	2	419	174		62	1	237	194		4		198	854
1999	274		239	5	518	337		98	4	439	157		2		159	1,116
2000	277		243	2	522	618		129	9	756	129				129	1,407
2001	273		194	4	471	318		91	20	429	123				123	1,023
2002	288		164	6	458	318		91	16	425	150		2		152	1,035
2003	275	1	149	1	426	284		80	6	370	106				106	902
2004	162		99	1	262	291		94	5	390	47		2		49	701
2005	189		118	5	312	215		58	13	286	37				37	635
2006	203		179	5	387	248		91	11	350	48				48	785
2007	174		196	1	371	239		86	7	332	58		1		59	762
2008	167		200	1	368	166		64	4	234	58				58	660
2009	156		153	4	313	195		72	27	294	15				15	622
2010	115		100	4	219	160		49	8	217	40				40	476
2011	55		50	2	107	127		59	6	192	57				57	356

2012	83		77	3	163	282		75	9	366	50				50	579
2013	6		27		33	36		35	9	80	28		1		29	142
Grand Total	5,711	2	4,462	110	10,285	4,789	18	2,002	225	7,034	1,652	3	88	1	1,744	19,063

Table 4.11.16 Number of trips with measured king mackerel and number of king mackerel measured in the South Atlantic in the SRHS by year and area aggregate. 2013 data are preliminary reported data.

Year	Trips (n)				Fish (n)			
	NC	SC	GA/FLE	South Atlantic	NC	SC	GA/FLE	South Atlantic
1978			78	78			268	268
1979	1		165	166	1		533	534
1980	5	1	205	211	5	1	610	616
1981	4		242	246	7		702	709
1982	4		150	154	7		481	488
1983	23	3	315	341	39	3	1,009	1051
1984	15	10	396	421	17	13	1,293	1323
1985	27	7	329	363	35	8	1,070	1113
1986	40	5	312	357	60	6	1,025	1091
1987	37	17	217	271	56	22	824	902
1988	37	11	88	136	58	11	248	317
1989	19	4	188	211	33	6	593	632
1990	14	10	105	129	16	13	344	373
1991	34	8	121	163	59	13	469	541
1992	55	22	94	171	111	80	266	457
1993	39	21	117	177	87	75	388	550
1994	13	9	117	139	20	15	419	454
1995	17	24	131	172	24	39	414	477
1996	13	16	22	51	32	33	62	127
1997	23	25	243	291	56	112	1,209	1377
1998	11	23	269	303	16	51	898	965
1999	21	11	136	168	29	21	396	446
2000	37	12	141	190	63	20	413	496
2001	14		152	166	19		421	440
2002	8	6	108	122	11	6	237	254
2003	4	7	179	190	7	9	637	653
2004	14		183	197	21		622	643
2005	19	1	183	203	33	1	794	828
2006	7	33	203	243	8	84	1,133	1225
2007	7	28	200	235	13	86	793	892
2008	1	13	139	153	1	34	395	430
2009	4	13	123	140	7	34	512	553
2010	2	10	109	121	3	12	525	540
2011	2	5	78	85	2	6	239	247
2012	2	1	118	121	2	1	227	230
2013	2	10	101	113	2	16	179	197

Table 4.11.17 Number of trips with measured king mackerel and number of king mackerel measured in the winter mixing zone in the SRHS by year and area aggregate. Only one area aggregate (GA/FLE) exists in the winter mixing zone. 2013 data are preliminary reported data.

Year	Trips (n)	Fish (n)
	GA/FLE	GA/FLE
1978		
1979	1	9
1980		
1981	23	137
1982	25	70
1983	30	191
1984	22	66
1985	21	76
1986	5	12
1987	8	28
1988		
1989	4	10
1990	16	97
1991	1	1
1992	6	12
1993	10	30
1994	7	14
1995	3	6
1996	13	40
1997	21	60
1998	9	13
1999	5	8
2000	2	4
2001	6	14
2002		
2003	5	9
2004	1	1
2005	4	33
2006	4	8
2007	1	1
2008	5	7
2009	4	5
2010	2	14
2011	12	38
2012	23	54
2013	6	9

Table 4.11.18 Number of trips with measured king mackerel and number of king mackerel measured in the Gulf of Mexico in the SRHS by year and area aggregate. 2013 data are preliminary reported data.

	Trips (n)					Fish (n)				
Year	FLW/AL	MS	LA	TX	Gulf of Mexico	FLW/AL	MS	LA	TX	Gulf of Mexico
1978										
1979										
1980										
1981										
1982										
1983										
1984										
1985										
1986	5		8	70	83	21		17	269	307
1987	24		7	60	91	27		19	205	251
1988	16		9	57	82	20		30	270	320
1989	29		11	57	97	43		47	374	464
1990	24		6	16	46	38		20	34	92
1991	61		14	31	106	114		29	112	255
1992	33		36	53	122	49		127	369	545
1993	31		17	65	113	44		39	356	439
1994	53		30	84	167	116		45	426	587
1995	40		46	103	189	64		105	641	810
1996	20		21	63	104	32		54	558	644
1997	39		51	16	106	73		153	43	269
1998	33		60	32	125	53		167	101	321
1999	30		69	56	155	37		197	178	412
2000	58		42	39	139	106		90	91	287
2001	23		20	37	80	30		49	118	197
2002	35		15	78	128	43		28	185	256
2003	26		19	75	120	41		41	164	246
2004	10			41	51	17			189	206
2005	11		4	27	42	19		7	191	217
2006	26		1	35	62	42		1	192	235
2007	18		14	21	53	21		41	157	219
2008	17		7	6	30	28		28	7	63
2009	28		14	16	58	35		64	51	150
2010	12			8	20	19			60	79
2011	7		8	13	28	9		27	93	129
2012	29	13	14	112	168	38	42	36	842	958
2013	22	4	6	175	207	34	6	11	1032	1083

Table 4.11.19 Number of king mackerel measured in the state of Texas in the TPWD by year and mode. 2013 data is through May 14th.

YEAR	Cbt	Private	Grand Total
1983	114	344	458

1984	37	738	775
1985	82	764	846
1986	49	490	539
1987	93	432	525
1988	50	385	435
1989	27	325	352
1990	45	426	471
1991	85	702	787
1992	81	680	761
1993	36	534	570
1994	62	577	639
1995	48	1,066	1,114
1996	83	1,016	1,099
1997	115	1,304	1,419
1998	85	813	898
1999	105	864	969
2000	64	593	657
2001	83	455	538
2002	77	489	566
2003	113	624	737
2004	85	653	738
2005	95	483	578
2006	177	1,150	1,327
2007	131	381	512
2008	95	378	473
2009	92	741	833
2010	49	209	258
2011	45	536	581
2012	75	368	443
2013		9	9
Grand Total	2,378	18,529	20,907

Table 4.11.20 Number of trips with measured king mackerel in the state of Texas in the TPWD by year and mode. 2013 data is through May 14th.

YEAR	Charterboat	Private	Grand Total
1983	25	119	144
1984	9	251	260
1985	14	281	295
1986	14	191	205
1987	24	183	207
1988	13	170	183
1989	10	145	155
1990	14	173	187
1991	20	235	255
1992	22	241	263
1993	7	194	201
1994	18	217	235
1995	13	379	392
1996	21	356	377
1997	28	447	475
1998	19	312	331
1999	29	332	361
2000	20	251	271
2001	20	200	220
2002	23	195	218
2003	28	239	267
2004	27	226	253
2005	25	192	217
2006	46	396	442
2007	34	164	198
2008	24	148	172
2009	22	285	307
2010	13	93	106
2011	14	183	197
2012	18	136	154
2013		4	4
Grand Total	614	6,938	7,552

Table 4.11.21 Atlantic and Gulf of Mexico (ME-TX) estimated number of **angler trips** for MRFSS (1981-2003) and MRIP (2004-2012) by year and migratory group. Texas boat mode angler trip estimates have been excluded. South Atlantic headboat mode angler trips have been excluded. 2013 data is preliminary and through June.

YEAR	Atlantic	Gulf	Mixing	Grand Total
1981	29,679,917	11,239,162	2,962,866	43,881,945
1982	37,145,265	15,115,781	1,218,488	53,479,534
1983	42,081,195	21,211,368	2,692,039	65,984,602
1984	37,223,673	18,513,620	3,250,134	58,987,427
1985	38,038,621	16,962,482	925,095	55,926,198
1986	42,541,991	18,428,834	626,712	61,597,537
1987	38,580,646	13,968,848	2,033,422	54,582,915
1988	40,272,788	18,927,600	854,800	60,055,188
1989	34,491,274	14,631,406	1,024,725	50,147,405
1990	33,178,575	12,163,056	1,186,362	46,527,993
1991	40,988,942	15,748,358	2,430,539	59,167,839
1992	35,300,324	16,312,539	1,795,879	53,408,742
1993	39,504,528	15,379,816	2,091,997	56,976,341
1994	43,546,415	15,860,973	1,677,502	61,084,890
1995	42,173,133	15,857,708	1,659,028	59,689,869
1996	40,817,910	15,272,567	1,869,420	57,959,897
1997	44,304,194	16,862,882	1,847,094	63,014,170
1998	38,835,190	15,524,545	1,036,316	55,396,050
1999	35,628,461	15,011,316	689,140	51,328,916
2000	48,996,502	20,336,390	653,696	69,986,588
2001	52,615,427	22,057,161	832,537	75,505,124
2002	43,597,154	19,150,906	514,672	63,262,733
2003	50,408,923	22,201,006	775,508	73,385,437
2004	48,444,263	25,235,993	1,202,142	74,882,397
2005	51,022,975	22,642,292	652,138	74,317,404
2006	51,310,434	22,708,691	592,645	74,611,770
2007	53,470,085	23,254,225	1,048,814	77,773,124
2008	51,648,069	23,467,421	1,342,169	76,457,659
2009	42,858,679	21,970,867	636,724	65,466,270
2010	42,864,249	20,495,030	571,935	63,931,215
2011	39,708,129	22,086,537	513,900	62,308,566
2012	38,388,280	22,359,966	841,138	61,589,384
2013	12,610,130	11,230,796	640,076	24,481,002
Grand Total	1,362,276,340	602,190,142	42,689,649	2,007,156,132

Table 4.11.22 South Atlantic estimated number of **angler days** from SRHS by year and area aggregate.

Year	NC	SC	GA/FLE	South Atlantic
1981	19,374	59,030	261,245	339,649
1982	26,939	67,539	255,943	350,421
1983	23,830	65,733	242,789	332,352
1984	28,865	67,314	250,098	346,277
1985	31,384	66,001	242,745	340,130
1986	31,187	67,227	277,332	375,746
1987	35,261	78,806	292,255	406,322
1988	42,421	76,468	261,425	380,314
1989	38,678	62,708	277,026	378,412
1990	43,240	57,151	285,126	385,517
1991	40,936	67,982	245,619	354,537
1992	41,176	61,790	227,459	330,425
1993	42,786	64,457	202,182	309,425
1994	36,691	63,231	209,307	309,229
1995	40,295	61,739	179,999	282,033
1996	35,142	54,929	172,860	262,931
1997	37,189	60,150	143,727	241,066
1998	37,399	61,342	129,516	228,257
1999	31,596	55,499	141,672	228,767
2000	31,351	40,291	158,848	230,490
2001	31,779	49,265	141,763	222,807
2002	27,601	42,467	127,451	197,519
2003	22,998	36,556	125,910	185,464
2004	27,255	48,763	150,602	226,620
2005	31,573	34,036	149,460	215,069
2006	25,736	56,074	150,844	232,654
2007	29,002	60,729	142,431	232,162
2008	17,158	47,287	110,525	174,970
2009	19,468	40,919	122,676	183,063
2010	21,071	44,951	111,927	177,949
2011	18,457	44,645	108,838	171,940
2012	20,766	41,003	123,696	185,465
2013	256	1,212	24,131	25,599

Table 4.11.23 Winter mixing zone estimated number of **angler days** from SRHS by year and area aggregate.

Year	GA/FLE
1981	37,638
1982	37,190
1983	35,074
1984	38,896
1985	38,100
1986	39,726
1987	40,786
1988	40,350
1989	39,838
1990	37,769
1991	34,403
1992	37,064
1993	34,791
1994	33,474
1995	30,715
1996	26,997
1997	29,546
1998	25,825
1999	22,380
2000	23,401
2001	21,626
2002	24,095
2003	19,101
2004	24,798
2005	23,379
2006	24,678
2007	14,719
2008	13,418
2009	13,744
2010	11,735
2011	15,203
2012	15,927
2013	9,372

Table 4.11.24 Gulf of Mexico estimated number of **angler days** from SRHS by year and area aggregate.

Year	FLW/AL	MS	LA	TX	Gulf of Mexico
1981					
1982					
1983					
1984					
1985					
1986	240,077		5,891	56,568	302,536
1987	217,049		6,362	63,363	286,774
1988	195,948		7,691	70,396	274,035
1989	208,325		2,867	63,389	274,581
1990	213,906		6,898	58,144	278,948
1991	174,312		6,373	59,969	240,654
1992	184,802		9,911	76,218	270,931
1993	207,898		11,256	80,904	300,058
1994	204,562		12,651	100,778	317,991
1995	182,410		10,498	90,464	283,372
1996	154,913		10,988	91,852	257,753
1997	149,442		9,008	82,207	240,657
1998	185,331		7,854	77,650	270,835
1999	176,117		8,026	58,235	242,378
2000	159,331		4,952	58,395	222,678
2001	157,243		6,222	55,361	218,826
2002	141,831		6,222	66,951	215,004
2003	144,211		6,636	74,432	225,279
2004	158,430			64,990	223,420
2005	130,233			59,857	190,090
2006	124,049		5,005	70,789	199,843
2007	136,880		2,522	63,764	203,166
2008	130,176		2,945	41,188	174,309
2009	142,438		3,268	50,737	196,443
2010	111,018	498	217	47,154	158,887
2011	157,025	1,771	1,886	47,284	207,966
2012	161,975	1,841	1,839	51,776	217,431
2013	27,900	47	70	6,219	34,236

Table 4.11.25 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	Grand 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
2013		396,840	396,840
Grand Total	21,791,358	10,344,703	32,136,061

4.12 FIGURES

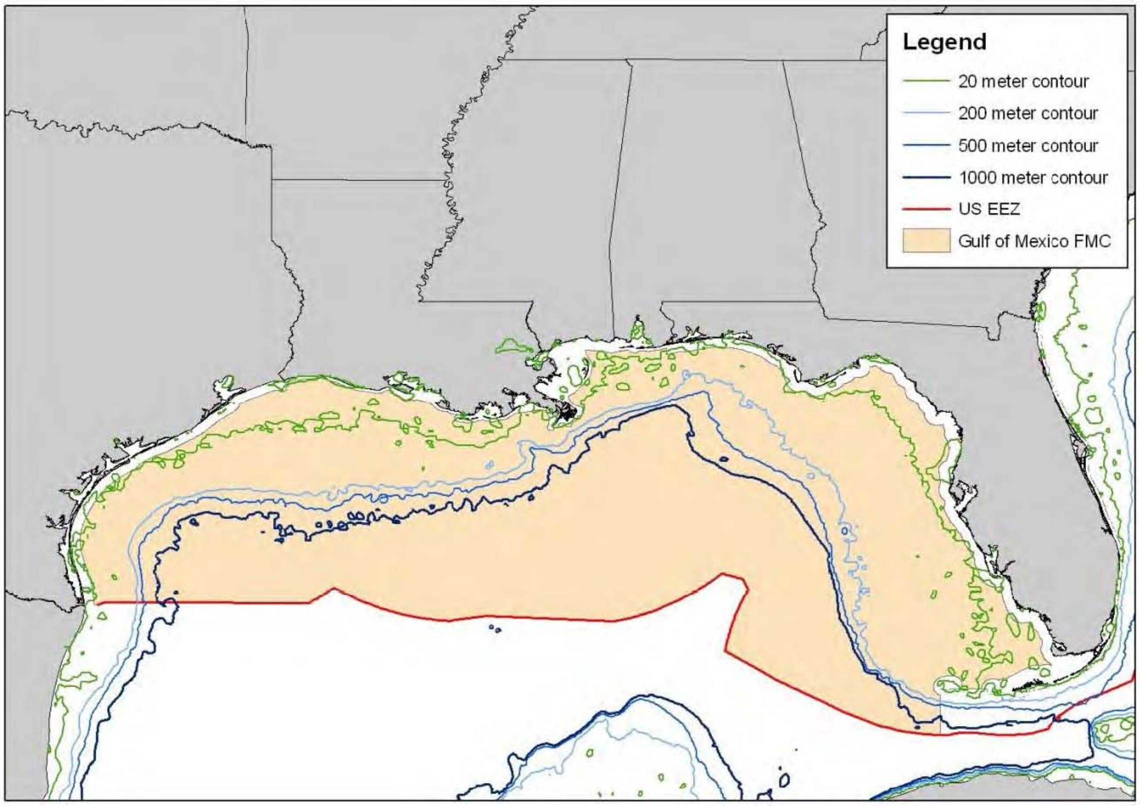

Figure 4.12.1 Gulf of Mexico Fishery Management Council Jurisdictional Boundaries.

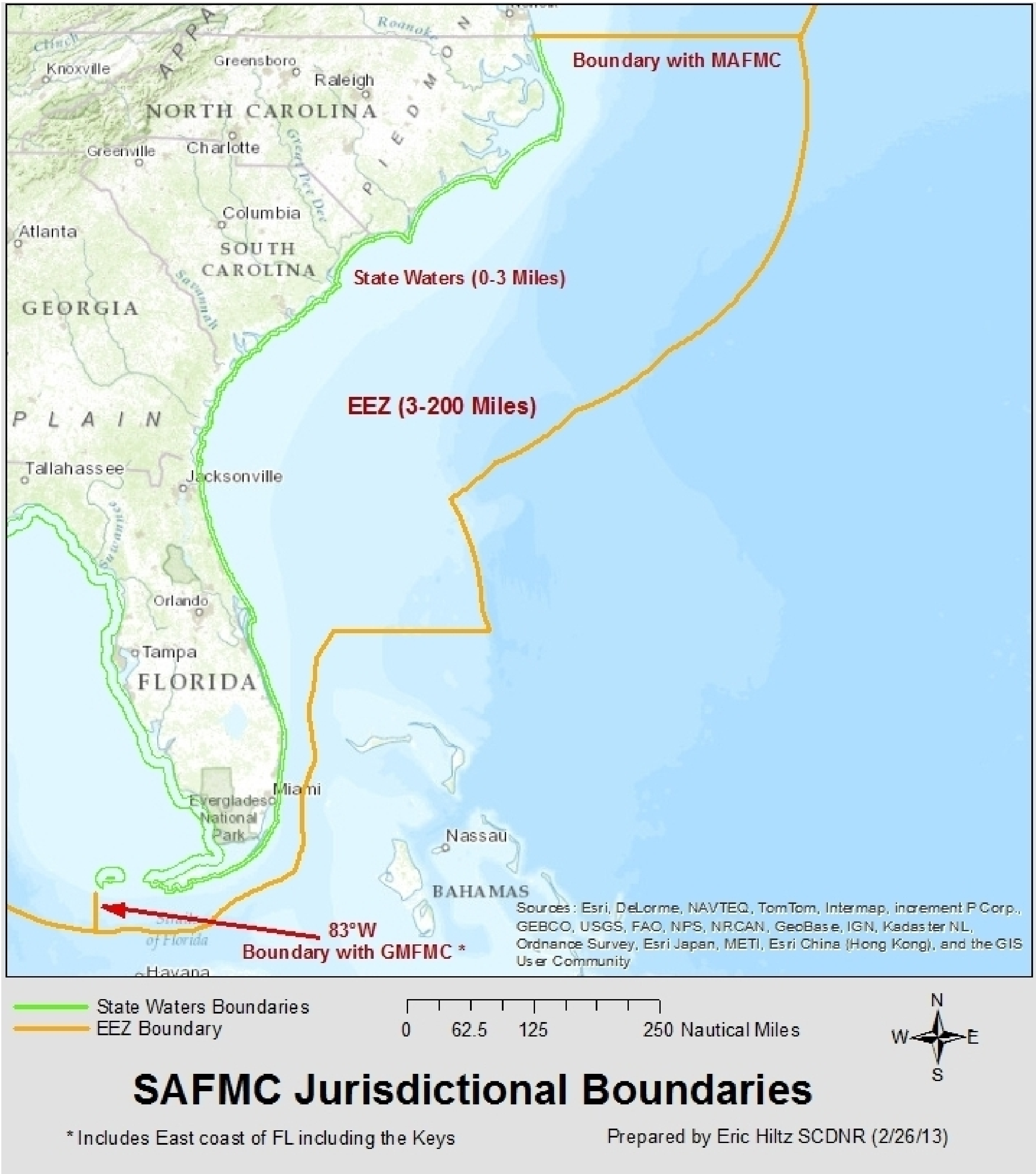

Figure 4.12.2 South Atlantic Fishery Management Council Jurisdictional Boundaries.

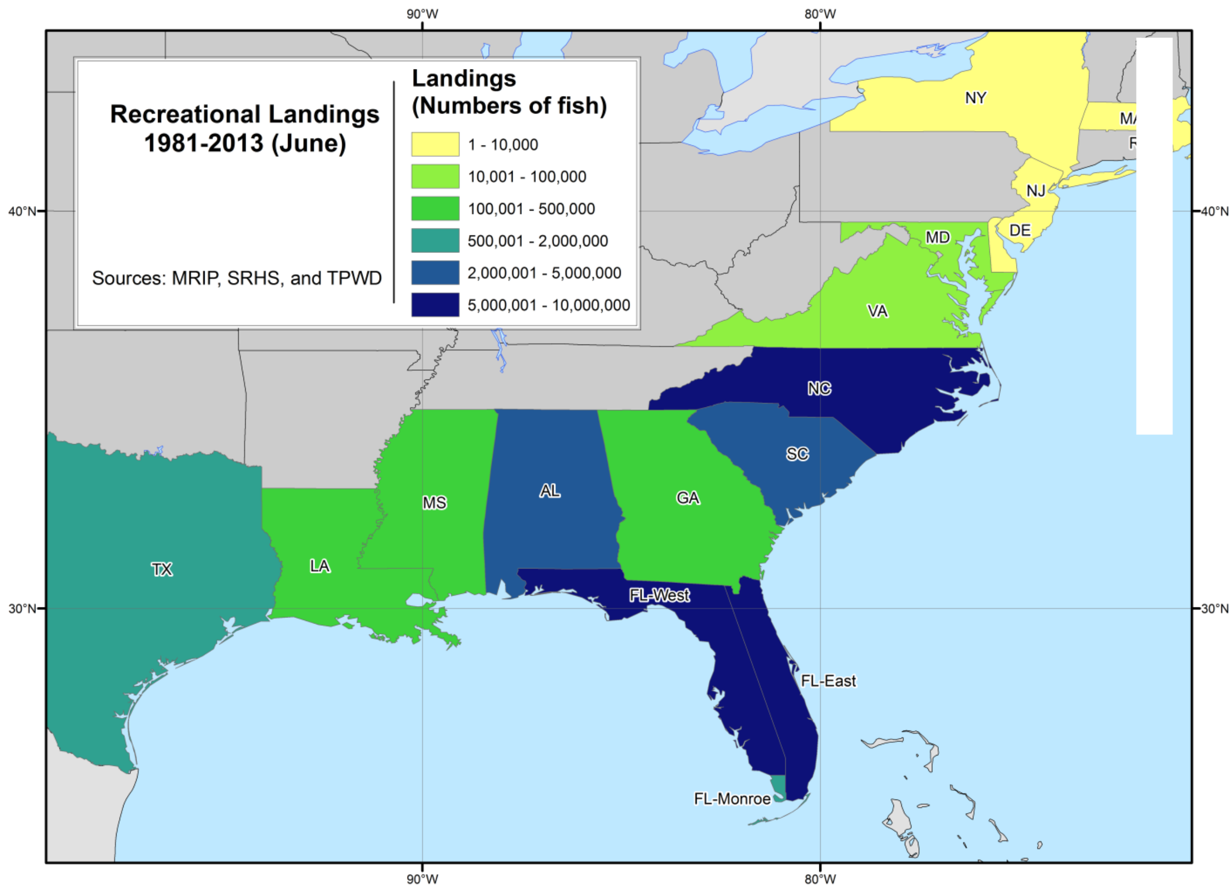

Figure 4.12.3: Atlantic and Gulf of Mexico estimated number of king mackerel landings from MRFSS/MRIP, TPWD, and SRHS (1981-2013, June) by state.

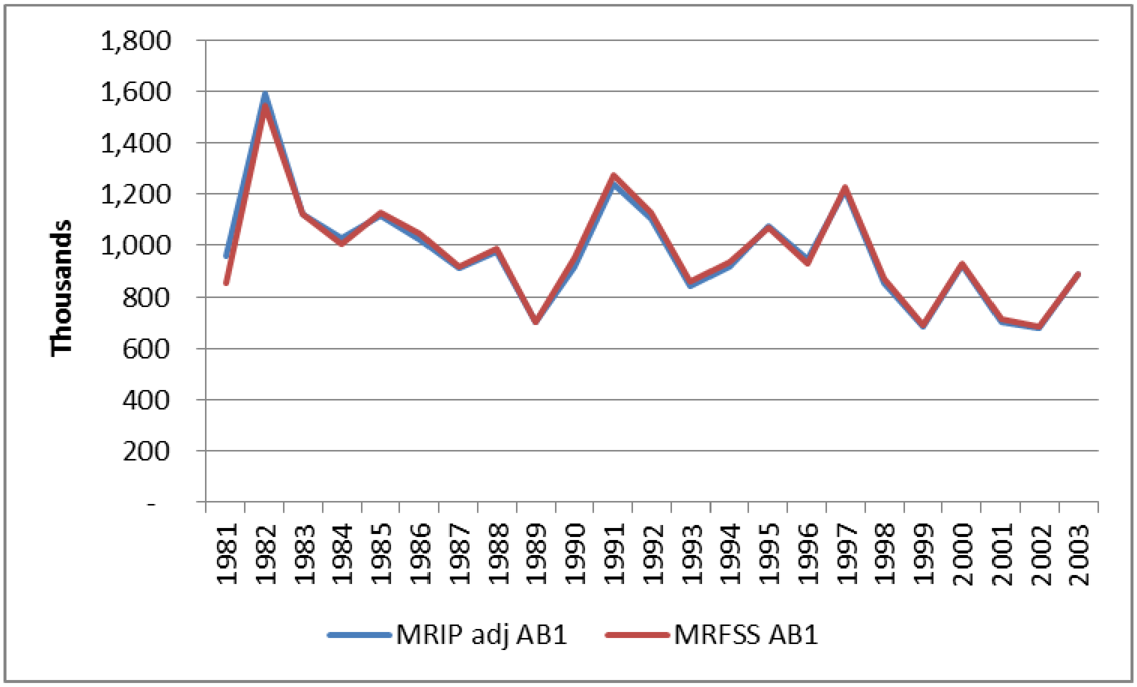

Figure 4.12.4 MRFSS AB1 estimates (number of fish) versus MRIP adjusted AB1 estimates for Atlantic and Gulf of Mexico king mackerel 1981-2003.

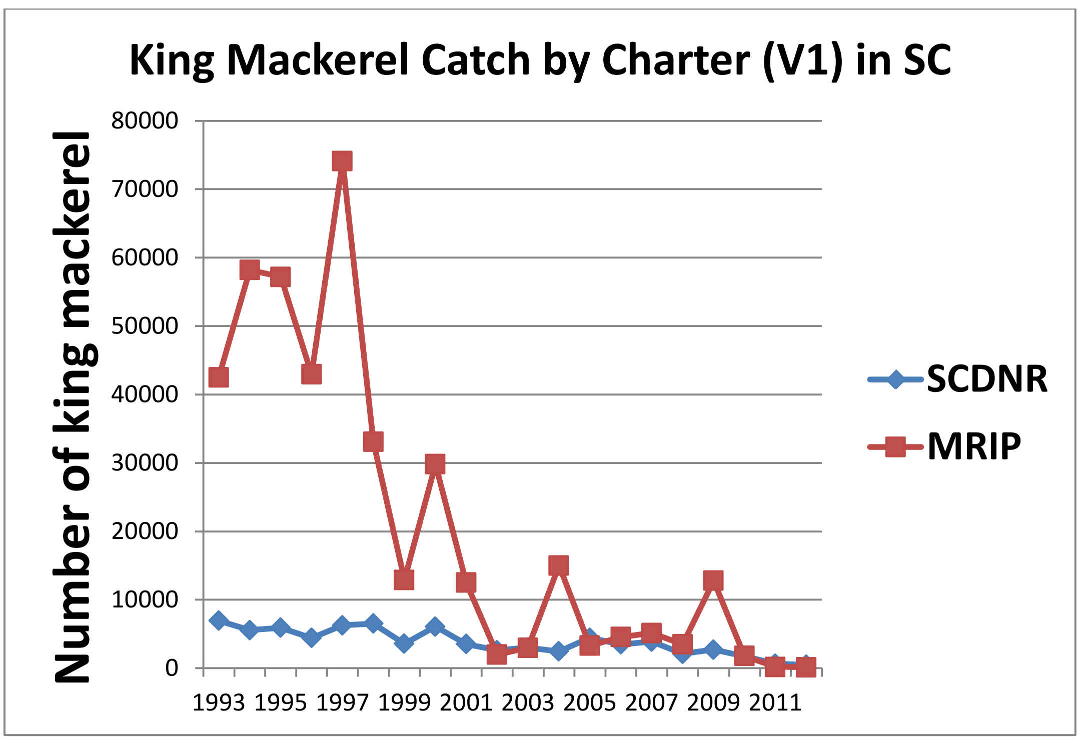

Figure 4.12.5 Comparison of South Carolina charterboat logbook survey and South Carolina MRIP catch estimates for king mackerel.

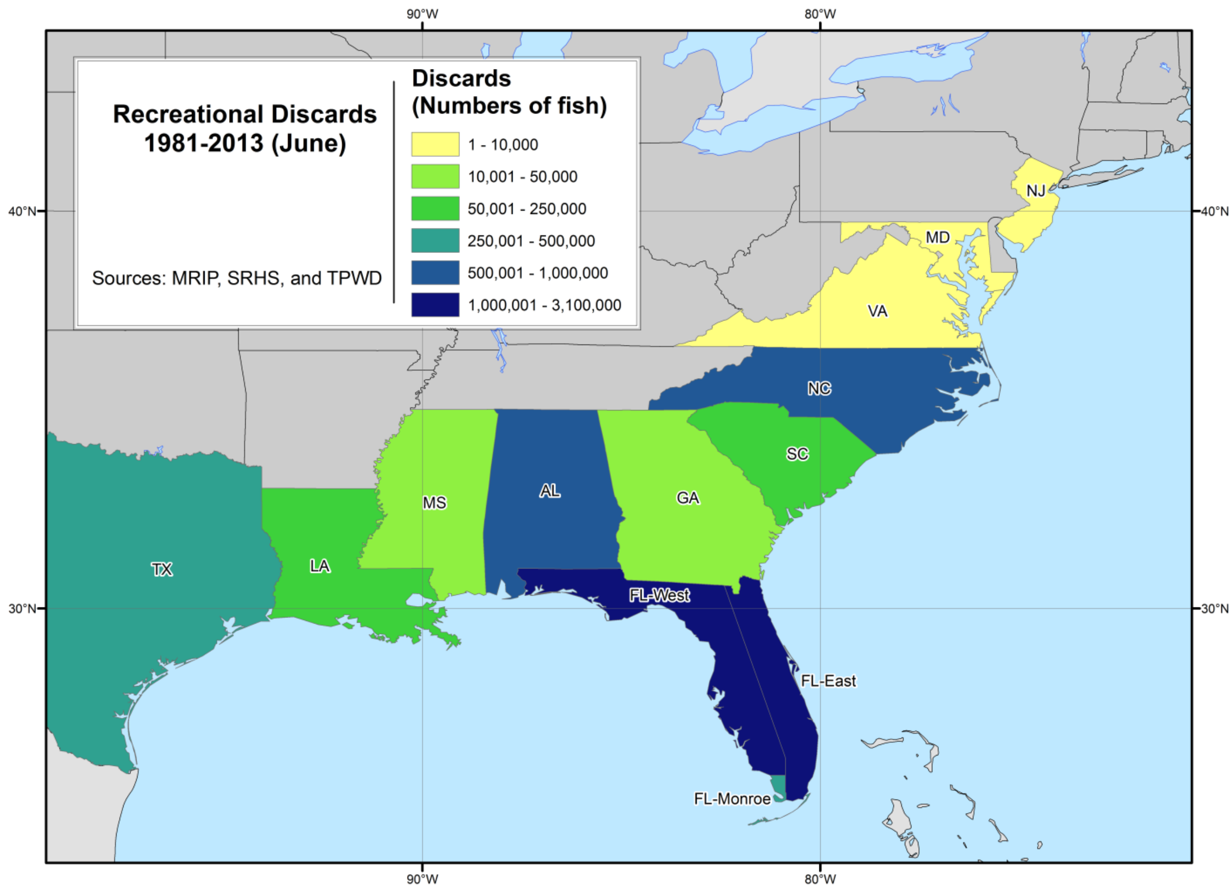

Figure 4.12.6: Atlantic and Gulf of Mexico estimated number of king mackerel discards from MRFSS/MRIP, TPWD, and SRHS (1981-2013, June) by state.

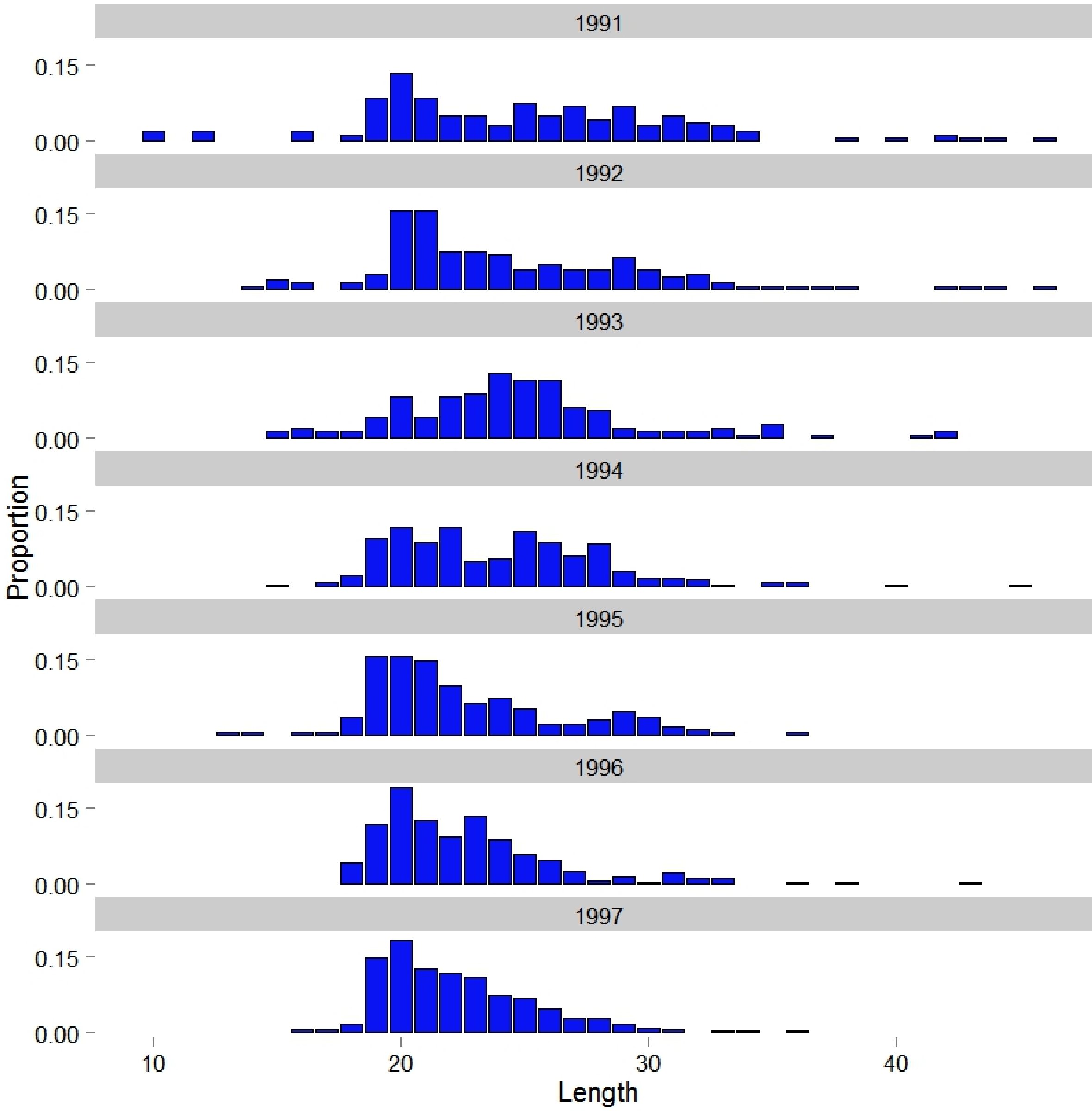

Figure 4.12.7a. Length frequency distributions for king mackerel length samples collected from recreational headboat fisheries located in the Gulf of Mexico from 1991 to 1997.

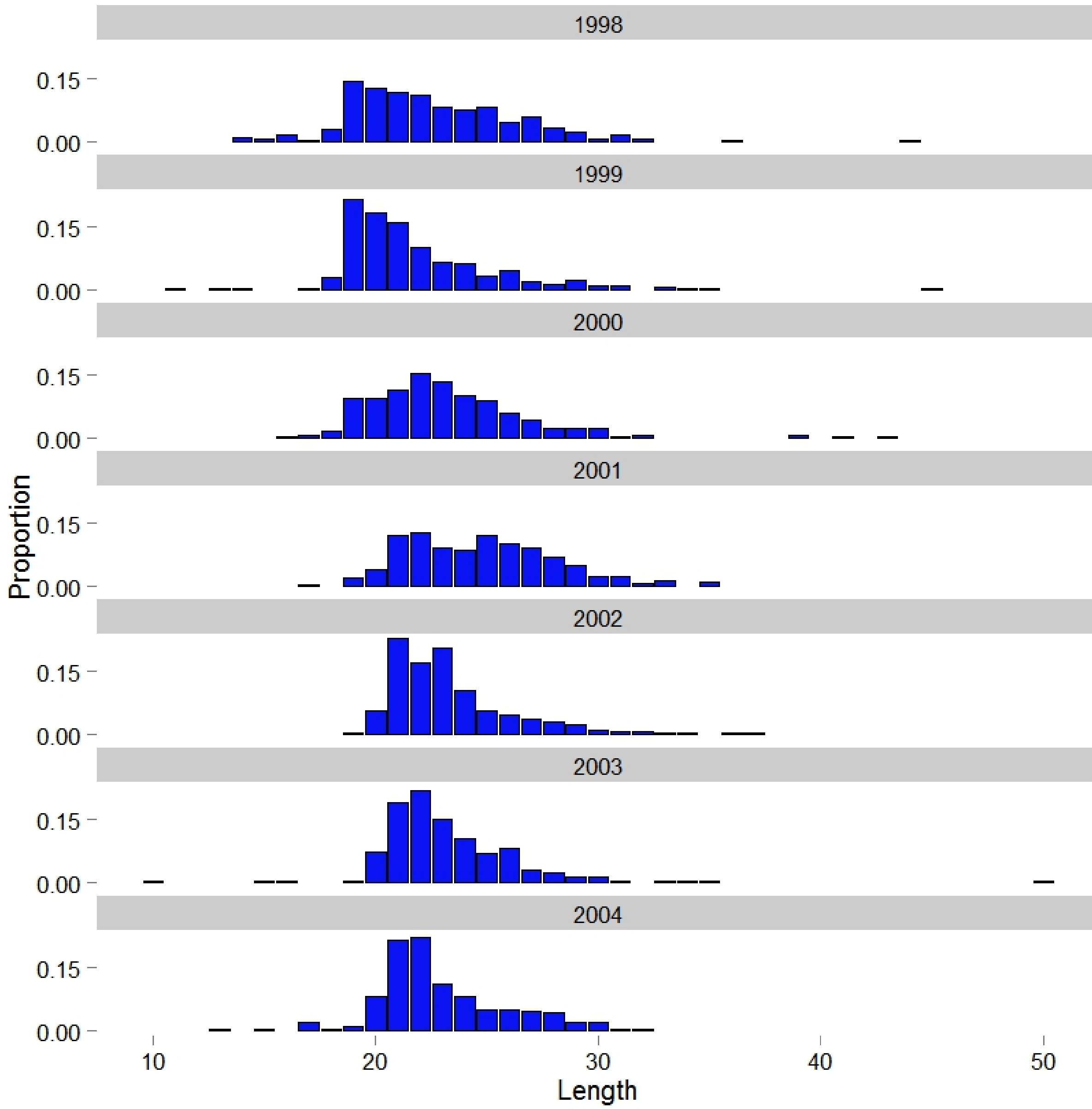

Figure 4.12.7b. Length frequency distributions for king mackerel length samples collected from recreational headboat fisheries located in the Gulf of Mexico from 1998 to 2004.

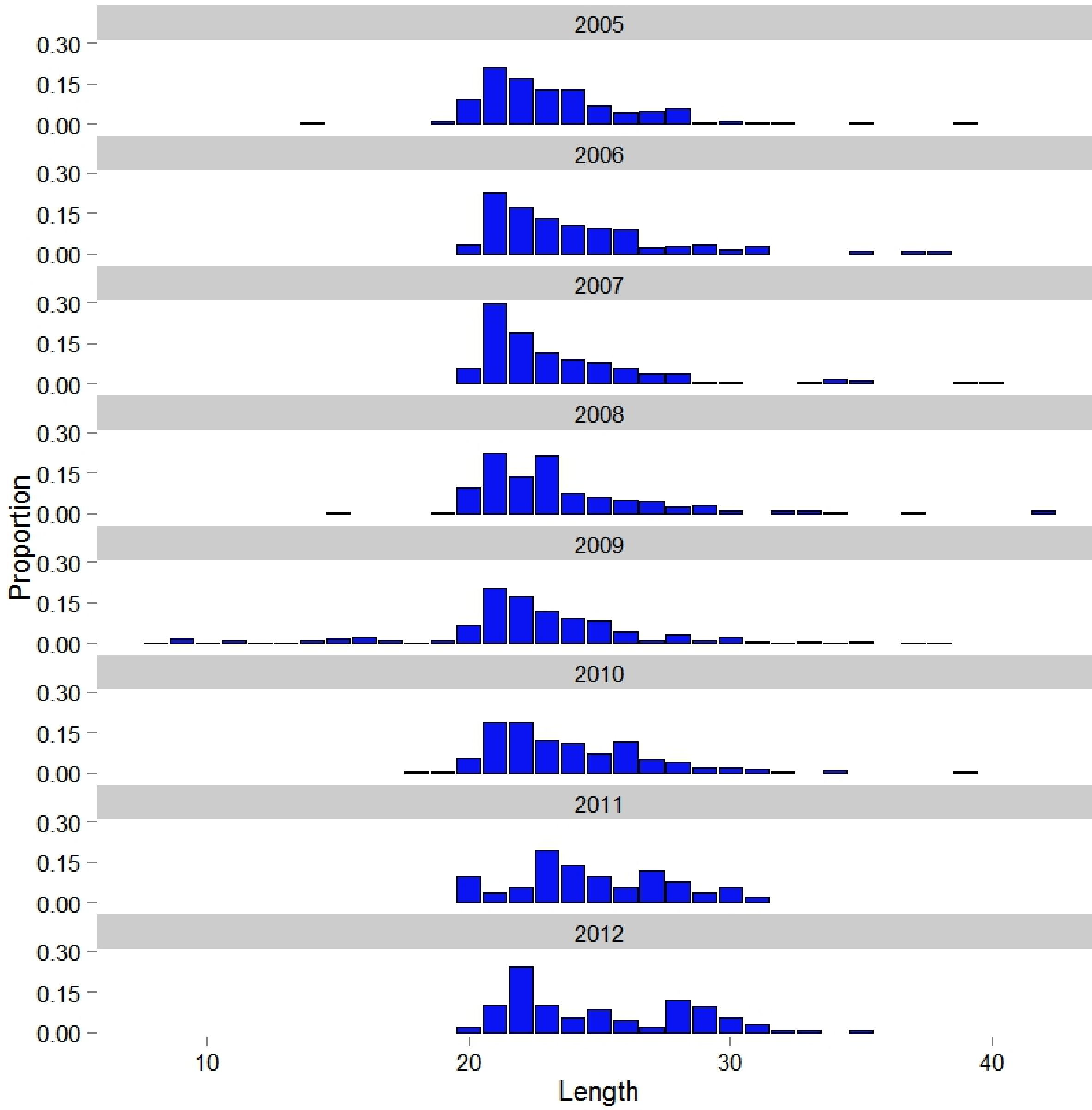

Figure 4.12.7c. Length frequency distributions of king mackerel length samples collected from recreational head boat fisheries located in the Gulf of Mexico from 2005 to 2012.

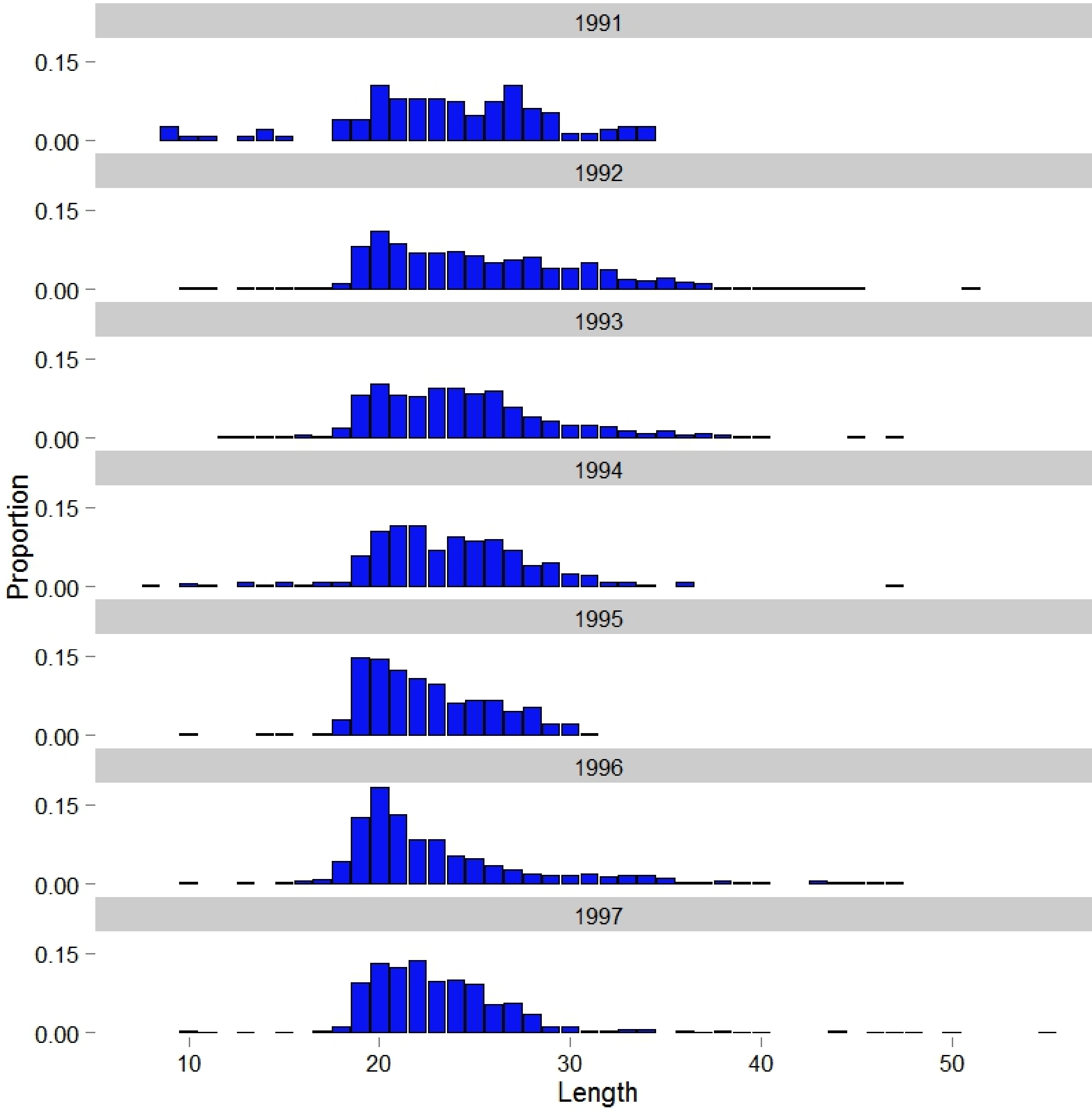

Figure 4.12.8a. Length frequency distributions for king mackerel length samples collected from recreational charter boat and private boat fisheries located in the Gulf of Mexico from 1991 to 1997.

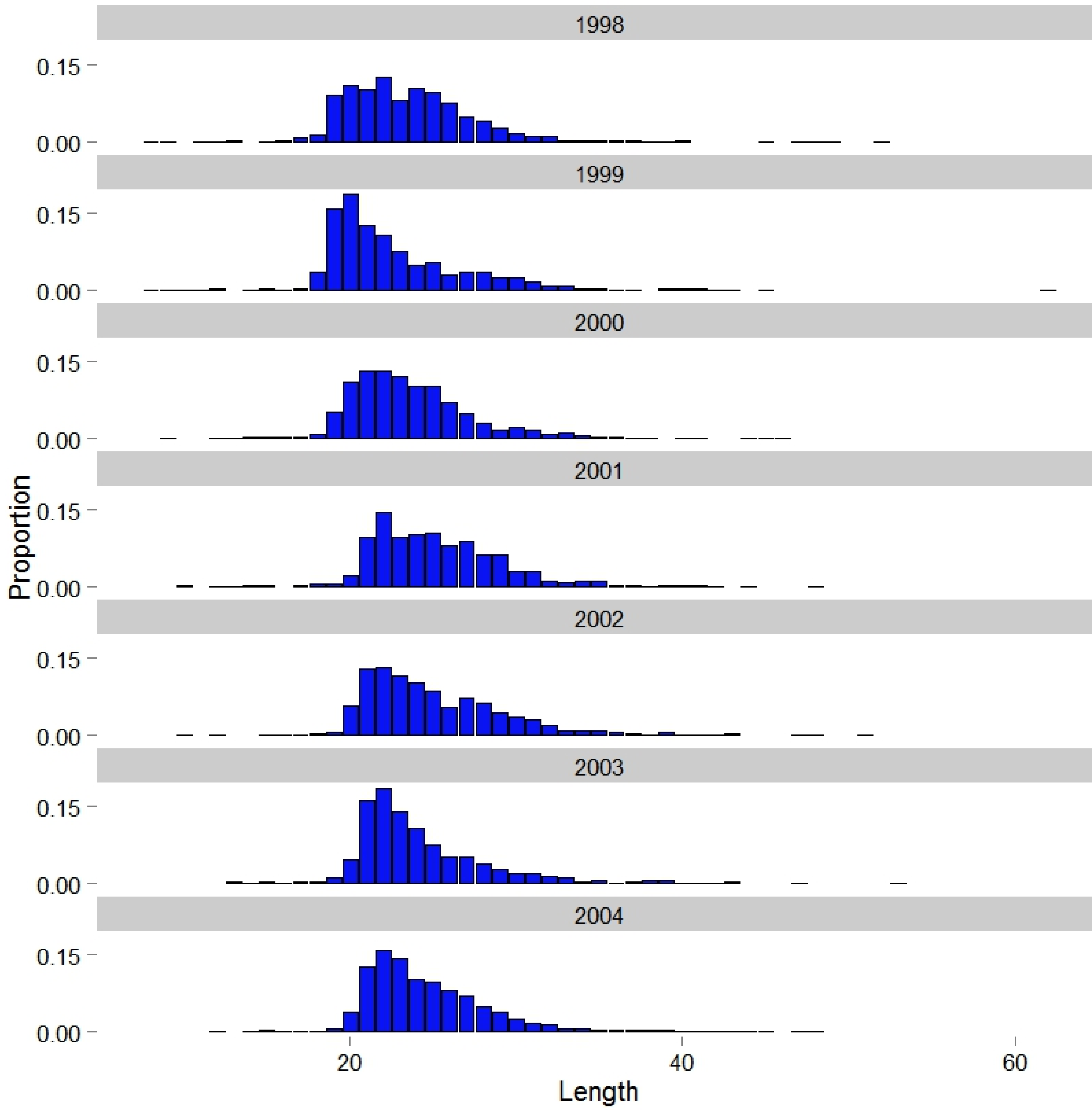

Figure 4.12.8b. Length frequency distributions for king mackerel length samples collected from recreational charter boat and private boat fisheries located in the Gulf of Mexico from 1998 to 2004.

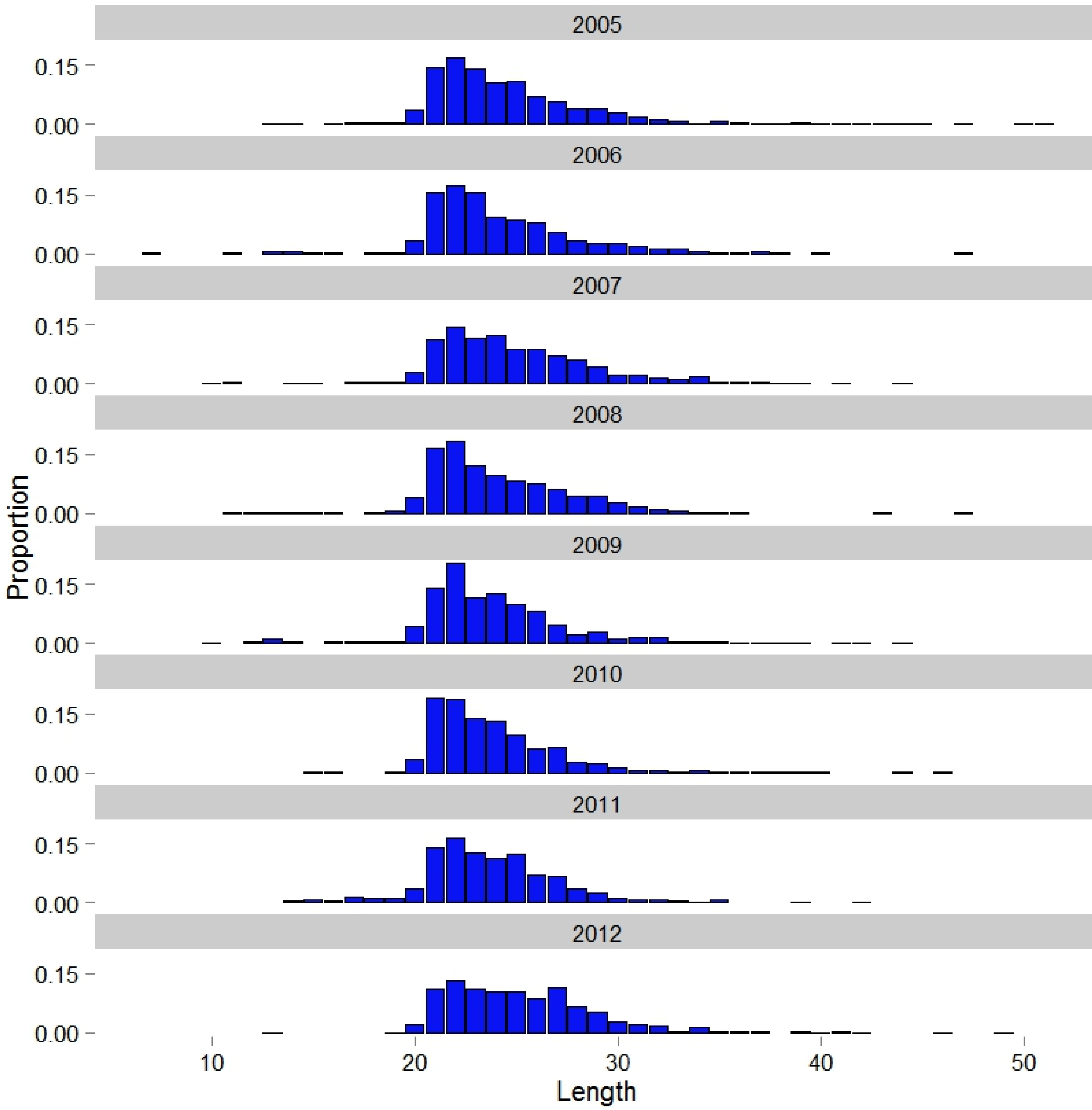

Figure 4.11.8c. . Length frequency distributions of king mackerel length samples collected from recreational charter boat and private boat fisheries located in the Gulf of Mexico from 2005 to 2012.

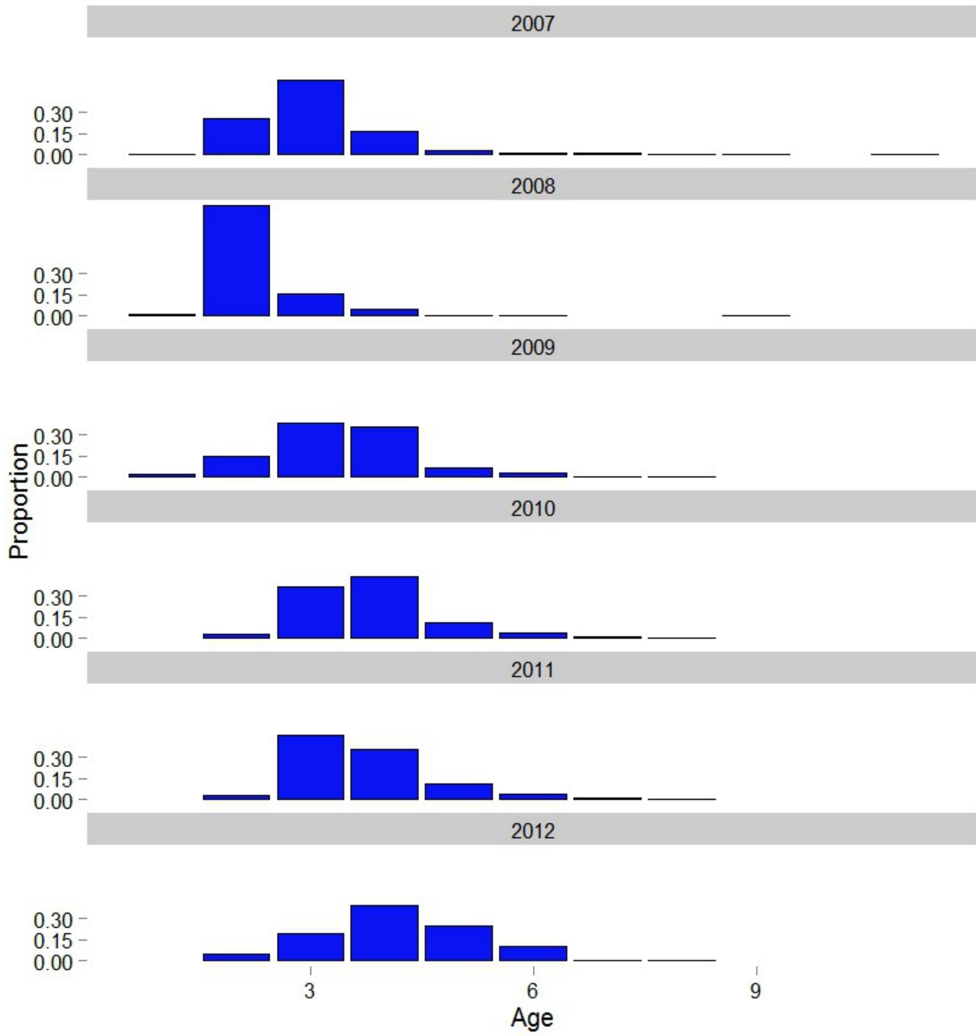

Figure 4.11.9. Reweighted age frequency distributions for king mackerel samples collected from recreational head boat fisheries located in the Gulf of Mexico from 2007 to 2012.

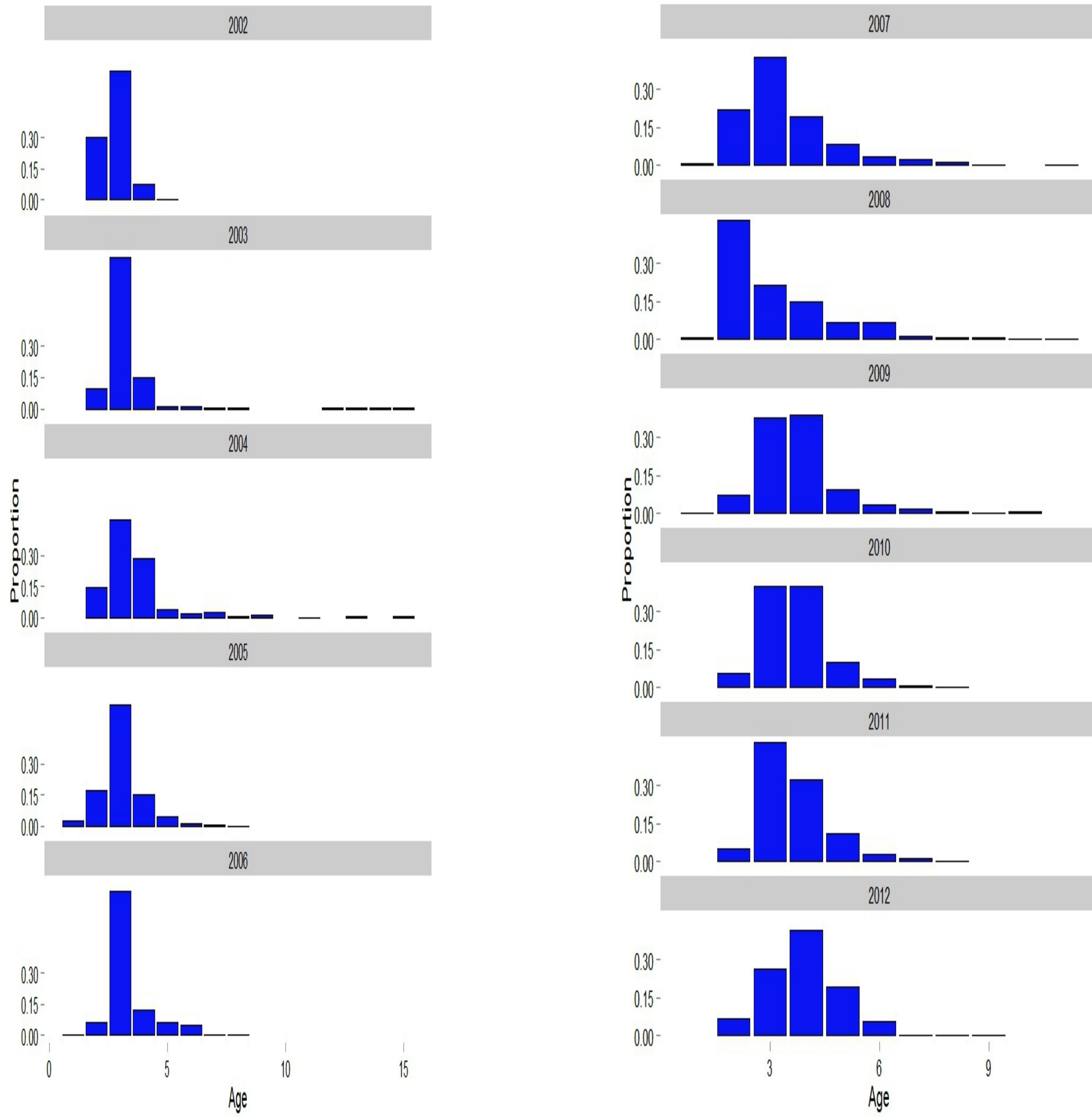

Figure 4.12.10. Reweighted age frequency distributions for king mackerel samples collected from recreational charter boat and private boat fisheries located in the Gulf of Mexico 2002 to 2012.

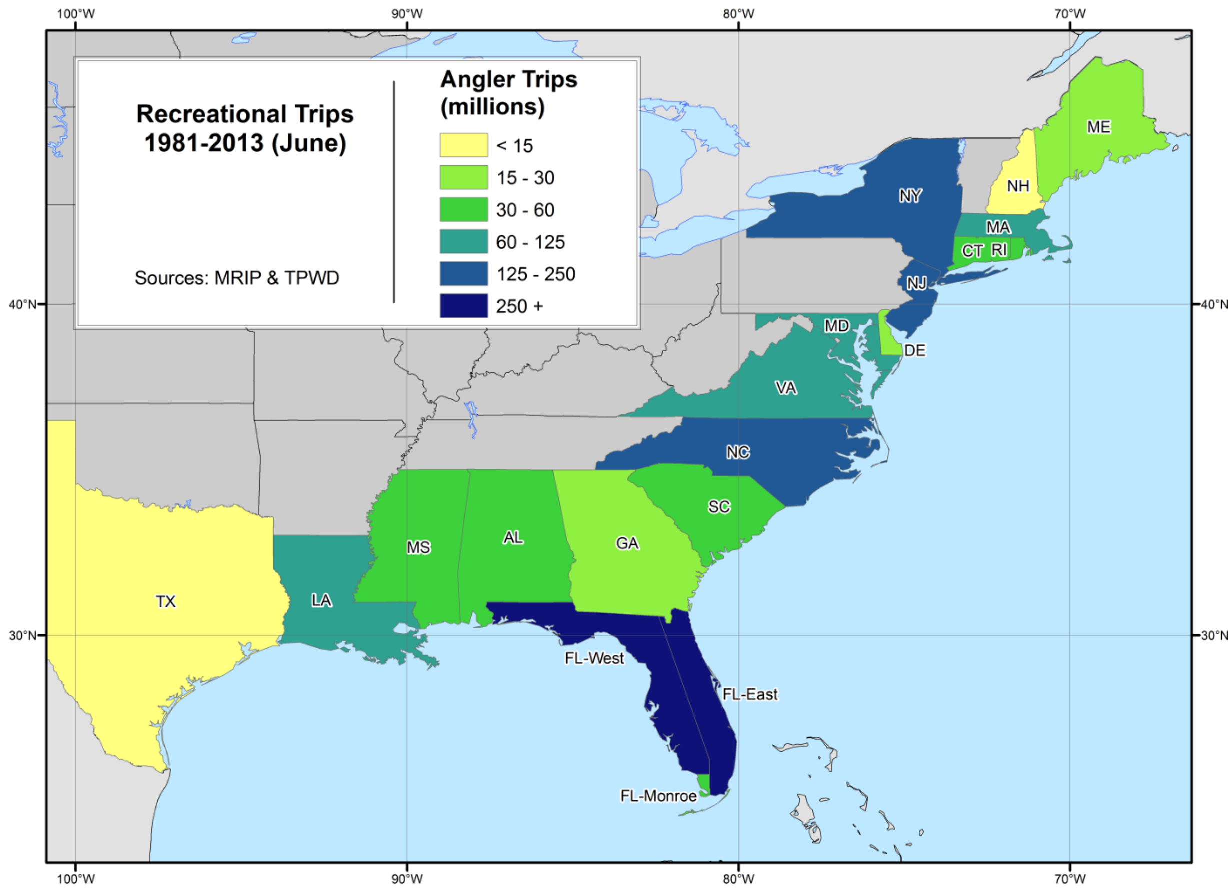

Figure 4.12.11: Atlantic and Gulf of Mexico estimated number of angler trips from MRFSS/MRIP (1981-2013, June) and TPWD (1983-2013, May) by state.

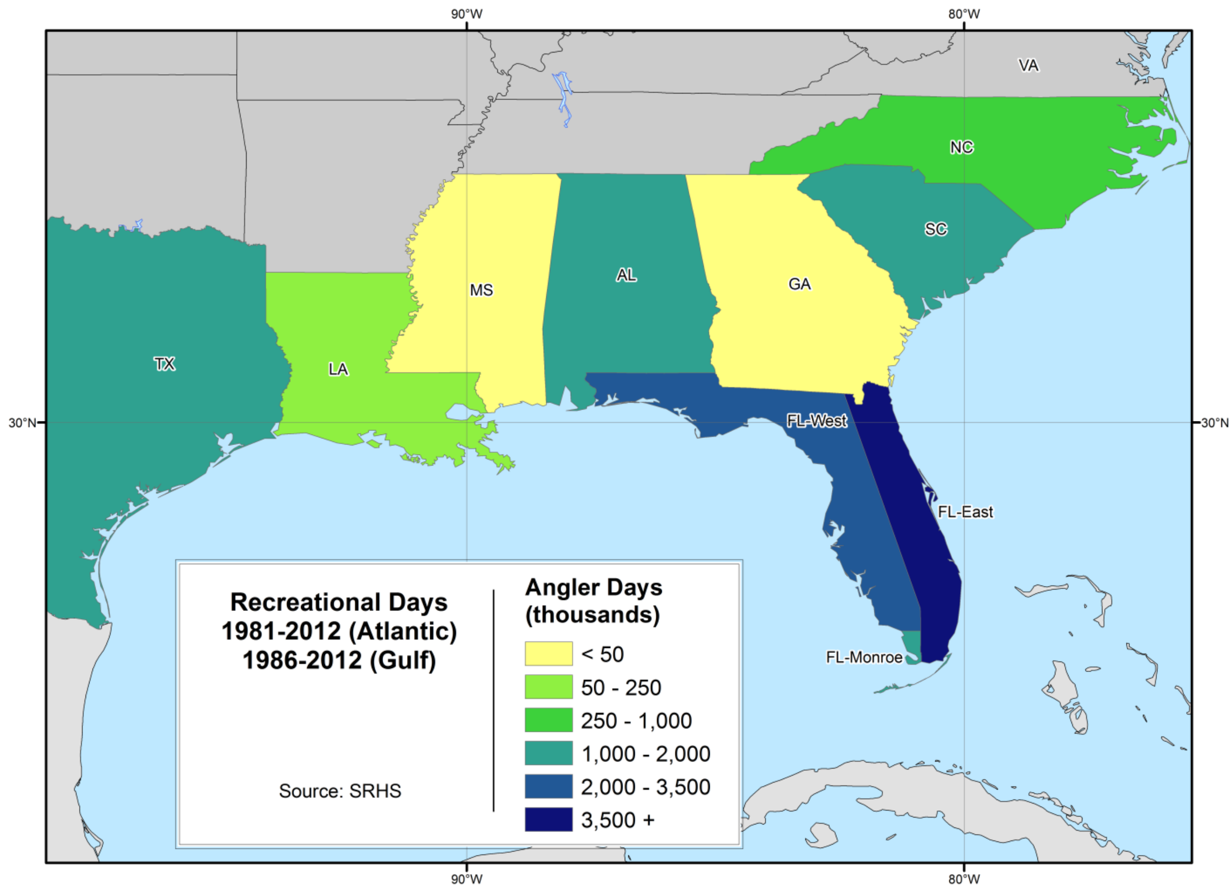

Figure 4.12.12: South Atlantic and Gulf of Mexico estimated number of angler days from SRHS (Atlantic 1981-2012; Gulf 1986-2012) by state.

5. MEASURES OF POPULATION ABUNDANCE

5.1 OVERVIEW

The working group was chaired by Matthew Lauretta (SEFSC). Participants included John Walter (SEFSC), David Hanisko (SEFSC), Tracy Smart (SCDNR), Jeanie Boylan (SCDNR), Jon Richardson (SCDNR), Mary Christman, Peter Barille, and Christian Johnson (UMCES). The working group presented and reviewed documents pertaining to indices of relative abundance for the assessment of King mackerel stocks. A list of the reviewed documents is provided in **Table 5.7.1**.

The working group reviewed the methods and relative abundance indices to be used in the SEDAR 38 continuity assessment model, replicating the methods of the previous assessment, SEDAR 16. The continuity model is the VPA base assessment accepted by the previous assessment panel (SEDAR 16), and associated methods for relative abundance indices standardization were adapted for the continuity indices. For the continuity indices, the Atlantic non-mixing zone was defined to be north of Volusia/Flagler counties line in the Atlantic all year, and including the region between Collier/Monroe counties line and Volusia/Flagler counties line during from April 1 to October 31, the Gulf of Mexico non-mixing zone was defined to be north and west of the Collier/Monroe counties line of Florida to the Texas/Mexico border, and a "winter mixing zone" was defined to be the region between the Collier/Monroe counties line and Volusia/Flagler counties line in Southeast Florida from November 1 through March 31. Indices of relative abundance (fishery independent and dependent) were requested for these regional areas during the data scoping webinar with the provisions that different spatial-temporal partitioning of the mixing zone may emerge from the Data Workshop. The above partitions and index constructions are intended to demonstrate the result of updating the indices using methods consistent with SEDAR 16. Each continuity index was reviewed according to the protocols determined by the SEDAR Abundance Indices Workgroup (SEDAR Procedures Workshop 1), a checklist report card was completed for each reviewed index and the report cards were compiled into a single document (SEDAR 38-DW-05), along with tabulated summaries of the working group notes related to each index. **Table 5.7.2** summarizes the updated continuity indices for SEDAR 38 continuity assessment of Atlantic King mackerel, and **Table 5.7.3** summarizes the continuity indices for Gulf of Mexico King mackerel.

According to the SEDAR 38 Terms of Reference, a primary objective of the 2014 assessment of King mackerel is to review the stock structure and stock unit definitions of Atlantic and Gulf of Mexico migratory groups. After review of submitted working documents and synthesis of information presented by the life history group, the stock delineations and mixing zone boundary were redefined by the life history group to be (1) U.S. South Atlantic King mackerel stock ranges from North Carolina to Florida at the Monroe-Dade counties line during November 1st to March 31st, and North Carolina to Florida including Monroe County south of the Florida Keys during April 1st to October 31st, (2) the Gulf of Mexico King mackerel stock ranges from Texas to Florida including Monroe County north of the Florida Keys during all months of the year, and (3) the winter mixing zone is defined to be Monroe County, Florida, south of the Keys during November 1st to March 31st. After discussion of indices spatial coverage and distribution, it was concluded that the change in stock unit definitions may affect fishery dependent indices of abundance by the inclusion of samples from the Florida Atlantic coast which were previously excluded. The fishery independent indices of abundance will remain unaffected by this change in stock unit definitions, since sampling is limited in the extended spatial areas, or the spatial strata is already excluded from the analysis for additional reasons. North Carolina trip ticket indices will not change as a result of the change in stock units. It was recommended that samples from the Gulf of Mexico, north of the Florida Keys in Monroe County be excluded from the Gulf stock indices standardization. The change in stock unit definitions is expected to alter the sample distribution of recreational and commercial indices for the Atlantic stock, including

Headboat, MRFSS, and Logbook indices. Further investigation and discussion on the effects of the change in stock unit definitions on standardized indices was requested.

5.2 REVIEW OF WORKING PAPERS

All documents pertaining to indices of relative abundance for the assessment of King mackerel stocks were presented and reviewed by the working group (**Table 5.7.1**). Information sources reviewed included five fishery dependent indices for the Atlantic stock; recreational Headboat, Marine Recreational Fisheries Statistics Survey (MRFSS/ MRIP), commercial Logbook, North Carolina commercial Trip Tickets, and South Carolina Pier recreational Survey; and one fishery independent index, the Southeast Area Monitoring and Assessment Program (SEAMAP) Trawl Survey. Data sources reviewed for the Gulf of Mexico stock included three fishery dependent indices; recreational Headboat, MRFSS/MRIP and commercial Logbook. Three fishery independent indices were reviewed; SEAMAP Fall Plankton Survey, SEAMAP Fall Trawl Survey, and SEAMAP Small Pelagics Survey. It was recommended that two indices be excluded from the assessment, the South Carolina Pier Survey due to lack of effort information and small spatial coverage, and the SEAMAP Small Pelagics Survey due to low observed frequency of occurrence and the potentially spurious influence of outliers (i.e. the majority of King mackerel observed occurred within a single sample). All other indices were recommended for consideration of inclusion in both the continuity and base assessment models and are discussed in detail below.

5.3 FISHERY INDEPENDENT SURVEYS

The fishery independent survey for the Atlantic includes the SEAMAP Trawl Survey, and the fishery independent surveys for the Gulf of Mexico include the SEAMAP Fall Trawl, and the SEAMAP Fall Plankton Survey.

5.3.1 *Methods, Gears, and Coverage*

SEAMAP Trawl Survey-Atlantic. Survey methods are described in detail in SEDAR 38-DW-11. Samples are taken with a modified falcon bottom trawl net (22.9 m, 1.975 cm mesh, 20 min tow duration) from the coastal zone of the South Atlantic Bight (SAB) between Cape Hatteras, North Carolina, and Cape Canaveral, Florida (**Figure 5.8.1**). Multi-day survey cruises are conducted in spring (early April to mid-May), summer (mid-July to early August), and fall (October to mid-November). Stations are randomly selected from a designated pool of stations within each stratum between 4 and 10 m depth contours. A delta-lognormal generalized linear model analysis was conducted using a base-10 data transformation. Covariates examined included fishing year, area, season, depth, temperature, and salinity (backward factor selection based on AIC selection criteria).

SEAMAP Fall Trawl Survey-Gulf of Mexico. Survey methods are described in detail in SEDAR 38-DW-02. The survey follows a stratified random sampling design with sample station location assignment and strata defined by depth zones, shrimp statistical zones and time of day. At each sample station, trawling was done with a 40-ft shrimp survey trawl. **Figure 5.8.1** depicts the sampling spatial effort distribution in the Atlantic and Gulf of Mexico survey. A delta-lognormal generalized linear model analysis was conducted using a natural log data transformation of positive catch rates. Backward factor selection was based on AIC model selection criteria. Covariates examined included fishing year, shrimp statistical zone, and depth (categorical).

SEAMAP Fall Plankton Survey-Gulf of Mexico. The development of the SEAMAP Larval Index from the plankton survey is described in the document SEDAR38-DW-01. The SEAMAP Fall Plankton survey covers coastal and continental shelf waters from Texas to south Florida and is thought to span the majority of the spatial extent of King mackerel spawning area in the U.S. Gulf of Mexico (**Figure 5.8.1**). The survey uses a 60-cm bongo plankton tow net (oblique tow) to capture larval fishes. The relative abundance of larvae from this survey has been used as a proxy for the abundance of spawners in the Gulf stock unit in previous assessments. A delta-lognormal generalized linear model analysis was conducted using a natural log data transformation of positive catch rates. Forward factor selection was based on model deviance per degree of freedom criteria. Covariates examined included fishing year, region, depth (categorical), and time of day (categorical).

5.3.2 Sampling Intensity – Time Series

SEAMAP Trawl Survey-Atlantic. The survey has been conducted from 1986 to present; however, due to inconsistencies in survey methods during the first years, data from 1986 to 1989 were excluded from the time series. The number of stations sampled per survey year ranged from 102 to 306. The number of King mackerel captured per year ranged from 270 to 4,158.

SEAMAP Fall Groundfish Survey-Gulf of Mexico. The survey has been conducted since 1972; however, methodologies for the modern standardized survey design have been implemented from 1987 to present. In order to incorporate the early survey data (i.e. 1972 to 1986), data were post-stratified into the strata defined by the modern survey. These strata served as the covariates in each sub-model of a delta-lognormal generalized linear model. The number of King mackerel specimens collected per year ranged from 0 to 215.

SEAMAP Fall Plankton Survey-Gulf of Mexico. The Fall Plankton survey began in 1986 and continues to be conducted annually. Due to tropical storms, the survey was cancelled in 1998 and 2005. Only bongo net samples from the 1986 to 1997, 1999 to 2004 and 2006 to 2012 surveys, taken in accordance with the sample design from stations sampled during at least ten years of the time series, were used to calculate the King mackerel larval index. The index is based on approximately 110 samples each year.

5.3.3 Size/Age data

SEAMAP Trawl Survey-Atlantic. The size of King mackerel captured in the trawl ranged from 4 to 43 cm fork length. Size frequency distribution of sample King indicated that this survey catches “young-of-the-year” King mackerel (age 0).

SEAMAP Fall Groundfish Survey-Gulf of Mexico. The size of King mackerel captured in the Gulf of Mexico trawl survey ranged from 6 to 80 cm fork length with an overall mean fork length of 25 cm. The index is assumed to represent the relative abundance of “young-of-the-year” King mackerel (age 0) in the western Gulf of Mexico.

SEAMAP Fall Plankton Survey-Gulf of Mexico. Larvae captured in bongo nets ranged from 0.1 to 1.4 cm body length with a mean of 0.3 cm. The index is assumed to represent a proxy for spawning stock abundance (ages 1-11+) in the Gulf of Mexico.

5.3.4 Catch Rates – Number and Biomass

SEAMAP Trawl Survey-Atlantic. Catch rates of King mackerel are calculated as number of fish per hour of trawling. **Figure 5.8.2** displays the observed and predicted means by fishing year, along with 95% confidence intervals of GLM predictions.

SEAMAP Trawl Survey-Gulf of Mexico. Catch rates of King mackerel are calculated as number of fish per hour of trawling. **Figure 5.8.3** displays the observed and predicted means by fishing year, along with 95% confidence intervals of GLM predictions.

SEAMAP Fall Plankton Survey-Gulf of Mexico. Catches of larvae in bongo net samples are standardized to account for sampling effort and expressed as number of larvae per 10 m^2 sea surface area. **Figure 5.8.3** displays the observed and predicted means by fishing year, along with 95% confidence intervals of GLM predictions.

5.3.5 Uncertainty and Measures of Precision

SEAMAP Trawl Survey-Atlantic. Measures of index precision are calculated as coefficient of variation and 95% confidence intervals of the predicted least squares means per fishing year (**Table 5.7.2**). Coefficient of variation for the continuity indices ranged from 0.17 to 0.29.

SEAMAP Trawl Survey-Gulf of Mexico. Measures of index precision are calculated as coefficient of variation and 95% confidence intervals of the predicted least squares means per fishing year (**Table 5.7.3**). Coefficient of variation for the continuity indices ranged from 0.20 to 1.10.

SEAMAP Fall Plankton Survey-Gulf of Mexico. Measures of index precision are calculated as coefficient of variation and 95% confidence intervals of the predicted least squares means per fishing year (**Table 5.7.3**). Coefficient of variation for the continuity indices ranged from 0.20 to 0.53.

5.3.6 Comments on Adequacy for assessment

SEAMAP Trawl Survey-Atlantic. The workgroup recommended this fishery independent index be included in the stock assessment as a measure of abundance for "young-of-the-year" Atlantic King mackerel, consistent with the previous assessment. The group recommended that inclusion of environmental covariates that demonstrate long-term trends be carefully considered whether the covariate is likely to affect the population or the catchability of the gear. If the covariate results in a population effect (e.g., low or high recruitment), then it should be excluded from the indices standardization and incorporated into the assessment models. If the covariate is expected to affect gear catchability, then it should be included in the standardization model. For this index, temperature is thought to affect the catchability of the gear and modeling as a covariate was determined to be appropriate.

SEAMAP Trawl Survey-Gulf of Mexico. The workgroup recommended this fishery independent index be included in the stock assessment as a measure of abundance for "young-of-the-year" Gulf of Mexico King mackerel, consistent with the previous assessment. No concerns were raised related to this recommendation.

SEAMAP Fall Plankton Survey-Gulf of Mexico. The workgroup recommended this fishery independent index be included in the stock assessment as a measure of abundance for spawning stock biomass of Gulf of Mexico King mackerel, consistent with the previous assessment. No concerns were raised related to this recommendation.

5.4 FISHERY-DEPENDENT MEASURES

5.4.1 Methods of Estimation

NMFS MRFSS-Atlantic and Gulf of Mexico. Standardization methods are described in detail in SEDAR 38-DW-04. Data were restricted to include hook and line gear only, and stock units for the continuity model were based on SEDAR 16 stock definitions. A delta-lognormal generalized linear model analysis was conducted using a natural log data transformation. Covariates examined included fishing year, region, season, mode (charter, private vessel, or shore), guild (pelagic, reef, inshore, unclassified, carcharhinid) and area (inshore, state, and EEZ). Forward factor selection was based on model deviance reduction criteria. Factor interactions were tested as fixed effects and modeled as random effects. Indices of abundance were estimated for the King mackerel Gulf of Mexico and Atlantic migratory groups, excluding samples from the winter mixing zone (SEDAR 16 stock unit definitions) during November 1 to March 31.

NMFS Headboat-Atlantic and Gulf of Mexico. Standardization methods are described in detail in SEDAR 38-DW-16. Data were restricted to include vessels that fished at least 10 years over the time series, and trip selection was based on co-occurring species (Stephens and McCall 2004). Stock units for the continuity model were based on SEDAR 16 stock definitions. A delta-lognormal generalized linear model analysis was conducted using a natural log data transformation and repeated measures analysis to estimate variance between individual vessels. Covariates examined included fishing year, region, and season. Forward factor selection was based on model deviance reduction criteria. Factor interactions were tested as fixed effects and modeled as random effects. Indices of abundance were estimated for the King mackerel Gulf of Mexico and Atlantic migratory groups, excluding samples from the winter mixing zone (SEDAR 16 stock unit definitions) during November 1 to March 31.

NMFS Logbook-Atlantic and Gulf of Mexico. Five indices were constructed from the NMFS coastal logbook program for King mackerel for the years 1993-2013 using a delta lognormal model. Vessels were selected for inclusion in the index by sorting the vessels by the number of years that they have reported landings and the total magnitude of their landings. Vessels catching up to 80% of the total landings were retained. This was done to limit the analysis to vessels that generally targeted King mackerel and would be good candidates for tracking relative abundance signals. Three indices represent updated (refit models) versions of indices used in SEDAR 16 for the Gulf, Mixing zone and South Atlantic, constructed by calendar year. The other indices were revised versions of the continuity indices and were constructed by fishing year for the Gulf and for the Atlantic plus the summer mixing zone commensurate with data partitioning instructions for SEDAR 38. Vessel selection, trip selection, data processing and handling of regulatory impacts largely mimic those of SEDAR 16.

North Carolina Trip Index-Atlantic. The North Carolina trip ticket index was developed as a strict update to the index used in SEDAR 16 (SEDAR16-DW-11) and follows similar methodology. The data analyzed included single trip catch information for all commercial fishers from 1994 to spring of 2013 (2012-2013 fishing year) collected by the Trip Ticket Program. Analyses took into account not only trips targeting mackerels, but also other coastal pelagic species likely associated with the catch of mackerels using a Stephens and McCall (2004) trip selection approach. Standardization procedures used generalized linear models (GLMs) with a delta lognormal approach with year and season as factors.

5.4.2 Sampling Intensity

NMFS MRFSS-Atlantic and Gulf of Mexico. The MRFSS data has been collected since 1980, based on dock intercept and telephone survey information. Data from 1980 are limited in spatial coverage and were excluded from the analysis. Sample sizes used in the analysis (after applied filters) ranged from 4,665 to 7,876 surveys per year during 1981 to 1985 and ranged from 11,896 to 24,892 surveys per year during 1986 to present in the Atlantic excluding SEDAR 16 winter mixing zone. Samples sizes in the Gulf of Mexico (excluding SEDAR 16 winter mixing zone) ranged 4,295 to 6,847 from 1981 to 1985, and ranged 9,014 to over 40,000 samples per year during 1986 to present.

NMFS Headboat-Atlantic and Gulf of Mexico. In the Atlantic region, catch and effort data are available from Cape Lookout, NC southward to the Volusia/Flagler county line in Northeast Florida (SEDAR 16 stock unit definition) from 1979 to 2006. Each year, approximately 2,000 to 4,000 trips are reported. In the Gulf of Mexico region, data are available from the Collier/Monroe county line to South Texas (SEDAR 16 stock unit definition) from 1986 to 2006. In this region, 3,000 to 9,000 trips are reported annually.

NMFS Logbook-Atlantic and Gulf of Mexico. The coastal logbook program began in 1990 with the objective of a complete census of coastal fisheries permitted vessel activity, with the exception of Florida, where a 20% sample of vessels was targeted. Beginning in 1993, the sampling was increased to require reports from all vessels permitted in coastal fisheries. At SEDAR 16 there was substantial discussion about when to start the commercial logbook time series in either 1993 (incomplete reporting) or 1998 (full reporting). The continuity indices ran the time series from 1993; however, issues were raised by the Commercial Working Group related to incomplete reporting prior to 1998, and further discussion and consideration was requested related to exclusion of the period prior to 1998.

North Carolina Trip Index-Atlantic. Since 1994, all state-licensed dealers are required to report trip-level landings data in North Carolina. Fishers were selected for the index in a manner similar to the index development for SEDAR 16. Participant Identification Numbers were selected for inclusion if they had 8 or more years of landing King mackerel. Between 1994 and 2007 about 315 (17%) of the Participant Identification Numbers (PIDs) reported catch of King mackerel for at least eight or more years, and they accounted for 76% of the overall catch of King mackerel. This suggests that this subgroup of PIDs are likely to have consistently targeted King mackerel since 1994, and are likely to provide more consistent catch rate information than the excluded PIDs who only occasionally catch/target King mackerel and are therefore more opportunistic in nature. Therefore, for the catch rate analyses, the data were further restricted to those PIDs with a history of 8 or more years of catch reported for King mackerel.

5.4.3 Size/Age data

NMFS MRFSS-Atlantic and Gulf of Mexico. The standardized indices should be applied to the same size/age range defined in SEDAR 16 (ages 1 to 11+ in the Atlantic and ages 1 to 8 in the Gulf of Mexico). Further evaluation and revision (if necessary) should be conducted based on size and age information collected from the recreational hook and line fishery, by region, to the extent possible.

NMFS Headboat-Atlantic and Gulf of Mexico. The standardized indices should be applied to the same size/age range defined in SEDAR 16 (ages 1 to 11+ in the Atlantic and ages 1 to 6 in the Gulf of Mexico). Further evaluation and revision (if necessary) should be conducted based on size and age information collected from the recreational headboat fishery, by region, to the extent possible.

NMFS Logbook-Atlantic and Gulf of Mexico. These indices apply to ages 1-11+ but the actual length or age composition obtained from the commercial handline fishery in the TIP dataset should be used for partial catches or as the length or age composition input to assessment models.

North Carolina Trip Index-Atlantic. These indices apply to ages 1-11+ but the actual length or age composition obtained from the commercial handline fishery in the TIP dataset should be used for partial catches or as the length or age composition input to assessment models.

5.4.4 Catch Rates – Number and Biomass

NMFS MRFSS-Atlantic and Gulf of Mexico. Fishing effort was estimated as the number of anglers times the number of hours fishing; nominal catch rates were defined as the total catch kept and released per ten angler hours. **Figures 5.8.2** and **5.8.3** display the observed and predicted means by fishing year, along with 95% confidence intervals of GLM predictions.

NMFS Headboat-Atlantic and Gulf of Mexico. Fishing effort was estimated as the number of anglers times the number of hours fishing; nominal catch rates were defined as the total catch kept and released per ten angler hours. **Figures 5.8.2** and **5.8.3** display the observed and predicted means by fishing year, along with 95% confidence intervals of GLM predictions.

NMFS Logbook-Atlantic and Gulf of Mexico. Catch rates are total biomass (kilograms) of King mackerel per unit effort measured in hook hours (number of lines fished*number of hooks per line*total hours fished). **Figures 5.8.2 and 5.8.3** display the observed and predicted means by fishing year, along with 95% confidence intervals of GLM predictions.

North Carolina Trip Index-Atlantic. Catch rates are in biomass (kg) per trip with no information on the length of trip and therefore most trips were assumed to be single days. **Figure 5.8.2** displays the observed and predicted means by fishing year, along with 95% confidence intervals of GLM predictions.

5.4.5 Uncertainty and Measures of Precision

NMFS MRFSS-Atlantic and Gulf of Mexico. Measures of index precision are calculated as coefficient of variation and 95% confidence intervals of the predicted least squares means per fishing year (**Tables 5.7.2** and **5.7.3,** and **Figures 5.8.2** and **5.8.3**). Coefficient of variation for the continuity indices ranged from 0.55 to 1.32 for the Atlantic, and ranged 0.25 to 0.40 for the Gulf of Mexico.

NMFS Headboat-Atlantic and Gulf of Mexico. Measures of index precision are calculated as coefficient of variation and 95% confidence intervals of the predicted least squares means per fishing year (**Tables 5.7.2 and 5.3** and **Figures 5.8.2** and **5.8.3**). Coefficient of variation for the continuity indices ranged from 0.22 to 0.53 for the Atlantic, and ranged 0.13 to 0.19 for the Gulf of Mexico.

NMFS Logbook-Atlantic and Gulf of Mexico. Measures of index precision are calculated as coefficient of variation and 95% confidence intervals of the predicted least squares means per fishing year (**Tables 5.7.2 and 5.3** and **Figures 5.8.2** and **5.8.3**). Coefficient of variation for the continuity indices ranged from 0.07 to 0.09 for the Atlantic, and ranged 0.07 to 0.15 for the Gulf of Mexico.

North Carolina Trip Index-Atlantic. Measures of index precision are calculated as coefficient of variation and 95% confidence intervals of the predicted least squares means per fishing year (**Tables 5.7.2 and 5.7.3** and **Figures 5.8.2** and **5.8.3**). Coefficient of variation for the continuity indices ranged from 0.17 to 0.18.

5.4.6 Comments on Adequacy for Assessment

NMFS MRFSS-Atlantic and Gulf of Mexico. The continuity indices should be applied to the continuity assessment model, and revised methods should be assessed to include approaches to estimate the effect of bag limits (i.e. censored regression approach used for red snapper during SEDAR 31). The continuity methods also used “id_code” to identify individual trips; however, this data field can have multiple entries and result in duplicate samples. Therefore, sample unit definitions should be based on trip leader id combined with other trip data, including date and area. This approach has been applied during recent SEDAR assessment of greater amberjack (SEDAR 33), and those methods should be adapted for the revised indices. The inclusion of inshore samples should be evaluated, as the number of trips that observed King mackerel is likely small and the data are comprised of mostly zero catches. The spatial coverage of the survey should exclude the Northeast states, including Virginia to Maine, and revised indices should be based on samples from North Carolina to Florida (excluding the winter mixing zone). Lastly, the revised definitions of stock unit structure are likely to alter the distribution of samples within the defined stock units. Revised Atlantic indices should include samples from all counties in Florida north of Monroe County to be consistent with the new stock unit definitions. It is recommended that Gulf of Mexico indices exclude Monroe County, since samples cannot be identified as being north or south of the Florida Keys, and therefore cannot be assigned to Gulf or Mixing Zone during the winter mixing months. This would result in no change in the spatial distribution of samples for the Gulf of Mexico indices. Based on these revisions the indices should be used for both the Atlantic and Gulf of Mexico assessments.

NMFS Headboat-Atlantic and Gulf of Mexico. The continuity indices should be applied to the continuity assessment model, and bag limits should be assessed to validate the results of SEDAR 16 which indicated that few trips caught the bag limit over the time series. If a high proportion of trips caught the bag limit within any year, then revised methods should be assessed to include approaches to estimate the effect of bag limits (i.e. censored regression approach used for red snapper during SEDAR 31). The revised definitions of stock unit structure are likely to alter the distribution of samples within the defined stock units. Revised Atlantic indices should include samples from all counties in Florida north of Monroe County to be consistent with the new stock unit definitions. It is recommended that Gulf of Mexico indices exclude Monroe County, since samples cannot be identified as being north or south of the Florida Keys, and therefore cannot be assigned to Gulf or Mixing Zone during the winter mixing months. This would result in no change in the spatial distribution of samples for the Gulf of Mexico indices. Based on these revisions the indices should be used for both the Atlantic and Gulf of Mexico assessments.

NMFS Logbook-Atlantic and Gulf of Mexico. The continuity indices should be applied to the continuity assessment model. It was determined that trip limit regulations are not likely to affect the indices, as few trips recorded catching the trip limit across the time series. The revised definitions of stock unit structure are likely to alter the distribution of samples within the stock units. Revised Atlantic indices should include samples from all counties in Florida north of Monroe County to be consistent with the new stock unit definitions. It is recommended that Gulf of Mexico indices exclude Monroe County, since samples cannot be identified as being north or south of the Florida Keys, and therefore cannot be assigned to Gulf or Mixing Zone during the winter mixing months. This would result in no change in the spatial distribution of samples for the Gulf of Mexico indices. The indices should be based on fishing year definitions, instead of calendar year used in the continuity methods. It was noted by the commercial statistics workgroup that data prior to 1998 are not reliable, and that indices should be estimated for 1998 to present. It was recommended that the Florida trip ticket indices be used prior to 1998 and logbook indices used from 1998 to present with no overlap, since data are duplicated in the trip ticket and logbook databases. For the Atlantic, the North Carolina Trip Ticket index should be used prior to 1998, and for the Gulf of Mexico, the Florida Trip Ticket index prior to 1998 (adapted from SEDAR 16) should be used. Based on these revisions the indices should be used for both the Atlantic and Gulf of Mexico assessments as indices of age 1 to 11+ abundance.

North Carolina Trip Index-Atlantic. The continuity indices should be applied to the continuity assessment model. It was determined that trip limit regulations are not likely to affect the indices, as few trips recorded catching the trip limit across the time series. The revised definitions of stock unit structure are not likely to alter the distribution of samples within the defined stock units, since samples are limited to North Carolina, exclusively. The main problem with the index is that there is no recording of effort or the length of a trip. It is also likely that the information contained in this index is superseded by similar but more complete data contained in the coastal logbook program which includes data from all Atlantic states from FL to NC. It is recommended that the logbook index replace the North Carolina Trip Ticket index for SEDAR 38.

Florida Trip Ticket Index. The Florida trip ticket index was presented in SEDAR 16 for three regions (Panhandle, Gulf and Atlantic) but was ultimately not used in the base VPA. Given that the FL Trip Ticket database does not contain details on the length of trip or gear configurations, and since it only contains data from Florida it was determined that the Coastal logbook indices should instead be used for SEDAR 38 indices. However, since the coastal logbook only contains a complete recording of all effort from 1998 onwards the group considered that the FL Trip Ticket indices constructed for SEDAR 16 could be used for the years 1986-1997. Further data exploration and evaluation of the appropriateness of using these indices for the Atlantic and Gulf of Mexico stocks was requested.

5.5 CONSENSUS RECOMMENDATIONS AND SURVEY EVALUATIONS

Two relative abundance indices were excluded from further consideration for inclusion in the assessment models, including the South Carolina Pier Recreational Survey and the SEAMAP Small Pelagics Survey. The South Carolina Pier Recreational Survey was excluded due to lack of effort data and limited spatial coverage (a total of two fishing piers have been sampled consistently over the time series). The SEAMAP Small Pelagics Survey was excluded due to low sample sizes, and because the positive observations of King mackerel were primarily from a single sample. All other indices were recommended for inclusion in the continuity model using the methods replicated from SEDAR 16. These indices are ranked based on their hypothesized accuracy in tracking changes in population abundance, and these rankings are presented in **Table 5.7.4**. The working group cautioned that these rankings are strictly hypotheses, and further evaluation was requested based on the goodness-of-fit of each index to the model predictions of the SEDAR 16 base VPA.

Revisions to indices, as documented above, should be evaluated for inclusion in the revised base assessment model. Changes in the definition of stock structure are not expected to affect the fishery independent indices or the fishery dependent indices for the Gulf of Mexico, but are likely to affect the fishery dependent indices in the Atlantic as the sample distribution is altered to include samples from counties in Florida, north of Monroe on the Atlantic Coast. Further evaluation and discussion is needed to address this potential revision to the spatial distribution of samples.

5.6 RESEARCH RECOMMENDATIONS

The index working group recommends that:

1) Fisheries independent sampling continues and be expanded to the extent practical, employing consistent sampling protocols.
2) The defined ages that each of the recommended fishery dependent indices applies to be evaluated based on catch-at-size or catch-at-age information.
3) Censored regression modeling approaches (adapted from SEDAR 31) be applied to recreational fishery dependent indices of abundance to evaluate bag limit effects on catch rate indices.
4) Evaluation of environmental (e.g., temperature, salinity) effects on CPUE indices. The workgroup recommends that inclusion of environmental covariates that demonstrate long-term trends be carefully considered whether the covariates are likely to affect the population abundance or the catchability of the gear. If the effect is thought to be on the population abundance, then the covariate should be excluded from the catch rate standardization and incorporated into the assessment model. If the covariate is thought to affect the catchability of the gear (e.g., fish behavior changes as temperature increases or decreases), then the covariate should be incorporated into the catch rate standardization. The strongest effects are predicted to occur during distinct periods of coldwater upwelling, as this hypothesis deserves further evaluation.
5) The South Carolina Pier Recreational Pier Survey was excluded from the assessment model; however, the data represent a catch record from two fixed sites. Therefore, data from this survey represent repeated measures of catch and may be useful for evaluating environmental covariates effects on catches of King mackerel.
6) Evaluation of the delta-lognormal generalized linear model structure. Specifically, the appropriateness of modeling factor interactions as random effects and the effect of this assumption on the resulting mean and variance estimates.
7) Stock assessment analysts evaluate density-dependent effects on gear catchability, to the extent possible. The hypothesis that catchability increases with the abundance of King mackerel, particularly juveniles, was proposed by stakeholders at the data workshop. It is recommended that a sensitivity run of the base assessment model include this assumption, and that this sensitivity run is compared and ranked with a base model that assumes constant catchability over time.

5.7 TABLES

Table 5.7.1. Working documents reviewed by SEDAR 38 Indices workgroup

Document #	Title	Author(s)
SEDAR38-DW-01	SEAMAP Larval Index	David S. Hanisko
SEDAR38-DW-02	King Mackerel Abundance Indices from SEAMAP Groundfish Surveys in the Northern Gulf of Mexico	Adam Pollack
SEDAR38-DW-03	King Mackerel Abundance Indices from NMFS Small Pelagics Trawl Surveys in the Northern Gulf of Mexico	Adam Pollack
SEDAR38-DW-04	Standardized catch indices of King mackerel from the U.S. Marine Recreational Fisheries Statistics Survey, 1981 to 2012	Matthew Lauretta and John F. Walter
SEDAR38-DW-16	Standardized catch indices of King mackerel from the U.S. Recreational Headboat Fishery in the Gulf of Mexico and Southeast Atlantic	Matthew Lauretta and Shannon Cass-Calay
SEDAR38-DW-06	Standardized catch rates of Atlantic King mackerel (*Scomberomorus cavalla*) from the North Carolina Commercial fisheries trip tickets 1994-2013	John Walter and Stephanie McInerny
SEDAR38-DW-10	Standardized catch rates from commercial logbook data for King mackerel from the United States Gulf of Mexico, South Atlantic, and Mixing Zone, 1993-2013	John F. Walter and Kevin J. McCarthy
SEDAR38-DW-11	King mackerel index of abundance in coastal US South Atlantic waters based on a fishery-independent trawl survey	Tracey I. Smart and Jeanne Boylan
SEDAR38-DW-12	Trends from Non-CPUE Standardized King mackerel Landing Logs from Long Bay, South Carolina Recreational Pier Fishery	Christian Johnson

Table 5.7.2. Standardized continuity indices of relative abundance for the SEDAR 38 continuity assessment of Atlantic King mackerel.

	Headboat		Logbook		MRFSS		NC_Trip_Ticket		SEAMAP_Trawl	
units	number		biomass		number		biomass		number	
GLM	delta-lognormal		delta-lognormal		delta-lognormal		delta-lognormal		delta-lognormal	
ages	1-11+		1-11+		1-11+		2-11+		1	
	Index	CV	Index	CV	Index	CV	Index	CV	Index	CV
1980	0.60	0.45	-	-	-	-	-	-	-	-
1981	1.45	0.50	-	-	1.36	0.75	-	-	-	-
1982	0.63	0.53	-	-	1.57	0.68	-	-	-	-
1983	1.58	0.38	-	-	1.56	0.70	-	-	-	-
1984	0.91	0.31	-	-	1.70	0.67	-	-	-	-
1985	0.57	0.31	-	-	1.57	0.64	-	-	-	-
1986	0.60	0.25	-	-	5.18	0.55	-	-	-	-
1987	0.81	0.25	-	-	1.90	0.60	-	-	-	-
1988	0.83	0.25	-	-	1.36	0.60	-	-	-	-
1989	0.49	0.30	-	-	1.10	0.60	-	-	-	-
1990	0.65	0.31	-	-	1.00	0.62	-	-	2.86	0.17
1991	1.32	0.25	-	-	1.38	0.59	-	-	0.62	0.22
1992	1.71	0.24	-	-	1.09	0.61	-	-	0.86	0.24
1993	0.76	0.25	1.705	0.069	0.63	0.69	-	-	0.50	0.22
1994	0.60	0.26	1.445	0.065	0.40	0.74	0.80	0.17	0.75	0.22
1995	0.70	0.25	1.368	0.064	0.44	0.74	0.83	0.17	1.32	0.22
1996	0.48	0.27	1.027	0.066	0.39	0.73	1.24	0.17	2.10	0.19
1997	1.08	0.25	1.349	0.059	1.32	0.59	1.16	0.17	0.56	0.24
1998	1.36	0.23	1.120	0.054	0.64	0.65	1.09	0.17	1.91	0.23
1999	1.04	0.24	1.104	0.054	1.09	0.62	0.97	0.17	1.26	0.19
2000	1.91	0.22	1.143	0.054	0.94	0.64	1.04	0.17	0.84	0.24
2001	1.43	0.23	1.063	0.053	0.46	0.71	1.12	0.17	0.46	0.25
2002	0.91	0.26	0.935	0.060	0.21	0.87	0.97	0.17	0.51	0.20
2003	0.98	0.25	0.871	0.063	0.30	0.79	0.87	0.17	0.82	0.20
2004	1.03	0.25	0.974	0.063	0.51	0.70	1.29	0.17	1.13	0.22
2005	1.34	0.27	1.147	0.057	0.96	0.61	1.15	0.17	1.45	0.20
2006	1.25	0.24	1.103	0.056	0.69	0.66	1.02	0.17	1.03	0.22
2007	1.49	0.23	1.066	0.054	0.69	0.65	1.23	0.17	1.31	0.19
2008	1.20	0.24	0.944	0.061	0.66	0.67	1.06	0.17	1.04	0.22
2009	1.27	0.24	0.725	0.068	0.46	0.73	0.88	0.17	0.55	0.22
2010	0.87	0.28	0.514	0.092	0.20	0.89	0.62	0.18	0.29	0.23
2011	0.70	0.28	0.516	0.095	0.08	1.32	0.73	0.18	0.55	0.29
2012	0.44	0.30	0.410	0.099	0.15	0.98	0.91	0.18	0.28	0.22

Table 5.7.3. Standardized continuity indices of relative abundance for the SEDAR 38 continuity assessment of Gulf of Mexico King mackerel.

	Headboat		Logbook		MRFSS		SEAMAP_Plankton		SEAMAP_Trawl	
units	number		biomass		number		number		number	
GLM	delta-lognormal		delta-lognormal		delta-lognormal		delta-lognormal		delta-lognormal	
ages	1-6		1-11		1-8		1-11		0	
	Index	CV	Index	CV	Index	CV	Index	CV	Index	CV
1972	-	-	-	-	-	-	-	-	3.50	0.37
1973	-	-	-	-	-	-	-	-	-	-
1974	-	-	-	-	-	-	-	-	1.30	0.57
1975	-	-	-	-	-	-	-	-	-	-
1976	-	-	-	-	-	-	-	-	0.07	1.10
1977	-	-	-	-	-	-	-	-	-	-
1978	-	-	-	-	-	-	-	-	0.86	0.67
1979	-	-	-	-	-	-	-	-	1.11	0.47
1980	-	-	-	-	-	-	-	-	0.06	1.10
1981	-	-	-	-	0.71	0.40	-	-	0.20	0.80
1982	-	-	-	-	0.45	0.38	-	-	0.09	1.10
1983	-	-	-	-	0.90	0.40	-	-	-	-
1984	-	-	-	-	0.49	0.36	-	-	0.82	0.58
1985	-	-	-	-	0.54	0.39	-	-	0.27	0.53
1986	0.71	0.17	-	-	0.46	0.31	0.11	0.53	0.51	0.80
1987	0.66	0.17	-	-	1.09	0.27	0.38	0.32	0.06	1.10
1988	0.79	0.19	-	-	0.72	0.29	0.59	0.43	0.63	0.37
1989	0.81	0.18	-	-	0.92	0.30	0.80	0.33	0.41	0.57
1990	0.55	0.16	-	-	1.27	0.29	0.66	0.33	1.45	0.26
1991	1.29	0.15	-	-	1.26	0.27	0.70	0.31	0.22	0.44
1992	1.20	0.15	-	-	1.00	0.26	0.63	0.23	0.30	0.47
1993	0.86	0.14	0.676	0.147	0.97	0.27	1.22	0.21	2.35	0.23
1994	1.16	0.13	0.735	0.121	1.20	0.26	1.01	0.22	0.87	0.35
1995	1.27	0.13	0.906	0.110	1.07	0.28	1.94	0.20	0.61	0.43
1996	1.39	0.13	0.867	0.095	1.28	0.27	0.74	0.26	0.60	0.37
1997	1.16	0.16	1.028	0.084	1.49	0.26	1.29	0.20	1.15	0.30
1998	1.04	0.14	1.198	0.078	1.08	0.26	-	-	1.00	0.29
1999	0.95	0.16	0.941	0.076	0.92	0.25	0.92	0.22	0.99	0.29
2000	0.88	0.14	1.044	0.072	1.23	0.25	0.91	0.27	0.51	0.41
2001	0.69	0.15	0.850	0.082	1.12	0.25	1.54	0.20	1.43	0.28
2002	0.73	0.14	0.945	0.074	1.25	0.25	1.42	0.21	1.24	0.31
2003	1.00	0.14	0.887	0.083	0.98	0.25	1.05	0.22	2.49	0.20
2004	0.67	0.15	0.867	0.085	1.01	0.25	1.45	0.21	2.18	0.22
2005	1.01	0.15	0.698	0.102	0.85	0.26	-	-	1.45	0.21
2006	1.28	0.14	0.913	0.088	1.56	0.25	1.15	0.25	1.59	0.26
2007	1.18	0.14	1.092	0.085	0.92	0.25	1.40	0.22	2.65	0.20
2008	1.07	0.16	0.949	0.083	0.84	0.26	-	-	0.23	0.57
2009	1.57	0.13	1.181	0.077	1.39	0.25	0.82	0.24	1.50	0.23
2010	0.95	0.16	1.431	0.104	1.01	0.26	1.13	0.25	1.15	0.28
2011	1.15	0.14	1.306	0.106	0.80	0.26	1.27	0.25	0.31	0.66
2012	0.97	0.13	1.404	0.101	1.21	0.25	0.86	0.26	0.85	0.44

Table 5.7.4. Working group hypothesized rankings of indices of relative abundance, based on assumed adequateness of tracking changes in stock abundance. The working group notes that these rankings are open to debate and an analysis of the goodness-of-fit of indices to SEDAR 16 base VPA predicted stock abundance was requested to provide a quantitative measure of indices rankings.

Index	Type	Rank	Justification
Atlantic			
SEAMAP Trawl Survey	Fishery Independent	**1**	Fishery independent scientific sampling. Consistent sample design. Large spatial coverage. Relatively small sample sizes and encounters of King mackerel.
Commercial Logbook	Fishery Dependent	**2**	Large spatial coverage and high samples sizes. Regulation effects (i.e. trip limits) not observed.
MRFSS	Fishery Dependent	**4**	Large spatial coverage and high samples sizes. Regulation effects (size and bag limits) likely. Documented issues with sampling protocols.
Headboat	Fishery Dependent	**5**	Large spatial coverage. Size limit effects likely. King mackerel not likely a targeted species.
NC Trip Tickets	Fishery Dependent	**3**	Limited spatial coverage and lower sample sizes compared to other datasets. No effort information in database.
Gulf of Mexico			
SEAMAP Trawl Survey	Fishery Independent	**1**	Fishery independent scientific sampling. Consistent sample design. Large spatial coverage. Relatively small sample sizes and encounters of King mackerel.
Commercial Logbook	Fishery Dependent	**2**	Large spatial coverage and high samples sizes. Regulation effects (i.e. trip limits) not observed.
MRFSS	Fishery Dependent	**3**	Large spatial coverage and high samples sizes. Regulation effects (size and bag limits) likely. Documented issues with sampling protocols.
Headboat	Fishery Dependent	**4**	Large spatial coverage. Size limit effects likely. King mackerel not likely a targeted species.
SEAMAP Larval Survey	Fishery Independent	**5**	Relatively small sample sizes and low encounter rates of King mackerel.

5.8 FIGURES

A) B) C)

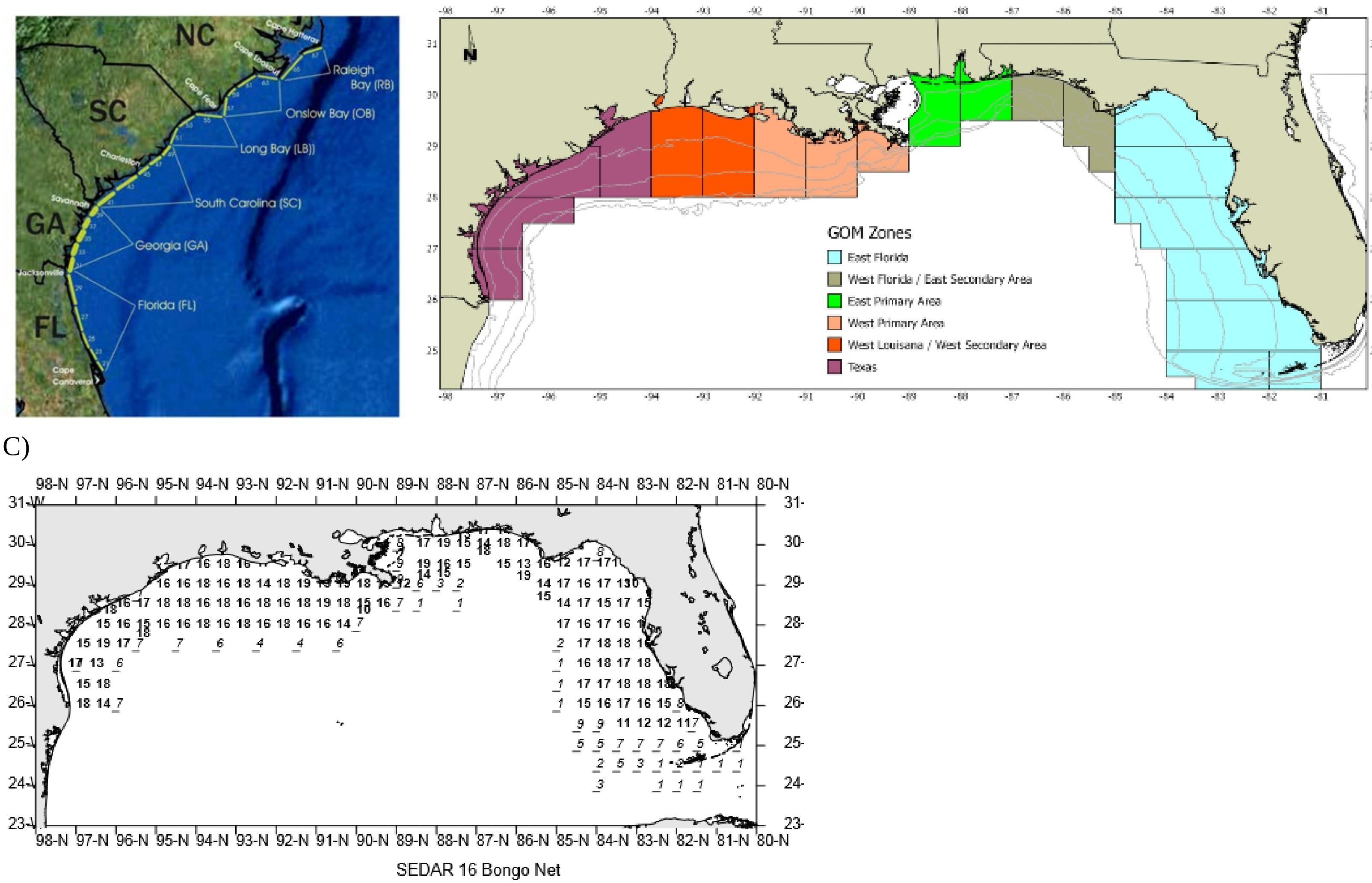

Figure 5.8.1. Spatial coverage of fishery independent indices of abundance. A) SEAMAP Atlantic Trawl Survey, B) SEAMAP Gulf of Mexico Fall Trawl Survey, and C) SEAMAP Gulf of Mexico Larval Plankton Survey.

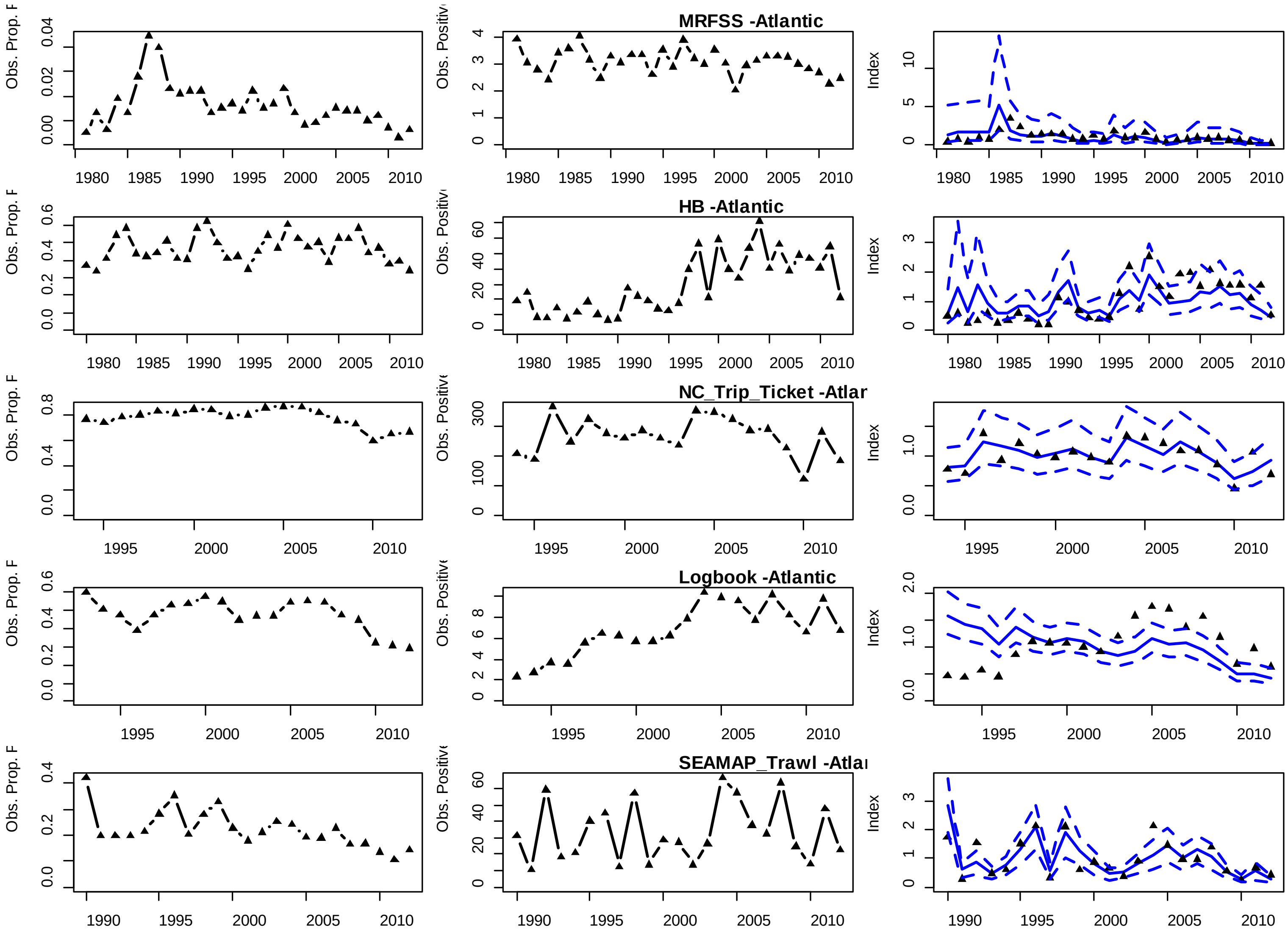

Figure 5.8.2. SEDAR 38 continuity indices of relative abundance of King mackerel in the U.S. South Atlantic. The proportion of sample that observed King mackerel, observed mean catch-per-unit-effort on positive trips, and the predicted mean index are shown.

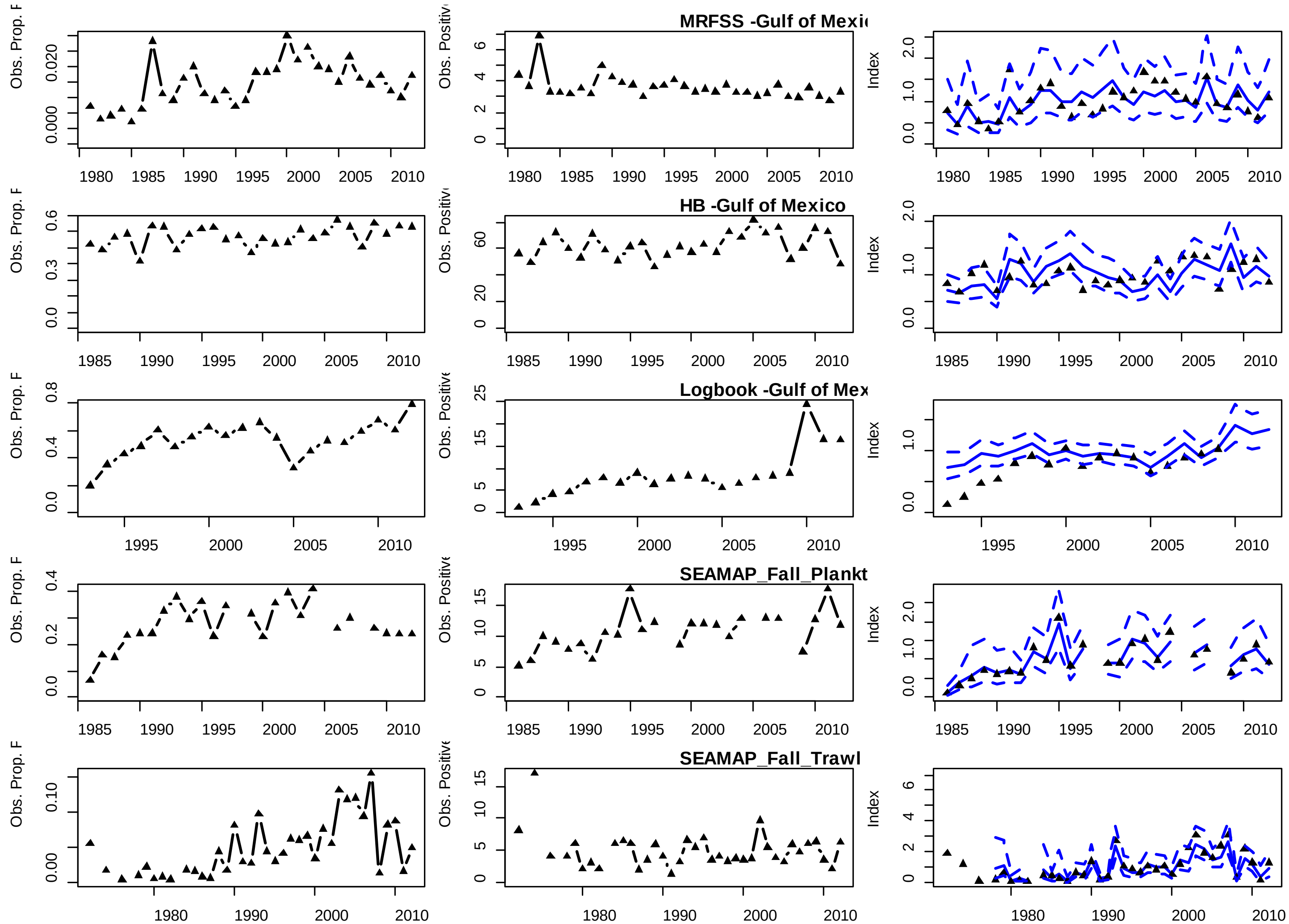

Figure 5.8.3. SEDAR 38 continuity indices of relative abundance of King mackerel in the U.S. Gulf of Mexico. The proportion of sample that observed King mackerel, observed mean catch-per-unit-effort on positive trips, and the predicted mean index are shown.

6. INTEGRATED ECOSYSTEM ASSESSMENT AD-HOC WORKING GROUP

6.1 OVERVIEW

The Integrated Ecosystem Assessment (IEA) Working Group was convened for SEDAR 38 as a result of recognition that King mackerel landings, and hence population abundance over space and time may be regulated by water column temperature regimes. Specifically, King mackerel are recognized to be isothermic, with an adult temperature preference of ~ 20 ºC (Beaumarige 1973), where latitudinal migration patterns result from seasonal temperature changes (see SEDAR 16 SAR). Off west-central Florida, strong associations were observed between recreational catch statistics derived from seasonal tournaments and environmental conditions including water clarity and presence of baitfish (see Wall 2006). Climate change has been recognized as an important environmental stressor where increasing water temperatures have altered distributions of important fishery populations in the Gulf of Mexico, as well as the Northeast Atlantic (Pinsky et al. 2013), for taxa including Atlantic mackerel (see Overholtz et al. 2011). The IEA recognized that there were likely two main considerations the Group could address: 1) use of environmental data in CPUE standardization in an attempt to account for changes in the indices due to environment rather than actual stock abundance; and 2) using environmental data to help refine annual estimates of stock mixing. Typically, the stock assessment model assumes a constant catchability for surveys and fisheries. Furthermore, the annual rate of mixing between the Atlantic and Gulf stocks is assumed to be constant. The integration of these ecosystem products will allow the Group to free the assessment model from these assumptions.

6.2 CPUE STANDARDIZATION

Introducing environmental covariates into CPUE analysis via generalized linear models (GLM) is one way to attempt to account for differences due to sea surface temperature (SST), water clarity, etc. Preliminary attempts to standardize CPUE using SST resulted in a significance level exceeding 0.05, the standard cutoff level. Further, to justify inclusion a covariate must explain at least 5% of the deviance. While these current findings do not support SST as an important covariate in explaining CPUE, additional efforts aimed at refining SST estimates or measuring in situ SST where mackerel are caught will enable a more comprehensive assessment of environmental associations.

A more appropriate way to include environmental data into the assessment process is to use the data to drive deviations in the catchability parameter directly. This is usually accomplished by first looking for a relation between CPUE fit residuals and the environmental data under consideration. This cannot be attempted until the full assessment model is configured and running.

6.3 STOCK MIXING

The Group spent a great deal more time discussing how environmental factors, specifically winter temperature regimes, could perhaps be used to challenge the assumption of a constant 50/50 ratio of Gulf and Atlantic fish in the current winter mixing zone. One idea that was discussed by the Group was possibly modeling the probability of king mackerel occurrence (presence/absence) as a function of sea surface temperature. Ideally, this model would have a month, area resolution. Regression was noted as a candidate model to test if a relationship exists between SST & landings/CPUE. Many other factors besides SST (river discharge, turbidity, nutrients, chlorophyll, etc.) could serve as covariates within the regression. For this analysis, data could be obtained from buoy data (daily, weekly, or monthly means).

The Group postulated that the range of temperatures king mackerel might encounter may be warmer water (high 70s) to colder water (low 50s). One theory that was discussed was that of a constricting effect of cold water, whereby cooler temperatures at higher latitudes force southerly migration of both Atlantic and Gulf stock fish into a more restricted warmer water portion of the mixing zone in south Florida and that this might result in stronger mixing in the "mixing zone". Conversely, the fish may be more widely distributed in warmer years and, alternatively, more aggregated in colder years. This would lead to good separation of stocks in warm years, but stronger mixing in cold years. Several studies defining stock structure (Gulf vs. Atlantic stock), via otolith analyses, are available for both "cold" and "warm" winters over the past two decades and can be used to guide the extent of stock migration into the mixing zone. As an example, a group of fish observed during fall of 2012 never went into the southern part of the mixing zone, suggesting all of these fish were from the SA.

Recommendations: Split landings based on year, month, and area (i.e., FL county) and track landings down the coast over time by month (county by county). Pay special attention to southern landings. It was also noted that perhaps catch rates may be a better metric than landings (?). However, the CPUE data did not lend itself to this pursuit.

6.3.1 Modeling approach

It was noted that a modeling approach is not necessarily the best or most efficient approach. Rather, simple observations and tracking of landings each year may be a viable approach. The group suggested, and did, look at histograms of landings by month across different counties with the intent of then incorporating temperature data. While exploratory analysis of the data was supported, the Group also noted that they would need to add some mechanistic rationale behind a subjective decision. Potential approaches included assessing the relationship with temperature in a model built a posteriori based on the best guess of where landings occurred or in a predictive model based on the fraction of landings in each county.

Recommendations: Generate average gradient over time or long-term mean, maybe a function of temperature. Ignore years and create histograms that look at each county monthly. If no good guess, fall back on default (50/50 ratio in mixing zone until obvious evidence). When data allows, look at specific patterns in years (across month and county).

Issues: We know where fish are landed but don't know exactly where fish were caught using trip ticket information (record county landed) as trip ticket does not record effort and is filled out by the fish house. Commercial logbooks do provide this information but it does not have adequate information by county (but log book data can be cross-referenced w/ FL TT data). Another issue was that of the problem of confidential data in some areas/counties. The Group also discussed dividing length compositions, but we would need to see if we have a signal in combined lengths before separating them.

6.3.2 Sea Surface Temperature

The Group considered the possibility that different size classes might have different temperature tolerances. Perhaps the youngest fish stay in the coldest water as they lack energy to make long migrations whereas larger fish go further north. Conversely, perhaps larger fish can tolerate cold water more easily than smaller fish, given their larger body size. Age-0 king mackerel tend to prefer 23-26°C according to the SEAMAP survey.

Recommendation: overlay temperature onto bar graphs of landings (as deviates).

Issue: How do we handle SST (deviations, anomalies, isopleths, etc.) and where do we extract temperature? Noted considerations were a range of preferred temperature, deviations from a long term average, and deviations from monthly county means. Since fishers tend to catch fish at particular depths, use this to determine a minimum and maximum depth and define king mackerel habitat. Mackerel come in shallower during summertime. The Group suggested using 60-100 feet to define the depth/habitat polygon for extraction although the width of this region will differ between south FL and off north FL (e.g., Canaveral). Utility of the commercial logbook and SST analysis may have been hindered by low spatial resolution as SST was extracted and averaged over huge bins (catches reported based on statistical zones, usually 1° by 1°). It must also be recognized that temperature stratification in shelf environments may confound utilization of SST. The range of SST's occupied by the fishery, which is prosecuted at depth, may differ significantly from the temperature strata preferred by King mackerel.

Remaining questions: Can we separate the SA and Gulf and are there enough years to do that well (e.g.: if 90% of landings piled up)? Otolith data collected in 2000 and 2001 (DeVries et al. 2002) can be used to verify what we model. Also, what are long-term regional climatology considerations (NAO, etc.) that may affect inter-annual water column temperature regimes, and hence, catchability of king mackerel from year to year?

6.4 OTHER ECOSYSTEM CONSIDERATIONS

Along with SST and mixing, other ecosystem considerations were also discussed. One theory was that, like many fishes, King mackerel are fattening up somewhere to prepare for spawning. The Group considered perhaps during winter /early spring the fish were putting on fat and developing ovaries for the upcoming spawning season, with the first spawning in May. Another peak spawning period occurs during August (see SEDAR 16 DW-06).

Atlantic king mackerel come when menhaden are running (menhaden coming from Chesapeake Bay?). Since menhaden are mobile fish, it is possible that king mackerel are following menhaden to a certain degree. Could fluctuations in gulf menhaden abundance be affecting abundance of king mackerel in the Gulf? Do king mackerel larvae respond to menhaden abundance? A reasonable hypothesis could be tested within the model to determine whether king mackerel recruitment is affected by menhaden. Inclusion of an environmental index of menhaden abundance (i.e., prey availability) would enable an assessment of whether it fits the recruitment signal. Does the 10 year cycle in landings correspond to menhaden dynamics? Further, what is the overall dynamic of other potentially important prey species such as Atlantic bumper, Spanish mackerel, sardines, and mullet in Florida (i.e. the greater prey complex)? What is the influence of the decline in the functionality of SE US estuaries (see Dame et al. 2000) as it relates to prey availability?

The SEAMAP dataset provides good coverage of age-0 king mackerel catch in relation to temperature and prey catch. An understanding of the spatial and temporal extent of juvenile habitat is critical to the evaluation of successful recruitment events. For example, SEAMAP trawls indicate significant juvenile recruitment along the coast between Jacksonville, FL and Cape Canaveral. This corresponds in space and time with the outflow of the St. John’s River estuary, a site of elevated primary productivity (see Schaeffer et al. 2012), but also where toxic and harmful algal blooms (HABs) have recently become commonplace (see Williams et al. 2001). What are the consequences of land-based sources of pollution (nutrients, chlorophyll, turbidity, HABs) on historically important king mackerel recruitment areas in the nearshore coastal environment? The SAFMC has recently raised concerns about land-based discharges of freshwater and associated material fluxes in the SE US on fisheries sustainability with the Council’s jurisdiction.

The observation was noted that some fish stay off SC/NC and move offshore to spawn. During colder temperatures fishermen see fewer adult king mackerel and fewer baitfish while observing more squid. King mackerel are thought opportunistic predators and will eat tomtates, squids, clupeids, etc. Consequently, it may be hard to quantify a menhaden-king mackerel link.

While prey remains on the back burner for now, abnormalities within the population model during development may encourage efforts to revisit these environmental considerations.

7. ANALYTIC APPROACH

7.1 OVERVIEW

The assessment team for SEDAR 38 will be chaired by Matthew Lauretta (SEFSC), John Walter (SEFSC), and Michael Schirripa (SEFSC). Two separate modeling frameworks will be applied to the data, VPA analysis using VPA-2Box, and an integrated modeling approach that uses Stock Synthesis, which allows for more flexibility in the structure of the input data and model construction. The model time series start depends upon data availability for each model platform and will end in 2012. The previous (SEDAR 16) VPA models started in 1981 and a similar start date will likely be used for SEDAR 38 VPA models. SS models can start prior to size composition data (i.e. landings only) and will probably have an earlier start date.

Virtual population analyses (VPA) will be conducted to (1) incorporate revised indices of abundance, life-history information, and landings estimates in the model, and (2) assess VPA model sensitivity to uncertainty in stock mixing of Atlantic (ATL) and Gulf of Mexico (GOM) King mackerel in the winter mixing zone. Stock Synthesis will be applied to (1) integrate catch-at-size and size-at-age information directly, thereby loosening several of the strict assumptions applied during catch-at-age estimation required for the VPA, (2) integrate environmental covariates into the stock assessments, to the extent possible, and (3) evaluate model sensitivity to mixing rate assumptions, Mexico fisheries, and information sources. The following models will be considered:

7.2 SUGGESTED ANALYTICAL APPROACHES

Four VPA models

1. Gulf VPA using new winter mixing zone definitions partitioned 50/50 between SA and Gulf, new CPUE indices, life history information and *de novo* catch at age matrices.
    - Intended to be the best-practices version of the VPAs using the most recent information
2. Atlantic VPA new winter mixing zone definitions partitioned 50/50 between SA and Gulf, new CPUE indices, life history information and *de novo* catch at age matrices.
    - Same as (1)

3. Gulf Continuity VPA using old winter mixing zone partitioned 50/50 and continuity indices updated through 2012.
    - Intended to demonstrate the results of updating the data inputs without making revision to the modeling methodologies or incorporating recently developed life history information or changes in stock unit definitions.
4. Atlantic Continuity VPA old winter mixing zone partitioned 50/50 and continuity indices updated through 2012.
    - Same purpose as (3)

Four Stock Synthesis models

5. Gulf SEDAR 16 mimic using SEDAR 16 CAA and similar assumptions as VPA
    - Intention is to demonstrate that similar results can be obtained with SS, under the same data inputs and assumptions, not intended for advice purposes.
6. Atlantic SEDAR 16 mimic using SEDAR 16 CAA and similar assumptions as VPA
    - Same purpose as (5)
7. Gulf SS best practices model using both age and length composition data with new winter mixing zone landings, length and age composition data partitioned 50/50.
8. Atlantic SS best practices model using both age and length composition data with new winter mixing zone landings, length and age comp partitioned 50/50.

Sensitivity runs

9. VPA sensitivity to stock mixing rates

Little information is available to estimate the mixing rates of Atlantic (ATL) and Gulf of Mexico (GOM) king mackerel within the newly defined and much smaller winter mixing zone. Therefore several sensitivity runs varying the proportion of Atlantic:Gulf from 10:90 to 90:10 will be assessed.

10. SS3 Sensitivity to Mexican Landings. This analysis will use model 7 to evaluate the sensitivity of results to the magnitude of Mexican landings.

11. Other standard sensitivity analysis may be conducted as key uncertainties emerge.

SEDAR

Southeast Data, Assessment, and Review

SEDAR 38

South Atlantic King Mackerel

SECTION III: Assessment Workshop Report

July 2014

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

NOTE: Modifications to the model results reported in this report were made during the Review Workshop held 12-14 August 2014. For complete results reflecting those changes, please see the Addendum of this Stock Assessment Report (Section VI).

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Table of Contents

1 WORKSHOP PROCEEDINGS

1.1 Introduction

1.1.1 Workshop Time and Place

The SEDAR 38 Assessment Workshop for South Atlantic King Mackerel was conducted in Miami during March 24 to 28, 2014 and as a series of five webinars, which were held between May 18th and July 16th, 2014.

1.1.2 Terms of Reference

1. Review any changes in data following the data workshop and any analyses suggested by the data workshop. Summarize data as used in each assessment model. Provide justification for any deviations from Data Workshop recommendations.
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.
3. Provide estimates of stock population parameters, if feasible.

   • Include fishing mortality, abundance, biomass, selectivity, stock-recruitment relationship, and other parameters as necessary to describe the population.

   • Include appropriate and representative measures of precision for parameter estimates.
4. Characterize uncertainty in the assessment and estimated values.

   • Consider uncertainty in input data, modeling approach, and model configuration.

   • 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.

   • Consider other sources as appropriate for this assessment.

- Provide appropriate measures of model performance, reliability, and 'goodness of fit'.
- Provide measures of uncertainty for estimated parameters.

5. Provide estimates of yield and productivity.
   - Include yield-per-recruit, spawner-per-recruit, and stock-recruitment models.
6. Provide estimates of population benchmarks or management criteria consistent with available data, applicable FMPs, proposed FMPs and Amendments, other ongoing or proposed management programs, and National Standards.
   - Evaluate existing or proposed management criteria as specified in the management summary.
   - Recommend proxy values when necessary.
7. Provide declarations of stock status relative to management benchmarks or alternative data poor approaches if necessary.
8. Perform a probabilistic analysis of proposed reference points, stock status, and yield.
   - Provide the probability of overfishing at various harvest or exploitation levels.
   - Provide a probability density function for biological reference point estimates.
   - If the stock is overfished, provide the probability of rebuilding within mandated time periods as described in the management summary or applicable federal regulations.
9. Project future stock conditions (biomass, abundance, and exploitation) and develop rebuilding schedules if warranted; include estimated generation time. Stock projections shall be developed in accordance with the following:

   A) If stock is overfished:

   F=0, F=Current, F=FMSY, FTarget

   F=FRebuild (max that rebuild in allowed time)

   B) If stock is overfishing

   F=FCurrent, F=FMSY, F= FTarget

   C) If stock is neither overfished nor overfishing

   F=FCurrent, F=FMSY, F=FTarget

   D) If data limitations preclude classic projections (i.e. A, B, C above), explore alternate models to provide management advice.
10. Provide recommendations for future research and data collection.
    - Be as specific as practicable in describing sampling design and sampling intensity.
    - Emphasize items which will improve future assessment capabilities and reliability.
    - Consider data, monitoring, and assessment needs.
11. Complete the Assessment Workshop Report in accordance with project schedule deadlines (Section III of the SEDAR Stock Assessment Report)

1.1.3 List of participants

Workshop Panel
Matt Lauretta, Lead Analyst .... NMFS Miami
Michael Schirripa, Lead Analyst .... NMFS Miami
John Walter, Lead Analyst .... NMFS Miami
Jeff Isley .... NMFS Miami
Scott Crosson .... SEFSC/SA SSC
Bob Gill .... Gulf SSC
Sean Powers .... Gulf SSC
Marcel Reichert .... SCDNR/SA SSC
John Ward .... Gulf SSC

Council Representation
Anna Beckwith .... SAFMC

Appointed Observers
Peter Barile .... Marine Resources & Consulting

Attendees
Susan Gerhart .... SERO
Bill Harford .... RSMAS
Skyler Sagarese .... RSMAS/SEFSC

Staff
Julie Neer .... SEDAR 38 Coordinator
Craig Brown .... NMFS Miami
Julia Byrd .... SEDAR
Shannon Cass-Calay .... NMFS Miami
Mike Errigo .... SAFMC
Doug Gregory .... GMFMC
Michael Larkin .... SERO
Clay Porch .... NMFS Miami
Ryan Rindone .... GMFMC

Additional Participants via Webinars
Ben Hartig .... SAFMC
Mandy Kamauskas .... SEFSC
Linda Lombardi .... NMFS Panama City
Ben Hartig .... SAFMC
Nicholas Hill .... Southeastern Fisheries Assoc

Rusty Hudson.. DSF

1.1.4 List of Data Workshop papers and reference documents

Document #	Title	Authors	Date Submitted
Documents Prepared for the Assessment Process			
SEDAR38-AW-01	Growth models for king mackerel from the south Atlantic and Gulf of Mexico	Linda Lombardi	7 March 2014 Addendum: 9 May 2014
SEDAR38-AW-02	Addendum to "SEDAR 38-10": New South Atlantic logbook index based upon revised mixing zone definition and new indices for the Gulf and South Atlantic using only trolling gear	John Walter	10 March 2014
SEDAR38-AW-03	The NMFS-SEFSC must account for climate change and inter-annual environmental variability in all South Atlantic stock assessments	Peter J. Barile	10 March 2014
SEDAR38-AW-04	Can climate explain temporal trends in king mackerel (Scomberomorus cavalla) catch-per-unit-effort and landings?	Harford, W.J, Sagarese, S.R., Nuttall, M.A., Karnauskas, M., Liu, H., Lauretta, M., Schirripa, M. & Walter, J.F.	20 March 2014 Updated 14 July 2014
SEDAR38-AW-05	Age frequency distributions, age length keys, length at ages, and sex ratios for king mackerels in the Gulf of Mexico and South Atlantic from 1986-2013	Ching-Ping Chih	20 March 2014
SEDAR38-AW-06	Length frequency distributions for king mackerels in the Gulf of Mexico and South Atlantics from 1978-2013	Ching-Ping Chih	20 March 2014
Reference Documents			
SEDAR38-RD01	Spatial and temporal variability in the relative contribution of king mackerel	Todd R. Clardy, William F. Patterson III, Douglas A. DeVries,	

	(*Scomberomorus cavalla*) stocks to winter mixed fisheries off South Florida	and Christopher Palmer
SEDAR38-RD02	King mackerel population dynamics and stock mixing in the United States Atlantic Ocean and Gulf of Mexico	Katherine E. Shepard
SEDAR38-RD03	A Cooperative Research Approach to Estimating Atlantic and Gulf of Mexico King Mackerel Stock Mixing and Population Dynamics Parameters	William F. Patterson III and Katherine E. Shepard
SEDAR38-RD04	Contemporary versus historical estimates of king mackerel (*Scomberomorus cavalla*) age and growth in the U.S. Atlantic Ocean and Gulf of Mexico	Katherine E. Shepard, William F. Patterson III, Douglas A. DeVries, and Mauricio Ortiz
SEDAR38-RD05	Trends in Atlantic contribution to mixed-stock king mackerel landings in South Florida inferred from otolith shape analysis	Katherine E. Shepard, William F. Patterson III, and Douglas A. DeVries
SEDAR38-RD06	Coastal upwelling in the South Atlantic Bight: A revisit of the 2003 cold event using long term observations and model hindcast solutions	Kyung Hoon Hyun and Ruoying He
SEDAR38-RD07	FishSmart: An Innovative Role for Science in Stakeholder-Centered Approaches to Fisheries Management	Thomas J. Miller , Jeff A. Blair , Thomas F. Ihde , Robert M. Jones, David H. Secor & Michael J. Wilberg
SEDAR38-RD08	FishSmart: Harnessing the Knowledge of Stakeholders to Enhance U.S. Marine Recreational Fisheries with Application to the Atlantic King Mackerel Fishery	Thomas F. Ihde, Michael J. Wilberg, David H. Secor, and Thomas J. Miller
SEDAR38-RD09	SEDAR 16 Final Document List	SEDAR 16 Panels
SEDAR38-RD10	History of fishing in Ponce Inlet	The Quarterly Newsletter of the Ponce de Leon Inlet Lighthouse Preservation Association, Inc.
SEDAR38-RD11	Biological-Statistical Census of the Species Entering Fisheries in the	William W. Anderson and Jack W. Gehringer

	Cape Canaveral Area	
SEDAR38-RD12	Impacts of Interannual Environmental Forcing and Climate Change on the Distribution of Atlantic Mackerel on the U.S. Northeast Continental Shelf	W. J. Overholtz, J. A. Hare and C. M. Keith
SEDAR38-RD13	Characterization of the near-shore commercial shrimp trawl fishery from Carteret County to Brunswick County, North Carolina	Kevin Brown
SEDAR38-RD14	South Atlantic Shrimp System	
SEDAR38-RD15	SEAMAP (Gulf of Mexico) Field Operations Manual for Collection of Data	NMFS

1.2 Panel Recommendations and Comment on Terms of Reference

Term of Reference 1

Review any changes in data following the data workshop and any analyses suggested by the data workshop. Summarize data as used in each assessment model. Provide justification for any deviations from Data Workshop recommendations.

Landings, discards, age, and length data were revised after the data workshop based on the revised stock boundaries and mixing zone defined as the Atlantic Ocean from North Carolina to Monroe-Dade counties line in Florida, including Monroe County south of the Florida Keys during April 1 to October 31. Additionally, 50% of landings and discards from the revised mixing zone, Monroe County Florida south of the Florida Keys during November 1 to March 31, were apportioned to the Atlantic stock. Age and length samples from the East Coast of Florida, north of and excluding Monroe County, were allocated to the Atlantic stock; while samples from the West Coast of Florida, north of and excluding Monroe County, were allocated to the Gulf of Mexico stock. Estimates of shrimp bycatch were evaluated during the Assessment Workshop, and revisions to methods and final estimates are documented in SEDAR38-RWXX. Changes to the life-history assumptions are documented below in Section 2.1.

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.

A fully integrated, length-based, statistical-catch-at-age population model was parameterized in Stock Synthesis with available information for the period 1901 to 2012. Two sexes were modeled to account for known differences in King Mackerel life histories, primarily dimorphic growth patterns and size structure. Data inputs are described in Section 2 of this report, and model parameterization and results are detailed in Sections 3 and 4.

Term of Reference 3

Provide estimates of stock population parameters, if feasible. Include fishing mortality, abundance, biomass, selectivity, stock-recruitment relationship, and other parameters as necessary to describe the population. Include appropriate and representative measures of precision for parameter estimates.

Estimates of stock and fishery parameters and their associated standard errors are reported in Section 4 Estimates of total stock biomass, stock spawning biomass, recruitment, fishing mortality, fleet selectivity-at-length, and stock benchmarks relative to maximum sustainable yield are presented and discussed in Section 4.

Term of Reference 4

Characterize uncertainty in the assessment and estimated values. Consider uncertainty in input data, modeling approach, and model configuration. 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. Consider other sources as appropriate for this assessment. Provide appropriate measures of model performance, reliability, and 'goodness of fit'. Provide measures of uncertainty for estimated parameters.

The application of Stock Synthesis provided a new approach to the assessment of King Mackerel, and improved the ability to account for differences in growth of males and females and available information sources (fishery specific length and age data). Previous assessments applied a virtual population analysis (VPA), and both continuity and revised VPAs were constructed and presented at the Assessment Workshop and during subsequent webinars. The results of the VPA assessments are detailed in a separate document (SEDAR38_RWXX), and the results of this document are for the base assessment model in Stock Synthesis. A comparison of stock biomass and recruitment estimates between the two modeling platforms is provided in Section 4. Stock Synthesis model performance and reliability are assessed by fits to data sources, likelihood profiling, parameter jitter analysis, sensitivity analyses (e.g., indices jackknife and retrospective analyses), and parametric bootstrapping. The results of these analyses are presented in Section 4.

Term of Reference 5

Provide estimates of yield and productivity. Include yield-per-recruit, spawner-per-recruit, and stock-recruitment models.

Estimates of yield and productivity were derived from estimates of steepness and unfished recruitment. For the Atlantic stock, long-term contrast in the landings and indices provided information to directly estimate these key parameters within SS. Estimates of steepness and stock recruitment at unfished spawner biomass are summarized here, presented and discussed in Section 4.

Term of Reference 6

Provide estimates of population benchmarks or management criteria consistent with available data, applicable FMPs, proposed FMPs and Amendments, other ongoing or proposed management programs, and National Standards. Evaluate existing or proposed management criteria as specified in the management summary. Recommend proxy values when necessary.

Estimates of maximum sustainable yield (MSY) and stock benchmarks relative to MSY were obtained and are presented below, as well as summarized in Table 4.15.6 and discussed in Section 4.

MSY = 4,282 metric tons

SSB_{MSY} = 3,123

F_{MSY} = 0.08

Term of Reference 7

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

Estimates of stock and fishery status relative to benchmarks are shown in Figures 4.16.62, specifically, current spawning stock status (SSB_{2012}/SSB_{MSY}) and current fishery status (F_{2012}/F_{MSY}). The stock determination is not overfished and not undergoing overfishing.

SSB_{2012}/SSB_{MSY} = 1.24

F_{2012}/F_{MSY} = 0.37

Term of Reference 8

Perform a probabilistic analysis of proposed reference points, stock status, and yield. Provide the probability of overfishing at various harvest or exploitation levels. Provide a probability density function for biological reference point estimates. If the stock is overfished, provide the probability of rebuilding within mandated time periods as described in the management summary or applicable federal regulations.

A probabilistic estimation of biological reference points was conducted by incorporating uncertainty in estimates of both stock status and benchmarks. The combined variances of spawning stock biomass/fishing mortality estimates and benchmarks (SSB_{MSY},F_{MSY}) were estimated to calculate the probability that the stock is overfished and undergoing overfishing. Normal probability density functions with means equal to the estimates of SSB_{2012}/SSB_{MSY} and F_{2012}/F_{MSY} and variance equal to combined variance estimates were assumed to estimate 95% confidence intervals of stock and fishery status. The stock status and fishery estimated time series are presented in Figure 4.16.61.

The 95% confidence interval of current stock status ($SSB_{201}2/SSB_{MSY}$) is 0.98 to 1.49, and fishery status ($F2012/F_{MSY}$) is 0.26 to 0.48 (Table 4.15.6). The estimated probability the stock is overfished is 3.5% and the estimated probability that overfishing is occurring is less than 1%.

Term of Reference 9

Project future stock conditions (biomass, abundance, and exploitation) and develop rebuilding schedules if warranted; include estimated generation time. Stock projections shall be developed in accordance with the following:

A) If stock is overfished:

F=0, F=Current, F=FMSY, FTarget

F=FRebuild (max that rebuild in allowed time)

B) If stock is overfishing

F=FCurrent, F=FMSY, F= FTarget

C) If stock is neither overfished nor overfishing

F=FCurrent, F=FMSY, F=FTarget

D) If data limitations preclude classic projections (i.e. A, B, C above), explore alternate models to provide management advice.

Projections were constructed to predict stock status and associated yields under the current allowable catch limit from 2013 to 2023 for the base model configuration, assuming Beverton-Holt predicted recruitment. Three scenarios of low, medium and high recruitment were used to account for the potential of reduced recruitment in the first three years of projection, after which recruitment was assumed to follow the stock recruitment curve. Projection results are described in Section 4.11).

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. Consider data, monitoring, and assessment needs

Recommendations for future research and data collection are summarized in Section 4.12.

Term of Reference 11

Complete the Assessment Workshop Report in accordance with project schedule deadlines (Section III of the SEDAR Stock Assessment Report).

This report documents the proceedings and findings of the assessment panel for Atlantic King Mackerel.

2 DATA REVIEW AND UPDATE

The following list summarizes the main data inputs used in the assessment model:

2.1. Life history

- Stock structure and mixing was evaluated extensively and redefined during the data workshop
- Growth was estimated using a von Bertalanffy model modified to allow for a linear increase in growth from age 0 to age 0.5, fitted to length-at-age data from samples collected from commercial and recreational fisheries.
- Meristic relationship parameters were estimated from observer collected length and weight data of commercial and recreational fisheries.
- Natural mortality was estimated using a Lorenzen model based on growth parameters and the maximum observed age
- Maturity was assumed to be a logistic function of length with the first age of maturity = 1
- Fecundity was assumed to be a power function of length based on the length-weight conversion meristic relationship.

2.2. Landings

- Commercial Handline: 1901 to 2012-13 FY, measured in metric tons
- Commercial Gillnet: 1949 to 2012-13 FY, measured in metric tons
- Recreational Headboat: 1936 to 2012-13 FY, measured in number of fish
- Recreational Charter/ Private: 1946 to 2012-13 FY, measured in number of fish
- Recreational Tournament: 1946 to 2012-13 FY, measured in number of fish

2.3. Discards

- Commercial Combined: 1998 to 2012-13 FY, measured in number of fish
- Recreational Headboat: 1987 to 2012-13 FY, measured in number of fish
- Recreational Charter/ Private 1981 to 2012-13 FY, measured in number of fish
- Recreational Tournament: 1981 to 2012-13 FY, measured in number of fish
- Shrimp Bycatch: 1978 to 2012-13 FY, measured in number of fish

2.4. Length composition of landings

- Commercial Handline: 1984 to 2012-13 FY
- Recreational Headboat: 1984 to 2012-13 FY
- Recreational Charter/ Private: 1984 to 2012-13 FY
- Recreational Tournament: 1984 to 2012-13 FY

2.5. Length composition of discards

- Discards for all fleets were assumed to be age zero based on a review of available observer information.

2.6. Age composition

- Commercial handline: 1991 to 2012-13 FY
- Recreational Charter/ Private: 1986 to 2012-13 FY
- Recreational Tournament: 1986 to 2012-13 FY

2.7. Abundance indices

- Fishery-dependent
  - Commercial hook and line trolling: 1998 to 2012-13 FY
  - Recreational headboat: 1981 to 2012-13 FY
- Fishery-independent
  - SEAMAP Age-0 Trawl: 1981 to 1982, 1984 to 2012-13 FY

A summary of each dataset is provided in the following section.

2.1 Life History

An extensive review of information on stock distribution and migration patterns was conducted during the data workshop that provided new insight into the stock structure of King Mackerel and seasonal mixing between the Gulf of Mexico and Atlantic stocks. After review of submitted working documents and synthesis of information presented by the life history group, the stock delineations and mixing zone boundary was redefined by the life history group to be (1) South Atlantic King Mackerel stock range from North Carolina to Florida at the Monroe-Dade counties line during November 1st to March 31st, and North Carolina to Florida including Monroe County south of the Florida Keys during April 1st to October 31st, (2) the Gulf of Mexico King Mackerel stock ranges from Texas to Florida including Monroe County north of the Florida Keys during all months of the year, and (3) the winter mixing zone is defined to be Monroe County, Florida, south of the Keys during November 1st to March 31st (**Figure 2.9.1**). All analyses presented in this document are based on the revised stock structure and mixing assumptions. Revision of the mixing zone represented a substantial restructuring of the landings (**Figure 2.9.2**). A virtual population analysis (VPA) was conducted under the previous stock structure and data assumptions for continuity with the previous assessment (SEDAR 16) and the model results are compared with VPA estimates under the revised stock structures and data. The results of the VPA analyses are summarized in a separate document (SEDAR38-RWXX).

The changes to the new winter mixing zone resulted in some restructuring of the landings with an overall 6% increase in attributed to the Atlantic stock and a 7% decrease for the Gulf relative to the SEDAR 16 stock definitions. Note that the increases and decreases are not simply additive.

	Gulf decrease	Atlantic increase
Recreational (in number)	-6%	8%
Commercial	-6%	4%
Overall in wt (assuming 8 lb avg rec fish)	-7%	6%

King Mackerel life history assumptions, including natural mortality, growth, fecundity, and maturity, are listed in **Table 2.8.1**. Some of the life history parameters were modeled in Stock Synthesis as fixed inputs (natural mortality, fecundity, and maturity), while growth was assumed to follow a von Bertalanffy model with estimable parameters based on the length and age information. Length-weight conversions and other meristic relationships were provided at the data workshop and remained unchanged during the assessment. The parameters describing these relationships are summarized in **Tables 2.8.1-2.8.3**.

Many of the life history inputs, in particular, growth, natural mortality and maturity inputs were developed at the AW. Substantial reconsideration and re-estimation of growth parameters was conducted at the AW (SEDAR38-AW-01 addendum 4) resulting in different parameter estimates than presented at the DW. Standard von Bertalanffy models showed a systematic lack of fit to age-0 fish, where the size at age-0 was estimated to be substantially higher than observed sizes at age. This was likely due to the influence of size selectivity on larger fish, a shortage of age-0 fish in the aging database relative to older fish and the likely possibility that Scombrid early growth does not follow von Bertalanffy growth dynamics. A modified von Bertalanffy equation was developed to allow for a linear increase in growth up to a certain pre-specified size and age in the same way as assumed by SS (here the mean size from the SEAMAP trawl surveys, 21cm, was assumed to be representative of age 0.5 fish) and then standard von Bertalanffy growth beyond this age. The newly developed growth models also excluded tournament fish and included only fish from the Atlantic, non-mixing area so as to represent a pure "Atlantic" sample without the potential size bias due to tournaments selecting for the largest fish. The modified two-stage growth curves fit the observed sizes at age better and provided more realistic sizes at age-0, which is important for the Lorenzen scaled M-at age vectors. Sex and stock-specific von Bertalanffy parameters, CVs on early and late age and were estimated and recommended as parameter starting values for estimating growth internally in the model (**Table 2.8.3**).

Regressions of batch fecundity (in millions of eggs) as a function of length was originally developed in SEDAR16 using data from Fitzhugh et al (SEDAR16-DW-06). The same relationship was converted to parameters as a function of length for input to SS and a single relationship used for both stocks (**Table 2.8.2**). Estimates of maturity were also re-evaluated and rather than using Finucane et al. (1986) estimates, a more recent data set of 244 female King Mackerel collected in 2005-2007 (Gary Fitzhugh, *pers comm*) was used to estimate maturity at length.

The vector of natural mortality was obtained by rescaling the Lorenzen (1996) curve such that the average mortality rate on fully exploited ages (age 2 and older) matched the value of M inferred from the Hoenig (1983) relationship with the maximum observed age of 26 (0.16).

Separate [rescaled] Lorenzen (1996) curves were developed for the Gulf and Atlantic populations based on the respective combined-sex growth equations (and setting the size at age 0.5 to 21cm, as inferred from the combined Gulf and ATL SEAMAP trawl surveys). The age-specific values for the natural mortality vector input into the assessment model were taken from the respective Lorenzen curves at midyear (i.e., ageclass+0.5). The M vectors derived for the Gulf and SA were averaged to create a single M-vector for both stocks under the assumption that natural mortality is unlikely to be substantially different at age between the two stocks, despite the very small differences due to growth. The rationale for using the combined sex growth models was that males and females had the same maximum age (26), but females grow somewhat faster (larger at age). This created an incongruity in that, after the rescaling, the faster-growing females were assigned a higher mortality rate (whereas Lorenzen theory would imply a lower mortality rate). Hence so that the desired properties of the Lorenzen scaling could be achieved. i.e. larger fish should have lower M, the combined sex growth curve was used to create an scaled M vector for each stock which was then averaged to obtain a single M at age vector **(Table 2.8.2).**

2.2 Landings

2.2.1 Commercial landings

Commercial landings of King Mackerel in the South Atlantic are predominantly from trolling and other hook and line gears (handlines), followed by gillnets (**Figure 2.9.3**). Landings estimates were based on the revised stock structure assumptions, as recommended by the life-history group during the data workshop (**Figure 2.9.1**). The commercial landings reviewed at the data workshop remained unchanged during the assessment and are presented in **Table 2.8.4**. Commercial landings were estimated for the period 1929 to 2012 for handlines, and for the period 1949 to 2012 for gillnets. Commercial landings prior 1950 were not reported by fishing year so they represent calendar year, however as there are no recruitment deviations estimated for any of these years is unlikely to matter if there is a slight offset to the if landings are offset from one year or the next in this early time period.

2.2.2 Recreational landings

Recreational landings of king mackerel in the South Atlantic are predominantly from private and charter boats, followed by headboats (**Figures 2.9.4 and 2.9.5**). Landings estimates were based on the revised stock structure assumptions, as recommended by the life-history group during the data workshop. Recreational landings were measured in numbers of fish and total landings were estimated for the period 1946 to 2012 for charter, private, and tournament fisheries, and for the period 1936 to 2012 for the headboat fishery with the start dates being the assumed start of the fisheries. The recreational landings reviewed at the data workshop remained unchanged during the assessment, with the exception of private, charter and tournament estimates.

During the assessment workshop, it was noted that the length and age composition data from tournaments (summarized in Section 2.4) provided a signal of cohort strength, may be the only asymptotic selectivity fleet and represented ~25% of the total age composition information. Hence it was decided to include tournament information in the assessment model. Note that tournament effort is part of the MRFSS/MRIP sampling frame, but tournament intercepts are excluded so that tournament CPUE is not averaged into the overall private/charter catch rate to determine overall landings. This could result in a small underestimation of recreational landings, to the extent that they come from tournaments as they might have higher CPUE than standard private/rec trips. The decision to include tournament age and length information represents a change from the SEDAR 16 VPA where the large number of aged fish from tournaments was excluded from the catch at age. To include tournament fish it was necessary to assume what fraction of private/rec landings were from tournaments. To do so, tournament landings were assumed to start in 1980 (generally considered to be the start of the tournament fishery) and ramped up to be 3% of recreational private landings until 1990 and to be 3% of recreational landings for the rest of the time series on the basis of the magnitude of the tournament fishery estimated from the FishSmart project (Idhe et al 2014, Miller et al 2014). Final estimates of recreational landings in number are presented in **Table 2.8.4**.

As there is considerable uncertainty in recreational landings estimates for the Private/Charter, Headboat and Tournament fleets they were modeled with a CV of 0.20 similar to estimated CVs in the MRIP/MRFSS or headboat surveys that provide these estimates.

2.3 Discards

2.3.1 Commercial discards

Estimates of King Mackerel commercial discards were provided at the data workshop for the periods 1998 to 2012 and remained unchanged for the assessment. Commercial discards from the handline and other fisheries that target King Mackerel are small compared to landings (**Table 2.8.5, Figure 2.9.5**). Bycatch of mackerel from the shrimp fisheries and handline fisheries were the predominant sources of discards (**Table 2.8.5, Fig 2.9.5**).

To estimate shrimp bycatch a generalized linear modeling approach using a combination of observer data and SEAMAP scientific sampling similar to methods applied in the Gulf of Mexico was developed to estimate shrimp fishery discards (SEDAR 38RW01). Model factors were year, area, depth, season and survey type with the survey type accounting for the higher catch rate in the SEAMAP survey. Combining the two datasets provided spatial and temporal coverage with the SEAMAP dataset providing much of the annual trend and the OBSERVER dataset providing the scaling to the fishery. Predictions were then obtained by year, area, season, depth zone and grid. The strata-specific estimates of observer cpue were multiplied by effort on the same grid to estimate of total bycatch. South Atlantic shrimp effort is not depth and year specific so an average depth distribution of effort over time was assumed. As estimates were derived for observer data collected after the implementation of bycatch reduction devices in 1999, estimates prior to 1999 had to be increased to account an estimated 27% reduction in discard catch rates after the mandatory use of bycatch reduction devices (BRDs). The effect of BRDs was obtained from the Gulf of Mexico where paired BRD and non-BRD experiments allowed for estimation of the reduction in catch rates of juvenile king mackerel.

Commensurate with other treatments of shrimp bycatch (SEDAR31) the annual estimates are input into the SS model as a single median value. The likelihood expression in SS therefore only compared the single average value with the model prediction of that average over the indicated year range (in SS lingo this it referred to as a superyear) Doing so avoids forcing the model to falsely interpret the large interannual fluctuations in bycatch estimates as recruitment signals. Instead, the SS model is fit to an index of shrimp effort, which was believed to a more precisely known quantity,

The primary considerations for shrimp effort were the development of a recent time series of shrimp effort (Gloeckner 2014) that accounted for duplicative records in some datasets and the development of historical time series of effort through historical reconstruction. Historical reconstruction of the shrimp effort time series was conducted by AW panelists to account for key time periods in the history of the shrimp fishery, particularly related to shrimp boat building in the St. Augustine area.

2.3.2 Recreational discards

Estimates of recreational discards were available for the periods 1987 to 2012 for recreational headboats; and 1981 to 2012 for recreational charter, private, and tournament fisheries (**Figure 2.9.5, Table 2.8.5**). Headboat discards were relatively minimal. Discards from recreational fisheries are predominantly from the private and charter boat fisheries, and are believed to be a result primarily of size limits but it was noted at the AW that there is also discarding due to bag limits or due to catch and release fishing. Discards from other recreational fisheries were considerably less in comparison. Derived discard estimates were input to the model but then internally estimated under the assumption that they were due entirely to the size limits in place at the time.

2.3.3 Discard mortality

Discard mortality assumptions remained unchanged from the data workshop recommendations, and are as follows: 20% mortality from commercial handline, 100% mortality for the gillnet and shrimp trawl fishery, 22% mortality for the recreational headboat fishery, and 20% mortality for recreational private/charter fisheries.

2.4 Length Composition of Samples

2.4.1 Commercial length composition

The annual length composition data of landings from the commercial handline fishery remained unchanged from the data workshop and are presented in **Figure 2.9.6**. Length observations were combined into 5cm bin with a minimum size of 20cm and a maximum size of 160cm.

2.4.2 Recreational length composition

Length composition data used in the assessment remained unchanged from the data workshop. The recreational length composition data were collected by the MRFSS/MRIP program as well as the Head Boat Survey (HBS). The data are presented in **Figures 2.9.7** for the recreational headboat fishery, **Figure 2.9.8** for the charter and private fisheries combined, and **Figure 2.9.9** for the recreational tournament fishery. Length observations were summarized by 5cm bins with a minimum size of 20cm and a maximum size of 160cm. The small numbers of fish below the size limits during periods where size limits were in place were excluded from modeling under the assumption that these fish were either mis-reported or simply mis-identified by the fisher and mistakenly retained. Small king mackerel look similar to Spanish mackerel and could be confused. Ideally, the very small number of fish below the size limits simply are not fit by the model when knife-edged retention functions are used. But this creates large residuals that obscure the ability to diagnose residual patterns in the actual modeled size ranges. In contrast, requiring the model to estimate incomplete retention functions can create modeling difficulties with very little practical impact. In the worst case scenario, the model interprets these fish as actual recruitment events. Hence we have adopted the practice of removing these lengths.

2.5 Length Composition of Discards

The assumptions of the length composition of discarded fish from commercial and recreational fisheries were readdressed during the assessment workshop. Based on input from the assessment panel and stakeholders, discards from the commercial fisheries were expected to be comprised solely of undersized fish compared to the minimum legal retention limit (< 50cm fork length), and therefore primarily age-0 fish. Bycatch discards from the shrimp fisheries were assumed to be all age-0 fish, consistent with the recommendations from the data workshop. Headboat observer data collected by the Florida Fish and Wildlife Conservation Commission (**Figure 2.9.10**) indicated that discards were also under the legal minimum retention size (< 50cm fork length) and primarily age-0 fish.

A study of recreational tournaments that estimated a size-at-retention function of King Mackerel in the Atlantic (Idhe et al 2014, Miller et al 2014) indicated only 20% retention for 100 cm fish and 100% retention only for fish above 130 cm. Initially it was considered that this retention function might allow for the estimation of tournament discards, however models incorporating a fixed retention function for tournament landed fish performed poorly and these issues could not be resolved in the time available. As tournament landed fish represent a small fraction of the total removals (estimated to be 3%) the impact of these discards on the population is likely to be low. However the tournament retention function could reconcile some difficulties of the model in fitting the tournament composition data with further work.

2.6 Age Composition

The age composition data are input to the SS model as conditional age at length data. This was done because, for many years the biological sampling of king mackerel was geared towards an age-length key (getting sufficient numbers at size) and not necessarily to obtain a representative sample of the overall age. This approach avoids double use of fish for both age and size information and provides more detailed information about the relationship between size and age. This provides stronger ability to estimate growth parameters and especially the variance of size-at-age. Further details of this modeling input follow in Section 3.

2.6.1 Commercial age composition

Age composition data of commercial handline landings remained unchanged from the data workshop and were provided for the period 1991 to 2012 (**Figure 2.9.10)**.

2.6.2 Recreational age composition

Recreational age composition show the strong 1989, 1996, and 2003 cohorts moving through each of the fleets over time (**Figures 2.9.12** and **2.9.13)**. No age composition data for the headboat fishery landings was available.

2.7 Indices of Abundance

Three indices were included in the assessment; commercial logbook handline trolling only index, headboat and the SEAMAP trawl survey (**Table 2.8.6, Figure 2.9.14**). The commercial trolling handline is the primary gear used in the commercial fishery and the index. Initially several other indices were considered for inclusion; the North Carolina Trip Ticket index, the Marine Recreational Fishery Statistics Survey (MRFSS) for recreational private and charter fisheries and a South Carolina pier logbook index. Review of the indices during the resulted in rejection of the MRFSS index for inclusion in the assessment model as a result of observed sharp declines in index values corresponding to changes in management regulations. It was concluded that the MRFSS index may be affected by changes in catchability associated with management regulations, and it was recommended that the index be excluded. In contrast the headboat survey was considered to be as affected management regulations. The North Carolina Trip ticket index data was considered a subset of the commercial logbook data and thus not needed as a separate index and the SC pier index was considered too spatially limited to apply to the stock as a whole.

2.8 Tables

Table 2.8.1. Meristic relationships for South Atlantic King Mackerel.

Conversion and units	Equation	Sample Size	R^2 value
Total Length (cm) to Fork Length (cm)	FL= -4.28 +0.963 * TL	2034	0.99
Standard Length (cm) to Fork Length (cm)	FL= 0.663 + 1.051 * SL	2083	0.99
Fork Length (cm) to Gutted Weight (kg)	G. Wt = 4.34 x 10-06 * (FL^3.119)	22491	0.95
Fork Length (cm) to Whole Weight (kg)	W. Wt = 7.31 x 10-06 * (FL^3.009)	53224	0.96

Table 2.8.2. Life history assumptions of South Atlantic King Mackerel.

	Age-0	Age-1	Age-2	Age-3	Age-4	Age-5	Age-6	Age-7	Age-8	Age-9	Age-10	Age-11+
Nat. Mort.	0.657	0.247	0.224	0.208	0.195	0.186	0.178	0.172	0.167	0.163	0.160	0.157
Hi M	0.707	0.297	0.274	0.258	0.246	0.236	0.228	0.222	0.217	0.213	0.210	0.207
Lo M	0.607	0.197	0.174	0.158	0.146	0.136	0.128	0.122	0.117	0.113	0.110	0.107
Maturity	Maturity= 1/(1 + exp(-0.36886*(58.113)))											
Fecundity	Eggs = 0.0000073141*Length^ 3.0087053											

Table 2.8.3. Estimated growth parameters for King Mackerel, used as starting values in the SS model.

	Atlantic		Gulf	
	Female	Male	Female	Male
L_{inf} (mm FL)	130.13	98.928	142.71	97.77
k (year^{-1})	0.145	0.26	0.121	0.227
t_0 (year)	-3.66	-2.38	-3.410	-2.63
cv1	0.21	0.33	0.16	0.20
cv2	0.05	0.05	0.06	0.05

Table 2.8.4. Commercial and recreational landings of South Atlantic King Mackerel by fleet.

Fishing_Year	Com_Handline (metric tons, whole wt)	Com_Gillnet (metric tons whole wt)	Rec_Headboat (thousands of fish)	Rec_Charter_Private (thousands of fish)	Rec_Tournament (thousands of fish)
1929	1188.9	0	0	0	0
1930	1106.65	0	0	0	0
1931	1249.68	0	0	0	0
1932	1257.68	0	0	0	0
1933	1094.13	0	0	0	0
1934	930.58	0	0	0	0
1935	1158.16	0	0	0	0
1936	1385.74	0	0.59	0	0
1937	969.47	0	1.19	0	0
1938	1315.56	0	1.78	0	0
1939	1187.68	0	2.37	0	0
1940	783.41	0	2.96	0	0
1941	0	0	3.56	0	0
1942	0	0	4.15	0	0
1943	0	0	4.74	0	0
1944	0	0	5.34	0	0
1945	1318.48	0	5.93	0	0
1946	879	0	7.71	25.88	0
1947	439.51	0	9.49	46.89	0
1948	0.03	0	11.27	67.89	0
1949	153.94	0.59	13.04	88.9	0
1950	692.36	10.51	14.82	109.9	0
1951	880.6	16.57	16.6	130.91	0
1952	730.1	7.18	18.38	151.91	0
1953	565.62	58.73	20.16	172.92	0
1954	437.46	88.34	21.94	193.92	0
1955	770.69	68.93	23.72	214.92	0
1956	1037.33	116.74	25.5	235.93	0
1957	1072.64	53.21	27.28	256.93	0
1958	940.52	20.16	29.05	277.94	0
1959	1046.51	10.05	30.83	298.94	0
1960	958.19	27.74	32.61	319.95	0
1961	1002.51	32.75	34.39	348.92	0
1962	906.29	120.44	36.17	377.9	0
1963	815.6	199.94	37.95	406.87	0

1964	813.84	249.99	39.73	435.84	0
1965	744.24	403.31	41.51	464.82	0
1966	521.81	510.02	40.91	467.54	0
1967	529.46	703.38	40.32	470.26	0
1968	539	768.75	39.73	472.98	0
1969	642.46	940.96	39.13	475.71	0
1970	821.18	976.88	38.54	478.43	0
1971	706.78	686.74	36.17	525.71	0
1972	1054.95	616.18	35.16	573	0
1973	1211.29	685.4	26.68	620.28	0
1974	1218.7	691.89	31.13	667.57	0
1975	1237.6	739.84	42.99	714.85	0
1976	1368.34	963.84	38.54	722.92	0
1977	1588.4	599.17	39.53	730.98	0
1978	1228.41	483.63	40.52	739.05	0
1979	1158.31	401.41	35.58	747.12	0
1980	1980.05	681.22	42.99	755.18	0
1981	1957.56	776.07	99.91	783.79	1.69
1982	1917.82	805.73	54.34	608.52	2.97
1983	1280.84	445.29	77.43	837.22	6.37
1984	1187.88	369.6	40.19	678.56	7.02
1985	1329.76	267.32	45.67	955.51	12.49
1986	1460.14	31.32	130.85	891.96	14.09
1987	1671.39	35.86	38.33	608.13	11.26
1988	1477.09	54.43	29	689.06	14.64
1989	1278.78	36.64	59.72	445.88	10.69
1990	1409.77	38.07	64.84	556.92	14.87
1991	1407.93	35.56	74.06	760.5	22.82
1992	1331.94	60.35	58.91	836.85	25.11
1993	1171.46	35.72	57.73	457.8	13.73
1994	1312.22	56.77	55.48	536.13	16.08
1995	1190.36	43.15	40.53	660.59	19.82
1996	1537.75	129.11	78.47	598.27	17.95
1997	1521.78	199.25	58.73	755.03	22.65
1998	1693.48	57.38	34.91	560.12	16.8
1999	1351.87	52.42	45.7	414.88	12.45
2000	1281.27	82.94	38.28	585.56	17.57
2001	1272.67	58.1	21.12	399.03	11.97
2002	1246.95	72.67	21.68	483.65	14.51
2003	1218.81	46.35	21.23	510.57	15.32
2004	1615.1	90.38	40.07	454.96	13.65
2005	1312.05	134.73	56.27	417.9	12.54
2006	1671.7	107.24	33.78	538.26	16.15
2007	1715.41	92.33	38.1	790.16	23.7

2008	1869.22	104.92	24.15	466.54	14
2009	2108.06	62.9	29.53	386.47	11.59
2010	2002.97	52.07	25.66	224.89	6.75
2011	1444.21	31.43	13.28	165.14	4.95
2012	1024.46	34.43	8.81	139.01	4.17

Table 2.8.5. Commercial and recreational discards (in thousands of fish) calculated from observer reported discard data. Tournament discards not available and were assumed to be negligible in the model.

Fishing_Year	Commercial Discards	Rec_Headboat Discards	Rec_Charter_Private Discards	Rec_Tournament Discards	Shrimp Bycatch
1978	0.0	0.0	0.0	NA	NA
1979	0.0	0.0	0.0	NA	NA
1980	0.0	0.0	0.0	NA	NA
1981	0.0	0.0	2.3	NA	NA
1982	0.0	0.0	1.0	NA	NA
1983	0.0	0.0	0.1	NA	NA
1984	0.0	0.0	0.5	NA	NA
1985	0.0	0.0	19.4	NA	NA
1986	0.0	0.0	21.6	NA	NA
1987	0.0	0.4	69.5	NA	NA
1988	0.0	0.1	46.6	NA	NA
1989	0.0	0.1	45.4	NA	178.9
1990	0.0	0.0	28.0	NA	646.9
1991	0.0	0.0	98.5	NA	120.0
1992	0.0	0.0	63.9	NA	122.7
1993	0.0	0.1	50.1	NA	59.8
1994	0.0	0.0	37.4	NA	146.7
1995	0.0	0.1	86.0	NA	231.5
1996	0.0	0.1	90.5	NA	466.3
1997	0.0	0.2	113.3	NA	118.4
1998	17.5	0.6	104.4	NA	294.1
1999	15.3	0.5	112.1	NA	156.6
2000	15.7	3.1	100.9	NA	64.6
2001	16.1	7.2	104.9	NA	26.3
2002	14.0	2.0	98.8	NA	33.3
2003	14.1	0.5	268.0	NA	81.2
2004	11.8	2.7	231.0	NA	107.2
2005	11.2	3.1	198.5	NA	124.1
2006	13.0	2.7	203.5	NA	53.2
2007	14.6	2.2	303.2	NA	91.5
2008	15.4	4.4	170.4	NA	43.3
2009	16.9	2.4	98.1	NA	23.3
2010	14.1	1.9	77.1	NA	15.3
2011	12.8	1.7	48.5	NA	19.8
2012	12.1	0.6	30.1	NA	8.0

Table 2.8.6. Standardized indices of abundance and the associated coefficient of variation.

Fishing Year	Com_Handline	Handline CV	Rec Headboat	Headboat CV	SEAMAP Trawl	SEAMAP CV
1980			1.17	0.15		
1981			1.26	0.15		
1982			0.71	0.18		
1983			0.7	0.15		
1984			0.86	0.16		
1985			0.46	0.16		
1986			0.7	0.14		
1987			0.9	0.15		
1988			0.52	0.16		
1989			0.95	0.17		
1990			0.88	0.17	2.86	0.17
1991			1.43	0.16	0.62	0.22
1992			0.98	0.13	0.86	0.24
1993			0.95	0.13	0.5	0.22
1994			0.85	0.13	0.75	0.22
1995			0.65	0.13	1.32	0.22
1996			0.87	0.14	2.1	0.19
1997			1.22	0.15	0.56	0.24
1998	0.95	0.04	1.31	0.14	1.91	0.23
1999	0.87	0.04	0.87	0.16	1.26	0.19
2000	0.84	0.04	1.34	0.15	0.84	0.24
2001	0.85	0.04	0.99	0.16	0.46	0.25
2002	0.94	0.04	0.67	0.17	0.51	0.2
2003	1.02	0.05	0.81	0.18	0.82	0.2
2004	1.14	0.05	1.35	0.19	1.13	0.22
2005	1.1	0.05	1.53	0.18	1.45	0.2
2006	1.21	0.05	1.76	0.18	1.03	0.22
2007	1.16	0.05	1.82	0.17	1.31	0.19
2008	1.18	0.04	1.33	0.14	1.04	0.22
2009	1.11	0.05	1.24	0.14	0.55	0.22
2010	1.09	0.05	1.06	0.15	0.29	0.23
2011	1.14	0.05	0.52	0.17	0.55	0.29
2012	0.93	0.05	0.36	0.16	0.28	0.22

2.9 Figures

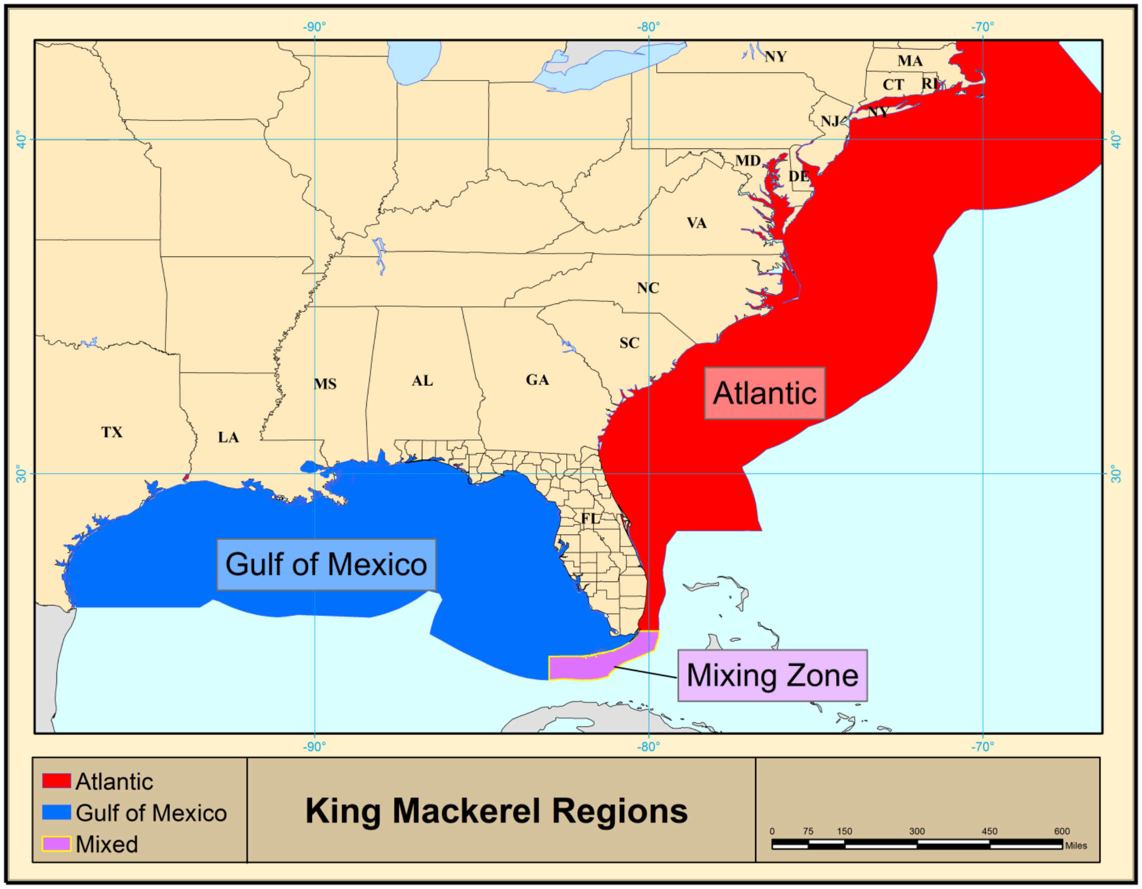
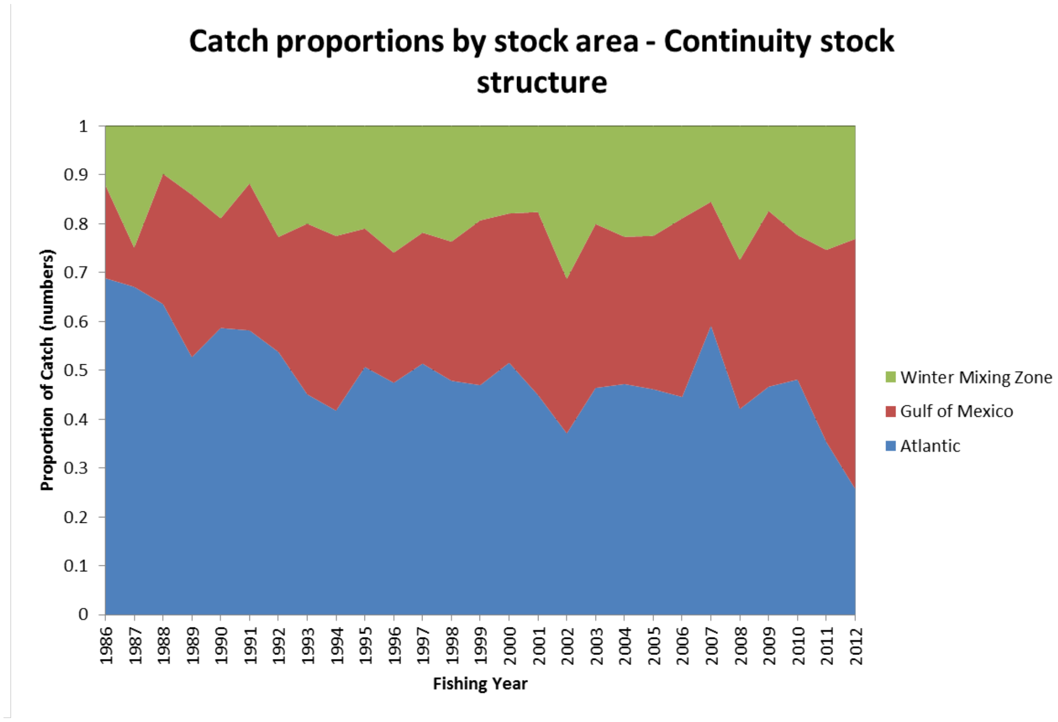


Figure 2.9.1. Regions used to aggregate landings for stock assessment of king mackerel in the GMFMC and SAFMC management area showing new winter mixing zone.



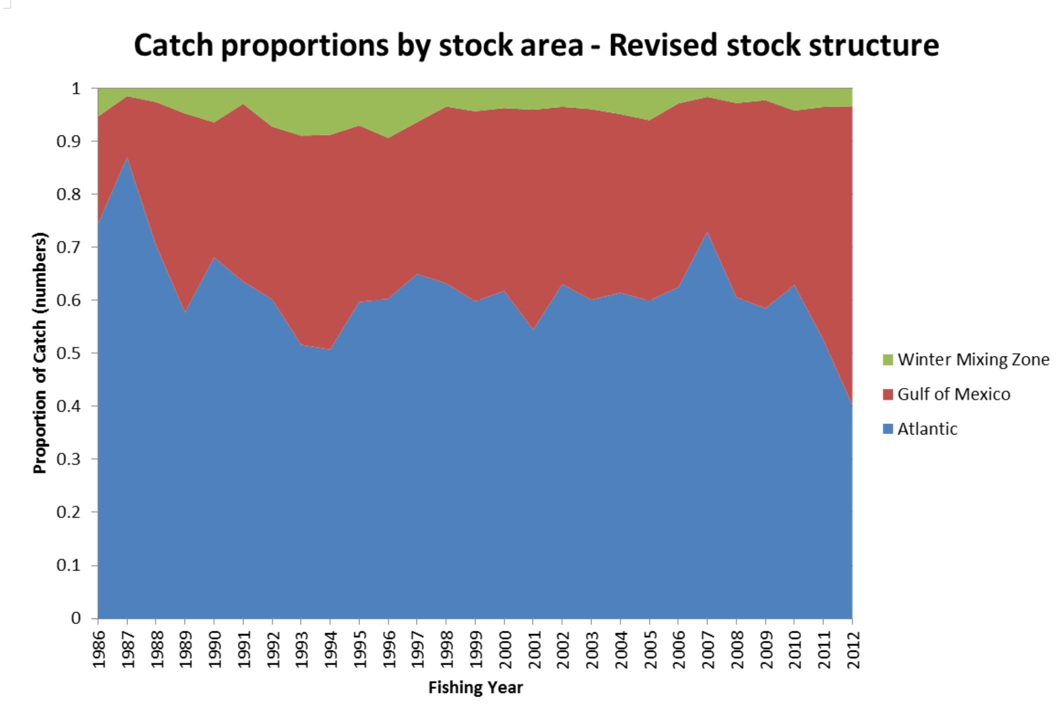


Figure 2.9.2. Proportion of total catch in number derived from VPA for the continuity winter mixing zone and the new winter mixing zone.

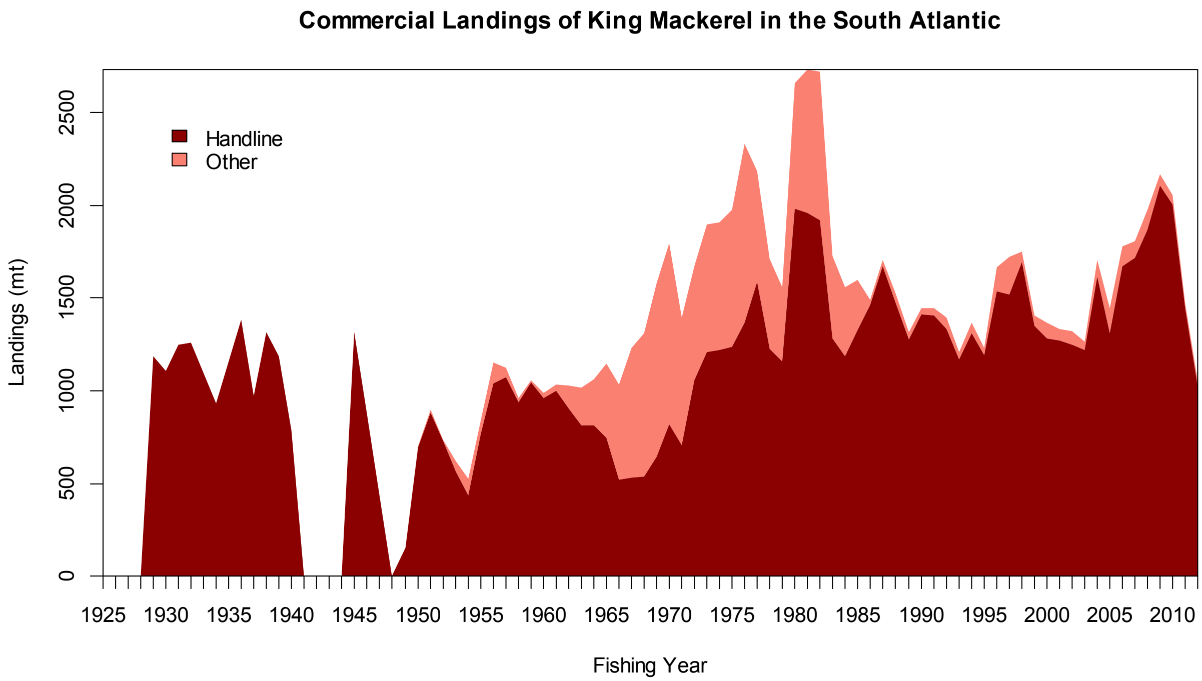


Figure 2.9.3. Estimated commercial landings of South Atlantic King Mackerel (whole wt).

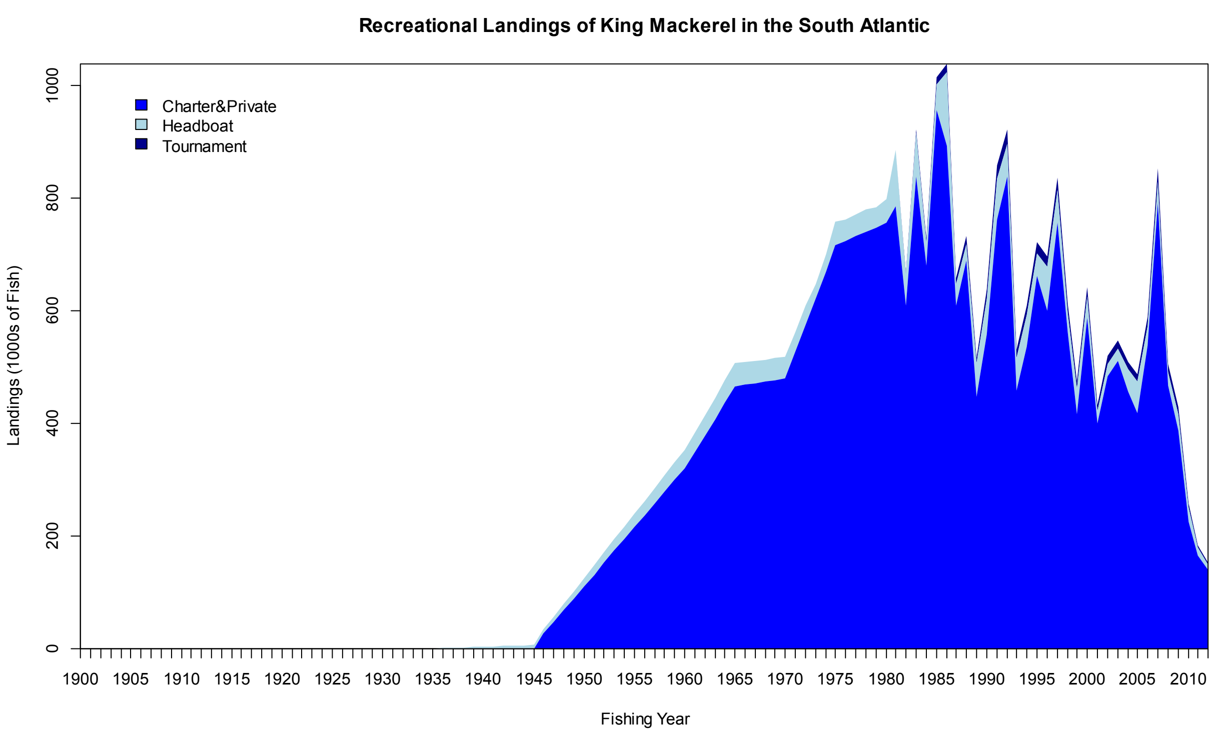


Figure 2.9.4. Estimated recreational landings of South Atlantic king mackerel.

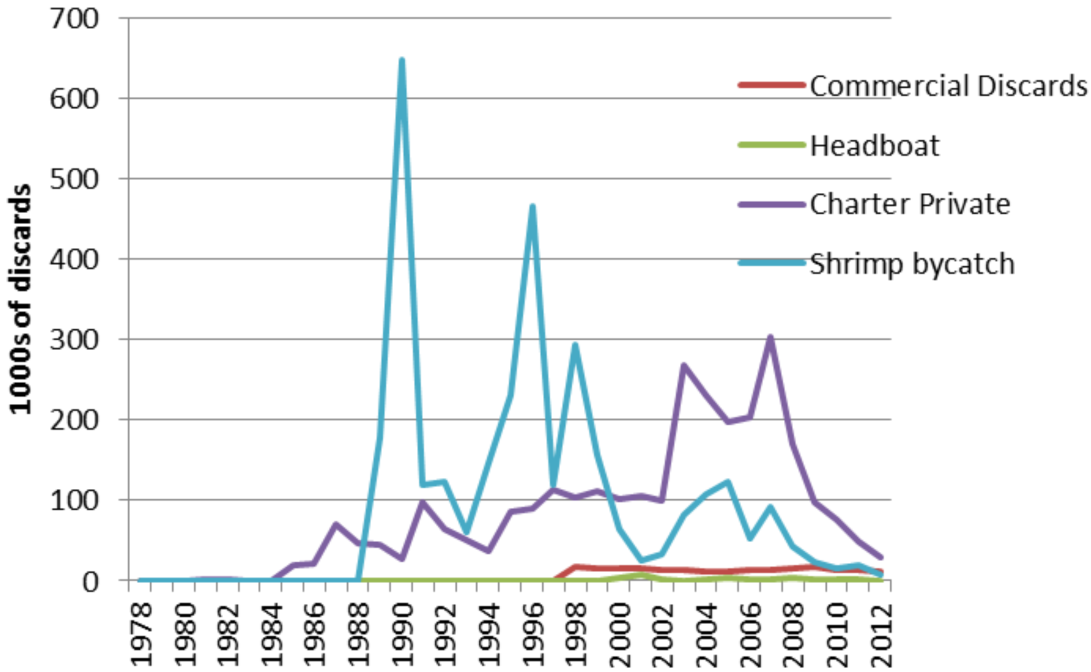


Figure 2.9.5. Estimated discards of South Atlantic king mackerel.

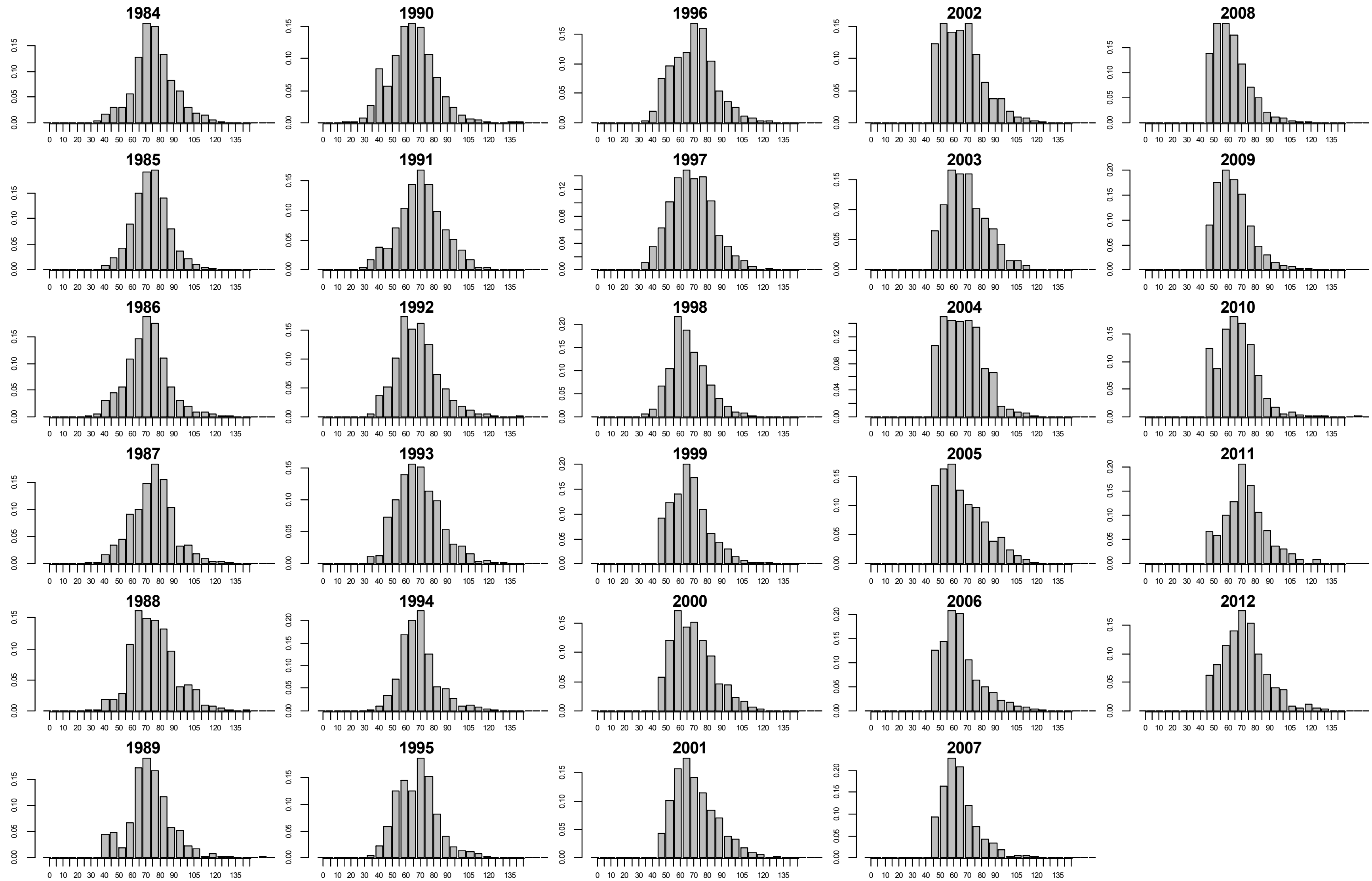


Figure 2.9.6. Annual length composition landed by the commercial handline fishery. Length measurements are fork length in cm, shown on the x-axis, and the frequency of observations is shown on the y-axis.

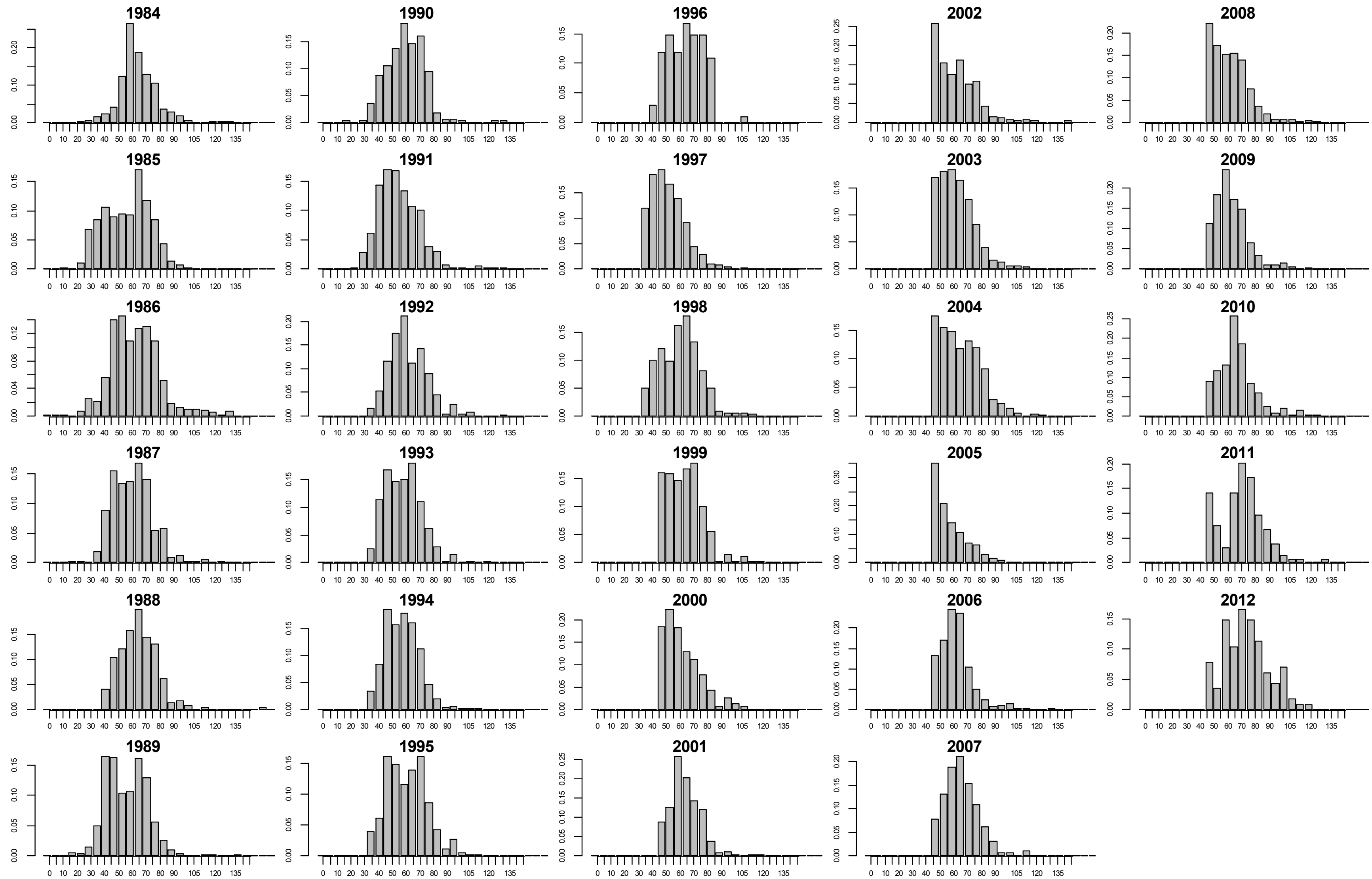


Figure 2.9.7. Annual length composition of the recreational headboat fishery. Length measurements are fork length in cm, shown on the x-axis, and the frequency of observations is shown on the y-axis.

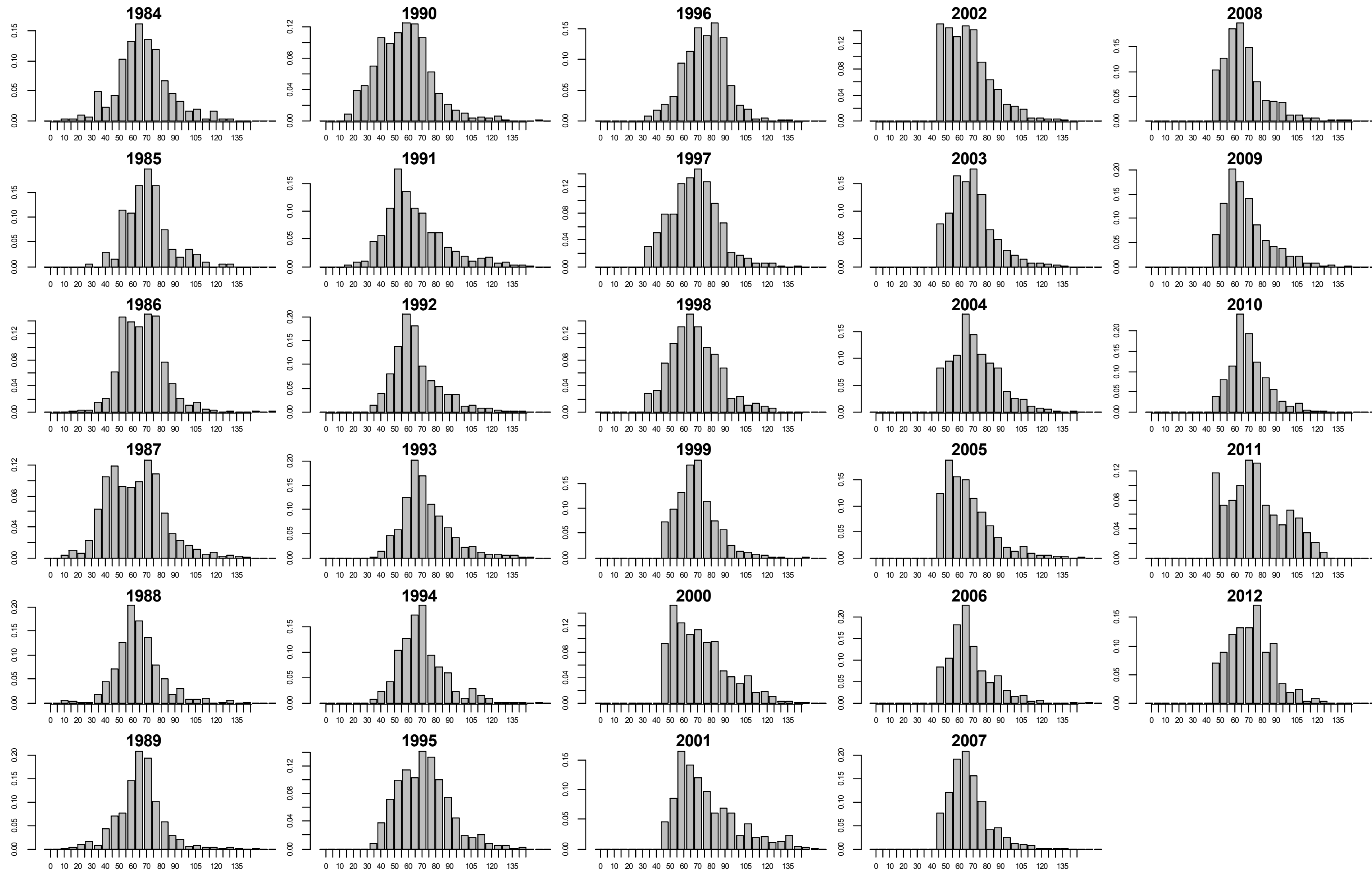


Figure 2.9.8. Annual length composition of the recreational charter and private boat fishery. Length measurements are fork length in cm, shown on the x-axis, and the frequency of observations is shown on the y-axis.

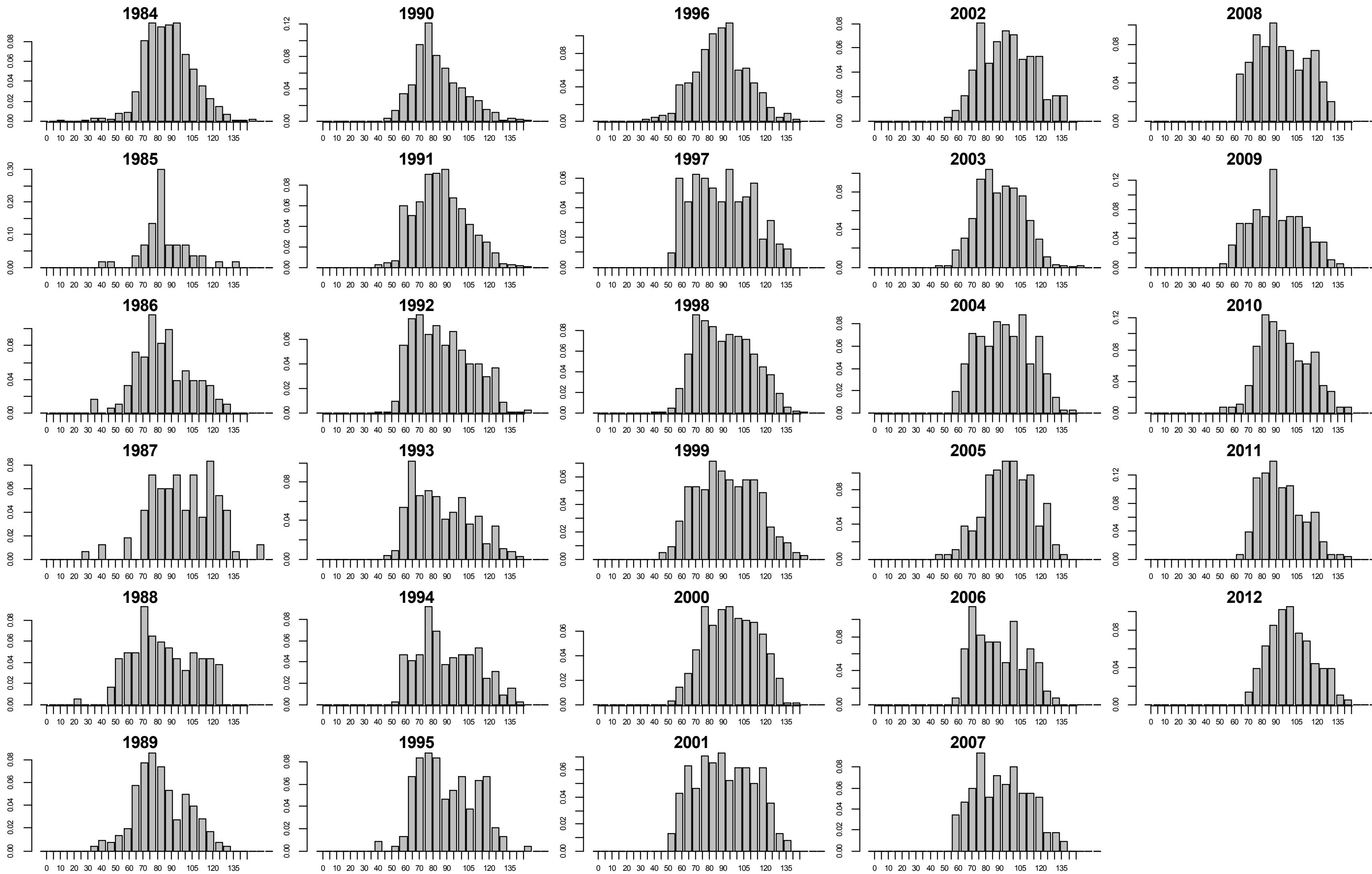


Figure 2.9.9. Annual length composition of recreational tournaments. Length measurements are fork length in cm, shown on the x-axis, and the frequency of observations is shown on the y-axis.

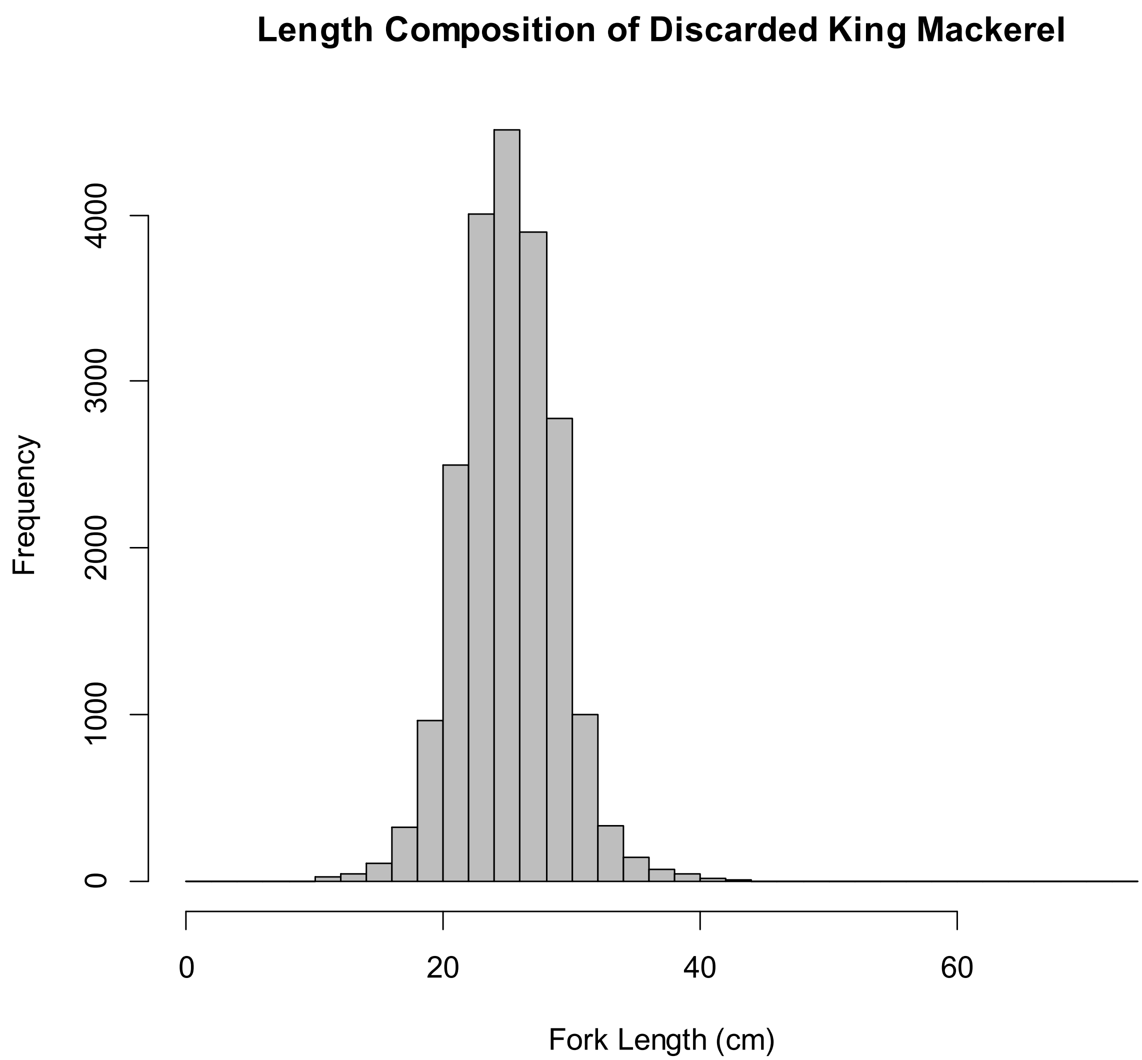


Figure 2.9.10. Observed length composition of King Mackerel discarded by recreational headboat fishery in Florida.

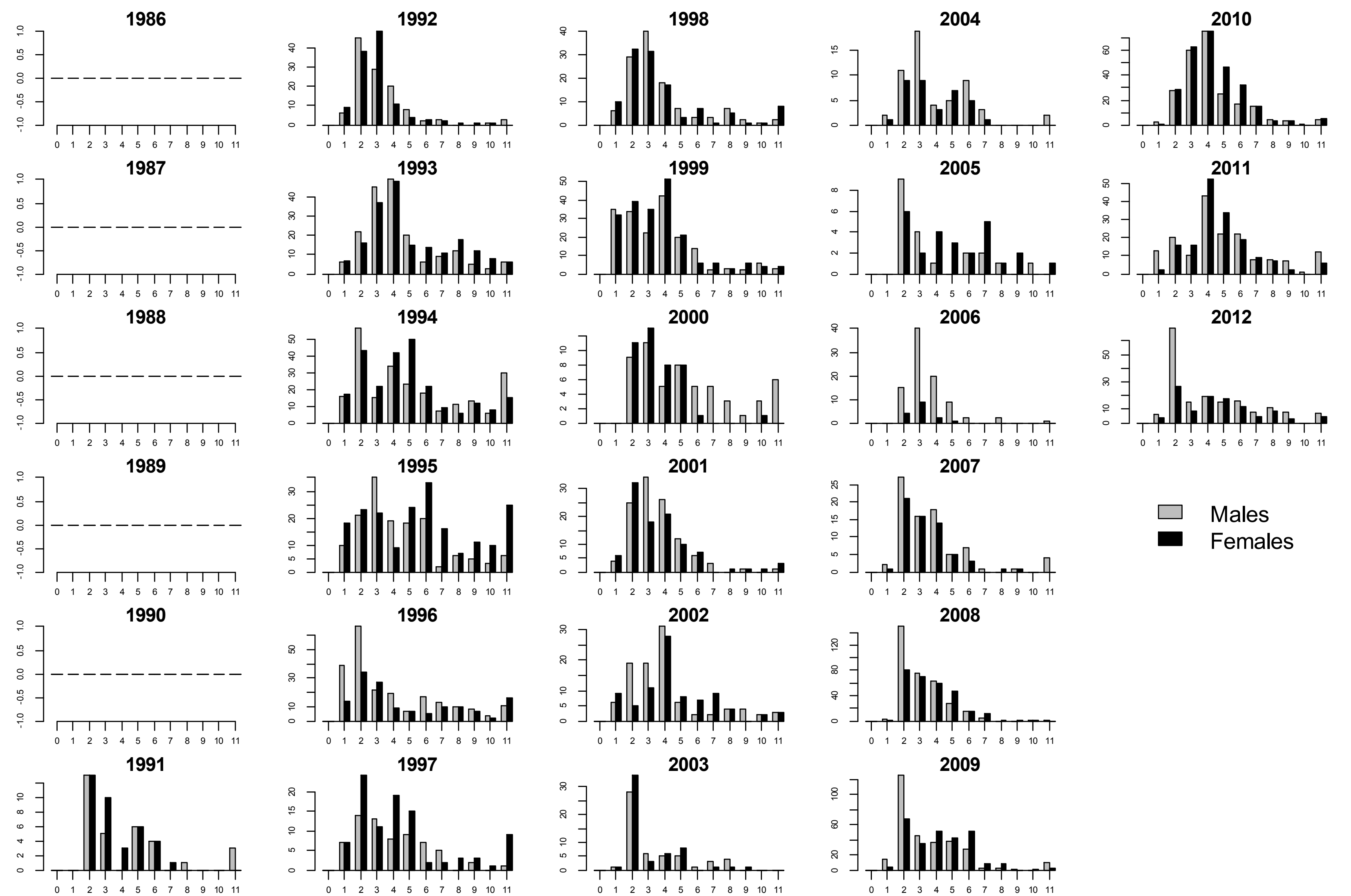


Figure 2.9.11. Annual age composition data from the commercial handline fishery. The x-axis is the measured age, and the y-axis is the frequency of observations.

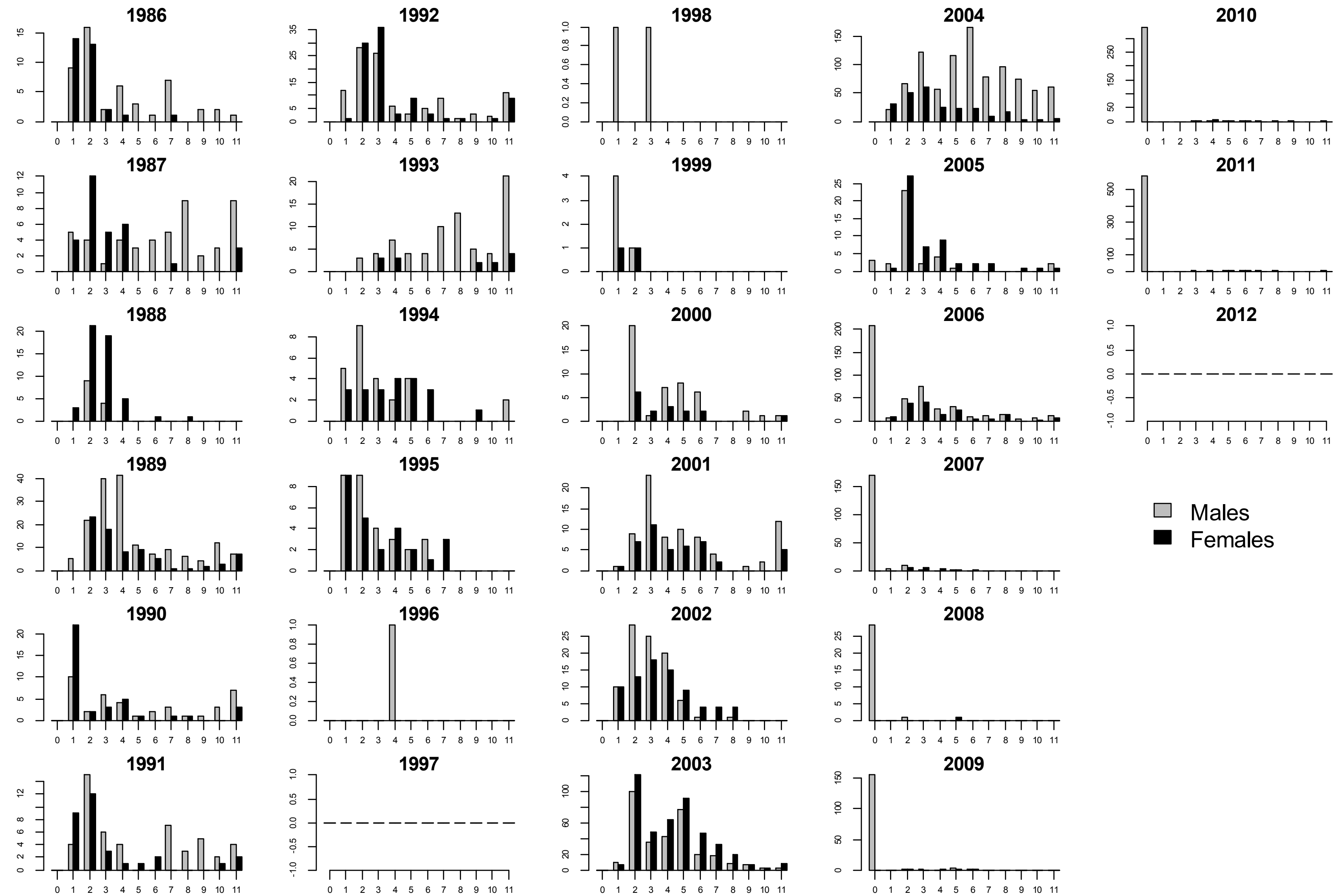


Figure 2.9.12. Annual age composition data from the recreational charter and private boat fishery. The x-axis is the measured age, and the y-axis is the frequency of observations.

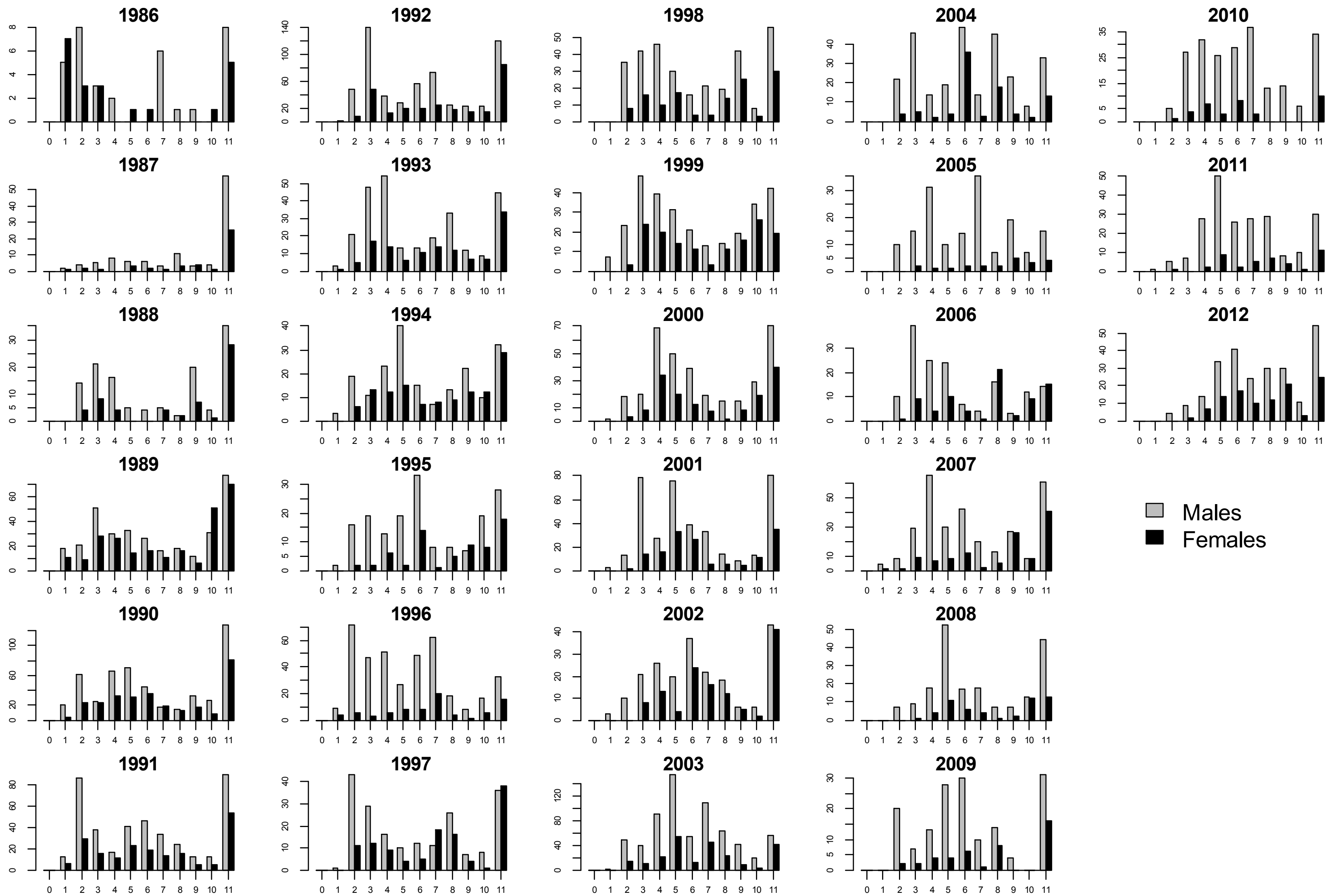


Figure 2.9.13. Annual age composition data from the recreational tournament fishery. The x-axis is the measured age, and the y-axis is the frequency of observations.

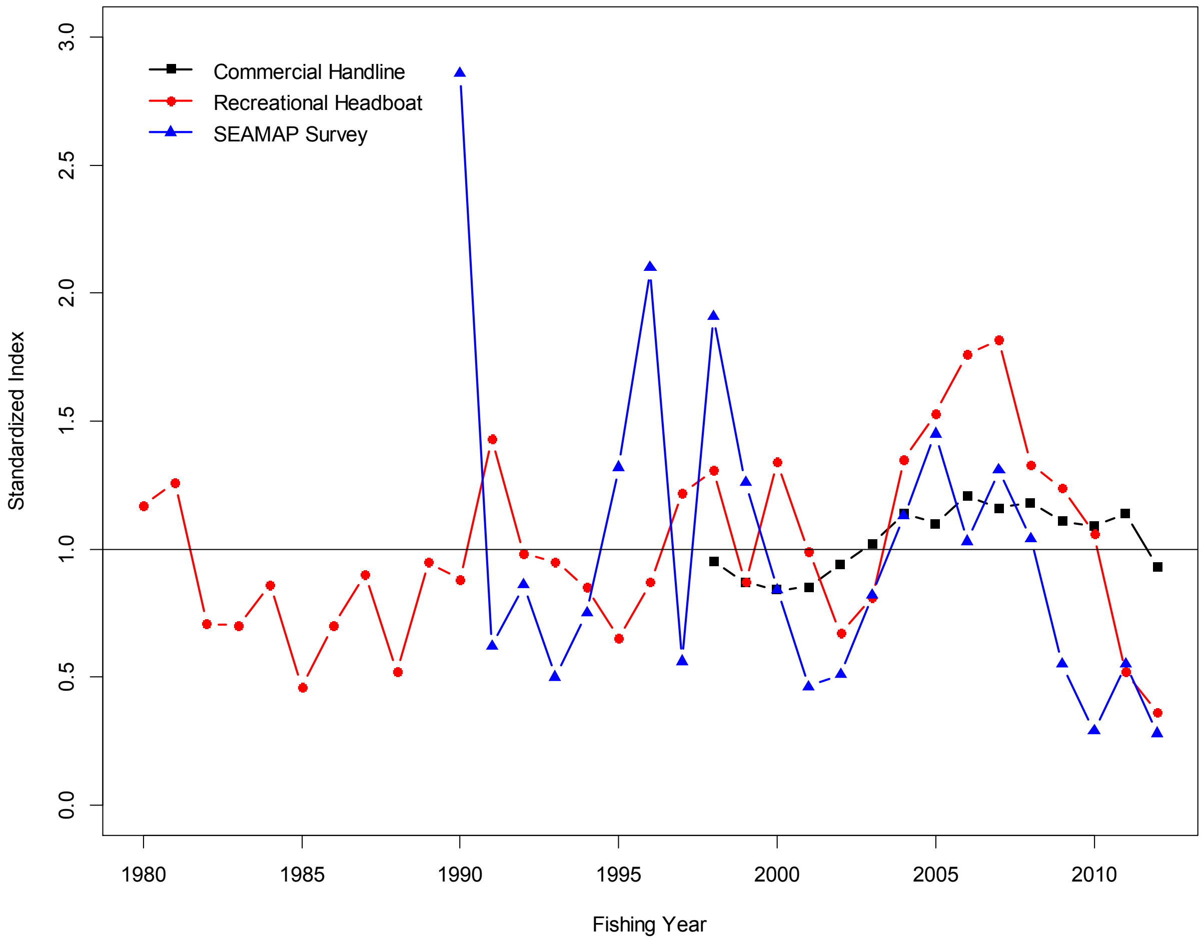


Figure 2.9.14. Standardized indices of abundance of King Mackerel in the South Atlantic

3 STOCK ASSESSMENT MODEL – STOCK SYSNTHESIS

3.1 Overview

The primary assessment model for the South Atlantic King Mackerel was implemented using Stock Synthesis software (Methot 2013) version 3.24P. Additional runs were made using the VPA models employed in SEDAR 16 to help distinguish the effects of changes in data and changes in modeling on the estimates of stock status. The results of these VPA runs are presented in a separate document (SEDAR-2014-RW_TBD).

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 (Methot and Wetzel 2013 http://nft.nefsc.noaa.gov/Stock_Synthesis_3.htm). 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. 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 is comprised of three subcomponents: 1) a population subcomponent that recreates an estimate of the numbers/biomass at age using estimates of natural mortality, growth, fecundity, etc.; 2) an observational sub-component that consists of observed (measured) quantities such as CPUE or proportion at length/age; and 3) a statistical sub-component that uses likelihoods to quantify the fit of the observations to the recreated population.

For this assessment, SS was first configured to mimic the previous VPA stock assessment of South Atlantic King Mackerel (SEDAR 16). After it was demonstrated that the SS model could obtain similar predictions as the VPA model when using the same data sets and similar model configuration, the SS model was extended to include additional data sources and added flexibility such as sexually-dimorphic growth and relaxing the assumptions inherent to VPA models. The final model configurations are detailed in the following sections.

3.2 Data Sources

The landings, discards, length composition, age data, and indices of abundance used in the SS model remained unchanged from the data workshop described in Section 2, with the following exception the age-composition of recreational and commercial discards was defined to be age-0 fish, exclusively, based on available observer data reviewed during the Assessment Workshop. **Figure 4.16.1** illustrates the data sources and the temporal scale of each. Appendix A (available upon request from SEDAR) contains the input files for the South Atlantic SS model.

3.3 Model Configuration and Equations

The South Atlantic King Mackerel population was modeled as a single stock that encompasses all U.S. waters of the South Atlantic. The exact stock definition is all waters North of the Miami-Dade-Monroe county line year round and then 50% of the fish captured from November 1 to March 31 in waters from the south of the Florida Keys and Dry Tortugas, demarcated in the west by a line west from Key West to the Dry Tortugas at 24°35' N. lat, then south at 83º W from the Dry Tortugas (the Gulf of Mexico/South Atlantic Council boundary) to the shelf edge, and in the east from the Dade-Monroe county line to the shelf edge (**Figure 2.9.1).** Landings from North of Cape Hatteras are included, but they are very minor. The assessment uses data through the 2012 fishing year (Mar-2012-Feb 2013) and the time period of the assessment is 1900-2012 fishing years. The starting year of 1900 was chosen so that the stock could be assumed to be at virgin conditions. The model operates on annual time steps with fish assumed to be born July 1. Inputs to the model by year and data type indicate the long time series of landings and the time series of indices, length and age composition (**Figure 4.16.1**).

3.3.1 Life history

A sex-combined fixed length-weight relationship was used to convert body length (cm) to body weight (kg). Fixed length-weight relationships, maturity, fecundity and spawning output as a function of length were input (**Figure 4.16.2**) and described below. The age-specific natural mortality vector developed at the DW was input into SS as a fixed vector. The assessment model was set-up with two genders to account for sexually dimorphic growth. Growth rates were estimated in the assessment model using a separate growth curve for both sexes (**Figure 4.16.3)**. Growth was modeled with a three parameter von Bertalanffy equation (L_{min}, L_{max}, and K). In SS, when fish recruit at the real age of 0.0 they have a body size equal to the lower limit of the first population bin (L_{bin}; fixed at 21 cm FL). Fish then grow linearly until they reach a real age equal to the input value of A_{min} (growth age for $L_{min,}$ assumed to be age 0.5) and have a size equal to the L_{min}. As they age further, they grow according to the von Bertalanffy growth equation. L_{max} was specified as equivalent to L_{∞}. Two additional growth parameters were estimated that reflect the CV in length-at-age at A_{min} (age 0.5) and A_{max} (age at L_{max}). A sex-combined fixed length-weight relationship was used to convert body length (cm) to body weight (kg).

3.3.2 Stock-recruitment model

A Beverton-Holt stock-recruitment model was used in this assessment. Two parameters of the stock recruitment relationship were estimated in the model; the log of unexploited equilibrium recruitment (R_0) and the steepness (h) parameter. The steepness parameter describes the fraction of the unexploited recruits produced at 20% of the equilibrium spawning biomass level. A third parameter representing the standard deviation in recruitment (σ_R) was input as a fixed value of 0.6. Rarely is σ_R directly estimable from the given data and hence it is often necessary to input as a fixed parameter.

Annual deviations from the stock-recruit function were estimated for the time period 1981-2012 due to the availability of length composition data beginning mostly in the early 1980s and length age composition data beginning in 1991. Over this time period the log (recruitment) deviations were assumed to sum to zero. Stock synthesis estimates recruitment deviations on a log scale so that expected recruitments require a bias adjustment so that the recruitment level is mean-unbiased. Methot and Taylor (2011) recommend that the full bias adjustment be applied to data-rich years in the assessment and thus the full bias correction was applied for the years 1981-2012. No bias-adjustment ramping was conducted.

3.3.3 Starting conditions

The starting year of the assessment model is 1900 when the stock was assumed to be in virgin conditions and initial fishing mortalities for all fleets equal to 0. No equilibrium Fs or equilibrium catch for any fleet were required as landings were assumed to have been reconstructed back to the initiation of the fishery. Initial model scoping required some lowering of the starting values for many of the initial Fs for the first year of catch for a given fleet and also for many of the early Fs that occurred prior to index, length or age composition data.

3.3.4 Definition of fleets and Indices of abundance

The six fishing fleets in the model are commercial handline, commercial gillnet, shrimp trawl bycatch fleet, recreational headboat, charter/private and tournament. The six fleets were chosen to represent fairly homogenous fisheries with similar selectivity patterns.

The assessment includes two fishery-dependent indices; commercial handline- trolling only and recreational headboat and one survey; SEAMAP age-0 trawl. Shrimp effort was input as a survey, however as this indexes F for the shrimp fishery there is little other information to conflict with a near perfect fit to the effort vector. Additional details regarding the indices of abundance can be found in Section 2.7 of the Assessment Report and in the SEDAR 38 Data Workshop Report. Indices were weighted according to the standardization-model estimated CVs. Index timing was the middle of the year, except for the SEAMAP trawl which was indexed to the first part of the model annual time step (August-Sept, since the model year starts in July).

3.3.5 Conditional age at length input

A conditional age-at-length likelihood approach was used: the expected age composition within each length bin was fit to age data conditioned on length (conditional age-at-length) in the objective function, rather than fitting the expected marginal age-composition to age data (which are typically calculated external to the model as a function of the conditional age-at-length data and the length-composition data). The von Bertalanffy growth curve and variability in the length-at-age relationship were estimated by the model using the conditional age-at-length data and an aging error vector assumed a CV of 0.1 on each age. Twelve age classes (0-11) with 11 as a plus group were modeled. A plus group of 11 was used as this matched the age definition in the SEDAR 16 VPA.

3.3.6 Length composition input

Length composition was input by fleet and sex as male, female or unknown. Data length bins ranged from 20-160 by 5cm and input sample size was either capped at 100 or the actual sample size, if less.

3.3.7 Selectivity and retention functions

Selectivity was specified as length based for all directed fisheries in the model and age-based for the SEAMAP survey and the shrimp bycatch fishery where only age-0 fish were assumed vulnerable. For the tournament fisheries, selectivity was assumed to be logistic due to targeting of the largest fish. Due to changes in tournaments from an aggregate catch award to single trophy fish a second time block on selectivity was imposed beginning in 1997. For all other fleets a double normal selectivity pattern was assumed that can take on flexible shapes ranging from dome-shaped to flat-topped, depending upon estimated selectivity. Selectivities for the handline, headboat, gillnet and charter/private were modeled separately for males and females with female selectivity being and offset of male. Hence if the estimates were the same, then the offset would be zero for each parameter. The rationale behind this was to initially fix male selectivity for the handline fleet as asymptotic, as males grow to a smaller size than females. This would provide an asymptotic selectivity to reduce confounding between the descending limb of selectivity and mortality. However the residual patterns were so poor when male selectivity was fixed that this assumption had to be relaxed, allowing for a dome-shaped male selectivity of the handline fleet.

For estimation of length-based selectivities, several constraints were imposed. First, parameter 5 of the double normal selectivity function that defines the initial selectivity at the first size bin was fixed at to be zero and not estimated, as fish in the smallest size bin (20 cm) were unlikely to be captured by any of the directed fisheries. Second, for the gill net fishery the ascending and descending limbs were allowed to have a smooth increase and a smooth decay using the SS technical specification (-999) for parameters 5 and 6. In addition, a normal(4.78, 2) prior was used for gill net selectivity parameter 3 which defines the ascending width of the selectivity curve. These specifications were necessary due to the sparse size composition data for the gill net fishery leading to difficulty in estimating its selectivity.

Four blocks of time-varying retention patterns were defined to model minimum size limits. The breaks were 1989, 1990, 1992, 1999 and each coincide with a change in the size or retention limit. Retention was modeled as a step function of size, with the probability of being retained based on the minimum size regulations, below which, all fish were assumed to be discarded, and above which fish were assumed to be retained.

3.4 Parameters Estimated

Of the 523 parameters estimated in the base case model (**Table 4.15.1**), 452 active parameters were annual fleet specific fishing mortality rates. Of the remaining 71 parameters, 32 were recruitment deviations, 28 selectivity parameters, 8 growth parameters, 2 stock recruitment parameters and 1 shrimp fishery catchability.

Fishing mortalities for each fleet in each year were estimated as continuous F parameters (SS lingo F method 2) requiring a high number of parameters but providing the flexibility to model catch with error and to estimate F from an effort time series such as the shrimp bycatch fleet.

Table 4.15.1 includes predicted parameter values and their associated asymptotic standard errors, initial parameter values, and minimum and maximum bounds, priors, if any, and phase of estimation. The 452 fishing mortality rate parameters are available in **Appendix B** (available from SEDAR upon request). Parameters designated as fixed were held at their initial values. Starting values for all biological parameters were based on recommendations from the data workshop report and detailed above. Steepness was freely estimated with no prior. Uniform, non-informative priors were applied to all estimated selectivity parameters in the base model, except for one gill net selectivity parameter, as described above. Starting values for selectivity parameters were taken from estimated selectivity patterns from SEDAR 16. Parameter bounds were selected to be sufficiently wide to avoid truncating the searching procedure during model fitting. The soft bounds option in SS was utilized when fitting the assessment model. This option creates a weak symmetric beta penalty to keep parameters off of bounds (Methot 2011).

3.5 Model Convergence and model diagnostics

Model convergence was assessed using several means. The first diagnostic was whether the Hessian, (i.e., the matrix of second derivatives of the likelihood with respect to the parameters) inverts. The second measure is the maximum gradient component which, ideally, should be low. The third diagnostic was a jitter analysis of parameter starting values to evaluate whether the model has converged to a global solution, rather than a local minimum. Starting values of all estimated parameters were randomly perturbed by 10% and 50 trials were run.

Other diagnostics performed included likelihood profiling of key parameters, evaluation of fits to residuals for indices and length composition, retrospective analyses and sensitivity to different indices and compositional data inputs.

3.6 Uncertainty and Measures of Precision

Uncertainty in parameter estimates and derived quantities was evaluated using multiple approaches. First, uncertainty in parameter estimates was quantified by computing asymptotic standard errors for each parameter (**Table 4.15.1**). Asymptotic standard errors are calculated by inverting the Hessian matrix after the model fitting process. Asymptotic standard errors are based upon the maximum likelihood estimates of parameter variances at the converged solution.

Second, uncertainty in parameter estimates and derived quantities was investigated using a parametric bootstrap approach. Bootstrapping is a standard technique used to estimate confidence intervals for model parameters or other quantities of interest. There is a built-in option to create bootstrapped data-sets using SS. This feature performs a parametric bootstrap using the error assumptions and sample sizes from the input data to generate new observations about the fitted model expectations. The model was refit to approximately 350 bootstrapped data-sets and the distribution of the parameter estimates was used to represent the uncertainty in the parameters and derived quantities of interest (**Table 4.15.10**).

Likelihood profiles were completed for two key model parameters: steepness of the stock-recruit relationship (h) and the log of unexploited equilibrium recruitment (R_0). Likelihood profiles elucidate conflicting information among various data sources, determine asymmetry around the likelihood surface surrounding point estimates and evaluate the precision of parameter estimation

3.7 Model listing and sensitivities

Uncertainty in data inputs and model configuration was examined through several sensitivity analyses. The following sensitivity analyses were conducted:

1. Indices only
2. Indices and length composition

3. Indices, length and conditional age at length composition
4. Indices, length and conditional age at length composition (Base)
5. Time block on Tournament selex
6. Allow for dome-shaped male HL selex
7. Evaluate higher and lower natural mortality
8. Equal weighting of index data according to a common CV and low error on catch.
9. Removing tournament data
10. Remove-one (Jack-knife) analysis of indices of abundance

3.7.1 Indices only

This model run represents one of the initial scoping runs performed to evaluate solely the signal in the indices and the landings. Essentially this model run is an analog to a production model. The only estimated parameters are R0, steepness, recruitment deviations, shrimp bycatch fleet catchability and the fleet and year-specific fishing mortality rates. Biological parameters were fixed at initial values. Selectivity was fixed at constant for all ages except only ages 0 were selected by the shrimp fishery and the SEAMAP trawl.

3.7.2 Indices and length composition

This model run builds on the previous index only model (1) but adds in the length composition data. This model estimates all selectivity parameters but does not estimate growth. The goal of this model is to evaluate the signal obtained by adding in length composition data.

3.7.3 Indices, length and conditional age at length

This model builds upon (2) and adds in conditional length at age composition data. The goal of this model is to evaluate the additional signal provided by the age composition data. Ultimately this model will become the Base model formulation.

3.7.4 Indices, length and cond. Age at length and male HL selex dome (Base)

The model builds upon (3) but adds frees male selectivity to be dome-shaped to resolve a systematic lack of fit to males. Also a timeblock on tournament selectivity is created. This becomes the base model.

3.7.5 Natural mortality

Two model sensitivities to varying natural mortality was considered by evaluating high and low values for M. M was varied by adding or subtracting 0.05 from the M at age vector. High and low vectors are shown in **Table 2.8.2**.

3.7.6 Data weighting

Two model runs evaluating different weighting scenarios were run. In the base model run, length and age composition data were weighted by the number of fish observed, with sample sizes capped at 200 fish to prevent the model fitting the composition data to the exclusion of the indices of abundance. Indices of abundance were weighted by the log-scale standard errors estimated as part of the index standardization process. During the AW webinar process runs were made that achieved an overall equal CV of ~0.15 for all indices to effectively weight them equally but to preserve the interannual variability in each index CV. Another model run was made with very low (CV=0.01) error on the recreational landings.

3.7.7 Removing tournament data

Due to concerns about the lack of fit to the tournament data and to the potential that selection for the largest fish tournament could give a false picture of the stock status, a sensitivity run was conducted to remove all tournament age and length information and to place all tournament landings back into the private recreational category.

3.7.8 Jack-knife indices of abundance

The final set of sensitivity runs was used to evaluate the model sensitivity to each of the indices of abundance. A jack-knife approach was used where each index of abundance was removed from the model and then the model was refit to the remaining data, including the other indices.

3.8 Retrospective Analysis

Retrospective analysis was conducted to assess the consistency of stock assessment results by sequentially eliminating the years of data from the terminal year while using the same model configuration. The primary purpose of this is to evaluate whether there is a systematic bias in key stock status indicators as terminal years are peeled off of the full data set. Ideally retrospective patterns are random and do not show a clear bias in any particular direction. Additional retrospective peels were conducted going back 20 years to evaluate an apparent cyclical pattern in estimates of steepness.

3.9 Environmental/Ecosystem considerations

The DW Integrated ecosystem assessment ad-hoc working group postulated a number of ecosystem factors might be of concern for this stock assessment. The primary itemized concerns were: 1) use of environmental data in CPUE standardization in an attempt to account for changes in the indices due to environment rather than actual stock abundance; and 2) using environmental data to help refine annual estimates of stock mixing. A number of other concerns were raised including impacts of harmful algal blooms, land-based pollution and predator-prey dynamics but these were not elevated to the level of primary attention but the IEA working group. These was due to time, data limitations (particularly for predator-prey dynamics) and absence of a clear impact of these factors on king mackerel populations similar to that observed with red tides and gag and red grouper (SEDAR 2009, SEDAR33).

With regards to the two itemized primary concerns, the most substantial of these considerations relative to this assessment was the re-evaluation of stock boundaries on the basis of monthly landings, considering temperature impacts that cause fish to move into the mixing zone (**SEDAR 38DW report, Figure 2.15.1).** This re-evaluation produced the new, much smaller winter mixing zone (**Figure 2.9.1)**, greatly reducing the amount of landings that previously were allocated to a much larger mixing zone in SEDAR 16 and presumably resulting in more precise stock allocations.

Relative to evaluating impacts of temperature on CPUE, substantial work was also conducted to create time series of average sea surface temperature, annual number of degree days above an assumed king mackerel preferred sea surface temperature threshold above 20^{o}C and an annual index of summertime upwelling, as all of these factors were proposed to be affect king mackerel landings, catch rate or other population metrics.

The proposed methodology to evaluate these indices was to correlate them with deviations to model fits to the commercial handline and headboat CPUE and to recruitment deviations. Then if the indices showed a promising correlation they could be incorporated as environmental indices of either catchability or recruitment deviations (Schirripa et al. 2009).

3.10 Benchmark/Reference Point Methods

Benchmarks for stock status were based upon F_{MSY} and SSB_{MSY} using female fecundity as the metric for SSB. As steepness was estimated by the model allowing for direct MSY calculation rather than use of proxies such spawning biomass per recruit (SPR) though these metrics are calculated and could be of use for management considerations.

3.11 Projection Methods

Projections were run to evaluate stock status and associated yields for a range of fishing mortality rate scenarios. Projections were run from FY 2013 to 2023 for the base model configuration (Run 1). The projections assume current FY2012-2013 yields persist into the future for the 2013-14 and 2014-15 fishing years. These yields are substantially below the ACLs.

Projections were run assuming that selectivity, discarding, and retention were the same as the three most recent two years (2011-2012). Due to concerns related to Deepwater Horizon effects upon the fishery only years 2011 and 2012 were averaged. The catch allocation among fleets used for the projections reflects the average distribution of fishing intensity among fleets during 2011-2012.Forecast recruitments are obtained with three sets of forecast recruitment deviations to evaluate three hypotheses regarding future recruitment.

Given the low recruitment deviations in the last five years there is potential that recruitment may not immediately jump to the long-term average and that recruitment may remain low for several years in the future. While it is not known what environmental factors may be accounting for the low recruitment deviations, the fact remains that recruitment deviations are estimated to be low.

So as to provide ACL advice that is robust to low recruitment, recruitment in the next three years was modeled with three scenarios:

High- assumes that recruitment immediately reverts to the stock recruitment curve in the first year of the projections; forecast recruitment deviations have a mean of 0 and standard deviation equal to sigma r (0.6).

Medium- assumes that recruitment deviations are halfway between the last five years and 0; forecast recruitment deviation mean of -0.277

Low - assumes that recruitment deviations have a mean similar to deviations in the last five years (-0.555)

After three years, future recruitment was assumed to be the from the stock recruitment curve; deviation mean =0

For deterministic projections the estimated Beverton-Holt stock-recruitment relationship was used with the terminal year estimate of steepness. Deterministic projections were run for three fishing mortality rate scenarios for the base model configuration and the three recruitment hypotheses:

- $F_{Current}$: fishing mortality rates set to the mean of the past 2 years (2011-2012)
- F_{MSY}: the fishing mortality rate that results in an maximum sustainable yield
- F_{OY}: 75% of $F_{MSY\,\%}$

Uncertainty in stock status and forecasted yields for the projection years was investigated using the parametric bootstrap approach discussed in Section 3.6. Bootstrap datasets were created for the same model configuration used for deterministic projections. For each model configuration, the model was refit to 500 bootstrap datasets and then projected forward with each of the F metrics. The projections followed the same methods and assumptions described above for the deterministic projections; however, the bootstrap projections included random recruitment deviations for the projection period. Random deviations were created from a normal distribution with mean equal to the High, Medium and Low scenarios, above, and standard deviation equal the sigma r (0.6). The projections from the bootstrap runs were used to create probability distribution functions for the development of management advice, including OFL and ABC.

4 ASSESSMENT MODEL RESULTS

4.1 Model Convergence and model diagnostics

4.1.1 Convergence performance

Overall the model shows some issues with convergence. The Hessian inverted but the maximum gradient component is 0.0229 which is higher than 0.001, a value commonly used as a default criterion for convergence. High maximum gradient components have been observed in other assessments (SEDAR31) that estimated 100s of F parameters to accommodate effort time series and estimate bycatch. In previous model runs where each of the Fs were not estimated (using SS-lingo- hybrid F method 3) this high gradient problem was not observed indicating that it is likely a product of estimating many, highly correlated, F parameters, particularly for early time periods with little to no contrasting information.

The next performance metric was to evaluate the sensitivity of the model to starting values by jittering them by 10% (**Figure 4.16.4**). The minimum log-likelihood found in the non-jittered estimation (red line in figure), was not the most common solution, though these solutions only differed by 5 likelihood units and the key parameters and benchmark quantities differed very little. Beyond these two solutions, three of the remaining showed rather extreme differences in log-likelihood. Nonetheless, even at the most extreme, the differences in key parameters and benchmarks were not that high, indicating that these fluctuations would be unlikely to substantively alter stock perception. This conclusion is further reinforced by plots of the time series of recruitment, SSB and F (**Figure 4.16.5**) that indicate even the most extreme outlier runs show little divergence.

Previous model iterations with no error on catch converged on the exact same solution during jittering analysis indicating that much of these convergence problems originate from the relatively high (cv =0.2) on greater than 60% of the total removals.

4.1.2 Likelihood profiling of key parameters

Likelihood profiles for steepness (**Figure 4.16.6**) indicate that it is estimable and that most sources of information are in relative agreement on the most likely values, except for the age composition information. Overall the length composition data dominates the total likelihood. Virgin recruitment is quite well estimated by the model but there is a conflict between the length composition which has a minimum log-likelihood at values around 8.5 and the age data which tend to favor higher values (**Figure 4.16.7**). Taken in total, the sum of the information provides a fairly well-defined minimum for virgin recruitment, though much of this is due to the average minimum between the conflicting age and length data.

4.2 Measures of overall model fit

4.2.1 Landings

The input CVs on the commercial landings in whole weight (0.02) effectively treats these as being known without error and the fits are not shown. For the recreational fleets, landings in number were input with a CV of 0.2, allowing the model to diverge from the observed values

(**Figure 4.16.8**). Private/rec landings showed some substantial divergence with a time trend in the pattern. Prior to 1992 estimated landings were 2-18% less than observed. After 1992 this pattern reverses and the model estimates between 5 and 40% higher recreational landings. Similarly for the headboat fleet there is some substantial divergence from the input catch with most estimated catches being substantially lower than input for the years 1990-2008.

For the commercial fisheries (handline and gillnet) the landings match exactly the input values. For the recreational fleets the estimates diverge according to **Figure 4.16.8** and the estimated landings in number were converted to estimated landings in weight. Overall estimated landings indicate historical influence of the handline fleet and then the rapid emergence of the charter/private fleet after 1945 (**Figure 4.16.9**). Overall estimated landings peaked in the early 1980s and then again in 2008, a peak largely created by the high model-estimated charter/private landings in that year (**Figure 4.16.8**).

4.2.2 Discards

The model was fit to four discard fleets; commercial handline, private recreational/charterboat, headboat and shrimp bycatch fishery (**Figure 4.16.10**). All targeted fleets used time-varying retention to account for changes in size limits. For the shrimp fishery, discards were fit only to the median value of the time series. The model generally estimated discards relatively well except that the charter/private discards were estimated lower than input by the model (**Figure 4.16.11**). This is particularly pronounced during the 2005-2010 time period when the model estimates fewer discards and a greater amount of landed fish.

Overall estimated total (live +dead) discards represent a relatively minor component of total removals but show relatively high numbers post-1990 with the imposition of restrictive size limits (**Figure 4.16.10**). Shrimp discards were estimated to have been a relatively low amount of total discards compared to the other fisheries and have declined in recent years with declines in shrimping effort.

In general the discard fractions (ratio of discarded/landed in number) are quite low except for the shrimp fishery which is assumed to discard all age-0 king mackerel with 100% mortality (**Figure 4.16.12**). Hence, discards are not a substantial component of fishing mortality for this stock, under the current model assumptions.

4.2.3 Indices of abundance

Model fits to the indices were mediocre (**Figure 4.16.13**). Fit was best to the commercial handline (RMSE= 0.087) and substantially worse to the headboat (RMSE= 0.32) and SEAMAP trawl index (RMSE=0.53) (**Figure 4.16.14**). All indices show some evidence of declines in recent years, but the model predictions indicate substantial declines, beyond those of the indices. The indices decline but only in the most recent years, with the SEAMAP index declines starting about 2009, the headboat decline in 2011 and the handline index only showing a decline in the last year. Each fleet has a different selectivity so the indices apply to different size or age fish. The fits to the headboat index might also expected to diverge from the input due to the explicit modeling of the retention function time blocks.

Fleet	Q	N	r.m.s.e.
1_HL	4.19E-05	15	0.087267
3_Shrimp	168.33	85	0.009639
4_HB	0.00018	33	0.316726
7_SeaTrawl	0.000145	23	0.528253

4.2.4 Length composition

Fits to the length composition and associated model residuals provided a primary diagnostic of model performance. Predicted population size structure and sex-specific model fit to length composition data are shown by fleet in **Figures 4.16.15 - 4.16.19**, and aggregated across years to compare overall fleet observed and predicted length compositions in **Figure 4.16.20**. Pearson residuals are shown for the population and by sex for individual fleets in **Figures 4.16.21-4.16.25**, and aggregated across years in **Figure 4.16.26**. In general, the model demonstrated adequate fit to the length composition data for the commercial and recreational data. Fits to the size structure of the catch for both sexes looked adequate for the recreational headboat and charter and private fleets; however, fits to the sex specific length data were poorer across years. Predicted tournament length composition showed good fit to the population and female data, but predicted lengths of males showed a consistent lack of fit. Pearson residuals also demonstrated reasonable model fit across the range of the majority of the data, but showed a lack-of-fit to some data sources near the extreme upper and lower tails of the size distributions where a few observations create high positive residuals. Overall, the fits to the length composition data were adequate across fleets, particularly those that comprise the bulk of the removals (i.e. commercial handline and recreational charter and private) and those that have consistent sampling and wide coverage (i.e., commercial handline, recreational private and charter, and tournaments).

4.2.5 Conditional age at length

Fits the conditional age at length composition can be evaluated by plots of the observed versus expected mean age-at-length (**Figure 4.16.27**). As there is a single plot for each year, fleet and age only one randomly chosen plot is shown. The full suite of plots are available as **Appendix C** (available from SEDAR upon request).

4.3 Parameter estimates & associated measures of uncertainty

A list of all model parameters is presented in **Table 4.15.1**. The table includes estimated parameter values and their associated asymptotic standard errors from SS, initial parameter values, minimum and maximum values, priors and prior inputs, if used, whether the parameter was fixed or estimated and the phase at which the parameter was initially estimated. The phase of initial estimation was varied for different parameters as a means of reducing confounding of correlated parameters and of stabilizing model performance. The general approach taken was to estimate leading parameters in early phases and then turn on estimation of parameters that function as tuning parameters in later phases.

The standard errors are low for the majority of parameters with a few exceptions. Standard errors were high for the most recent recruitment deviations and for several of the selectivity parameters. We discuss the selectivity parameters below in more detail. The standard errors for the two most recent recruitment deviations (2011 and 2012) are higher (~0.2) than in earlier years likely due to the more limited signal from age and length information for these most recent recruitments.

4.4 Fishery Selectivity

Length based selectivity for all sexes and fleets other than tournaments was estimated to be strongly dome-shaped (**Figures 4.16.28- 4.16.35**). Initial model runs with asymptotic selectivity for handline males showed a strong residual pattern with far more expected large male fish than observed in the populations. Allowing a dome-shaped selectivity for the handline males substantially improved fit.

Most selectivity parameter estimates were relatively precisely estimated with low standard errors relative their estimates. Several parameters had exceptionally high CVs and were poorly estimated (**Table 4.15.1**). For the Handline, Gillnet and Charter/private the width of plateau of the dome (parameter 2, SizeSel_1P_2_1_HL, SizeSel_2P_2_2_GN, SizeSel_5P_2_5_CP) had very CVs greater than 100% indicating that these were very poorly estimated or potentially correlated with other parameters. In addition the female offset to the first parameter defining the location of peak selectivity was also poorly estimated (SzSel_1Fem_Ascend_1_HL).

Time-varying retention patterns were not estimated and were assumed to be knife-edged as the size limit for all fleets that had discards (**Figures 4.16.XX - 4.216.XX, 4.16.XX - 4.16.XX**). For the tournament fishery the logistic selectivity estimates that only fish at or above 100 cm are fully selected which contrasts with every other fleet (**Figure 4.16.36**). The time-block in 1997 indicates a shift in tournament selectivity towards larger fish. Both the SEAMAP survey and the Shrimp fishery selectivities were fixed to only age-0 fish (**Figure 4.16.37**).

4.5 Recruitment

The two leading parameters for defining the stock-recruitment relationship were steepness (*h*), virgin recruitment (R_0). Steepness (estimate=0.50, se=0.026) and R_0 (estimate = 9.25986, se=0.035, or 10,507,662 age-0 recruits) estimates both had very low asymptotic standard errors (**Table 4.15.1**). The likelihood profiles for steepness and R_0 indicate that both are reasonably estimated (**Figures 4.16.6** and **4.16.7**) but that there is some conflict between age and length data for R_0. Neither, however are estimated to be at boundary conditions, which is common situation for many Gulf and South Atlantic fisheries. Furthermore, steepness was freely estimated with no prior.

The plot of the stock-recruitment relationship indicates that despite the likelihood profile analysis, steepness was likely not that well estimated, given the scatter of points within the range of observed recruitments (**Figure 4.16.38**). Further comments regarding the estimation of steepness in the model will follow in the discussion of the retrospective results.

The time series of recruitment deviations indicate high variability in recruitment not explained by spawning stock size (**Figure 4.16.39**). Deviations were estimated for the time period 1981-2012 and show a period of generally lower deviations in the early time period 1981-94 and a period of generally higher deviations from 1995-2007. The most problematic signal in the deviations is the last five years of estimates which are all well below zero, indicating lower than expected recruitment. These recruitment estimates come from an amalgam of all input data and are not solely the product of the age-0 SEAMAP survey. In the most recent years, however these declines match declines in the SEAMAP index and this index is more influential in the most recent years as age and length composition data on the most recent year classes is sparse. Timeseries of total recruits (**Figure 4.16.40**) indicate also indicate the declining trend in recruitment but as SSB is relatively high, these declines are masked somewhat relative to the recruitment deviations.

4.6 Stock Biomass

Overall stock biomass and female spawning biomass trajectories show very little depletion until the 1950s when a slow decline started and then accelerated around 1980 (**Table 4.15.2**, **Figure 4.16.41**). Estimates of SSB are fairly well determined as seen in the 95% intervals. The stock biomass reached its lowest point around the late 1990s and has increased up until 2010. Since 2010, however, there has been a slight decrease in SSB. SSB exactly mirrors stock biomass (**Figure 4.16.41**). However there has been a fairly substantial decline in estimated recruitment in the last five years, resulting lagged declines in the SSB in the most recent years (**Figure 4.16.35**).

The increase in SSB while the absolute numbers have been declining is further evident in the plots of the numbers at age and numbers at length (**Figs 4.16.43-46**) for males and females which show the progression of the relatively large 2001-2007 and, in particular, 2003 cohorts through the population. Due to a combination of low fishing mortality on these cohorts and an absence of younger recruits filling in behind them, the average age and average length of the population is increasing substantially (**Figures 4.16.43-46**).

4.7 Fishing Mortality

Continuous fishing (both discard and retained) mortality rates by fleet indicate that the primary sources of fishing mortality currently are the charter/private fleet and the commercial handline (**Figure 4.16.47**). The shrimp fishery is a minor component of mortality and the gillnet, headboat and tournament fisheries are even smaller. Fishing mortality rates for all fleets have dropped fairly substantially since 2008 for the recreational and commercial handline and since 1995 for the shrimp fishery commensurate with declines in shrimping effort.

Overall exploitation rate in numbers was used as the metric for fishing mortality and for calculation of benchmarks (**Table 4.14.3, Fig 4.16.48**). Exploitation rates are relatively low as a fraction of the total population as these rates include age-0 which are generally not fished in the targeted fisheries. Exploitation rates peaked in the 1990s and then experienced a decline to relatively stable levels in the 2000s during times of relatively strict management. Since 2009, fishing mortality rates have exhibited steady declines. These declines have come at a time when the major fisheries are also not landing all of the ACL (**Table 4.15.11**). These exploitation rates are not strictly comparable to fishing mortality rates from previous VPA assessments (SEDAR16) that used an average instantaneous F over a several ages.

4.8 Environmental/Ecosystem considerations

None of the three environmental indices showed any substantial correlation with CPUE residuals or with recruitment deviations. Furthermore an exhaustive exploration of the correlation between handline CPUE and temperature metrics (Harford et al 2014) was explored and no clear correlation was found. This does not indicates that environmental factors are not important in king mackerel population dynamics, it simply means that, of the metrics explored- mean SST, degree days >72^{o}C, and an index of upwelling, none of them were significantly correlated with CPUE deviations or recruitment deviations. Other environmental factors such as freshwater run-off, water quality, predator-prey interactions, etc. should be explored in the future and may be important indicators of recruitment. Nonetheless, even if the explicit environmental mechanism is not known or explicitly modeled, the estimated recruit deviations are a product of the environment. Essentially they represent all of the factors not explicitly considered that determine recruitment in a given year.

4.9 Evaluation of Uncertainty

4.9.1 Parameter uncertainty

Estimates of asymptotic standard errors for all model parameters are presented in **Table 4.15.1**. A list of the mean and standard deviation from the distribution of parameter estimates for the ~350 bootstrap samples is presented in **Table 4.15.10**. Of the total of 343 bootstraps, 30 (9%) had likelihoods twice as high as the median likelihood and were likely to represent runs that would not have converged and were removed. Twelve had steepness estimates hit upper bounds and were also removed from the calculation of medians and histograms. Ideally convergence of the runs would be determined by the ability of the model to invert the hessian but inverting the hessian for all bootstraps will likely be time-prohibitive. The median values of parameters and derived quantities were similar to the deterministic runs (**Table 4.15.10, Figure 4.16.68)** but the CV for the bootstrap estimates of steepness was twice that of the deterministic run. The bootstrapping analysis appears to more adequately capture variability in the estimates of steepness compared with the deterministic runs.

4.9.2 Model listing

Model results are summarized in **Table 4.15.7**. (likelihoods) and **Table 4.15.9** (parameter estimates). Likelihoods by component for the base model are summarized in **Table 4.15.8**.

Indices only

This model represents essentially a production model (**Figure 4.16.49**). For this model steepness bounded at 0.99 and R_0 was lower than any other model. Essentially this model serves as a scoping model to determine the signal in only the landings and indices. This model likely had convergence issues due to the 100s of F parameters. Little diagnostics were performed on it as the goal was to build to a fully age and length structured model.

Indices and length composition

This modeled added in length composition information and estimated selectivities (**Figure 4.16.49**). The model estimated steepness at 0.67.

Indices, length composition and conditional age at length

This model builds on (2) by adding in conditional age at length data and estimates slightly different recruitment pattern and a higher R_0 (**Figure 4.16.49**). It represents the full set of model data and so the log likelihood is comparable to the base model.This model has male selectivity fixed as asymptotic with female selectivity parameters modeled as offsets from male. The lack of fit to male length composition can be seen in the systematic absence of larger males in the residual pattern (**Figure 4.16.50**).

Base model

This model differs from (3) in that male selectivity is freed to allow doming and there is a time-block on tournament selectivity. In practice the changes were phased in and they resulted in reductions in the LL of 265 (dome, male) and 203 (time block) units.

The base model has higher absolute levels of R_0 and SSB than models 2-4 but very similar patterns over time. When considering models 1-4 it is clear that the length composition and age composition has important signals on absolute biomass levels not observed in the indices. This may be due to the poor contrast in the indices, but adding, sequentially, the length composition and then the age composition resulted in higher estimates of virgin recruitment, SSB and an increasing stock trajectory in the most recent years.

For comparison, the 2014 VPA recruits and SSB (green line) are shown **(Figure 4.16.49)**. In absolute level of recruitment the VPA (SEDAR 38RWXX) very closely mimics model (3) but it is has a very similar pattern of high and low recruitment as both 3 and the base model, and also exhibits recent declines in recruitments. The trend in SSB is similar to the other models but has higher absolute values, despite lower, on average, number of fish (**Figure 4.16.49)**. This is likely due to not accounting for separate male and female growth or to the high levels of fecundity for the plus group relative to ages 1-10 in the VPA. Nonetheless, the patterns are similar.

Overall the defining characteristic of the build-up of the models from simple to more complex is one of general agreement in trends. As MSY-related benchmarks equilibrium biomass for the VPA has not been calculated, SSB/SSB_{1986} is plotted for the models 2-4 (**Fig. 4.16.50**). Model 1 shows extreme behavior, likely due to poor convergence and is not plotted. All other models 2-4 and the VPA show similar trends in SSB relative to SSB_{1986} except the VPA shows a sharper decline in SSB in the most recent years.

Natural mortality rate

As expected, the model was sensitive to the estimate of natural mortality rate, however much of this sensitivity was due to changing estimates of steepness. The higher natural mortality rate run estimated steepness at 0.26 whereas the low M run estimated steepness at 0.91. These two contrasting situations give very different benchmarks values and hence the model sensitivity to varying natural mortality is somewhat contrary to commonly observed sensitivities to changing natural mortality. Often the base M results fall directly in the middle of high and low M, however due to the different steepness estimates this was not the case due to the differing steepness estimates. The high M model did result in a lower log likelihood than the base model (8609.81 vs 8620, **Table 4.15.7**) with the improvement in fit coming primarily from the conditional age at length data, but its convergence is in doubt and the full suite of model diagnostics have not been performed. Some of the benchmark calculations are questionable which leads to concerns over its convergence. Nonetheless, neither of the two sensitivities to M changed stock status (**Figure 4.16.52**), however they result in different yields at MSY (**Table 4.15.8**). Furthermore, solving the Hoenig (1993) estimator of mortality to determine the maximum age that either the high M or low M scenarios would imply a maximum age of 20 and 35 years, respectively lower and substantially higher than the max age observed (26).

Equal index weighting and low CV on recreational landings

Model results were relatively insensitive to equally weighting the indices relative to each other by scaling their CVs and even less sensitive to increasing error on the catch (**Figure 4.16.53**). Reducing the error on the catch did, however, result in a much more stable model on the basis of jittering exercises and faster model run time.

Removing tournament data

Removing the tournament length composition and conditional age at length data had relatively minor impact upon model results (**Figure 4.16.54**). It had very little impact upon stock status but it did result in about an 18% lower virgin recruitment but a higher steepness. The resulting offsetting of steepness and R_0 resulted in less than 1% change in retained MSY (**Table 4.15.9**).

Jack-knife of abundance indices

The two indices most influential indices were the SEAMAP larval index and the headboat index (**Figure 4.16.55**). Removing the headboat index resulted in lower estimates of recruitment in 2003-2008, reducing SSB and resulting in increasing fishing mortality rates. The HB index is shows sharply increasing catch rates during 2004-2009 which the model interprets as evidence of high recruitment one year prior. Removing the SEAMAP age-0 index resulted in higher peaks of recruitment in the late 1990s and 2000s and, most critically, higher recruitment in the last three years. Nonetheless, even with removal of this index there is still a pattern of low recruitment and, importantly, low recruitment deviations in the last 5 years. Due to the differences in recruitment there is some slight increase in recent estimated SSB and some slight decrease in estimated F when removing the SEAMAP index.

Retrospective analysis

The model shows a moderate retrospective bias in recruitment, SSB and F (**Figure 4.16.56**) as well as in stock status (**Figure 4.16.57**) relative to MSY benchmarks. The primary reason for this retrospective bias appears to be the rapidly changing estimate of steepness in the most recent four years, and noticeably in the terminal year of 2012 (**Figure 4.16.58**). Stock status for the 22 years of retrospective peels (**Figure 4.16.59**) shows this switching of status with the changing estimates of steepness. One hypothesis for these changes in the estimate of steepness is that the stock-recruitment relationship is not that well determined and that only a few pairs of high recruitment at low SSB or, conversely low recruitment at low SSB can shift the steepness estimates between high and low values. In this case, the true steepness of the stock may not be any particular terminal year estimate but may be better characterized by retrospective analysis. Furthermore the terminal year estimates of the standard error of steepness are also likely to underestimate the true uncertainty in the value from a retrospective perspective.

4.10 Benchmarks/Reference points

Key biological reference points, including maximum sustainable yield (MSY), and associated benchmarks (SSB_{MSY} and F_{MSY}) were successfully derived (**Table 4.15.6**). Yield per recruit as a function of exploitation rate indicates maximum yield at an exploitation rate of ~25% and the F that would give an SPR30% would be ~%15, whereas the F_{MSY} is estimated to be 0.08% under the assumed stock recruitment relationship (**Figure 4.16.60**). Fishing at either FMAX or FSPR30% (25% or 15%) would result in substantial declines in the population and result in overexploitation relative to F_{MSY} (**Figure 4.16.60**). The reference point and benchmark estimates obtained from the terminal year estimate of steepness for Atlantic King Mackerel were:

- MSY = 4,282 metric tons (whole weight)

- SSB_{MSY} = 3,123 (million eggs)
- F_{MSY} = 0.08 (exploitation rate in numbers, not instantaneous F)

Time series of stock and fishery status relative to benchmarks are shown in **Figure 4.16.61** and **Tables 4.15.4** and **4.15.5**. The same trajectories on a Kobe plot of (F/F_{MSY}) and SSB/SSB_{MSY} indicate a period of increasing fishing pressure from 1950 to 1990, multiple years of overfishing between 1991 and 1998, and a period of lower but stable fishing pressure from 1999-2008 and a sharp decrease in the most recent years (**Figure 4.16.62**). Coincidently, the estimated stock biomass declined steadily from 1950 to the 1990s, was overfished during the period from 1993 to 2002 with the lowest SSB observed in 1996, and has been increasing up until 2010 with a slight decrease since that time. The current stock determination is not overfished and not undergoing overfishing. The estimates of current stock status and fishery status and provided here and summarized in **Table 4.15.6**.

- SSB_{2012}/SSB_{MSY} = 1.24 (95% CI 0.98 to 1.49)
- F_{2012}/F_{MSY} = 0.37 (95% CI 0.26 to 0.48)

4.11 Projections

Deterministic projections for F_{MSY}, F_{OY} (75% of F_{MSY}) and $F_{current}$, (average fishing mortality in the last two years) were conducted with the three levels of near-term (3 year) recruitment followed by recruitment from the stock recruitment relationship. It should be noted that these deterministic projections use the point estimate of steepness in the terminal year and do not incorporate any uncertainty. ACL advice will be calculated on the basis of the probability density function around the ACL that incorporates scientific uncertainty, to the extent possible.

Another assumption of the projections was that the FY2012 landings were carried over for FY2013 and FY2014 values. As final estimates for these landings become available final projections for ACL advice will use the most recent values. The 2012 estimates are substantially under the 2012 ACL (10,460,000 lbs or 4,745 mt).

Projected recruitment at each of the three fishing levels and indicates the effects of each of the three assumed recruitment levels (**Figure 4.16.63**). Fishing effects upon future recruitment are as would be expected with the highest level of F (F_{MSY}) resulting in lower recruitment as it results in a greater reduction in SSB (**Figure 4.16.64**). If recruitment immediately reverts to the long-term average then recruitment would be predicted to jump up much higher than the last five years (**Figure 4.16.65**). In contrast, the low (blue line) and medium (red line) recruitment scenarios reflect a temporary reduction. Future improvements for stochastic projections could involve employing an estimate of the correlation between successive recruitment deviations, estimated to be 0.35, as an autoregressive(1) process into the projections.

The effects of the reductions in recruitment can be seen in the impact on SSB/SSB_{MSY} under the three F scenarios. Fishing at F_{MSY} or F_{OY} under the low recruitment scenario would be expected to reduce the stock below B_{MSY} if recruitment stays similar to the last 5 years (**Figure 4.16.64).** Fishing at $F_{current}$ the stock would grow at under all recruitment scenarios. The SSB and F benchmarks are exactly the same each recruitment scenario, i.e., the assumption of three years of lower recruitment deviations does not assume any change in the long-term productivity of the stock.

Short term retained yields at F_{MSY} under these scenarios at F_{MSY} would range from 3500-4600 mt and, in the future, approach MSY (**Figure 4.16.65**). The high scenario (as SSB is above B_{MSY}) produces yields above MSY that decline slightly in the future as the stock is reduce towards BMSY. As low recruitments reduce the stock to or below B_{MSY}, an opposite pattern is observed for the medium and low recruitment. The 1000 mt difference between the low and the high scenario represents the difference in biomass available under each recruitment scenario. At F_{OY} yields range from 2600-4000 mt. At $F_{current}$ yield ranges from 1800-2600 mt and steadily builds.

Projections also conducted for both $FSPR_{30\%}$ and $FSPR_{40\%}$ (**Figure 4.16.66**) indicate that both SPR metrics will lead to declines in SSB below 30% of virgin levels under all three recruitment scenarios. Long-term declines in the stock indicate that neither SPR metric leads to sustainable biomass levels under the estimated stock recruitment relationship, and hence entertaining SPR-proxies rather than MSY-based benchmarks will likely require some assumptions about constant future recruitment rather than employing the stock-recruitment relationship.

For comparison purposes, retained yields under FMSY, $FSPR_{30\%}$ and $FSPR_{40\%}$ are shown relative to historical yields (**Figure 4.16.67)**. Yields under both $FSPR_{30\%}$ and $FSPR_{40\%}$ are as high or higher than any observed yields in the time series. For comparison purposes, the current ACL (4744 mt or 10.46 million lbs) for the Atlantic stock under the SEDAR 16 stock definitions is shown, indicating that yields under $FSPR_{30\%}$ would be higher than any landings observed in the history of the fishery, and yields at FSPR40% would be higher than most years except for a few. New ACL advice has not been finalized from this assessment.

Preliminary stochastic bootstrap projections have been conducted (**Table 4.15.10**). Of the total of 343 bootstraps, 29 (8%) had likelihoods twice as high as the median likelihood and were likely to represent runs that would not have converged. These runs were removed from the calculations. Ideally convergence of the runs would be determined by the ability of the model to invert the hessian but inverting the hessian for all bootstraps will likely be time-prohibitive. The median values of parameters and derived quantities are similar to the deterministic runs (**Table 4.15.10,** (**Figure 4.16.68**) but the CV for the bootstrap estimate of steepness is twice that of the deterministic run. This translates to greater uncertainty in the forecasted yields for 2015-2018 (**Figure 4.16.69**). A more complete suite of projections will be forthcoming when final specifications such as 2013 and 2014 landings are available.

4.12 Discussion and Recommendations

4.12.1 Discussion

This assessment predicts that the Atlantic King mackerel stock is not overfished nor is overfishing occurring. All sensitivity runs and model constructions agree in this regard. The model diagnostics, while not perfect, appear adequate for providing management advice.

Modeling strengths

The model benefits from a long time series of landings that begin at virgin conditions. The model also has a high volume of age and length composition information, a juvenile trawl survey and it benefits from substantial biological research to precisely characterize growth and fecundity. The overall information content in this assessment ranks fairly high for a Southeast assessment. The model estimated well the virgin recruitment level (R_0) and, on the basis of likelihood profiling, also estimated steepness allowing for the direct utilization of MSY-based reference points rather than proxies.

Substantial progress has been incorporated into this assessment since SEDAR 16. In particular the current, much smaller, mixing zone means that the landings that have to be apportioned 50:50 to each stock are very small compared to the total for each stock. The fraction of the total landings in the new winter mixing zone is only 7% now compared with 24% in SEDAR 16 substantially reduces the greatest uncertainty in SEDAR 16. The model now incorporates improved estimates of shrimp bycatch obtained with a GLM modeling approach similar to methodology in the Gulf. These estimates are modeled not as precisely known inputs but as median values along with a vector of shrimp effort. This more adequately accounts for the true uncertainty in estimates of shrimp bycatch. The SS model also explicitly models sexually dimorphic growth which is a clear pattern of the biology of the species.

The modeling also benefits from the work conducted by the FishSmart project which provided key details to allow for the incorporation of age and length composition data from the tournament fisheries. During the modeling process there was an extensive discussion of environmental factors that may influence king mackerel. Temperature and several temperature derived metrics were explored, however none of the derived indices had a strong enough signal to incorporate into the model to fit to CPUE or recruitment deviations. While not explicitly incorporated in the modeling, discussion of these environmental factors strengthened the scientific basis of this assessment and led to some research recommendations, outlined below.

Modeling challenges

The greatest challenge for South Atlantic king mackerel is clearly the low recruitments observed in the most recent five years and how to predict future recruitment. King mackerel fisheries are highly recruitment driven- as evidenced by the high landings seen after the record 2003 year class and nearby high recruitments and the general selection patterns of all fisheries for smaller sized fish. Currently most fisheries are landing far less than the ACL (**Table 4.15.11**), and the model suggests that this is due to declines in recruitment.

The first question is whether these declines in recruitment are real or an artifact of the model. Given that the SEAMAP survey shows low index values in recent years, as well as in 2013, a data point not included in the model, these declines appear reflected in a scientific survey. Concerns were raised about the applicability of this survey in that it does not sample below Cape Canaveral, but even if this survey is removed entirely from the model, the recruitment deviations are still low. The other concern is that recruitment may be shifting northward out of the modeled areas. We evaluated larval and juvenile trawl data outside of the range (North of Cape Hatteras to New England) and found little evidence of increases in abundance of age-0 or larval king mackerel in areas north of Cape Hatteras. King mackerel were extremely rare in larval (SEDAR38RW01) and juvenile trawl (NEAMAP, http://www.vims.edu/research/departments/fisheries/ programs/multispecies_fisheries_research/ neamap/index.php) samples in these areas and there was no evidence of a distributional substantial recruitment north of Cape Hatteras. Hence while the most recent two recruitment deviations have higher standard errors, there does not appear to be strong ancillary evidence that the model is getting an incorrect signal regarding recent recruitment.

The other concern raised was about declining availability of fish due to fish moving to follow bait or the population shifting northward with changing climatic or oceanographic factors. Such a population-wide change would have needed to affect five consecutive cohorts of fish to lead to their absence in the age and length composition data. Adult scientific survey data for king mackerel is lacking but landings of king mackerel in recreational fisheries north of Cape Hatteras have shown no recent increases. While there is no conclusive evidence that the fish have not become inaccessible to fishermen in other areas, such a situation raises problematic and unanswered questions of where the fish have moved and when will they again be available to support a fishery.

The declining recruitment in the most recent years while spawning stock biomass is increasing also creates a modeling difficulty in that these conflicting signals alter the estimate of steepness with each additional year of conflicting moderately high SSB-low recruit pairs appearing to lower the estimate of steepness. These contrasting signals manifest as a retrospective pattern to the steepness estimate where the recent period of low recruitment deviations clearly shifts the estimates of stock productivity downward. This poses a modeling difficulty in that the terminal year estimate of steepness may not be the best estimate, or at least the variance of that estimate is likely to be an underestimate compared to values estimated over 22 year retrospective history.

The poor estimation of the top of the plateau of the selectivity for the handline, gillnet and charter/private fleets is another weakness of the model. This means the current formulation of the model cannot estimate well the width of the descending limb of the dome. The conflict is unlikely to be as severe as a dome vs flat-topped dichotomy but it could mean that there is some greater selection for a broader range of sizes than currently estimated. But even the model run with flat-topped male handline selectivity did not result in substantial differences in benchmarks, indicating that this is a lesser concern.

Challenges for management

The most problematic aspect of the assessment in terms of providing management advice is the extremely low recruitment deviations in the recent five years. At a time when fishing mortality has been declining substantially, allowing some earlier large year classes to grow, recent recruitments appear to be some of the lowest on record.

The challenge is best exemplified by fact management requires determining a fixed quota. Fishing at the yield calculated at F_{MSY} under one recruitment scenario could result in overfishing or lead to an overfished situation if recruitment is lower than assumed. Hence the AW panel considered that the best approach will be to provide decision tables that outline the risk of each harvest policy under different assumptions of near-term recruitment to illustrate tradeoffs.

4.12.2 Research Recommendations

1. Evaluate environmental influences on recruitment and larval/juvenile survival, focusing on potential predator prey impacts, hydrodynamic influences on recruitment, pollution, HABs or excess nutrient run-off.
2. Develop scientific survey to obtain reliable age/size composition data and relative abundance of adult fish. This could be done using gillnets or handlines.
3. Determine dynamic stock mixing rates using genetic methods, otolith microchemistry, stable istopes or otolith shape. Even though the mixing zone is now smaller, stock mixing is a dynamic process and may vary substantially from one year to the next, particularly in relation to cold temperature years that may compress both the Gulf and Atlantic stock into South Florida waters.
4. Evaluate the stock mixing within integrated modeling approaches
5. Expand SEAMAP trawl survey below the Cape Canaveral area and potentially into deeper shelf waters
6. Quantify tournament landings from the Gulf of Mexico
7. Determine if female spawning periodicity varies by size or age.
8. More accurately characterize juvenile growth by increasing samples of age-0 and 1 fish.
9. Conduct studies to estimate of natural mortality.

4.13 Acknowledgements

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4.15 Tables

Table 4.15.1. List of Non-F SS parameters, initial parameter starting values, estimated parameter values and standard errors and probability density functions assigned as priors. Parameters that were held constant to their input values are labeled fixed.

Active number	Parameter_label	Estimation	Initial	PR type	Prior	Pr_SD	Estimate	SD	Phase
_	L_at_Amin_Fem_GP_1	fixed	21	_	_	_	21	_	_
1	L_at_Amax_Fem_GP_1	Est	130.13	_	_	_	116.208	0.354	3
2	VonBert_K_Fem_GP_1	Est	0.1448	_	_	_	0.315147	0.003	4
3	CV_young_Fem_GP_1	Est	0.2	_	_	_	0.232827	0.004	6
4	CV_old_Fem_GP_1	Est	0.08	_	_	_	0.0807103	0.001	6
_	L_at_Amin_Mal_GP_1	fixed	21	_	_	_	21	_	_
5	L_at_Amax_Mal_GP_1	Est	98.928	_	_	_	96.0267	0.252	3
6	VonBert_K_Mal_GP_1	Est	0.2603	_	_	_	0.400857	0.005	4
7	CV_young_Mal_GP_1	Est	0.2	_	_	_	0.24336	0.005	6
8	CV_old_Mal_GP_1	Est	0.08	_	_	_	0.0621361	0.001	6
_	Wtlen_1_Fem	fixed	7E-06	_	_	_	7.314E-06	_	_
_	Wtlen_2_Fem	fixed	3.0087	_	_	_	3.00871	_	_
_	Mat50%_Fem	fixed	58.113	_	_	_	58.113	_	_
_	Mat_slope_Fem	fixed	-0.369	_	_	_	-0.36886	_	_
_	Eggs_scalar_Fem	fixed	6E-07	_	_	_	6.085E-07	_	_
_	Eggs_exp_len_Fem	fixed	3.0512	_	_	_	3.0512	_	_
_	Wtlen_1_Mal	fixed	7E-06	_	_	_	7.314E-06	_	_
_	Wtlen_2_Mal	fixed	3.0087	_	_	_	3.00871	_	_
_	RecrDist_GP_1	fixed	0	_	_	_	0	_	_
_	RecrDist_Area_1	fixed	0	_	_	_	0	_	_
_	RecrDist_Seas_1	fixed	0	_	_	_	0	_	_
_	CohortGrowDev	fixed	0	_	_	_	0	_	_
9	SR_LN(R0)	Est	9	_	_	_	9.25986	0.035	1
10	SR_BH_steep	Est	0.6	_	_	_	0.500134	0.026	2
_	SR_sigmaR	fixed	0.6	_	_	_	0.6	_	_
_	SR_envlink	fixed	0	_	_	_	0	_	_
_	SR_R1_offset	fixed	0	_	_	_	0	_	_
_	SR_autocorr	fixed	0	_	_	_	0	_	_
11	Main_RecrDev_1981	Est	_	dev	0	0	0.0300908	0.077	_
12	Main_RecrDev_1982	Est	_	dev	0	0	-0.344672	0.078	_
13	Main_RecrDev_1983	Est	_	dev	0	0	-0.352431	0.069	_
14	Main_RecrDev_1984	Est	_	dev	0	0	0.0070489	0.051	_
15	Main_RecrDev_1985	Est	_	dev	0	0	0.171699	0.044	_
16	Main_RecrDev_1986	Est	_	dev	0	0	-0.0964042	0.046	_
17	Main_RecrDev_1987	Est	_	dev	0	0	-0.643407	0.057	_
18	Main_RecrDev_1988	Est	_	dev	0	0	-0.398474	0.052	_
19	Main_RecrDev_1989	Est	_	dev	0	0	0.444632	0.039	_
20	Main_RecrDev_1990	Est	_	dev	0	0	0.114626	0.042	_
21	Main_RecrDev_1991	Est	_	dev	0	0	-0.586437	0.055	_
22	Main_RecrDev_1992	Est	_	dev	0	0	-0.28654	0.053	_
23	Main_RecrDev_1993	Est	_	dev	0	0	-0.220187	0.054	_
24	Main_RecrDev_1994	Est	_	dev	0	0	0.279925	0.047	_
25	Main_RecrDev_1995	Est	_	dev	0	0	0.553468	0.045	_
26	Main_RecrDev_1996	Est	_	dev	0	0	0.665529	0.043	_
27	Main_RecrDev_1997	Est	_	dev	0	0	-0.0419226	0.051	_
28	Main_RecrDev_1998	Est	_	dev	0	0	0.708299	0.039	_
29	Main_RecrDev_1999	Est	_	dev	0	0	0.0169116	0.046	_
30	Main_RecrDev_2000	Est	_	dev	0	0	-0.375821	0.055	_
31	Main_RecrDev_2001	Est	_	dev	0	0	0.612998	0.041	_
32	Main_RecrDev_2002	Est	_	dev	0	0	0.111532	0.053	_

33	Main_RecrDev_2003	Est	_	dev	0	0	0.901013	0.040	_
34	Main_RecrDev_2004	Est	_	dev	0	0	0.556399	0.045	_
35	Main_RecrDev_2005	Est	_	dev	0	0	0.276007	0.046	_
36	Main_RecrDev_2006	Est	_	dev	0	0	0.363718	0.042	_
37	Main_RecrDev_2007	Est	_	dev	0	0	0.306426	0.045	_
38	Main_RecrDev_2008	Est	_	dev	0	0	-0.499941	0.072	_
39	Main_RecrDev_2009	Est	_	dev	0	0	-0.71964	0.095	_
40	Main_RecrDev_2010	Est	_	dev	0	0	-0.17823	0.097	_
41	Main_RecrDev_2011	Est	_	dev	0	0	-0.335997	0.199	_
42	Main_RecrDev_2012	Est	_	dev	0	0	-1.04022	0.205	_
_	InitF_11_HL	fixed	0	_	_	_	0	_	_
_	InitF_22_GN	fixed	0	_	_	_	0	_	_
_	InitF_33_Shrimp	fixed	0	_	_	_	0	_	_
_	InitF_44_HB	fixed	0	_	_	_	0	_	_
_	InitF_55_CP	fixed	0	_	_	_	0	_	_
_	InitF_66_TOURN	fixed	0	_	_	_	0	_	_
495	LnQ_base_3_3_Shrimp	Est	5	_	_	_	5.12593	0.133	1
496	SizeSel_1P_1_1_HL	Est	67	_	_	_	72.2834	0.776	3
497	SizeSel_1P_2_1_HL	Est	-2.92	_	_	_	-11.0081	63.522	3
498	SizeSel_1P_3_1_HL	Est	4.5	_	_	_	5.00616	0.111	4
499	SizeSel_1P_4_1_HL	Est	4.214	_	_	_	4.78199	0.183	3
_	SizeSel_1P_5_1_HL	fixed	-15	_	_	_	-15	_	_
500	SizeSel_1P_6_1_HL	Est	5	_	_	_	-1.56698	0.176	5
_	Retain_1P_1_1_HL	fixed	29	_	_	_	29	_	_
_	Retain_1P_2_1_HL	fixed	1	_	_	_	1	_	_
_	Retain_1P_3_1_HL	fixed	1	_	_	_	1	_	_
_	Retain_1P_4_1_HL	fixed	0	_	_	_	0	_	_
_	DiscMort_1P_1_1_HL	fixed	10	_	_	_	10	_	_
_	DiscMort_1P_2_1_HL	fixed	1	_	_	_	1	_	_
_	DiscMort_1P_3_1_HL	fixed	0.25	_	_	_	0.25	_	_
_	DiscMort_1P_4_1_HL	fixed	0	_	_	_	0	_	_
501	SzSel_1Fem_Peak_1_HL	Est	0	_	_	_	3.60871	1.221	5
502	SzSel_1Fem_Ascend_1_HL	Est	0	_	_	_	0.0282522	0.179	5
503	SzSel_1Fem_Descend_1_HL	Est	0	_	_	_	0.899503	0.218	5
504	SzSel_1Fem_Final_1_HL	Est	-5	_	_	_	-0.702605	0.223	5
_	SzSel_1Fem_Scale_1_HL	fixed	1	_	_	_	1	_	_
505	SizeSel_2P_1_2_GN	Est	76	_	_	_	74.8705	1.810	3
506	SizeSel_2P_2_2_GN	Est	-11	_	_	_	-11.6346	55.746	3
507	SizeSel_2P_3_2_GN	Est	4.7804	Norm	4.7804	2	4.54229	0.333	4
508	SizeSel_2P_4_2_GN	Est	7	_	_	_	7.06783	0.186	3
_	SizeSel_2P_5_2_GN	fixed	-999	_	_	_	-999	_	_
_	SizeSel_2P_6_2_GN	fixed	-999	_	_	_	-999	_	_
509	SizeSel_4P_1_4_HB	Est	64	_	_	_	64.9085	0.444	3
510	SizeSel_4P_2_4_HB	Est	-2.6	_	_	_	-2.59216	0.194	3
511	SizeSel_4P_3_4_HB	Est	3.4	_	_	_	4.17745	0.075	4
512	SizeSel_4P_4_4_HB	Est	5.3	_	_	_	5.12545	0.138	4
_	SizeSel_4P_5_4_HB	fixed	-15	_	_	_	-15	_	_
513	SizeSel_4P_6_4_HB	Est	1	_	_	_	-2.54576	0.111	5
_	Retain_4P_1_4_HB	fixed	29	_	_	_	29	_	_
_	Retain_4P_2_4_HB	fixed	1	_	_	_	1	_	_
_	Retain_4P_3_4_HB	fixed	1	_	_	_	1	_	_
_	Retain_4P_4_4_HB	fixed	0	_	_	_	0	_	_
_	DiscMort_4P_1_4_HB	fixed	10	_	_	_	10	_	_
_	DiscMort_4P_2_4_HB	fixed	1	_	_	_	1	_	_
_	DiscMort_4P_3_4_HB	fixed	0.22	_	_	_	0.22	_	_
_	DiscMort_4P_4_4_HB	fixed	0	_	_	_	0	_	_
514	SizeSel_5P_1_5_CP	Est	73	_	_	_	73.9888	0.585	3

515	SizeSel_5P_2_5_CP	Est	-12.9	_	_	_	-12.9266	39.039	3
516	SizeSel_5P_3_5_CP	Est	5.78	_	_	_	5.82496	0.069	3
517	SizeSel_5P_4_5_CP	Est	4.15	_	_	_	4.16268	0.180	3
_	SizeSel_5P_5_5_CP	fixed	-15	_	_	_	-15	_	_
518	SizeSel_5P_6_5_CP	Est	1	_	_	_	-0.899282	0.069	5
_	Retain_5P_1_5_CP	fixed	29	_	_	_	29	_	_
_	Retain_5P_2_5_CP	fixed	1	_	_	_	1	_	_
_	Retain_5P_3_5_CP	fixed	1	_	_	_	1	_	_
_	Retain_5P_4_5_CP	fixed	0	_	_	_	0	_	_
_	DiscMort_5P_1_5_CP	fixed	10	_	_	_	10	_	_
_	DiscMort_5P_2_5_CP	fixed	1	_	_	_	1	_	_
_	DiscMort_5P_3_5_CP	fixed	0.2	_	_	_	0.2	_	_
_	DiscMort_5P_4_5_CP	fixed	0	_	_	_	0	_	_
519	SizeSel_6P_1_6_TOURN	Est	100	_	_	_	92.3172	0.072	3
_	SizeSel_6P_2_6_TOURN	fixed	-6.076	_	_	_	-6.07561	_	_
520	SizeSel_6P_3_6_TOURN	Est	6.1	_	_	_	6.02601	0.056	3
_	SizeSel_6P_4_6_TOURN	fixed	4.214	_	_	_	4.21396	_	_
_	SizeSel_6P_5_6_TOURN	fixed	-15	_	_	_	-15	_	_
_	SizeSel_6P_6_6_TOURN	fixed	15	_	_	_	15	_	_
_	SzSel_6Fem_Peak_6_TOURN	fixed	-10	_	_	_	-10	_	_
521	SzSel_6Fem_Ascend_6_TOURN	Est	0	_	_	_	-0.103822	0.056	2
_	SzSel_6Fem_Descend_6_TOURN	fixed	-10	_	_	_	-10	_	_
_	SzSel_6Fem_Final_6_TOURN	fixed	-10	_	_	_	-10	_	_
_	SzSel_6Fem_Scale_6_TOURN	fixed	1	_	_	_	1	_	_
_	AgeSel_3P_1_3_Shrimp	fixed	0	_	_	_	0	_	_
_	AgeSel_3P_2_3_Shrimp	fixed	0	_	_	_	0	_	_
_	AgeSel_7P_1_7_SeaTrawl	fixed	0	_	_	_	0	_	_
_	AgeSel_7P_2_7_SeaTrawl	fixed	0	_	_	_	0	_	_
_	Retain_1P_1_1_HL_BLK1repl_1900	fixed	35	_	_	_	35	_	_
_	Retain_1P_1_1_HL_BLK1repl_1990	fixed	35	_	_	_	35	_	_
_	Retain_1P_1_1_HL_BLK1repl_1992	fixed	51	_	_	_	51	_	_
_	Retain_1P_1_1_HL_BLK1repl_1999	fixed	61	_	_	_	61	_	_
_	Retain_4P_1_4_HB_BLK1repl_1900	fixed	35	_	_	_	35	_	_
_	Retain_4P_1_4_HB_BLK1repl_1990	fixed	35	_	_	_	35	_	_
_	Retain_4P_1_4_HB_BLK1repl_1992	fixed	51	_	_	_	51	_	_
_	Retain_4P_1_4_HB_BLK1repl_1999	fixed	61	_	_	_	61	_	_
_	Retain_5P_1_5_CP_BLK1repl_1900	fixed	35	_	_	_	35	_	_
_	Retain_5P_1_5_CP_BLK1repl_1990	fixed	35	_	_	_	35	_	_
_	Retain_5P_1_5_CP_BLK1repl_1992	fixed	51	_	_	_	51	_	_
_	Retain_5P_1_5_CP_BLK1repl_1999	fixed	61	_	_	_	61	_	_
522	SizeSel_6P_1_6_TOURN_BLK2repl_1997	Est	100	_	_	_	112.253	0.342	6
523	SizeSel_6P_3_6_TOURN_BLK2repl_1997	Est	6.1	_	_	_	6.29663	0.049	6

Table 4.15.2. Estimated spawning stock biomass (millions of eggs) and recruitment (in 1000s)

Fishing_Year	SSB	Rec	Fishing_Year	SSB	Rec	Fishing_Year	SSB	Rec
1901	8596	10508	1951	7971	10306	2001	3019	11086
1902	8595	10507	1952	7922	10289	2002	3068	6766
1903	8593	10507	1953	7877	10274	2003	3128	15040
1904	8587	10505	1954	7835	10259	2004	3221	10805
1905	8577	10502	1955	7796	10245	2005	3384	8352
1906	8563	10498	1956	7734	10223	2006	3712	9503
1907	8546	10492	1957	7650	10193	2007	3909	9175
1908	8525	10486	1958	7566	10162	2008	3939	4110
1909	8502	10479	1959	7489	10133	2009	4066	3343
1910	8476	10471	1960	7405	10102	2010	4084	5755
1911	8447	10462	1961	7324	10071	2011	3974	4860
1912	8417	10452	1962	7236	10037	2012	3862	2374
1913	8384	10442	1963	7146	10001			
1914	8349	10431	1964	7053	9963			
1915	8313	10419	1965	6956	9923			
1916	8275	10407	1966	6853	9880			
1917	8236	10394	1967	6764	9842			
1918	8195	10381	1968	6669	9800			
1919	8153	10367	1969	6577	9760			
1920	8117	10355	1970	6476	9713			
1921	8086	10345	1971	6369	9663			
1922	8061	10337	1972	6279	9621			
1923	8042	10330	1973	6167	9566			
1924	8027	10325	1974	6037	9502			
1925	7995	10314	1975	5901	9432			
1926	7960	10302	1976	5755	9354			
1927	7930	10292	1977	5597	9267			
1928	7884	10276	1978	5453	9185			
1929	7858	10267	1979	5342	9120			
1930	7840	10261	1980	5235	9055			
1931	7829	10257	1981	5077	7710			
1932	7811	10250	1982	4917	5239			
1933	7794	10244	1983	4777	5143			
1934	7788	10242	1984	4587	7255			
1935	7792	10244	1985	4336	8367			
1936	7784	10241	1986	4036	6216			
1937	7762	10233	1987	3834	3520			
1938	7765	10234	1988	3723	4440			
1939	7749	10229	1989	3535	10084			
1940	7740	10225	1990	3348	7073			
1941	7755	10231	1991	3239	3455			
1942	7817	10253	1992	3194	4632			
1943	7879	10274	1993	3025	4823			

1944	7938	10295	1994	2889	7775
1945	7994	10314	1995	2730	9933
1946	7969	10305	1996	2590	10812
1947	7958	10301	1997	2593	5332
1948	7965	10304	1998	2663	11449
1949	7991	10313	1999	2739	5819
1950	8001	10316	2000	2892	4037

Table 4.15.3. Estimated annual fishing mortality as exploitation rate in numbers.

Fishing_Year	Fishing_Mortality	Fishing_Year	Fishing_Mortality	Fishing_Year	Fishing_Mortality
1901	0.000	1951	0.014	2001	0.070
1902	0.000	1952	0.013	2002	0.058
1903	0.001	1953	0.013	2003	0.075
1904	0.001	1954	0.014	2004	0.065
1905	0.002	1955	0.017	2005	0.054
1906	0.002	1956	0.021	2006	0.068
1907	0.003	1957	0.022	2007	0.083
1908	0.003	1958	0.022	2008	0.056
1909	0.004	1959	0.024	2009	0.059
1910	0.004	1960	0.025	2010	0.053
1911	0.005	1961	0.027	2011	0.038
1912	0.005	1962	0.029	2012	0.030
1913	0.006	1963	0.030		
1914	0.006	1964	0.032		
1915	0.007	1965	0.034		
1916	0.007	1966	0.033		
1917	0.008	1967	0.035		
1918	0.008	1968	0.036		
1919	0.008	1969	0.038		
1920	0.008	1970	0.041		
1921	0.008	1971	0.040		
1922	0.007	1972	0.045		
1923	0.007	1973	0.049		
1924	0.009	1974	0.052		
1925	0.010	1975	0.056		
1926	0.010	1976	0.060		
1927	0.012	1977	0.061		
1928	0.010	1978	0.057		
1929	0.009	1979	0.059		
1930	0.009	1980	0.071		
1931	0.010	1981	0.071		
1932	0.010	1982	0.067		
1933	0.009	1983	0.069		
1934	0.007	1984	0.068		
1935	0.009	1985	0.082		
1936	0.011	1986	0.081		
1937	0.008	1987	0.068		
1938	0.011	1988	0.079		
1939	0.010	1989	0.070		
1940	0.006	1990	0.066		
1941	0.000	1991	0.081		
1942	0.000	1992	0.107		
1943	0.000	1993	0.078		

1944	0.000	1994	0.095
1945	0.011	1995	0.110
1946	0.009	1996	0.096
1947	0.006	1997	0.101
1948	0.004	1998	0.108
1949	0.006	1999	0.064
1950	0.011	2000	0.076

Table 4.15.4. Stock status estimates of measured as SSB / SSB_{MSY}.

Fishing_Year	SSB/SSB_{MSY}	Fishing_Year	SSB/SSB_{MSY}	Fishing_Year	SSB/SSB_{MSY}
1901	2.75	1951	2.55	2001	0.97
1902	2.75	1952	2.54	2002	0.98
1903	2.75	1953	2.52	2003	1.00
1904	2.75	1954	2.51	2004	1.03
1905	2.75	1955	2.50	2005	1.08
1906	2.74	1956	2.48	2006	1.19
1907	2.74	1957	2.45	2007	1.25
1908	2.73	1958	2.42	2008	1.26
1909	2.72	1959	2.40	2009	1.30
1910	2.71	1960	2.37	2010	1.31
1911	2.70	1961	2.34	2011	1.27
1912	2.69	1962	2.32	2012	1.24
1913	2.68	1963	2.29		
1914	2.67	1964	2.26		
1915	2.66	1965	2.23		
1916	2.65	1966	2.19		
1917	2.64	1967	2.17		
1918	2.62	1968	2.14		
1919	2.61	1969	2.11		
1920	2.60	1970	2.07		
1921	2.59	1971	2.04		
1922	2.58	1972	2.01		
1923	2.57	1973	1.97		
1924	2.57	1974	1.93		
1925	2.56	1975	1.89		
1926	2.55	1976	1.84		
1927	2.54	1977	1.79		
1928	2.52	1978	1.75		
1929	2.52	1979	1.71		
1930	2.51	1980	1.68		
1931	2.51	1981	1.63		
1932	2.50	1982	1.57		
1933	2.50	1983	1.53		
1934	2.49	1984	1.47		
1935	2.49	1985	1.39		
1936	2.49	1986	1.29		
1937	2.49	1987	1.23		
1938	2.49	1988	1.19		
1939	2.48	1989	1.13		
1940	2.48	1990	1.07		
1941	2.48	1991	1.04		
1942	2.50	1992	1.02		
1943	2.52	1993	0.97		

1944	2.54	1994	0.93
1945	2.56	1995	0.87
1946	2.55	1996	0.83
1947	2.55	1997	0.83
1948	2.55	1998	0.85
1949	2.56	1999	0.88
1950	2.56	2000	0.93

Table 4.15.5. Fishery status as F/Fmsy.

Fishing_Year	F/F_{MSY}	Fishing_Year	F/F_{MSY}	Fishing_Year	F/F_{MSY}
1901	0.00	1951	0.17	2001	0.89
1902	0.00	1952	0.17	2002	0.73
1903	0.01	1953	0.17	2003	0.95
1904	0.02	1954	0.17	2004	0.82
1905	0.02	1955	0.22	2005	0.68
1906	0.03	1956	0.26	2006	0.86
1907	0.03	1957	0.27	2007	1.04
1908	0.04	1958	0.28	2008	0.70
1909	0.05	1959	0.30	2009	0.74
1910	0.05	1960	0.32	2010	0.67
1911	0.06	1961	0.34	2011	0.48
1912	0.07	1962	0.36	2012	0.37
1913	0.07	1963	0.38		
1914	0.08	1964	0.40		
1915	0.09	1965	0.43		
1916	0.09	1966	0.42		
1917	0.10	1967	0.44		
1918	0.11	1968	0.45		
1919	0.10	1969	0.48		
1920	0.10	1970	0.51		
1921	0.10	1971	0.50		
1922	0.09	1972	0.56		
1923	0.09	1973	0.62		
1924	0.12	1974	0.65		
1925	0.12	1975	0.70		
1926	0.12	1976	0.75		
1927	0.15	1977	0.76		
1928	0.12	1978	0.71		
1929	0.12	1979	0.75		
1930	0.11	1980	0.89		
1931	0.12	1981	0.90		
1932	0.12	1982	0.84		
1933	0.11	1983	0.86		
1934	0.09	1984	0.86		
1935	0.12	1985	1.03		
1936	0.14	1986	1.02		
1937	0.10	1987	0.86		
1938	0.13	1988	1.00		
1939	0.12	1989	0.88		
1940	0.08	1990	0.83		
1941	0.00	1991	1.02		
1942	0.00	1992	1.35		
1943	0.00	1993	0.98		

1944	0.00	1994	1.20
1945	0.14	1995	1.38
1946	0.11	1996	1.21
1947	0.08	1997	1.27
1948	0.05	1998	1.37
1949	0.08	1999	0.81
1950	0.14	2000	0.96

Table 4.15.6. Summary of stock status of Atlantic King Mackerel.

Metric	Value/Determination
Assessment Year	2014
Data Range	1901 to 2012
Spawning Stock Biomass(million eggs) $_{2012}$	3862
Fishing Mortality(exploitation rate in N)$_{2012}$	0.030
Recruitment (1000s age-0)$_{2012}$	2374
Spawning Stock Biomass$_{Unfished}$	8596
Recruitment$_{Unfished}$	10508
Maximum Sustainable Yield (retained MT, whole wt)	4282
Spawning Stock Biomass$_{MSY}$	3123
Fishing mortality$_{MSY}$	0.08
SSB_{2012}/SSB_{MSY}	1.24
F_{2012}/F_{MSY}	0.37
Stock Status	Not Overfished
Fishery Status	Not Undergoing Overfishing

Table 4.15.7. Likelihood values for the various data components the base and sensitivity runs

	1. ind only	2. ind and length	3. Indices, length and age	4. BASE	5. HiM	6. LoM	7. No Tournament	8. Index = wt	9. Low error on catch
max grad component	3.054	0.077	1.739	0.023	0.073	1.501	0.217	0.276	0.271
TOTAL	-180.13	4086.06	9448.33	8620.95	8609.8	8688.5	4764.4	9027.76	8976.4
Catch	0.0	1.4	2.1	140.3	132.1	152.4	137.2	2.1	2.1
Equil_catch	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Survey	-176.9	-62.8	-68.0	-65.4	-52.8	-74.3	-72.1	-22.4	-62.6
Discard	-	233.8	262.9	149.7	151.8	148.2	153.8	264.2	263.6
Length_comp	-	3910.1	3521.9	2826.4	2852.7	2846.3	2085.5	3174.2	3183.8
Age_comp	-	0.0	5733.2	5572.6	5522.8	5620.9	2463.5	5612.0	5592.1
Recruitment	-3.6	-1.8	-7.5	-6.9	-4.9	-8.1	-7.0	-6.4	-6.9
Forecast Recruitment	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Parm_priors	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Parm_softbnd	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Parm_devs	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Crash_Pen	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Directly comparable same data, same weighting

indirectly comparable same data, different weighting

Table 4.15.8. Likelihood values for by component element for base model

Fleet:	ALL	1. HL	2. GN	3. Shrimp	4. HB	5. C/P	6. tourn	7. SEAMAP
Catch_lambda:	_	1	1	1	1	1	1	1
Catch_like:	140.269	0.069622	0.000252	0	129.338	10.8482	0.013393	0
Surv_lambda:	_	1	0	1	1	0	0	1
Surv_like:	-65.3749	-19.0555	0	-87.91	3.00186	-5.49238	0	38.5887
Disc_lambda:	_	1	0	1	1	1	0	0
Disc_like:	149.707	38.2178	0	2.60026	-30.898	139.786	0	0
Length_lambda:	_	1	1	0	1	1	1	0
Length_like:	2826.36	418.498	90.8963	0	695.181	906.785	715	0
Age_lambda:	_	1	0	0	0	1	1	0
Age_like:	5572.6	1509.6	0	0	0	1123.82	2939.19	0
total	8623.5611							

lambas determine whether the likelihood component is active (1 yes, 0 no)

C/P index is turned off

Table 4.15.9. Summary of key parameters and benchmark quantities from sensitivity runs for South Atlantic King Mackerel.

	1. ind only	SE	2. ind and length	SE	3. ind, len and wt, male HL flat	SE	4. BASE	SE
SR_LN(R0)	8.58	0.01	9.09	0.02	9.18	0.02	9.26	0.04
SR_BH_steep	0.99	0.00	0.64	0.03	0.47	0.02	0.50	0.03
SSB_Unfished	3317	37	5102	108	7869	167	8596	314
TotBio_Unfished	61176	678	94284	1988	130892	2711	144664	5247
SmryBio_Unfished	61097	677	94153	1985	130748	2708	144506	5242
Recr_Unfished	5316	59	8858	187	9656	193	10508	371
SSB_B40%virgin	1327	15	2041	43	3147	67	3438	126
SPR_B40%virgin	0.40	0.000001	0.48	0.01	0.57	0.01	0.55	0.02
Fstd_B40%virgin	0.08	0.00	0.06	0.00	0.08	0.00	0.07	0.00
TotYield_40%virgin	2588	29	3912	80	4229	99	4461	208
SSB_SPR40%	1322	15	1537	43	1330	135	1720	212
Fstd_SPR40%	0.08	0.00	0.07	0.00	0.12	0.00	0.12	0.00
TotYield_SPRtgt	2592	29	3992	113	3179	320	3871	472
SSB_MSY	710	7.87	1644	80	3105	106	3123	178
SPR_MSY	0.22	0.00	0.42	0.02	0.56	0.01	0.52	0.02
Fstd_MSY	0.15	0.00	0.07	0.00	0.08	0.00	0.08	0.01
TotYield_MSY	2870.0	31.8	3999.5	99.0	4229	100	4484.7	219.6
RetYield_MSY	2870.0	31.8	3972.4	97.8	4196	99	4446.2	216.8

	5. HiM	SE	6. LoM	SE	7. No Tournament	SE
SR_LN(R0)	10.59	0.12	8.47	0.03	9.05	0.05
SR_BH_steep	0.26	0.01	0.91	0.06	0.57	0.04
SSB_Unfished	20393	2569	6914	233	6955	349
TotBio_Unfished	353540	44515	113607	3799	117505	5839
SmryBio_Unfished	39739	4941	4765	159	8548	400
Recr_Unfished	8157	1028	2765	93	2782	139
SSB_B40%virgin	0.83	0.03	0.41	0.01	0.51	0.02
SPR_B40%virgin	0.02	0.00	0.09	0.00	0.08	0.00
Fstd_B40%virgin	3595	560	4222	118	4371	171
TotYield_40%virgin	0.00	0.00	2666	64	1814	129
SSB_SPR40%	0.13	0.00	0.09	0.00	0.12	0.00
Fstd_SPR40%	0.00	0.00	4287	104	4311	298
TotYield_SPRtgt	9512	1268	1420	262	2353	194
SSB_MSY	0.85	0.02	0.22	0.05	0.46	0.03
SPR_MSY	0.02	0.00	0.16	0.03	0.10	0.01
Fstd_MSY	3660.9	561.1	4763.6	249.9	4436.5	193.1
TotYield_MSY	3630.1	555.8	4715.8	241.8	4398.5	190.3

hiM model convergence criteria doubtful

Table 4.15.9, continued

	8. Index = wt	SE	9. Low error on catch	SE
SR_LN(R0)	9.311	0.03	9.312	0.03
SR_BH_steep	0.44	0.02	0.47	0.02
SSB_Unfished	9081	258	9094	271
TotBio_Unfished	152776	4287	152995	4506
SmryBio_Unfished	11058	295	11071	310
Recr_Unfished	3632	103	3638	108
SSB_B40%virgin	0.59	0.01	0.57	0.01
SPR_B40%virgin	0.06	0.00	0.07	0.00
Fstd_B40%virgin	4042	135	4308	175
TotYield_40%virgin	1120	218	1449	223
SSB_SPR40%	0.12	0.00	0.12	0.00
Fstd_SPR40%	2510	485	3230	492
TotYield_SPRtgt	3497	143	3421	152
SSB_MSY	0.58	0.02	0.55	0.02
SPR_MSY	0.07	0.00	0.07	0.00
Fstd_MSY	4046.0	138.1	4317.9	180.5
TotYield_MSY	4014.2	136.4	4282.0	178.2

Table 4.15.10. Mean and standard deviation of parameter estimates and key derived quantities from 314 bootstrap samples compared with deterministic quantities.

	Bootstraps			Deterministic		
parameter/derived quantity	median	sd	CV	estimate	sd	CV
R0	9.29	0.06	1%	9.26	0.04	0%
H	0.47	0.05	11%	0.50	0.03	5%
SPB_Virgin	8939.34	580.94	6%	8595.62	370.62	4%
Recr_Virgin	10780.65	690.42	6%	10507.70	370.62	4%
Fstd_MSY	0.074	0.02	28%	0.079	0.01	8%
RetYield_MSY	4176.66	728.74	17%	4446.15	216.80	5%
SSB_MSY	3347.32	429.70	13%	3861.94	342.84	9%
SPB_2012	4227.66	906.85	21%	3861.94	342.84	9%
ForeCatchret_2013	1841.04	54.44	3%	1838.19	16.15	1%
ForeCatchret_2014	1862.69	38.00	2%	1864.97	19.36	1%
ForeCatchret_2015	4070.62	2249.23	55%	4270.27	749.82	18%
ForeCatchret_2016	4241.32	1857.68	44%	4446.65	1091.05	25%
ForeCatchret_2017	4376.53	1580.21	36%	4578.69	1206.40	26%
ForeCatchret_2018	4421.91	1388.60	31%	4635.68	1254.69	27%
	Total boostraps	loglikelihood >2*median LL	Hit steepness bound	Total 'good' boots		
	343	30	12	312		

Table 4.15.11. Atlantic stock commercial and recreational king mackerel landings for quota monitoring. Note that stock definition differs from what is used in SEDAR38 and these landings may differ from those used for scientific analysis of the stock. From: http://sero.nmfs.noaa.gov/sustainable_fisheries/acl_monitoring/

	Commercial			Recreational		
FY	Landings	ACL/Quota	%	Landings	ACL/Quota	%
2000-2001	2,101,530	3,710,000	57%	NA		
2001-2002	2,017,251	3,710,000	54%	NA		
2002-2003	1,737,833	3,710,000	47%	NA		
2003-2004	1,708,341	3,710,000	46%	NA		
2004-2005	2,734,198	3,710,000	74%	NA		
2005-2006	2,250,990	3,710,000	61%	NA		
2006-2007	2,994,818	3,710,000	81%	NA		
2007-2008	2,667,227	3,710,000	72%	NA		
2008-2009	3,107,996	3,710,000	84%	NA		
2009-2010	3,564,108	3,710,000	96%	NA		
2010-2011	3,405,650	3,710,000	92%	NA		
2011-2012	2,101,530	3,880,000	54%	NA		
2012-2013	1,762,959	3,880,000	45%	1,719,199	6,580,000	26%
2013-2014	1,116,833	3,880,000	29%	1,004,441**	6,580,000	15%

** preliminary and possibly incomplete

4.16 Figures

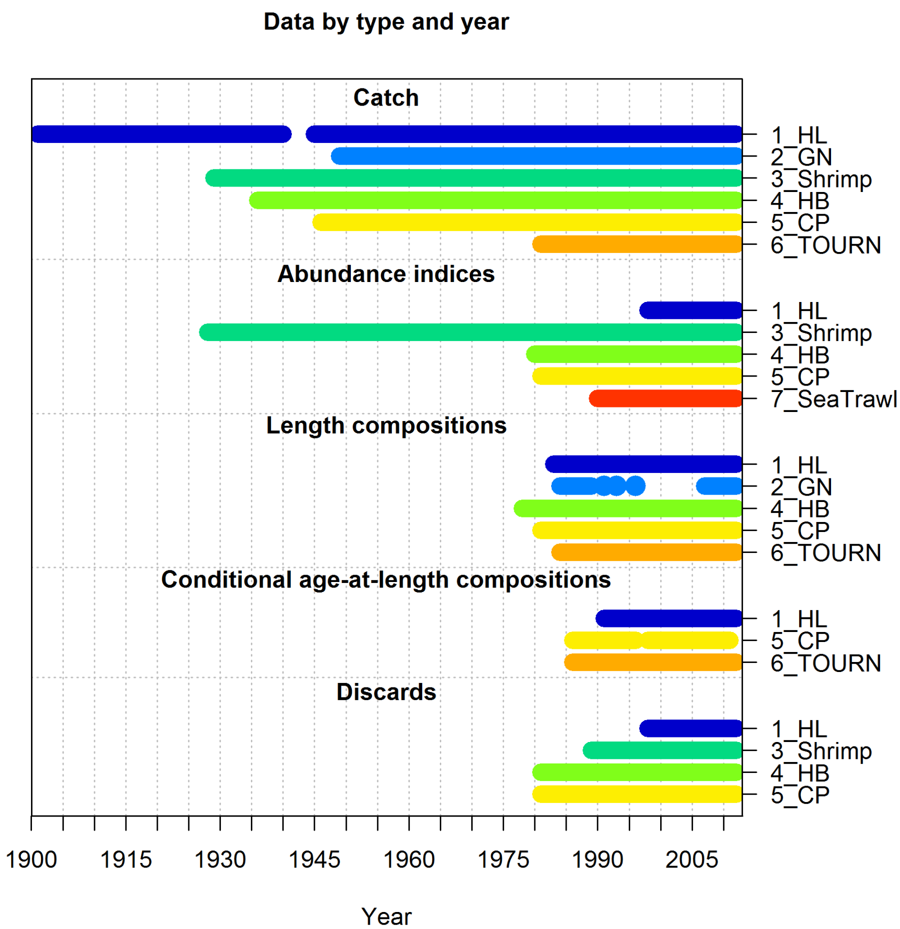


Figure 4.16.1. Data sources used in the assessment model.

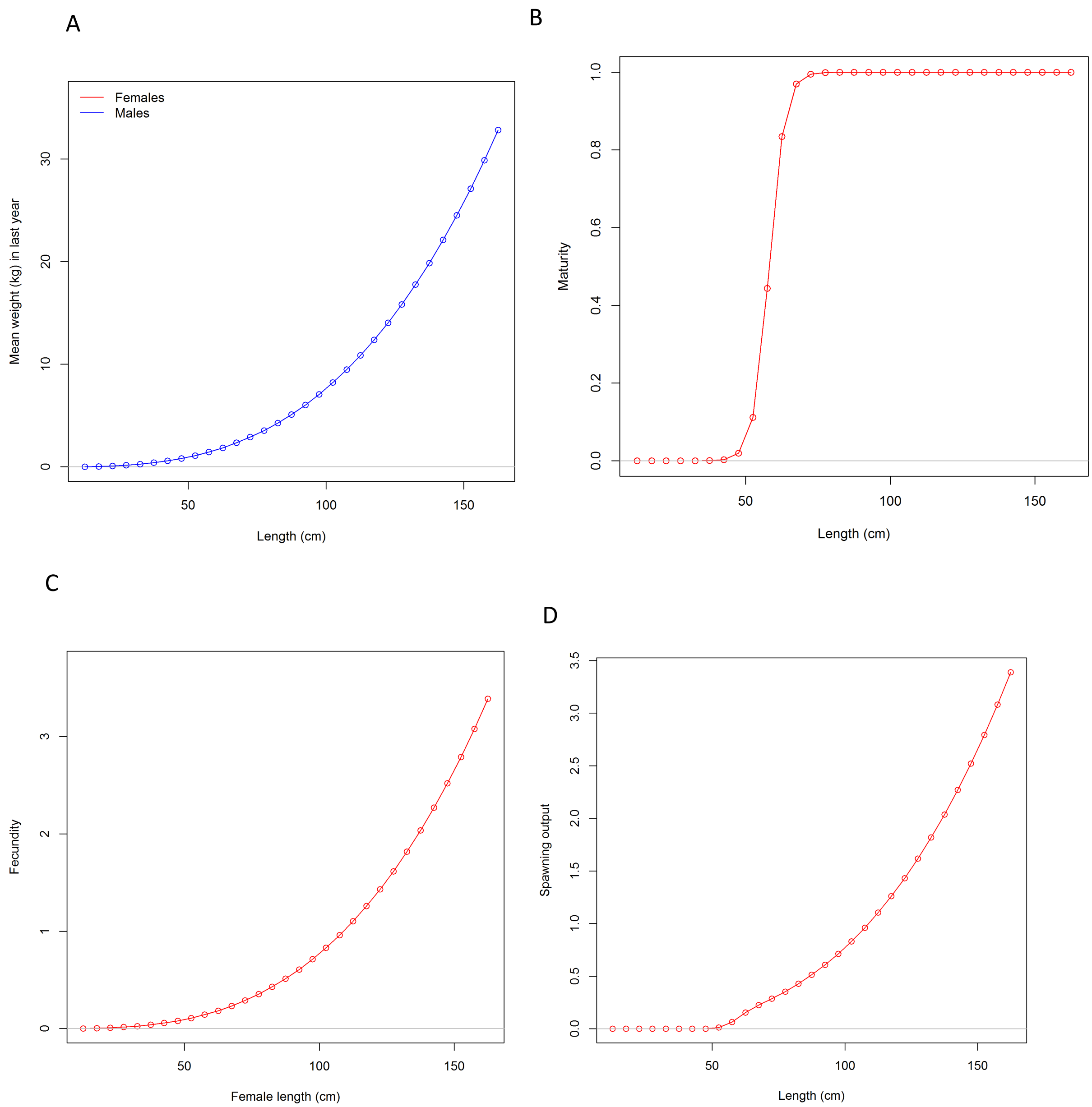


Figure 4.16.2. A. Length-Weight relationship, B. maturity as a function of length, C. fecundity as function of length and D. Spawning output as a function of length (product of maturity and fecundity.

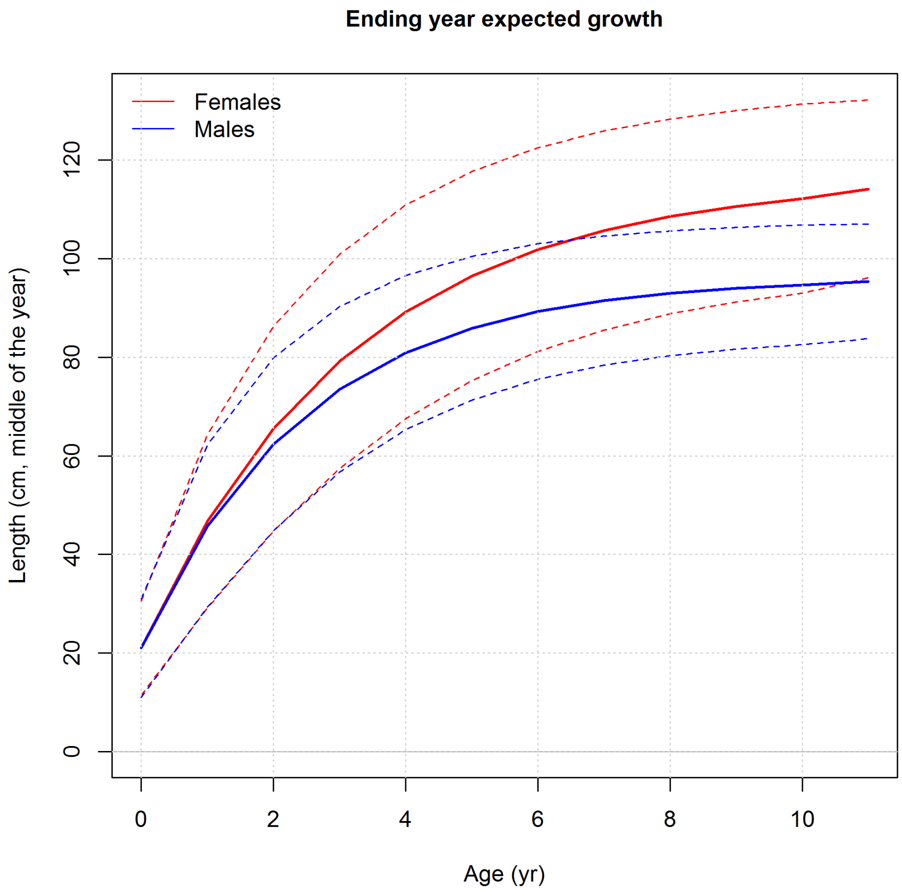


Figure 4.16.3. Growth relationship and 95% intervals for males (blue line) and females (red line) estimated in model.

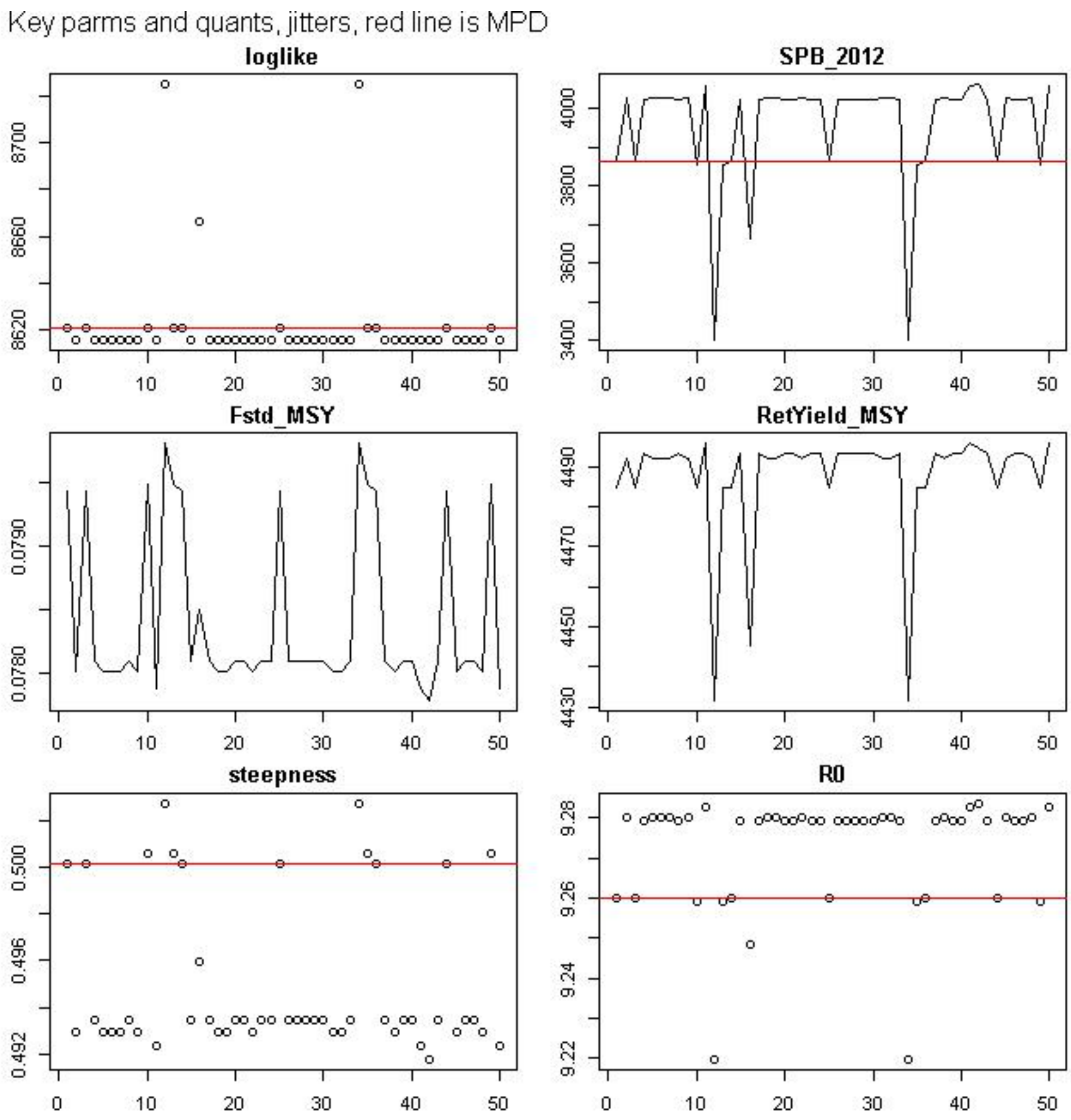


Figure 4.16.4. Analysis of results of jittering starting values by 10%. Red line is maximum posterior density estimate.

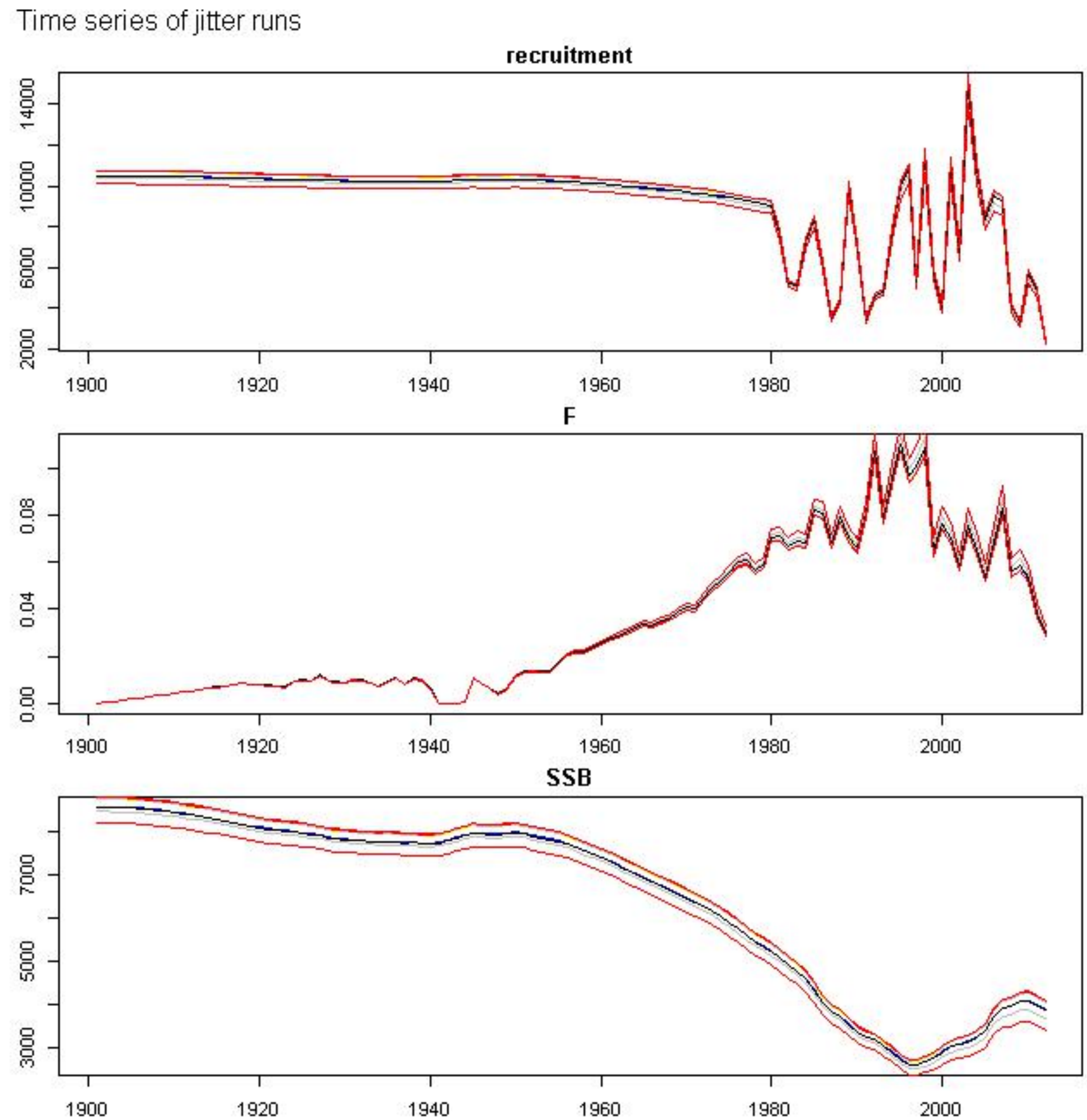


Figure 4.16.5. Time series of jitter runs.

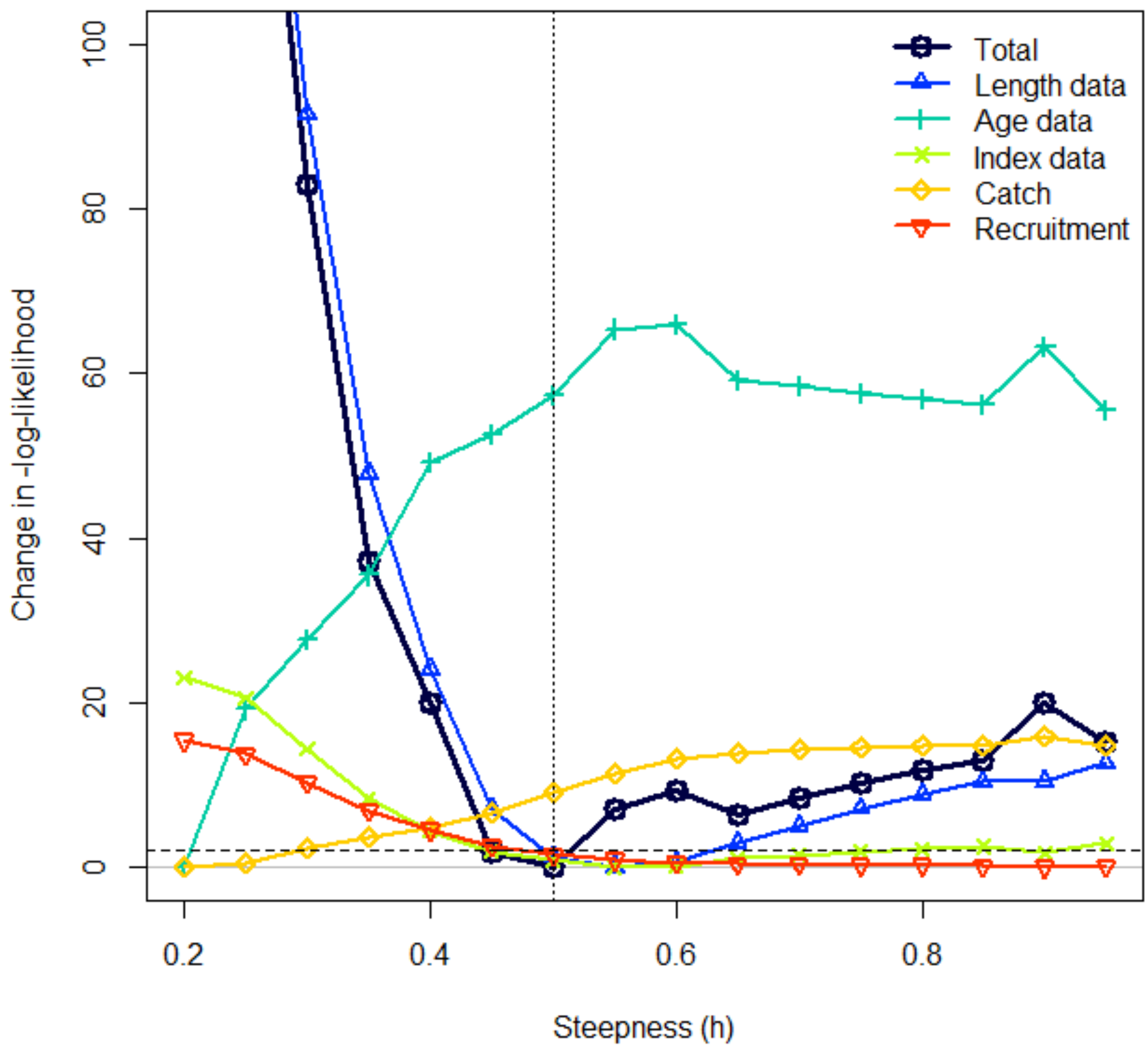


Figure 4.16.6. Likelihood profile for Beverton-Holt steepness. The dotted line represents the point estimate from the base model. The values represent the change in negative log-likelihood, by component.

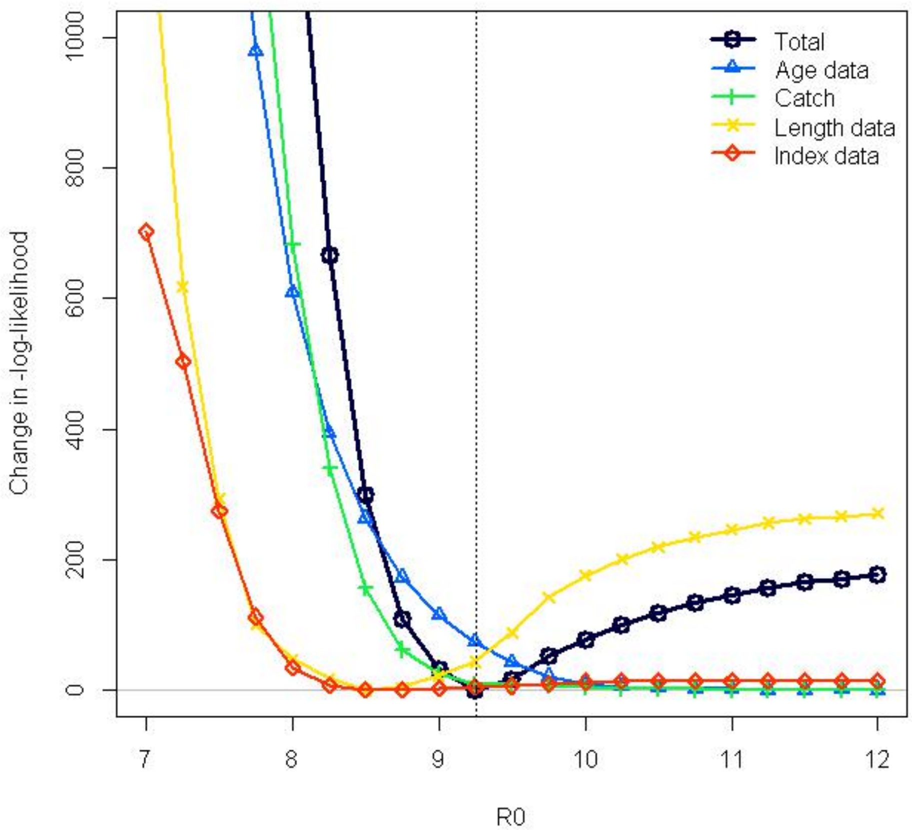


Figure 4.16.7. Likelihood profile for virgin recruitment. The dotted line represents the point estimate from the base model. The values represent the change in negative log-likelihood, by component.

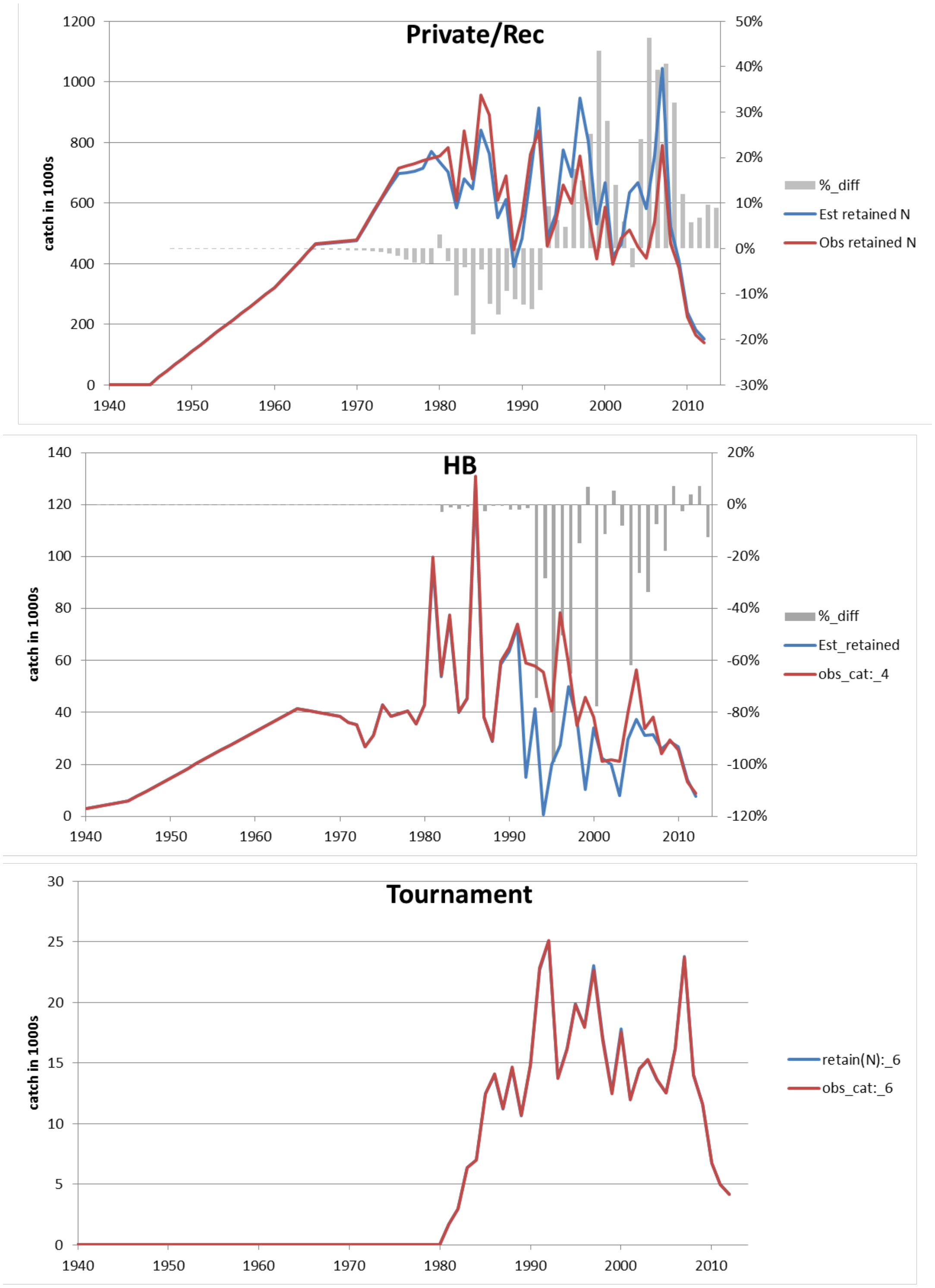


Figure 4.16.8. Observed (red) versus estimated (blue) retained catch in number for recreational fleets. Each fleet had a 20% CV on the input catch. Bars on the private/rec fleet are the percent difference between observed and predicted.

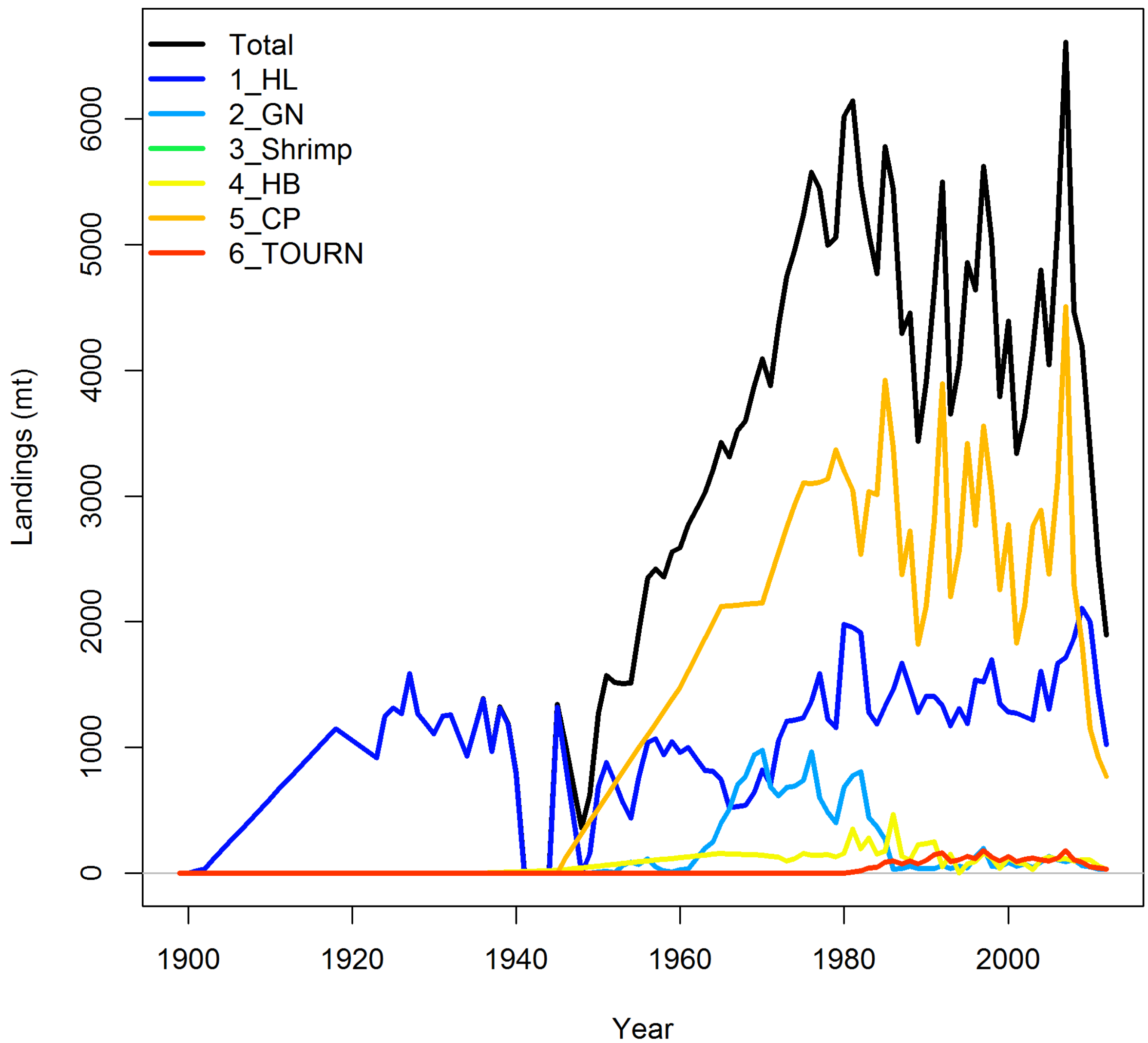


Figure 4.16.9. Model estimated landings by fleet and year.

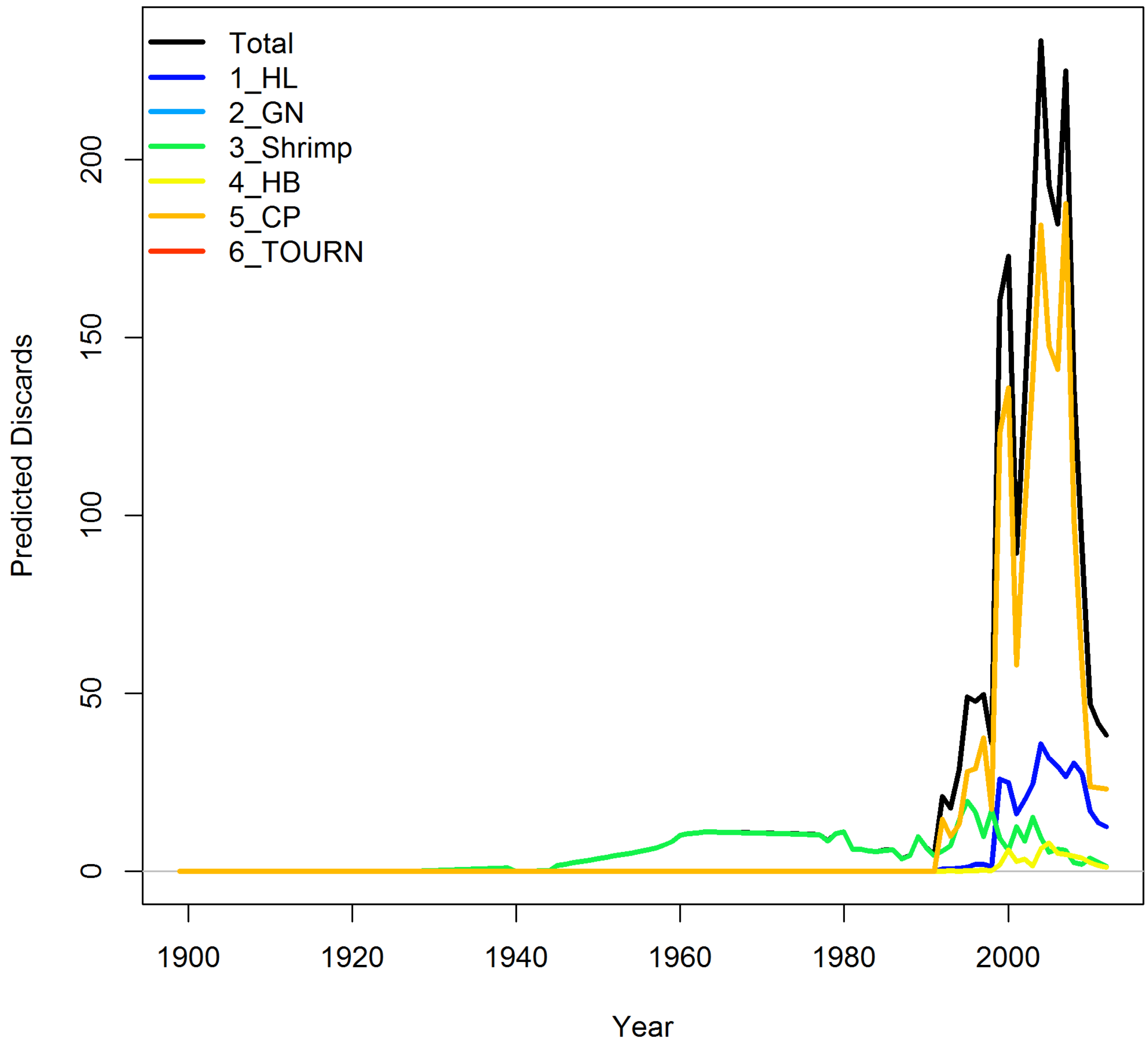


Figure 4.16.10. Model estimated discards by fleet and year.

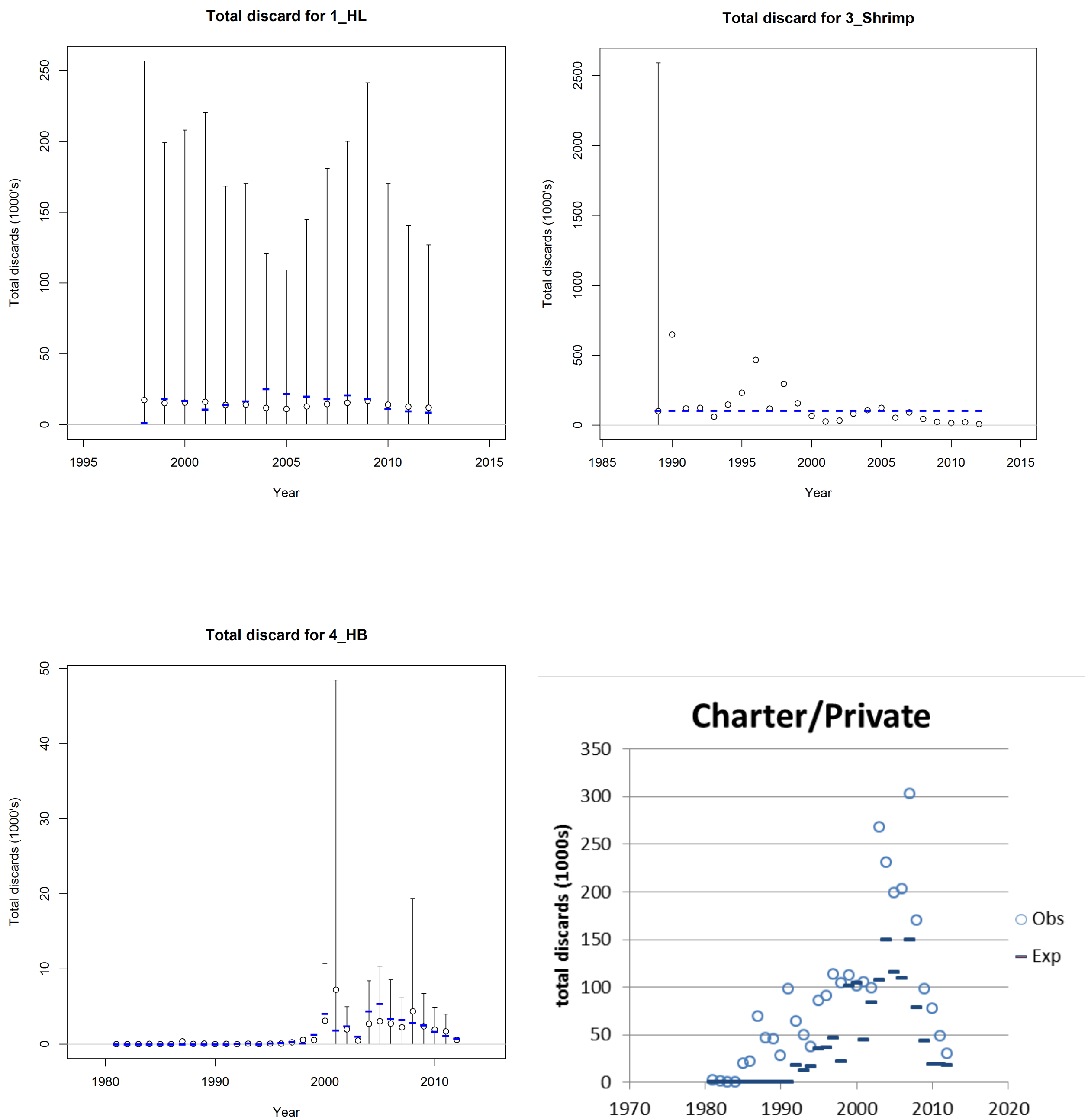


Figure 4.16.11. Observed (open circles) and predicted discards (blue dashes) (mt) of South Atlantic King Mackerel from the commercial handline line fishing fleet, shrimp bycatch, headboat and charter/private fleets.

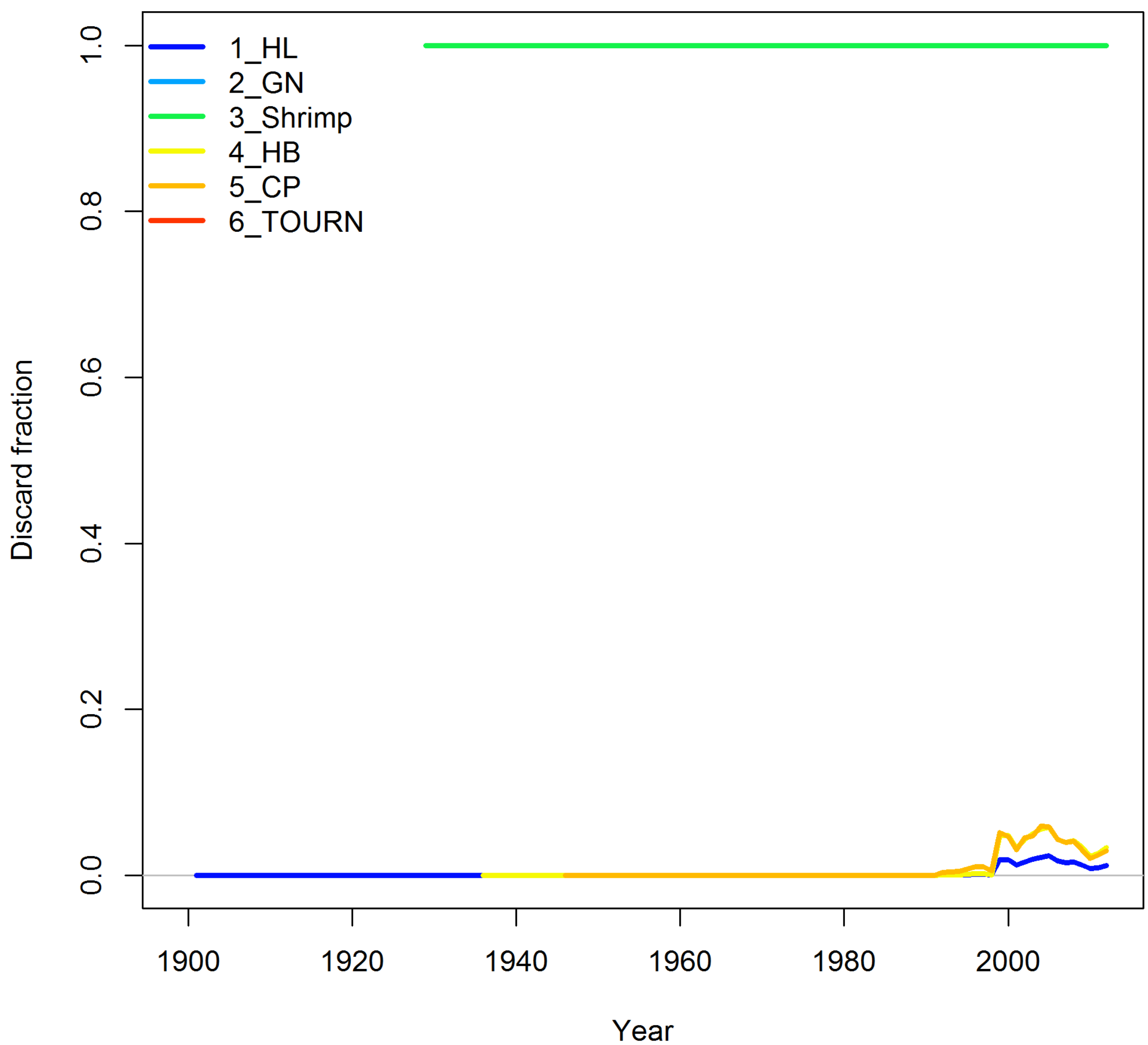


Figure 4.16.12. Model estimated discard fraction by fleet and year.

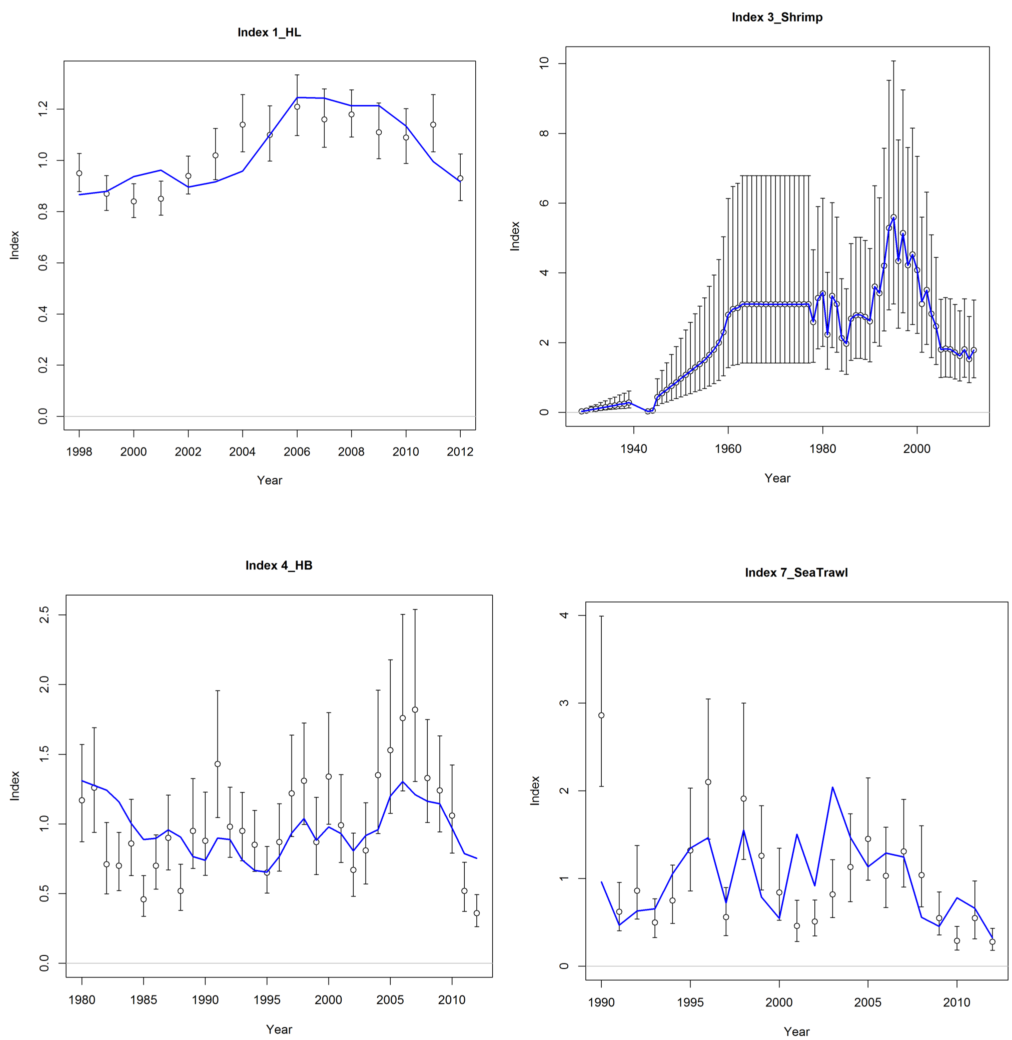


Figure 4.16.13. Model fit (blue line) to the standardized commercial vertical line CPUE index (open circles with 95% confidence interval assuming lognormal error), 1990-2009 (top panel).

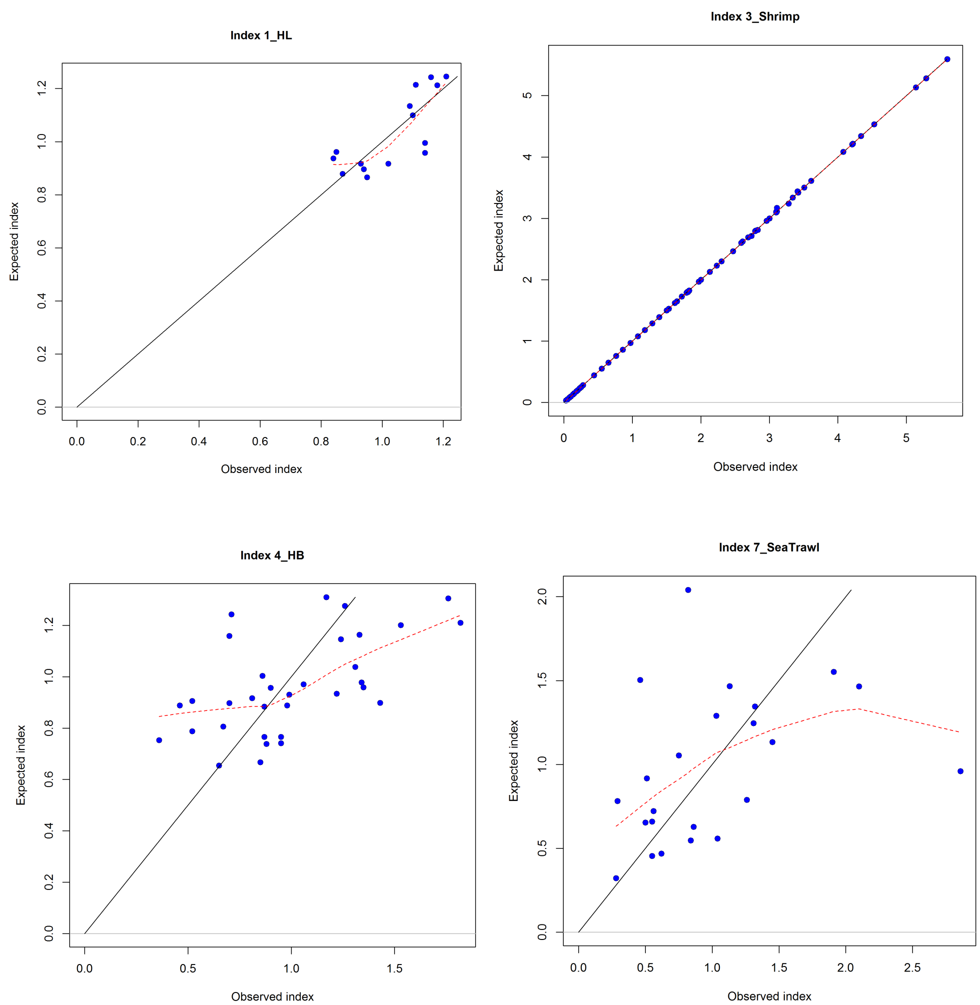


Figure 4.16.14. Observed and predicted indices, where the black line is the 1:1 line.

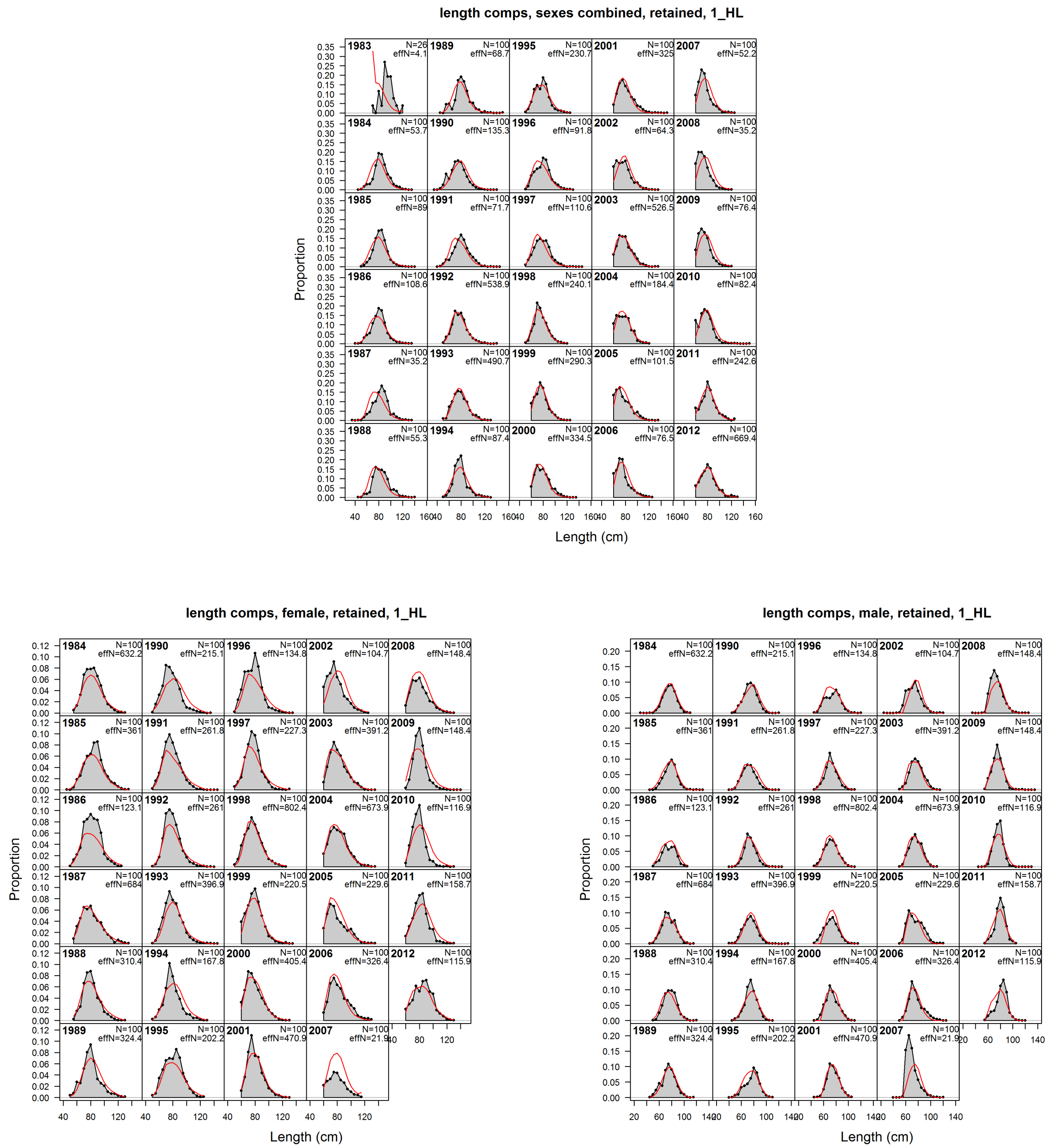


Figure 4.16.15. Observed (gray histograms) and predicted (red lines) length compositions of the commercial vertical line fleet. Observed (N) sample sizes and effective sample sizes (effN) estimated by SS are also reported. Observed sample sizes were capped at a maximum of 200 fish.

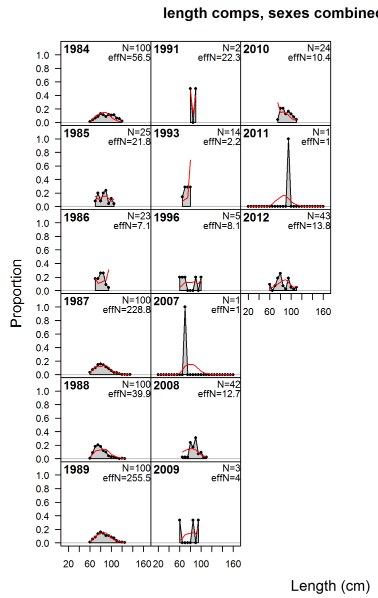


Figure 4.16.16. Observed (gray histograms) and predicted (red lines) length compositions of the commercial gillnet fleet. Observed (N) sample sizes and effective sample sizes (effN) estimated by SS are also reported. Observed sample sizes were capped at a maximum of 200 fish.

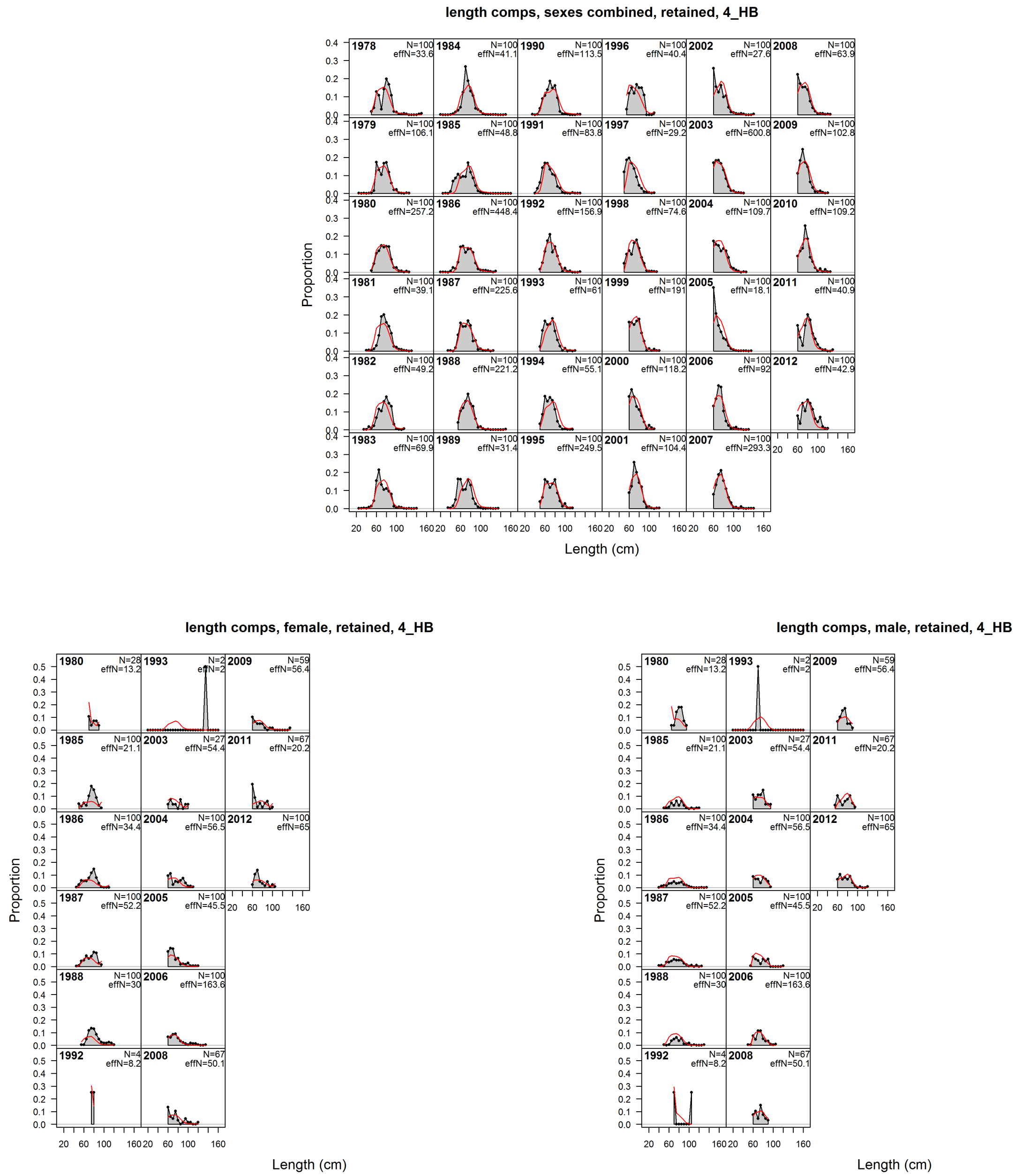
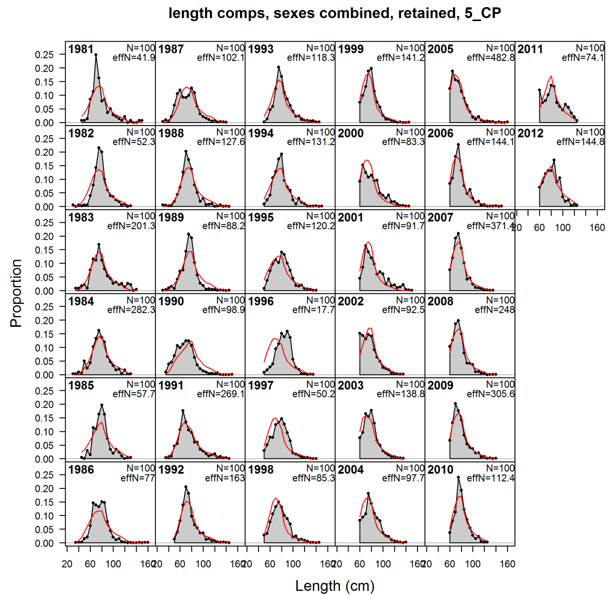
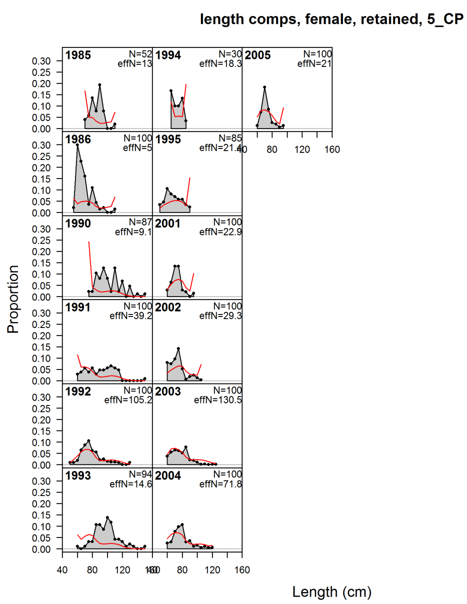


Figure 4.16.17. Observed (gray histograms) and predicted (red lines) length compositions of the recreational headboat fleet. Observed (N) sample sizes and effective sample sizes (effN) estimated by SS are also reported. Observed sample sizes were capped at a maximum of 200 fish.





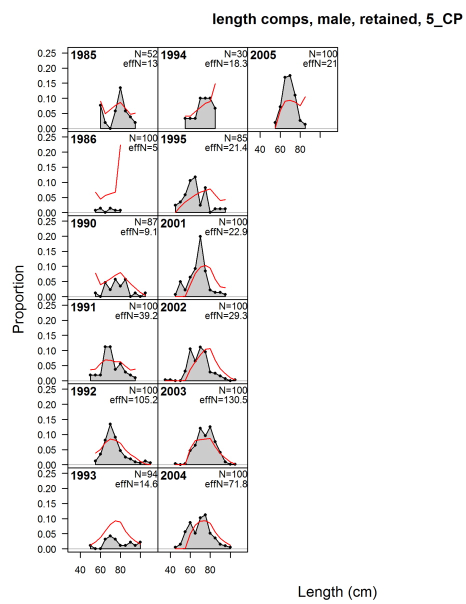


Figure 4.16.18. Observed (gray histograms) and predicted (red lines) length compositions of the recreational private and charter fleet. Observed (N) sample sizes and effective sample sizes (effN) estimated by SS are also reported. Observed sample sizes were capped at a maximum of 200 fish.

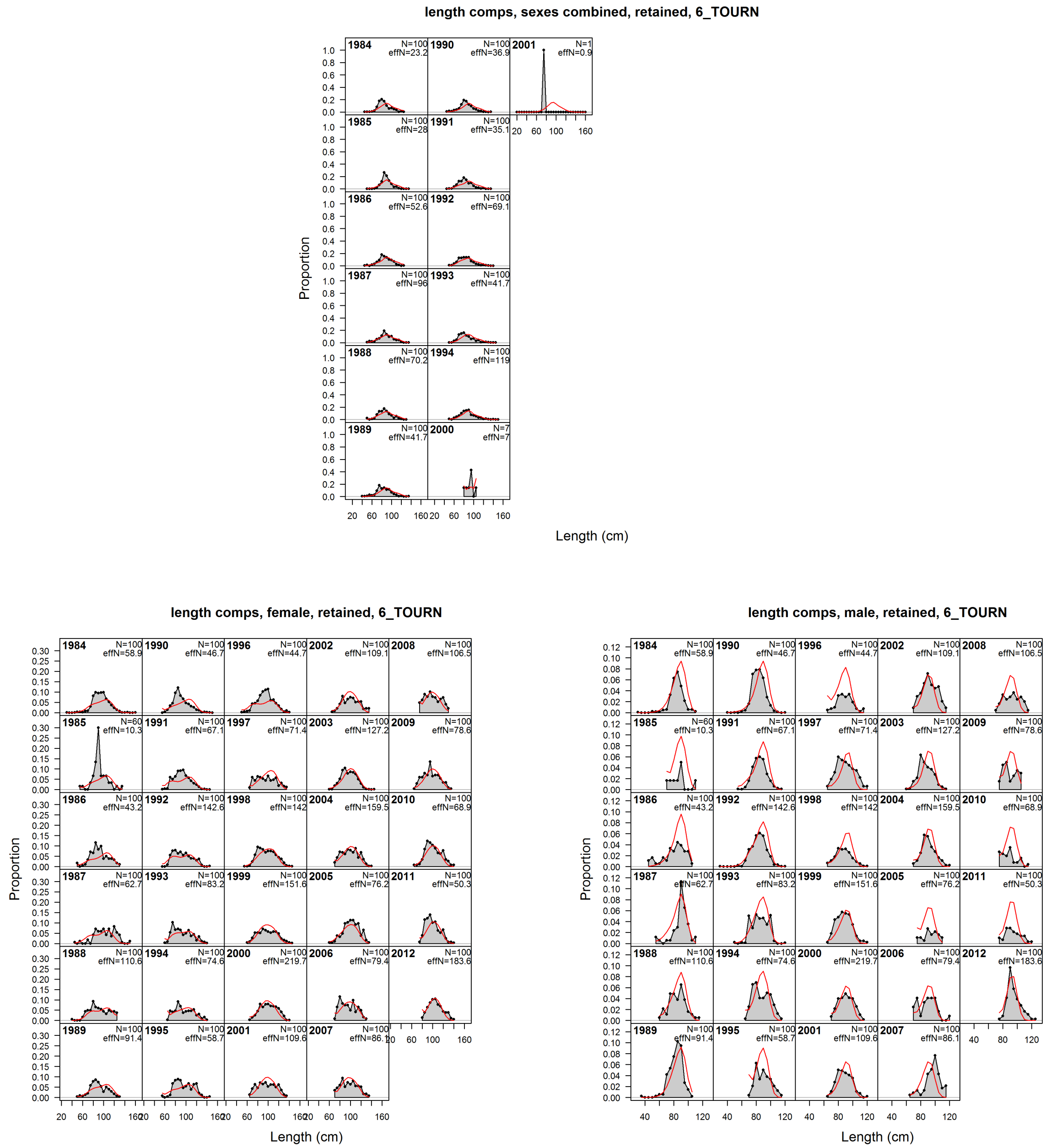


Figure 4.16.19. Observed (gray histograms) and predicted (red lines) length compositions of the recreational tournament fleet. Observed (N) sample sizes and effective sample sizes (effN) estimated by SS are also reported. Observed sample sizes were capped at a maximum of 200 fish.

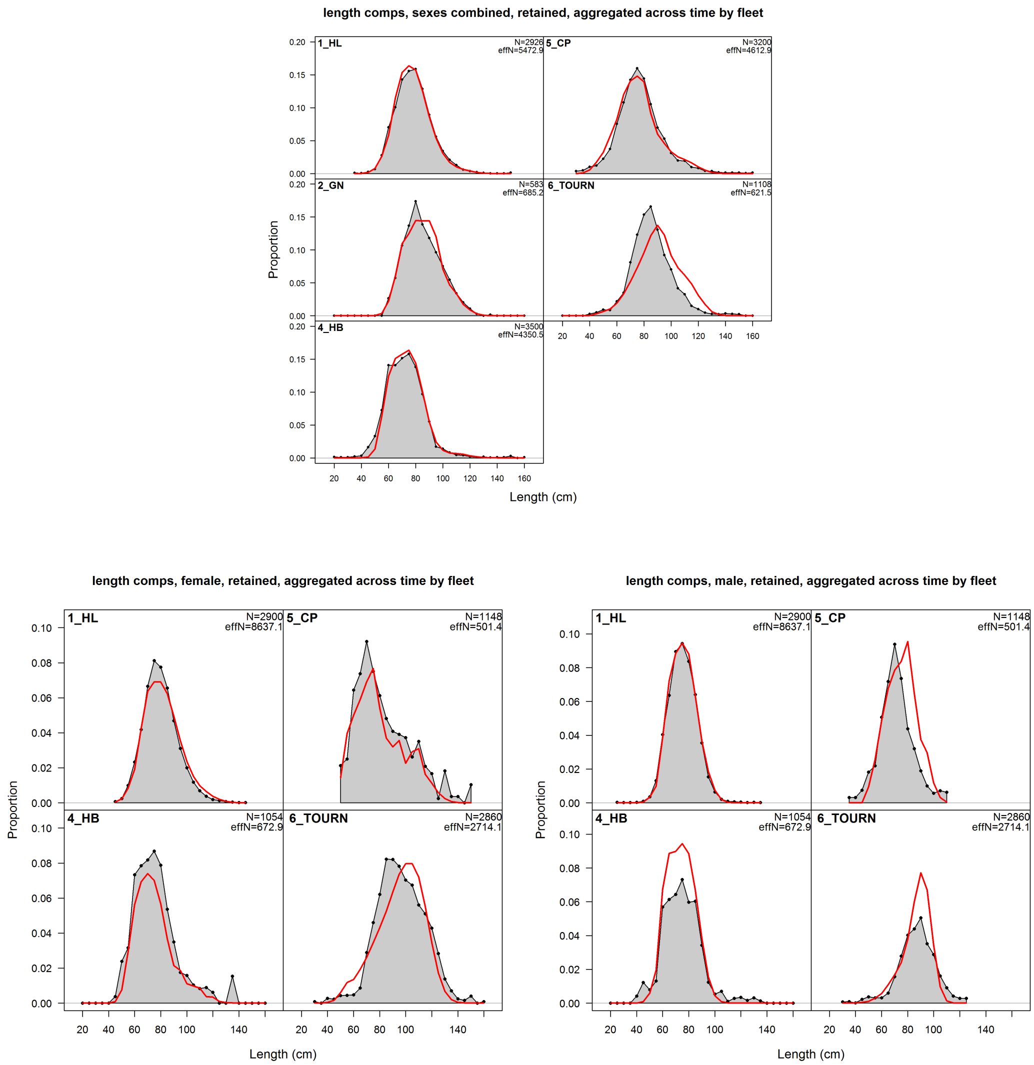


Figure 4.16.20. Fits to length composition data aggregated across years.

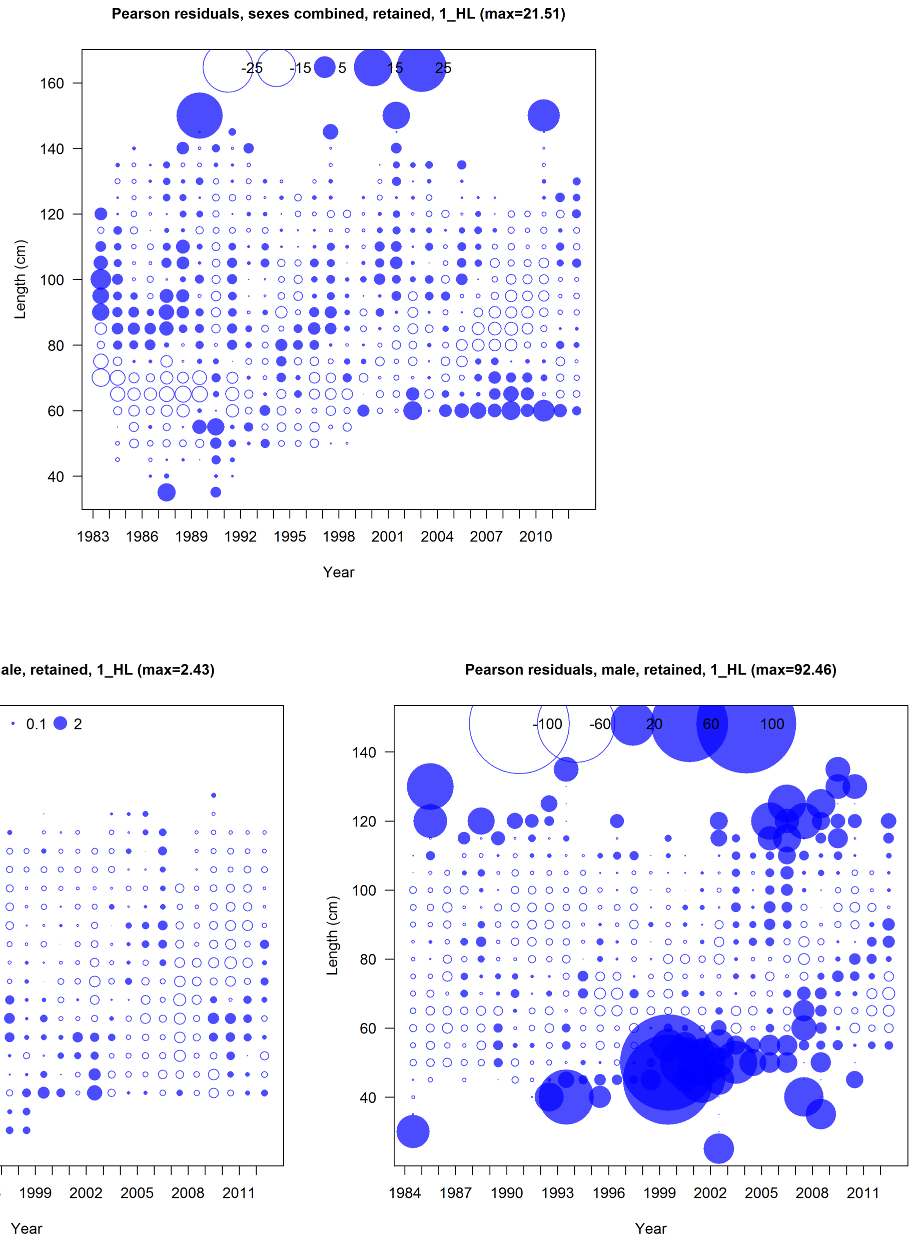


Figure 4.16.21. Pearson residuals for the length composition fit to commercial vertical line landings. Solid circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

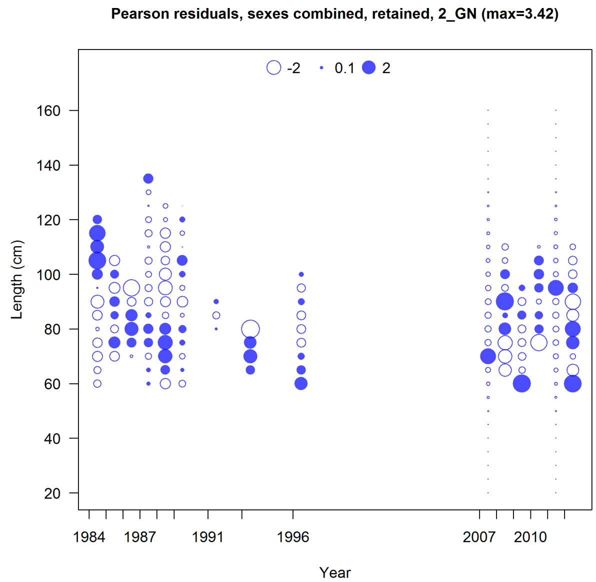


Figure 4.16.22. Pearson residuals for the length composition fit to commercial gillnet landings. Solid circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

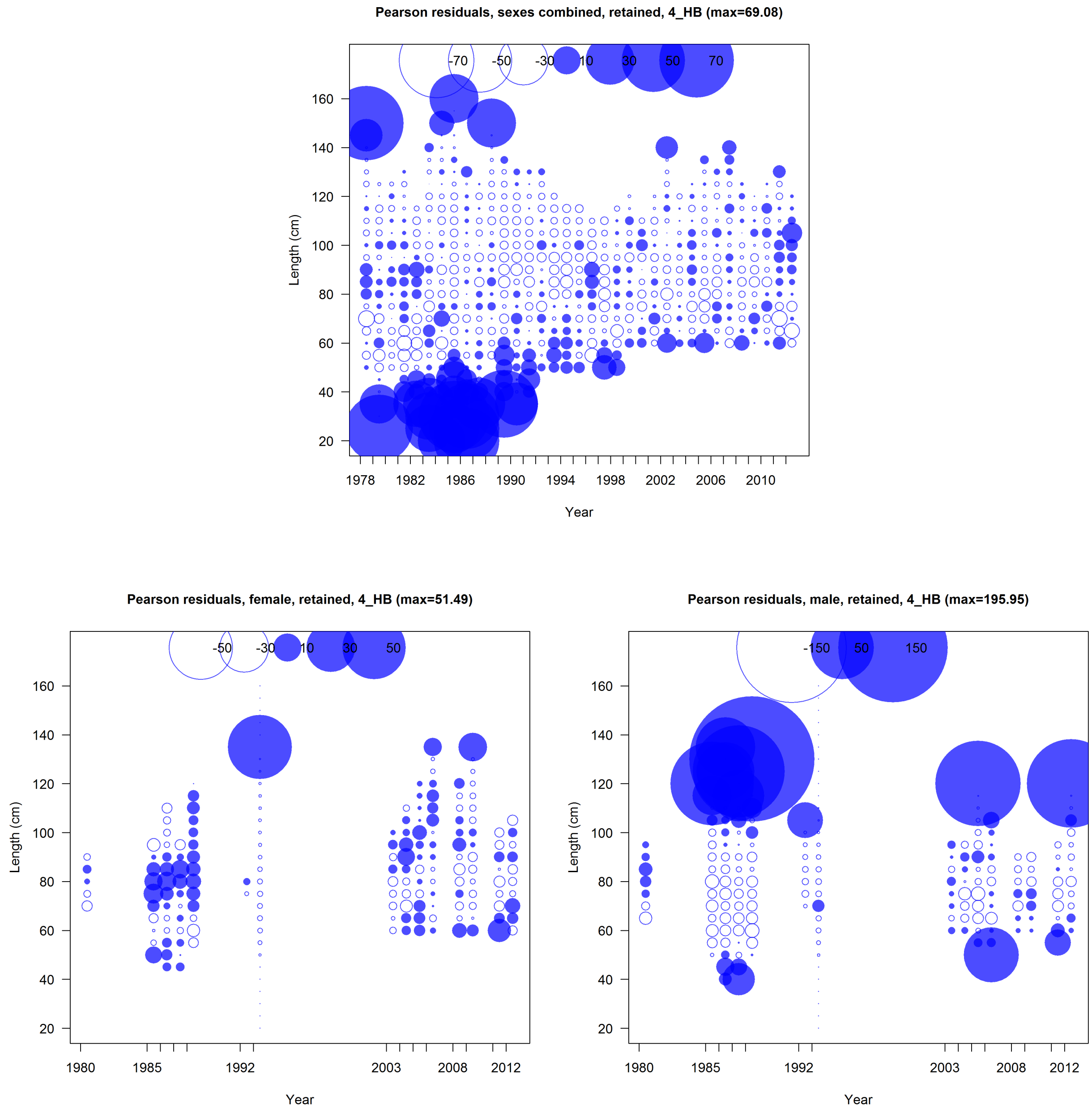
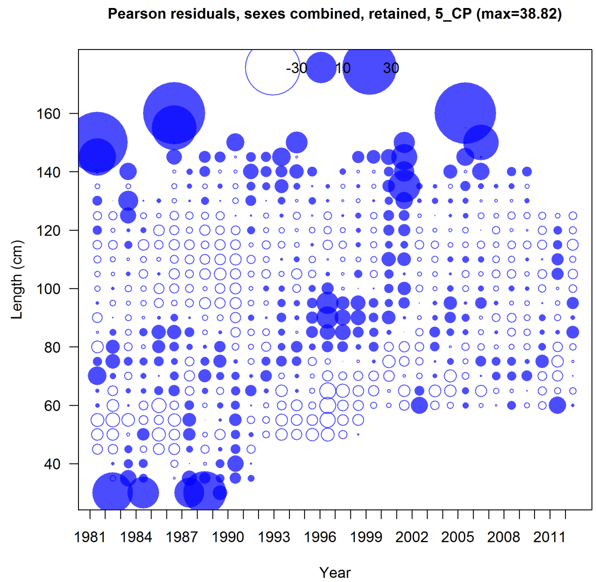
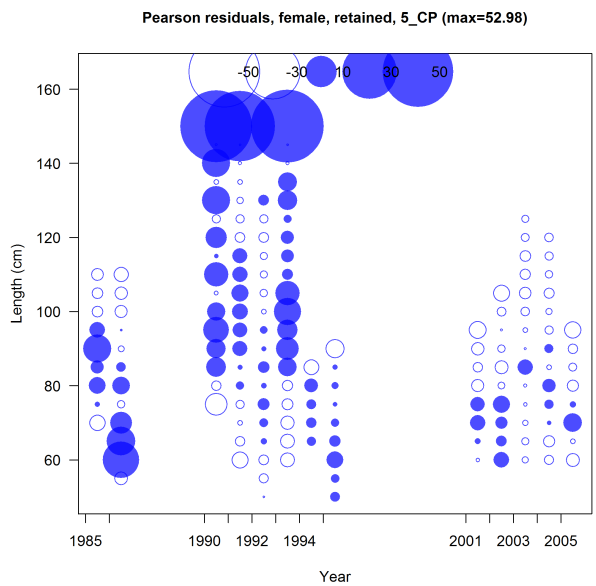


Figure 4.16.23. Pearson residuals for the length composition fit to recreational headboat data. Solid circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).





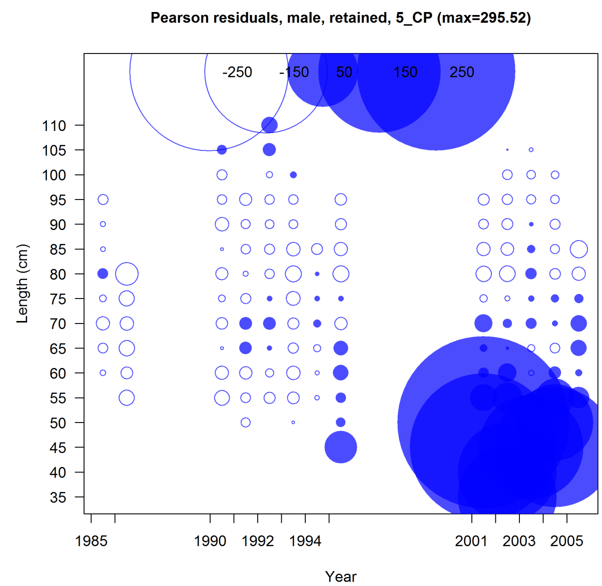


Figure 4.16.24. Pearson residuals for the length composition fit to recreational charter and private boat data. Solid circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

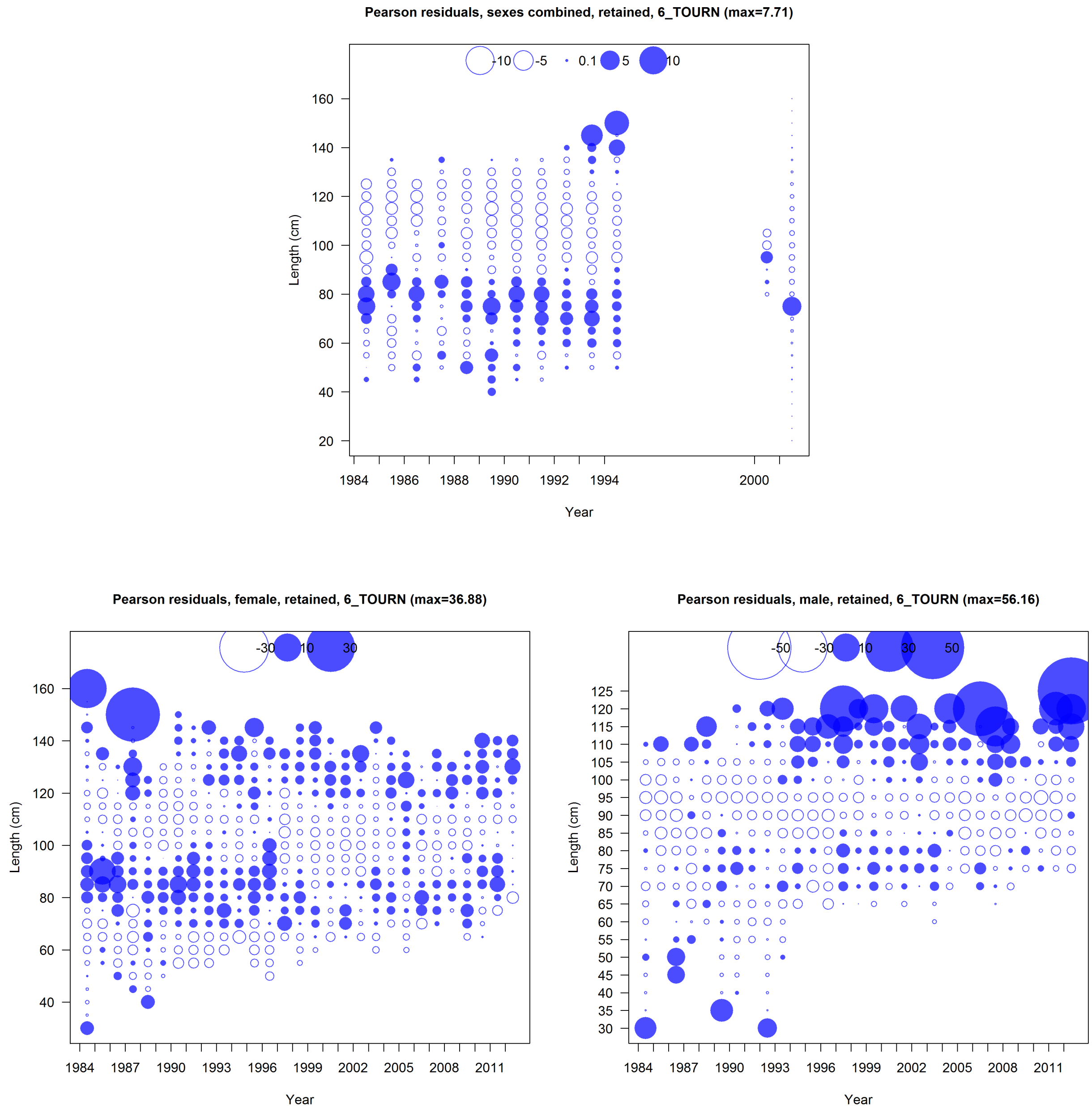


Figure 4.16.25. Pearson residuals for the length composition fit to recreational tournament data. Solid circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

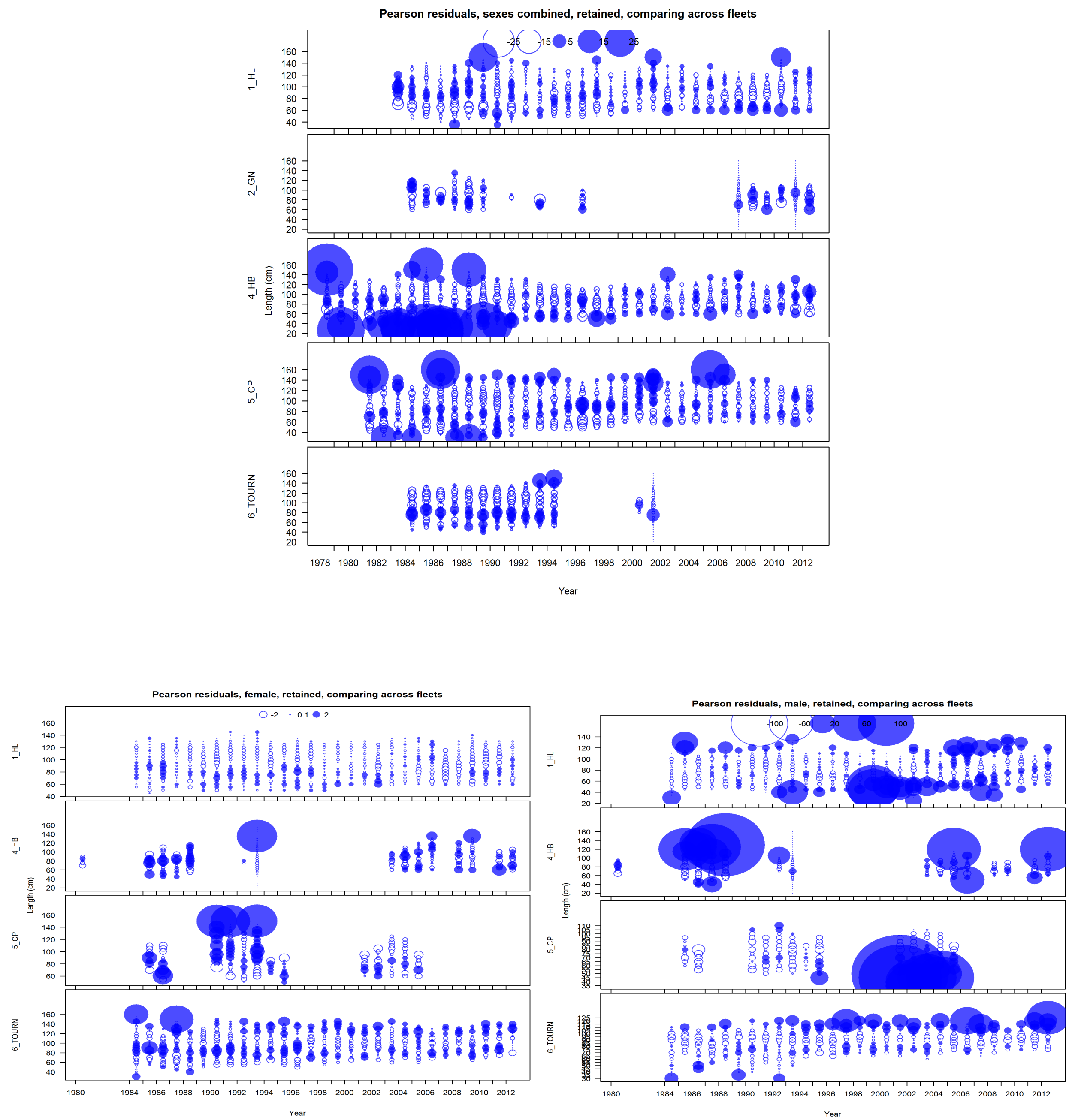


Figure 4.16.26. Pearson residuals model fit to all length composition data for Atlantic King Mackerel. Solid circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

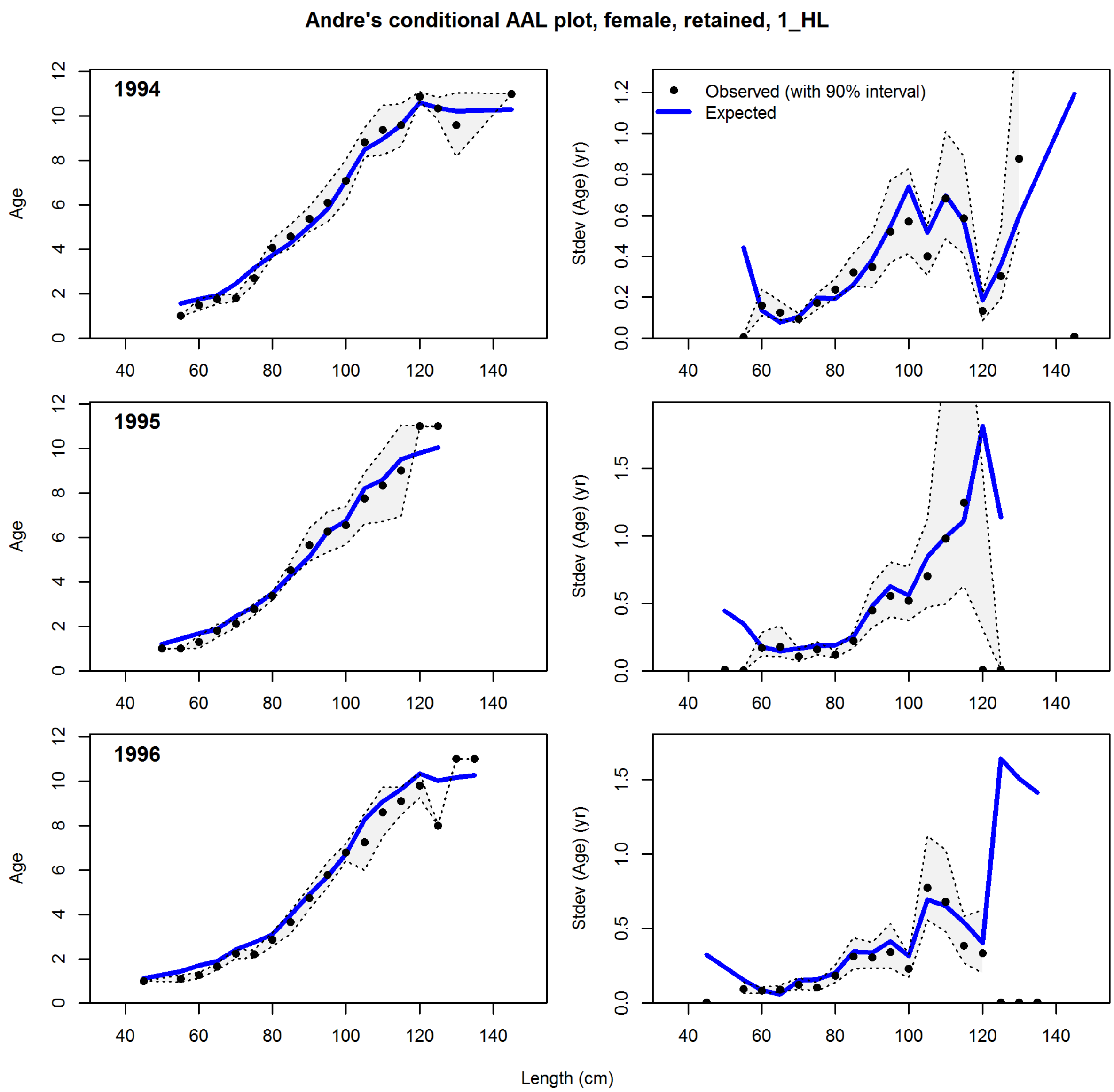


Figure 4.16.27. Observed and expected female handline mean age-at-length with 95% intervals about observed age at length (left panels) and observed and expected standard deviation in age-at-length (right panels). The years 1994-1996 were chosen randomly for illustrative purposes.

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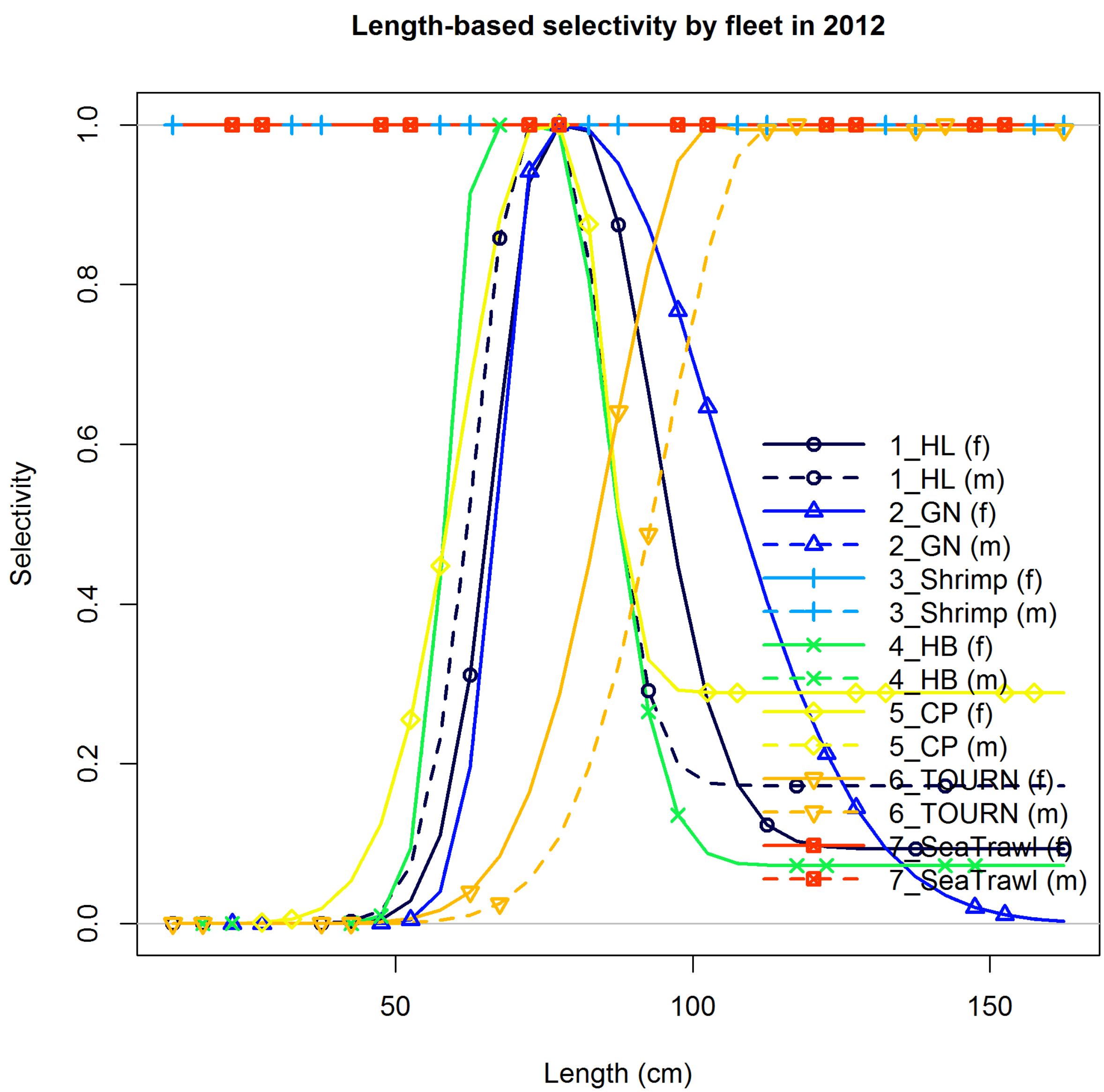


Figure 4.16.28. Estimated fleet selectivities-at-length by fleet and sex.

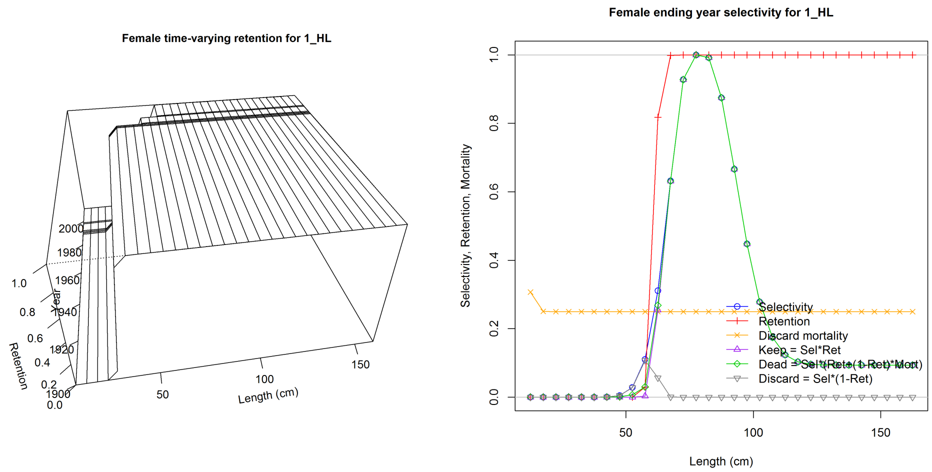


Figure 4.16.29. Female time-varying retention and ending year selectivity patterns for the commercial handline fishery (4 time blocks), double normal model.

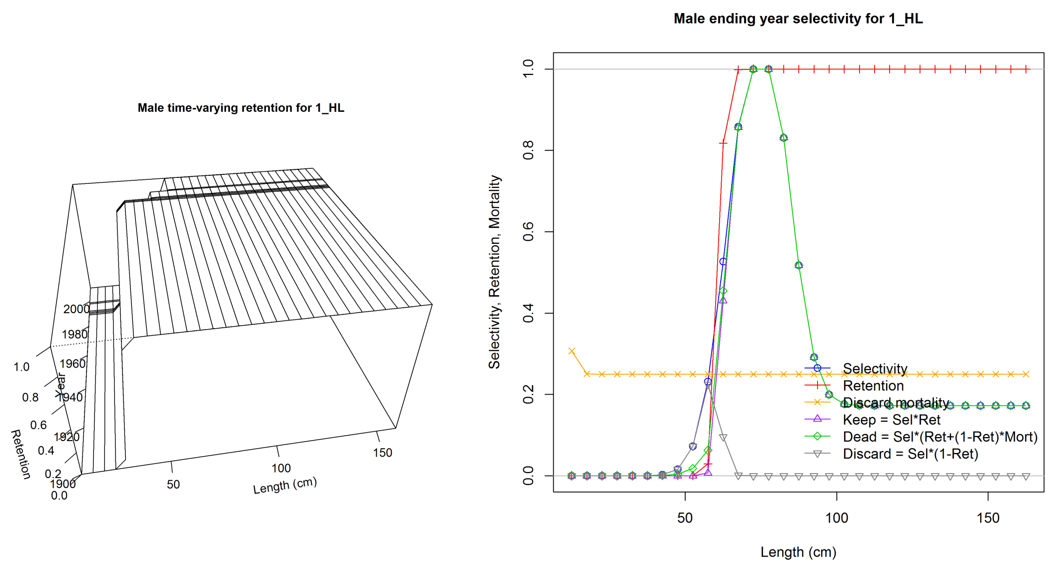


Figure 4.16.30. Male time-varying retention and ending year selectivity patterns for the commercial handline fishery (4 time blocks), double normal model.

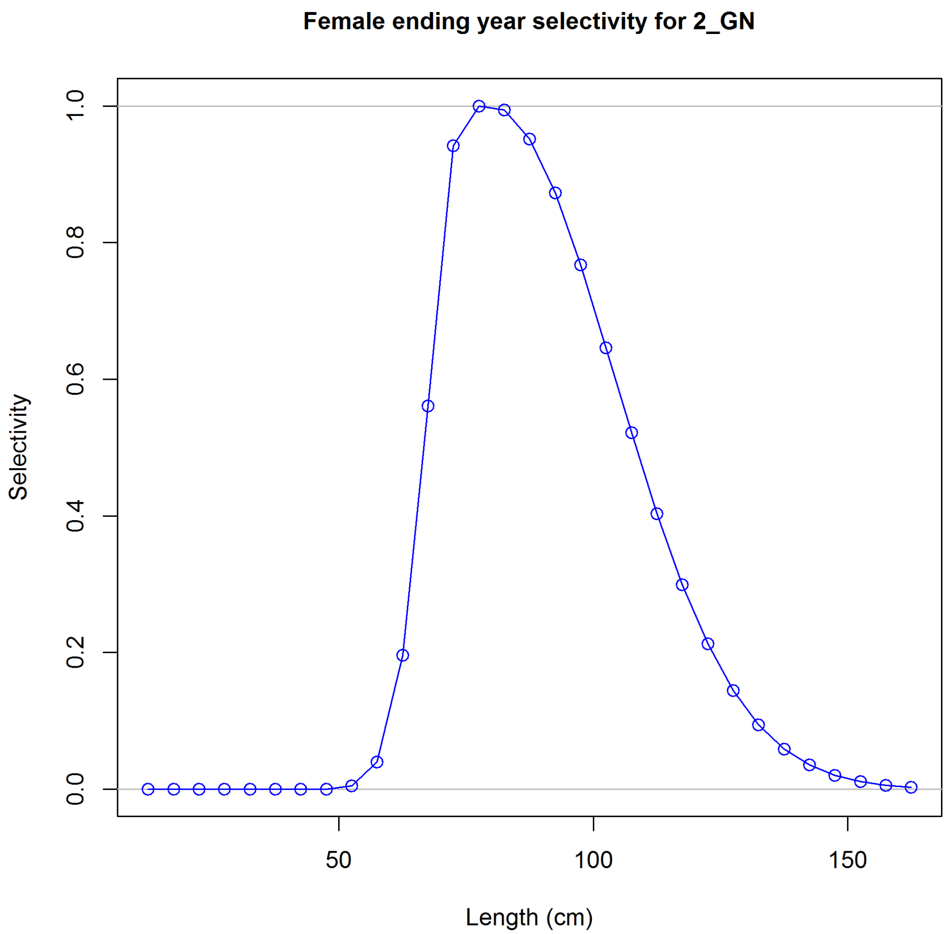


Figure 4.16.31. Male and female selectivity for the gillnet fishery (no timeblocks), double normal model.

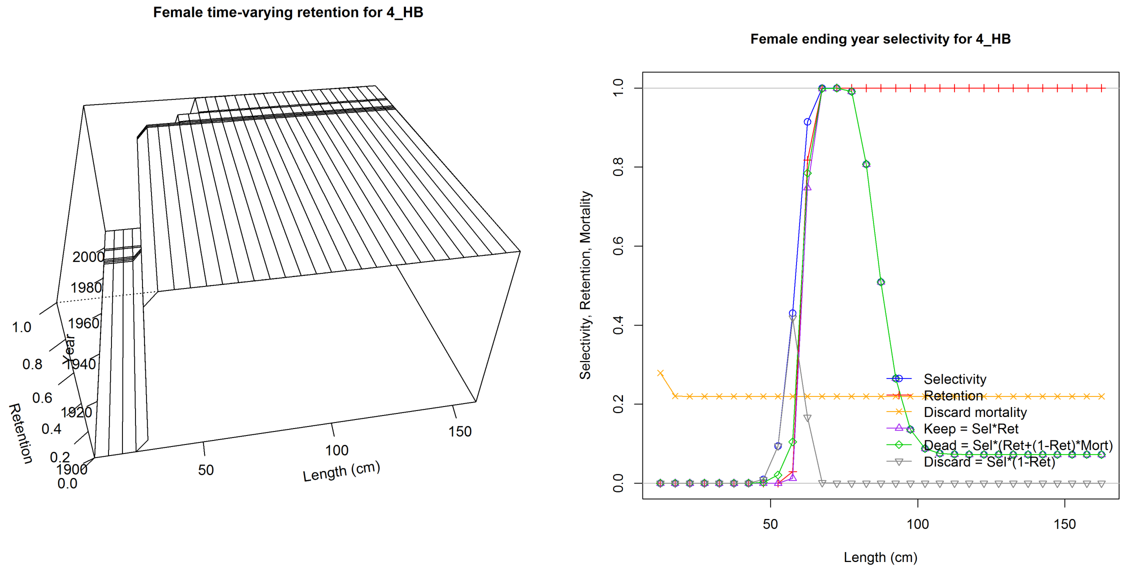


Figure 4.16.32. Female time-varying retention and ending year selectivity patterns for the recreational headboat fishery (4 time blocks), double normal model.

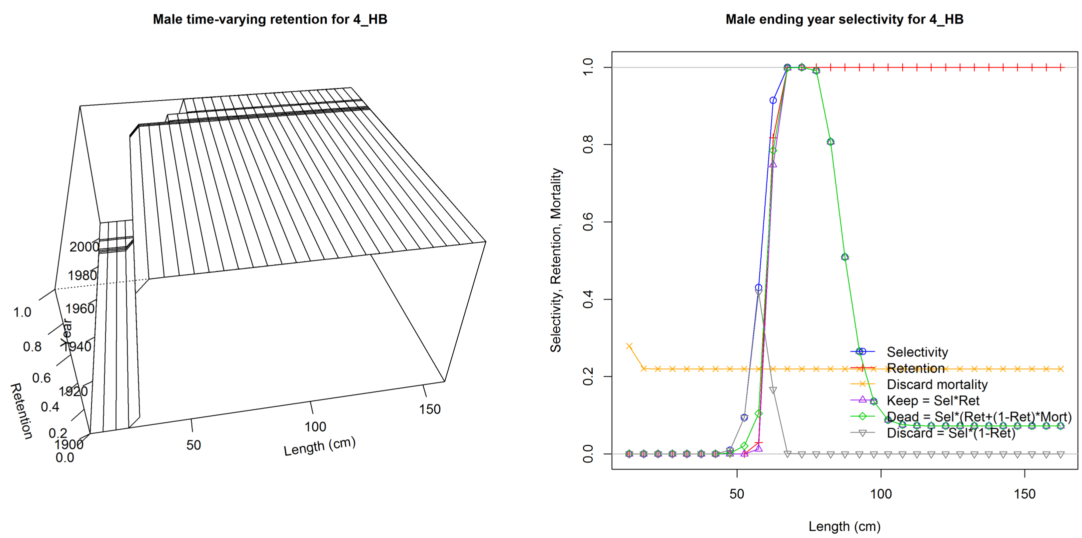


Figure 4.16.33. Male time-varying retention and ending year selectivity patterns for the recreational headboat fishery (4 time blocks), double normal model.

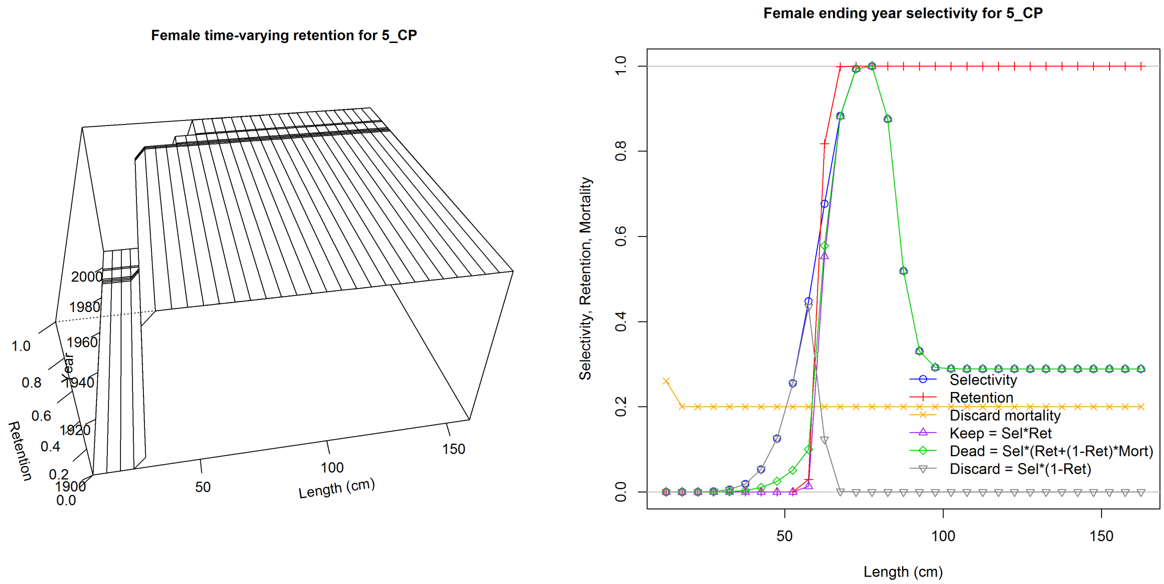


Figure 4.16.34. Female time-varying retention and ending year selectivity patterns for recreational charter and private fishery (4 time blocks), double normal model.

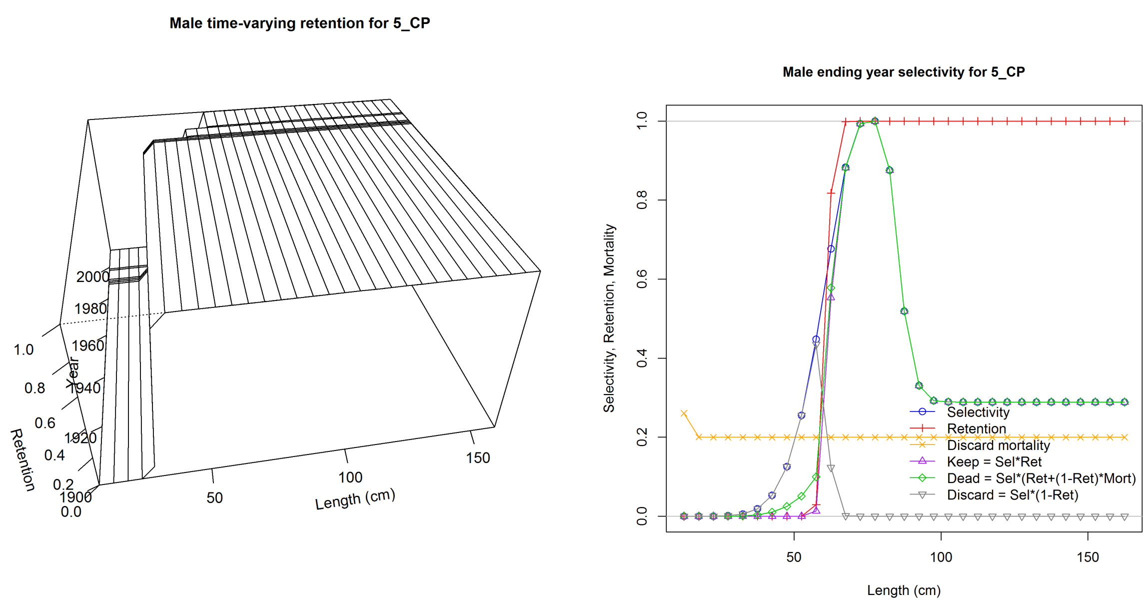


Figure 4.16.35. Male time-varying retention and ending year selectivity patterns for the recreational charter and private boat fishery (4 time blocks), double normal model.

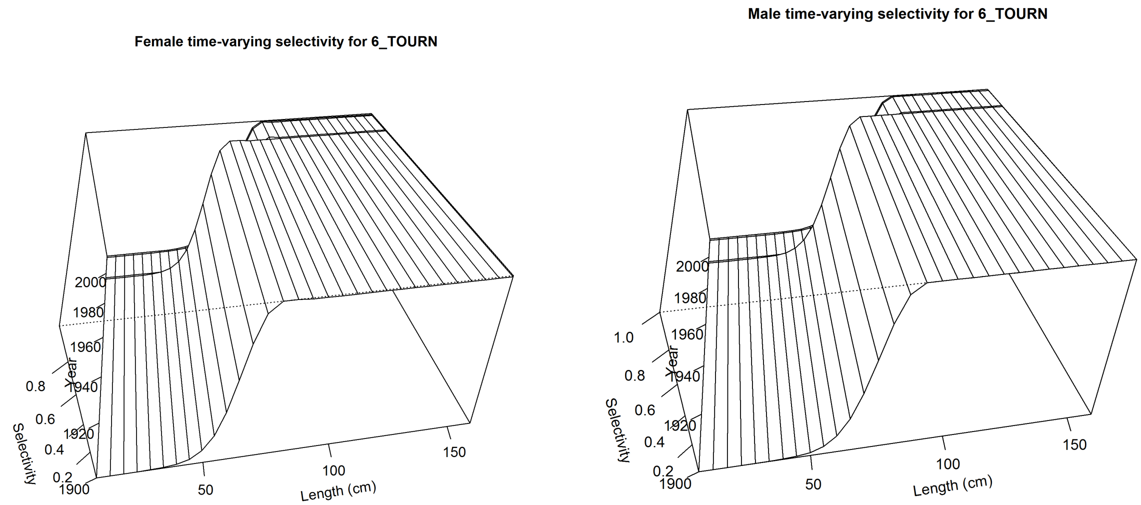


Figure 4.16.36. Female and male time-varying selectivity for tournament fleet (logistic model, two time blocks starting in 1997).

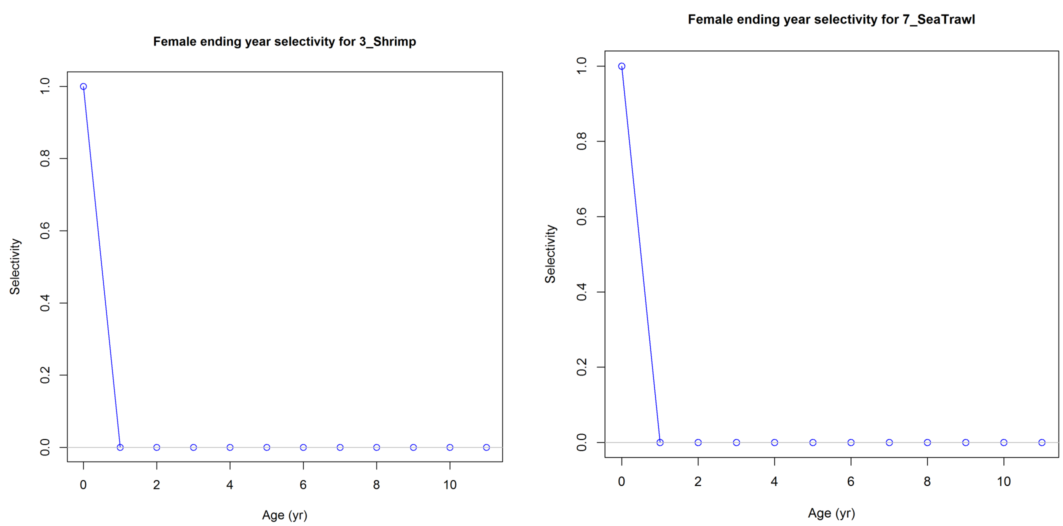


Figure 4.16.37. Female age-based selectivity (age 0 only) for Shrimp bycatch fishery and SEAMAP trawl survey. Male selectivity is the same.

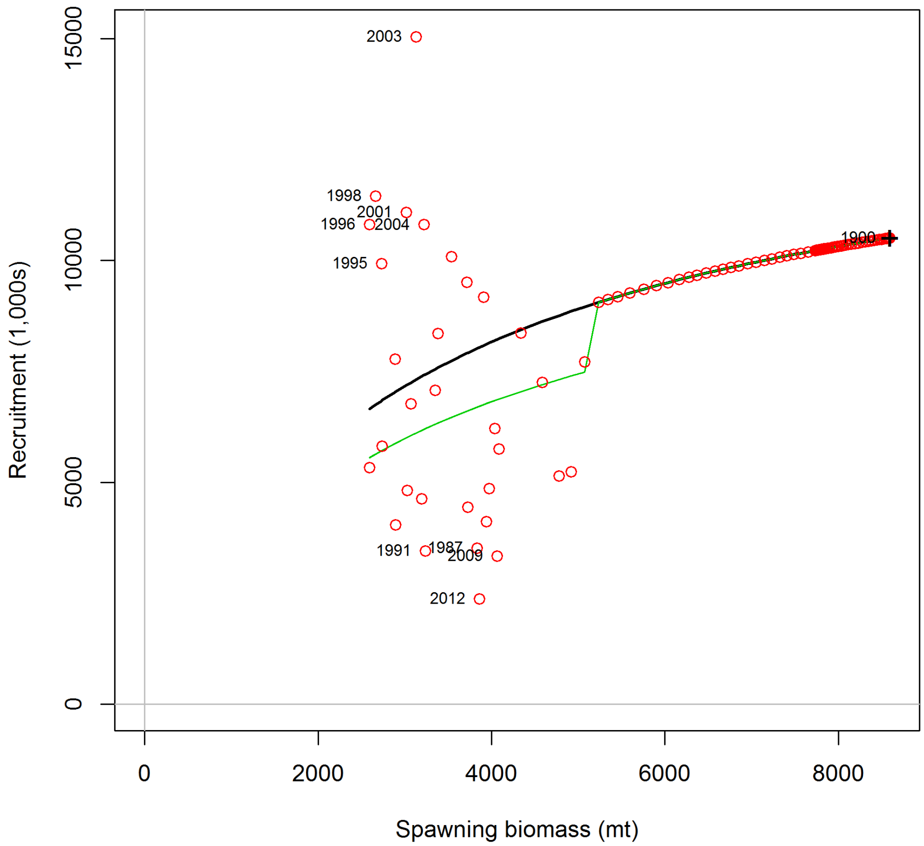


Figure 4.16.38. Predicted stock-recruitment relationship for South Atlantic King Mackerel for the central model. Plotted are predicted annual recruitments from SS (circles), expected recruitment from the stock-recruit relationship (black line), and bias adjusted recruitment from the stock-recruit relationship (green line).

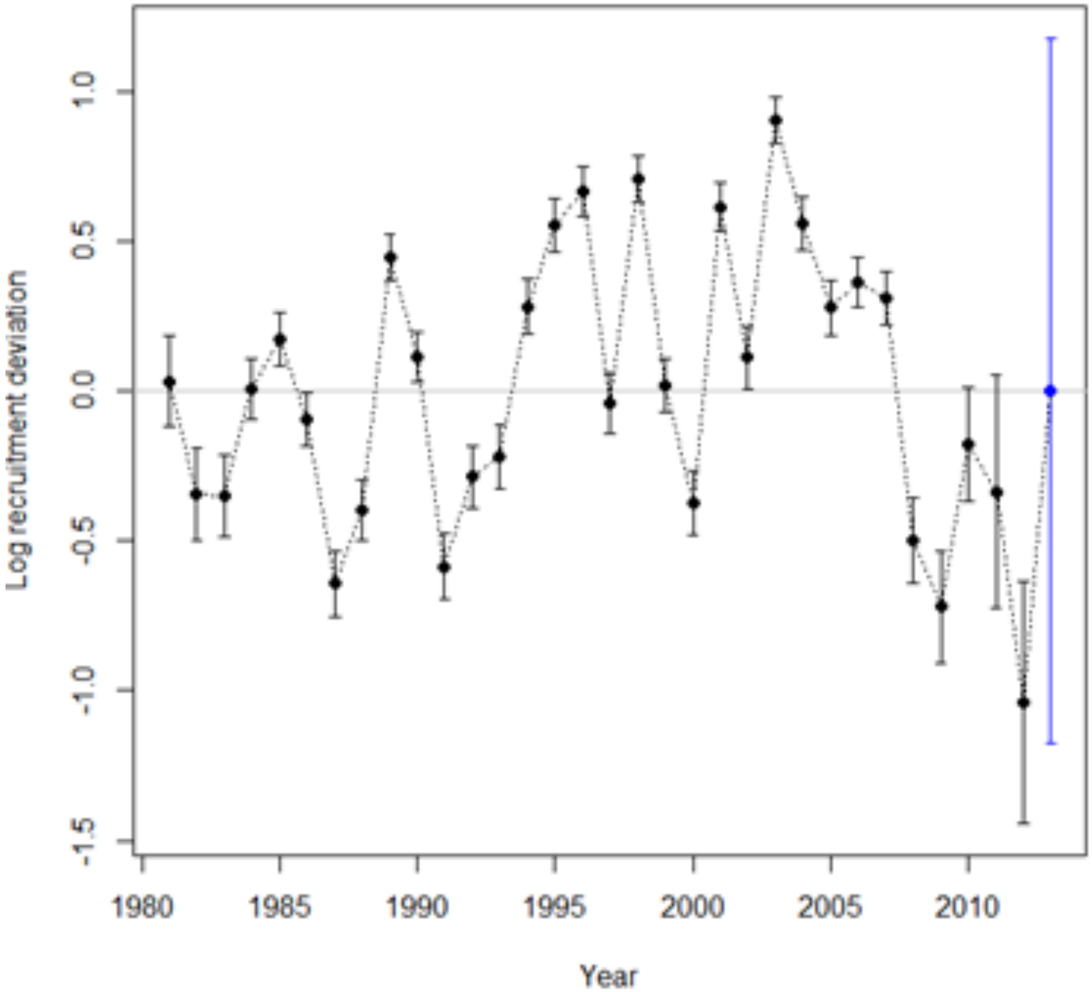


Figure 4.16.39. Predicted log recruitment deviations with associated 95% asymptotic intervals. Note that the point in blue is for 2013 and would represent a future prediction based on a recruitment deviation of zero.

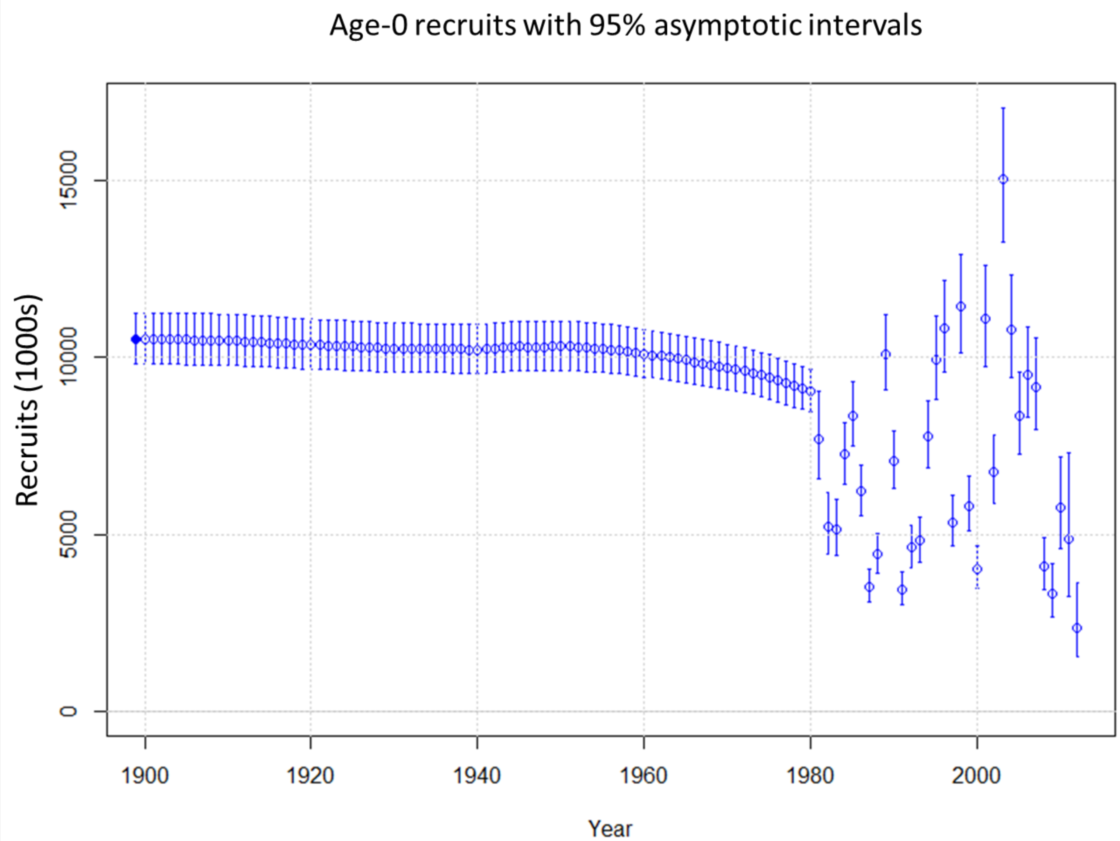
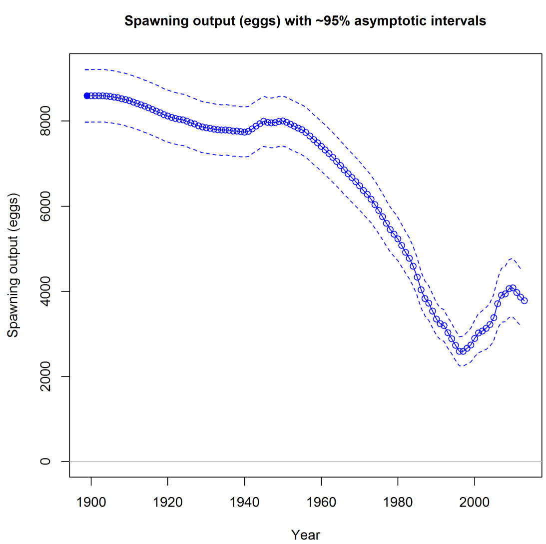


Figure 4.16.40. Predicted age-0 recruits with associated 95% asymptotic intervals.



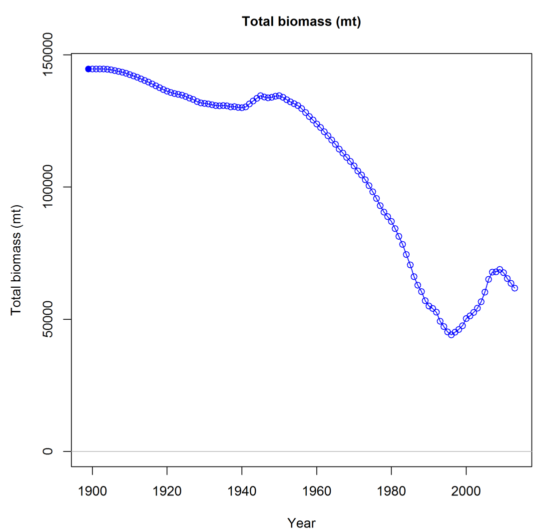


Figure 4.16.41. Predicted spawning biomass (female eggs in millions) with 95% CI and total biomass in whole metric tons.

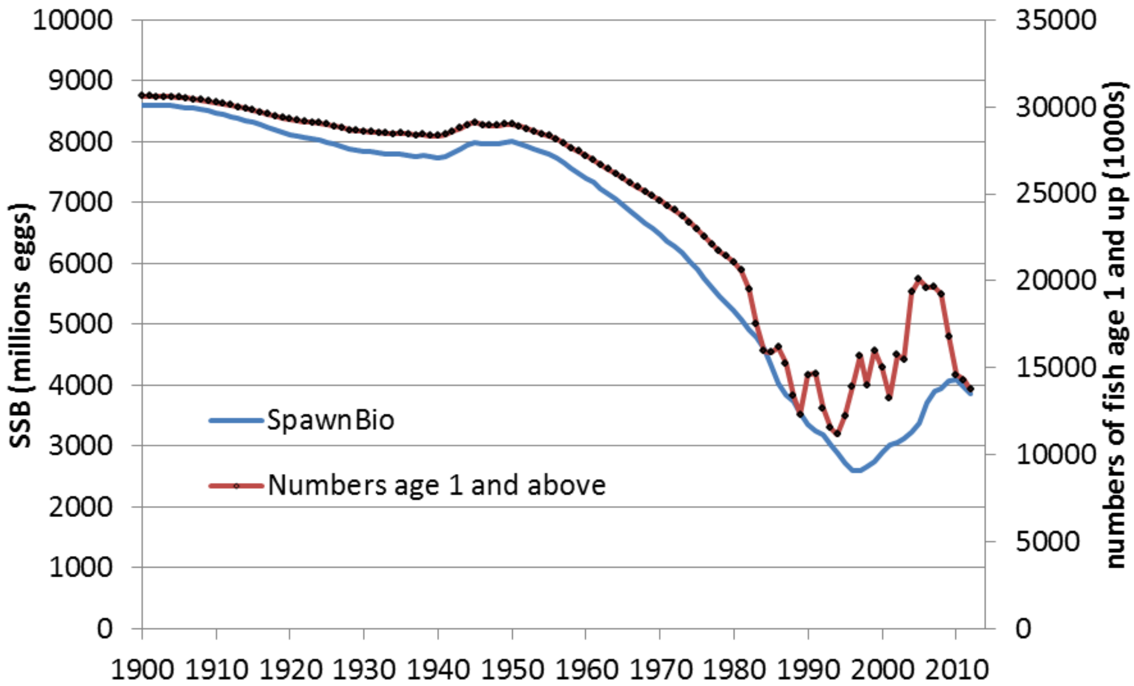


Figure 4.16.42. Spawning biomass (blue line) and numbers of age 1 and above fish (red line)

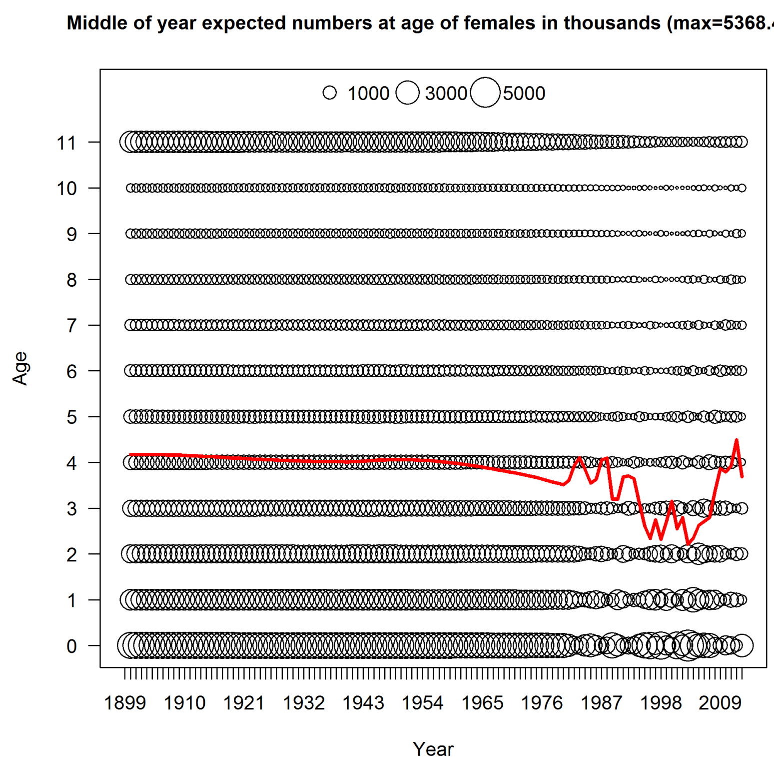


Figure 4.16.43. Predicted female numbers-at-age (bubbles) and mean age (red ine).

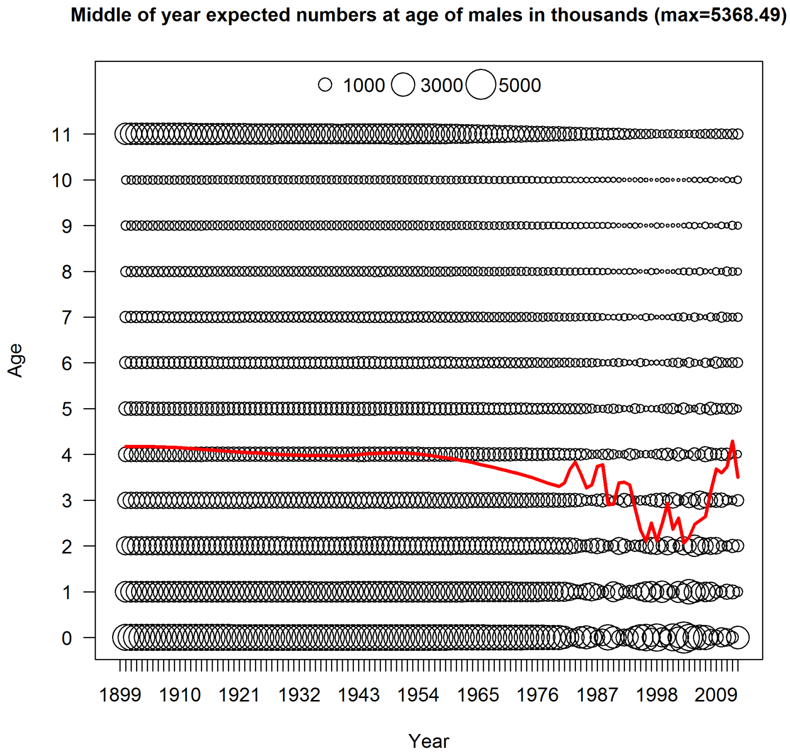


Figure 4.16.44. Predicted male numbers-at-age (bubbles) and mean age (red line).

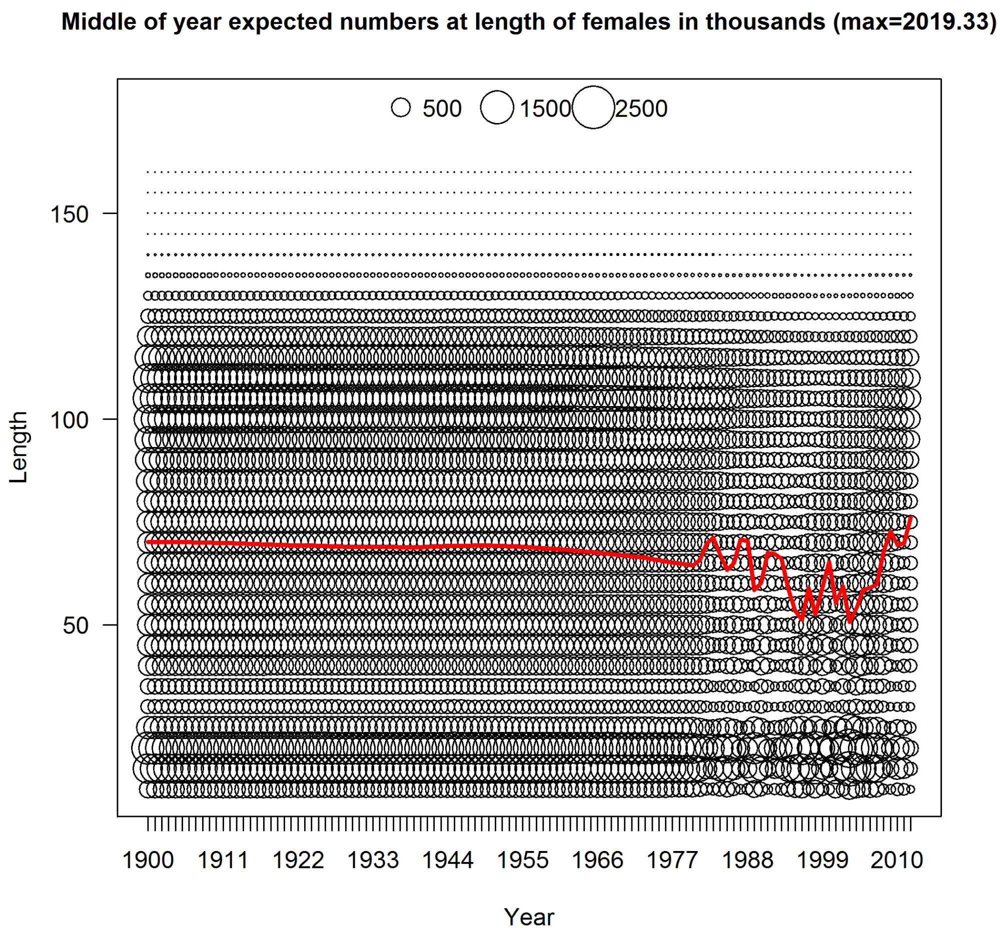


Figure 4.16.45. Predicted female numbers-at-length (bubbles) and mean length (red line).

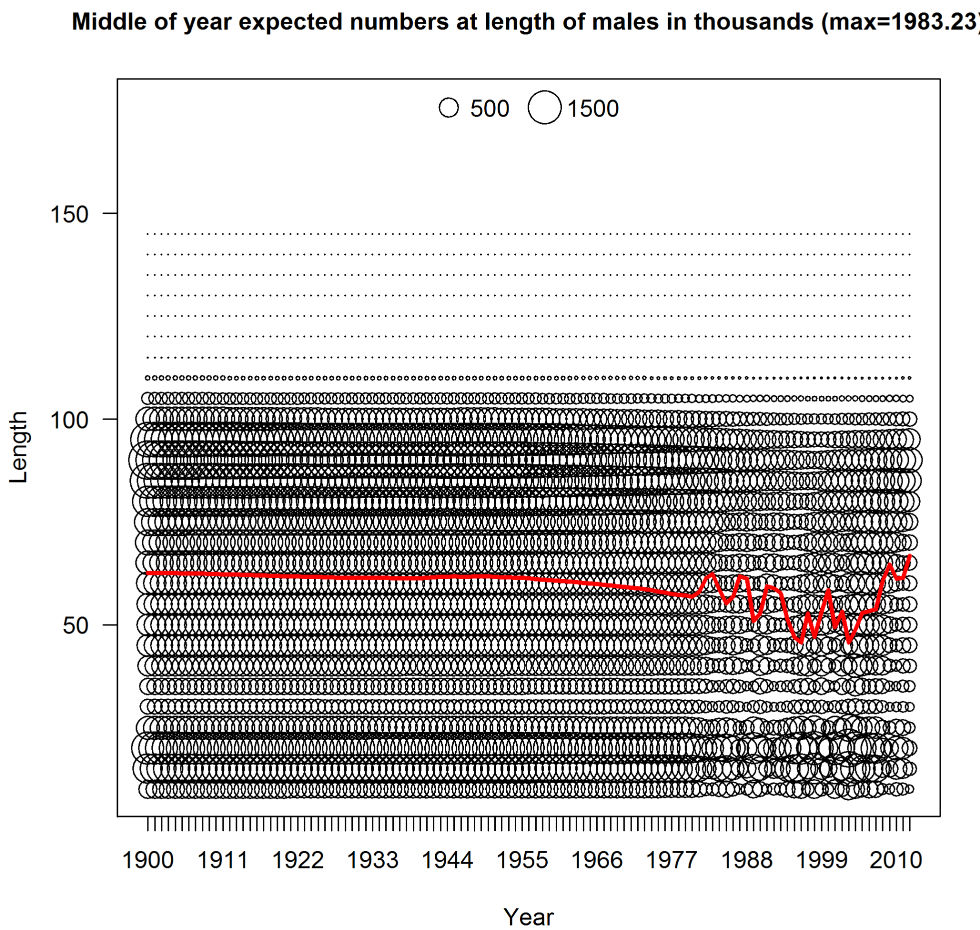


Figure 4.16.46. Predicted male numbers-at-length (bubbles) and mean length (red line).

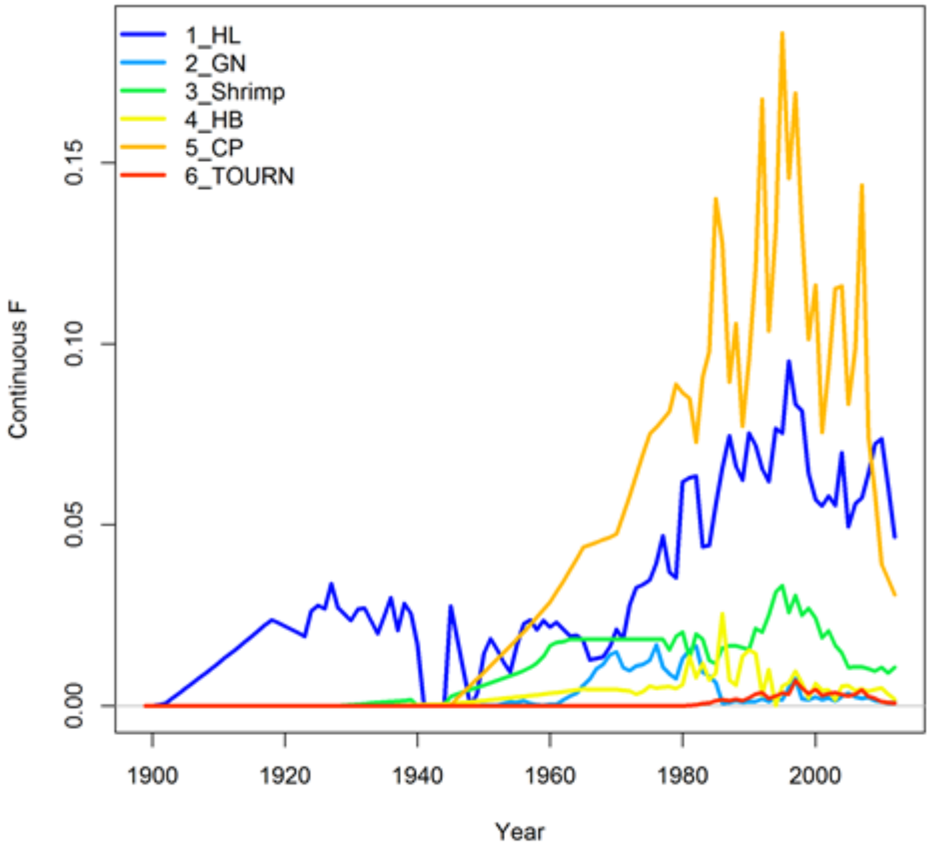


Figure 4.16.47. Estimated fishing mortality rates by fleet of Atlantic King Mackerel.

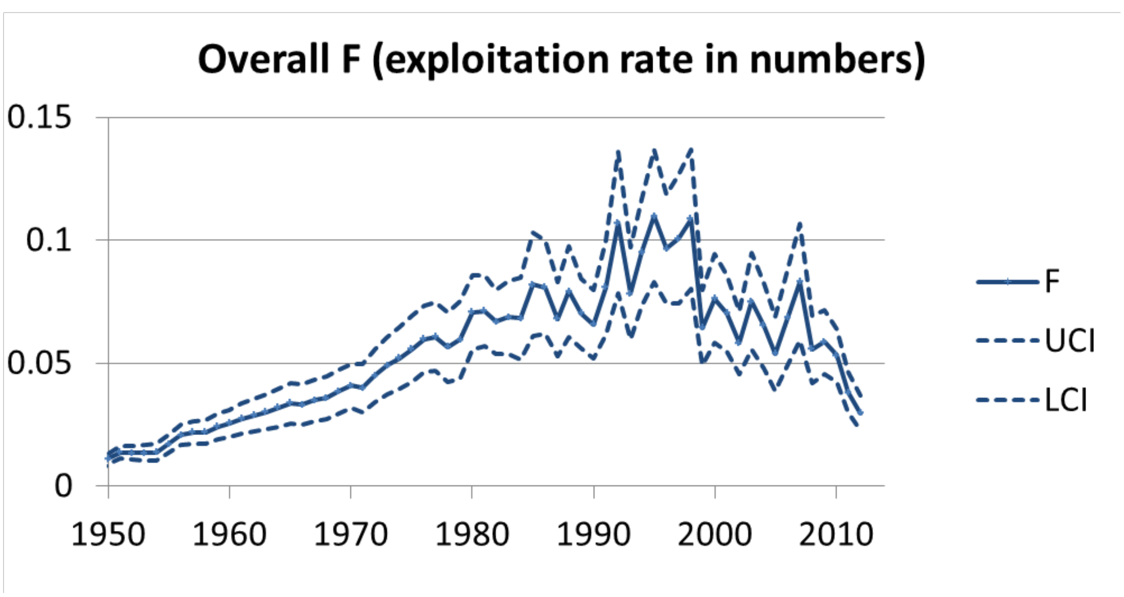


Figure 4.16.48. Overall fishing mortality rates (exploitation rate in number).

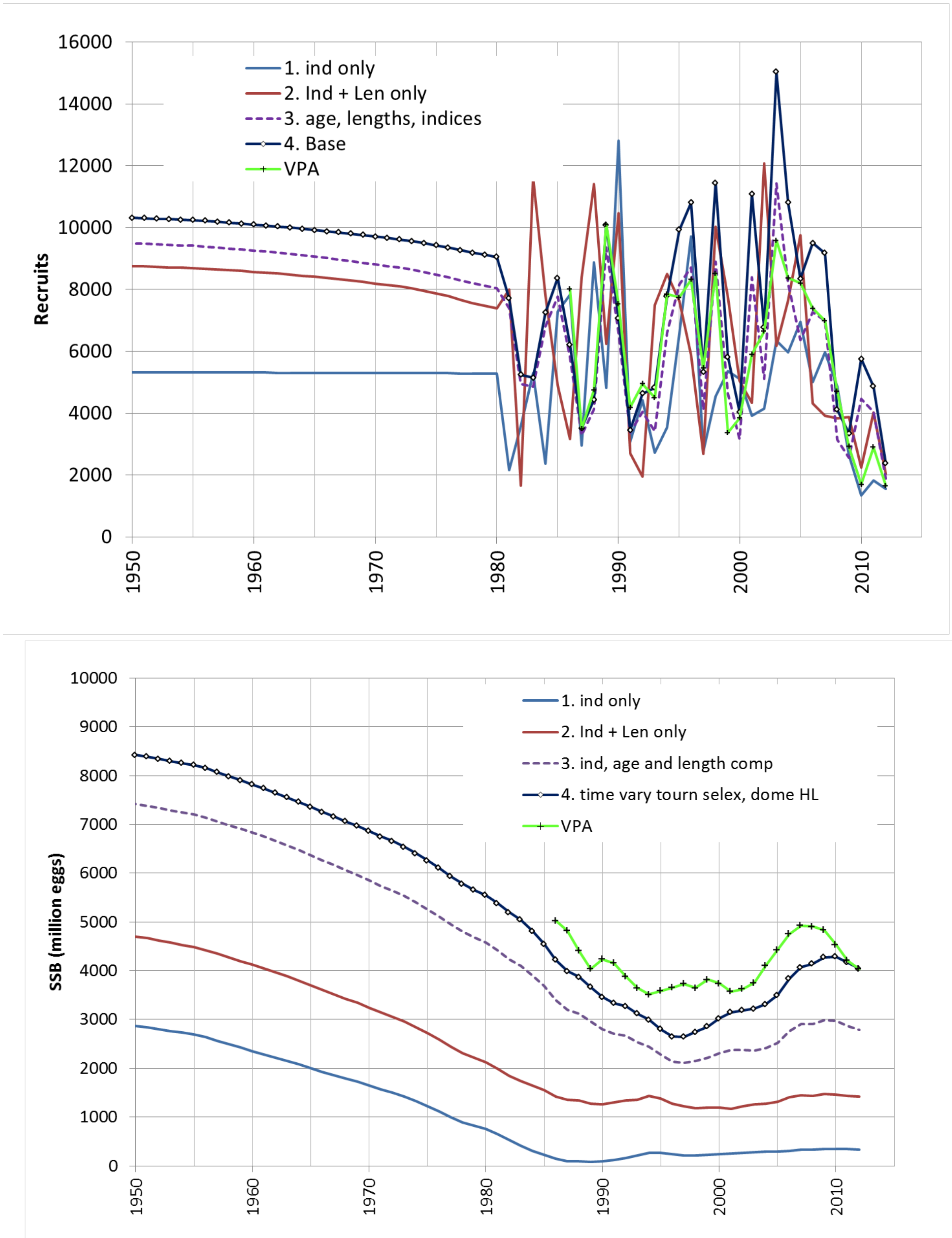
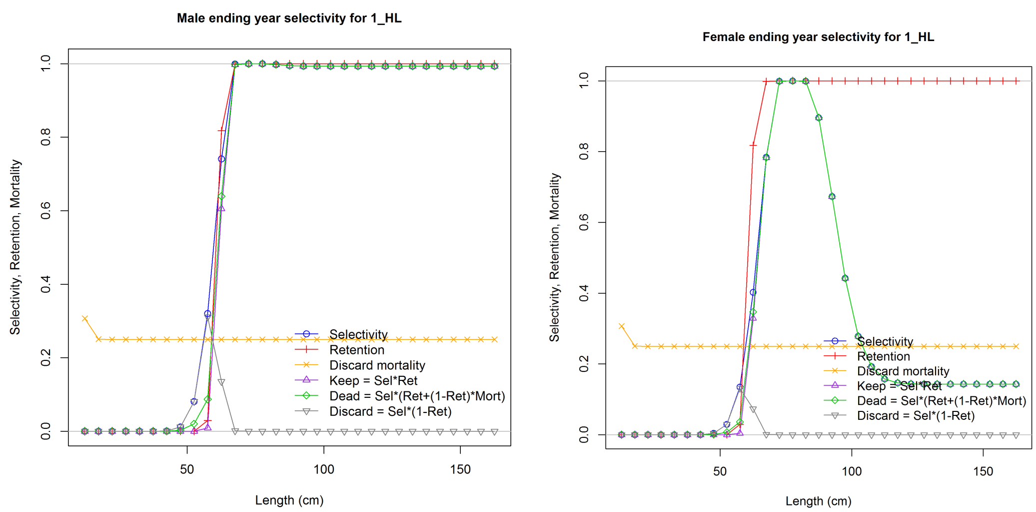


Figure 4.16.49. SSB and recruits across sensitivity for models 1, 2, 3 4 (base) and the VPA.



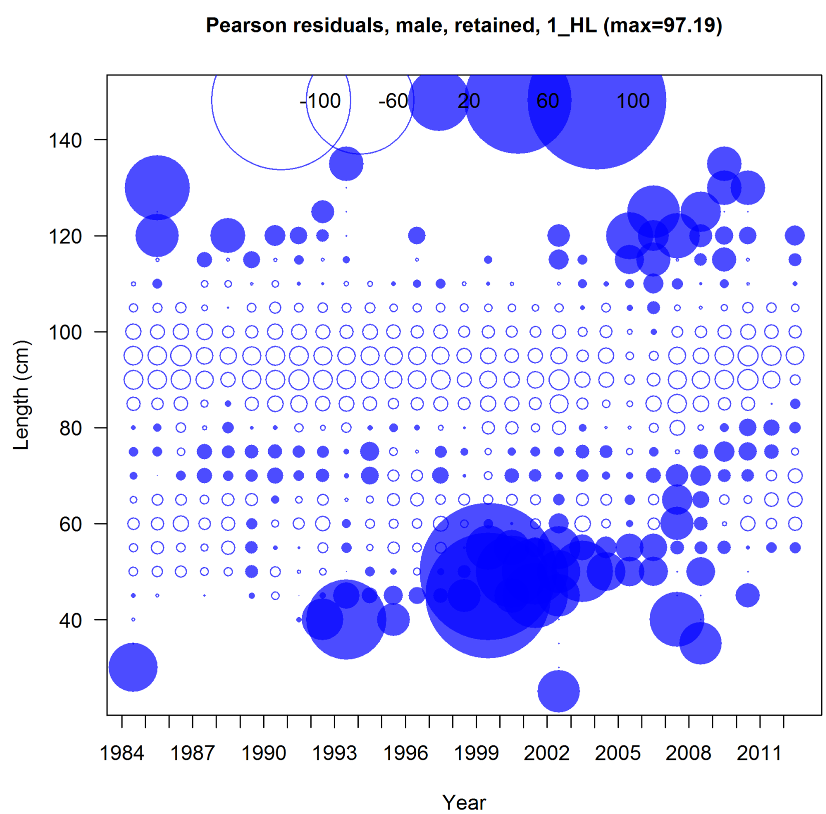


Figure 4.16.50. Pearson residuals to length composition for showing systematic lack of fit to male fish when male size selectivity was logistic.

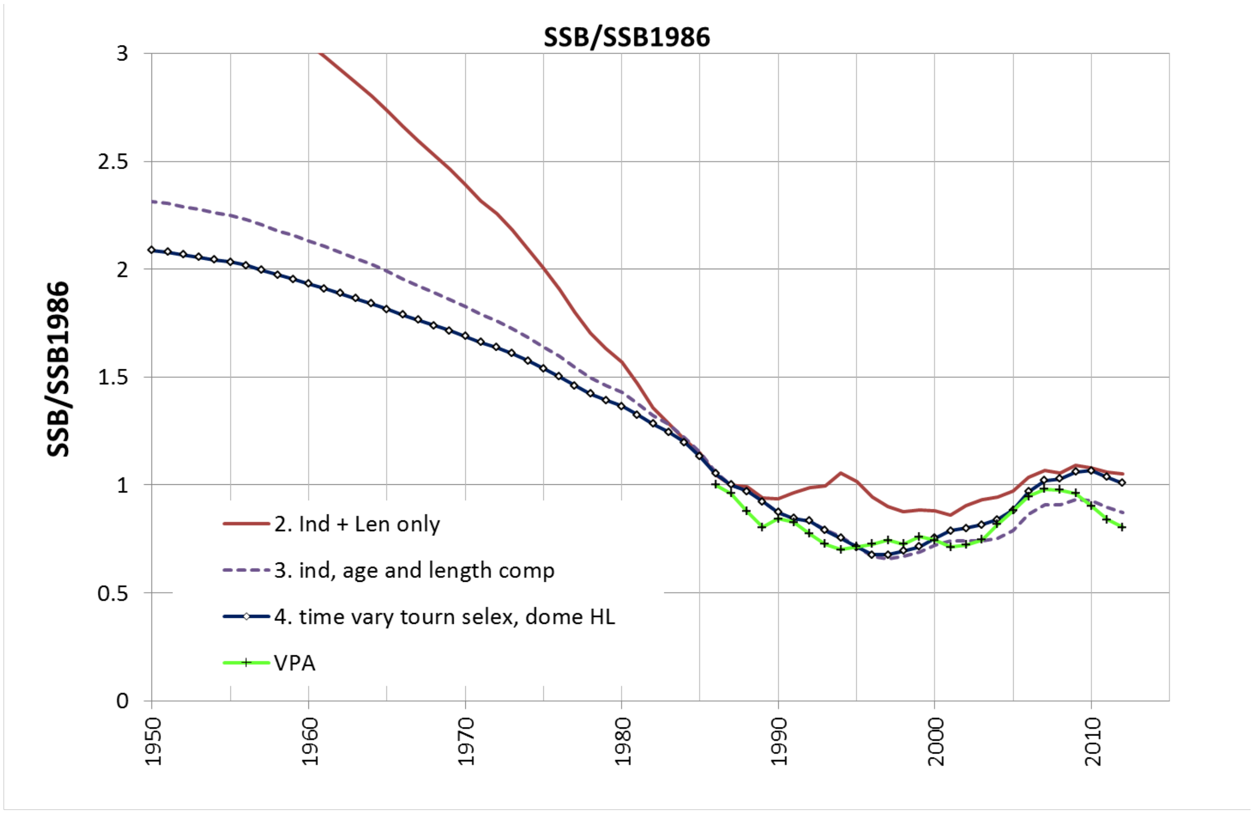


Figure 4.16.51. SSB/SSB_{1986} for models 2-4 and the VPA.

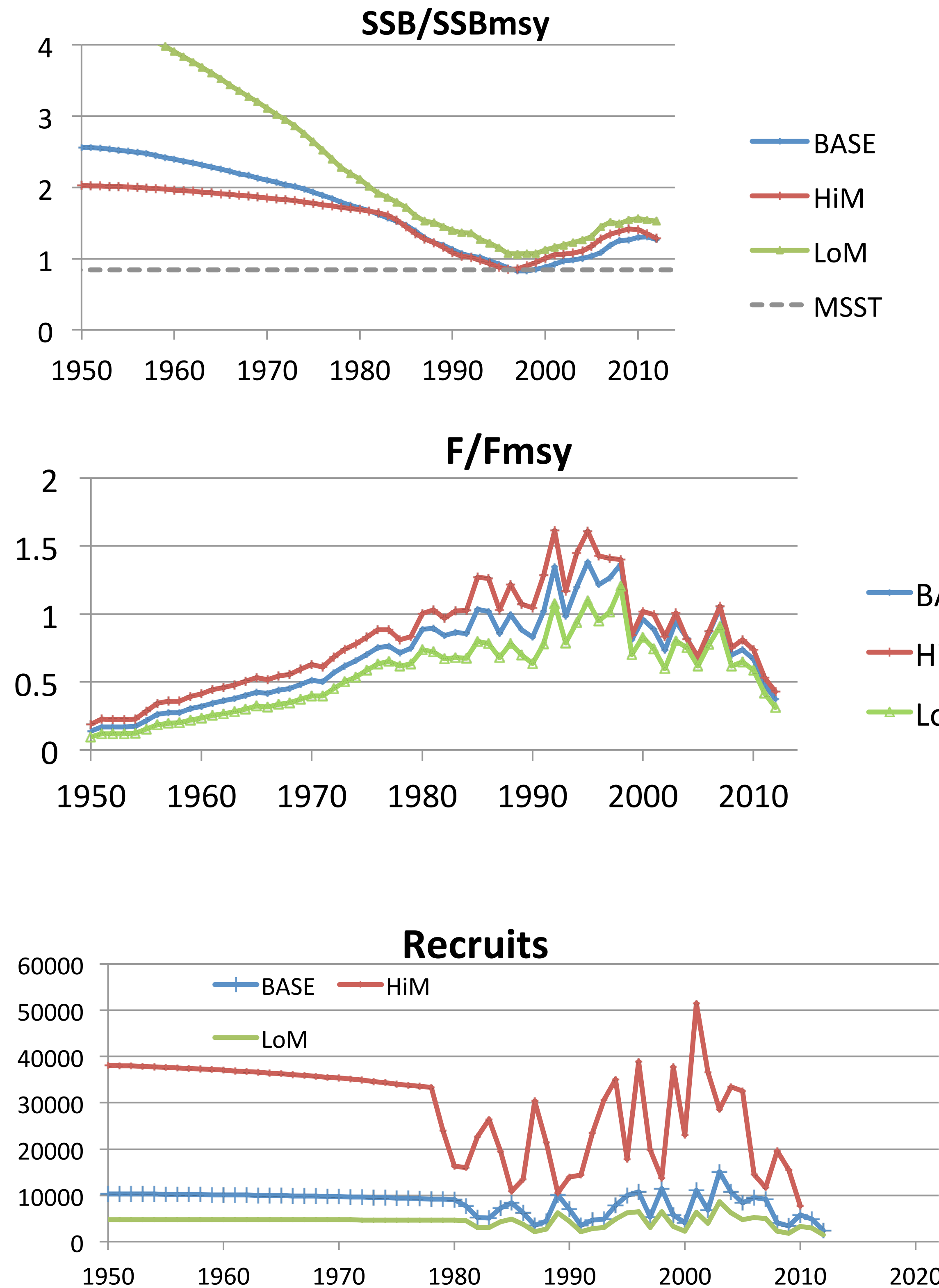


Figure 4.16.52. SSB/SSB$_{MSY}$ and F/F$_{MSY}$ rate and recruits across sensitivity for high and low M

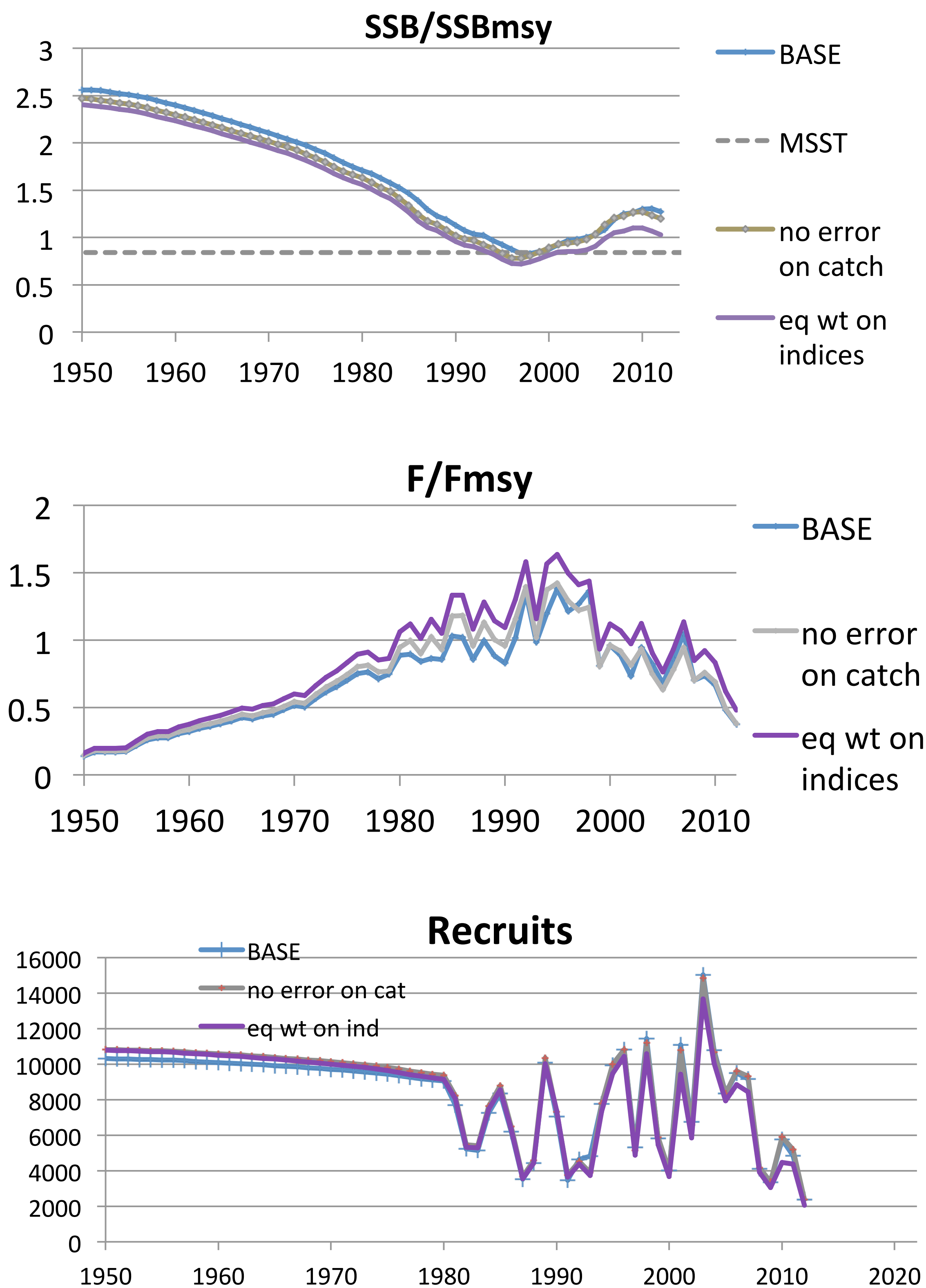


Figure 4.16.53. SSB/SSB$_{MSY}$ and F/F$_{MSY}$ rate and recruits across sensitivity runs with low error on recreational catch (cv~0.01) and with indices equally weighted.

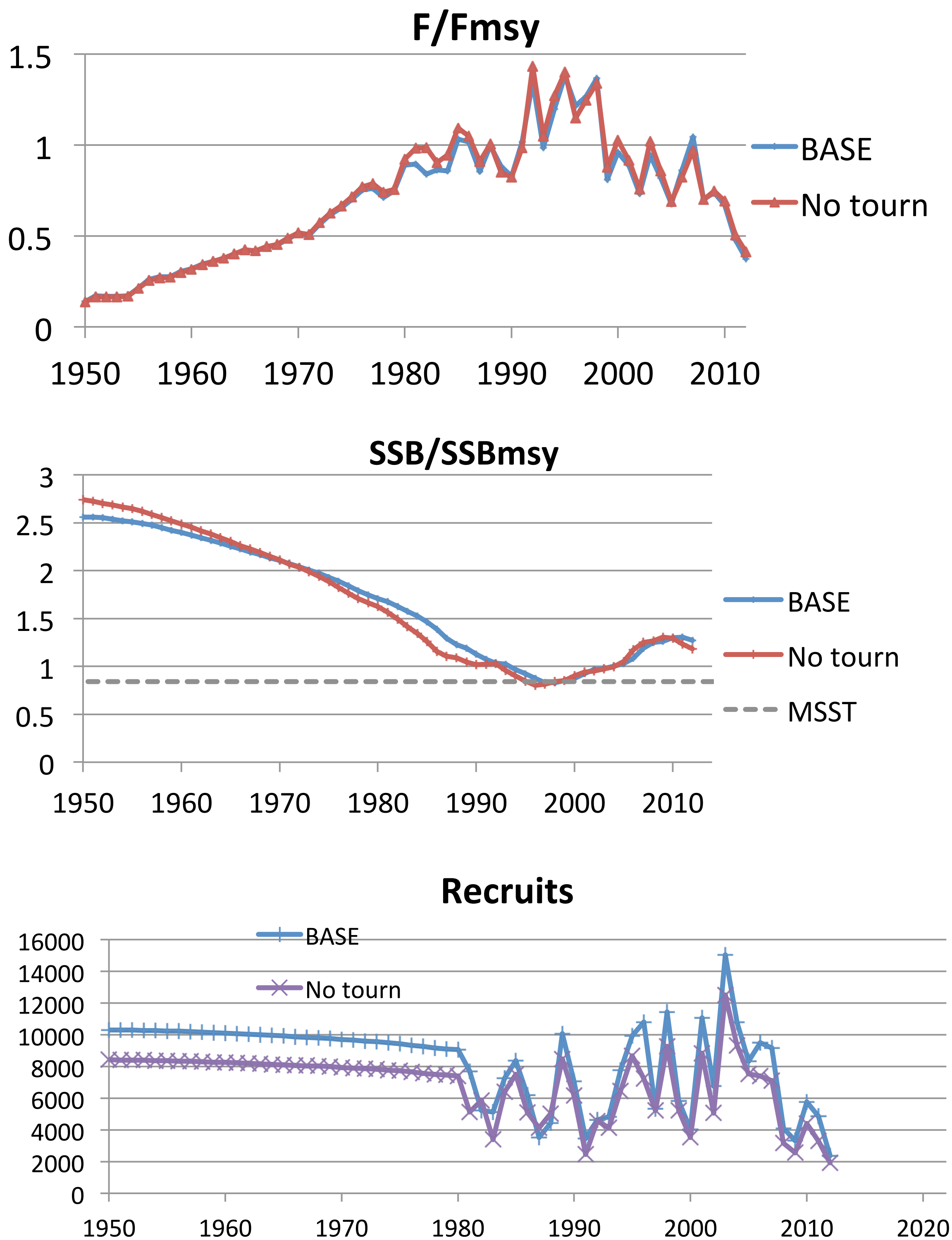


Figure 4.16.54. F/F_{MSY} and SSB/SSB_{MSY} and estimated recruitment for sensitivity run with and without tournament composition data.

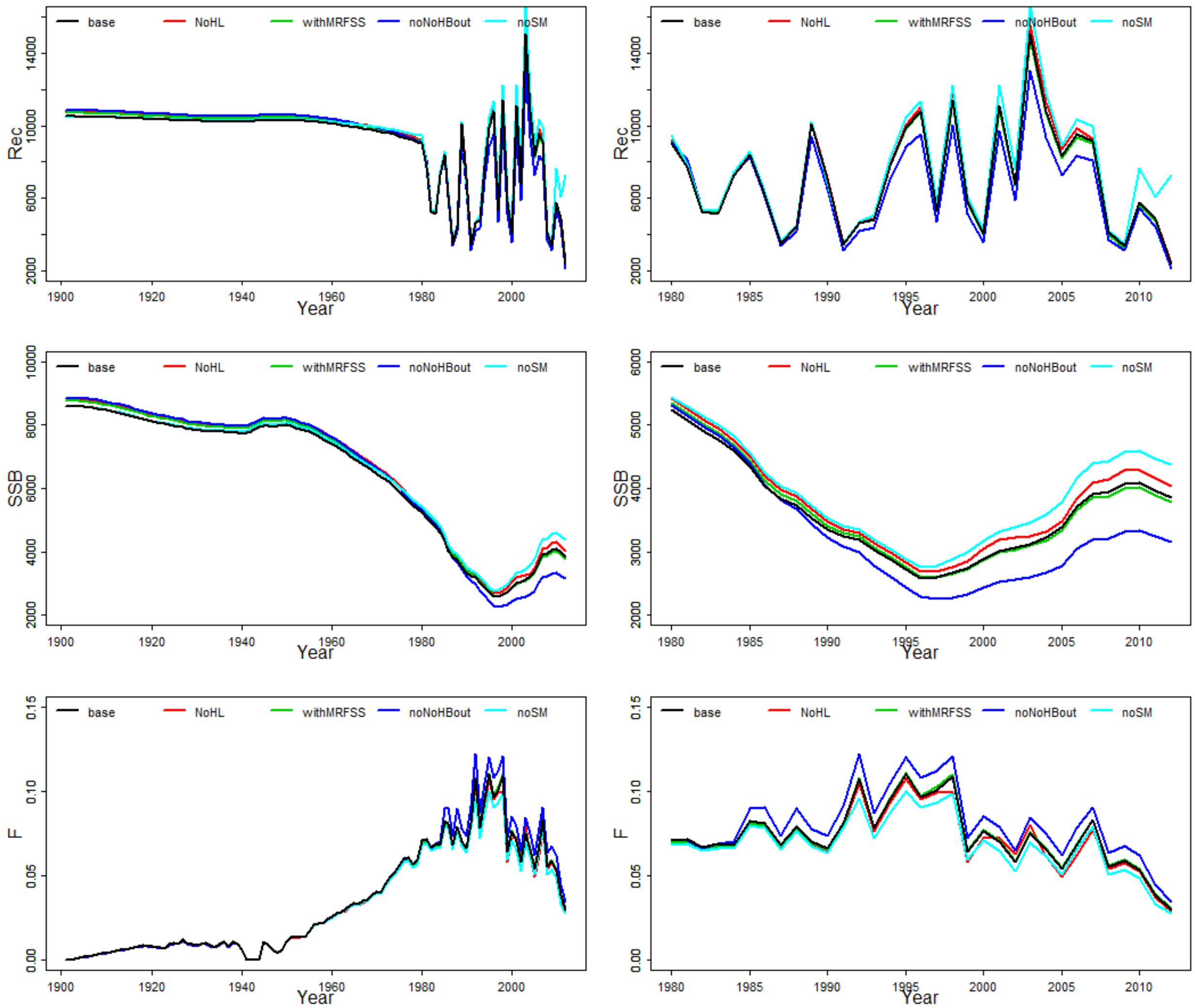


Figure 4.16.55. Predicted age-0 recruitment, spawning stock biomass (female SSB) and fishing mortality (exploitation rate in numbers) from jack-knife of abundance indices.

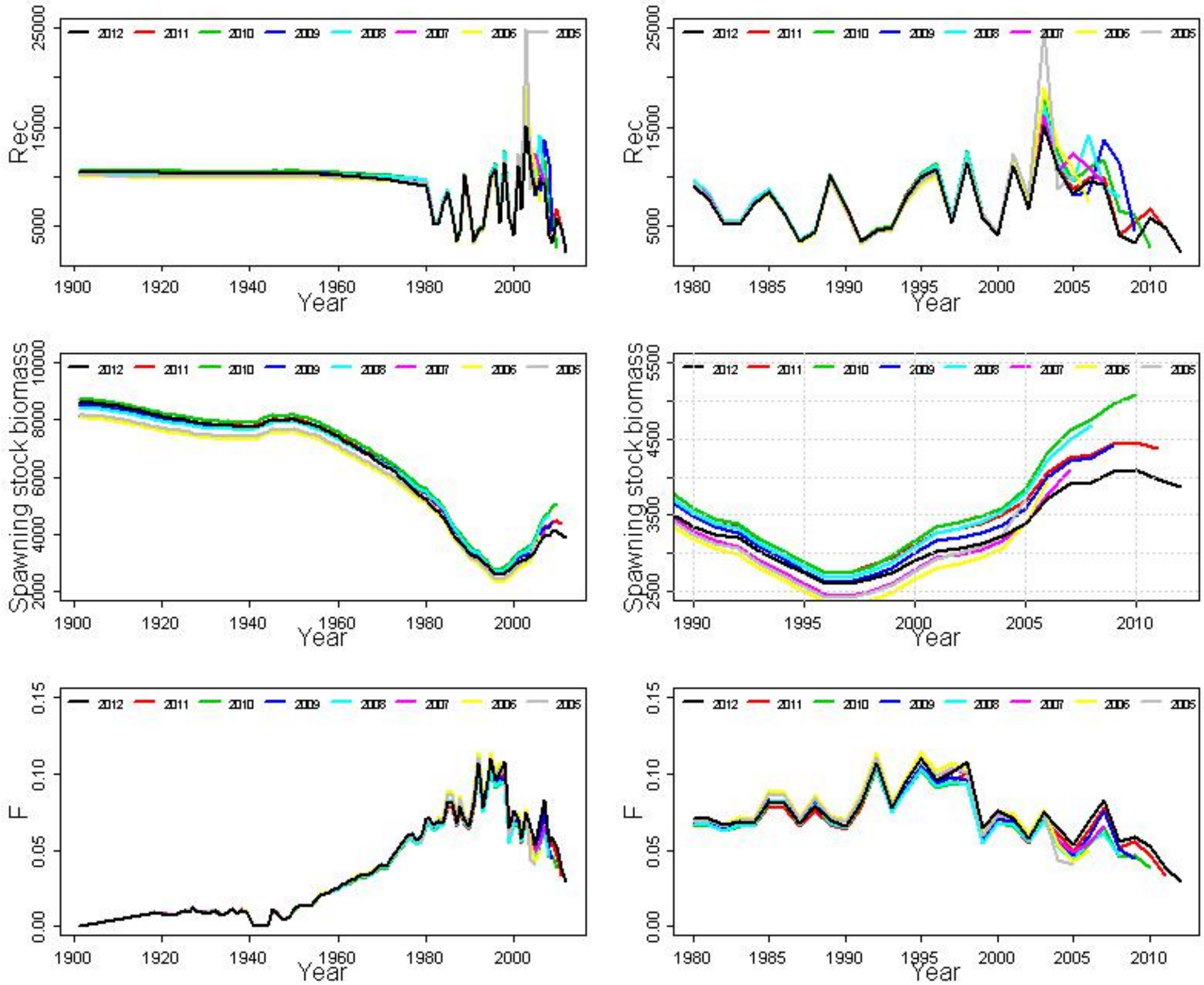


Figure 4.16.56. Predicted age-0 recruitment, spawning stock biomass (female SSB) and fishing mortality (exploitation rate in numbers) from the retrospective analysis for the entire time series and expanded to1980-2012.

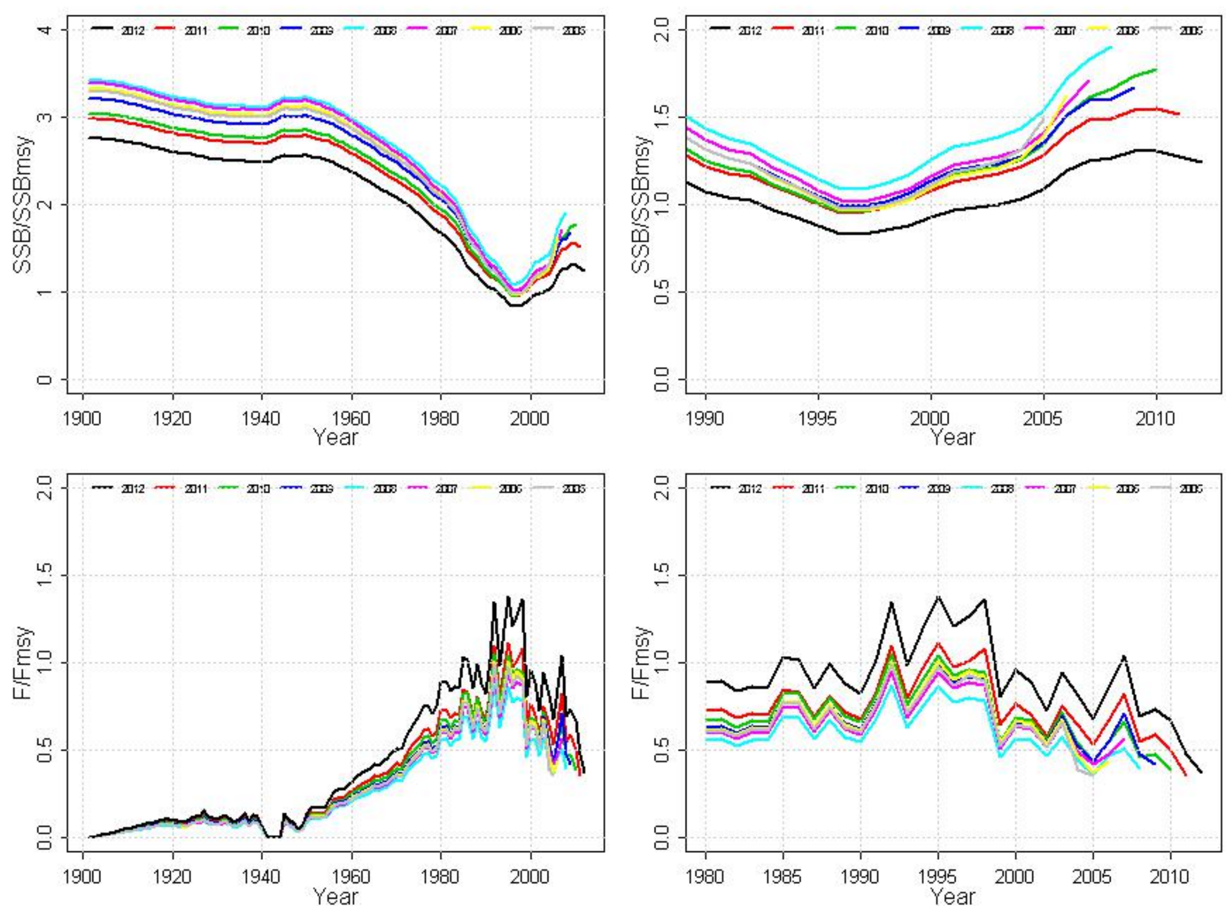


Figure 4.16.57. Predicted stock status (B/Bmsy and F/Fmsy) from the retrospective analysis for the entire time series and expanded to1980-2012.

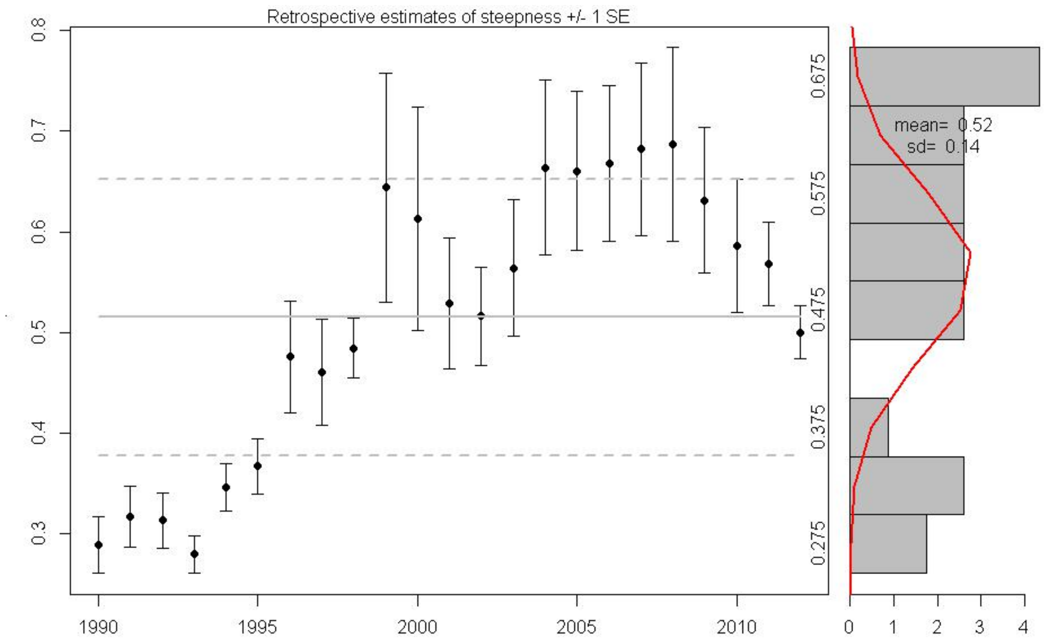


Figure 4.16.58. Retrospective estimates of steepnesss +/- 1 SE from 23 years of retrospective peels.

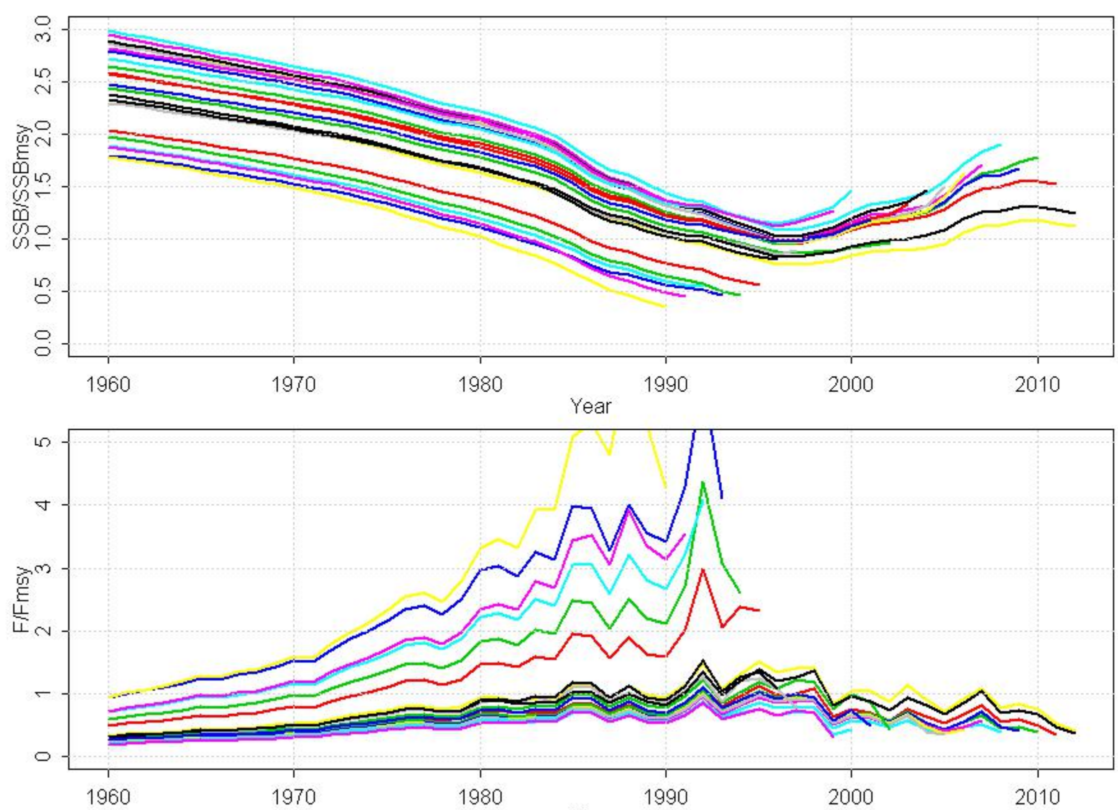


Figure 4.16.59. Predicted stock status (B/Bmsy and F/Fmsy) from the retrospective analysis for 22 years of retrospective peels.

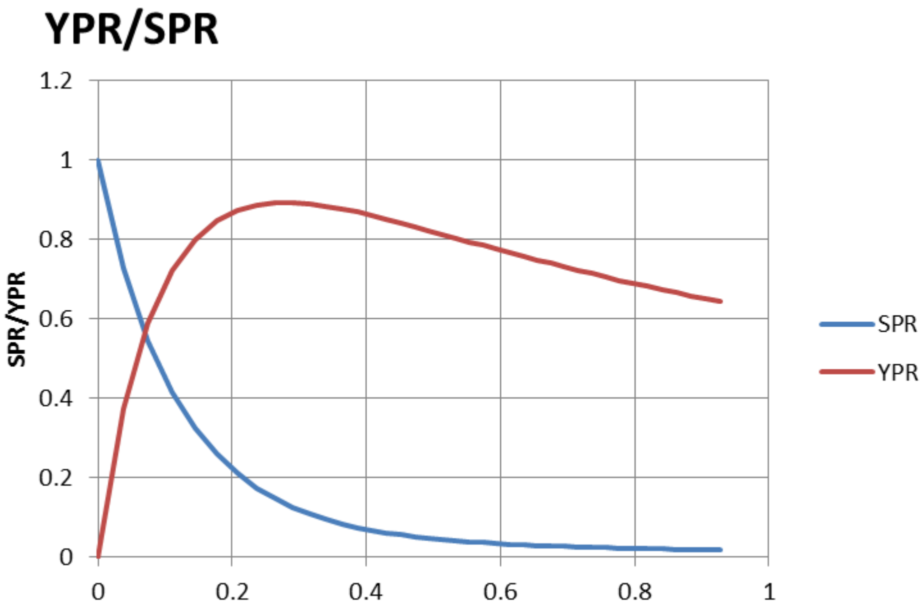


Figure 4.16.60. Yield and spawner per recruit as function of exploitation as a function of fishing mortality.

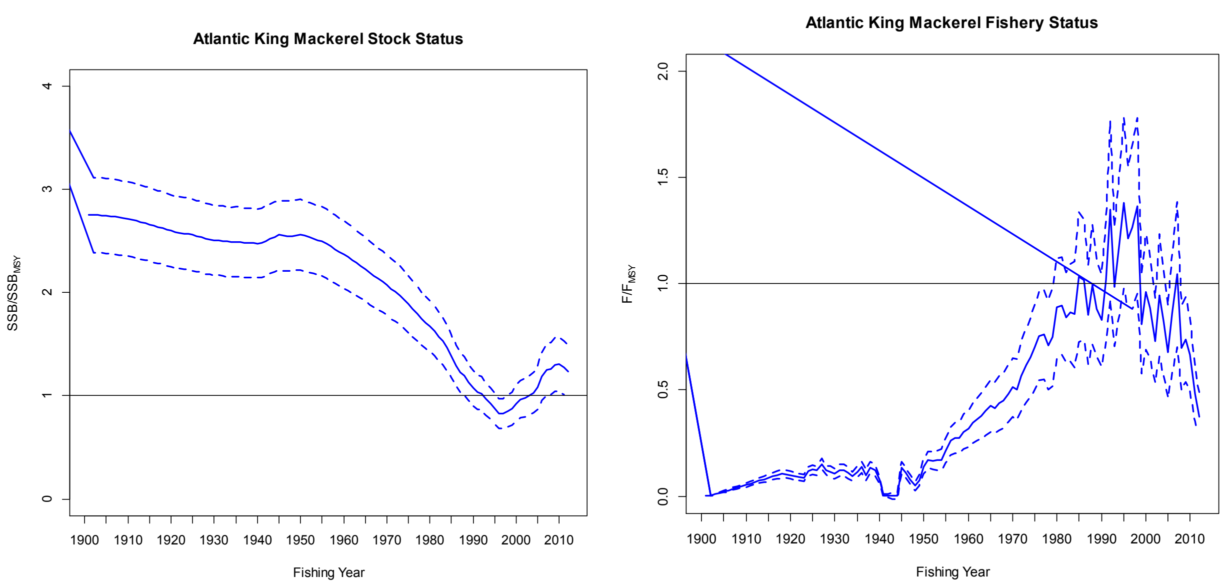


Figure 4.16.61. Stock status trend for Atlantic King Mackerel, measured as spawning stock biomass (SSB) relative to spawning stock biomass at maximum sustainable yield (SSB_{MSY}) and fishing mortality (F) relative to fishing mortality at maximum sustainable yield (F_{MSY}), dashed lines are 95% intervals.

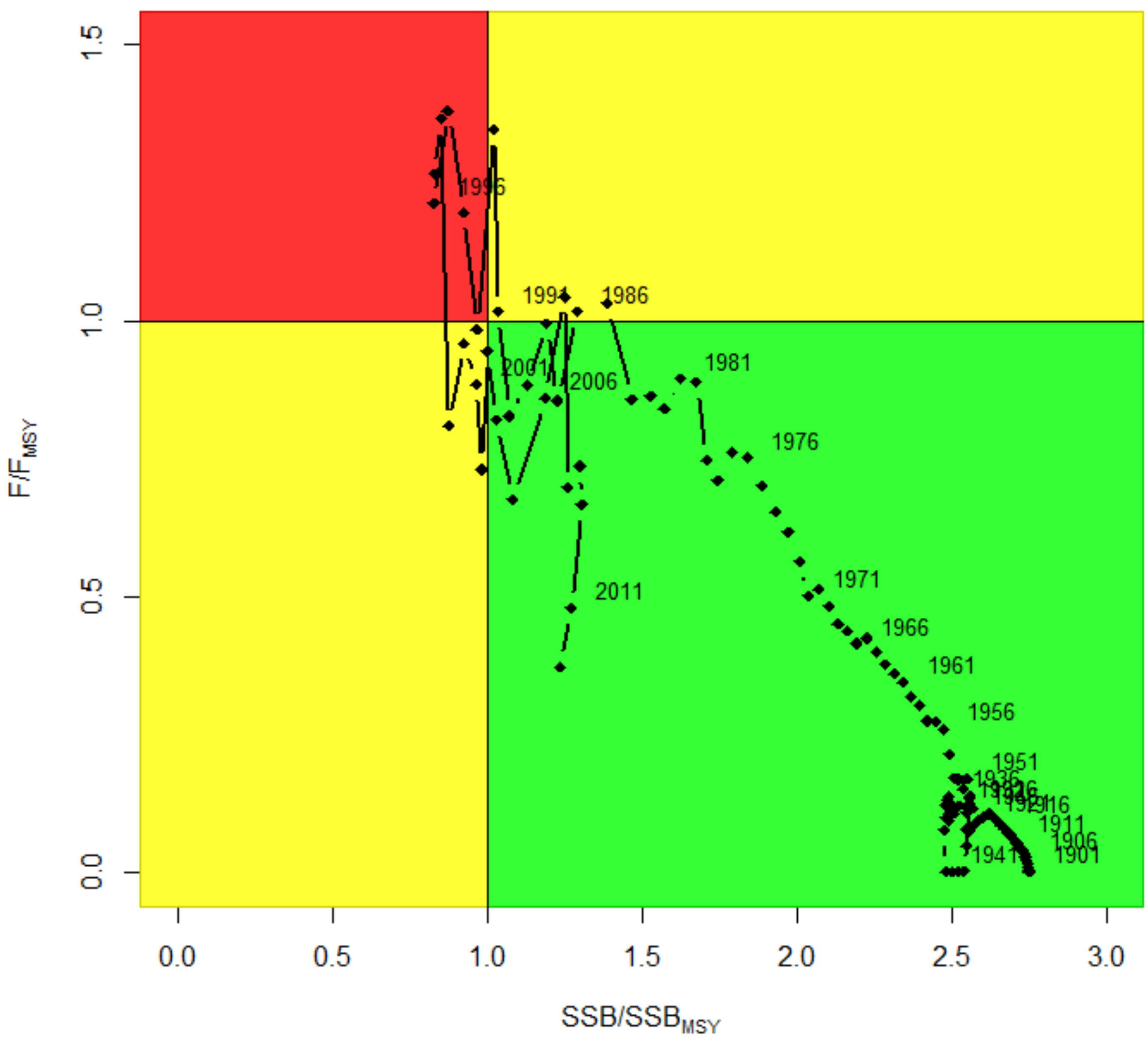
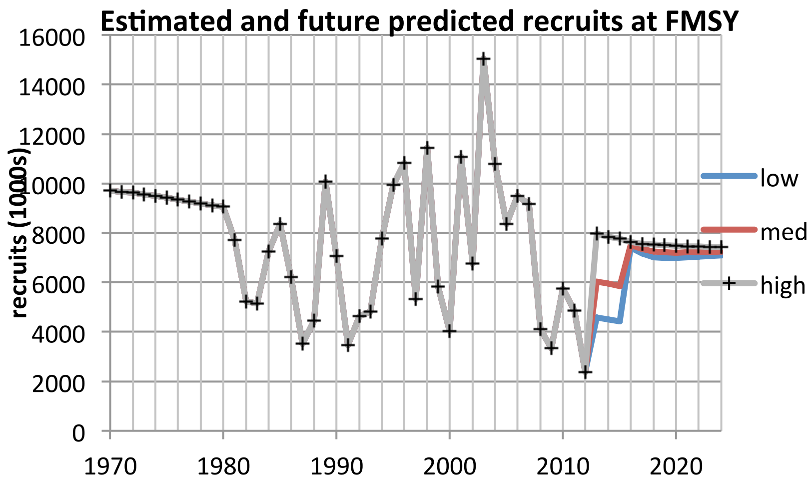
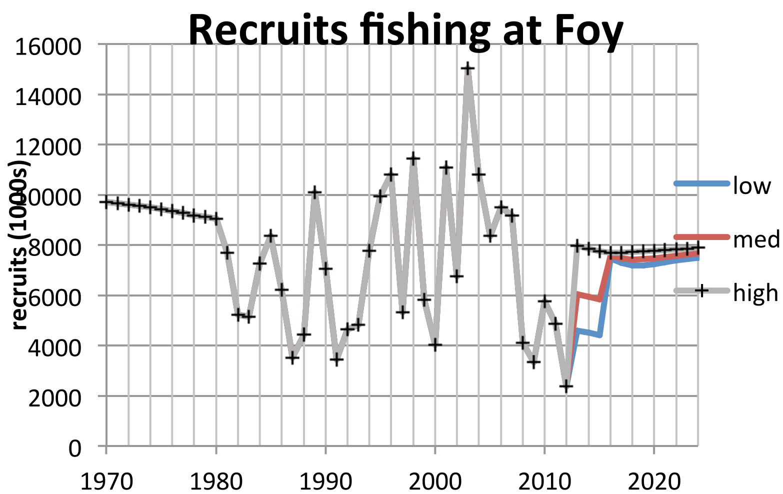


Figure 4.16.62. Kobe plot showing stock status and fishery status trajectory. Green quadrant (lower right) represents a status of not overfished and not undergoing overfishing. The red quadrant (upper left) represents a status of overfished and undergoing overfishing. The yellow quadrants represent statuses of not overfished but undergoing overfishing (upper left), or overfished but not undergoing overfishing (lower left).





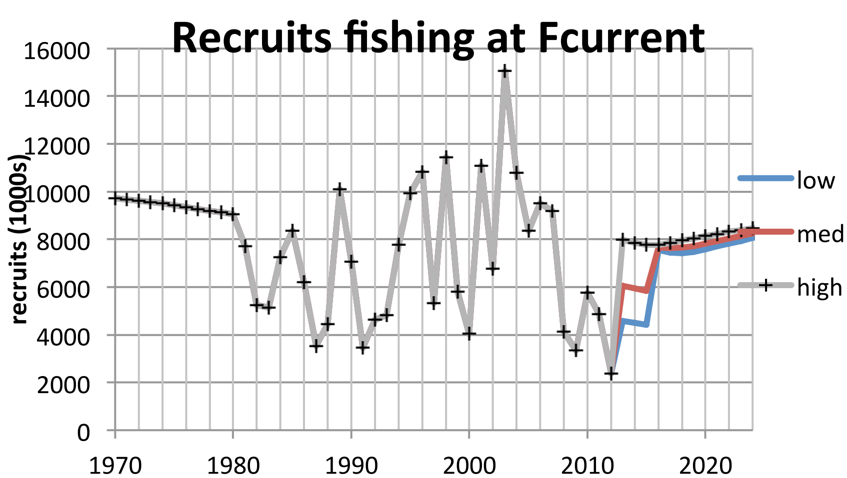


Figure 4.16.63. Deterministic projection recruitment from three fixed F scenarios and three recruitment scenarios.

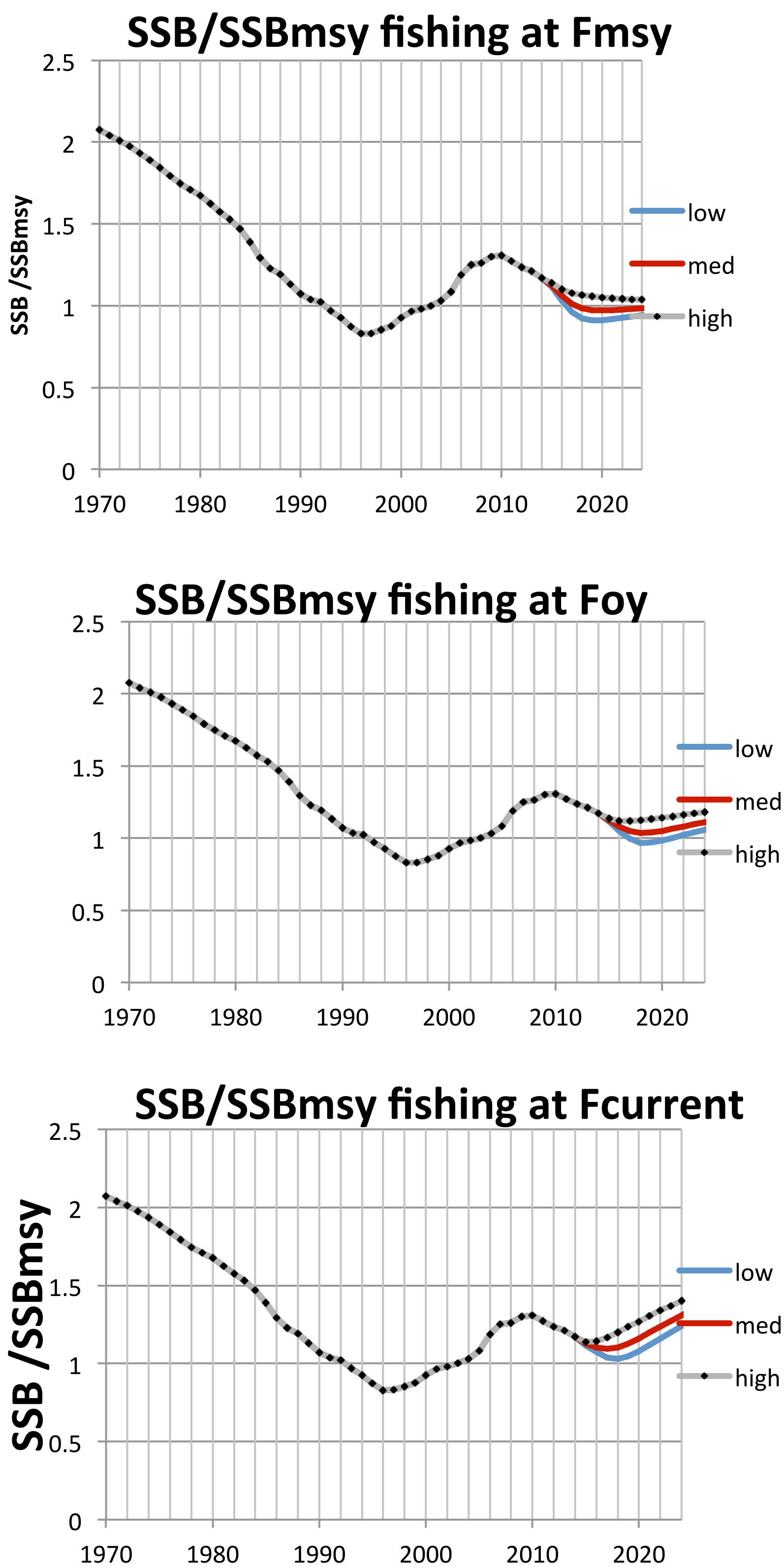
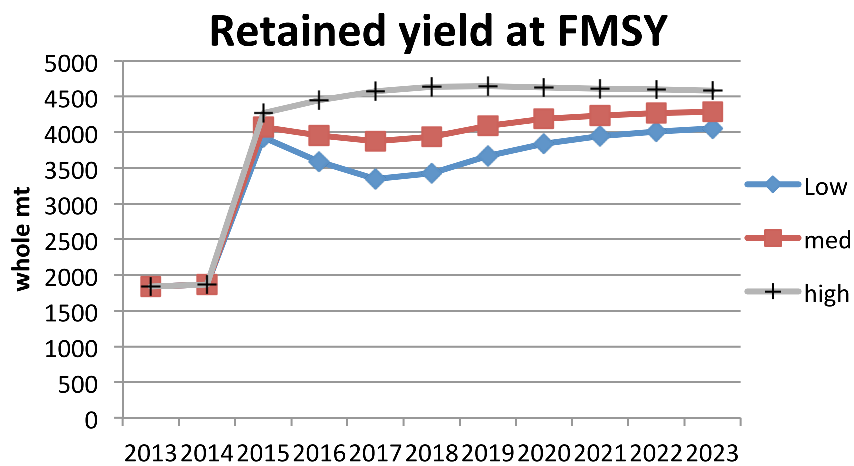
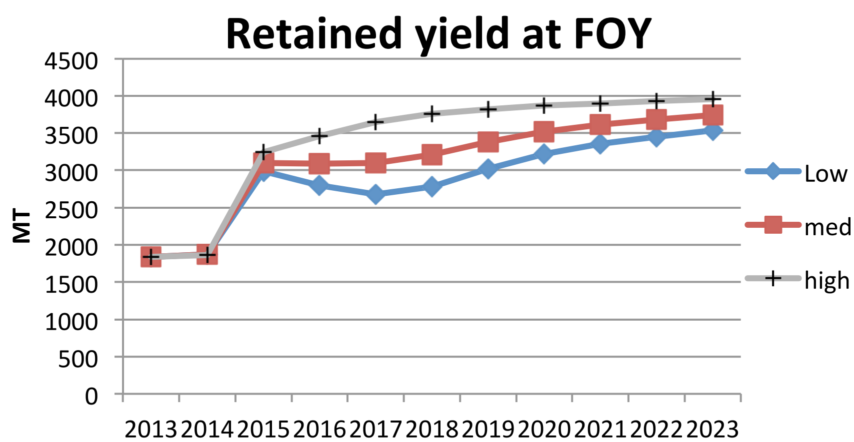


Figure 4.16.64. Deterministic projection SSB/SSBmsy from three fixed F scenarios and three recruitment scenarios. SSB_{MSY} benchmarks are the same for all three.





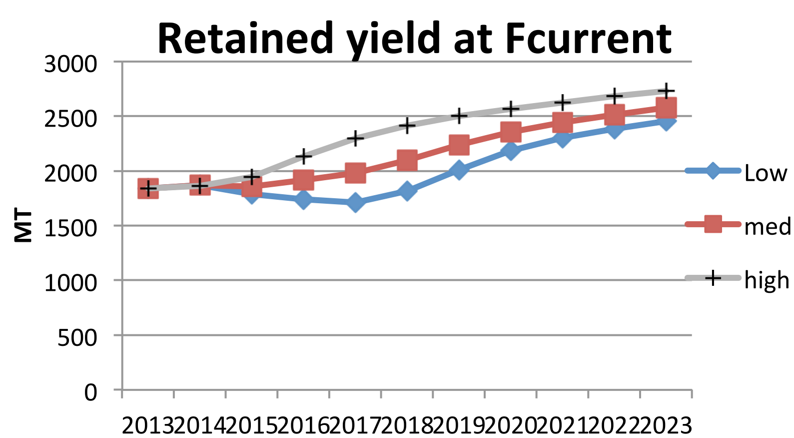


Figure 4.16.65. Deterministic projection retained yields from three fixed F scenarios and three recruitment scenarios. SSB_{MSY} benchmarks are the same for all three.

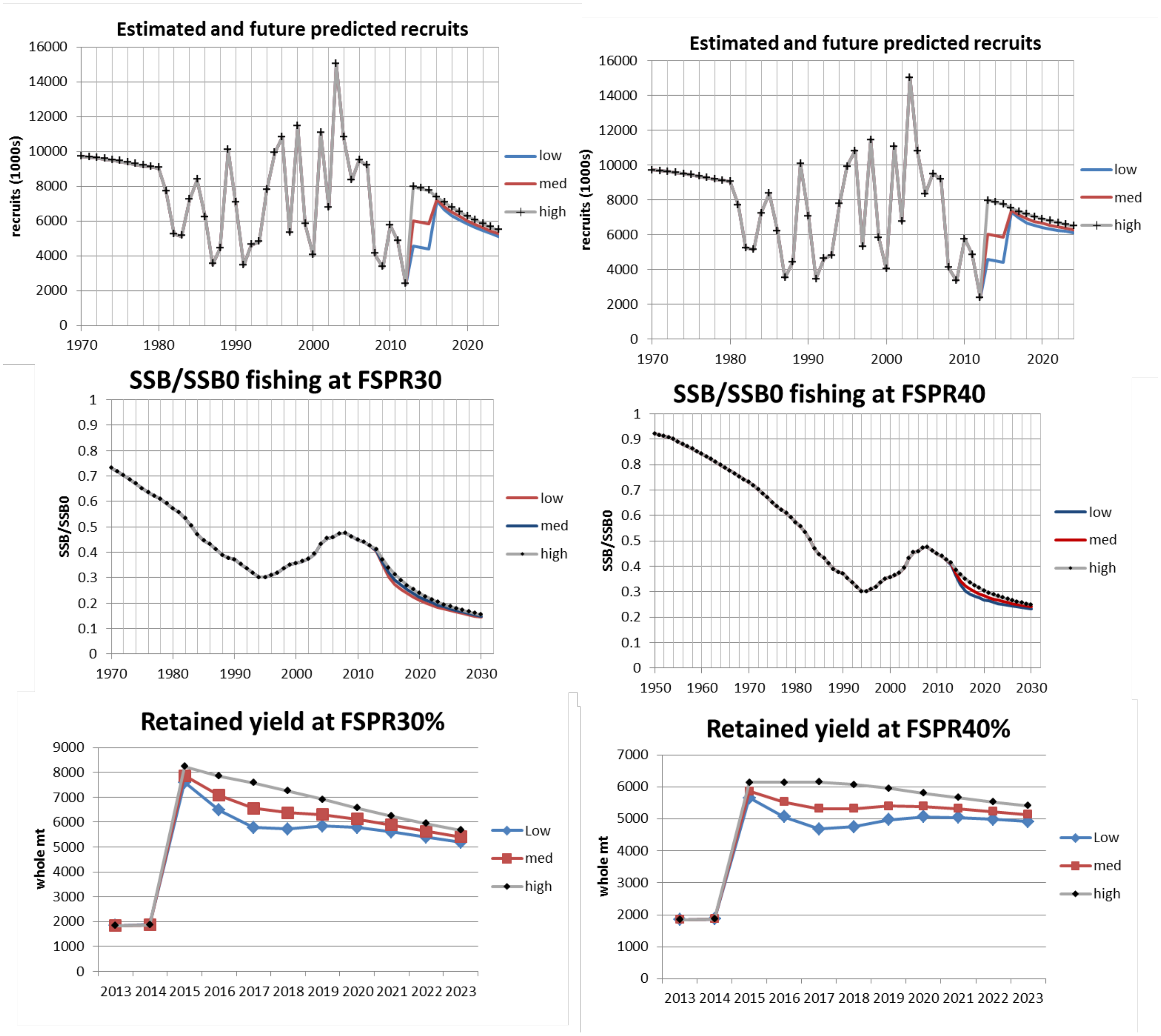


Figure 4.16.66. Projection recruitment, SSB/SSB0 and retained yield at FSPR30% and FSPR40%.

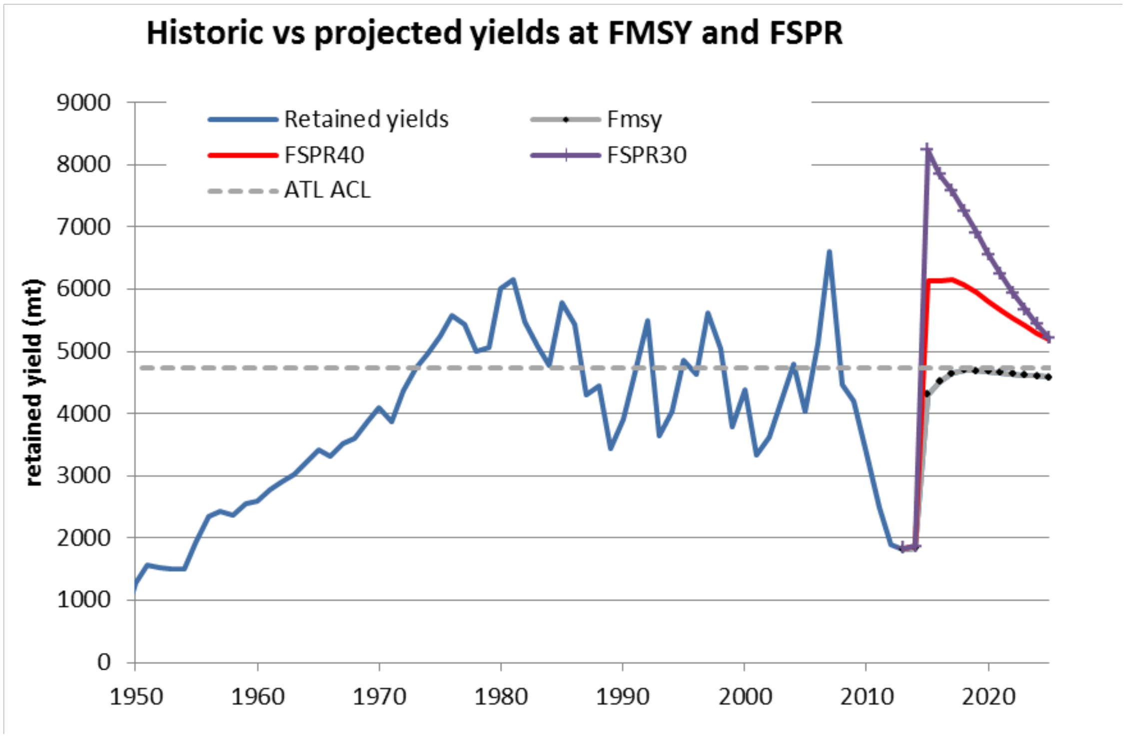


Figure 4.16.67. Comparison of projected and historical retained yields at FMSY, FSPR30 and FSPR40% assuming the estimated Beverton-Holt stock recruitment relationship and no short-term reduction in recruitment. For comparison purposes, the current ACL (4744 mt or 10.46 million lbs) for the Atlantic stock under the SEDAR 16 stock definitions is shown.

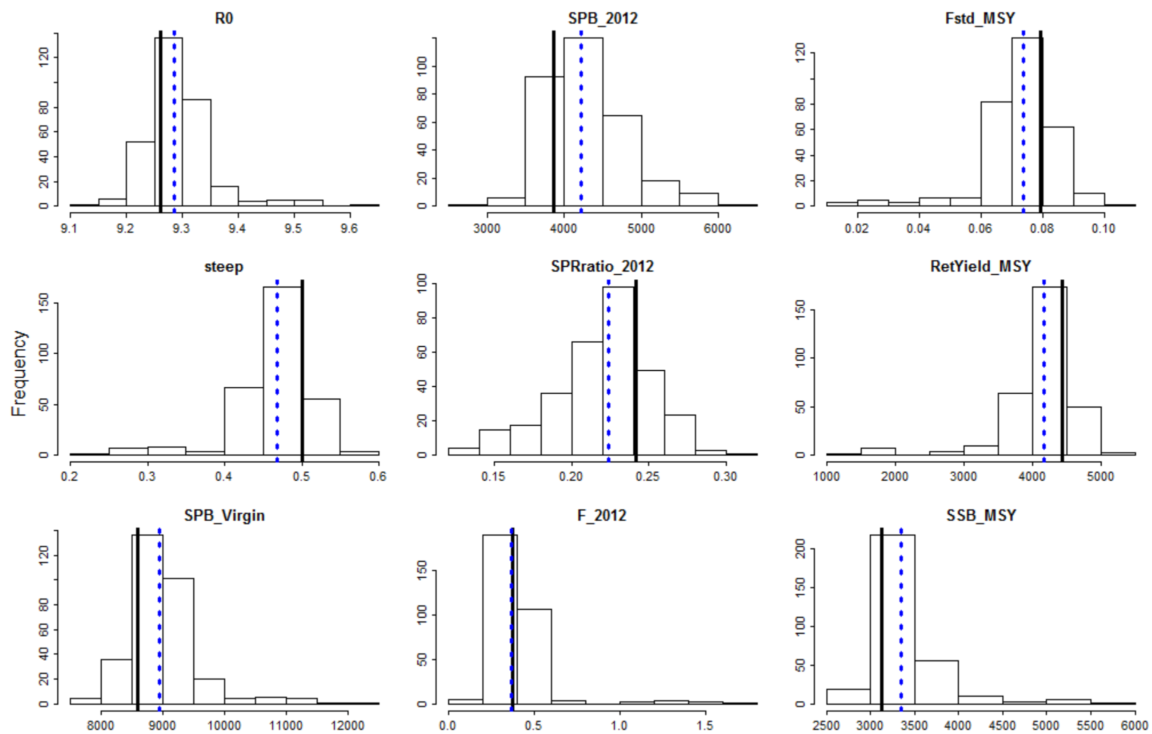


Figure 4.16.68. Histograms of key estimated parameters and key derived quantities from bootstraps. Blue line is the bootstrap median and black line is the deterministic estimate.

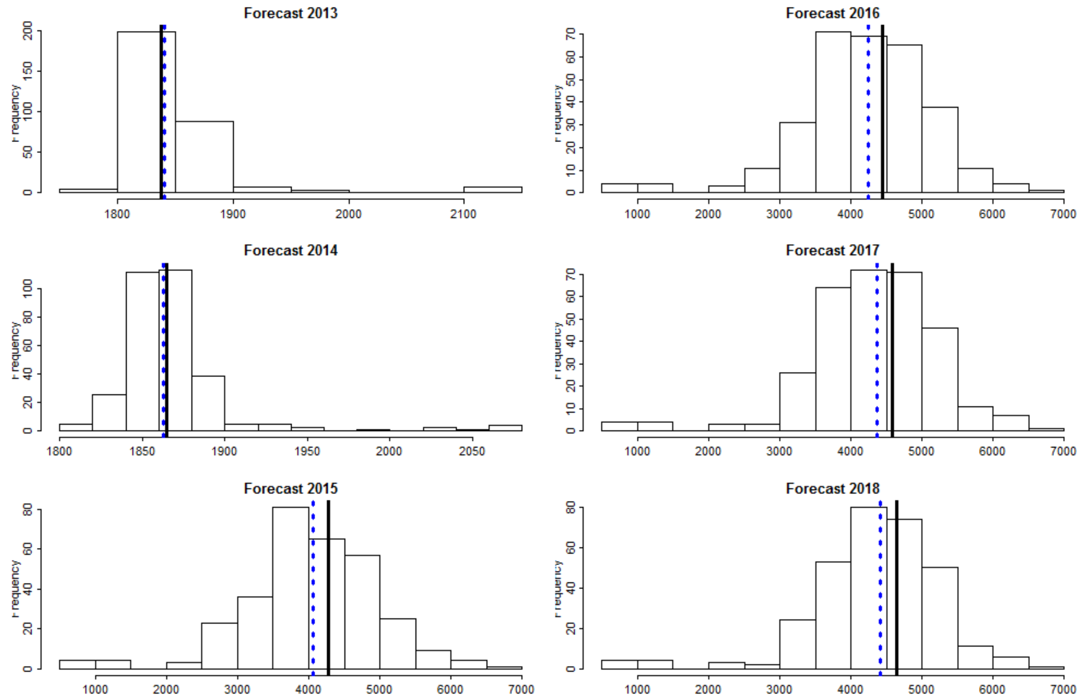


Figure 4.16.69. Histograms of forecasted yields. Blue line is the bootstrap median and black line is the deterministic estimate.

SEDAR

Southeast Data, Assessment, and Review

SEDAR 38

South Atlantic King Mackerel

SECTION IV: Research Recommendations

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

1. DATA WORKSHOP RESEARCH RECOMMENDATIONS

1.1 Life History Working Group Recommendations

1) Examine population connectivity throughout the Gulf and S. Atlantic using otolith elemental and stable isotope signatures of age-0 fish as natural tags of various regions. Otolith signatures of juvenile king mackerel collected in various resource surveys should first be examined to determine if population- or region-specific differences exist in otolith signatures, although success seems likely given the degree of classification success seen in adult mackerel whose otolith chemical signatures are integrated over several years of life, which adds greater variance to their signatures. Once otolith chemical signatures are determined, the chemistry of adult cores could be sampled to examine interregional mixing between purported migratory groups (populations) in the Atlantic, eastern Gulf, western Gulf, and even Mexico. **From SEDAR16**

2) Investigate and quantify mixing between eastern Gulf and western Gulf populations using the new next-generation DNA sequencing techniques and/or otolith elemental and stable isotope analyses. The magnitude of the Mexican landings in comparison to U.S. landings from the GOM unit (annually 3-4 times higher during last 20 yr) indicates clarification of this issue should be a priority for future assessments (see SEDAR38_com_DW_Day4-2 presentation). **Modified from SEDAR16 recommendation.**

3) Further investigate/estimate the vulnerability of the western Gulf migratory group to overfished Mexican fisheries in winter (Chavez and Arreguin-Sanchez 1995). **From SEDAR16**
4) Conduct studies and monitoring that will allow estimation of natural mortality. **From SEDAR16**

5) Continue holding ageing workshops and training to standardize techniques and increase the ageing precision among laboratories. **From SEDAR16**

6) Increase age sampling in South Carolina and Georgia and length sampling north of Florida in the Atlantic. **From SEDAR16**

7) Try to recover and include age and size data from Collins et al. (1989) Atlantic age and growth study in the next stock assessment of Atlantic king mackerel. **From SEDAR16**

8) Establish clear priorities for added reproductive information as expanded work would involve considerable costs for a long-term sampling program. **From SEDAR16**

9) If made a priority, more precisely determine 1) the extent of hydration that can be determined via routine observations in the field and 2) the timing of this phase relative to final oocyte maturation and spawning and 3) calibration of the degeneration of post-ovulatory follicles. This

is needed to account for and correct a likely bias in spawning frequency estimates. **From SEDAR16**

10) If made a priority, design and implement a reproductive sampling program (in concert with age sampling) on an annual basis that expands and intensifies spatial and temporal coverage (particularly adding the western Gulf of Mexico). A goal would be to provide annual estimates of spawning frequency. This would include regular training of port agents and scientific observers in macroscopic methods and additionally include a quality control component of random sub-sampling for histological comparisons. **From SEDAR16**

1.2 Commercial Fisheries Working Group Recommendations

- Consistent and sufficient levels of observers are needed in both the Gulf of Mexico and the South Atlantic. The South Atlantic shrimp fishery has especially been under sampled.
- Increase Biological Sampling efforts to better define mixing zone boundaries in the South Atlantic and Gulf of Mexico.
- Increase cooperative research with Mexican scientists to understand the relationships between king mackerel exploited in Mexican and U.S. waters. Additionally, participation of Mexican scientists is needed in the assessment process (both accumulation and interpretation of data as well as assessment) to better understand the Mexican fisheries and possible connectivity of Gulf stocks.

1.3 Recreational Fisheries Working Group 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

1.4 Indices of Relative Abundance Working Group Recommendations

1) Fisheries independent sampling continues and be expanded to the extent practical, employing consistent sampling protocols.
2) The defined ages that each of the recommended fishery dependent indices applies to be evaluated based on catch-at-size or catch-at-age information.
3) Censored regression modeling approaches (adapted from SEDAR 31) be applied to recreational fishery dependent indices of abundance to evaluate bag limit effects on catch rate indices.

4) Evaluation of environmental (e.g., temperature, salinity) effects on CPUE indices. The workgroup recommends that inclusion of environmental covariates that demonstrate long-term trends be carefully considered whether the covariates are likely to affect the population abundance or the catchability of the gear. If the effect is thought to be on the population abundance, then the covariate should be excluded from the catch rate standardization and incorporated into the assessment model. If the covariate is thought to affect the catchability of the gear (e.g., fish behavior changes as temperature increases or decreases), then the covariate should be incorporated into the catch rate standardization. The strongest effects are predicted to occur during distinct periods of coldwater upwelling, as this hypothesis deserves further evaluation.
5) The South Carolina Pier Recreational Pier Survey was excluded from the assessment model; however, the data represent a catch record from two fixed sites. Therefore, data from this survey represent repeated measures of catch and may be useful for evaluating environmental covariates effects on catches of King mackerel.
6) Evaluation of the delta-lognormal generalized linear model structure. Specifically, the appropriateness of modeling factor interactions as random effects and the effect of this assumption on the resulting mean and variance estimates.
7) Stock assessment analysts evaluate density-dependent effects on gear catchability, to the extent possible. The hypothesis that catchability increases with the abundance of King mackerel, particularly juveniles, was proposed by stakeholders at the data workshop. It is recommended that a sensitivity run of the base assessment model include this assumption, and that this sensitivity run is compared and ranked with a base model that assumes constant catchability over time.

2. ASSESSMENT WORKSHOP RESEARCH RECOMMENDATIONS

1. Evaluate environmental influences on recruitment and larval/juvenile survival, focusing on potential predator prey impacts, hydrodynamic influences on recruitment, pollution, HABs or excess nutrient run-off.
2. Develop scientific survey to obtain reliable age/size composition data and relative abundance of adult fish. This could be done using gillnets or handlines.
3. Determine dynamic stock mixing rates using genetic methods, otolith microchemistry, stable istopes or otolith shape. Even though the mixing zone is now smaller, stock mixing is a dynamic process and may vary substantially from one year to the next, particularly in relation to cold temperature years that may compress both the Gulf and Atlantic stock into South Florida waters.
4. Evaluate the stock mixing within integrated modeling approaches
5. Expand SEAMAP trawl survey below the Cape Canaveral area and potentially into deeper shelf waters
6. Quantify tournament landings from the Gulf of Mexico

7. Determine if female spawning periodicity varies by size or age.
8. More accurately characterize juvenile growth by increasing samples of age-0 and 1 fish.
9. Conduct studies to estimate of natural mortality.

3. REVIEW PANEL RESEARCH RECOMMENDATIONS

1. Develop a survey to obtain reliable age/size composition data and relative abundance of adult fish. This could be done using gillnets or handlines. The review panel recommends that the design of a scientific survey be peer reviewed.

2. Determine most appropriate methods to deal with changing selectivity in fisheries over time, particularly changing selectivity related to management actions or targeting of specific cohorts. The review panel suggests that historical mark-recapture data available from NMFS SEFSC and FWRI could be used to compare size composition of recaptures for different fishing gears to evaluate selectivity for historic periods.

3. Determine stock mixing rates using otolith microchemistry and/or otolith shape analysis on a routine basis that would allow future stock assessments to capture the dynamic spatial and temporal nature of mixing of the Atlantic and Gulf of Mexico stocks, and consider evaluating stock mixing within integrated modeling approaches.

4. More accurately characterize juvenile growth by increasing samples of age-0 and 1 fish. Further investigate 2-phase growth models including different breakpoints and different growth models to better model size and age. Consider if there is temporal (annual and seasonal) variability in growth rates. Results of this analysis in terms of the best model will need to be implementable in SS3 to continue with the integrated modeling approach.

5. Determine if female spawning periodicity varies by size or age.

6. Expand the SEAMAP trawl survey below the Cape Canaveral area and potentially into deeper continental shelf waters.

7. Consider conducting an extensive tagging program to: a) better understand migration patterns; b) provide additional and individual growth rate information; c) better understand fishery selectivity; d) provide fishery exploitation rates; and e) provide information about natural mortality rates. Fishery independent recapture information (i.e., use acoustic and satellite tags) will assist with a). Age at capture information of tagged animals will assist with b). A multi-year tagging program will be required for e). The review panel recommends that a specific workshop be held to consider in detail the design of a tagging program.

SEDAR

Southeast Data, Assessment, and Review

SEDAR 38

South Atlantic King Mackerel

SECTION V: Review Workshop Report

September 2014

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4055 Faber Place Drive, Suite 201
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Table of Contents

1. INTRODUCTION

1.1 WORKSHOP TIME AND PLACE

The SEDAR 38 Review Workshop was held August 12-14, 2014 in Miami, Florida.

1.2 TERMS OF REFERENCE

1. Evaluate the data used in the assessment, addressing the following:
   a) Are data decisions made by the DW and AW sound and robust?
   b) Are data uncertainties acknowledged, reported, and within normal or expected levels?
   c) Are data applied properly within the assessment model?
   d) Are input data series reliable and sufficient to support the assessment approach and findings?
2. Evaluate the methods used to assess the stock, taking into account the available data.
   a) Are methods scientifically sound and robust?
   b) Are assessment models configured properly and used consistent with standard practices?
   c) Are the methods appropriate for the available data?
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 status inferences?
   b) Is the stock overfished? What information helps you reach this conclusion?
   c) Is the stock undergoing overfishing? What information helps you reach this conclusion?

d) Is there an informative stock recruitment relationship? Is the stock recruitment curve reliable and useful for evaluation of productivity and future stock conditions?

e) Are the quantitative estimates of the 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:

   a) Are the methods consistent with accepted practices and available data?

   b) Are the methods appropriate for the assessment model and outputs?

   c) Are the results informative and robust, and useful to support inferences of probable future conditions?

   d) 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.

   - 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 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.

1.3 LIST OF PARTICIPANTS

Workshop Panel

Jim Berkson, Chair...SAFMC SSC
Luiz Barbieri .... GMFMC SSC
Noel Cadigan ....CIE Reviewer
Churchill Grimes..SAFMC SSC
Sven Kupschus...CIE Reviewer
Mrni Magnusson ....CIE Reviewer

Jim Tolan .... GMFMC SSC

Analytic Representation
Matt Lauretta..SEFSC
Michael Schirripa...SEFSC
John Walter ....SEFSC
Jeff Isley..SEFSC

Council Representation
Anna Beckwith...SAFMC
Ben Hartig..SAFMC

Other Observers
Ashleigh Anmentront..RSMAS
Peter Barile.. SFA
Craig Brown..SEFSC
Scott Crosson .... SA SSC
Nancie Cummings...SEFSC
Mike Errigo .... SAFMC Staff
Doug Gregory ....GMFMC
Rusty Hudson..DSF, Inc
Michael Larkin.. SERO
Matt Nuttall...U of Miami
Clay Porch...SEFSC
Skyler Sagarese...SEFSC

Staff
Julie Neer .... SEDAR
Charlotte Schiaffo ....GMFMC Staff
Ryan Rindone...GMFMC Staff

1.4 LIST OF REVIEW WORKSHOP WORKING PAPERS AND DOCUMENTS

Documents Prepared for the Review Workshop			
SEDAR38-RW-01	South Atlantic Shrimp fishery bycatch of king mackerel	Walter, J. and J. Isely	6 August 2014
SEDAR38-RW-02	Methods Used to Compile South Atlantic Shrimp Effort Used in the Estimation of King Mackerel	Gloeckner, D.	5 August 2014

	Bycatch in the South Atlantic Shrimp Fishery		
SEDAR38-RW-03	Virtual population analysis for Atlantic king mackerel	Matthew Lauretta	4 August 2014
SEDAR38-RW-04	Virtual population analysis of Gulf of Mexico king mackerel	Matthew Lauretta	4 August 2014
SEDAR38-RW-05	King Mackerel and Spanish Mackerel larval data on the northeast U.S. Shelf	Harvey J. Walsh, David E. Richardson, Katrin E. Marancik, and Jon A. Hare	22 July 2014
SEDAR38-RW-06	Public comments received during the SEDAR 38 Process		8 August 2014
SEDAR38-RW-07	NMFS- Trip Intercept Program (TIP) data indicates significant Atlantic King Mackerel recruitment of new age classes into the East Florida commercial handline fishery in April 2014	Peter J. Barile	7 August 2014

2. REVIEW PANEL REPORT

EXECUTIVE SUMMARY

Stock assessment scientists provided detailed and well documented methods and results for King mackerel stock assessments in the US South Atlantic and the Gulf of Mexico. Overall, data decisions made by the Data Workshop and Assessment Workshop were sound and robust. A major change in data inputs since the last assessment is the reconfiguration of the 'Winter Mixing Zone', now much smaller, with only ~7% unaccounted landings by stock. Both assessments relied primarily on fishery dependent information.

Both the Gulf and South Atlantic King Mackerel stocks were primarily assessed using Stock Synthesis 3 (SS3), but VPAs were also provided for continuity with previous assessments. Both modeling platforms are widely used and accepted. The strongly dome shaped selectivity pattern implemented for most fleets in both the Gulf and South Atlantic model were of concern to the panel because of the potential for a sizeable cryptic biomass. Because of this concern the assessment team had, for each stock, implemented at least one logistic selectivity (South Atlantic: tournament males and females; Gulf: handline males). The various likelihood components suggested that there is some conflict between age and length composition data, but they were resolved appropriately.

The absence of a discernible stock recruitment relationship, the uncharacteristically low estimate and high degree of predicted certainty in the estimate of *h* given the species and the convergence issues convinced the panel that the estimate of steepness was unrealistic. The panel concluded an alteration to AW-recommended model was required to remove the stock recruitment relationship assumption and base stock status estimation on spawning potential ratios, rather than MSY criteria. For projections, the panel recommends fixing $h = 0.99$, but this should not be interpreted as a measure of very high stock productivity, but is merely a method for implementing a forecast going forward with random recruitment. To compensate for the uncertainty in stock productivity the review group suggests using SPR reference points as limit reference points rather than the development of MSY target reference points.

For both the South Atlantic and Gulf of Mexico stocks, the SSB_SPR30% reference point was chosen by the review panel based on accepted practice when there is no evidence of a stock recruit relationship. For both the South Atlantic and Gulf of Mexico stocks, the FSPR30% reference point was chosen by the review panel for the overfishing status evaluation. Neither stock was assessed as being overfished or subject to overfishing. Status conclusions based on FSPR 40% are the same.

Overall, the uncertainty analysis successfully addressed the main sources of uncertainty. The analysts responded quickly to panel suggestions and made further improvements to the uncertainty analysis during the RW meeting.

The panel offered research recommendations and provided guidance on key improvements in data or modeling approaches which should be considered when scheduling the next assessment.

TOR 1

Evaluate the data used in the assessment, addressing the following:

a) *Are data decisions made by the DW and AW sound and robust?*

General: A wide range of commercial and recreational fisheries data, as well as limited scientific survey and research data was made available for assessing both stocks. The data were explored extensively at the DW. Overall, data decisions made by the DW and AW were sound and robust. Likewise, data generally were applied properly and uncertainty in data inputs was appropriately acknowledged. One point to note for both stocks is the fact that substantial reconsideration and re-estimation of growth parameters was conducted at the AW resulting in different parameter estimates then presented at the DW. The RW panel felt that the 2-phase model developed at the AW was an improvement but there is still some evidence of model misspecification that should be investigated for the next assessment.

A major change in data inputs since the last assessment is the reconfiguration of the 'Winter Mixing Zone', now much smaller, with only ~7% unaccounted landings by stock. Although the changes were suggested as warranted in the early 2000's and corroborated several times in recent years, this is the first assessment to fully incorporate the suggested mixing proportion changes. The RW panel felt this to be a major change in the basic structure of the assessment for both stocks—i.e., nearly the entire landings in the southeast Florida winter fishery that used to be allocated to the Gulf stock are now counted as Atlantic fish—with potential significant impact on assessment outcomes and stock status determination.

Based on different data sources, it appears that insufficient gonad samples are being collected for more complete assessment of the reproductive biology (i.e., histological analyses) for both stocks.

Further, the RW panel made some specific observations and comments that should be considered when interpreting the results of assessments for each of the areas:

South Atlantic: the assessment relied primarily on fishery-dependent data sources with information on abundance indices, length compositions, conditional age-length compositions, and discards covering only the last 30 years. Most of the landings data go back to 1930-1940 but the handline commercial landings data go as far back as 1901. The only fishery-independent index of abundance was provided by the SEAMAP survey for age-0. Many of the life history inputs, in particular, growth, natural mortality and maturity inputs were developed at the AW (i.e., after the DW).

Gulf of Mexico: like for the South Atlantic, the assessment relied primarily on fishery-dependent data sources with fishery-independent indices being available only for juvenile life stages (SEAMAP trawl and plankton surveys). No major revisions to the landings, age, and length data were performed after the data workshop. However, estimates of shrimp bycatch were re-evaluated during the AW with revisions to methods and final estimates documented in the AW Report. Changes to life-history assumptions for the South Atlantic stock are also documented in the AW report.

b) *Are data uncertainties acknowledged, reported, and within normal or expected levels?*

South Atlantic and Gulf of Mexico: in general, uncertainty in data inputs was appropriately acknowledged. However, a clearer framework for documenting known or potential data quality issues (bias and precision) in relation to design, implementation, sampling achievement and analysis of data over different periods, using suitable quality indicators, would be very helpful for assessment analysts and reviewers. Evaluating data quality through performance in an assessment model is not sufficient in itself if the errors in the data include biases as well as sampling variance.

Some of the life history parameters were modeled in Stock Synthesis (SS) as fixed values (natural mortality, fecundity, and maturity), while growth was estimated internally within the model. Further, the RW panel expressed considerable concern regarding uncertainty in selectivities for each of the different fleets. Additional data from tagging programs could have helped resolve some of these uncertainties (see *Research Recommendations* section below).

The RW panel also recommends collection of fishery-independent samples to provide more complete and reliable information on population (i.e., not fishery) size/age composition data. These are the data that provide information on growth, selectivity, and year class strength. If they are not representative of the population as a whole then legitimate signals in the data will be obscured. For both stocks the composition data were sampled in an *ad hoc* basis (or there were inadequate sample sizes in the original fishery-dependent stratification), therefore, it is important to post-stratify in such a way that the full (spatial and temporal) extent of the fishery is covered with adequate sample sizes in each stratum (for the years, or groups of years, in which there are adequate data).

Lastly, uncertainty in potential mixing or population connectivity between Gulf king mackerel off US and Mexico waters needs to be better explored. The DW's Life History Workgroup recommended two sensitivity runs to address this and, unfortunately, those were never completed. It is highly recommended that this issue be addressed at the next assessment.

c) *Are data applied properly within the assessment model?*

South Atlantic and Gulf of Mexico: in general, data were applied properly within the assessment model. However, changes in the size and configuration of the Winter Mixing Zone may warrant a reevaluation of how landings, size and age compositions were assigned to South Atlantic or Gulf of Mexico stocks in future assessments.

There are obviously some poor fits to the length and age composition data, perhaps at least partly related to the model trying to fit the noisy data resulting from small sample sizes. The assessment team chose an assessment model that can make use of all data available, but it is a complex model that requires many assumptions, and the sensitivities to these were not always explored fully.

d) *Are input data series reliable and sufficient to support the assessment approach and findings?*

South Atlantic and Gulf of Mexico: yes, input data series were considered reliable and sufficient to support the assessment methods and findings. However, the RW panel discussed potential improvements for the next assessments. In particular, the use of age data as conditional age-at-length could benefit from more thorough evaluation of spatial coverage and distribution of sampling. Use of age data as conditional age-at-length reduces concerns about the double-use of age and length data, where the age data came from a subset of the fish that were measured. Also, it allows non-randomly collected age samples to be used in the assessment in a natural fashion and facilitates the estimation of growth parameters. However, it does not preclude the necessity for a careful analysis of the age data in terms of where samples came from as well as of how and when they were collected.

TOR 2:

Evaluate the methods used to assess the stock, taking into account the available data

a) *Are methods scientifically sound and robust?*
Both the Gulf and South Atlantic King Mackerel stocks were primarily assessed using SS3, but VPAs were also provided for continuity with previous assessments. SS3 is now widely used and accepted as a state of the art assessment tool and in principle it presents a scientifically sound and robust method to assess almost any type of stock dynamic from almost any combination of data. This flexibility achieved through full integration is its main strength, but it can also makes it time consuming to gain the necessary understanding of the linkages between different likelihood components and their effects on parameter estimates required to develop a balanced assessment. The VPA models provided valuable insights into the major stock dynamics such as selectivity and cohort strength and the implications of different data sources. The ability to understand the more complex SS model through these simpler incarnations of the stock dynamics was very helpful to the panel.

b) *Are assessments models configured properly and used consistent with standard practice?*

Dome-shaped selectivity

The strongly dome shaped selectivity pattern implemented for most fleets in both the Gulf and South Atlantic model were of concern to the panel because of the potential for a sizeable cryptic biomass. Because of this concern the assessment team had, for each stock, implemented at least one logistic selectivity (South Atlantic: tournament males and females; Gulf: handline males). Although this practice is often necessary to aid convergence in the model it does carry a potential penalty in the assessment of stock dynamics when the selectivities of the fleets would be better represented by other selectivity forms. In the case of the South Atlantic stock the direct effects of this are minor, since the tournament fleet catches only a small proportion of the stock, and the indirect effects on the other selectivities were minimal as shown by a sensitivity run where all selectivities were set to dome-shaped.

South Atlantic model:

To determine if the models were accumulating a significant cryptic biomass the panel was provided with an evaluation of the vulnerable biomass which suggested that around 40% of the SSB was cryptic at current stock status. This fact, and the tendency of the VPA method to estimate similar selectivity at age patterns for the fleets suggests that at this time the dome-shaped selectivites in the South Atlantic Mackerel stock is likely real and unlikely to be a problem for the current assessment. Industry information provided at the workshop suggests that there is both a plausible mechanism for establishing dome-shaped selectivities in terms of the spatio-temporal interactions with gears, as well as a financial incentive for fishermen to target intermediate sized fish.

Gulf model:

In the Gulf stock assessment the potential direct effects were greater, because the logistic selectivity was applied to the handline caught males, which represents a greater proportion of the total catches than in the South Atlantic. The gulf model suggested similar cryptic proportion of the spawning biomass (around 40%) but the evidence for dome-shaped selectivities in the VPA was weaker. However the proportion was strongly influenced by the variability in cohort strength and given recent low recruitments the amount of cryptic biomass is only likely to decrease in the near future.

Conflict between length and age-comps

The various likelihood components suggested that there is some conflict in the data. Investigations for the Gulf model, suggested materially different stock trajectories in recent years for models using different data sources. Index and length information suggested that the recent SSB were flat, while the age information implied more of an increase in SSB since the closure of the gillnet fishery. However fixing the growth to the externally estimated “Panama City” von Bertalanffy parameters swayed the model to the more pessimistic outlook (Figure1).

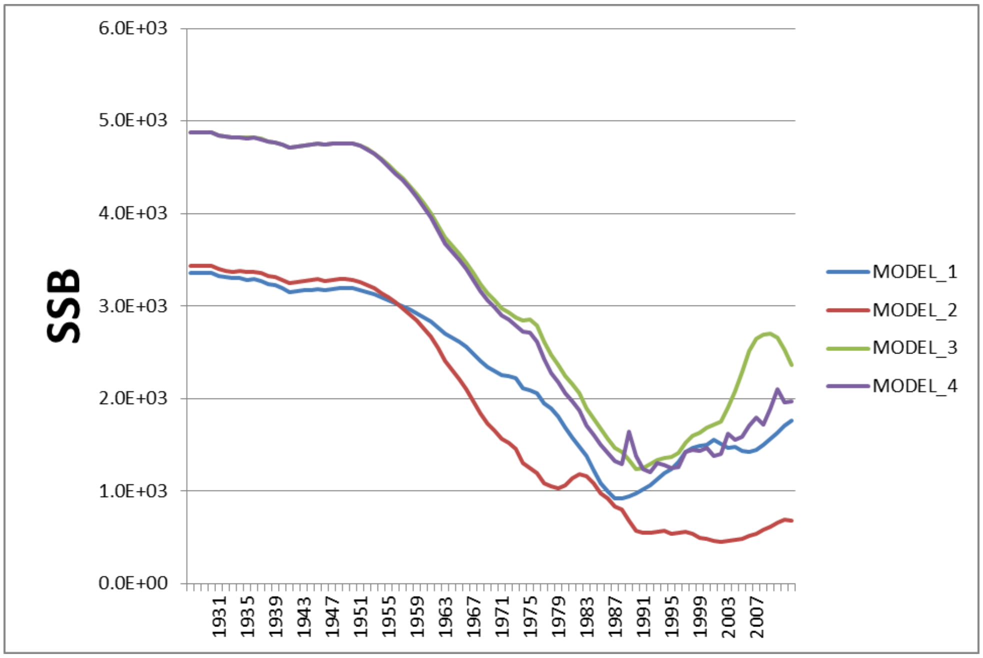


Figure 1 Showing the effects of incremental inclusion of additional data sources in the Gulf model. Model 1= CPUE only, 2 = + length, 3=+ages aw-recommended, 4= as 3 but fixed "Panama city" growth.

Similar concerns were raised about the South Atlantic model and a set of sensitivities was created by down weighting the effects of length compositions and increasing age components. Both analyses indicated similar conflicts in the data sources in both stocks (Figure 2).

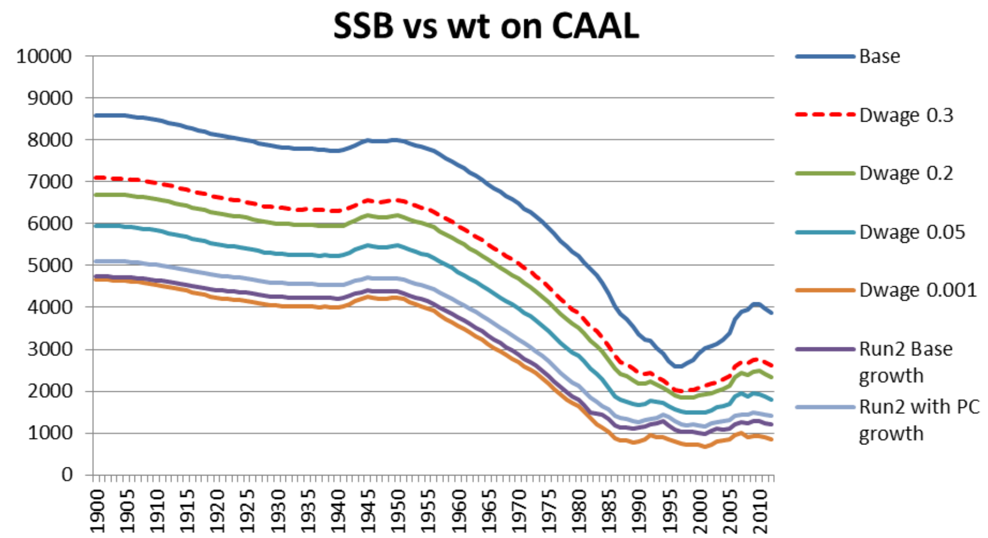


Figure 2: Results of progressively down weighting the length information in the South Atlantic model and the effects of using "Panama city" growth parameters.

The culprit in both models appears to be a misspecification of the growth model. This is also reflected in the length residuals of a number of the fleets catching larger fish. Length residuals go through a bias of negative residuals for all years followed by positive residuals at the largest lengths suggesting that the fisheries are seeing fish that the model does not expect to be there at the estimated fishing mortalities. In theory this pattern is reconcilable by a dome shapes selectivity but even when this is invoked the pattern persists. This suggests the model is having trouble creating the size of fish captured in the tournament fishery due to a problem with the growth specification.

Assessment workshop document (AW1) developed external von Bertalanffy parameter estimates for growth of both stocks. It is apparent is that even in the external fit (i.e. not influenced by other parameter fits) there is an clear systematic trend in the residuals in length-at-age implying some under estimation at the smallest sizes, overestimation at intermediate lengths and underestimation at the larges lengths (Figure 3 as an example).

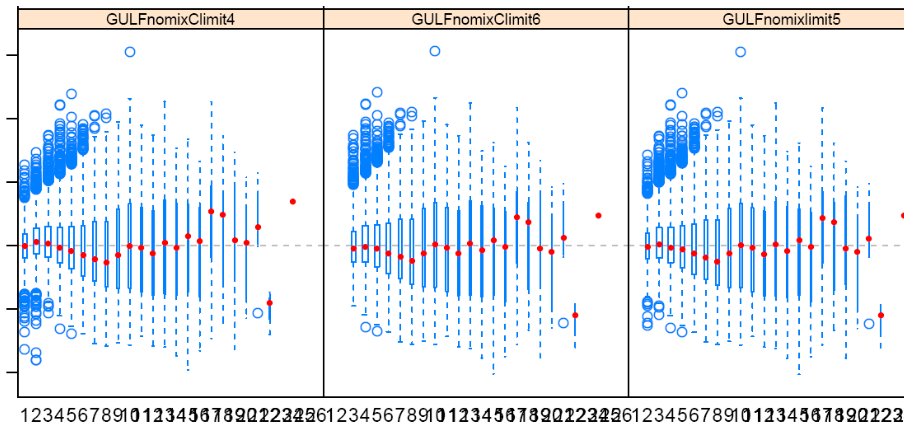


Figure 3 example showing the residual pattern in the central tendency of length-at-age from AW1 consistent with the residual pattern observed in the catch-at-length in the aw-recommended models particularly for the fleets catching the largest fish.

This is the analogous to the residual pattern observed in the base model. Even though this is re-estimated in the base model with different estimates of k and l_{inf} it seems the growth as we understand it from the length-at-age data does not conform to the assumptions of von Bertalanffy growth. The internal estimation has the additional problem that age comp data is entered as a plus group at ages greater 10. However, this group is taken as 11 by the model in its current set up so that the model sees the data as in Figure 4. The divergence of the growth parameter estimates between the internal and external fitting seems to be caused by the plus group issue although the integration of selectivity within the model cannot be excluded as a cause.

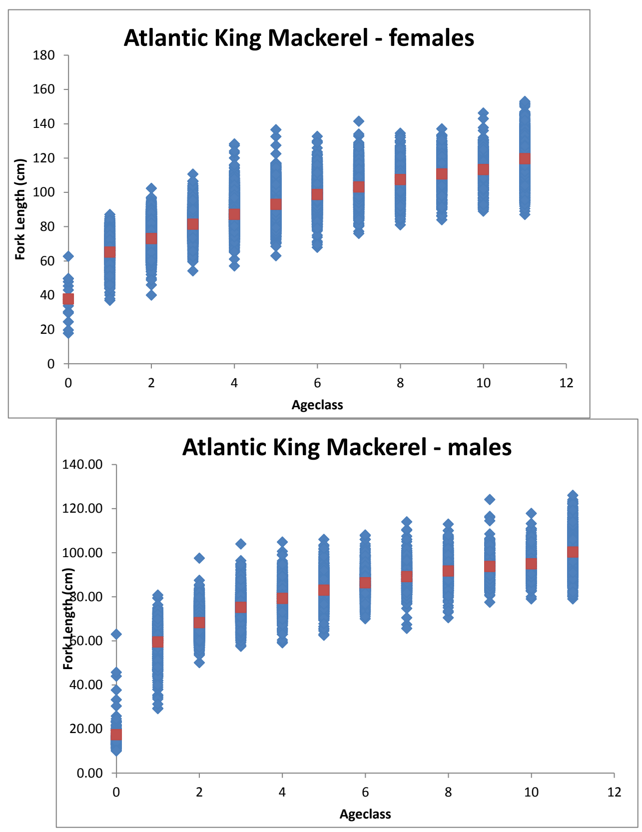


Figure 4: Raw length at age information for South Atlantic stock. Red points indicate the mean length at age. Age 11 is a plus group including older larger fish, but not distinguishable as such by the model because of the way the data is aggregated.

In the process of investigating the matter of the length residuals it became apparent that changes to the selectivity parameterization had little effects on the estimation of the major stock dynamics. This suggests that the model could be approaching over-parameterisation. There was no anecdotal information, such as differential behaviour with respect to gear or differences in the spatial distribution between sexes that would suggest that separate length-based selectivity curve were warranted.

South Atlantic Model:
The origins of the separation in length selectivity by gender are in the model development and a sensitivity run was conducted for the South Atlantic stock to use a combined sex length selectivity curve for all fleets to increase model parsimony. The reduction in the likelihood was small for a saving of a number of parameters suggesting that it would improve model parsimony. The effect on the output metrics however was minimal. Unexpectedly, the L_{50} selectivity for the combined sexes was larger than either of the separate sexes, but there was insufficient time to fully evaluate the causes of this change. Consequently the panel decided to present advice based on the separate sex selectivity model, but it is suggested that greater model parsimony is implemented in future models.

Gulf model:
The same sensitivity run could not be conducted in the Gulf model because of the requirement for at least one logistic fleet selectivity (chosen to be the male handline selectivity). However given the gender similarity in selectivity for some of the other fleets it is suggested that here too improvements in model parsimony are possible. Here too the aw-recommended model was retained.

c) *Are the methods appropriate for the available data?*

As described under section 2a SS3 is specifically designed to deal with virtually all possible data sources and characteristics that regularly occur in fisheries data. Therefore it is not a question whether the method is appropriate for the available data, but more a question of whether the implementation is appropriate for the data.

Steepness

Both aw-recommended models were set up to try to estimate steepness within the modeling process. The Gulf model required a beta-prior (set at 0.7, sd=0.11) to avoid hitting the upper bounds estimate of steepness, while the South Atlantic model converged at an estimated steepness of 0.5 without priors. However examination of the SSB and r vectors of either model did not provide convincing evidence of a stock recruitment model. In addition, the South Atlantic model indicated very sporadic changes in the likelihood profile across various values of steepness in the sensitivity analysis. It was decided to conduct an external analysis, assuming that the effect of the stock recruitment relationship in the model would be minor in the recent period.

The stock-recruitment scatter does not offer much visual information about the steepness (h) of the relationship, neither in the South Atlantic nor the Gulf, mainly because of the lack of historical SSB contrast (Figures 5 and 6, left panel). The likelihood profile over h

for the AW-recommended model was estimates of *h* demonstrated a number of peaks and troughs suggesting there were convergence problems that impacted both the estimated values and the perceived uncertainty. Therefore the panel requested a diagnostic stock-recruitment analysis outside the assessment model, using S and R values from the AW models.

South Atlantic model:
The AW model estimate was *h*=0.50, using no Bayesian prior. However, a simple external analysis showed that the best Beverton-Holt fit through the scatter was a straight horizontal line, corresponding to *h*=1. Lower values of *h* have progressively lower likelihood (Figure 5, right panel) with a 95% confidence interval ranging from 0.52 to 1.00.

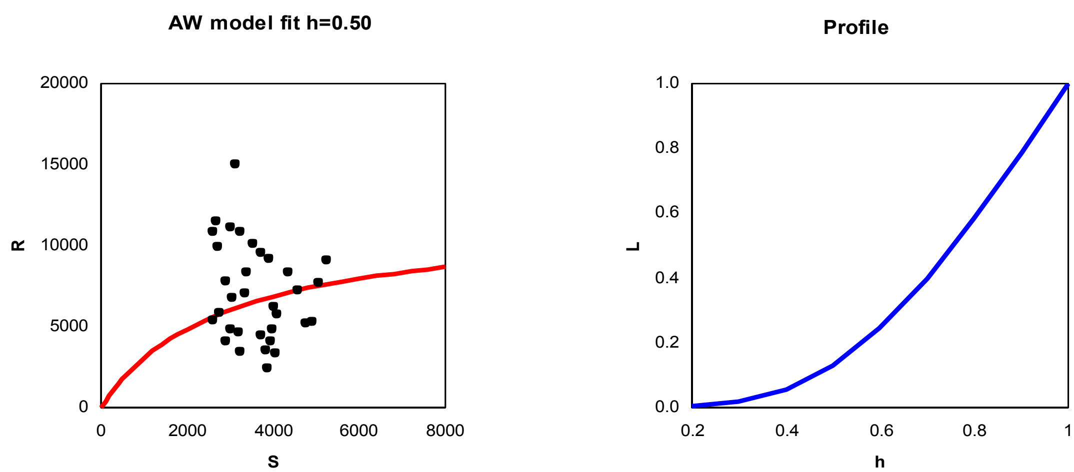


Figure 5. South Atlantic Stock-recruitment scatter (left panel) and profile likelihood of steepness (right panel).

The absence of a discernible stock recruitment relationship, the uncharacteristically low estimate and high degree of predicted certainty in the estimate of *h* given the species and the convergence issues convinced the panel that the estimate of steepness was unrealistic. The external analysis based on the vectors of SSB and recruitment estimated from the aw-recommended model suggested that even though the data contained an internally estimated sr-relationship estimates of H hit the upper bounds at 1. The panel concluded an alteration to aw-recommended model was required to remove the stock recruitment relationship assumption and base stock status estimation on spawning potential ratios, rather than MSY criteria.

Short-term projections from the model with *h* fixed at 0.99 to take recruitments forward at the average levels was not straight forward in stock synthesis, because of the bias correction inherent in the model interacting with the fixed variability in recruitment deviates. Realistic forward projections were only possible if this variability was estimated. Fixing h = 0.99 should not be interpreted as a measure of very high stock productivity, but is merely a method for implementing a forecast going forward with random recruitment. To compensate for the uncertainty in stock productivity the review group suggests using SPR reference points as limit reference points rather than the development of MSY target reference points. See section 4.

Gulf model:
The AW-recommended model estimate was h=0.79, using an informative Bayesian prior with a mean of 0.7. However, a simple external analysis showed that the best Beverton-Holt fit through the scatter was a straight horizontal line, corresponding to h=1. Lower values of h have progressively lower likelihood (Figure Y, right panel) with a 95% confidence interval ranging from 0.69 to 1.00.

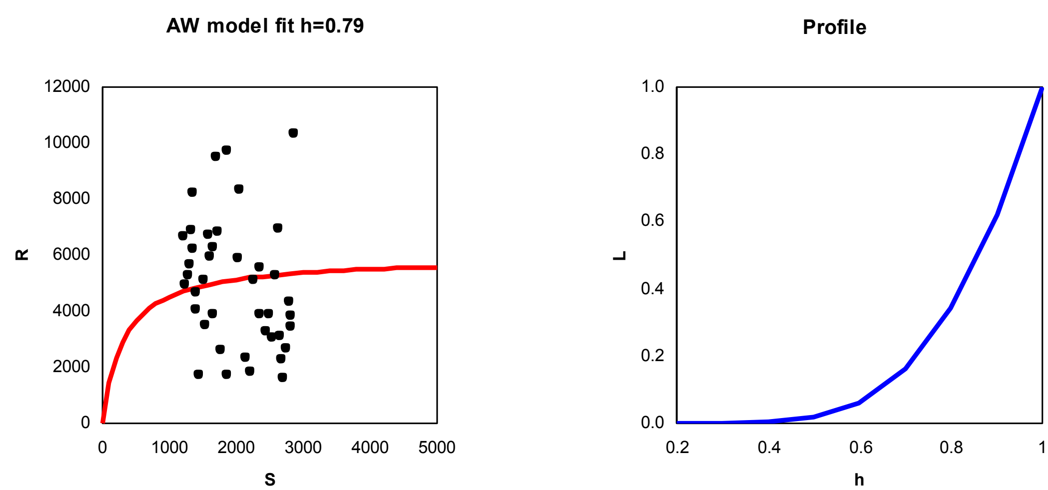


Figure 6. Gulf Stock-recruitment scatter (left panel) and profile likelihood of steepness (right panel).

The absence of a discernible stock recruitment relationship, the lack of convergence in the absence of a Baysian prior, and the lack of consistency with the South Atlantic model convinced the panel that the estimate of steepness was unrealistic. The external analysis based on the vectors of SSB and recruitment estimated from the aw-recommended model suggested that even though the data contained an internally estimated sr-relationship estimates of H hit the upper bounds at 1. The panel concluded an alteration to aw-recommended model was required to remove the stock recruitment relationship assumption and base stock status estimation on spawning potential ratios, rather than MSY criteria.

Short-term projections from the model with h fixed at 0.99 to take recruitments forward at the average levels was not straight forward in stock synthesis, because of the bias correction inherent in the model interacting with the fixed variability in recruitment deviates. Realistic forward projections were only possible if this variability was estimated. Fixing h = 0.99 should not be interpreted as a measure of very high stock productivity, but is merely a method for implementing a forecast going forward with random recruitment. To compensate for the uncertainty in stock productivity the review group suggests using SPR reference points as limit reference points rather than the development of MSY target reference points. See section 4.

TOR3

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 status inferences?

South Atlantic stock

Estimated trends in abundance and biomass are consistent with tuning indices. The RW recommended assessment model fit the commercial handline and SEAMAP survey indices reasonably well. The model fit the recreational headboat index less well, with a lower rate of decline than the index over the last five years, but the fit was consider to be acceptable.

The reliability of the scale of abundance and biomass estimates is closely related to the reliability of the scale of the exploitation rate estimates. This is more difficult to assess. Estimates of total exploitation rates were expressed as total catch in numbers divided by age 0+ total abundance. This was done to reflect discard mortalities at age zero. These young mackerel are not part of the landings; however, they are usually the most abundant age class contributing to the total exploitation rate and this means that this rate does not represent the exploitation rate on ages selected by the fishery (see section at end of this ToR). Total exploitation rates were about 7% since 1980.

The selectivity of most fishing fleets had pronounced “domes” and it is well known that this can be confounded with the magnitude of fishing mortality. However, total exploitation rates estimates were broadly consistent between the SS3 and VPA models, although the VPA model estimated higher exploitation rates in the last 5 years. Selectivity at age was also consistent between the two models. Cohorts track well through the age compositions and this provides important information on the magnitude of exploitation rates. A sensitivity run in which the male HL selectivity was fixed to be asymptotic fit much worse (change in likelihood = 827) particularly for the length and age composition data. This suggests that the domed selectivity is not confounded with the magnitude of fishing mortality for this stock.

The estimates of stock size and exploitation rates are useful to provide status inferences.

Gulf stock

Estimated trends in abundance and biomass were somewhat consistent with tuning indices. The RW recommended model fit to the recreational charter/private cpue index was fairly good and usually within the 95% confidence intervals. This is the dominant fleet in the Gulf mackerel landings. The fit was also fairly good to the Seamap trawl index of age 0 fish. The fit to the recreational headboat cpue index was less good but this fleet contributes only a small part of the total landings. The fit to the Seamap larval SSB index was not good overall, however this index had wide standard errors and it is not clear if this lack of fit represents serious model mis-specification. The fit to the commercial handline cpue index was poor with fairly different trends although not in opposite directions. This fleet represents the second largest source of landings overall in the Gulf. It is also the fleet in which the selectivity was fixed to be asymptotic for males. This may suggest that this is not a valid assumption for this fleet, and in the South Atlantic stock this fleet was estimated to have a domed selectivity pattern for both males and females. However, for reasons outlined under ToR 2 the AW fixed the selectivity for gillnet caught males in the Gulf, which the review panel agreed with.

The fits from the AW recommended model were similar to the RW model.

The reliability of the scale of abundance, biomass, and exploitation rate estimates is more difficult to assess. Similar to the South Atlantic stock, estimates of total exploitation rates were calculated. The selectivity of most fishing fleets had pronounced “domes” and it is well known that this can be confounded with the magnitude of fishing mortality. Total exploitation rates were about 17% since 1980, which is higher than in the south Atlantic. These exploitation rates usually fairly similar but a little lower than VPA results. However, the VPA indicated more asymptotic selectivities for the recreational headboat and commercial gillnet indices compared to the AW recommended model. Note that these are the only two indices that can be compared between the two models. This is probably the reason why the VPA produced somewhat higher exploitation rates. The RW recommended model estimates of selectivity (apart from commercial handlines) were fairly consistent with those estimated for the South Atlantic stock.

The review panel concluded that the RW recommended model estimates of stock size and exploitation rates are useful to provide status inferences.

<u>South Atlantic + Gulf stocks</u>

The total exploitation rate as calculated may change as a consequence of strong recruitment and not changes in exploitation rates at older ages. Alternative metrics such as the average fishing mortality rate at more vulnerable ages or the biomass exploitation rate should also be considered.

b. Is the stock overfished? What information helps you reach this conclusion?

For both the South Atlantic and Gulf of Mexico stocks, the SSB_SPR30% reference point was chosen by the review panel based on accepted practice when there is no evidence of a stock recruit relationship (see Tor2 e). SSB_SPR30% = Ro x SPR30% where Ro is derived from the RW assessment model and is the same as average estimated recruitment.

The following conclusions are based on the results of the RW recommended stock assessment model.

South Atlantic stock

The stock is not overfished. The current (FY 2012) estimate of SSB (4400 million eggs) is 86% greater than the SPR biomass reference point (2372 million eggs), with a low probability (0.001%) that SSB2012 < SSB_SPR30%.

Gulf stock

The stock is not overfished. The current (FY 2012) estimate of SSB (2353 million eggs) is 107% greater than the SPR biomass reference point (1138 million eggs), with a low probability (0.01%) that SSB2012 < SSB_SPR30%.

South Atlantic + Gulf stocks

Status conclusions based on other SSB reference points (e.g. SSB_BB30%, SSB_SPR40%) are the same.

c. Is the stock undergoing overfishing? What information helps you reach this conclusion?

For both the South Atlantic and Gulf of Mexico stocks, the FSPR30% reference point was chosen by the review panel for the overfishing status evaluation.

The following conclusions are based on the results of the RW recommended stock assessment model.

South Atlantic stock

The stock is not undergoing overfishing. The current (FY 2012) exploitation rate (2.6%) was estimated to be 17% of the SPR30% exploitation rate reference point, with less than 0.0001% probability of exceeding this reference point.

Gulf stock

The stock is not undergoing overfishing. The current (FY 2012) exploitation rate (8%) was estimated to be 51% of the SPR30% exploitation rate reference point, with <0.01% probability of exceeding this reference point.

South Atlantic + Gulf stocks

Status conclusions based on FSPR 40% are the same.

d. Is there an informative stock recruitment relationship? Is the stock recruitment curve reliable and useful for evaluation of productivity and future stock conditions?

South Atlantic stock

The AW recommended stock assessment model estimated steepness to be 0.5, with a low standard error (0.03). A bootstrap analysis provided a similar standard error. However, it was not clear to the review panel that these results were reliable because there was no evidence of a stock-recruit relationship in the plot of recruitment versus SSB. Steepness changed substantially in retrospective analyses (first increasing then decreasing) which disagrees with the low standard error. The profile likelihood for steepness indicated some possible convergence issues. This seemed to be related to the age data. External estimation of steepness suggested a preference for a high value (see ToR2).

The review panel concluded that the AW recommended stock recruitment curve is unreliable and possibly over-optimistic for the evaluation of productivity and future stock conditions.

Gulf stock

The AW recommended assessment model used a prior on steepness because otherwise the model estimated steepness to be close to one. The estimate of steepness was 0.8 and model estimates of recruitment were essentially constant over the estimated range of SSB's.

The review panel concluded that the AW recommended stock recruitment curve is unreliable.

e. Are the quantitative estimates of the 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?

The review panel concluded that the MSY benchmarks for the South Atlantic and Gulf of Mexico stocks provided by the AW were not reliable because of the uncertainty about the stock-recruitment relationship. Therefore, the 30% SPR reference level was chosen based on past practice for this stock.

The uncertainty of FSPR30% recommended benchmark estimates with respect to the relevant estimated productivity processes (i.e. weights, maturities, selectivities) was not evaluated.

South Atlantic stock

The panel notes that fishing at FSPR30% is expected to reduce the stock below the lowest observed SSB and the stock response to exploitation in this case are unknown.

The review panel is not recommending that FSPR30% is a proxy for Fmsy for this stock, nor that the implied yield by fishing at FSPR30% is an estimate of MSY.

The status evaluations (overfished and overfishing) are reliable; however, the FSPR30% value of 0.16 is outside of the observed exploitation range in the RW recommended assessment.

Gulf stock

The status evaluations (overfished and overfishing) are reliable.

ToR4

The projection results from the review panel recommended model were not available for the Gulf of Mexico stock at the review meeting.

South Atlantic

a. Are the methods consistent with accepted practices and available data?

The methods were options in the SS3 package and were consistent with accepted practices. They were consistent with the available data.

b. Are the methods appropriate for the assessment model and outputs?

The RW recommended a change in the assessment model and this affects the stock projections. The methods were appropriate for the assessment model and outputs. Short-term projections with constant recruitment seemed reasonable given the lack of a stock-recruit relationship in the AW recommended model. This was implemented by fixing steepness at 0.99 in the RW recommended model.

c. Are the results informative and robust, and useful to support inferences of probable future conditions?

The robustness of the projection results was not specifically evaluated but there was no evidence of a lack of robustness.

The results were informative for short term projections but additional caution should be used when interpreting the projection yield and stock size calculations because the FSPR30% value of 0.16 is outside of the observed exploitation range in the assessment. Projected yields are substantially greater than ever observed in the fishery, and such extrapolations may not be realized.

d. Are key uncertainties acknowledged, discussed, and reflected in the projection results?

Some key uncertainties were acknowledged and discussed. Uncertainty about the initial projection stock size was propagated through the projections, along with uncertainty about future recruitment. This was achieved using the parametric bootstrap procedure (considered further under ToR5) and resampling of projected recruitment using the estimated recruitment variability.

However, this recruitment resampling procedure does not account for potential autocorrelation in recruitment. Recruitment deviations during 2008-2012 were all negative in the AW and RW recommended assessment models and this suggests the potential that recruitment in the short term may also be below average. This uncertainty was accounted for by adjusting projection recruitment deviations downward by 50% and 100% of the average deviation during 2008-2012. In these scenarios the deviations to adjust were randomly generated.

However, the uncertainty in the projections did not include all sources of variation. In particular, uncertainty about M was not included.

TOR 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*

A variety of methods were used to evaluate the uncertainty about the model structure, key parameters, stock status, projections, and reference points. These aspects of uncertainty are discussed sequentially below, as indicated by the '5-number' subheadings.

5-1 Model structure

<u>Atlantic and Gulf stocks</u>
Estimates from the AW models (Stock Synthesis) were compared to a VPA model. This was a useful comparison, both as a general diagnostic (the SS estimates were not very different from VPA estimates), to answer specific questions (selectivities were more dome-shaped in SS than VPA), and also because it is easier understand what is going on in models fitted to age data only.

Different data components were excluded from the assessment model, one by one, to identify the effect each component had on the overall model fit. The profile likelihood for key parameters were also presented segregated by likelihood component, to identify the effect each component had on the overall estimated parameter value.

Atlantic stock
The AW models used sex-specific selectivities. Responding to panel suggestions, a sensitivity run using the same length-based selectivity for both sexes was explored. This reduced the number of estimated parameters, but did not greatly affect the overall conclusions.

5-2 Key parameters

Atlantic and Gulf stocks
The selectivity shape parameters, resulting in dome-shaped selectivities, were identified as particularly important parameters, since this creates a 'cryptic' biomass of older individuals that are not observed in the fisheries or surveys. Attempts to statistically validate the dome shape was based on two approaches. (1) length comp likelihoods responded strongly against higher selectivity of older/larger individuals, and (2) the VPA estimated selectivities were compared to the AW estimated selectivities.

The steepness of the stock-recruitment relationship was identified as another key parameter, especially with respect to reference points and long-term advice. The panel requested that the uncertainty about steepness be analyzed using profile likelihood, external to the assessment model, which was done (see Section 2c).

Atlantic stock
In the VPA model, the estimated selectivities were dome-shaped.

The steepness value that fits the S-R scatter best is 1.00, with a confidence interval from 0.52 to 1.00, based on profile likelihood. In the AW model, steepness was estimated without a Bayesian prior as 0.50, but in the RW recommended model steepness was fixed at 0.99.

Uncertainty about the natural mortality rate *M* was addressed using sensitivity runs with scenarios based on lower and higher *M* vectors than the base AW model. The effect of increasing the assumed *M* was that the estimated virgin stock increased and the $F_{SPR40\%}$ reference point increased as well.

Gulf stock
In the VPA model, the estimated selectivities were nearly asymptotic.

The steepness value that fits the S-R scatter best is 1.00, with a confidence interval from 0.69 to 1.00, based on profile likelihood. In the AW model, steepness was estimated with a Bayesian prior of N(0.7, σ=0.11) as 0.80, but in the RW recommended model steepness was fixed at 0.99.

A sensitivity run with time-varying growth parameters indicated slightly lower SSB levels in recent years, compared to the AW model.

5-3 Stock status, projections, and reference points

Atlantic and Gulf stocks

Uncertainty about SSB and F was evaluated using the delta method and parametric bootstrap. Retrospective analysis was also performed for SSB. The panel identified the cryptic biomass, not observed in fisheries or surveys, as an important source of uncertainty and requested that the cryptic proportion of SSB be estimated.

Short-term projections were deterministic, evaluated for $F_{current}$, F_{OY}, and F_{MSY}. The RW panel concluded that the uncertainty about steepness made MSY-related reference points unreliable.

Atlantic stock

The cryptic proportion of the SSB has been around 40% on the average.

Three recruitment scenarios were considered: high (long-term average), medium, and low (average of 5 most recent years).

The uncertainty about reference points was evaluated using the delta method, including $B_{SPR40\%}$, $F_{SPR40\%}$, B_{MSY}, and F_{MSY}.

Gulf stock

The cryptic proportion of the SSB has been around 40% on the average.
Recruitment in projections was based on the estimated stock-recruitment relationship.

5-4 Summary

Atlantic and Gulf stocks

Overall, the uncertainty analysis successfully addressed the main sources of uncertainty (Table 1). The analysts responded quickly to panel suggestions and made further improvements to the uncertainty analysis during the RW meeting.

Table 1. List of main issues of uncertainties that were examined.

Model structure	SS vs. VPA, data components, unisex selectivities
Key parameters	dome-shaped selectivities, steepness, M, time-varying growth
Stock status	SSB confint, F confint, retrospective analysis
Projections	SSB, catch
Reference points	$B_{SPR40\%}$, $F_{SPR40\%}$, B_{MSY}, F_{MSY}

MCMC was not applied in the uncertainty analysis, but could have been useful to evaluate the uncertainty about parameters and estimated quantities, and to identify which parameters were causing problems with model convergence.

All of the above uncertainty analysis was based on the AW models, where steepness was estimated. Similar uncertainty analysis was not presented for the RW recommended models, with a fixed steepness of 0.99, as these models were run for the first time during the RW, in response from panel suggestions. The panel recommends that a similar uncertainty analysis be performed with the RW models.

TOR 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.*

Gulf of Mexico Stock

1. Develop a scientific survey to obtain reliable age/size composition data. This is needed, particularly as the composition data coming from the fisheries is substantially impacted by changing selectivity. This might be done with a handline survey of fixed sites. The idea would be not necessarily to get a random sample of the age composition but a reliable, relative estimate where selectivity can be assumed constant. An index would be beneficial. The review panel recommends that the design of a scientific survey be peer reviewed.

2. Determine most appropriate methods to deal with changing selectivity in fisheries over time, particularly changing selectivity related to management actions or targeting of specific cohorts. The review panel suggests that historical mark-recapture data available from NMFS SEFSC (Panama City) and FWRI could be used to compare size composition of recaptures for different fishing gears to evaluate selectivity for historic periods.

3. Conduct research on the U.S. Gulf of Mexico stock overlap with Mexico. The review panel recommends this work include determination of mixing rates/connectivity between the eastern and western Gulf migratory groups using otolith shape and/or microchemistry analysis, as well as model simulations to evaluate the impact of Mexican harvest on the putative single Gulf of Mexico stock.

4. Determine stock mixing rates using otolith microchemistry and/or otolith shape analysis on a routine basis that would allow future stock assessments to capture the dynamic spatial and temporal nature of mixing of the Atlantic and Gulf of Mexico stocks, and consider evaluating stock mixing within integrated modeling approaches.

5. Quantify tournament landings from the Gulf of Mexico.

6. Develop/Evaluate methods to maintain continuity of fishery-dependent indices in light of management regulations and ITQs.

7. Consider conducting an extensive tagging program to: a) better understand migration patterns; b) provide additional and individual growth rate information; c) better understand fishery selectivity; d) provide fishery exploitation rates; e) provide information about natural mortality rates. Fishery independent recapture information (i.e. use acoustic and satellite tags) will assist with a). Age at capture information of tagged animals will assist with b). A multi-year tagging program will be required for e). The review panel recommends that a specific workshop be held to consider in detail the design of a tagging program.

<u>South Atlantic Stock</u>

1. Develop a survey to obtain reliable age/size composition data and relative abundance of adult fish. This could be done using gillnets or handlines. The review panel recommends that the design of a scientific survey be peer reviewed.

2. Determine most appropriate methods to deal with changing selectivity in fisheries over time, particularly changing selectivity related to management actions or targeting of specific cohorts. The review panel suggests that historical mark-recapture data available from NMFS SEFSC and FWRI could be used to compare size composition of recaptures for different fishing gears to evaluate selectivity for historic periods.

3. Determine stock mixing rates using otolith microchemistry and/or otolith shape analysis on a routine basis that would allow future stock assessments to capture the dynamic spatial and temporal nature of mixing of the Atlantic and Gulf of Mexico stocks, and consider evaluating stock mixing within integrated modeling approaches.

4. More accurately characterize juvenile growth by increasing samples of age-0 and 1 fish. Further investigate 2-phase growth models including different breakpoints and different growth models to better model size and age. Consider if there is temporal (annual and seasonal) variability in growth rates. Results of this analysis in terms of the best model will need to be implementable in SS3 to continue with the integrated modeling approach.

5. Determine if female spawning periodicity varies by size or age.

6. Expand the SEAMAP trawl survey below the Cape Canaveral area and potentially into deeper continental shelf waters.

7. Consider conducting an extensive tagging program to: a) better understand migration patterns; b) provide additional and individual growth rate information; c) better understand fishery selectivity; d) provide fishery exploitation rates; and e) provide information about natural mortality rates. Fishery independent recapture information (i.e., use acoustic and satellite tags) will assist with a). Age at capture information of tagged animals will assist with b). A multi-year tagging program will be required for e). The review panel recommends that a specific workshop be held to consider in detail the design of a tagging program.

TOR 7

Provide guidance on key improvements in data or modeling approaches which should be considered when scheduling the next assessment.

Gulf of Mexico Stock

1. Evaluate most appropriate methods to deal with unreliable historic discard size-composition data so that discard ratios can be reliably estimated.

2. Evaluate environmental influence on recruitment, larval/juvenile survival and stock production using a more mechanistic approach than the SEFSC presented in a working paper at the assessment workshop that links the key physical and biological processes that may in sequence be influencing the production process.

3. Consider using logistic or asymptotic selectivities, instead of the current domed-shaped structure, for more of the Gulf fishery fleet estimates. This may help resolve any questions of the influence of cryptic biomass within the 11+ group of the Gulf stock.

4. Consider using a VPA via a statistical catch-at-age model, either total or by specific fleet, instead of maintaining a separate external VPA or maintaining a VPA within SS3 (i.e., drop the duplicative effort of a VPA running in the background).

South Atlantic Stock

1. Evaluate environmental influence on recruitment, larval/juvenile survival and stock production using a more mechanistic approach than the SEFSC presented in a working paper at the assessment workshop that links the key physical and biological processes that may in sequence be influencing the production process.

2. A move to single sex selectivities, across all fleets, could be used to save parameters in the final model configuration. The Review Panel suggests that, overall, fewer parameters be used in the final model configuration. As an example, the difference in numbers-at-age between the VPA and SS3 are relatively small through time, even though SS3 integrates over a much larger time scale. Hence, are all the extra parameters in SS3 really needed to model this stock?

SEDAR

Southeast Data, Assessment, and Review

SEDAR 38

South Atlantic King Mackerel

Section VI: Addenda and Post-Review Updates

September 2014

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

Addendum to SEDAR 38 stock assessment report and description of review workshop preferred model

This addendum documents analyses requested from by the Review Panel during the Review Workshop.

Notable changes:

1) Advice model changed from RW-Base to RW-preferred with fixed steepness of 0.99 and estimated sigma R
2) The decision was made to provide advice in terms of SPR30%, for consistency with the approach taken during SEDAR 16.
3) Model performance for the fixed steepness run was not ideal but showed little overall divergence from the base model (<2 log-likelihood point difference)
4) Projection and benchmarks specifications changed to use geometric mean recent (1990-2012) recruitment (7.0 million recruits) rather than virgin recruitment (9.6 million recruits) under the assumption that future recruitment is likely to be similar to the recent time period.
5) This resulted in a lower estimate of $SSB_{SPR30\%}$ using geomean recruitment than using R0 and a raising of stock status from 1.86 times the SSB at SPR30% to 2.6.
6) Several other issues related to data treatment or data weighting were considered and results are briefly described in this document.

Introduction

At the SEDAR 38 review workshop, there was some concern over the reliability of the estimated steepness (0.5) in the base model. These concerns focused primarily on the absence of a detectable stock-recruitment relationship in the plots of SSB versus recruits. The review workshop panel preferred a model with a fixed value of steepness at 0.99 as a more useful model for providing management advice over the model that estimated steepness at a value of 0.5. This model (RW-preferred) is recommended for stock status advice and for stochastic projections to provide yield advice. This document presents the diagnostics and model results from this model. In addition the advice from the RW was to project with average recruitment into the future and to use this level of average recruitment for calculation of benchmarks, final stock status and yield advice.

Other issues that were evaluated at the RW included the following:

1. Compare VPA F and NAA with Stock synthesis estimates
2. Calculate cryptic biomass
3. Remove female offset on selex
4. Downweight length comps
5. Downweight Conditional age at length
6. Compare run 2 with "Panama City" growth fixed and with base estimated growth

Methods

The RW recommended a model that used a fixed steepness at 0.99 to be used as the preferred model for projections and stock status recommendations. Models with steepness fixed at 0.99 and sigmaR fixed at 0.6 (model 10) and then with estimated sigmaR (model 11) were run. In all other respects the models and model set up were the same as documented previously in the AW report.

Projections and benchmarks

Projection specifications were similar to those outlines in SEDAR38AW but with some modifications to the recruitment specifications. The desired situation was that future recruitment would remain similar to current recent recruitment levels rather than reverting to the level of virgin recruitment. To reflect recent recruitment a decision was made by the assessment modeling team to use the years for which recruitments were likely to be well informed by both age and length composition information and recruitment indices, whichever input was more limiting. As the first index year is 1990 and the conditional age at length data starts in 1983, the years 1990-2012 would likely be fully informed recruitments and were used as the time period on which to base future recruitment and benchmark values.

SSB and F benchmarks were obtained with using a steepness of 0.99 and the geometric mean recruitment from 1990-2012 which was an average of 7,030,302 recruits. The fishing mortality proxy for MSY was SPR30% and the SSB at an equilibrium $F_{SPR30\%}$ was obtained by projecting the model at $F_{SPR30\%}$ out for 50 years until the SSB reached as stable value.

Projections were run to evaluate stock status and associated yields for a range of fishing mortality rate scenarios. Projections were run from FY 2013 to 2023 for the base model configuration (Run 1). The projections assume current FY2012-2013 yields persist into the future for the 2013-14 and 2014-15 fishing years. These yields are substantially below the ACLs.

Projections were run assuming that selectivity, discarding, and retention were the same as the three most recent two years (2011-2012) and the FY2012-2013 landings were carried over for FY2013-14 and FY2014-2015.

Future recruitment specifications

To obtain recruitment at levels equal to a geometric mean equal over a pre-specified range of years, it was necessary to *a priori* adjust future recruitment deviations by a level that would give equivalent recruitment estimates. This was done by calculating the deviate adjustment factor (A) that would make future recruitment equal to the geometric mean of past recruitment. Predicted recruitment is described by the Beverton-Holt equation:

$$4*h*\exp(r0)*SSBi/(SSB0*(1-h)+SSBi*(5*h-1))*\exp(A); \qquad (1)$$

Where h is the steepness, $r0$ is the model estimated virgin recruitment and $SSB0$ is estimated virgin biomass. SSB_i is the SSB in year i, for which a prediction is needed. Minimizing the difference between geometric mean recruitment and predicted recruitment requires solving for A:

$$\text{Geomean}-4*h*\exp(r0)*SSB_i/(SSB0*(1-h)+SSB_i*(5*h-1))*\exp(A)=0; \qquad (2)$$

So

$$A=\log(\text{Geomean} / 4*h*\exp(r0)*SSB_i/(SSB0*(1-h)+SSB_i*(5*h-1)); \qquad (3)$$

For deterministic projections future recruitment is obtained simply by using future recruitment deviations centered around a value of A. For stochastic projections (bootstraps) it is necessary to invoke the bias correction which must be applied to the recruitment deviation a priori. Hence the mean level of normally distributed recruitment deviations is corrected a prior for both the adjustment factor, A, to scale recruitment to the geometric mean and also for the bias correction necessary to make stochastic deviations mean-unbiased. Future stochastic recruitments are then centered around a mean, given below:

Mean_rec_dev= $A + \log(1/\exp(SigmaR^2/2))$; (4)

Where *SigmaR* is the estimated recruitment variability. This gives future recruitment that is equal to the geometric mean but with stochasticity (Figure 1). In theory, if steepness had not been fixed at 0.99, equation (3) would need to be solved in iteratively in each year with the corresponding SSB level so that the appropriate adjustment between predicted recruitment and the geometric mean was obtained. This would vastly slow down projections as the model would have to be re-run for each projection year. With the high levels of steepness used in these projections recruitment in any given year is largely independent of the SSB level in that year so we use the terminal year of the model (2012) estimate of SSB. Future recruitment then is obtained with random normal recruitment deviates centered at the level of Mean_rec_dev, above with a standard deviation equal to sigmaR.

For the RW-preferred model future recruitment was centered at the geometric mean of 1990-2012 (7,030,302 recruits). This was lower than R0, hence the correction factor A is -0.31. Deterministic future recruitment with then obtained from the stock-recruitment relationship with a steepness of 0.99 and a recruitment deviation equal to -0.319, resulting in future recruitment almost exactly equal to the geometric mean for 1990-2012.

This level represents the new baseline level of recruitment so it was necessary to adjust the future high, medium and low recruitment scenarios accordingly to reflect this new baseline. Rather than averaging the recruitment deviations, the actual recruitments were averaged to get the adjustment factor specified in (3), above. This gave three levels of recruitment for the first three years, after which recruitment was assumed to revert to the geometric mean level:

High- assumes that recruitment immediately reverts to the stock recruitment curve in the first year of the projections; forecast recruitment deviations have a mean of -0.3194679 and standard deviation equal to sigma r (0.83).

Medium- assumes that recruitment deviations are halfway between the last five years and the baseline; forecast recruitment deviation mean of -0.5397 and standard deviation equal to sigma r (0.83).

Low - assumes that recruitment deviations have a mean similar to deviations in the last five years (--0.822655) and standard deviation equal to sigma r (0.83).

Deterministic projections were run at three levels of fishing mortality, FSPR30%, FSPR40% and FOY (75% of FSPR30%). Projections at FOY and FSPR30% are very similar as FSPR40% is essentially 75% of FSPR30%.

Other considerations

Other issues that were evaluated at the RW included the following:

1. Compare VPA F and NAA with Stock synthesis estimates.
2. Calculate cryptic biomass for base model. Cryptic biomass is the biomass not selected by the fishery.
3. Remove female offset on selectivity. The female offset from males was essentially a relic from the initial set up of the Gulf and South Atlantic models to be similar. With fixed tournament selectivity at asymptotic this parameterization became largely obsolete. An additional model run was conducted to evaluate the effect of removing this offset and reducing the number of estimated selex parameters by 3.
4. Downweight length comps. This series of runs was conducted to evaluate the effects of reducing the weight on the length composition.
5. Downweight Conditional age at length. This series of runs was conducted to evaluate the effects of reducing the weight on the conditional age at length composition.
6. Compare run 2 with "Panama City" growth fixed and with base estimated growth. This run was conducted to evaluate the effects of fixing growth at the PC values.

Results

Model performance

Fixing steepness at 0.99 and sigmaR at 0.6 resulted in extremely high and unrealistic levels of recruitment due to the way in which the bias correction for lognormal estimation of recruitment is applied in SS. The bias correction ensures that the recruitment initially estimated with log-scale deviates is unbiased when back-transformed to the normal scale. SigmaR operates in two ways within the SS model. First it reflects the interannual variability in recruitment deviations, which are assumed to be lognormally distributed. Second due to the lognormal estimation of recruitment it is used to bias correct the expected recruitment during the time period where deviations are estimated:

E(Recruitment) = f(SpBio) * exp(-0.5 * sigmaR ^2 + dev) ; (1)

Where dev is the recruitment deviations.

This bias-correction aspect of sigmaR means that it also operates in a scaling capacity so that the higher the value of sigmaR the greater the bias correction applied and the lower the actual recruitment is from the recruitment predicted from the stock recruitment relationship and the recruitment deviation (Figure 1). When specified at a fixed value sigmaR can then scale the absolute recruitment up or down with little penalty, with the resulting absolute level bias corrected recruitment relative to predicted recruitment simply being a function of the chosen sigmaR (Figure 1). This resulted in very high levels of recruitment in which did not seem supported by the data and, further, were only due to the fixed sigmaR (Figure 2).

Hence, it was desirable that, if steepness was to be fixed, then sigmaR should be allowed to be estimated. Likelihood profiling of sigmaR indicates that it is estimable with a clear minimum (Figure 3) however there is a divergence between the signal in the actual recruits which favor a value of ~0.45 and the catch and length data that favor a much higher value. This translates to approximately 20% higher recruitment just based on the assumed sigmaR of 0.6 versus the model estimate of 0.83. Hence, while recruitment is not as variable as a sigmaR of 0.83 would indicate, the scaling aspect of the parameter is quite important to the absolute level of recruitment (Figure 2). For comparison the VPA-estimate recruits are shown on the same Figure 2 so that if one believed the assumed M and F estimates from the VPA, then simply back calculating from the catch at age would give the VPA recruits.

Overall model performance was similar to the Base model with less than 2 log-likelihood points separating the base model from the RW-preferred model (Table 1). With less than a log-likelihood point separating the length comp and only 6 points separating the age composition likelihoods it was unlikely that any difference in fit would be visually detectable so the composition fits are not shown in this document. The primary difference was a slight improvement in the age-composition and a decrease in the fit to the recruitment (Table 1). This decrease in the fit to the recruitment appears to be the penalty that the model estimates a lower absolute recruitment level while not fitting the actual variability in recruitment, hence the divergence between the fits to the comp data (wanting a higher sigmaR) and the recruitment data (wanting lower sigmaR) in the likelihood profile for sigmaR (Figure 3).

Likelihood profiling (Figure 4) of R0 was repeated for the RW-preferred model and indicated that R0 remained fairly well estimated and was slightly lower than (9.18) than with the base model (9.26). Jitter analysis indicated some instability in model estimation with several other model fits obtained. In contrast to the RW-base model the model fit from the initial conditions was also the lowest log-likelihood model from the jitter exercises (Figure 5). The jitter exercise identified most model runs as fairly similar with one as a clear outlier (Figures 5 and 6). Other than this single outlier run, none of the other potential solutions would have resulted in a change in stock status.

The stock recruitment relationship was largely fixed as the steepness was fixed at 0.99 (Figure 8). Predicted recruitment deviations were quite similar to the base model (Figure 9), and all showed negative deviations in the last five years of the model. The time series of recruitment and SSB were similar to the Base model but the RW-preferred model had a lower estimated virgin recruitment resulting in a lower historical recruitments and lower historical SSB. In recent years the RW-preferred model has higher estimated of recruitment and leads to higher overall SSB then the Base model (Figure 10). Time series of SSB relative to SSB0 and F relative to FSPR30% benchmarks indicate that the RW-preferred model has a higher biomass status and a slightly lower F status but, in neither case, does stock status inference change (Figure 11) when using R0 as the recruitment level and $SSB_{SPR30\%}$ as the benchmark.

With the change the using the geometric mean recruitment level, the SSBSPR30% benchmarks changes, resulting in a lower SSB benchmark. The resulting stock status is higher but, with either metric the stock is not overfished, nor has it ever been overfished (Figure 12). Changing the recruitment level does not change the F/FSPR30% metric (Figure 12).

Parameter estimates (Table 2) were slightly different than the Base model, due to the fixed value of steepness. Estimated SSB and recruitment (Table 3), F (exploitation rate in numbers, Table 4) and stock status values relative to SPR30% (Tables 5 and 6) also differed slightly from the Base model but not enough to alter the perception of the stock (Table 7). Derived quantities and benchmarks obtained at an $F_{SPR30\%}$ and $SSB_{SPR30\%}$ also were slightly different than the BASE model that used an estimated steepness (Table 8).

Stock status

Stock status determinations (not overfished, nor is overfishing occurring) remain the similar to the Base model (Table 9). Final status determinations and projections use the geometric mean recruitment (Table 10). Accordingly the stock is not overfished (SSB2012/SSB30% with geometric mean rec =2.6). The change to using the geometric mean recruitment lowered the SSB benchmark. SSBSPR30% was obtained by assuming geometric mean recruitment and fishing the stock at FSPR30% for 50 years into the future. Assuming virgin recruitment the stock is also not overfished (SSB2012/SSB30% = 1.86) and there is also a very low probability (P<0.001, Table 3) that the stock is overfished.

The stock is also not undergoing overfishing (F/Fspr30%= 0.17) and an extremely low probability that the stock could be undergoing overfishing (P<0.0001, Table 3).

Deterministic projections

Note that any of these projections should be considered preliminary until final 2012 and 2013 landings are available. Deterministic projections use three levels of recruitment in the first three years that then level off at the geometric mean for 1990-2012 for the remainder of the projection time period (Figure 13). All three projections and all three levels of recruitment indicate a short-term spike in yield as the biomass above the $SSB_{SPR30\%}$ is reduced and then generally level off at constant values, given the constant recruitment (Figures 14-16). The notable exception is the low recruitment scenario where yields initially spike in the first two freely estimated yield year (2015 and 2016) but then show a drop in 2017-2019 as the lack of recruitment is felt by the fishery. Projections at $F_{SPR30\%}$ and FOY 75%SPR30 give very similar results and can be considered the same, except that the SSB benchmark for $F_{SPR40\%}$ is higher.

A key result of the projections is that the forecasted yields are all higher than the current Atlantic ACL. This is not unexpected as the previous ACL was based upon a different stock structure where the Atlantic had fewer landings. Hence it could be expected that, all things being equal, yields in the Atlantic might increase from S16 to S38. The other result is that the projected yields are relatively high compared to historical removals. This is also not unexpected given that the model indicates that the stock is well above the biomass target and has been for the

Fishing at $F_{SPR30\%}$ would be expected to reduce the spawning stock biomass down to a level below 30% of virgin (Figure 14) while the $F_{SPR40\%}$ or FOY would maintain the SSB at 30% of virgin (Figures 15 and 16). The reason for this is that the geometric mean recruitment is lower than R0.

Stochastic projections

As of the date of this document, stochastic projections for the RW-preferred model are still running and are anticipated to be ready for the SSC meeting in October.

Other considerations

1. Compare VPA F and NAA with Stock synthesis estimates.

This analysis indicated that the VPA and the Base SS model had similar numbers at age estimates, particularly for the early years (Figure 17). For later years the numbers at age began to diverge with the SS model having higher numbers at age and in the plus group, largely due to an increase in indicates that recruits in the later years. The main difference between the SS model and the VPA model appears to be a function of the treatment of the male selectivity. In the SS model 3 where male selectivity was modeled as asymptotic, it led to very similar levels of recruitment as the VPA (Figure 18). Estimates of exploitation rate were also similar amongst all three models but the base SS exploitation rate appears to have dropped in recent years more so than the VPA. Estimated selectivities at age were also compared showing both the VPA and SS estimated domed selectivity, but that the VPA showed less strong doming (Figure 19). Overall, the VPA and SS models are quite similar, as documented by this analysis.

2. Calculate cryptic biomass for base model. Cryptic biomass is the biomass not selected by the fishery.

This analysis shows that about 40% of the numbers of fish age 3+ are cryptic or not selected for by any fishery (Figure 20).

3. Remove female offset on selectivity.

This analysis showed that there were some minor differences in the selectivity estimates when the female offset was removed (Figure 21). The model fit degraded from 8620 to 8753 (133 LL points) with the reduction in fit primarily due to the length and age composition. Key stock estimates did not change drastically with this modeling change (Figure 22). The decision of the RW was to stay with the Base model selectivity formulation but that a more parsimonious approach would have been to model male and female selectivity as the same at length.

4. Downweight length comps. This series of runs was conducted to evaluate the effects of reducing the weight on the length composition.

The length composition was downweighted by 50% and 80% which resulted in *de facto* giving more weight to the age composition data (Figure 23). The result was that the recruits were estimated to be higher. Fits to the recruitment and surveys degraded but fit to the catch improved. No decision was made to alter the weighting within the RW-preferred model, however.

5. Downweight Conditional age at length and 6, compare run 2 with "Panama City" growth fixed and with base estimated growth.

Downweighting the conditional age at length (CAAL) had substantial impact upon estimated quantities. Primarily, reducing the weight on the CAAL resulted in lower estimates of R0, higher steepness and different baseline levels of the population. Initially it was assumed that it was in the estimation of growth that the CAAL had this impact. Hence two runs were made with Run 2 (no CAAL) to fix growth at the "Pamama City" values and at the Base model values to see if this would mimic the differences between downweighting the CAAL (Figure 24). These two model runs (blue and purple lines on the left side of Figure 24 were very similar indicating that it was not the estimation of growth that led to the different baseline levels of R0 but rather signal in the CAAL data itself on the estimates of R0. This can be seen in the likelihood profiling of R0 (Figure 4 shows a different model run but similar pattern) where the CAAL data pulls the value of R0 towards high values. This has an expected impact upon steepness where the tendency towards higher values of R0 is balanced by lower levels of steepness (Table in Figure 25). Nonetheless there was no decision from the RW about how to differentially weight the CAAL data and the base weighting method (input sample size capped at 100) was retained.

Table 1. Table of likelihoods by component for base model and subsequent RW model runs

	4. BASE	10. Stp 0.99, fix sigmaR	11. Est sigmaR*
max grad component	0.023	0.082	0.012
LIKELIHOOD	8620.950	8637.050	8622.390
Component	logL*Lambda	logL*Lambda	logL*Lambda
Catch	140.269	147.27	141.629
Equil_catch	0.000	0	0
Survey	-65.375	-63.7443	-65.0385
Discard	149.707	147.839	149.239
Length_comp	2826.360	2837	2828.69
Age_comp	5572.600	5572.14	5564.96
Recruitment	-6.874	-8.39171	-1.53308
Forecast_Recruitment	0.000	0	0
Parm_priors	0.007	0.0080533	0.0089483
Parm_softbounds	0.005	0.0056629	0.0053732
Parm_devs	0.000	0	0
Crash_Pen	0.000	0	0

*Review workshop preferred model

Table 2. List of Non-F SS parameters, initial parameter starting values, estimated parameter values and standard errors and probability density functions assigned as priors. Parameters that were held constant to their input values are labeled fixed.

Active number	Parameter_label	Estimation	Initial	PR type	Prior	Pr SD	Estimate	SD	Phase
_	L_at_Amin_Fem_GP_1	fixed	21	_	_	_	21	_	_
1	L_at_Amax_Fem_GP_1	Est	130.13	_	_	_	116.272	0.357509	3
2	VonBert_K_Fem_GP_1	Est	0.14484	_	_	_	0.315614	0.003214	4
3	CV_young_Fem_GP_1	Est	0.2	_	_	_	0.232778	0.003975	6
4	CV_old_Fem_GP_1	Est	0.08	_	_	_	0.0805676	0.001125	6
_	L_at_Amin_Mal_GP_1	fixed	21	_	_	_	21	_	_
5	L_at_Amax_Mal_GP_1	Est	98.928	_	_	_	96.1625	0.251269	3
6	VonBert_K_Mal_GP_1	Est	0.26032	_	_	_	0.400297	0.004823	4
7	CV_young_Mal_GP_1	Est	0.2	_	_	_	0.244391	0.005153	6
8	CV_old_Mal_GP_1	Est	0.08	_	_	_	0.0619908	0.000976	6
_	Wtlen_1_Fem	fixed	7.314E-06	_	_	_	7.314E-06	_	_
_	Wtlen_2_Fem	fixed	3.00871	_	_	_	3.00871	_	_
_	Mat50%_Fem	fixed	58.113	_	_	_	58.113	_	_
_	Mat_slope_Fem	fixed	-0.36886	_	_	_	-0.36886	_	_
_	Eggs_scalar_Fem	fixed	6.085E-07	_	_	_	6.085E-07	_	_
_	Eggs_exp_len_Fem	fixed	3.0512	_	_	_	3.0512	_	_
_	Wtlen_1_Mal	fixed	7.314E-06	_	_	_	7.314E-06	_	_
_	Wtlen_2_Mal	fixed	3.00871	_	_	_	3.00871	_	_
_	RecrDist_GP_1	fixed	0	_	_	_	0	_	_
_	RecrDist_Area_1	fixed	0	_	_	_	0	_	_
_	RecrDist_Seas_1	fixed	0	_	_	_	0	_	_
_	CohortGrowDev	fixed	0	_	_	_	0	_	_
9	SR_LN(R0)	Est	9	_	_	_	9.17949	0.0363717	1
_	SR_BH_steep	fixed	0.99	_	_	_	0.99	_	2
10	SR_sigmaR	fixed	0.6	_	_	_	0.830807	0.0457901	_
_	SR_envlink	fixed	0	_	_	_	0	_	_
_	SR_R1_offset	fixed	0	_	_	_	0	_	_
_	SR_autocorr	fixed	0	_	_	_	0	_	_
11	Main_RecrDev_1981	Est	_	dev	0	0	0.152098	0.077293	_
12	Main_RecrDev_1982	Est	_	dev	0	0	-0.234118	0.080587	_
13	Main_RecrDev_1983	Est	_	dev	0	0	-0.248514	0.072352	_
14	Main_RecrDev_1984	Est	_	dev	0	0	0.0990433	0.054822	_
15	Main_RecrDev_1985	Est	_	dev	0	0	0.244673	0.0472748	_
16	Main_RecrDev_1986	Est	_	dev	0	0	-0.0521252	0.0492195	_
17	Main_RecrDev_1987	Est	_	dev	0	0	-0.622425	0.059103	_
18	Main_RecrDev_1988	Est	_	dev	0	0	-0.387995	0.0544646	_
19	Main_RecrDev_1989	Est	_	dev	0	0	0.434298	0.0420691	_
20	Main_RecrDev_1990	Est	_	dev	0	0	0.0826978	0.0437726	_
21	Main_RecrDev_1991	Est	_	dev	0	0	-0.632813	0.0557165	_
22	Main_RecrDev_1992	Est	_	dev	0	0	-0.336881	0.0529826	_
23	Main_RecrDev_1993	Est	_	dev	0	0	-0.292227	0.0540613	_
24	Main_RecrDev_1994	Est	_	dev	0	0	0.190347	0.045305	_
25	Main_RecrDev_1995	Est	_	dev	0	0	0.441745	0.0418748	_
26	Main_RecrDev_1996	Est	_	dev	0	0	0.532961	0.0378338	_
27	Main_RecrDev_1997	Est	_	dev	0	0	-0.170135	0.0471218	_
28	Main_RecrDev_1998	Est	_	dev	0	0	0.596238	0.0356386	_
29	Main_RecrDev_1999	Est	_	dev	0	0	-0.0798552	0.0445608	_
30	Main_RecrDev_2000	Est	_	dev	0	0	-0.446626	0.0546839	_
31	Main_RecrDev_2001	Est	_	dev	0	0	0.563091	0.0411271	_
32	Main_RecrDev_2002	Est	_	dev	0	0	0.0694744	0.0527266	_
33	Main_RecrDev_2003	Est	_	dev	0	0	0.869481	0.0398745	_
34	Main_RecrDev_2004	Est	_	dev	0	0	0.539075	0.0453485	_
35	Main_RecrDev_2005	Est	_	dev	0	0	0.282797	0.0474909	_
36	Main_RecrDev_2006	Est	_	dev	0	0	0.413968	0.0438196	_
37	Main_RecrDev_2007	Est	_	dev	0	0	0.380032	0.0467976	_
38	Main_RecrDev_2008	Est	_	dev	0	0	-0.423863	0.0730497	_
39	Main_RecrDev_2009	Est	_	dev	0	0	-0.632124	0.0964871	_
40	Main_RecrDev_2010	Est	_	dev	0	0	-0.0805416	0.0977456	_
41	Main_RecrDev_2011	Est	_	dev	0	0	-0.246529	0.203129	_

42	Main_RecrDev_2012	Est	_	dev	0	0	-1.00525	0.212677	_
_	InitF_11_HL	fixed	0	_	_	_	0	_	_
_	InitF_22_GN	fixed	0	_	_	_	0	_	_
_	InitF_33_Shrimp	fixed	0	_	_	_	0	_	_
_	InitF_44_HB	fixed	0	_	_	_	0	_	_
_	InitF_55_CP	fixed	0	_	_	_	0	_	_
_	InitF_66_TOURN	fixed	0	_	_	_	0	_	_
495	LnQ_base_3_3_Shrimp	Est	5	_	_	_	5.19224	0.135203	1
496	SizeSel_1P_1_1_HL	Est	67	_	_	_	72.1895	0.773021	3
497	SizeSel_1P_2_1_HL	Est	-2.92	_	_	_	-11.1031	62.3471	3
498	SizeSel_1P_3_1_HL	Est	4.5	_	_	_	4.99979	0.110845	4
499	SizeSel_1P_4_1_HL	Est	4.214	_	_	_	4.79133	0.17816	3
_	SizeSel_1P_5_1_HL	fixed	-15	_	_	_	-15	_	_
500	SizeSel_1P_6_1_HL	Est	5	_	_	_	-1.62485	0.176495	5
_	Retain_1P_1_1_HL	fixed	29	_	_	_	29	_	_
_	Retain_1P_2_1_HL	fixed	1	_	_	_	1	_	_
_	Retain_1P_3_1_HL	fixed	1	_	_	_	1	_	_
_	Retain_1P_4_1_HL	fixed	0	_	_	_	0	_	_
_	DiscMort_1P_1_1_HL	fixed	10	_	_	_	10	_	_
_	DiscMort_1P_2_1_HL	fixed	1	_	_	_	1	_	_
_	DiscMort_1P_3_1_HL	fixed	0.25	_	_	_	0.25	_	_
_	DiscMort_1P_4_1_HL	fixed	0	_	_	_	0	_	_
501	SzSel_1Fem_Peak_1_HL	Est	0	_	_	_	3.59584	1.21895	5
502	SzSel_1Fem_Ascend_1_HL	Est	0	_	_	_	0.0270465	0.180027	5
503	SzSel_1Fem_Descend_1_HL	Est	0	_	_	_	0.88815	0.213655	5
504	SzSel_1Fem_Final_1_HL	Est	-5	_	_	_	-0.688499	0.222928	5
_	SzSel_1Fem_Scale_1_HL	fixed	1	_	_	_	1	_	_
505	SizeSel_2P_1_2_GN	Est	76	_	_	_	74.6307	1.82111	3
506	SizeSel_2P_2_2_GN	Est	-11	_	_	_	-11.6668	55.3447	3
507	SizeSel_2P_3_2_GN	Est	4.7804	Norm	4.7804	2	4.51288	0.339833	4
508	SizeSel_2P_4_2_GN	Est	7	_	_	_	7.05972	0.183787	3
_	SizeSel_2P_5_2_GN	fixed	-999	_	_	_	-999	_	_
_	SizeSel_2P_6_2_GN	fixed	-999	_	_	_	-999	_	_
509	SizeSel_4P_1_4_HB	Est	64	_	_	_	64.877	0.44432	3
510	SizeSel_4P_2_4_HB	Est	-2.6	_	_	_	-2.60301	0.195416	3
511	SizeSel_4P_3_4_HB	Est	3.4	_	_	_	4.17483	0.0751881	4
512	SizeSel_4P_4_4_HB	Est	5.3	_	_	_	5.12499	0.13666	4
_	SizeSel_4P_5_4_HB	fixed	-15	_	_	_	-15	_	_
513	SizeSel_4P_6_4_HB	Est	1	_	_	_	-2.57067	0.11081	5
_	Retain_4P_1_4_HB	fixed	29	_	_	_	29	_	_
_	Retain_4P_2_4_HB	fixed	1	_	_	_	1	_	_
_	Retain_4P_3_4_HB	fixed	1	_	_	_	1	_	_
_	Retain_4P_4_4_HB	fixed	0	_	_	_	0	_	_
_	DiscMort_4P_1_4_HB	fixed	10	_	_	_	10	_	_
_	DiscMort_4P_2_4_HB	fixed	1	_	_	_	1	_	_
_	DiscMort_4P_3_4_HB	fixed	0.22	_	_	_	0.22	_	_
_	DiscMort_4P_4_4_HB	fixed	0	_	_	_	0	_	_
514	SizeSel_5P_1_5_CP	Est	73	_	_	_	73.8942	0.585498	3
515	SizeSel_5P_2_5_CP	Est	-12.9	_	_	_	-12.9374	38.8935	3
516	SizeSel_5P_3_5_CP	Est	5.78	_	_	_	5.82165	0.0693368	3
517	SizeSel_5P_4_5_CP	Est	4.15	_	_	_	4.20096	0.176917	3
_	SizeSel_5P_5_5_CP	fixed	-15	_	_	_	-15	_	_
518	SizeSel_5P_6_5_CP	Est	1	_	_	_	-0.944716	0.0702698	5
_	Retain_5P_1_5_CP	fixed	29	_	_	_	29	_	_
_	Retain_5P_2_5_CP	fixed	1	_	_	_	1	_	_
_	Retain_5P_3_5_CP	fixed	1	_	_	_	1	_	_
_	Retain_5P_4_5_CP	fixed	0	_	_	_	0	_	_
_	DiscMort_5P_1_5_CP	fixed	10	_	_	_	10	_	_
_	DiscMort_5P_2_5_CP	fixed	1	_	_	_	1	_	_
_	DiscMort_5P_3_5_CP	fixed	0.2	_	_	_	0.2	_	_
_	DiscMort_5P_4_5_CP	fixed	0	_	_	_	0	_	_
519	SizeSel_6P_1_6_TOURN	Est	100	_	_	_	87.9577	1.10073	3
_	SizeSel_6P_2_6_TOURN	fixed	-6.076	_	_	_	-6.07561	_	_
520	SizeSel_6P_3_6_TOURN	Est	6.1	_	_	_	5.65195	0.117838	3
_	SizeSel_6P_4_6_TOURN	fixed	4.214	_	_	_	4.21396	_	_
_	SizeSel_6P_5_6_TOURN	fixed	-15	_	_	_	-15	_	_

_	SizeSel_6P_6_6_TOURN	fixed	15	_	_	_	15	_	_
_	SzSel_6Fem_Peak_6_TOURN	fixed	-10	_	_	_	-10	_	_
521	SzSel_6Fem_Ascend_6_TOURN	Est	0	_	_	_	-0.0613952	0.0603321	2
_	SzSel_6Fem_Descend_6_TOURN	fixed	-10	_	_	_	-10	_	_
_	SzSel_6Fem_Final_6_TOURN	fixed	-10	_	_	_	-10	_	_
_	SzSel_6Fem_Scale_6_TOURN	fixed	1	_	_	_	1	_	_
_	AgeSel_3P_1_3_Shrimp	fixed	0	_	_	_	0	_	_
_	AgeSel_3P_2_3_Shrimp	fixed	0	_	_	_	0	_	_
_	AgeSel_7P_1_7_SeaTrawl	fixed	0	_	_	_	0	_	_
_	AgeSel_7P_2_7_SeaTrawl	fixed	0	_	_	_	0	_	_
_	Retain_1P_1_1_HL_BLK1repl_1900	fixed	35	_	_	_	35	_	_
_	Retain_1P_1_1_HL_BLK1repl_1990	fixed	35	_	_	_	35	_	_
_	Retain_1P_1_1_HL_BLK1repl_1992	fixed	51	_	_	_	51	_	_
_	Retain_1P_1_1_HL_BLK1repl_1999	fixed	61	_	_	_	61	_	_
_	Retain_4P_1_4_HB_BLK1repl_1900	fixed	35	_	_	_	35	_	_
_	Retain_4P_1_4_HB_BLK1repl_1990	fixed	35	_	_	_	35	_	_
_	Retain_4P_1_4_HB_BLK1repl_1992	fixed	51	_	_	_	51	_	_
_	Retain_4P_1_4_HB_BLK1repl_1999	fixed	61	_	_	_	61	_	_
_	Retain_5P_1_5_CP_BLK1repl_1900	fixed	35	_	_	_	35	_	_
_	Retain_5P_1_5_CP_BLK1repl_1990	fixed	35	_	_	_	35	_	_
_	Retain_5P_1_5_CP_BLK1repl_1992	fixed	51	_	_	_	51	_	_
_	Retain_5P_1_5_CP_BLK1repl_1999	fixed	61	_	_	_	61	_	_
522	SizeSel_6P_1_6_TOURN_BLK2repl_1997	Est	100	_	_	_	113.328	1.92929	6
523	SizeSel_6P_3_6_TOURN_BLK2repl_1997	Est	6.1	_	_	_	6.35173	0.107111	6

Table 3. Estimated spawning stock biomass (millions of eggs) and recruitment (in 1000s)

Fishing_Year	SSB	Rec	Fishing_Year	SSB	Rec	Fishing_Year	SSB	Rec
1901	7952.51	9696.21	1951	7516.6	9694.79	2001	3376.79	12016.6
1902	7952.51	9696.21	1952	7464.88	9694.61	2002	3438.41	7335.9
1903	7952.51	9696.21	1953	7417.08	9694.45	2003	3512.01	16328.4
1904	7952.51	9696.21	1954	7372.94	9694.29	2004	3620.98	11736.1
1905	7951.49	9696.21	1955	7332.56	9694.14	2005	3812.12	9085.44
1906	7949.46	9696.2	1956	7271.59	9693.92	2006	4181.28	10363.7
1907	7943.42	9696.19	1957	7190.16	9693.62	2007	4410.28	10020.4
1908	7933.45	9696.15	1958	7108.72	9693.31	2008	4459.94	4485.17
1909	7919.79	9696.11	1959	7036.86	9693.03	2009	4609.93	3642.47
1910	7902.75	9696.06	1960	6960.16	9692.72	2010	4638.63	6323.49
1911	7882.67	9696	1961	6888.28	9692.43	2011	4522.89	5355.76
1912	7859.88	9695.93	1962	6811.86	9692.12	2012	4399.67	2507.61
1913	7834.71	9695.85	1963	6734.55	9691.79			
1914	7807.48	9695.76	1964	6657.31	9691.45			
1915	7778.45	9695.67	1965	6577.07	9691.1			
1916	7747.88	9695.57	1966	6492.57	9690.71			
1917	7715.99	9695.46	1967	6422.98	9690.39			
1918	7682.94	9695.35	1968	6350.63	9690.04			
1919	7648.9	9695.24	1969	6281.96	9689.71			
1920	7614.01	9695.13	1970	6205.36	9689.32			
1921	7578.37	9695	1971	6123.58	9688.91			
1922	7542.08	9694.88	1972	6061.2	9688.58			
1923	7511.98	9694.78	1973	5978.68	9688.14			
1924	7488.16	9694.7	1974	5880.74	9687.6			
1925	7470.37	9694.63	1975	5778.76	9687.01			
1926	7458.17	9694.59	1976	5670.11	9686.37			
1927	7451.05	9694.57	1977	5551.13	9685.63			
1928	7426.67	9694.48	1978	5447.67	9684.97			
1929	7399.53	9694.38	1979	5379.1	9684.51			
1930	7376.93	9694.3	1980	5325.49	9684.15			
1931	7338.14	9694.16	1981	5215.83	7983.59			
1932	7320.04	9694.1	1982	5100.97	5425.37			
1933	7309.71	9694.06	1983	4994.83	5347.38			
1934	7306.6	9694.05	1984	4822.73	7568.7			

1935	7296.82	9694.01	1985	4579.37	8753.29
1936	7287.58	9693.98	1986	4284.73	6503.43
1937	7288.92	9693.99	1987	4087.4	3675.92
1938	7300.77	9694.03	1988	3980.27	4646.45
1939	7299.7	9694.02	1989	3789.99	10571.3
1940	7284.79	9693.97	1990	3597.05	7435.46
1941	7293.82	9694	1991	3487.17	3634.87
1942	7282.95	9693.96	1992	3444.93	4886.3
1943	7279.2	9693.95	1993	3274.07	5107.89
1944	7299.36	9694.02	1994	3134.85	8273.76
1945	7365.91	9694.26	1995	2972.09	10634.9
1946	7432.07	9694.5	1996	2832.78	11646.7
1947	7494.84	9694.72	1997	2847.96	5765.92
1948	7552.61	9694.92	1998	2941.65	12410.7
1949	7527.43	9694.83	1999	3043.8	6313.53
1950	7514.69	9694.79	2000	3224.14	4376.69

Table 4. Estimated annual fishing mortality as exploitation rate in numbers.

Fishing_Year	Fishing_Mortality	Fishing_Year	Fishing_Mortality	Fishing_Year	Fishing_Mortality
1901	0.0001	1951	0.0142	2001	0.0648
1902	0.0003	1952	0.0140	2002	0.0538
1903	0.0008	1953	0.0141	2003	0.0697
1904	0.0013	1954	0.0143	2004	0.0598
1905	0.0019	1955	0.0180	2005	0.0490
1906	0.0024	1956	0.0217	2006	0.0624
1907	0.0030	1957	0.0229	2007	0.0767
1908	0.0035	1958	0.0229	2008	0.0505
1909	0.0041	1959	0.0252	2009	0.0529
1910	0.0046	1960	0.0264	2010	0.0475
1911	0.0052	1961	0.0285	2011	0.0341
1912	0.0058	1962	0.0298	2012	0.0264
1913	0.0063	1963	0.0311		
1914	0.0069	1964	0.0329		
1915	0.0075	1965	0.0349		
1916	0.0081	1966	0.0340		
1917	0.0086	1967	0.0358		
1918	0.0092	1968	0.0367		
1919	0.0089	1969	0.0392		
1920	0.0086	1970	0.0415		
1921	0.0082	1971	0.0404		
1922	0.0078	1972	0.0452		
1923	0.0075	1973	0.0490		
1924	0.0101	1974	0.0516		
1925	0.0107	1975	0.0548		
1926	0.0104	1976	0.0584		
1927	0.0130	1977	0.0588		
1928	0.0105	1978	0.0544		
1929	0.0098	1979	0.0552		
1930	0.0092	1980	0.0670		
1931	0.0104	1981	0.0674		
1932	0.0105	1982	0.0637		
1933	0.0092	1983	0.0655		
1934	0.0079	1984	0.0647		
1935	0.0098	1985	0.0776		

1936	0.0117	1986	0.0766
1937	0.0084	1987	0.0644
1938	0.0113	1988	0.0749
1939	0.0103	1989	0.0661
1940	0.0066	1990	0.0622
1941	0.0001	1991	0.0766
1942	0.0002	1992	0.1015
1943	0.0002	1993	0.0735
1944	0.0003	1994	0.0894
1945	0.0114	1995	0.1032
1946	0.0091	1996	0.0902
1947	0.0066	1997	0.0939
1948	0.0040	1998	0.1001
1949	0.0062	1999	0.0593
1950	0.0116	2000	0.0707

Table 5. Stock status estimates of measured as SSB / SSB_{MSY}.

Fishing_Year	SSB/SSB_{MSY}	Fishing_Year	SSB/SSB_{MSY}	Fishing_Year	SSB/SSB_{MSY}
1901	4.672	1951	4.416	2001	1.984
1902	4.672	1952	4.386	2002	2.020
1903	4.671	1953	4.358	2003	2.063
1904	4.667	1954	4.332	2004	2.127
1905	4.661	1955	4.308	2005	2.240
1906	4.653	1956	4.272	2006	2.457
1907	4.643	1957	4.225	2007	2.591
1908	4.631	1958	4.177	2008	2.620
1909	4.618	1959	4.134	2009	2.709
1910	4.603	1960	4.089	2010	2.725
1911	4.587	1961	4.047	2011	2.657
1912	4.570	1962	4.002	2012	2.585
1913	4.552	1963	3.957		
1914	4.533	1964	3.911		
1915	4.514	1965	3.864		
1916	4.494	1966	3.815		
1917	4.474	1967	3.774		
1918	4.453	1968	3.731		
1919	4.431	1969	3.691		
1920	4.414	1970	3.646		
1921	4.400	1971	3.598		
1922	4.389	1972	3.561		
1923	4.382	1973	3.513		
1924	4.378	1974	3.455		
1925	4.363	1975	3.395		
1926	4.348	1976	3.331		
1927	4.334	1977	3.262		
1928	4.311	1978	3.201		
1929	4.301	1979	3.160		
1930	4.295	1980	3.129		
1931	4.293	1981	3.065		
1932	4.287	1982	2.997		
1933	4.282	1983	2.935		
1934	4.283	1984	2.834		

1935	4.290	1985	2.691
1936	4.289	1986	2.517
1937	4.280	1987	2.402
1938	4.285	1988	2.339
1939	4.279	1989	2.227
1940	4.277	1990	2.113
1941	4.289	1991	2.049
1942	4.328	1992	2.024
1943	4.367	1993	1.924
1944	4.404	1994	1.842
1945	4.437	1995	1.746
1946	4.423	1996	1.664
1947	4.415	1997	1.673
1948	4.418	1998	1.728
1949	4.431	1999	1.788
1950	4.436	2000	1.894

Table 6. Fishery status as F/Fmsy.

Fishing_Year	F/F_{MSY}	Fishing_Year	F/F_{MSY}	Fishing_Year	F/F_{MSY}
1901	0.00	1951	0.17	2001	0.89
1902	0.00	1952	0.17	2002	0.73
1903	0.01	1953	0.17	2003	0.95
1904	0.02	1954	0.17	2004	0.82
1905	0.02	1955	0.22	2005	0.68
1906	0.03	1956	0.26	2006	0.86
1907	0.03	1957	0.27	2007	1.04
1908	0.04	1958	0.28	2008	0.70
1909	0.05	1959	0.30	2009	0.74
1910	0.05	1960	0.32	2010	0.67
1911	0.06	1961	0.34	2011	0.48
1912	0.07	1962	0.36	2012	0.37
1913	0.07	1963	0.38		
1914	0.08	1964	0.40		
1915	0.09	1965	0.43		
1916	0.09	1966	0.42		
1917	0.10	1967	0.44		
1918	0.11	1968	0.45		
1919	0.10	1969	0.48		
1920	0.10	1970	0.51		
1921	0.10	1971	0.50		
1922	0.09	1972	0.56		
1923	0.09	1973	0.62		
1924	0.12	1974	0.65		
1925	0.12	1975	0.70		
1926	0.12	1976	0.75		
1927	0.15	1977	0.76		
1928	0.12	1978	0.71		
1929	0.12	1979	0.75		
1930	0.11	1980	0.89		
1931	0.12	1981	0.90		
1932	0.12	1982	0.84		
1933	0.11	1983	0.86		

1934	0.09	1984	0.86
1935	0.12	1985	1.03
1936	0.14	1986	1.02
1937	0.10	1987	0.86
1938	0.13	1988	1.00
1939	0.12	1989	0.88
1940	0.08	1990	0.83
1941	0.00	1991	1.02
1942	0.00	1992	1.35
1943	0.00	1993	0.98
1944	0.00	1994	1.20
1945	0.14	1995	1.38
1946	0.11	1996	1.21
1947	0.08	1997	1.27
1948	0.05	1998	1.37
1949	0.08	1999	0.81
1950	0.14	2000	0.96

Table 7. Summary of stock status of Atlantic King Mackerel.

Metric	Value/Determination
Assessment Year (2012/13 fishing year)	2012
Data Range (south Atlantic fishing years)	1901 to 2012
Spawning Stock Biomass(million eggs) $_{2012}$	4400
Fishing Mortality(exploitation rate in N)$_{2012}$	0.0264
Recruitment (age-0)$_{2012}$	2,507,610
Spawning Stock Biomass$_{Unfished}$	7952
Recruitment$_{Unfished}$, (age 0)	9,696,210
Geometric mean recruitment (1990-2012, age 0)	7,030,302
Maximum Sustainable Yield	NA
Eq. Yield at FSPR30% and geometric mean recruitment (MT, whole wt)	5702
Spawning Stock Biomass at FSPR30% and geometric mean recruitment	1702
Fishing mortality$_{FSPR30\%}$	0.157
$SSB_{2012}/SSB_{SPR30\%\text{-geo mean rec**}}$	2.56
$F_{2012}/F_{SPR30\%}$	0.168
Stock Status	Not Overfished
Fishery Status	Not Undergoing Overfishing

*True MSY not estimated. Proxy for MSY could be considered to be Eq. yield at FSPR30%.

**SSB benchmark uses geometric mean recruitment not R0

Table 8. Derived quantities and parameter estimates for SPR30%. Yields are in metric tons whole weight, SSB is in millions of eggs and fishing mortality rates exploitation rate in numbers. For the three low, medium and high recruitment scenarios, the benchmarks remain the same

	4. BASE	SE	10. Stp 0.99	SE	11. Stp 0.99, sigma r est	se	Run 11 Low	Run 11 Med	Run 11 High
LL	8620.95		8637.05		8622.39		8622.4	8622.4	8622.4
SR_LN(R0)	9.26	0.04	9.18	0.04	9.18	0.04	9.18	9.18	9.18
SR_BH_steep	0.50		0.99		0.99	_	0.99	0.99	0.99
sigma R	0.60		0.60		0.83	0.05	0.83	0.83	0.83
SSB_Unfished	8595.62	314.32	7990.22	349.15	7952.51	302.91			
TotBio_Unfished	144664	5247	134495	5841	133870	5057			
SmryBio_Unfished	144506	5242	134348	5835	133724	5052			
Recr_Unfished	10507.70	370.62	9729.04	408.60	9696.21	352.67			
SSB_B30%	2578.69	94.30	2397.06	104.74	2385.75	90.87	2385.7	2385.7	2385.7
SPR_B30%	0.47	0.02	0.30	0.00	0.30	0.00			
Fstd_Btgt	0.09	0.01	0.16	0.00	0.16	0.00			
TotYield_Btgt	4404.34	236.43	7817.24	336.31	7852.89	293.80			
SSB_FSPR30%	574.47	270.67	2382.91	104.13	2371.66	90.34	1701.62	1701.6	1701.6
FstdSPR30%	0.16	0.0041	0.16	0.0046	0.16	0.00			
SPR_SPR30%	0.30	0.00	0.30	0.00	0.30	0.00			
FstdSPR30%	0.156	0.0041	0.160	0.0046	0.157	0.0043			
TotYieldSPR30%	1917.99	901.49	7829.07	336.93	7864.92	294.34	5771.3	5771.3	5771.3
RetYieldSPR30%	1894.30	890.26	7725.83	333.70	7765.37	291.81	5701.8	5701.8	5701.8

Table 9. Deterministic stock status/projections at FSPR30%. Note that the Run11 model is the RW-preferred model and the projections with geometric mean recruitment are to be used for yield advice and final stock status determination. The probabilities of SSB>SSBspr30% and F>Fspr30% are shown for the models assuming virgin recruitment levels. Final benchmarks should reflect the assumed level of recent geometric mean recruitment. Yields are in metric tons whole weight, SSB is in millions of eggs and fishing mortality rates is in exploitation rate in numbers.

							Run 11 projected with Geomean 1990-2012 recruitment		
	4. BASE	SE	10. Stp 0.99	SE	11. RW-pref. proj with R0	SE	Run 11 Low	Run 11 Med	Run 11 High
ForeCatch_2013	1865	21	1823	17	1831	17	1840	1840	1840
ForeCatch_2014	1895	22	1842	17	1848	17	1877	1874	1872
ForeCatch_2015	8310	1113	12253	779	9545	811	8319	8584	8849
ForeCatch_2016	7738	1670	11271	661	9405	672	6910	7476	8041
ForeCatch_2017	7279	1770	10548	594	9244	602	6031	6777	7523
ForeCatch_2018	6837	1779	9943	552	9003	565	5886	6505	7124
ForeCatch_2019	6410	1749	9479	524	8639	601	6029	6420	6811
ForeCatch_2020	6027	1709	9128	506	8360	547	6085	6325	6565
SSB2012	3861	342.8	5773	453.0	4399	433.7	4399	4399	4399
F2012	0.030	0.004	0.020	0.002	0.026	0.003	0.026	0.026	0.026
SSB2012/SSB SPR30	6.72	1.27	2.42	4.35	1.86	4.80	2.59	2.59	2.59
F2012/FSPR30	0.19	0.03	0.13	0.03	0.17	0.03	0.17	0.17	0.17
SSB2012/MSST	8.00	1.51	2.88	5.18	2.21	5.72	3.08	3.08	3.08
Prob B<Bspr30%	P<0.001		P<0.001		P<0.001				
Prob F>Fspr30%	P<0.0001		P<0.0001		P<0.0001				

Table 10. Deterministic stock status and projections at FSPR30%, 40% and 75% of FSPR30% (FOY). Yields are in metric tons whole weight, SSB is in millions of eggs and fishing mortality rates is in exploitation rate in numbers.

	SPR30%			SPR 40%			75% of FSPR30%		
Quantity	LOW*	MED*	HIGH *	LOW*	MED*	HIGH *	LOW*	MED*	HIGH*
SSB_FSPR (using R0)	2372	2372	2372	3169	3169	3169	2372	2372	2372
Fstd SPR	0.156	0.156	0.156	0.116	0.116	0.116	0.119$	0.119$	0.119$
TotYield at FSPRX% geomean rec**	5771	5771	5771	5200	5200	5200	5265	5265	5265
RetYield at FSPRX% geomean rec**	5702	5702	5702	5148	5148	5148	5211	5211	5211
SSB at FSPR X% geomean rec**	1702	1702	1702	2279	2279	2279	2220	2220	2220
ForeCatch_2013	1840	1840	1840	1840	1840	1840	1840	1840	1840
ForeCatch_2014	1877	1874	1872	1876	1874	1871	1876	1874	1871
ForeCatch_2015	8319	8584	8849	6198	6398	6598	6385	6590	6796
ForeCatch_2016	6910	7476	8041	5394	5840	6286	5534	5991	6448
ForeCatch_2017	6031	6777	7523	4883	5492	6101	4993	5616	6238
ForeCatch_2018	5886	6505	7124	4865	5401	5936	4966	5511	6055
ForeCatch_2019	6029	6420	6811	5064	5428	5791	5162	5529	5896
ForeCatch_2020	6085	6325	6565	5192	5429	5667	5285	5523	5762
ForeCatch_2021	6060	6217	6373	5239	5401	5564	5326	5489	5651
ForeCatch_2022	6007	6115	6224	5246	5363	5480	5328	5445	5562
SSB2012	4400	4400	4400	4400	4400	4400	4400	4400	4400
F2012	0.026	0.026	0.026	0.026	0.026	0.026	0.026	0.026	0.026
SSB2012/SSB SPR%	1.855	1.855	1.855	1.388	1.388	1.388	1.855	1.855	1.855
F2012/FSPR%	0.168	0.168	0.168	0.168	0.168	0.168	0.169	0.169	0.169
SSB2012/MSST	3.078	3.078	3.078	2.299	2.299	2.299	2.360	2.360	2.360
SSB2012 / SSB Geo Mean Rec SPR%	2.586	2.586	2.586	1.931	1.931	1.931	1.982	1.982	1.982

* Low, medium and high refer to recruitment levels for the first 3 years of projections.

**geometric mean recruitment if for years 1990-2012

$F for 75% of FSPR30% is almost exactly equal to FSPR40% as FSPR30 is ~75% of FSPR40.

Table 11. Downweighting conditional age at length composition by 70%(0.3), 80%, 95% and 99.9% and comparison of key parameters between run 2 (no CAAL data) with growth parms fixed at Base values or Panama City values.

	BASE	0.3	0.2	0.05	0.001	Run 2 with Base growth	No age comps, run 2, PC growth
L_at_Amin_Fem_GP_1	21.00	21.00	21.00	21.00	21.00	21.00	21.00
L_at_Amax_Fem_GP_1	116.21	115.89	115.52	112.52	110.00	116.21	130.13
VonBert_K_Fem_GP_1	0.32	0.31	0.31	0.33	0.40	0.32	0.14
CV_young_Fem_GP_1	0.23	0.22	0.22	0.19	0.17	0.23	0.20
CV_old_Fem_GP_1	0.08	0.09	0.10	0.13	0.17	0.08	0.08
L_at_Amin_Mal_GP_1	21.00	21.00	21.00	21.00	21.00	21.00	21.00
L_at_Amax_Mal_GP_1	96.03	97.06	97.12	95.68	94.23	96.03	98.93
VonBert_K_Mal_GP_1	0.40	0.37	0.36	0.36	0.43	0.40	0.26
CV_young_Mal_GP_1	0.24	0.25	0.25	0.23	0.24	0.24	0.20
CV_old_Mal_GP_1	0.06	0.07	0.08	0.10	0.11	0.06	0.08
SR_LN(R0)	9.26	9.07	9.02	8.94	8.62	8.66	9.09
SR_BH_steep	0.50	0.58	0.60	0.65	0.79	0.76	0.64

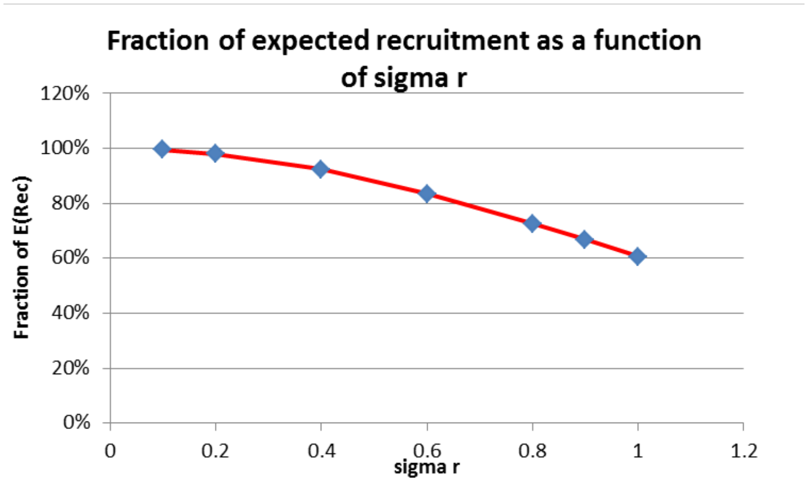


Figure 1. Fraction of bias corrected versus predicted recruitment as a function of the level of sigmaR.

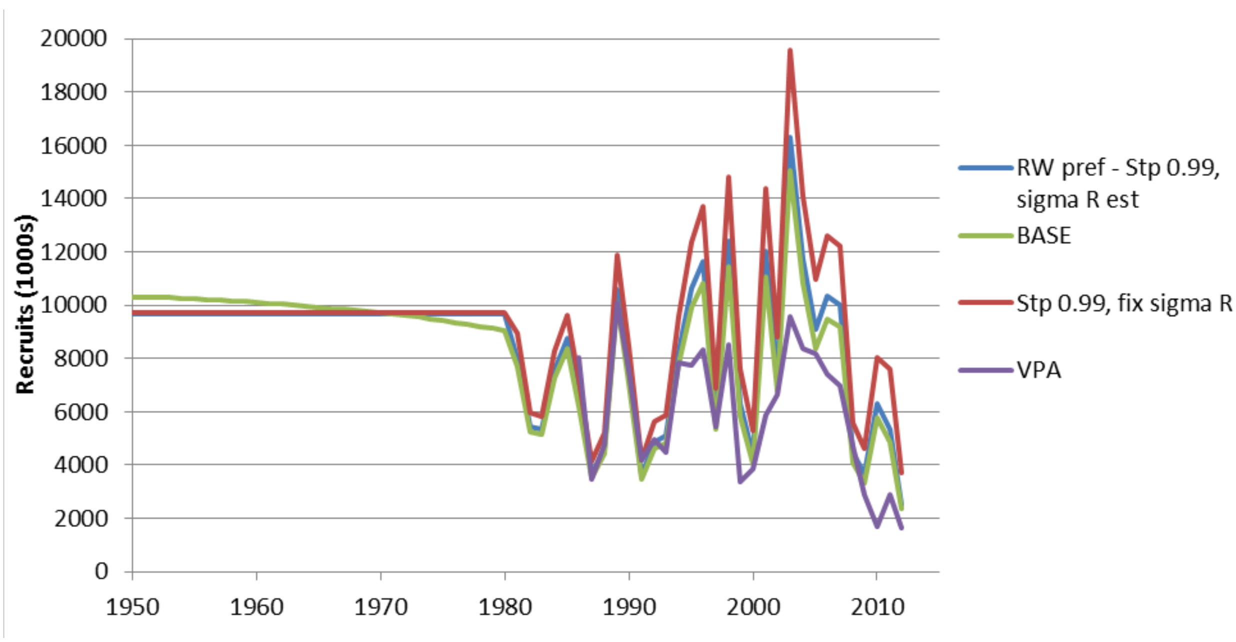


Figure 2. Comparison of estimated recruitment between the RW-preferred model, the RW base model, model 10 (Steepness fixed at 0.99, sigmaR fixed at 0.6) and the VPA.

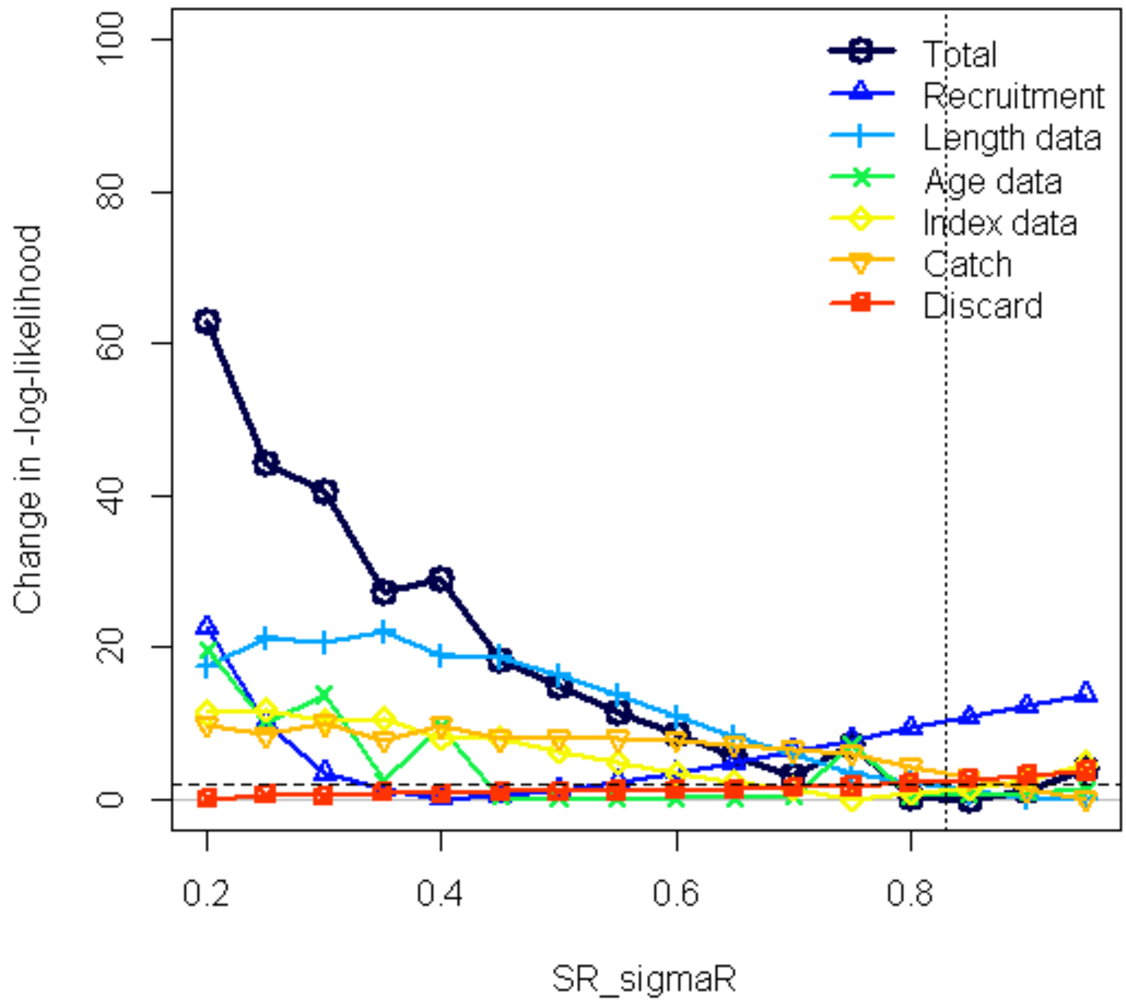


Figure 3. Likelihood profile for sigmaR. The dotted line represents the point estimate from the RW-preferred model. The values represent the change in negative log-likelihood, by component.

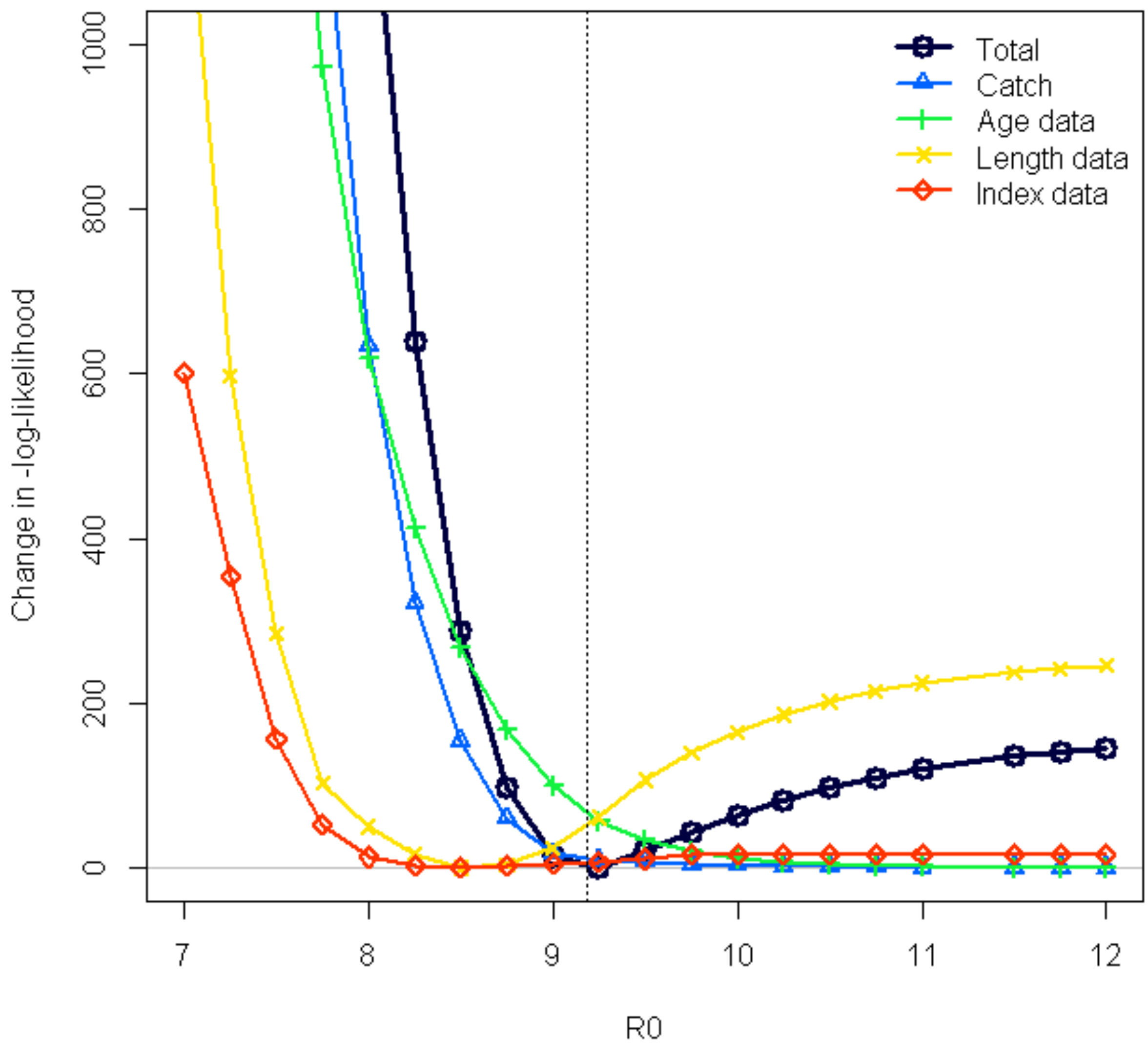


Figure 4. Likelihood profile for virgin recruitment. The dotted line represents the point estimate from the RW-preferred model. The values represent the change in negative log-likelihood, by component.

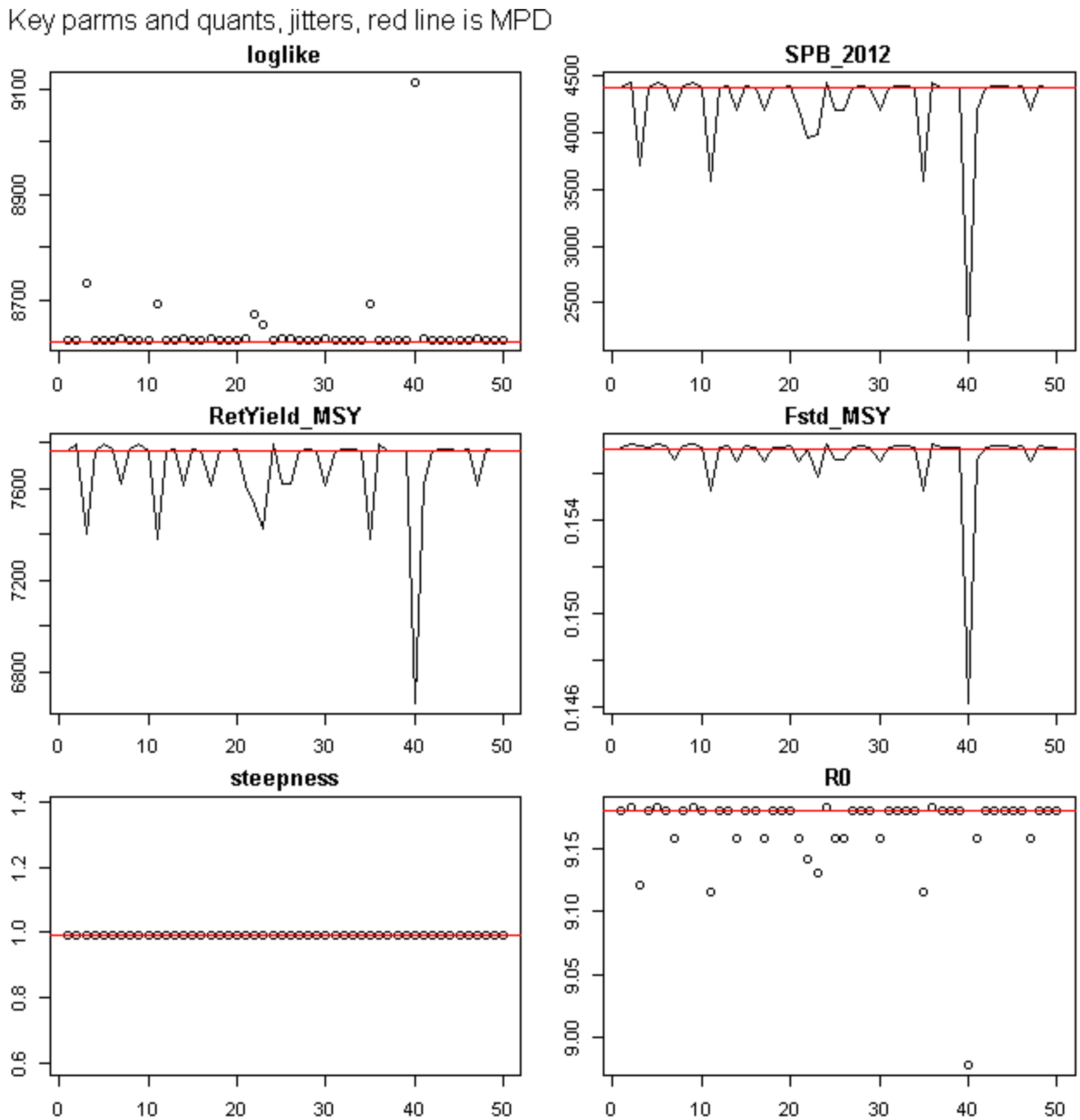


Figure 5. Analysis of results of jittering starting values by 10%. Red line is maximum posterior density estimate.

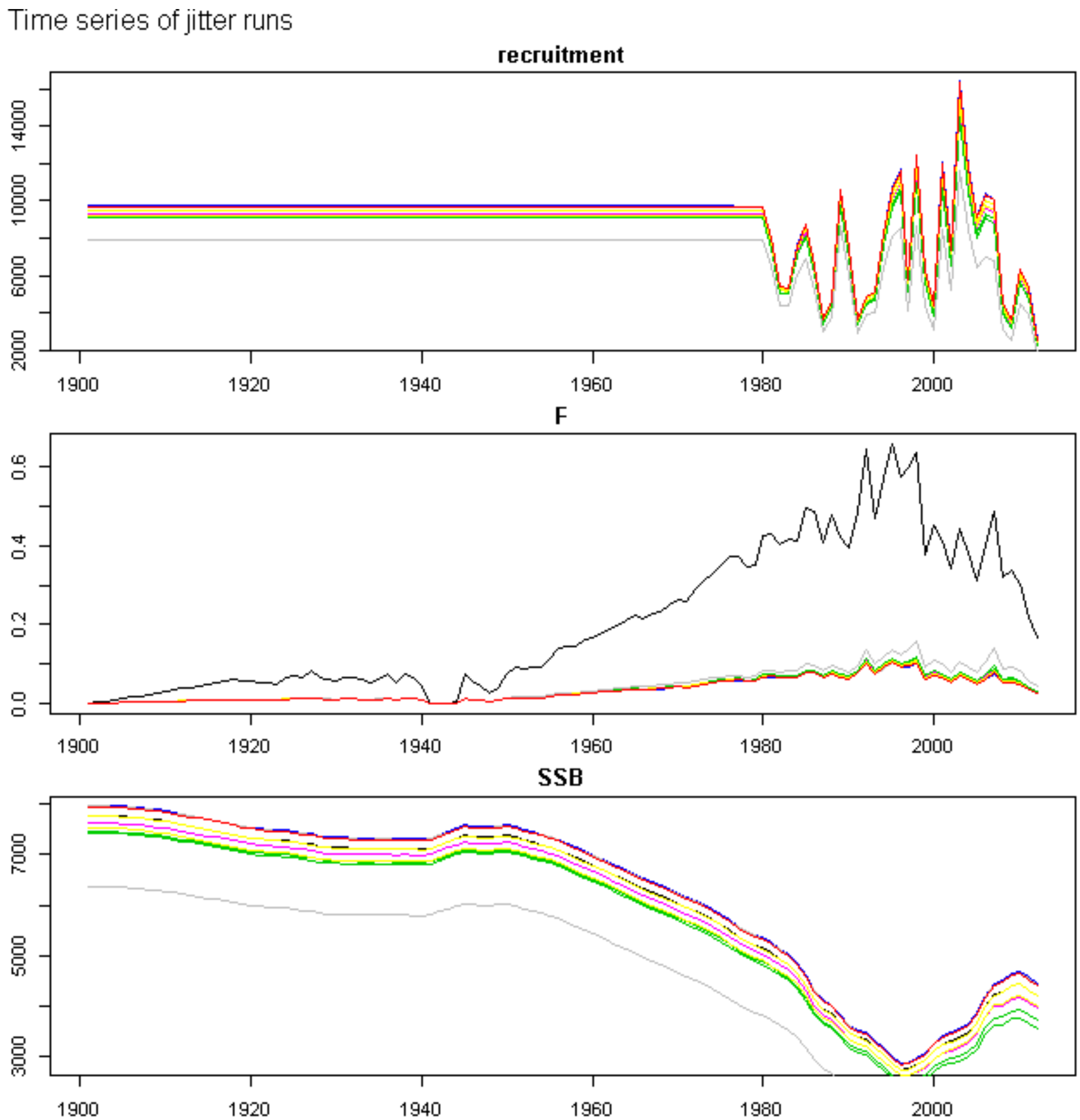


Figure 6. Time series of jitter runs recruitment, F and SSB.

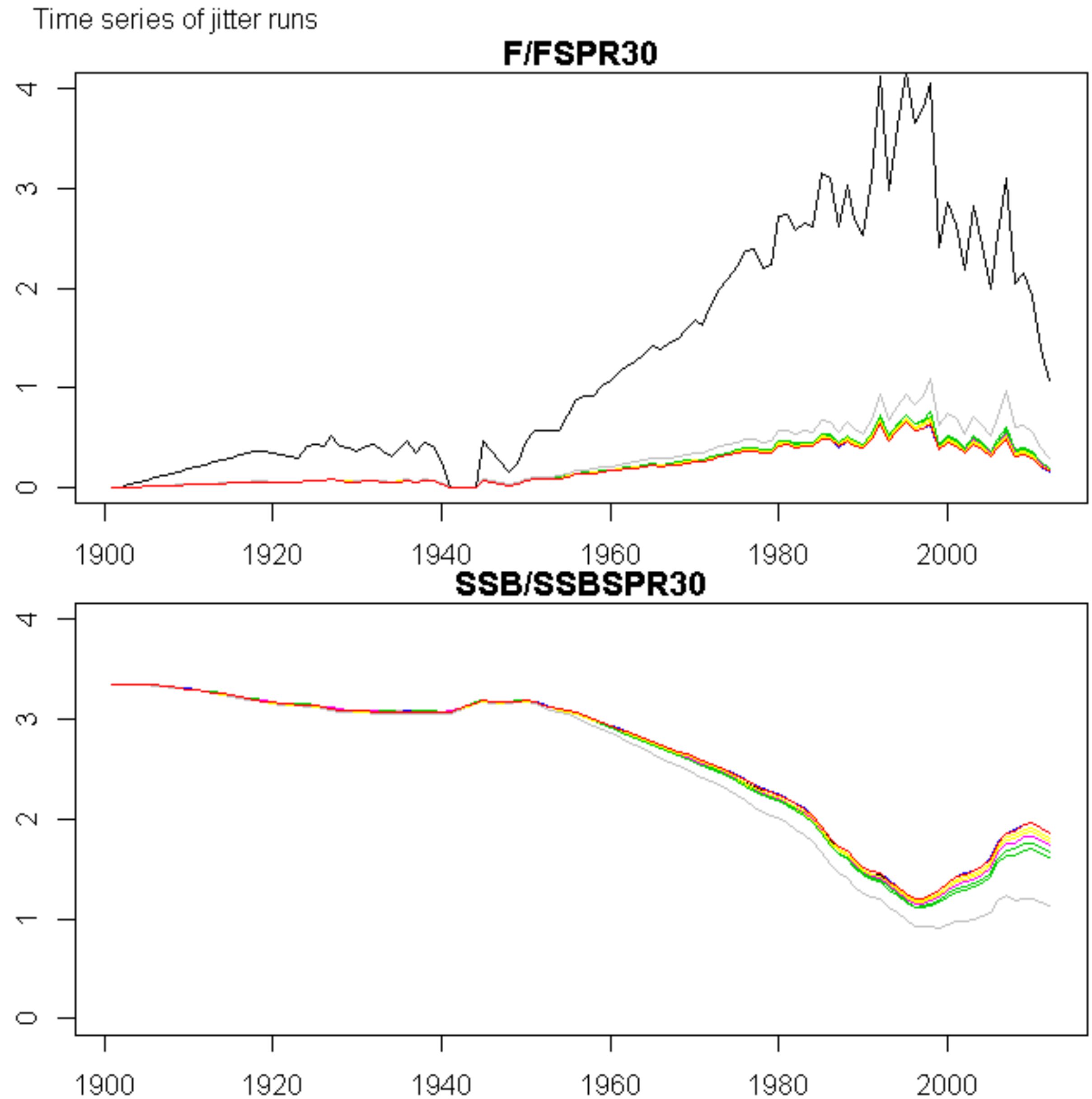


Figure 7. Time series of jitter runs $F/F_{SPR30\%}$ and $SSB/SSB_{SPR30\%}$

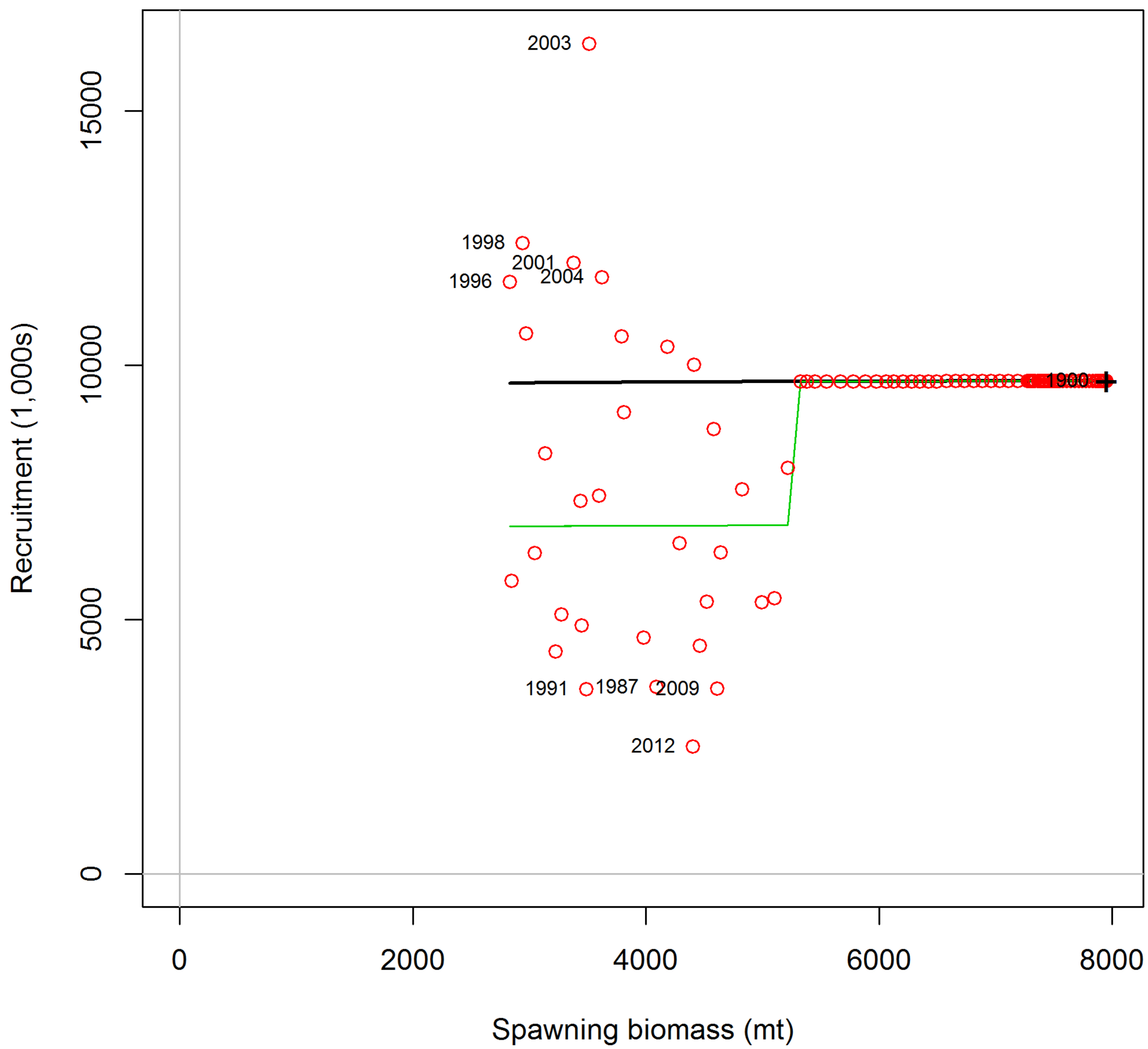


Figure 8. Predicted stock-recruitment relationship for South Atlantic king mackerel for the RW-preferred model with fixed steepness. Plotted are predicted annual recruitments from SS (circles), expected recruitment from the stock-recruit relationship (black line), and bias adjusted recruitment from the stock-recruit relationship (green line).

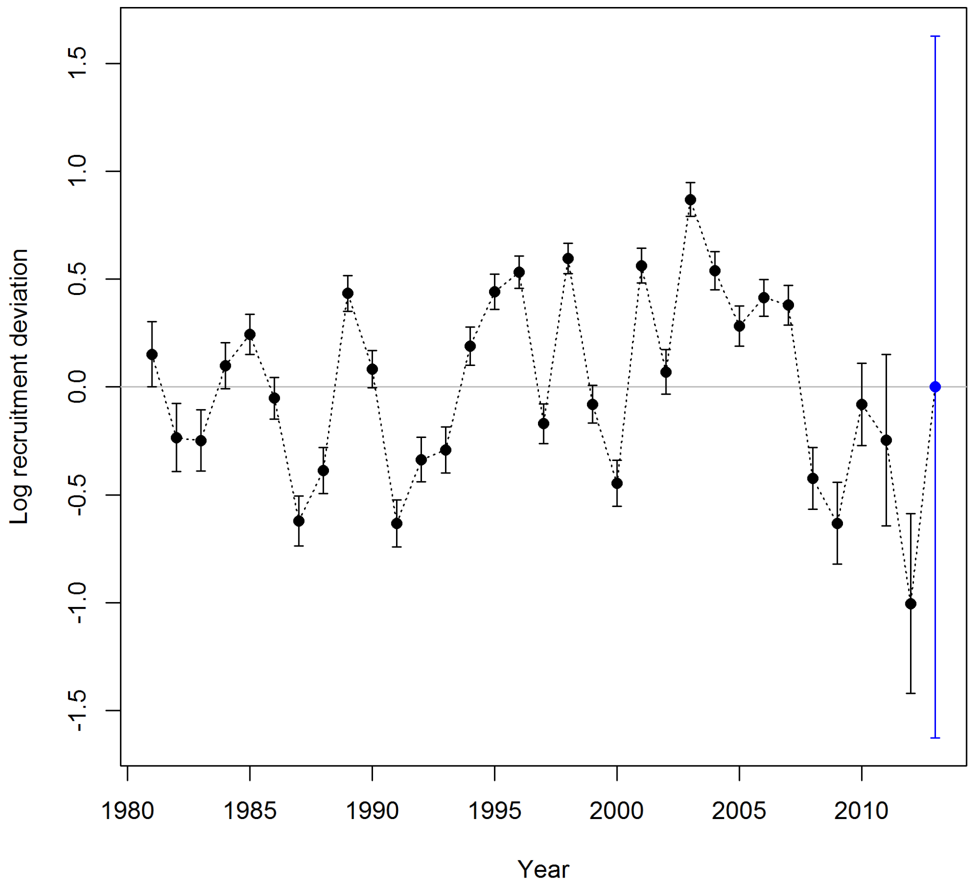
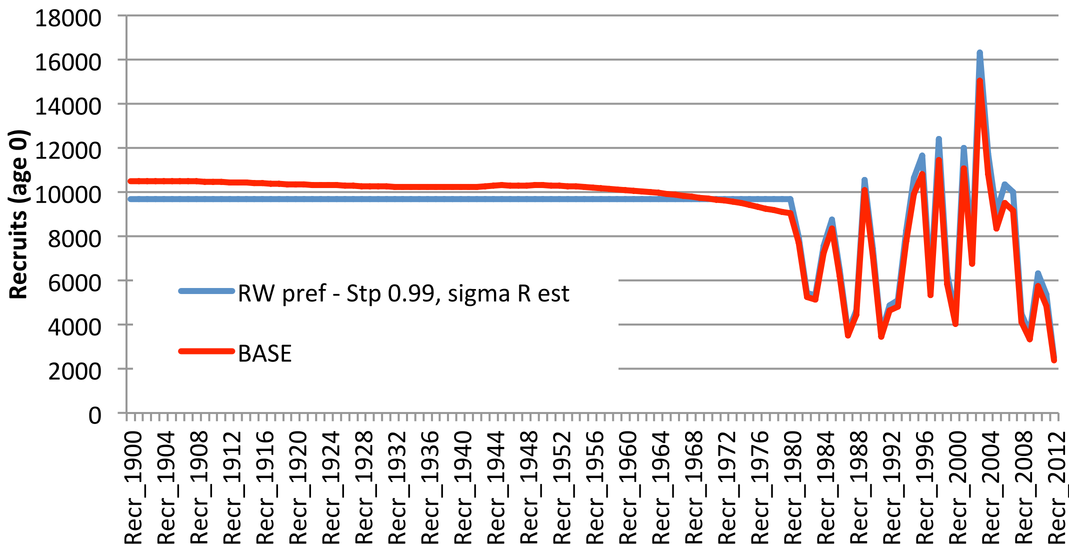


Figure 9. Predicted log recruitment deviations with associated 95% asymptotic intervals. Note that the point in blue is for 2013 and would represent a future prediction based on a recruitment deviation of zero.



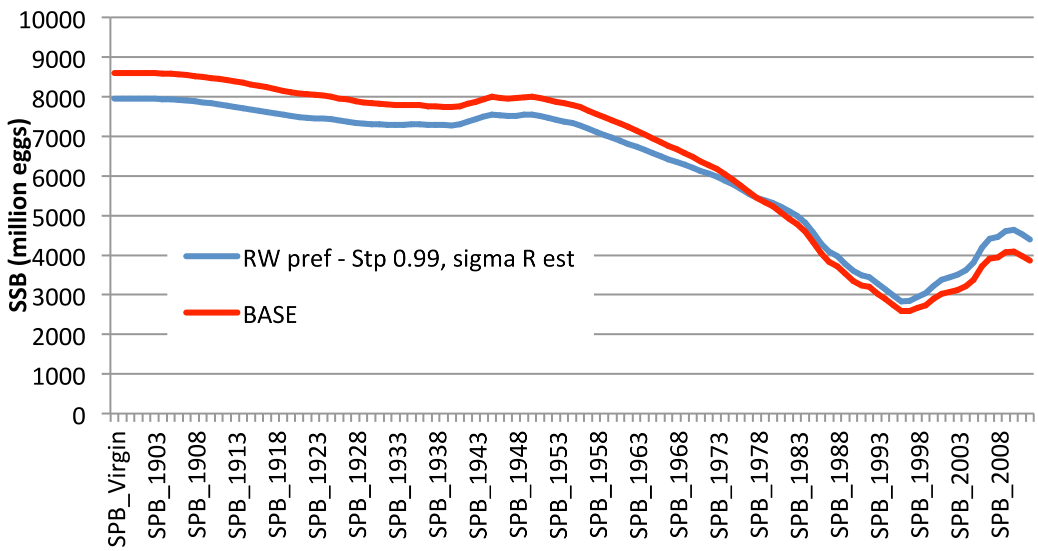


Figure 10. Time series of recruits and for the base and RW-preferred models.

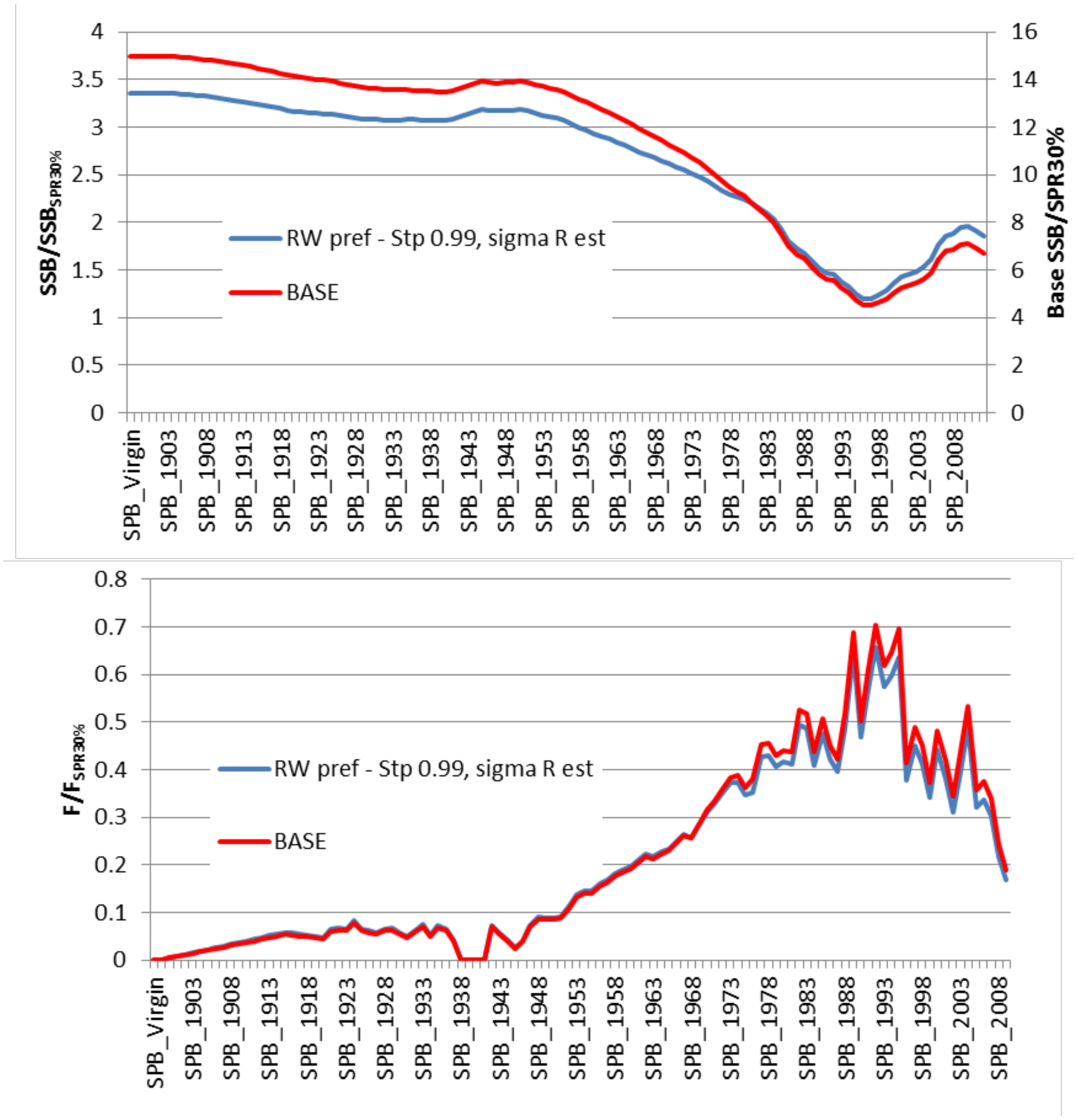


Figure 11. Time series of SSB relative to SSB$_{SPR30\%}$ and F relative F$_{SPR30\%}$ for the base and RW-preferred models. Note the change of axis for the Base model.

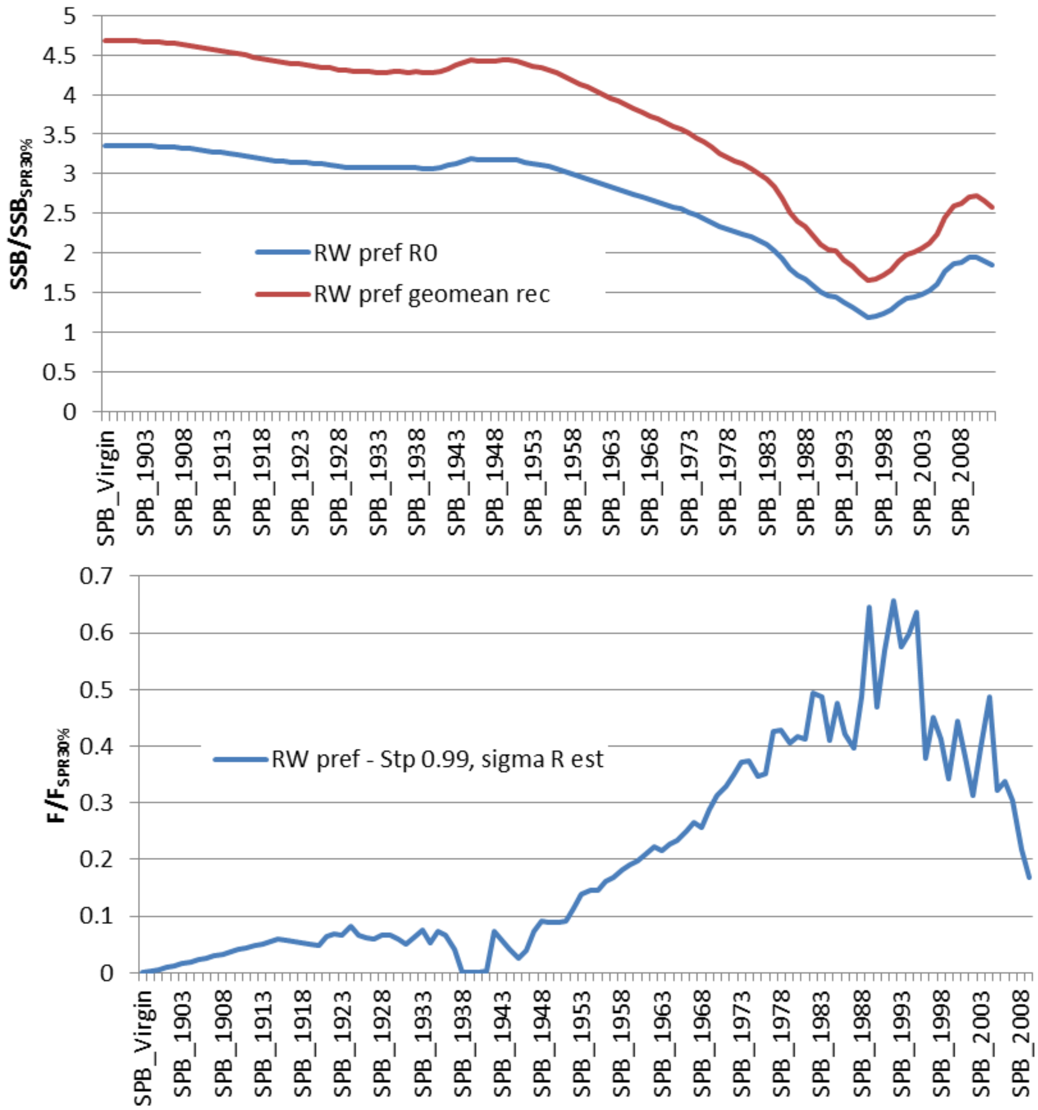


Figure 12. SSB/SSBSPR30% for using R0 or using the geometric mean (used for status advice) recruitment and F/Fspr30%.

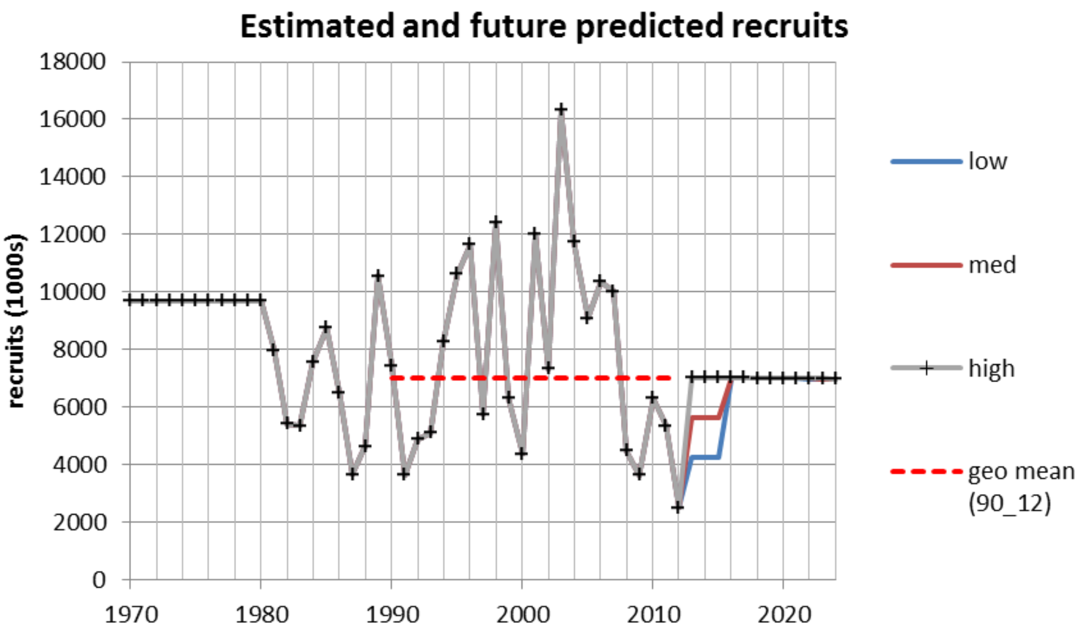


Figure 13.Estimated historical and future predicted recruits of the RW-preferred model at FSPR30%.

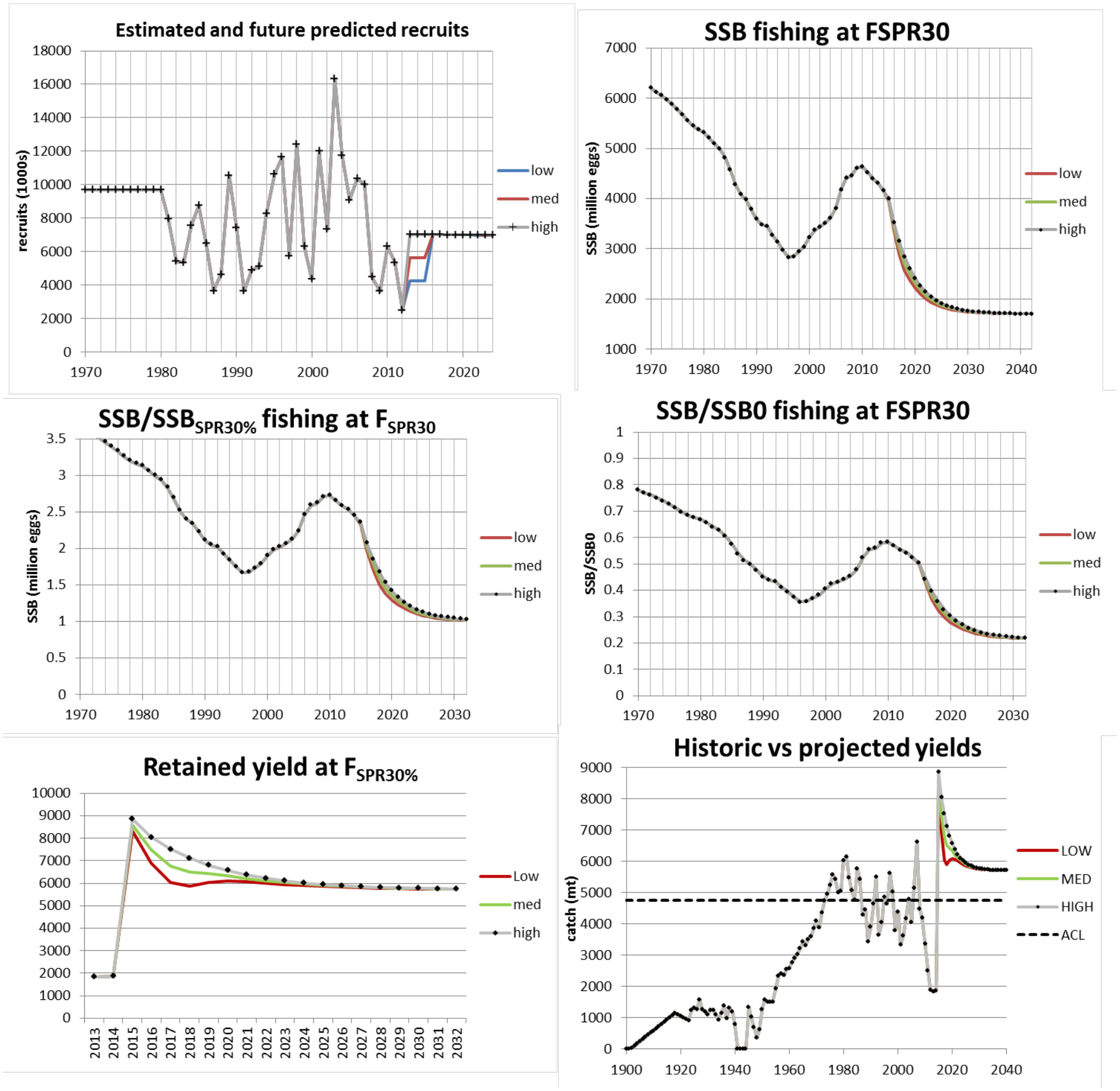


Figure 14. Deterministic Projections of the base and RW-preferred models projected at $F_{SPR30\%}$ using geometric mean recruitment. SSBSPR% benchmarks use geometric mean recruitment.

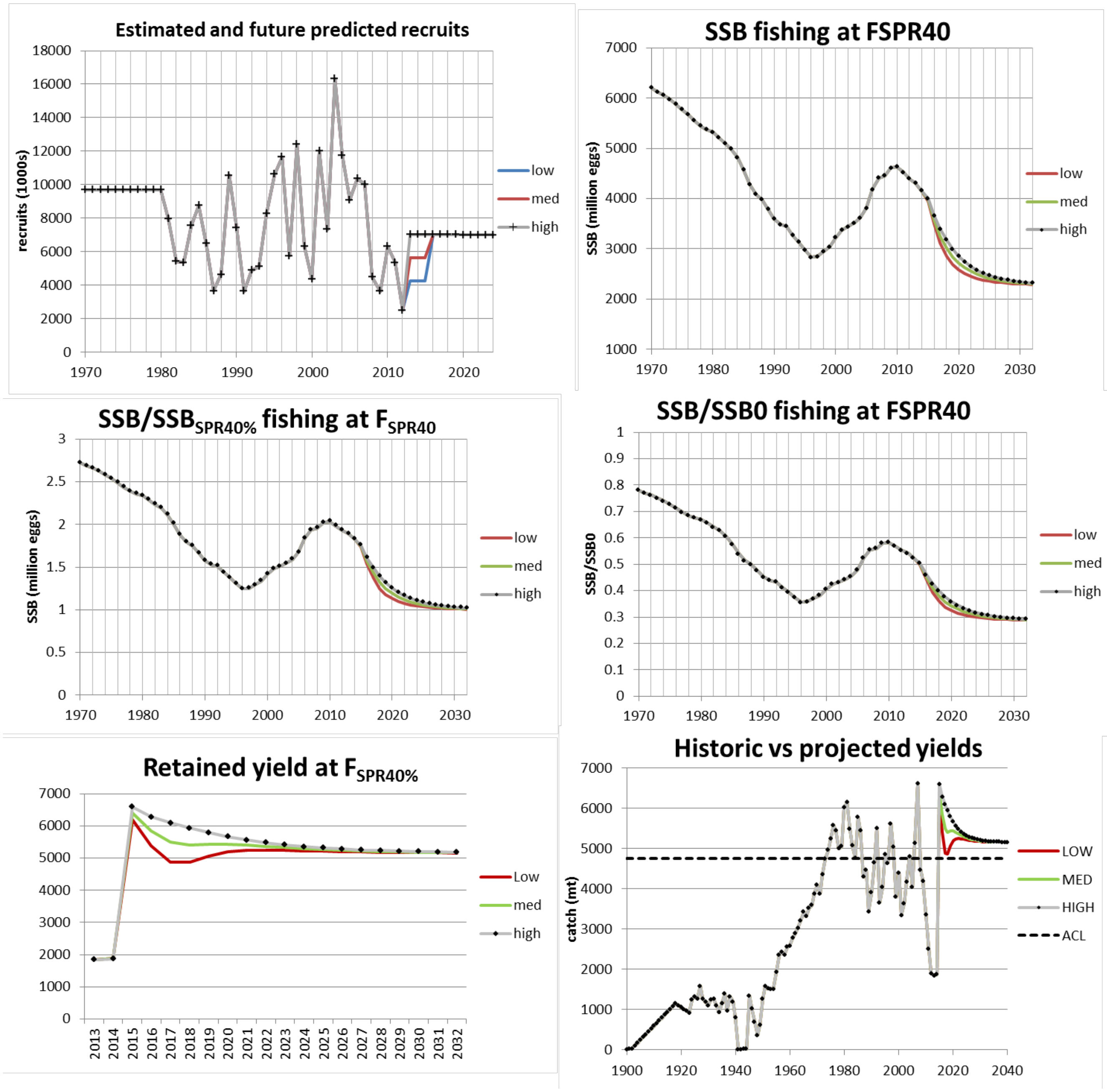


Figure 15. Deterministic projections of the base and RW-preferred models projected at $F_{SPR40\%}$ using geometric mean recruitment. SSBSPR% benchmarks use geometric mean recruitment.

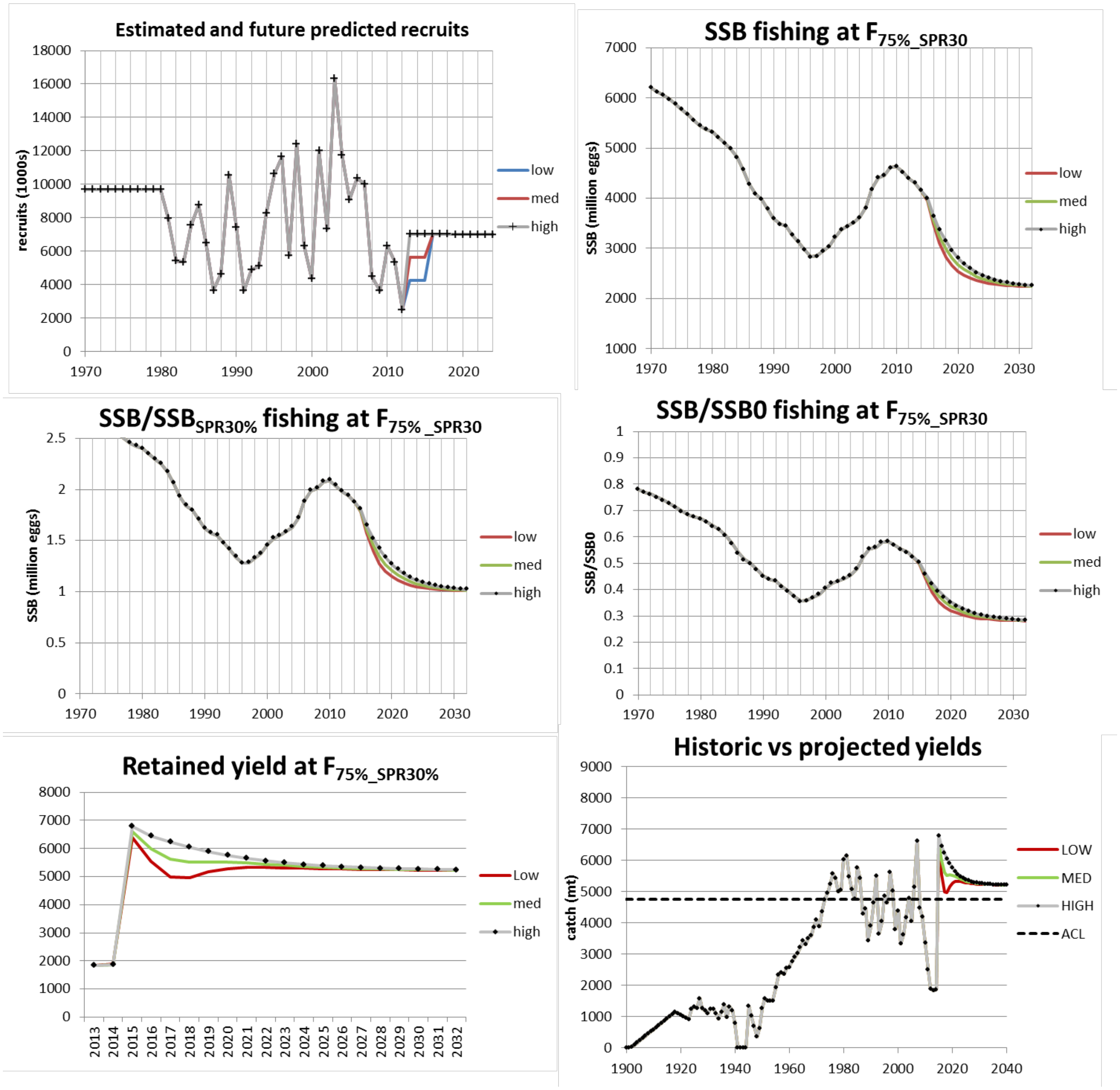


Figure 16. Deterministic projections of the base and RW-preferred models projected at 75% of $F_{SPR30\%}$ (FOY) using geometric mean recruitment. SSBSPR% benchmarks use geometric mean recruitment.

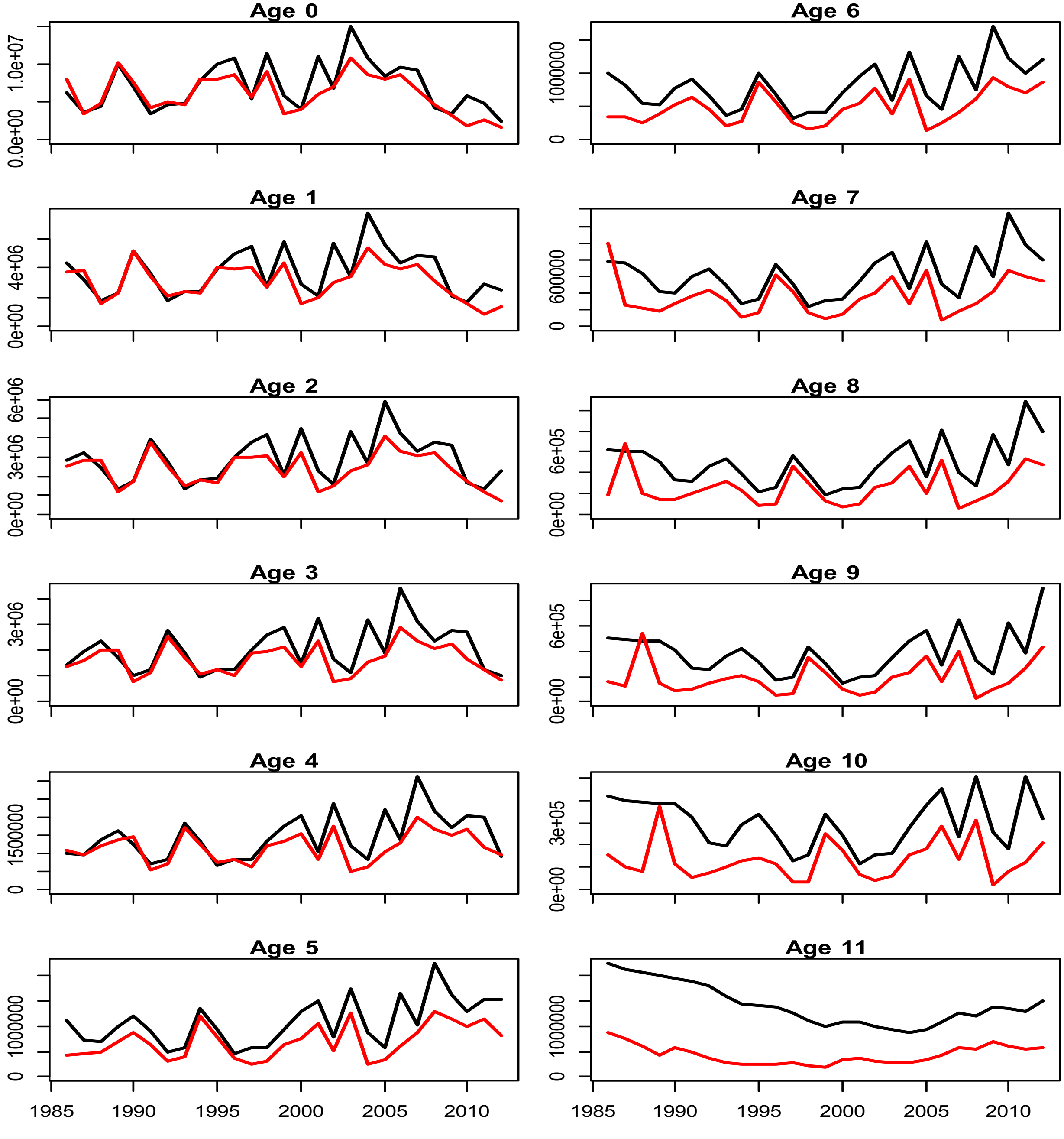


Figure 17. Comparison of the VPA (red) and SS base model (black) numbers at age.

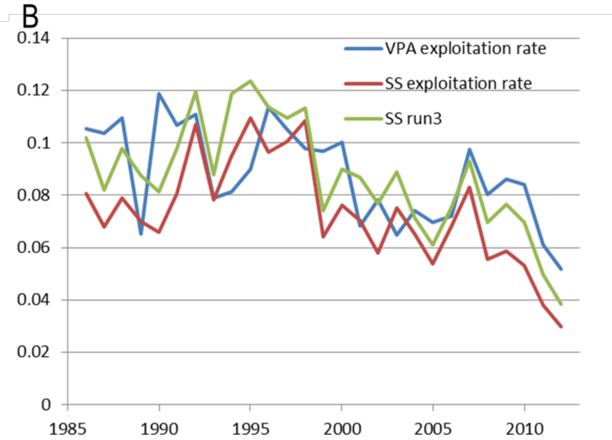


Figure 18. Comparison of a base model, Model 3 with male HL selex asymptotic and VPA recruits (A) and exploitation rate in number (B).

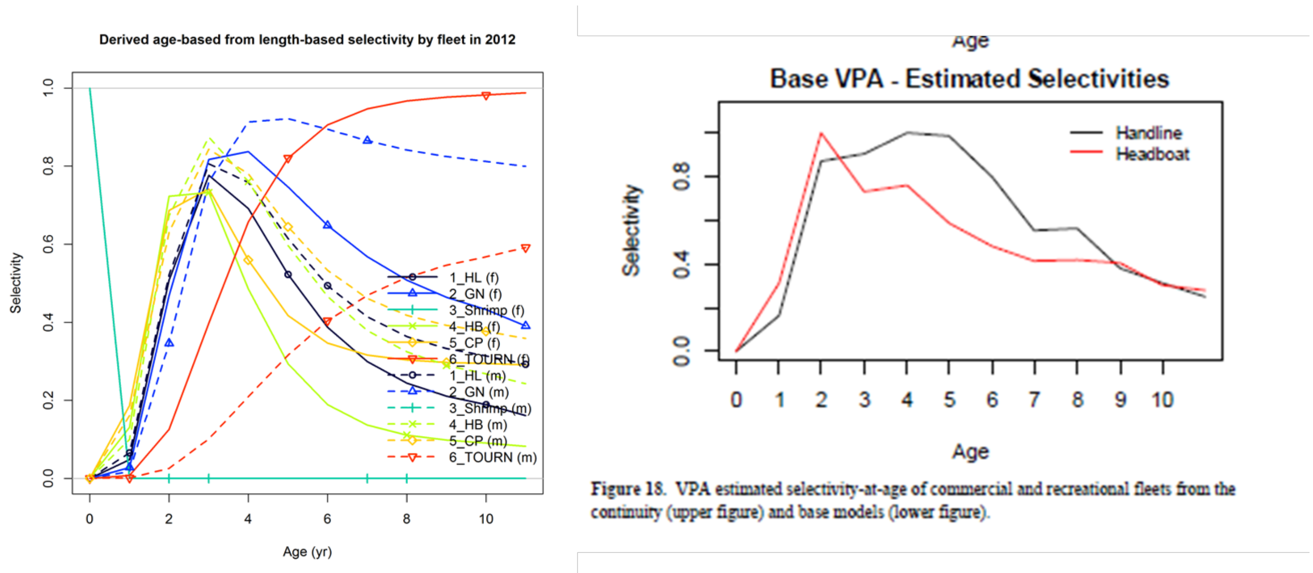


Figure 19. Comparison of the SS base model selectivity at age and VPA selectivity for the handline and headboat indices.

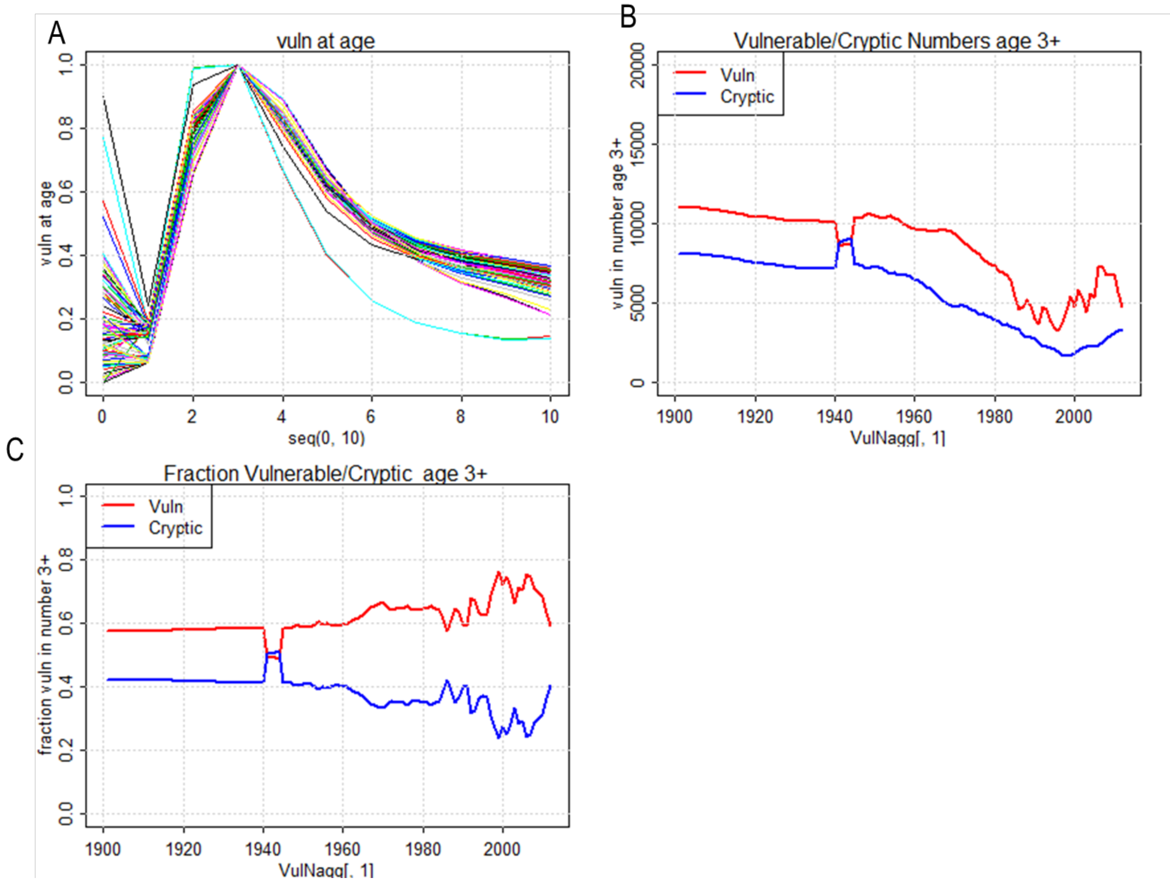


Figure 20. A. age-specific vulnerability used to calculate cryptic numbers, B. total numbers of vulnerable (red) and cryptic numbers of 3+ fish over time. C. Fraction of vulnerable or cryptic numbers of 3+ fish over time.

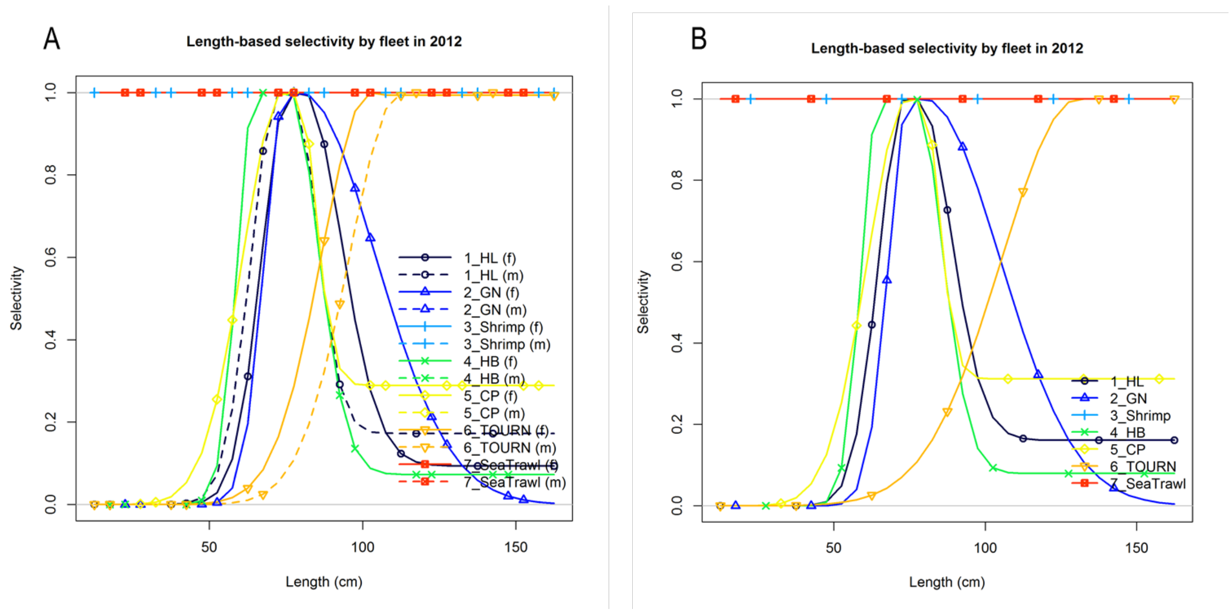


Figure 21. Comparison of selectivities estimated with the female offset (A, BASE model) and without the female offset (B).

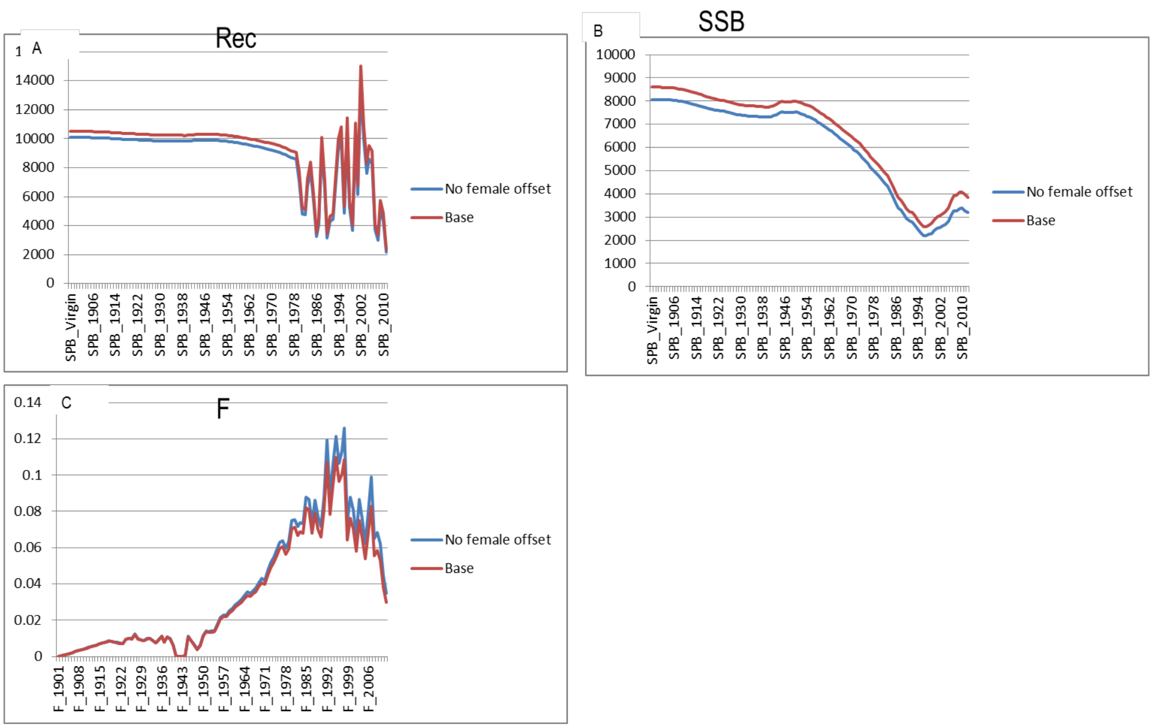
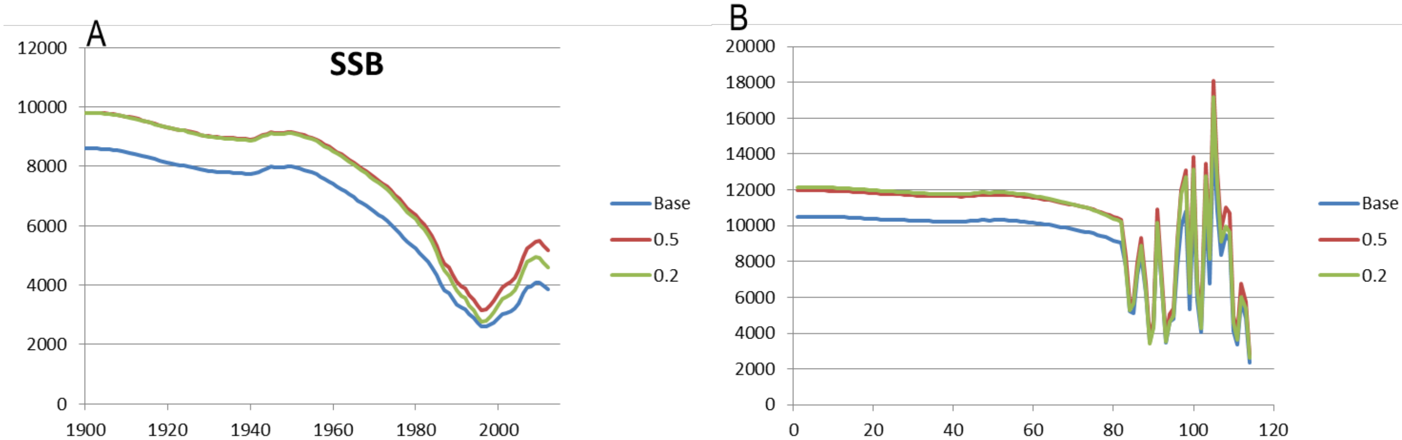
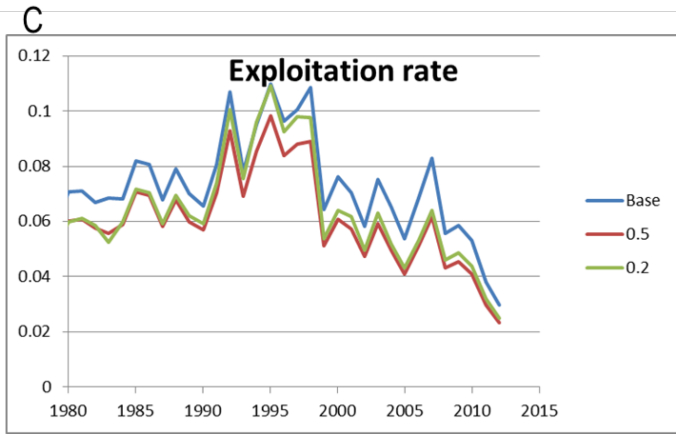


Figure 22. Comparison of A. recruits, B. SSB and C. F between the base model and the model with the female offset removed from handline and tournament selectivity.





	BASE	0.5	0.2
LIKELIHOOD	8621	7148	6177
Catch	140	99	60
Survey	-65	-60	-56
Discard	150	138	132
Length_comp	2826	1538	698
Age_comp	5573	5434	5344
Recruitment	-7	-6	-5

Figure 23. Effects of downweighting length composition by 50% and 80% on A. SSB, B. Recruits and C. exploitation rates. Likelihoods reflect the reduction in emphasis on the length composition so the reduction in LL for the length composition is artificial.

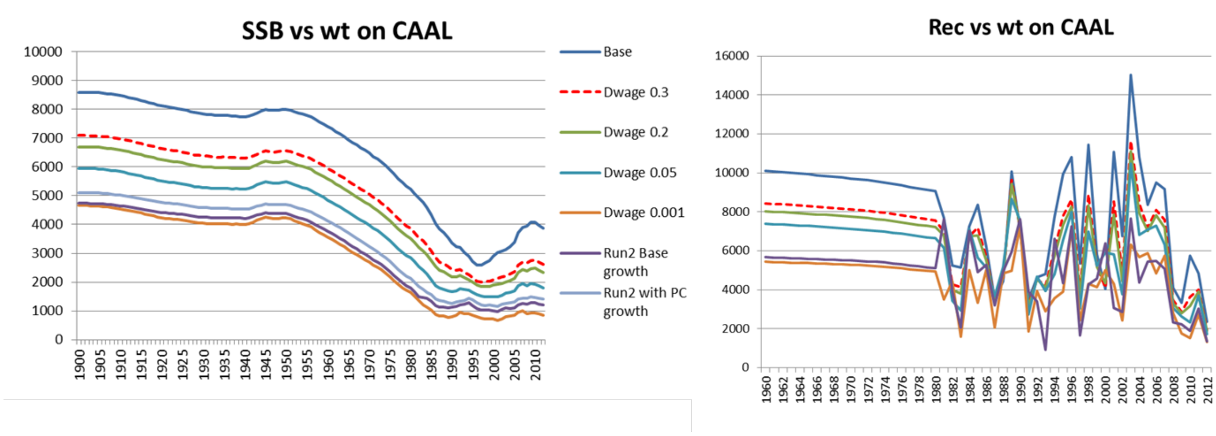
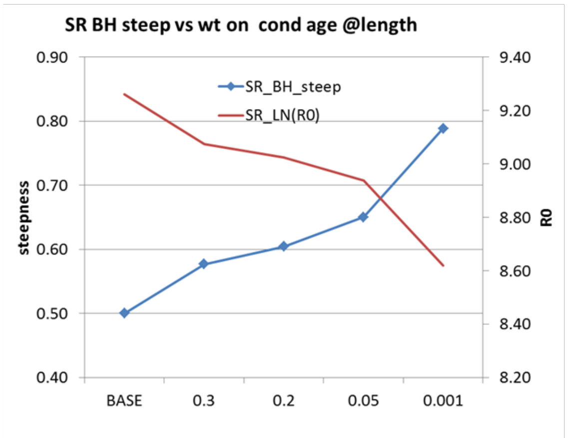
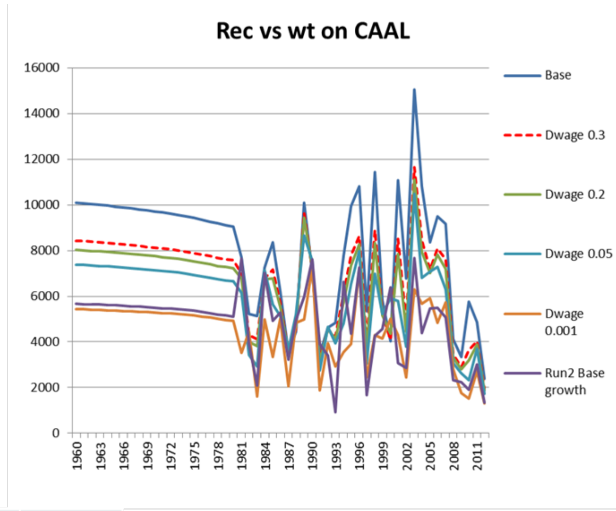


Figure 24. Effects of downweighting conditional age at length composition by 70%(0.3), 80%, 95% and 99.9%. Downweighting the CAAL results in model runs with lower absolute numbers of recruits but higher levels of steepness.





SR_LN(R0)	9.26	9.07	9.02	8.94	8.62
SR_BH_steep	0.50	0.58	0.60	0.65	0.79
SSB_MSY	3123	2378	2179	1824	1166
SPR_MSY	0.52	0.46	0.44	0.40	0.30
Fstd_MSY	0.08	0.09	0.10	0.10	0.15
RetYield_MSY	4446	4375	4377	4347	4461

Figure 25. Downweighting conditional age at length composition by 70%(0.3), 80%, 95% and 99.9% result in lower levels of R0 and higher levels of steepness. Downweighting the CAAL results in model runs with lower absolute numbers of recruits and, consequently, lower SSB.