SEDAR

Southeast Data, Assessment, and Review

SEDAR 28

Gulf of Mexico Spanish Mackerel

Stock Assessment Report

April 2013

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

Please cite this document as:

SEDAR. 2013. SEDAR 28 – Gulf of Mexico Spanish Mackerel Stock Assessment Report. SEDAR, North Charleston SC. 712 pp. Available online at:

http://www.sefsc.noaa.gov/sedar/Sedar_Workshops.jsp?WorkshopNum=28

Table of Contents

SEDAR

Southeast Data, Assessment, and Review

SEDAR 28
Gulf of Mexico Spanish Mackerel

SECTION I: Introduction
April 2013

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

Section I: Introduction

Contents

1. Introduction

1.1 SEDAR Process Description

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

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

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

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

SEDAR Review Workshop Panels typically consist of a chair, three reviewers appointed by the Center for Independent Experts (CIE), and one or more SSC representatives appointed by each council having jurisdiction over the stocks assessed. The Gulf stocks of Spanish mackerel and cobia in SEDAR 28 were reviewed through the CIE desk review process, wherein three reviewers received all stock assessment materials and generated individual summary reports of their findings with respect to the terms of reference.

2. Gulf of Mexico Spanish Mackerel Management History:

2.1. Fishery Management Plan and Amendments

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

Original GMFMC 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.

GMFMC FMP Amendments affecting Spanish mackerel:

Description of Action	FMP/Amendment	Effective Date
Recognized two migratory groups for Gulf Spanish mackerel	CMP FMP Amendment 2	1987
Reallocated catch equally between recreational and commercial fishermen	CMP FMP Amendment 4	1989
Revised fishing year for Gulf group Spanish mackerel to April - March, made GMFMC responsible for pre-season changes to TAC and bag limits	CMP FMP Amendment 5	1990
Increased income requirement for Gulf Spanish mackerel permit to 25% of earned income or $10,000 from commercial sale	CMP FMP Amendment 8	1998
Marine reserve establishment at Tortugas North and Tortugas South off Key West, FL	CMP FMP Amendment 13	2002

GMFMC Regulatory Amendments:

May 1987:
TAC for Gulf group Spanish mackerel was set at 2.5 MP with a commercial quota of 1.4 MP and recreational allocation for 1.1 MP. The bag limit for Spanish mackerel was set at 3 fish.

May 1988:
The TAC for Gulf group Spanish mackerel was increased to 5.0 MP allocated 43% to recreational sector and 57% to commercial sector. The Spanish mackerel bag limit was set at 4 fish off Florida and 10 fish off AL-TX.

May 1989:
The TAC for Gulf group Spanish mackerel was increased to 5.25 MP. The allocation ratio between commercial (57%) and recreational (43%) remained unchanged as did the bag limit.

May 1990:
The TAC (5.25 MP) for Gulf group Spanish mackerel was unchanged. The bag limits for Spanish mackerel were changed to 4 fish off FL, 3 fish off TX, and 10 Fish off AL-LA at the request of the states.

May 1991:
The TAC for Gulf group Spanish mackerel was increased to 8.6 MP and the bag limit modified to 3 fish off TX, 5 fish off FL, and 10 fish off AL-LA. The amendment also set the overfishing thresholds at 30% SPR (SSBR).

May 1992:
The TAC for Gulf group Spanish mackerel remained at 8.6 MP. The bag limits were increased to 7 fish off TX, and 10 fish off FL-LA.

May 1996:
TAC for Gulf group Spanish mackerel was reduced to 7.0 MP and bag limits were maintained.

July 1999:
The TAC for Gulf group Spanish was changed from 7.0 million pounds to 9.1 million pounds, and the bag limit for Gulf group Spanish was increased from 10 to 15 fish per person per day.

May 2003:
The 2003 regulatory amendment, implemented on May 14, 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.

2.2. Management Program Specifications

Table 2.2.1. General Management Information

Gulf of Mexico

Species	Spanish mackerel
Management Unit	Southeastern US
Management Unit Definition	All waters Dade/Monroe county to Texas within Gulf of Mexico Fishery Management Council Boundaries
Management Entity	Gulf of Mexico Fishery Management Council
Management Contacts SERO / Council	Ryan Rindone Sue Gerhart
Current stock exploitation status	Not undergoing overfishing/not overfished
Current stock biomass status	17.96 trillion eggs (2003 Gulf MSAP Report)

Table 2.2.2. Specific Management Criteria

Criteria	Gulf of Mexico - Current (2002/03)		Gulf of Mexico - Proposed	
	Definition	Value	Definition	Value
MSST	$(1\text{-}M)*SSB_{MSY}$	13.40 trillion eggs	$(1\text{-}M)*SSB_{MSY}$	SEDAR 28
MFMT	F_{MSY}	Not specified	F_{MSY}	SEDAR 28
MSY	Yield at F_{MSY}	Not Specified	Yield at F_{MSY}	SEDAR 28
F_{MSY}	$F_{30\%SPR}$	Not specified	F_{MSY}	SEDAR 28
OY	Equil. Yield @ 75% of $F_{30\%SPR}$	Not Specified	Equil. Yield @ 75% of $F_{30\%SPR}$	SEDAR 28
F_{OY}	75% of $F_{30\%SPR}$	0.40	F_{OY} = 65%,75%, 85% F_{MSY}	SEDAR 28
M	n/a	0.30	M	SEDAR 28

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.

Table 2.2.3. Stock projection information.

Gulf of Mexico

Requested Information	Value
First Year of Management	2013
Projection Criteria during interim years should be based on (e.g., exploitation or harvest)	Fixed Exploitation
Projection criteria values for interim years should be determined from (e.g., terminal year, avg of X years)	Average of previous 3 years

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

Projections:

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

A) If stock is overfished:

$F=0$, $F_{Current}$, F_{MSY}, F_{OY} (F_{OY}=65%, 75%, 85% F_{MSY})

$F=F_{Rebuild}$ (max that permits rebuild in allowed time)

B) If stock is undergoing overfishing:

F= $F_{Current}$, F_{MSY}, F_{OY}

C) If stock is neither overfished nor undergoing overfishing:

F= $F_{Current}$, F_{MSY}, F_{OY}

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

Table 2.2.4. Quota Calculation Details

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

Current Quota Value	9.1 mp
Next Scheduled Quota Change	Not specified
Annual or averaged quota ?	Annual
If averaged, number of years to average	n/a
Does the quota include bycatch/discard ?	Not specified

2.3. Management and Regulatory Timeline

The following tables provide a timeline of Federal management actions by fishery.

Table 2.3.1. Annual Commercial Spanish Mackerel Regulatory Summary

	Fishing Year	Size Limit	Possession Limit	Open date	Close date	Other
1983	Calendar Year	None	None set			
1984	"	"	"			
1985	"	"	"			
1986	"	"	"			
1987	"	'	quota of 1.40 MP			
1988	"	"	quota of 2.85 MP			
1989	"	"	quota of 2.99 MP			
1990	"	"	"			
1991	"	"	quota of 4.90 MP			
1992	"	"	"			
1993	April 1 - March 31	12" Fork Length	None	April 1	March 31	
1994	"	"	"	"	"	
1995	"	"	"	"	"	
1996	"	"	quota of 3.99 MP	"	"	
1997	"	"	"	"	"	
1998	"	"	"	"	"	
1999	"	"	quota of 5.187 MP	"	"	
2000	"	"	"	"	"	
2001	"	"	"	"	"	
2002	"	"	"	"	"	
2003	"	"	"	"	"	
2004	"	"	"	"	"	
2005	"	"	"	"	"	
2006	"	"	"	"	"	
2007	"	"	"	"	"	
2008	"	"	"	"	"	
2009	"	"	"	"	"	
2010	"	"	"	"	"	
2011	"	"	"	"	"	

Table 2.3.2. Annual Recreational Spanish Mackerel Regulatory Summary

	Fishing Year	Size Limit	Bag Limit	Open date	Close date	Other
1983	Calendar Year	Not specified	3 fish/person/day	"	"	
1984	"	"	"	"	"	
1985	"	"	"	"	"	
1986	"	"	"	"	"	
1987	"	"	"	"	"	
1988	"	"	FL: 4 fish/person/day AL-TX: 10 fish/person/day	"	"	
1989	"	"	"	"	"	
1990	"	"	FL: 4 fish/person/day AL-LA: 10 fish/person/day TX: 3 fish/person/day	"	"	
1991	"	"	FL: 5 fish/person/day AL-LA: 10 fish/person/day TX: 3 fish/person/day	"	"	
1992	"	"	FL-LA: 10 fish/person/day TX: 7 fish/person/day	"	"	
1993	April 1 - March 31	12" Fork Length	"	April 1	March 31	
1994	"	"	"	"	"	
1995	"	"	"	"	"	
1996	"	"	"	"	"	
1997	"	"	"	"	"	
1998	"	"	"	"	"	
1999	"	"	All: 15 fish/person/day	"	"	
2000	"	"	"	"	"	
2001	"	"	"	"	"	
2002	"	"	"	"	"	
2003	"	"	"	"	"	
2004	"	"	"	"	"	
2005	"	"	"	"	"	
2006	"	"	"	"	"	
2007	"	"	"	"	"	
2008	"	"	"	"	"	
2009	"	"	"	"	"	
2010	"	"	"	"	"	
2011	"	"	"	"	"	

3. Assessment History and Review

Full stock assessments of the Gulf of Mexico Spanish mackerel were conducted by Powers et al. (1996), Legault et al. (1998) and the Sustainable Fisheries Division (2003).

Historically, the Mackerel Stock Assessment Panel (MSAP) met regularly to oversee and review these assessments and to provide advice to the SAFMC and GMFMC. The most recent full stock assessment for Gulf of Mexico Spanish mackerel was conducted in 2003 through the Mackerel Stock Assessment Panel (MSAP), which included data through the 2001/2002 fishing year and presented projections through 2002/2003 (Sustainable Fisheries Division 2003). The model used in the 2003 assessment was an age based virtual population analysis procedure (Ortiz et al. 2002) calibrated to standardized fishery specific abundance indices. Uncertainty was incorporated into model estimates using a mixed Monte Carlo Bootstrap approach that accounted for variability in natural mortality, abundance indices, and estimated catch at age inputs. Based on MSAP recommendations, the Councils adopted $F_{30\%SPR}$ as the maximum fishing mortality threshold (MFMT). The proxy for maximum sustainable yield (MSY) for a given stock is computed as the long-term yield at $F_{30\%SPR}$ when the stock is at equilibrium. Following the Technical Guidelines, the MSAP recommended adopting $(1.0 - M)*B_{MSY}$ as the minimum stock size threshold (MSST) for all four migratory groups, which has been accepted by both councils.

The 2003 stock assessment indicated that the median estimate of F/F_{MSY} for Gulf Spanish mackerel was 0.53 in fishing year 2002/03 and the percentage of estimated $F_{2002/03}/F_{MSY}$ greater than 1.0 was 9% (n = 44 of 500 bootstraps). Based on the acceptable risk level chosen by the GMFMC, that there should be no greater than a 50% probability that current F exceeds MFMT, the MSAP's estimation is that overfishing was not occurring in 2002/03 for Gulf Spanish mackerel.

The median estimate of B_{2003}/B_{MSY} for Gulf Spanish mackerel was 1.34 and the estimated percentage of B_{2003} less than MSST was 3% (n = 16 of 500 bootstraps). Based on the acceptable risk level chosen by the GMFMC, that there should be no greater than a 50% probability that current B is less than MSST, the MSAP's estimation is that Gulf Spanish mackerel were not overfished in 2002/03. Estimated spawning stock size continued to increase in 2002/2003.

References Cited:

Legault, C.M., N. Cummings and P. Phares. 1998. Stock assessment analyses on Atlantic migratory group king mackerel, Gulf of Mexico migratory group king mackerel, Atlantic migratory group Spanish mackerel, and Gulf of Mexico migratory group Spanish mackerel. NMFS SEFSC Miami Sustainable Fisheries Division Contribution MIA-97/98-15.

Ortiz, M., G. P. Scott, N. J. Cummings, and P. Phares. 2002. Stock Assessment Analyses on Gulf of Mexico King Mackerel. SFD Contrib. SFD-01/02-161, 56 pp.

Powers, J.E., N. Cummings, and P. Phares. 1996. Stock assessment analyses on Gulf of Mexico migratory group Spanish mackerel, and Atlantic migratory group Spanish mackerel. NMFS SEFSC Miami Sustainable Fisheries Division Contribution MIA-95/96-11.

Powers, J.E. and V.R. Restrepo. 1992. Additional options for age-sequenced analysis. ICCAT Coll. Vol. Sci. Pap. 39:540-553.

Restrepo, V.R. 1996. FADAPT 3.0 A Guide. University of Miami, Cooperative Unit for Fisheries Research and Education (CUFER), Miami, FL. December 2012 South Atlantic Spanish mackerel.

Sustainable Fisheries Division. 2003. Stock assessment analyses on Spanish and king mackerel stocks. NMFS SEFSC Miami Sustainable Fisheries Division Contribution SFD-2003-0008, 147 pp.

4. Regional Maps

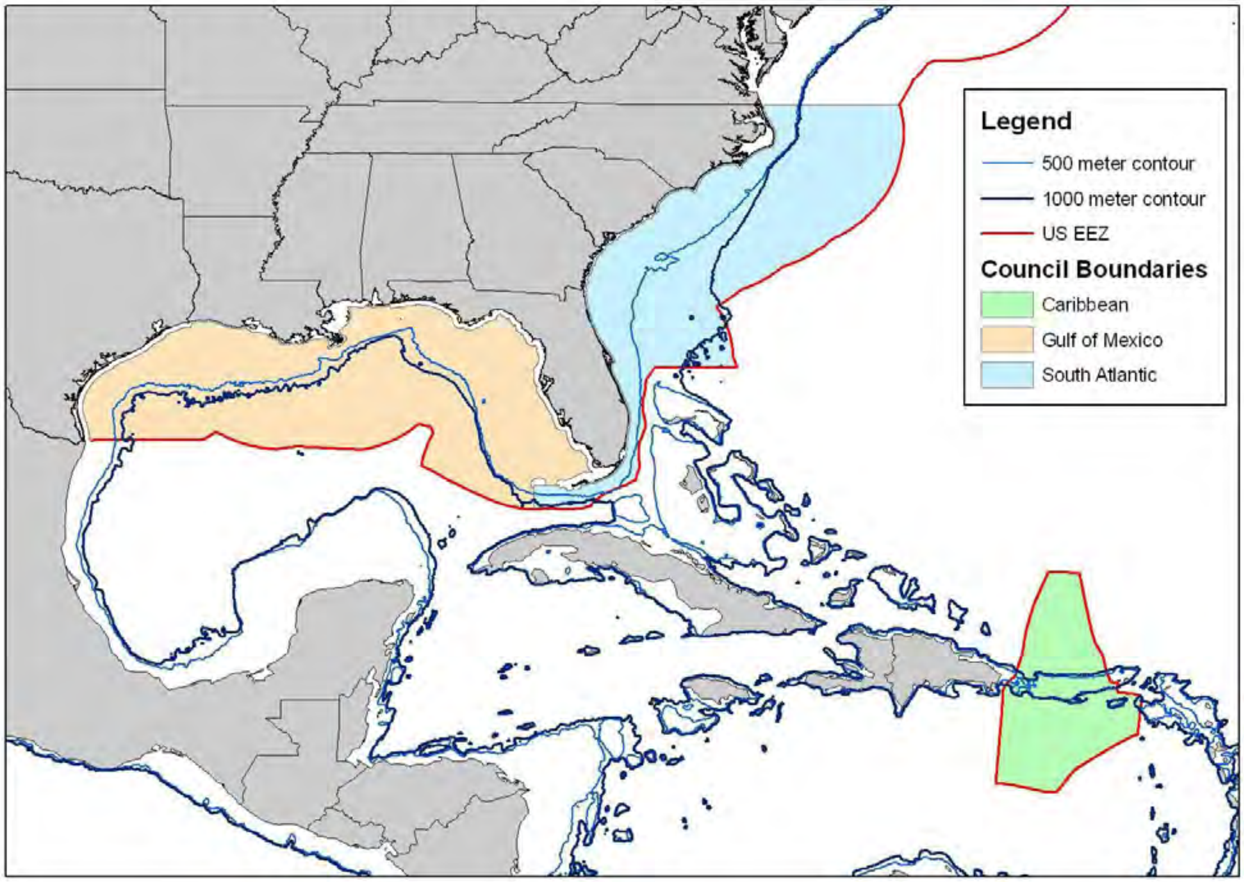


Figure 4.1: South Atlantic, Gulf of Mexico, and Caribbean Fishery Management Council boundaries, and United States EEZ.

5. Assessment Summary Report

The Assessment Summary Report provides a broad but concise view of the 2012 Gulf of Mexico Spanish mackerel (*Scomberomorus maculatus*) stock assessment (SEDAR 28). It recapitulates: (a) the information available to and prepared by the Data Workshop (DW); (b) the application of those data, development and execution of assessment models, and identification of a preferred model configuration by the Assessment Workshop (AW); and (c) the findings and advice determined during the CIE desk review performed in lieu of an in-person Review Workshop.

Executive Summary

The Gulf of Mexico Spanish mackerel stock assessment presented by the SEDAR 28 Assessment Workshop (AW) Panel was provided as a desk review to three reviewers from the Center for Independent Experts (CIE) with outputs and results. Each reviewer conducted an evaluation of the material and produced an independent review report. The modeling environment used was Stock Synthesis (SS) (Methot 2010) version 3.24h (beta). No clear status determination can be made from the assessment, as the independent reviewers differed on the appropriateness of the assessment for making such determinations.

Stock Status and Determination Criteria

Due to a lack of consensus amongst the CIE reviewers responsible for evaluating the assessment, point estimates of population benchmarks cannot be provided at this time. A phase plot of the recommended preferred base model run from the AW Panel (SS Model Run #3) and associated sensitivities analyses is provided in Figure 5.7.

Stock Identification and Management Unit

The Atlantic and Gulf of Mexico stocks were split along SAFMC/GMFMC jurisdictions. The Atlantic stock consists of all fish caught south of highway US 1 through the Florida Keys, northward along the east coast of Florida to Maine. Based on electrophoresis studies, spawning locations, stock distribution patterns, and catch history, Amendment 2 to the Coastal Pelagics FMP designated two groups of Spanish mackerel. For SEDAR 28 it was agreed that fish landed north of US Highway 1 in Monroe County Florida were part of the Gulf of Mexico stock and fish landed south of US Highway 1 were part of the Atlantic stock. This reflects a change from SEDAR 17 where data were split at the Dade-Monroe County line. This change was recommended as the oceanographic split and most efficient for splitting commercial data. It was acknowledged by the SEDAR 28 DW Panel that there was little biological evidence for either the Council Boundary or Dade-Monroe County line as the stock division.

Assessment Methods

The primary assessment model selected for the Gulf of Mexico Spanish mackerel stock evaluation assessment was Stock Synthesis (Methot 2010) version 3.24h (beta). Stock Synthesis has been widely used and tested for assessment evaluations, particularly in the US west coast NMFS centers (Methot 2010). Descriptions of SS algorithms and options are available in the SS user's manual (Methot 2010) and at the NOAA Fisheries Toolbox website (http://nft.nefsc.noaa.gov/). During the course of the SEDAR 28 assessment the lead analysts collaborated frequently with the model developer (Rick Methot, personal communication) on a variety of model issues, but particularly on the handling of discards in the model.

The r4ss software (www.cran.r-project.org/web/packages/**r4ss**/index.html) was utilized extensively to develop various graphics for SS outputs and also was used to summarize various SS output files and to initially conduct parametric bootstrapping.

The "Fishery Simulation" Graphics User Interface (GUI) tool developed by Lee et al. (2012) (see https://fisherysimulation.codeplex.com/) was used to characterize uncertainty in final model estimates and projections of future caches for a variety of alternative scenarios recommended by the Assessment Panel (AP). This tool is based on parametric bootstrap analyses used with SS (Methot 2011). Applications of the method to fisheries evaluations using SS are described in Lee et al. 2011, Piner et al. 2011, and Lee et al. 2012.

Assessment Data

The SS model was fitted to landings, discards, length composition, conditional age-length observations, and indices of abundance. These categories of data included: annual landings (metric tons), directed fishery discards (recreational and commercial fractions entered as super periods), shrimp fishery bycatch (dead discards as numbers in 1,000s), and standardized indices of relative abundance (recreational (MRFSS), commercial line gear fishery (FWC Vertical line fishery), SEAMAP Independent fishery trawl survey, and a time series of estimated shrimping effort (shrimp fishery)) (Figure 5.4). Although annual estimates of release mortality were not available, some information was available to characterize relative amounts of dead discards from directed commercial line gear and all recreational mode fisheries as described in the SEDAR 28 DW report.

Release Mortality

The SEDAR 28 DW Panel noted that "Commercial discards and shrimp bycatch are based on estimated encounter rates and effort. In years when multi-year averages are used to compute encounter rates, these estimates do not account for year-specific age structure, nor do these estimates account for variability in seasonal movements between areas in the Spanish mackerel stock". In addition, the SEDAR 28 DW Panel noted that other factors contributing to uncertainty in commercial discards were from low coverage of the logbook survey. Shrimp fishery discards in particular had low encounter rates of Spanish mackerel, thus estimation was hampered by dealing with a large number of "zero" observations. These concerns provide additional support to the use of super periods in the SS model to characterize the magnitude of removals. The discard mortality rate in the base model was assumed to be 20% for the recreational and 10% for the commercial fisheries as recommended by the DW Panel. The preferred base model as chosen by the AW Panel (SS Model Run #3) was not sensitive to increasing discard mortality rates to 40% for the recreational fishery or to 20% for the commercial fishery.

Catch Trends

The Spanish mackerel directed fishery has been dominated primarily by the recreational fleet in recent years. Recreational landings peaked in both the mid 1980s and the early 2000s, and have since declined. Prior to the 1980s, the commercial gill net fishery was a substantial source of directed fishery mortality. Commercial gill netting and vertical line fishing peaked around 1970, then decreased rapidly after. Bycatch from the shrimp fishery increased from the 1950s through the early 1990s, and has since declined in recent years (Figure 5.5).

Fishing Mortality Trends

Exploitation rate was used as the proxy for annual fishing mortality rate. Predicted annual fishing mortality estimates show flat and low levels of F through the late 1940s. Between the early 1950s and continuing through the mid 1980s, steady increasing trends in F are predicted. Since the mid 1980s estimated total annual F for respective fleets has continued to decline (Figures 5.1, 5.9).

Stock Abundance and Biomass Trends

Spawning biomass (Figure 5.2) and total biomass (Figure 5.3) show steady trends from the late 1880s through the early 1940s. Substantial declines in biomass are evident beginning in the late 1940s and continuing through the late 1980s. Increases in total and spawning stock biomass are predicted by SS beginning in the late 1990s (also see Figure 5.8).

Scientific Uncertainty

Estimated standard errors from the bootstrap analysis are generally low for most parameters estimated in the stock assessment, indicating that precision of parameters estimated is reasonable. Annual estimated asymptotic errors for the annual recruitment deviations ranged from 0.05 to 0.11 over the time series. In general, many of the standard errors associated with selectivity parameters had standard errors larger than 0.25.

Stock Synthesis provides for characterizing the uncertainty in important model parameters through an internal procedure (profiling). Through this procedure the model is implemented multiple times, fixing the parameter of interest to some assumed value. Profiling of steepness and virgin stock level (R0), and the recruitment standard deviation (∑R SS parameter) was conducted because of the concerns around estimating steepness. Results did not indicate any major deviance from the input value specified for the ∑R parameter (0.7), thus this model parameter value was not further adjusted. Bootstrapping results show that SS had difficulties in estimating steepness for the Gulf of Mexico Spanish mackerel stock. The model-estimated steepness was 0.52; the bootstrap summary estimated a range of steepness from about 0.4 to 1.0, hitting the upper bound on about 37% of the bootstrap runs. The SEDAR 28 AP thought that a steepness of around 0.5 was not reasonable for this species.

Key model output quantities were examined including: 1) total biomass (virgin, current biomass); 2) spawning biomass (virgin, current); and 3) recruitment (virgin, current). The trend results suggested that the model was insensitive to input assumptions regarding the level of natural mortality at age. The exception, however, is for the low natural mortality level scenario ($M = 0.27$) which results in higher levels of virgin biomass. Estimated virgin total and virgin recruitment for the scenarios assuming the low value of the range suggested a very different level of virgin biomass than either for the Run 3 model input value (0.38 into the Lorenzen function) or for the model assuming the high end of the range (0.49) input into the Lorenzen function. Neither varying the input level of M from the initial base level (0.38) nor changing the scaling reference age from age 4 to age 3 altered the SS estimated current stock status from that of the Run 3 model relative to SPR30%.

When either reweighting of indices or length or age composition data were incorporated into the model, little change in resulting estimates of biomass or recruitment of Spawning Potential Ratio (SPR) were predicted. Exclusion of individual indices of abundance (MRFS, FWC Trip Ticket, SEAMAP Survey) from the model also did not alter the perception of current stock status from Run 3 relative to SPR30%, and neither did increasing the level of discard mortality from 10% to 20% for the commercial vertical line fishery or from 20% to 40% for the recreational fishery.

Significant Assessment Modifications

The greatest change from the 2003 MSAP assessment for Gulf of Mexico Spanish mackerel was the transition to Stock Synthesis from the previously used age based virtual population analysis. Additional diagnostics were also performed, including retrospective analyses, likelihood profiling, and jittering exercises. The jittering and profiling exercises were used to diagnose the model stability and ability to reach a similar solution on parameter estimates over varying inputs.

Discards were incorporated into the assessment using the SS super period method. This is a departure from previous stock evaluations for this species as to the approach in which discards have been analytically incorporated into the population model, for both the shrimp bycatch fishery and the directed fishery.

Sources of Information

The contents of this summary report were taken from the SEDAR 28 Gulf of Mexico Spanish mackerel data, assessment, and CIE review reports.

Figures

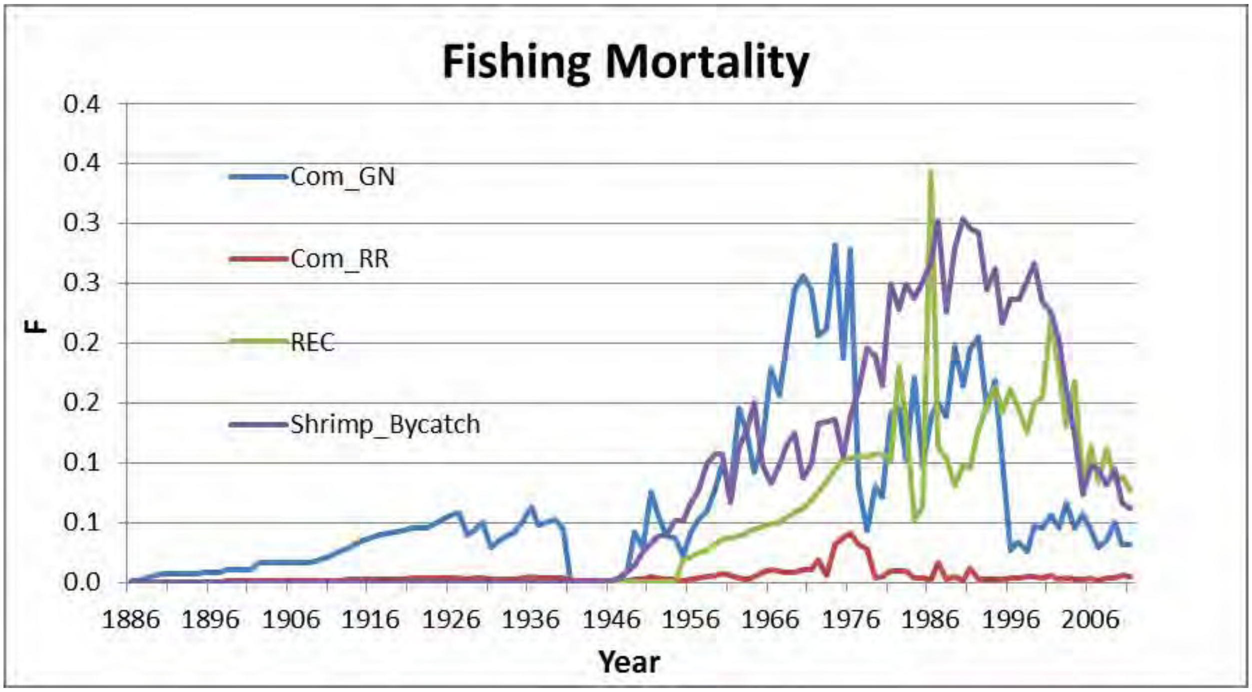


Figure 5.1. Fleet-specific continuous fishing mortality (AW Panel Preferred SS Model Run #3: M = 0.38 y^{-1}, steepness = 0.8).

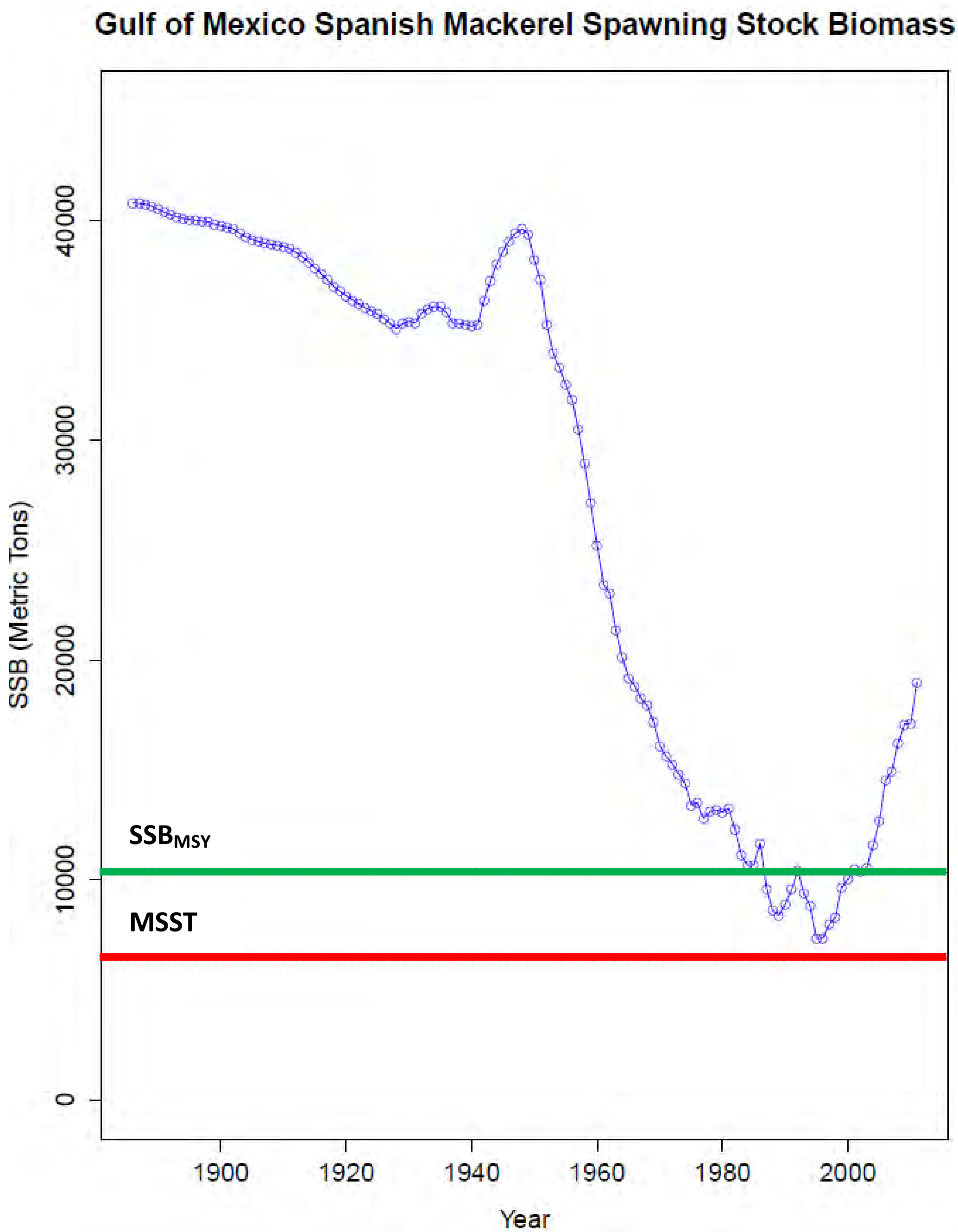


Figure 5.2. SS predicted spawning biomass for Gulf of Mexico Spanish mackerel from SS for AW Panel Preferred SS Model Run #3 (steepness = 0.8 and M = 0.38). Units are in metric tons whole weight. The green line indicates SSB_{MSY}, and the red line indicates MSST.

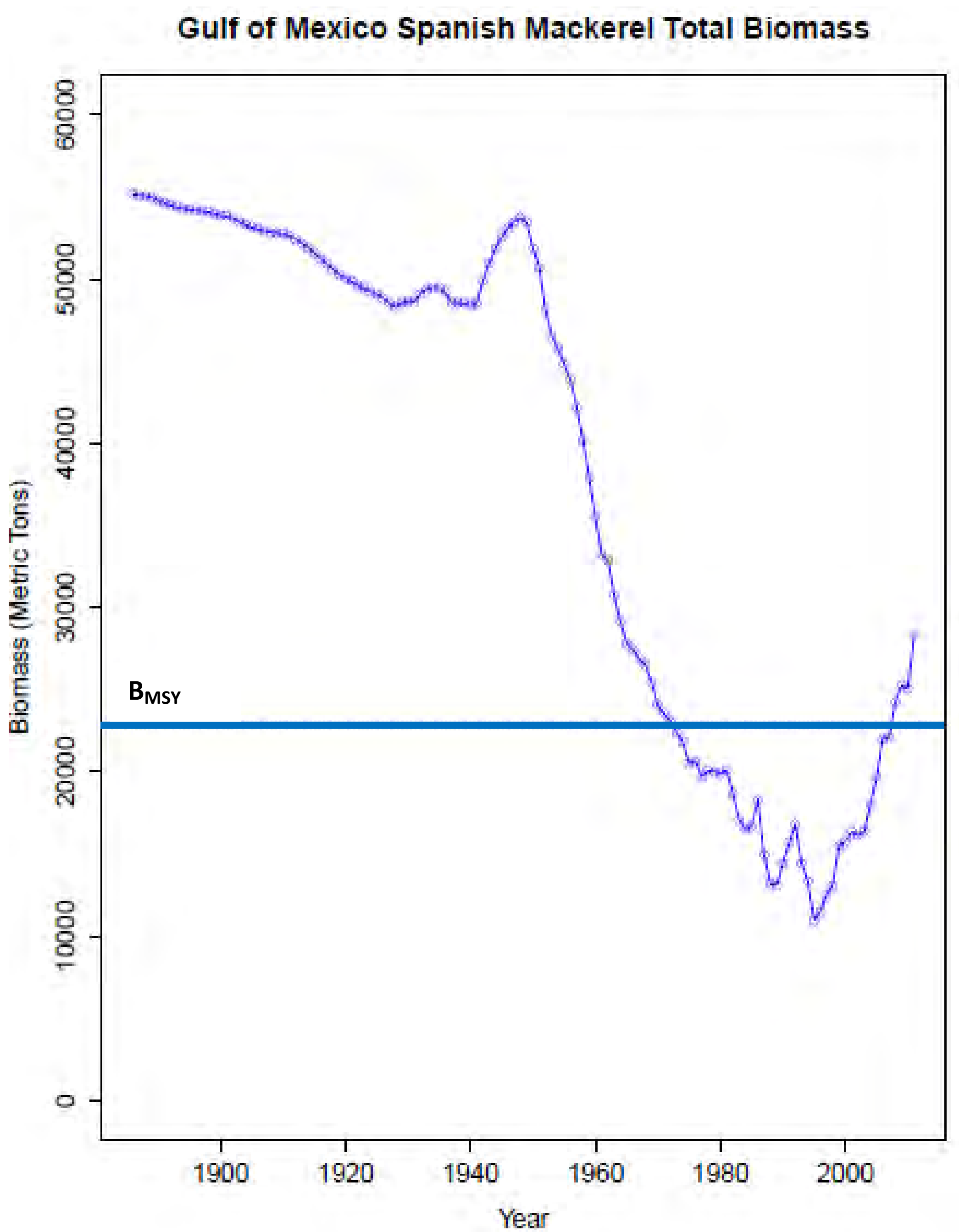


Figure 5.3. SS predicted total biomass for Gulf of Mexico Spanish mackerel for AW Panel Preferred SS Model Run #3 (steepness =0.8 and M = 0.38). Units are in metric tons whole weight. The blue line indicates projected B_{MSY}.

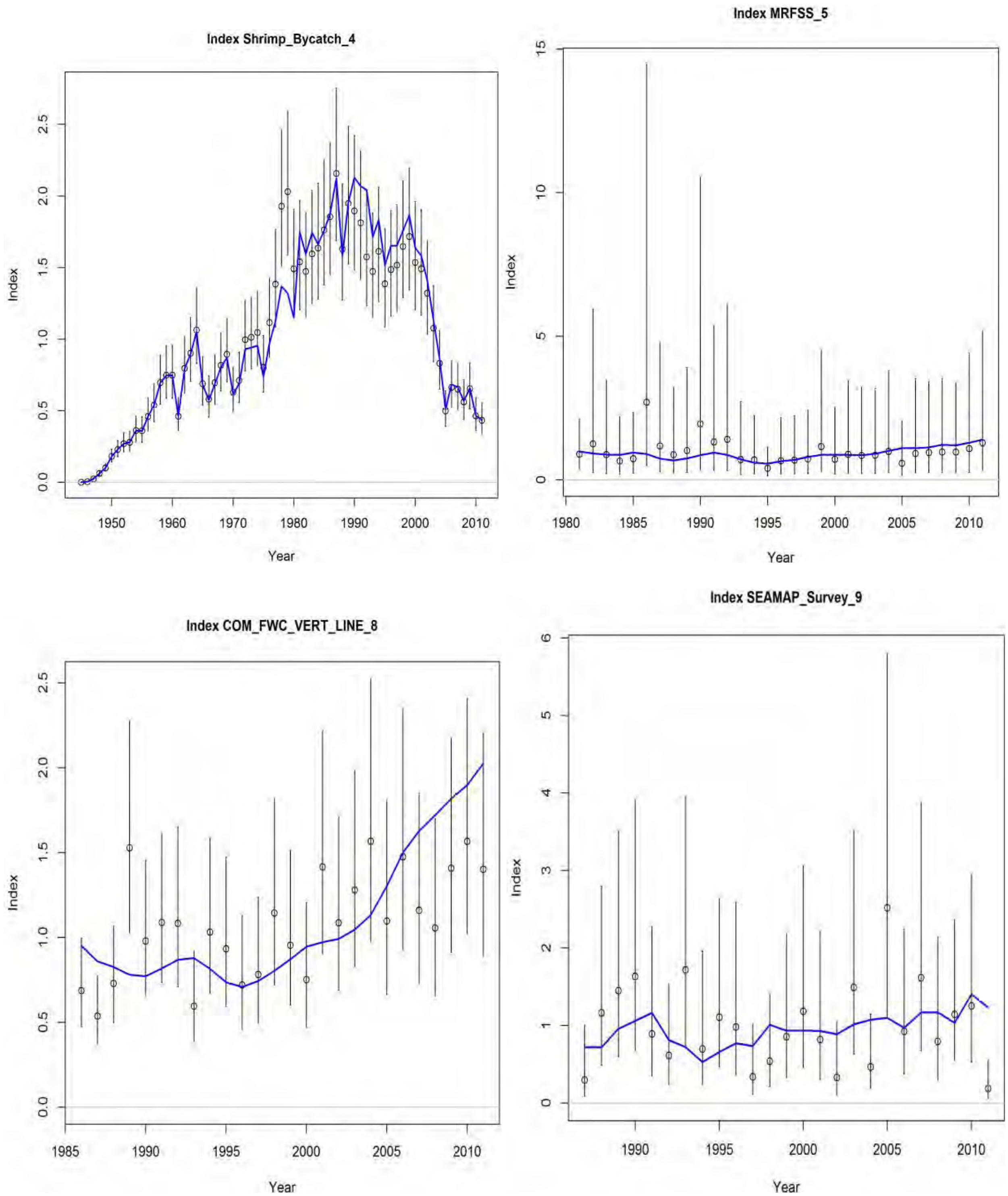


Figure 5.4. Observed and predicted index of CPUE for Gulf of Mexico Spanish mackerel from AW Panel Preferred SS Model Run #3. Indices include the shrimp fishery effort series (Shrimp_Bycatch_4), the recreational (MRFSS), the commercial line gear (COM_FWC_ VERT_Line), and the SEAMAP trawl survey (SEAMAP_Survey). Error bars represent the observed log-scale standard errors.

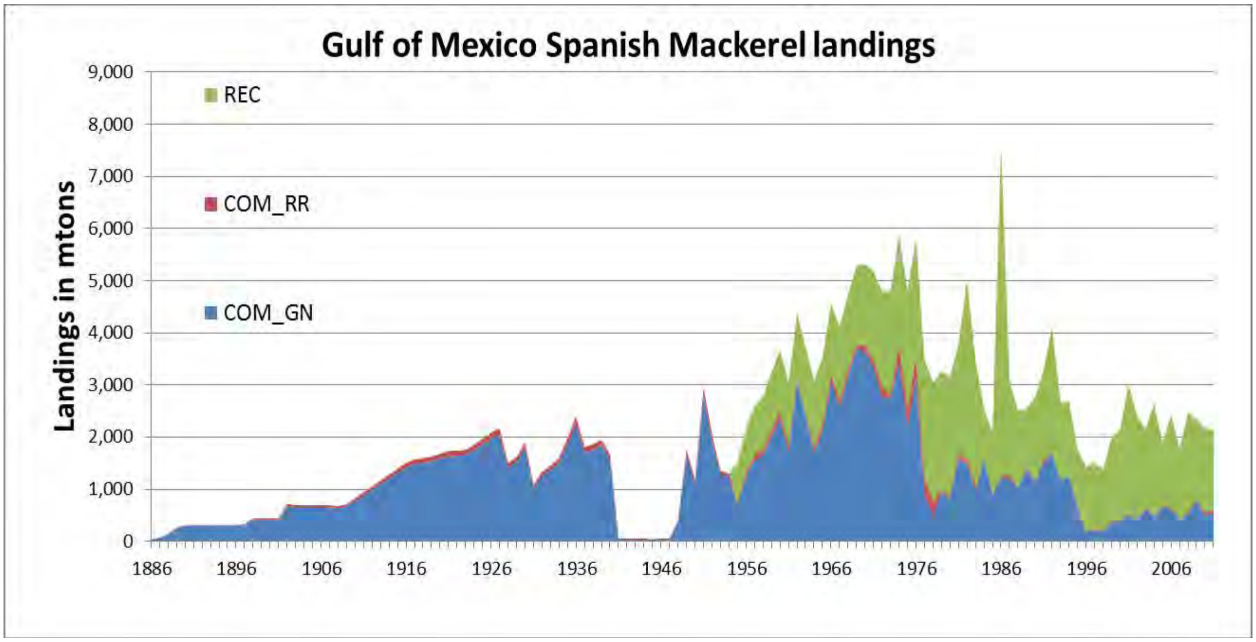


Figure 5.5. Combined landings (mtons, whole weight) for Gulf of Mexico Spanish mackerel. Landings are partitioned into three fisheries: commercial gillnet (COM_GN), commercial line gears (COM_RR), and recreational modes combined (REC=charter, private angler, shore and headboat).

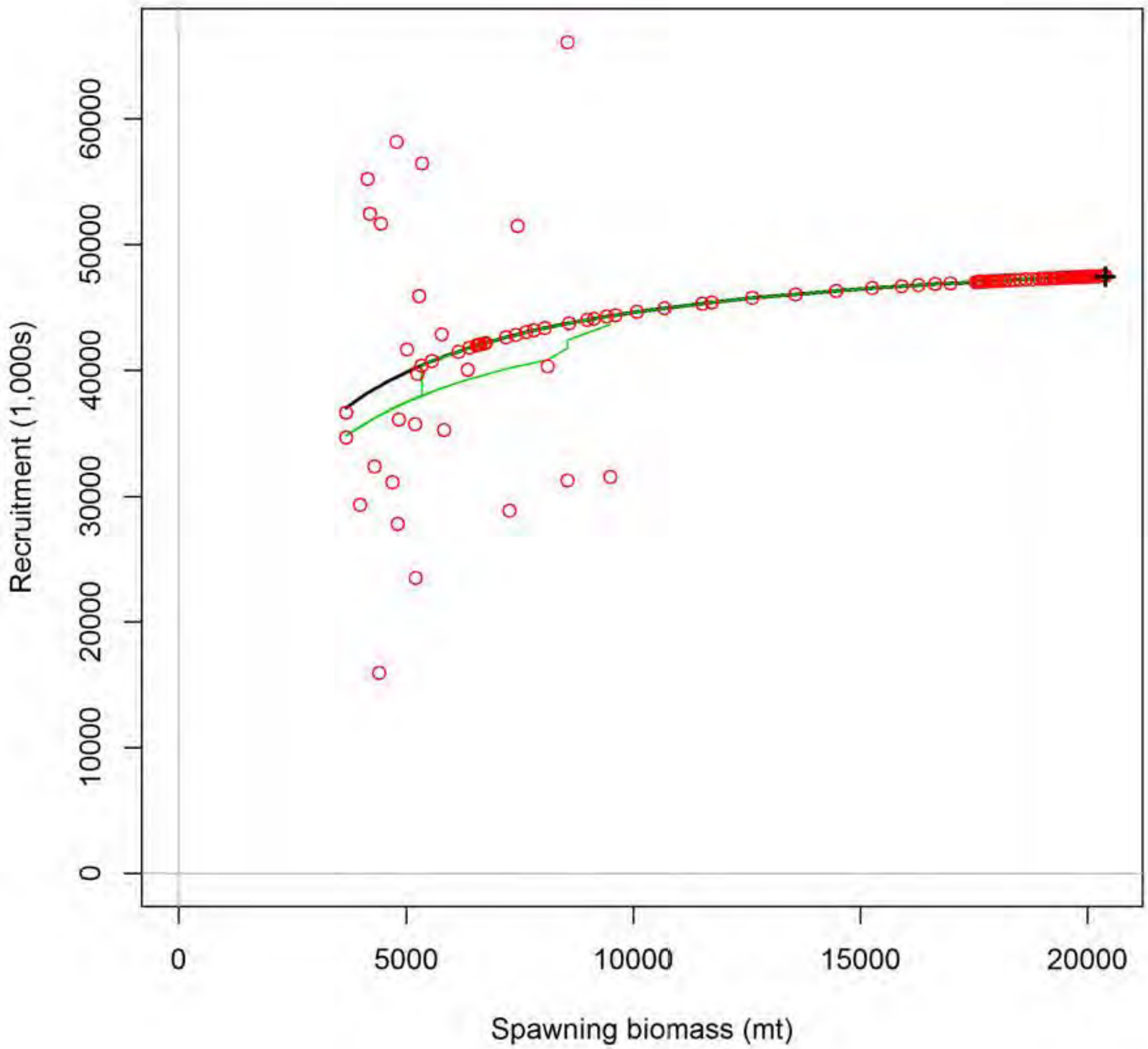


Figure 5.6. Predicted stock-recruitment relationship for Gulf of Mexico Spanish mackerel from AW Panel Preferred SS Model Run #3 (M = 0.38 y^{-1} and steepness = 0.8). Plotted are predicted annual recruitments from SS (circles), expected recruitment from the stock recruit relationship (green line), and bias adjusted recruitment from the stock-recruit relationship (black line). Labels included on first, last, and years with (log) deviations > 0.5.

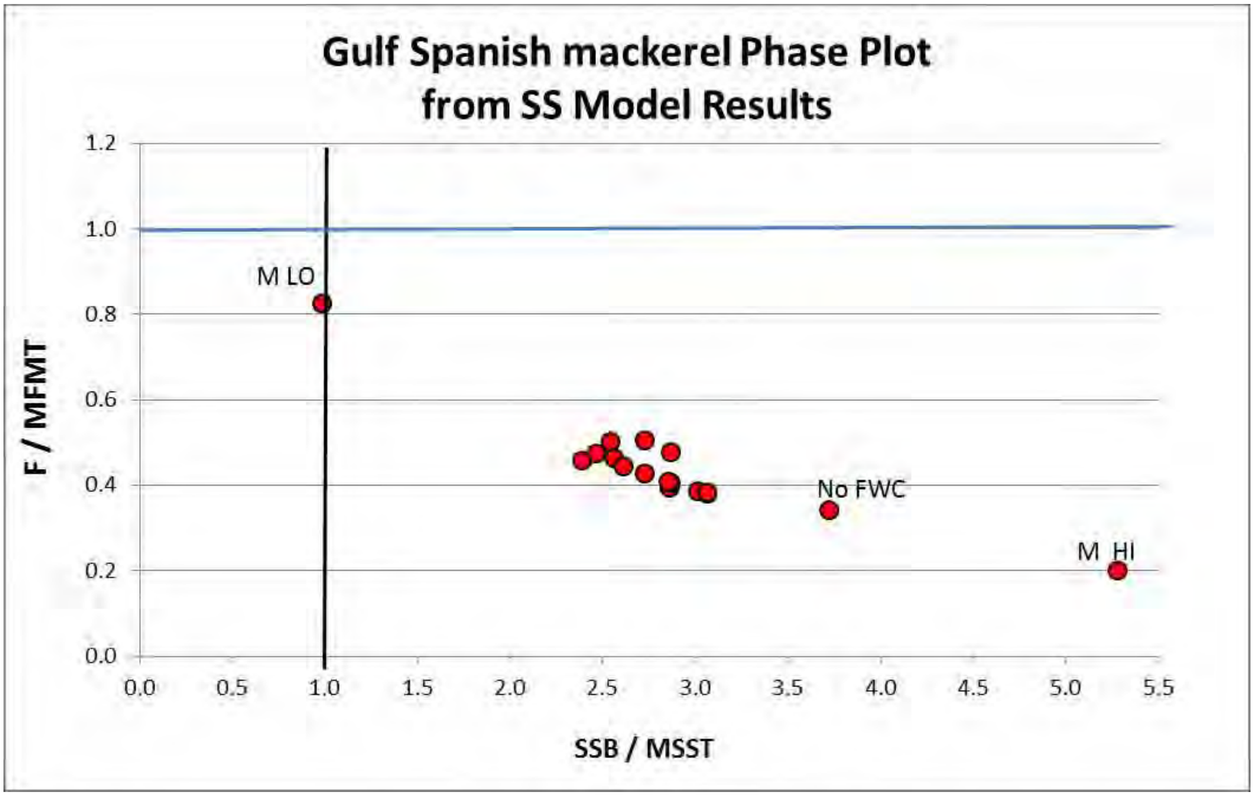


Figure 5.7. Phase plot of AW Panel Preferred SS Model Run #3 estimates of SSB/MSST and F/MFMT benchmarks for Gulf of Mexico Spanish mackerel, including sensitivities. SSB_{Ratio} = SSB_{2011} / MSST. MSST = (1-M) * SSB_{MSY}, where SSB_{MSY} = SSB @ $F_{30\%SPR}$. MFMT = $F_{30\%SPR}$.

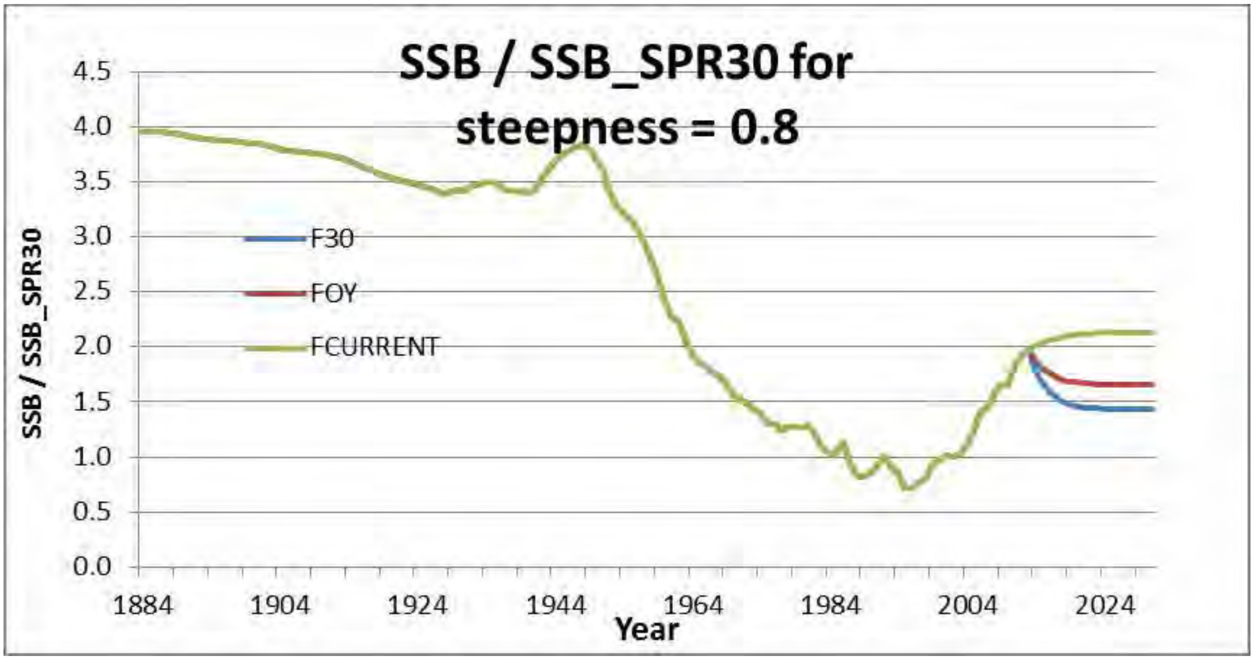


Figure 5.8. Predicted spawning biomass (SSB) relative to $F_{30\%SPR}$ for AW Panel Preferred SS Model Run #3 under three fishing mortality scenarios: $F_{Current}$, $F_{SPR30\%}$, and F_{OY}. All scenarios assumed M = 0.38y^{-1} in the input Lorenzen function.

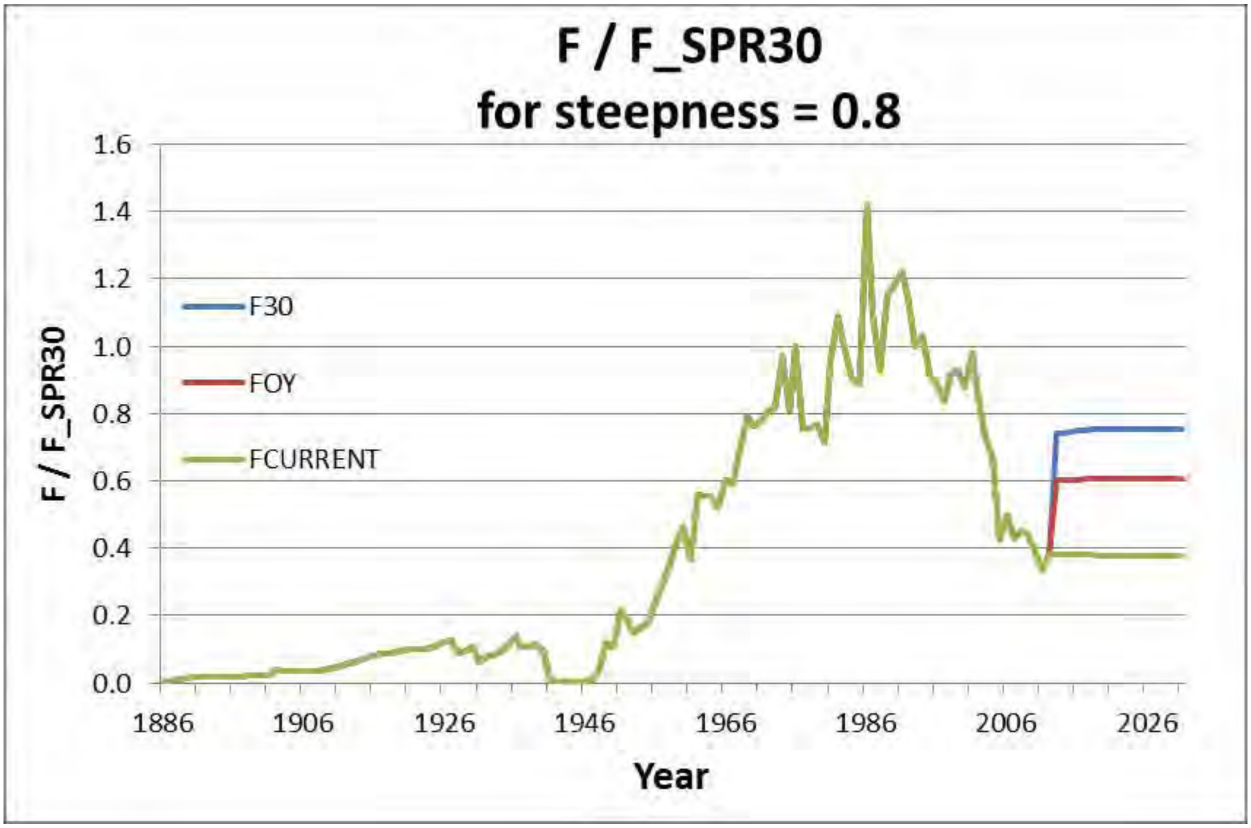


Figure 5.9. Projected fishing mortality rate relative to $F_{SPR30\%}$ for AW Panel Preferred SS Model Run #3 under three fishing mortality scenarios: $F_{Current}$, $F_{SPR30\%}$, and F_{OY}. All scenarios assumed $M = 0.38\ y^{-1}$ in the input Lorenzen function.

6. SEDAR Abbreviations

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

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

SEDAR

Southeast Data, Assessment, and Review

SEDAR 28

Gulf of Mexico Spanish Mackerel

SECTION II: Data Workshop Report

May 2012

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

Contents

1 Introduction

1.1 Workshop Time and Place

The SEDAR 28 Data Workshop was held February 6-10, 2012 in Charleston, South Carolina. Webinars were held January 11, 2012 and March 14, 2012.

1.2 Terms of Reference

I. Data Workshop

1. Characterize stock structure and develop an appropriate stock definition. Provide maps of species and stock distribution.
2. Review, discuss and tabulate available life history information.
   - 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. 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, addressing program objectives, methods, coverage (provide maps), sampling intensity, and other relevant characteristics
   - Develop CPUE and index values by appropriate strata (e.g., age, size, area, and fishery) and provide measures of precision and accuracy
   - Evaluate the degree to which available indices adequately represent fishery and population conditions
   - Recommend which data sources are considered adequate for use in assessment modeling
4. Characterize commercial and recreational catch.
   - Include both landings and discards, in pounds and number of fish
   - Provide estimates of discard mortality rates by fishery and other strata as feasible
   - Evaluate and discuss the adequacy of available data for accurately characterizing harvest and discard by species and fishery sector
   - Provide length and age distributions if feasible, and maps of fishery effort and harvest
5. Determine appropriate stock assessment models and/or other methods of evaluating stock status, determining yields, estimating appropriate population benchmarks, and making future projections that are suitable for making management decisions.
6. Describe any environmental covariates or episodic events that would be reasonably expected to affect population abundance.
7. Provide any information available about demographics and socioeconomics of fishermen, especially as they may relate to fishing effort.
8. Provide recommendations for future research, including guidance on sampling design, intensity, and appropriate strata and coverage.

9. Develop a spreadsheet of assessment model input data that reflects the decisions and recommendations of the Data Workshop. Review and approve the contents of the input spreadsheet.
10. Prepare the Data Workshop report providing complete documentation of workshop actions and decisions (Section II of the SEDAR assessment report).
    - Develop a list of tasks to be completed following the workshop
    - Review and describe any ecosystem consideration(s) that should be included in the stock assessment report

II. Assessment Process

1. Review and provide justification for any changes in data following the data workshop and any analyses suggested by the data workshop. Summarize data as used in each assessment model.
2. Recommend a model configuration which is deemed most reliable for providing management advice using available compatible data. Document all input data, assumptions, and equations.
3. Incorporate known applicable environmental covariates into the selected model, and provide justification for why any of those covariates cannot be included at the time of the assessment.
4. Provide estimates of stock population parameters.
    - Include fishing mortality, abundance, biomass, selectivity, stock-recruitment relationship, and other parameters as appropriate given data availability and modeling approaches
    - Include appropriate and representative measures of precision for parameter estimates
5. Characterize uncertainty in the assessment and estimated values.
    - Considering components such as input data, modeling approach, and model configuration
    - Provide appropriate measures of model performance, reliability, and 'goodness of fit'
6. Provide yield-per-recruit, spawner-per-recruit, and stock-recruitment evaluations.
7. Provide estimates of stock status relative to management criteria consistent with applicable FMPs, proposed FMPs and Amendments, other ongoing or proposed management programs, and National Standards for each model run presented for review.
8. Project future stock conditions and develop rebuilding schedules if warranted, including estimated generation time. Develop stock yield projections in both biomass and numbers of fish in accordance with the following:

   A) If stock is overfished:

   $F=0$, $F_{Current}$, F_{MSY}, F_{OY}

   $F=F_{Rebuild}$ (max that permits rebuild in allowed time)

   B) If stock is undergoing overfishing:

   $F= F_{Current}$, F_{MSY}, F_{OY}

   C) If stock is neither overfished nor undergoing overfishing:

   $F= F_{Current}$, F_{MSY}, F_{OY}

   D) If data limitations preclude classic projections (i.e. A, B, C above), explore alternate models to provide management advice
9. Provide a probability distribution function for the base model, or a combination of models that represent alternate states of nature, presented for review.
    - Determine the yield associated with a probability of exceeding OFL at P* values of 30% to 50% in single percentage increments for use with the Tier 1 ABC control rule

- Provide justification for the weightings used in producing combinations of models

10. Provide recommendations for future research and data collection. Be as specific as possible in describing sampling design and intensity, and emphasize items which will improve assessment capabilities and reliability. Recommend the interval and type for the next assessment.
11. Prepare a spreadsheet containing all model parameter estimates and all relevant population information resulting from model estimates and projection and simulation exercises. Include all data included in assessment report tables and all data that support assessment workshop figures.
12. Complete the Assessment Workshop Report (Section III: SEDAR Stock Assessment Report).

III. Review Workshop

1. Evaluate the quality and applicability of data used in the assessment.
2. Evaluate the quality and applicability of methods used to assess the stock.
3. Recommend appropriate estimates of stock abundance, biomass, and exploitation.
4. Evaluate the methods used to estimate population benchmarks and management parameters. Recommend and provide estimated values for appropriate management benchmarks and declarations of stock status for each model run presented for review.
5. Evaluate the quality and applicability of the methods used to project future population status. Recommend appropriate estimates of future stock condition.
6. Evaluate the quality and applicability of methods used to characterize uncertainty in estimated parameters.
   - Provide measures of uncertainty for estimated parameters
   - Ensure that the implications of uncertainty in technical conclusions are clearly stated
   - If there are significant changes to the base model, or to the choice of alternate states of nature, then provide a probability distribution function for the base model, or a combination of models that represent alternate states of nature, presented for review.
   - Determine the yield associated with a probability of exceeding OFL at P* values of 30% to 50% in single percentage increments
   - Provide justification for the weightings used in producing the combinations of models
7. If available, ensure that stock assessment results are accurately presented in the Stock Assessment Report and that stated results are consistent with Review Panel recommendations.
8. Evaluate the quality and applicability of the SEDAR Process as applied to the reviewed assessment and identify the degree to which Terms of Reference were addressed during the assessment process.
9. Make any additional recommendations or prioritizations warranted.
   - Clearly denote research and monitoring needs that could improve the reliability of future assessments
10. Prepare a Review Summary Report summarizing the Panel's evaluation of the stock assessment and addressing each Term of Reference. Develop a list of tasks to be completed following the workshop. Complete and submit the Review Summary Report no later than the date set by the Review Panel Chair at the conclusion of the workshop.

The review panel may request additional sensitivity analyses, evaluation of alternative assumptions, and correction of errors identified in the assessments provided by the assessment workshop panel; the review panel may not request a new assessment. Additional details regarding the latitude given the review panel to deviate from assessments provided by the assessment workshop panel are provided in the SEDAR Guidelines and the SEDAR Review Panel Overview and Instructions.

** The panel shall ensure that corrected estimates are provided by addenda to the assessment report in the event corrections are made, alternate model configurations are recommended, or additional analyses are prepared as a result of review panel findings regarding the TORs above.**

1.3 List of Participants

Amy Dukes
Amy Schueller
Beverly Sauls
Bill Parker
Bob Zales II
Chip Collier
Chris Kalinowski
Chris Palmer
Dave Donaldson
David Gloeckner
Donna Bellais
Doug Devries
Doug Mumford
Eric Fitzpatrick
Erik Williams
Ernst Peebles
Jeanne Boylan
Jeff Isely
Jennifer Potts
Jim Franks
Joe Cimino
Joe Smith
John Ward
Julia Byrd
Julie Defilippi
Justin Yost
Karl Brenkert
Katie Andrews
Kelly Fitzpatrick
Ken Brennan
Kevin Craig
Kevin McCarthy
Kyle Shertzer
Lew Coggins
Liz Scott-Denton
Marcel Reichert
Matt Perkinson
Meaghan Bryan
Mike Denson
Nancie Cummings
Neil Baertlein
Pearse Webster
Read Hendon
Refik Orhum
Rob Cheshire
Robert Johnson
Rusty Hudson
Shannon Calay
Stephanie McInerny
Steve Brown
Ben Hartig
Kari Fenske
Ryan Rindone
Rachael Silvas
Mike Errigo
Sue Gerhart
Gregg Waugh
Clay Porch
Todd Gedamke
Mike Larkin
Steve Saul
Adam Pollack
Steve Turner
Patrick Gilles
John Carmichael
Michael Schirripa
Julie Neer
Tanya Darden
Tim Sartwell
Tom Ogle
Vivian Matter
Walter Ingram
Danielle Chesky
Katie Drew
Erik Hiltz
Frank Hester
Peter Barile
Carly Altizer
Marin Hawk
Mark E Brown
C. Michelle Willis
Carrie Hendrix
Jon Richardsen
Patrick Biando

1.4 List of Data Workshop Working Papers

Gulf and South Atlantic Spanish Mackerel and Cobia
Workshop Document List

Document #	Title	Authors
Documents Prepared for the Data Workshop		
SEDAR28-DW01	Cobia preliminary data analyses – US Atlantic and GOM genetic population structure	T. Darden 2012
SEDAR28-DW02	South Carolina experimental stocking of cobia *Rachycentron canadum*	M. Denson 2012
SEDAR28-DW03	Spanish Mackerel and Cobia Abundance Indices from SEAMAP Groundfish Surveys in the Northern Gulf of Mexico	Pollack and Ingram, 2012
SEDAR28-DW04	Calculated discards of Spanish mackerel and cobia from commercial fishing vessels in the Gulf of Mexico and US South Atlantic	K. McCarthy
SEDAR28-DW05	Evaluation of cobia movement and distribution using tagging data from the Gulf of Mexico and South Atlantic coast of the United States	M. Perkinson and M. Denson 2012
SEDAR28-DW06	Methods for Estimating Shrimp Bycatch of Gulf of Mexico Spanish Mackerel and Cobia	B. Linton 2012
SEDAR28-DW07	Size Frequency Distribution of Spanish Mackerel from Dockside Sampling of Recreational and Commercial Landings in the Gulf of Mexico 1981-2011	N.Cummings and J. Isely
SEDAR28-DW08	Size Frequency Distribution of Cobia from Dockside Sampling of Recreational and Commercial Landings in the Gulf of Mexico 1986-2011	J. Isely and N. Cummings
SEDAR28-DW09	Texas Parks and Wildlife Catch Per unit of Effort Abundance Information for Spanish mackerel	N. Cummings and J. Isely
SEDAR28-DW10	Texas Parks and Wildlife Catch Per unit of Effort Abundance Information for cobia	J. Isely and N. Cummings
SEDAR28-DW11	Size Frequency Distribution of Cobia and Spanish Mackerel from the Galveston, Texas, Reef Fish Observer Program 2006-2011	J Isely and N Cummings
SEDAR28-DW12	Estimated conversion factors for calibrating MRFSS charterboat landings and effort estimates for the South Atlantic and Gulf of Mexico in 1981-1985 with For Hire Survey estimates with application to Spanish mackerel and cobia landings	V. Matter, N Cummings, J Isely, K Brennen, and K Fitzpatrick
SEDAR28-DW13	Constituent based tagging of cobia in the Atlantic and Gulf of Mexico waters	E. Orbesen
SEDAR28-DW14	Recreational Survey Data for Spanish Mackerel and Cobia in the Atlantic and the Gulf of Mexico	V. Matter

	from the MRFSS and TPWD Surveys	
SEDAR28-DW15	Commercial Vertical Line and Gillnet Vessel Standardized Catch Rates of Spanish Mackerel in the US Gulf of Mexico, 1998-2010	N. Baertlein and K. McCarthy
SEDAR28-DW16	Commercial Vertical Line Vessel Standardized Catch Rates of Cobia in the US Gulf of Mexico, 1993-2010	K. McCarthy
SEDAR28-DW17	Standardized Catch Rates of Spanish Mackerel from Commercial Handline, Trolling and Gillnet Fishing Vessels in the US South Atlantic, 1998-2010	K. McCarthy
SEDAR28-DW18	Standardized catch rates of cobia from commercial handline and trolling fishing vessels in the US South Atlantic, 1993-2010	K. McCarthy
SEDAR28-DW19	MRFSS Index for Atlantic Spanish mackerel and cobia	Drew et al.
SEDAR28-DW20	Preliminary standardized catch rates of Southeast US Atlantic cobia (*Rachycentron canadum*) from headboat data.	NMFS Beaufort
SEDAR28-DW21	Spanish mackerel preliminary data summary: SEAMAP-SA Coastal Survey	Boylan and Webster
SEDAR28-DW22	Recreational indices for cobia and Spanish mackerel in the Gulf of Mexico	Bryan and Saul
SEDAR28-DW23	A review of Gulf of Mexico and Atlantic Spanish mackerel (*Scomberomorus maculatus*) age data, 1987-2011, from the Panama City Laboratory, Southeast Fisheries Science Center, NOAA Fisheries Service	Palmer, DeVries, and Fioramonti
SEDAR28-DW24	SCDNR Charterboat Logbook Program Data, 1993 - 2010	Errigo, Hiltz, and Byrd
SEDAR28-DW25	South Carolina Department of Natural Resources State Finfish Survey (SFS)	Hiltz and Byrd
SEDAR28-DW26	Cobia bycatch on the VIMS elasmobranch longline survey:1989-2011	Parsons et al.
Reference Documents		
SEDAR28-RD01	List of documents and working papers for SEDAR 17 (South Atlantic Spanish mackerel) – all documents available on the SEDAR website	SEDAR 17
SEDAR28-RD02	2003 Report of the mackerel Stock Assessment Panel	GMFMC and SAFMC, 2003
SEDAR28-RD03	Assessment of cobia, *Rachycentron canadum*, in the waters of the U.S. Gulf of Mexico	Williams, 2001

SEDAR28-RD04	Biological-statistical census of the species entering fisheries in the Cape Canaveral area	Anderson and Gehringer, 1965
SEDAR28-RD05	A survey of offshore fishing in Florida	Moe 1963
SEDAR28-RD06	Age, growth, maturity, and spawning of Spanish mackerel, *Scomberomorus maculates* (Mitchill), from the Atlantic Coast of the southeastern United States	Schmidt et al. 1993
SEDAR28-RD07	Omnibus amendment to the Interstate Fishery Management Plans for Spanish mackerel, spot, and spotted seatrout	ASMFC 2011
SEDAR28-RD08	Life history of Cobia, *Rachycentron canadum* (Osteichthyes: Rachycentridae), in North Carolina waters	Smith 1995
SEDAR28-RD09	Population genetics of cobia *Rachycentron canadum*: Management implications along the Southeastern US coast	Darden et al, 2012
SEDAR28-RD10	Inshore spawning of cobia (*Rachycentron canadum*) in South Carolina	Lefebvre and Denson, 2012
SEDAR28-RD11	A review of age, growth, and reproduction of cobia *Rachycentron canadum*, from US water of the Gulf of Mexico and Atlantic ocean	Franks and Brown-Peterson, 2002
SEDAR28-RD12	An assessment of cobia in Southeast US waters	Thompson 1995
SEDAR28-RD13	Reproductive biology of cobia, *Rachycentron canadum*, from coastal waters of the southern United States	Brown-Peterson et al. 2001
SEDAR28-RD14	Larval development, distribution, and ecology of cobia *Rachycentron canadum* (Family: Rachycentridae) in the northern Gulf of Mexico	Ditty and Shaw 1992
SEDAR28-RD15	Age and growth of cobia, *Rachycentron canadum*, from the northeastern Gulf of Mexico	Franks et al 1999
SEDAR28-RD16	Age and growth of Spanish mackerel, *Scomberomorus maculates*, in the Chesapeake Bay region	Gaichas, 1997
SEDAR28-RD17	Status of the South Carolina fisheries for cobia	Hammond, 2001
SEDAR28-RD18	Age, growth and fecundity of the cobia, *Rachycentron canadum*, from Chesapeake Bay and adjacent Mid-Atlantic waters	Richards 1967
SEDAR28-RD19	Cobia (*Rachycentron canadum*) tagging within Cheasapeake Bay and updating of growth equations	Richards 1977
SEDAR28-RD20	Synopsis of biological data on the cobia *Rachycentron canadum* (Pisces: Rachycentridae)	Shaffer and Nakamura 1989
SEDAR28-RD21	South Carolina marine game fish tagging program 1978-2009	Wiggers, 2010

SEDAR28-RD22	Cobia (*Rachycentron canadum*), amberjack (*Seriola dumerili*), and dolphin (*Coryphaena hipurus*) migration and life history study off the southwest coast of Florida	MARFIN 1992
SEDAR28-RD23	Sport fish tag and release in Mississippi coastal water and the adjacent Gulf of Mexico	Hendon and Franks 2010
SEDAR28-RD24	VMRC Cobia otolith preparation protocol	VMRC
SEDAR28-RD25	VMRC Cobia otolith ageing protocol	VMRC

2 Life History

2.1 Overview

Overview
The life history working group (LHG) discussed information regarding stock structure, natural mortality, discard mortality, age, growth, movements, and reproduction of Atlantic and Gulf of Mexico stocks of Spanish mackerel.

Group Membership
Jennifer Potts (Workgroup Leader)……..…NMFS -Beaufort
Doug DeVries (Leader – Cobia)…………...NMFS - Panama City
Chris Palmer (Leader – Spanish mackerel)...NMFS – Panama City
Karl Brenkert……………………….…..SC DNR
Joe Cimino………………………………VMRC
Chip Collier……………………………..SA SSC
Tanya Darden…………………….……..SC DNR
Mike Denson……………………………SC DNR
Jim Franks…………………….…………USM
Randy Gregory………………………….NC DMF
Read Hendon……………………………USM
Chris Kalinowski………………………..GA DNR
Ernst Peebles………………..……..……USF
Matt Perkinson………………………….SC DNR
Marcel Reichert……………………..….SA SSC
Joe Smith……………………..…………NMFS Beaufort
John Ward……………………………....Gulf SSC
Erik Williams…………………………...NMFS Beaufort
Justin Yost…………………………..…...SC DNR

Issues
Some of the main issues discussed by the LHG were discard mortality rates in both the Atlantic and Gulf of Mexico stocks and fitting the von Bertalanffy parameter t_0 age 0 samples to more accurately model growth parameters as was the case in SEDAR 17.

2.2 Review of Working Papers

(SEDAR28-DW23) A review of Gulf of Mexico and Atlantic Spanish mackerel (Scomberomorus maculatus) age data, 1987-2011, from the Panama City Laboratory, Southeast Fisheries Science Center, NOAA Fisheries Service

C. Palmer, D. DeVries, and C. Fioramonti

Abstract

A total of 29,168 (n = 16,667 ATL, n = 12,501 GOM) Spanish mackerel collected during 1987 - 2011 have been aged by the Panama City Laboratory. Of those aged, 49% were from the commercial sector, 33% from the recreational sector (CP, HB, and PR combined), 10% from scientific surveys, 4% from tournaments, and 4% from unknown sectors. Spanish mackerel collected during 1987 – 2011 and aged by the NMFS Panama City Lab ranged in age from 0 to 11 yr, with the majority (Atlantic 90%, Gulf 89%) between 0 and 4 yr (Figure 2). Females from the Atlantic and Gulf ranged in age from 0 to 11 yr. Atlantic males ranged from 0 to 11 yr and Gulf males from 0 to 10 yr. Ninety percent of both Atlantic females and males and 89% of both Gulf females and males were ages 0 to 4 yr. The size ranges of Atlantic commercial (N = 10,699) and recreational (N = 3,972) Spanish mackerel age samples were similar (~250 – 700 mm / 9.8 – 27.6 in), and modal sizes were only slightly different (CM: 350-400 mm vs REC: 400-450 mm). Spanish mackerel age samples were similar (~300 – 650 mm / 011.8 – 25.6 in), but modal sizes of recreational samples were ~100 mm smaller than that of commercial samples (400 vs 500-550 mm). Recreationally-caught females from the Atlantic, ages 4 - 10, averaged 53 mm larger at age than those from commercial catches, probably reflecting differences in selectivity and/or spatial distribution of the samples.

Critique: The working paper describes Spanish mackerel age data from the Panama City laboratory. The data is collected from commercial and recreational fisheries. The data sources use uniform sampling methdologies. The data are reviewed using rigorous quality assurance, quality control procedures, validation rules for data entry and proofed against original data sheets. Ages were validated for precision using published techniques. Indexes of precision between readers is documented and descriptive statistics provided are appropriate.

2.3 Stock Definition and Description

Spanish mackerel are found throughout the Gulf of Mexico and US Atlantic Coast (Collette and Russo 1979, 1984). The bulk of the stock is found in Florida waters and are sought after by both the commercial and recreational sectors throughout their range (Trent and Anthony 1978). Based on electrophoresis studies, spawning locations, stock distribution patters, and catch history (Skow and Chittenden 1981; GMFMC and SAFMC 1987), amendment 2 to the Coastal Pelagics FMP designated two groups of Spanish mackerel. The Dade – Monroe County, Florida boundary was acknowledged as feasible boundary, because both commercial and recreational catch data for the Gulf and Atlantic have used this boundary. For SEDAR 28 it was agreed that fish landed north of US Highway 1 in Monroe County Florida were Gulf of Mexico stock and fish landed south of US Highway 1 were Atlantic stock.

Per SEDAR 17:
This species has been investigated for evidence of stock structure by multiple researchers with conflicting results. Early studies of morphometrics and meristics (Collette and Russo, 1984), a single allozyme study (Skow and Chittenden, 1981), and an electrophoresis study using 44 muscle enzyme loci (Nakamura, 1987) noted differences between Spanish mackerel in the Atlantic and Gulf of Mexico. More recent work using

mitochondrial and nuclear DNA (Buonaccorsi et al., 2001) did not detect a difference between the Atlantic and Gulf of Mexico Spanish mackerel. Given the highly migratory nature of this species, possible mixing of pelagic eggs, and low number of individuals needed to homogenize the genetic signal, it is not surprising that mitochondrial and nuclear DNA differences were not detected; and the authors themselves noted that "From an ecological and fisheries management perspective, even a sensitive genetic analysis is not sufficient to determine that there is no difference among putative stocks. Migration on the order of tens of individuals per generation is sufficient to homogenize allele frequencies among genetic stocks for both markers." In the report of the life history workgroup from the recent data workshop on the closely related king mackerel (SEDAR 16), a discussion on stock structure noted that "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)".

Additionally, the differences observed in morphometrics, meristics (Collette and Russo, 1984), and electrophoretic analyses (Nakamura, 1987) indicate separate stocks between the Atlantic and Gulf of Mexico Spanish mackerel. These stocks may have different demographic parameters (eg. length weight relationship, size at age, and fecundity), which will influence inputs and parameters for a stock assessment model. In the co-occurring king mackerel, for which there is ample evidence of movements and mixing between the Atlantic and Gulf of Mexico (Sutter et al. 1991), DeVries et al. (1997) reported significant differences in growth and size at age estimates between fish sampled in Atlantic waters off the SE U.S. and the eastern Gulf of Mexico. More recent studies of otolith shape and elemental composition (Clardy et al. 2008, Patterson and Shepard 2008) strongly supported the existence of separate Atlantic and eastern Gulf of Mexico stocks. The consensus of the LHG was that the management units should remain distinct between the Atlantic and Gulf to remain consistent with Amendment 2 of the Fishery Mangement Plan for the Coastal Migratory Pelagic Resources (Mackerels) (GMFMC and SAFMC, 1987).

Recommendation for the AW:
The Atlantic stock and Gulf of Mexico stock should be split along SAFMC/GMFMC jurisdictions. Atlantic stock consists of all fish caught south of highway US 1 through the Florida Keys, northward along the east coast of Florida to Maine.

2.4 Natural Mortality

Natural mortality (M) in many marine fish stocks is a difficult parameter to estimate. Several equations have been derived to attempt to estimate M that use various life history parameters (L_∞, K, maximum age, age at 50% maturity). The LHG selected 14 equations that give point estimates (Table 2.1) and the age-varying M from Lorenzen (1996) (Figure 2.1).

The point estimates of M ranged widely. The Beverton estimate was the highest at 3.44. Other estimates that rely heavily on K from the von Bertalanffy parameters include

Ralston, Jenson and Pauly, which also estimated high M, 0.92 – 2.20. The LHG is cautious of using these estimates because of the issues inherent in modeling growth of the species. The L_∞ and K parameters are inversely correlated and can be highly variable depending on the range of the input data and assumptions made when modeling growth.

The other estimates of M rely more on maximum age in the population. These estimates ranged from 0.16 – 0.40. Hoenig (1983), Hewitt and Hoenig (2005), and Alagaraja (1984), which all use maximum age exclusively, averaged 0.37. The Hoenig estimate from the "fish" equation was 0.38. Estimates of M using maximum age in the population have been generally accepted by previous SEDARs. Caution should be taken when selecting maximum age in the population: how many fish were sampled to find that one, old fish; what could be the longevity of the species in an un-fished stock; and what amount of error is associated with the age readings? These questions were taken into consideration by the LHG, and maximum age in the population was set at 11 years. This data point came from an aging study by Nobel et al. (1992).

The LHG recommends modeling the natural mortality rate of Spanish mackerel as a declining 'Lorenzen' function of size (translated to age by use of a growth curve) (Lorenzen 1996), scaled to the Hoenig (fish) point estimate for the fully recruited ages, 2 - 11 years. For sensitivity analysis, the LHG recommends using a CV of 54% (MacCall in Brodziak et al., 2011) about the Hoenig point estimate, though that value may be too high (Hoenig comment in MacCall in Brodziak et al., 2011). The assessment workshop can explore this option. This parallels the recommendations from SEDAR 16 (king mackerel) and 17 (Spanish mackerel).

2.5 Discard Mortality

The discussion concerning discard mortality was not addressed specifically to each region, Gulf or Atlantic, and was considered the same for both stocks.

Discard mortality rate is an important estimation included in stock assessments and rebuilding projections calculated from a stock assessment. Discard mortality rate can be impacted by several factors including: fish size, sea conditions, temperature, air exposure, handling, light conditions, and delayed mortality (Davis 2002). The longer fish are exposed to most of these factors and the more severe they are, the greater the cumulative stress on the fish (Rummer and Bennett 2007). The impacts of many of these factors are difficult to track or quantify and have led to variability in determining discard mortality rates. Spanish mackerel are harvested by several gears, which have varying discard mortality rates. Currently, few data sets are published on discard mortality of Spanish mackerel (Harrington et al. 2005). Data are collected by the NOAA Southeast Fisheries Science Center on discards in the commercial logbook program. This program randomly samples 20% of commercial vessels operating in the South Atlantic and Gulf of Mexico. From the commercial logbooks, discards were classified into five categories of kept, alive, mostly alive, mostly dead, and dead for gillnets, hook and line, and trolling fisheries (McCarthy 2008 SEDAR17-DW10). The gillnet fisheries, including set gillnets, run around gillnets, and cast nets, had a low number of discards due to gear selectivity for legal sized fish, but any discarded fish likely had a high release mortality rate. Three sources of information were available to estimate gillnet discard mortality: commercial logbook reports, a published study, and gillnet observers. The commercial logbooks estimated a gillnet discard mortality for Spanish mackerel at 100% (McCarthy 2008 SEDAR17-DW10). A discard mortality rate for Spanish mackerel in gillnets (one hour soak time) was estimated to be 93.4% based a fishery independent study off Florida (Hueter and Manire 1994). Observers have been onboard gillnet boats in the South Atlantic since 1998 with most observed trips occurring off Cape Hatteras and Cape Canaveral. The targeted species on the observed trips varied and included Spanish mackerel, sharks, sea mullet (*Menticirrhus* spp), Atlantic croaker, and other species. All Spanish mackerel that were discarded were reported discarded dead (discard mortality rate- 100%) but the number of fish discarded was very low (Table 2.2., Simon Gulak, Gillnet Coordinator SEFSC NOAA Fisheries, personal communication).

SEDAR 17 estimated a discard mortality of 80% for hand line, 98% for trolling fisheries, and a combined estimate of 88% for all hook fisheries based on logbook reporting. The numbers included a high percentage of discards reported with a kept disposition. The fish with a kept disposition were requested to be removed from the discard estimate and added to landings. The remaining discarded fish would have the discard mortality rate applied to them. Few data were available to estimate a discard mortality rate for hook and line fisheries. Discard mortality from the gill net fishery as reported by observer data is shown in Table 2.2. Commercial and recreational hook and line fishermen suggested discard mortality ranges from 5 to 15% based on personal observations. Potential sources of mortality included predation after release, broken gill arches, and other hooking injuries. The handling time was said to be short especially for the commercial fishermen and there has been an increase in the use of dehooking devices in the recreational fishery. A telemetry study tagged Spanish mackerel and recorded movements for up to five hours (Edwards 1994). The study observed two fish die immediately and two more died during the telemetry. The author estimated a range of discard mortality rate of 9 to 28%. A follow up study combined data for Spanish and king mackerels and estimated a range of discard mortality rate of 7 to 35%. SEDAR 16 for king mackerel used discard mortality rates of 20% for MRFSS and 33% for charter boats. Another surrogate species considered for estimating discard mortality rate was bluefish. The NEFSC used a 15% discard mortality rate in the bluefish stock assessment. Another bluefish study reported catch and release discard mortality was higher (38%) and included size, age, and handling time as factors in the model (Fabrizio et al. 2008). The bluefish were held in tanks for 21 days after capture to include estimates of delayed mortality. Most bluefish died on the first day (65%) and 35% of the mortality occurred after the first day.

A final component of discard mortality for Spanish mackerel would result from the shrimp trawl fishery. Any discarded would most likely have a high discard mortality rate around 100% (SEDAR 17).

Discussion

There was considerable discussion on the discard mortality rate estimates. There was some concern about the rate in hook and line fisheries, and the discussion was tabled for a following plenary. Bluefish were thought not be representative of Spanish mackerel discard mortality and there was some concern about holding fish in tanks. An experienced charter boat captain commented that bluefish are much hardier than Spanish mackerel; thus, their discard mortality rates are not comparable. After discussing several issues and reviewing the limited data on Spanish mackerel, the commercial fishery was suspected to have a lower discard mortality rate than the recreational. It was brought up that commercial fishermen can hook and release a fish within 20 seconds. Not all recreational fishermen would have this level of skill; and therefore, the discard mortality in the recreational fishery should be higher. The commercial fishermen present felt the 10% point estimate was appropriate with a range of 5 to 15% for the commercial fishery. The panel agreed to use a discard mortality rate point estimate of 20% for the base assessment run for the recreational fishery based on the Edwards (1994) telemetry study findings, which roughly ranged from 10 to 30%. The recreational fishermen present were comfortable with that estimate.

Recommendation for the AW:
Discard mortality rates:

Gillnet 100%
Handline 10% (5 to 15%) commercial
Handline 20% (10 to 30%) recreational
Shrimp Trawl 100%

2.6 Age

The Panama City NMFS Laboratory provided age and length data (n = 12,501) from 1987-2011 of Spanish mackerel collected in Gulf waters north of U.S. Highway 1 in Monroe County Florida (Figure 2.15.1). Per the SEDAR 17 report, ages from 1987 should be excluded from any analysis for SEDAR 28. A description of the methods, information on quality control, and the distribution of age samples by year, sex, geographical location, gear, fishery, and collection agency or program are detailed in SEDAR 28-DW23. Approximately 423 samples from The North Carolina Division of Marine Fisheries (2011) were not available for ageing at the time of this report and will be made available for the assessment workshop.

Recommendations for the AW:
None.

2.7 Growth

The LHG discussed several growth issues, including whether to model growth with a correction for minimum size-limit bias effect, inversely weighting the von Bertalanffy model by samples size at each age, the need to constrain $t_{0,}$ and whether to use sex-specific growth curves.

Growth of Atlantic Spanish mackerel was estimated for all fish combined and by sex. Spanish mackerel exhibit sexually-dimorphic growth, with females attaining larger sizes at age and a much larger maximum size than males. Because the majority of the age data was derived from fishery-dependent samples, which were subject to a minimum size limit, it was assumed that the fastest growers in the population would recruit to the fishery first. The presumed bias in size-at-age of the age affected most by the size-limit could be "corrected" by a model developed by Diaz et al. (2004). This model has been used in several previous SEDARs and specifically in SEDAR 17.

The LHG group agreed to run the growth model using the Diaz et al. (2004) correction that incorporates inverse weighted growth (Figure 2.3). The initial model run for all data combined resulted in the following parameter estimates: $t_0 = -1.03$, $K = 0.45$, and $L\infty = 572.8$. This t_0, which predicts an unrealistic size at age – 0 (Figure 2.4), results from the lack of very small fish (needed to estimate initial growth of the fish) in the age data set. Also, the value of k was lower than expected for a fast growing pelagic species. One way to handle these issues is to fix t_0 to a more biologically reasonable value, such as -0.5 and when this is done, the resulting parameters were $t_0 = -0.5$, $K = 0.61$, and $L\infty = 560.1$ (Figure 2.4). Because most of the aged samples are in the middle of the age distribution, the model was driven by those samples and had trouble fitting the tails (youngest and oldest fish) of the curve. Inverse weighting by sample size-at-age, an accepted practice in modeling growth, produces a better fit in the tails of the data distribution.

Due to the dimorphic growth exhibited by Spanish mackerel, sex specific growth models were run. The models incorporated the size-limit bias correction, inverse weighting, and a fixed t_0 value to -0.5 years (Figure 2.3). For females, the resulting parameter estimates were $t_0 = -0.5$, $K = 0.58$, and $L\infty = 586.9$. For males, the resulting parameter estimates were $t_0 = -0.5$, $K = 0.54$, and $L\infty = 538.1$.

<u>Recommendations for the AW:</u>
Because most of the fishery data does not identify the sex of the fish, use the model for the sexes combined, corrected for the minimum size limit bias and inversly weighted by sample size at calendar age for the overall population model. Use sex-specific growth models where appropriate

Fix t_0 at -0.5 to more realistically model the growth rate of younger fish.

2.8 Reproduction

Recent data concerning Spanish mackerel sexual maturity were queried from databases (Panama City Lab - PCLAB) and taken from at-sea surveys (MARMAP and SEAMAP). Results showed no notable departures from prior estimates (SEDAR 17). For consistency, the PCLAB maturity data included records of macroscopic maturity stage from northwest Florida (Apalachicola Bay west to St. Andrew's Bay) for all years available (1999 – 2011) from the months of April – September and were combined with the macroscopic Finucane and Collins (1986) tabular data from Gulf waters. Macroscopically staged mature fish were defined as having the characteristics of developing, spent, regressed, or ripe gonads (NMFS PCLAB, AGR 2008). Data from SEAMAP and MARMAP (both Atlantic data sets) sampling surveys were based on histological readings (Schmidt et al., 1993) and were filtered for the same monthly period and combined with the macroscopic Finucane and Collins (1986) tabular data from Atlantic waters. Percent maturity per size-class instead of age was used due to the lack of age data for all samples. Data sets from SEAMAP, MARMAP, and the Panama City Lab were combined and filtered by region. Tabular data by size-class as reported by Schmidt et al. (1993) and Finucane and Collins (1986) were combined with the newer data sets using the same size classes. The size classes used by Finucane and Collins (1986) were 1 mm FL smaller versus the size classes used by Schmidt et al. (1993) and it was decided that this would not be an issue when combining the data.

2.8.1 Spawning Seasonality

Per SEDAR 17:
The spawning season of Spanish mackerel is progressively longer from north to south, primarily due to water temperature. In lower Chesapeake Bay, Cooksey (1996) found partially spent, gravid, and running ripe females from June through August. Off the Carolinas and Georgia, females spawn from May through August (Finucane and Collins 1986; Schmidt et al. 1993), perhaps as late as September based on the presence of larvae (Collins and Stender 1987). Off the Atlantic coast of Florida, spawning females have been collected during April through September (Beaumariage 1970; Powell 1975; Finucane and Collins 1986), and as late as October in some years (Klima 1959).

The gonadosomatic index of females is at a maximum during June in the lower Chesapeake (Cooksey 1996) and off southeast Florida (Finucane and Collins 1986).

Spawning appears to take place on the inner continental shelf, as females with “maturing” (hydrated) oocytes have been collected with gillnets near inlets and shoals along Florida’s east coast (Powell 1975) and ripe females have been collected at depths of ca. 9 m from Onslow Bay (North Carolina) through Georgia (Schmidt et al. 1993). The spatial distribution of Spanish mackerel larvae also indicates that spawning takes place on the inner shelf (Collins and Stender 1987).

The major spawning period in Atlantic waters off of North Carolina and south into the Gulf of Mexico off of the Mississippi delta extended from May into September and peaked during the spring and early summer (Finucane and Collins 1986). There have been no new recent studies concerning spawning seasonality of Spanish mackerel in the Gulf of Mexico. The PCLAB maturity data shows the peak GSI occurring in the month of June (Figure 2.5). It should be noted that the low sample size (N =261) of Spanish mackerel data available may not confidently represent the spawning season.

2.8.2 Sexual Maturity

Combined tabular data of percent maturity by size class and region for females from the Atlantic and Gulf are shown in Table 2.3. In the Gulf, the smallest size-class of females collected was 226-250 mm FL; 1 of the 2 fish in that class was mature and it was 236 mm

FL. The size at 50% maturity for Gulf females fell in the 301-325 mm FL size class (Figure 2.6). Age at 50% maturity for Gulf females was 0.20 yr (std err 0.04-0.44) (Figure 2.8). This relatively young age at maturity may be attributed to the fact that all of the Gulf female gonads were staged macroscopically and the potential to stage immature gonads from younger fish, as mature, is high. Atlantic females were staged using histological methods, a more precise method. The youngest mature female was age 0 from both regions. In the Gulf both males in the smallest size-class (201-225 mm FL) were immature (Table 2.4). The smallest mature Gulf male was 274 mm FL and the size at 50% maturity was approximately 276-300 mm FL (Figure 2.7). The youngest mature male was age 0 from both regions.

2.8.3 Sex ratio

Strong sexual dimorphism in Spanish mackerel (females larger than males at aged 1- 5; see Powel 1975; Fable et al. 1987; Schmidt et al. 1993) may result in skewed adult sex ratios when data are analyzed by gear type. In the PCLAB data set females age 0 - 7 made up 69% of all gill net samples from commercial and scientific surveys and recreational hook-and-line samples (Figure 2.9, Table 2.5). Size selectivity due to gill net mesh size may have resulted in the targeting of larger fish which are generally females. Recreational hook and line caught females age 0 - 7 made up 63% of the catch (Table 2.6). However, above 40 cm females make up 72% of gill net sampled fish (Figure 2.10). Females above 40 cm from recreational hook-and-line samples totaled 76% of the catch (Figure 2.11). In recreational hook-and-line catches off southeast Florida Klima (1959) noted a highly skewed sex ratio (80% females, including immature fish). Klima speculated that the higher percentage of females was a product of their more aggressive feeding behavior and not the absence of males in the areas fished.

<u>Recommendations for the AW:</u>
Use the Atlantic age at 50% maturity value (0.70 yr) as a proxy for both regions.

Over all ages and gears, weighted percent females 66%.

Collect Spanish mackerel maturity data from both regions and both sexes from specimens approximately 275 mm FL. and lower to be staged via histological methods.

2.9 Movements and Migrations

Per SEDAR 17:
The following is quoted from section 3.1 of the Atlantic States Marine Fisheries Commission's fishery management plan for Spanish mackerel (Mercer et al. 1990): "Spanish mackerel make seasonal migrations along the Atlantic coast and appear to be much more abundant in Florida during the winter. They move northward each spring to occur off the Carolinas by April or May, off Chesapeake Bay by May or June, and some years, as far north as Narragansett Bay by July (Berrien and Finan 1977)." In a tagging study in North Carolina, 1986-1990, by the NC Division of Marine Fisheries, fish were recaptured as far south as Sebastian Inlet, FL and as far north as the York River in

Virginia (Noble 1992). The few fish recaptured in Florida were caught in winter and spring, confirming a southern movement during the fall, while those recaptured in Virginia were caught in summer and fall, supporting a northerly movement during that time of year (Phalen 1989, Noble 1992).

Recommendations for the AW:
None

2.10 Meristics and Conversion Factors

Equations to make length-length and weight-length conversions were derived using the simple linear regression model and power functions, respectively (Table 2.7). All weights are shown in kilograms and lengths in millimeters. Coefficients of determination (r^2) ranged from 0.916 to 0.989 for these linear (length) and nonlinear (weight) regressions.

Recommendations for the AW:
1) Use the equations based on combined sources.

2.11 Comments on adequacy of data for assessment analyses

Included in individual sections above.

2.12 Literature Cited

Alagaraja, K. 1984. Simple methods for estimation of parameters for assessing exploited fish stocks. Indian J. Fish. 31:177-208.

Berrien, P., and D. Finan. 1977. Biological and fisheries data on Spanish mackerel, *Scomberomorus maculatus*, (Mitchill). NMFS, Sandy Hook Laboratory, Highlands, NJ, Tech. Serv. Rep. No. 9. 52 p.

Buonaccorsi, V.P., E. Starkey, and J.E. Graves. 2001. Mitochondrial and nuclear DNA analysis of population subdivision among young-of-the-year Spanish mackerel (*Scomberomorus maculatus*) from the western Atlantic and Gulf of Mexico.Marine Biology 138:37-45.

Clardy, T.R., W.F. Patterson III, D.A. DeVries, and C.L. Palmer. 2008. Spatial and temporal variability in the relative contribution of U.S. king mackerel (*Scomberomorous cavalla*) stocks to winter mixed fisheries off south Florida. Fish. Bull. 106:152-160.

Collette, B.B., and J.L. Russo. 1979. An introduction to the Spanish mackerels, genus *Scomberomorus,* p. 3-16, In: Nakamura and Bullis (eds.), Proceedings: Colloquium on the Spanish and king mackerel resources of the Gulf of Mexico. Gulf States Marine Fisheries Commission, No. 4, Gulf States Marine Fisheries Commission, Ocean Springs, MS.

Collette, B.B., and J.L. Russo. 1984. Morphology, systematics, and biology of the Spanish mackerels (*Scomberomorus*, Scombridae). Fish. Bull., U.S. 82(4):545-692.

Davis, M.W. 2002. Key principles for understanding fish bycatch discard mortality. Canadian Journal of Fisheries and Aquatic Sciences 59: 1834-1843.

DeVries, D.A., and C.B. Grimes. 1997. Spatial and temporal variation in age and growth of king mackerel, *Scomberomorus cavalla*, from the southeastern United States. Fishery Bulletin. 81:97-106.

Diaz, G.A., C.E. Porch, and M. Ortiz. 2004. Growth models for red snapper in US Gulf of Mexico Waters estimated from landings with minimum size limit restrictions. NMFS/SFD Contribution SFD-2004-038. SEDAR7-AW1.

Edwards, R.E. 1994. Protocols for determining acute mortality of released red drum, snook, Spanish mackerel and king mackerel. Mote Marine Laboratory Technical Report No. 380. 88p

Fable, W.A., Jr., A.G. Johnson, and L.E. Barger. 1987. Age growth of Spanish mackerel, *Scomberomrus maculatus*, from Florida and the Gulf of Mexico. Fish. Bull., U.S. 85:777-783.

Fabrizio, M.C., F.S. Scharf, G.R. Shepherd, J.E. Rosendale. 2008. Factors affecting catch-and-release mortality of bluefish. North Carolina Journal of Fisheries Management 28: 533-546.

Finucane, J.H., and L.A. Collins. 1986. Reproduction of Spanish mackerel, *Scomberomorus maculatus*, from the southeastern United States. Northeast Gulf Sci. 8:97-106.

Gulf of Mexico Fishery Management Council and South Atlantic Fishery Management Council (GMFMC and SAFMC). 1987. Revised amendment 2 to the fishery management plan for the coastal migratory pelagic resources (mackerels) of the Gulf of Mexico and the south Atlantic. GMFMC, Tampa, FL and SAMFC, Charleston, SC. 54pp. plus addendums.

Harrington, J.M., R.A. Myers, and A. A. Rosenberg. 2005. Wasted fishery resources: discarded by-catch in the USA. Fish and Fisheries 6: 350–361.

Hewitt, D. A., & Hoenig, J. M. 2005. Comparison of two approaches for estimating natural mortality based on longevity. Fish. Bull., 103(2), 433-437.

Hoenig, J. M. 1983. Empirical use of longevity data to estimate mortality rates. Fish. Bull., 82: 898-903.

Hueter, R.E., and C.A. Manire. 1994. Bycatch and catch-release mortality of small sharks in the Gulf coast nursery grounds of Tampa Bay and Charlotte Harbor. Mote Marine Technical Report No. 368. (Final Report to NOAA/NMFS, MARFIN Project NA17FF078-01.

Klima, E. F. 1959. Aspects of the biology and the fishery for *Scomberomorus maculatus* (Mitchell), of southern Florida. FLa. Board Conserv., Mar. Res. Lab. Tech. Ser. No. 27, 39 p.

Lorenzen, K. 1996. The relationship between body weight and natural mortality in juvenile and adult fish: a comparison of natural ecosystems and aquaculture. Journal of Fish Biology 49: 627-647.

McCarthy, K. SEDAR17-DW10. 2008. Discards of Spanish Mackerel and Vermilion Snapper Calculated for Commercial Vessels With Federal Fishing Permits in the US South Atlantic. SEFSC

Nakamura, E.L. 1987. Mexus-Gulf coastal pelagic fish research, 1977-1984. Marine Fisheries Review 49: 36-38.

NMFS PCLAB. Age, Growth, and Reproduction Group. Procedure manual for age, growth, and reproduction lab. (September 2008). Panama City Laboratory, Southeast Fisheries Science Center. 2008.

Noble, E. B. 1992. Migration, age, and growth of Spanish mackerel (*Scomberomorus maculatus*) in North Carolina. Study 2 in Completion Report for Project –F/29. N. C. Dept. Env. Health and Nat. Res., Div. Mar. Fish. 51 pp.

Nolan, K. J. Gossfield, and I. Wirgin. 1991. Discriminating among Atlantic coast populations of American shad (*Alosa sapidissima*) using mitochondrial DNA. Canandian Journal of Fisheries and Aquatic Sciences. 48:1724-1734.

Patterson, W. F., III, and K. E. Shepard. 2008. Estimation of the stock composition of winter king mackerel fisheries off south Florida with natural tags based on otolith stable isotope chemistry. SEDAR16-DW26.

Phalen, L. R. 1989. Spanish mackerel. P. 8-12, In: Marine Fisheries Research, N. C. Div. Mar. Fish. Ann. Prog. Rep. F-29-3.

Powell, D. 1975. Age, growth, and reproduction in Florida stocks of Spanish mackerel, *Scomberomorus maculatus*. Fla. Dep. Nat. Resour., Fla. Mar. Res. Publ. No. 5, 21 p.

Pruett, C.L., E. Saillant, and J.R. Gold. 2005. Historical population demography of red snapper (*Lutjanus campechanus*) from the northern Gulf of Mexico based on analysis of sequences of mitochondrial DNA. Marine Biology 147:593-602.

Rummer, J.L., and Bennett, W.A. 2005. Physiological effects of swim bladder overexpansion and catastrophic decompression on red snapper. Transactions of the American Fisheries Society 134: 1457–1470.

Schmidt, D.J., M.R. Collins, and D.M. Wyanski. 1993. Age, growth, maturity, and spawning of Spanish mackerel, *Scomberomorus maculatus*, (Mitchil), from the Atlantic Coast of the southeastern United States. Fish. Bull., 91: 526-533.

SEDAR 16. 2009. Stock assessment report: Gulf of Mexico and South Atlantic king mackerel. North Charleston, SC. 484p.

SEDAR 17. 2008. Stock assessment report: South Atlantic Spanish mackerel. North Charleston, SC. 508p.

Skow, L.C., and M.E. Chittenden. 1981. Differences in hemoglobin phenotypes among Spanish mackerel, *Scomberomorus maculatus*. Northeast Gulf Sci. 5(1):67-70.

Sutter, F.C., R.O. Williams, and M.F. Godcharles.1991. Movement patterns and stock affinities of king mackerel in the southeastern United States. U.S. Fish. Bull. 89:315-324.

Trent, L. and A. Anthony. 1978. Commercial and recreational fisheries for Spanish mackerel, *Scomberomorus maculatus*. *In* E. L. Nakamura and H. R. Bullis, Jr. (editors), Proceedings of the Mackerel Colloquim, p. 17-32. Gulf States Marine Fisheries Commission. No. 4.

2.13 Tables

Table 2.1. Point estimates of natural mortality (M) for the Gulf stock of Spanish mackerel based on maximum age = 11 years and von Bertalanffy parameter estimates: $t_0 =$ -0.5, k = 0.61, and $L_\infty = 560$.

Equations for Estimating M:	**Parameters:**	**M**
Alverson & Carney	k, tmax	0.16
Beverton	k, am	3.44
$\text{Hoenig}_{\text{fish}}$	tmax	0.38
$\text{Hoenig}_{\text{alltaxa}}$	tmax	0.4
Pauly		1.03
Ralston	k	1.28
Ralston (geometric mean)	k	2.20
Ralston (method II)	k	2.11
Hewitt & Hoenig	tmax	0.36
Jensen	k	0.92
Rule of thumb	tmax	0.27
Alagaraja	survivorship to tmax: 0.1	0.42
Alagaraja	survivorship to tmax: 0.2	0.36
Alagaraja	survivorship to tmax: 0.5	0.27

Table 2.2. Number, percent kept, and percent discarded dead for Spanish mackerel caught in gillnet fisheries based on observed trips from 1998-2011. Data were provided by Simon Gulak (Gillnet Coordinator SEFSC NOAA Fisheries).

Gear Type	Species	Total Number Caught	% Kept	% Discarded Dead
Drift	Spanish mackerel	14,531	99%	99%
Sink	Spanish mackerel	40,810	99%	99%
Strike	Spanish mackerel	45	100%	0

Table 2.3. Percent maturity per size class of females from the Atlantic and Gulf; Finucane and Collins (1986), MARMAP, PCLAB, and SEAMAP combined data sets.

Atlantic Females					Gulf Females				
Size Class	No	Yes	Total	% Mature	Size Class	No	Yes	Total	% Mature
151-175	3	0	3	0	151-175				
176-200	6	0	6	0	176-200				
201-225	49	0	49	0	201-225				
226-250	72	0	72	0	226-250	1	1	2	50
251-275	97	4	101	4	251-275	5	1	6	17
276-300	73	14	87	16	276-300	16	3	19	16
301-325	54	38	92	41	301-325	18	25	43	58
326-350	32	63	95	66	326-350	29	115	144	80
351-375	20	81	101	80	351-375	22	159	181	88
376-400	4	73	77	95	376-400	10	212	222	95
401-425	3	64	67	96	401-425	10	190	200	95
426-450	1	41	42	98	426-450	11	146	157	93
451-475	0	24	24	100	451-475	4	147	151	97
476-500	0	17	17	100	476-500	11	85	96	89
501-525	0	17	17	100	501-525	0	101	101	100
526-550	0	6	6	100	526-550	1	66	67	99
551-575	0	7	7	100	551-575	2	60	62	97
576-600	0	4	4	100	576-600	1	57	58	98
601-625	0	12	12	100	601-625	0	31	31	100
626-650	0	4	4	100	626-650	1	20	21	95
651-725	0	7	7	100	651-725	0	12	12	100

Table 2.4. Percent maturity per size class of males from the Atlantic and Gulf from Finucane and Collins (1986), MARMAP, PCLAB, and SEAMAP combined data sets.

Atlantic Males					Gulf Males				
Size Class	No	Yes	Total	% Mature	Size Class	No	Yes	Total	% Mature
151-175	4	1	5	20	151-175				
176-200	15	1	16	6	176-200				
201-225	20	13	33	39	201-225	2	0	2	0
226-250	9	56	65	86	226-250	3	0	3	0
251-275	20	90	110	82	251-275	5	3	8	38
276-300	7	64	71	90	276-300	58	35	93	38
301-325	15	55	70	79	301-325	25	49	74	66
326-350	13	73	86	85	326-350	18	142	160	89
351-375	14	93	107	87	351-375	7	154	161	96
376-400	11	113	124	91	376-400	6	139	145	96
401-425	0	45	45	100	401-425	2	76	78	97
426-450	0	22	22	100	426-450	0	42	42	100
451-475	0	6	6	100	451-475	1	21	22	95
476-500	0	6	6	100	476-500	0	12	12	100
501-525	0	3	3	100	501-525	0	14	14	100
526-550	0	5	5	100	526-550	0	10	10	100
551-575	0	1	1	100	551-575	0	7	7	100
576-600	0	1	1	100	576-600	0	4	4	100
601-625	0	1	1	100	601-625				
626-650	0	1	1	100	626-650				
651-725	0	1	1	100	651-725				

Table 2.5. Sex ratios of Gulf of Mexico Spanish mackerel gill net samples by age from commercial and scientific surveys in the PCLAB data set; 5% and 95% confidence intervals.

Age	Females	Males	Total	% Female	F : M	low C.I.	high C.I.
0	60	14	74	81	4.3 : 1.0	71	88
1	451	152	603	75	2.8 : 1.0	71	78
2	639	284	923	69	2.2 : 1.0	66	72
3	754	318	1,072	70	2.4 : 1.0	68	73
4	485	194	679	71	2.5 : 1.0	68	75
5	215	118	333	65	1.8 : 1.0	59	70
6	70	53	123	57	1.3 : 1.0	48	65
7	36	21	57	63	1.7 : 1.0	50	74
8	6	10	16	38	0.6 : 1.0	18	61
9	2	6	8	25	0.3 : 1.0	7	59
10	0	0	0	0			
11	1	0	1	100	1.0 : 0.0	21	100
Total	2,719	1,170	3,889	69*	2.3 : 1.0		

* ages 0 - 7

Table 2.6. Sex ratios of Gulf of Mexico Spanish mackerel recreational hook-and-line samples by age in the PCLAB data set; 5% and 95% confidence intervals.

Sex ratio of GOM recreational hook-and-line SMK by age

Age	Females	Males	Total	% Female	F : M	low C.I.	high C.I.
0	215	98	313	69	2.2 : 1.0	63	74
1	1,168	692	1,860	63	1.7 : 1.0	61	65
2	831	571	1,402	59	1.5 : 1.0	57	62
3	636	335	971	65	1.9 : 1.0	62	68
4	357	187	544	66	1.9 : 1.0	62	69
5	154	107	261	59	1.4 : 1.0	53	65
6	66	45	111	59	1.5 : 1.0	50	68
7	17	11	28	61	1.5 : 1.0	42	76
8	5	6	11	45	0.8 : 1.0	21	72
9	1	0	1	100	1.0 : 0.0	21	100
10	0	2	2	0	0.0 : 2.0	0	66
Total	3,450	2,054	5,504	63*	1.7 : 1.0		

* ages 0 - 7

Table 2.7. Meristics and conversion factors.

LENGTH TO WEIGHT CONVERSIONS[1]				(see sex-specific results below)								
Data	Area	Dep. Var.	Ind. Var.	a	b	r2	n	LEN SE	WT SE	Length Range	Units	Function
Sexes Combined	S. Atl.	Weight	FL	2.2492e-8	2.8452	0.9132	49,471	0.3400	0.0019	160-900	kg mm	Power
Sexes Combined	Gulf	Weight	FL	2.0284e-8	2.8640	0.9152	37,785	0.4221	0.0024	110-892	kg mm	Power
Sexes Combined	Combined	Weight	FL	2.1591e-8	2.8530	0.9159	87,579	0.2692	0.0015	110-900	kg mm	Power
Sexes Combined	S. Atl.	Weight	TL	2.8627e-9	3.1056	0.9293	23,473	0.4653	0.0021	210-882	kg mm	Power
Sexes Combined	Gulf	Weight	TL	1.2237e-8	2.8790	0.9804	8,404	1.0660	0.0060	210-978	kg mm	Power
Sexes Combined	Combined	Weight	TL	5.4935e-9	3.0025	0.9644	31,877	0.5082	0.0025	210-978	kg mm	Power
LENGTH TO LENGTH CONVERSIONS[1]				RECOMMENDED								
Data	Area	Dep. Var.	Ind. Var.	a	b	r2	n	a SE	b SE	Length Range	Units	Function
Sexes Combined	S. Atl.	TL	FL	16.6508	1.1262	0.9874	19,334	0.3551	0.0009	194-780	mm	Linear
Sexes Combined	S. Atl.	FL	TL	-9.7850	0.8768	0.9874	19,334	0.3231	0.0007	224-882	mm	Linear
Sexes Combined	Gulf	TL	FL	27.6228	1.0995	0.9871	954	2.0529	0.0041	217-872	mm	Linear
Sexes Combined	Gulf	FL	TL	-18.4462	0.8978	0.9871	954	1.9335	0.0033	245-980	mm	Linear
Sexes Combined	Combined	TL	FL	18.4306	1.1214	0.9886	20,288	0.3339	0.0008	194-872	mm	Linear
Sexes Combined	Combined	FL	TL	-11.8218	0.8816	0.9886	20,288	0.3064	0.0007	224-980	mm	Linear
Sexes Combined	S. Atl.	SL	FL	-6.3811	0.9630	0.9923	2,640	0.6506	0.0016	194-753	mm	Linear
Sexes Combined	S. Atl.	FL	SL	9.5589	1.0306	0.9924	2,640	0.6594	0.0018	177-728	mm	Linear
Sexes Combined	S. Atl.	SL	TL	-19.4029	0.8450	0.9855	2,695	0.9197	0.0020	224-860	mm	Linear
Sexes Combined	S. Atl.	TL	SL	29.3078	1.1663	0.9855	2,695	1.0210	0.0027	177-728	mm	Linear
SEX-SPECIFIC WEIGHT AT LENGTH[1]				RECOMMENDED								
Data Source	Area	Dep. Var.	Ind. Var.	a	b	r2	n	LEN SE	WT SE	Length Range	Units	Function
Female	S. Atl.	Weight	FL	7.4558e-9	3.0244	0.9514	2,896	1.2412	0.0068	218-753	kg mm	Power
Male	S. Atl.	Weight	FL	1.6486e-8	2.8934	0.9091	2,141	0.9747	0.0039	252-605	kg mm	Power
Female	Gulf	Weight	FL	2.5969e-8	2.8310	0.9123	320	4.9400	0.0300	294-687	kg mm	Power
Male	Gulf	Weight	FL	5.1469e-9	3.0884	0.9657	124	7.1702	0.0395	298-640	kg mm	Power
Female	Combined	Weight	FL	7.9232e-9	3.0155	0.9464	3,216	1.2514	0.0070	218-753	kg mm	Power
Male	Combined	Weight	FL	1.0511e-8	2.9694	0.9280	2,265	1.0274	0.0044	252-640	kg mm	Power
Sexes Combined	Combined	Weight	FL	2.154E-08	2.8534	0.9161	88,067	0.2688	0.0015	110-900	kg mm	Power

[1] Data restrictions – TL < 1000, FL < 900, obvious errors omitted. Dep. Var. = Dependent variable, Ind. Var. = Independent variable.

2.14 Figures

Figure 2.1. Lorenzen age-varying natural mortality of the Gulf stock of Spanish mackerel.

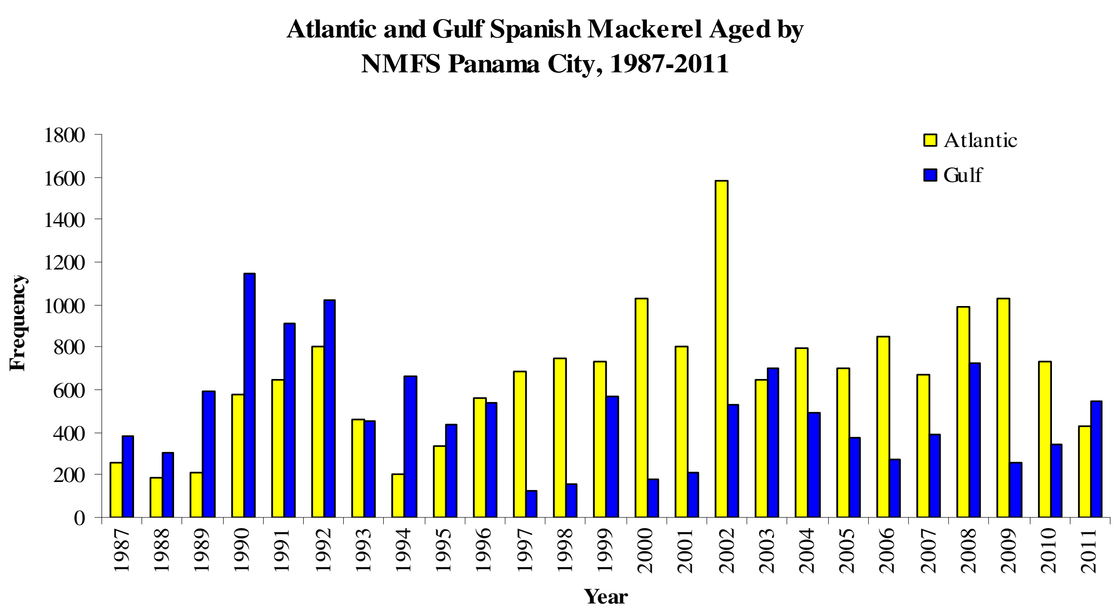


Figure 2.2. Atlantic and Gulf Spanish mackerel aged by NMFS Panama City, 1987-2011.

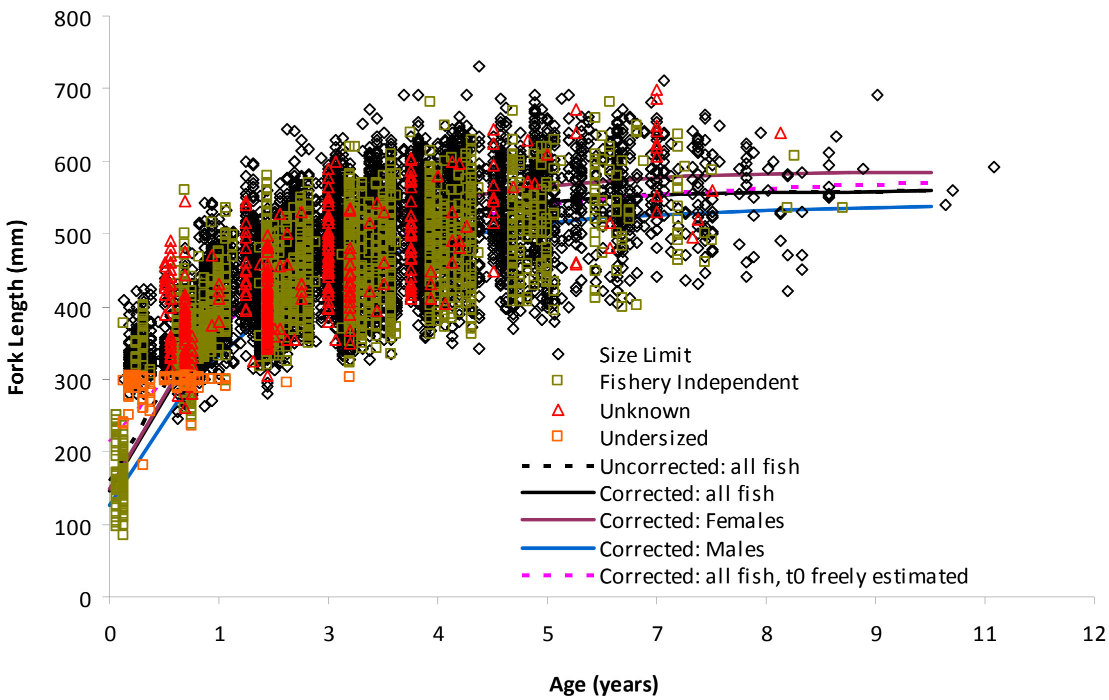


Figure 2.3. Gulf Spanish mackerel inversely weighted von Bertalanffy growth curves and raw data from the PCLAB data set. "Corrected" refers to the Diaz et al. correction in the growth model to handle the bias in the size-at-age data under the influence of the minimum size limit regulation.

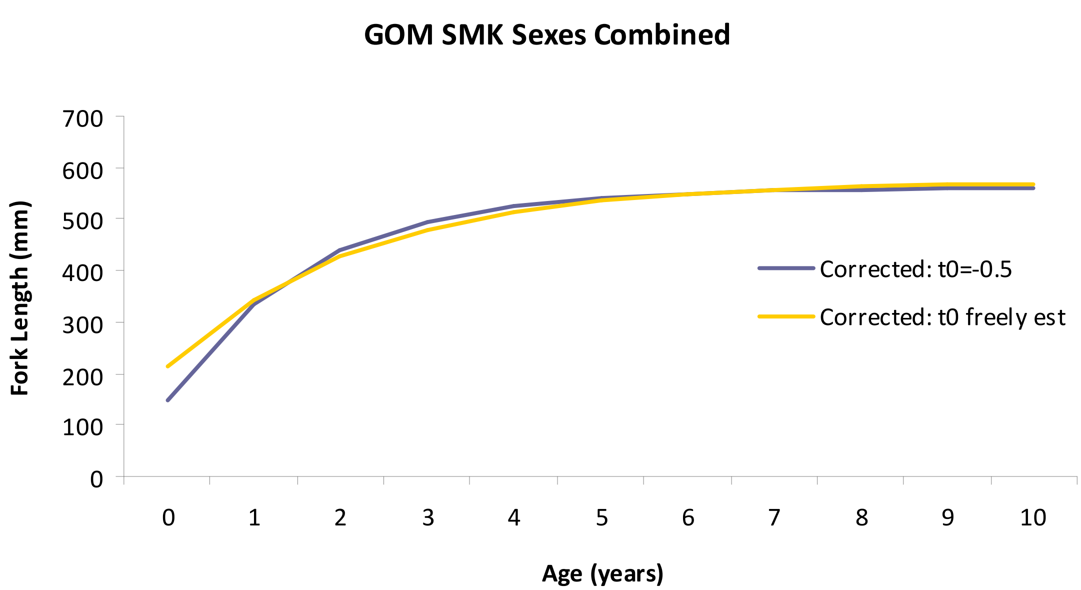


Figure 2.4. Spanish mackerel overall von Bertalanffy growth curves: corrected for size limit bias and inverse weighted with fixed $t_0 = -0.5$ and freely estimated $t_0 = -1.03$.

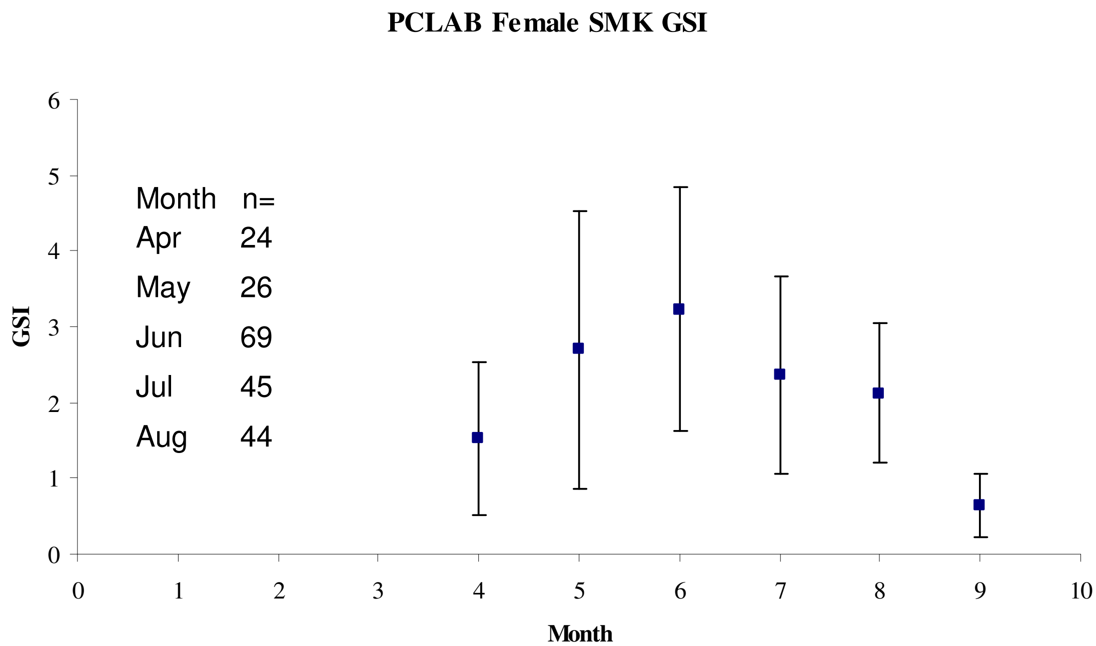


Figure 2.5. Gonadosmotic index of Gulf females from the PCLAB data set. Error bars are +/- 1 standard deviation.

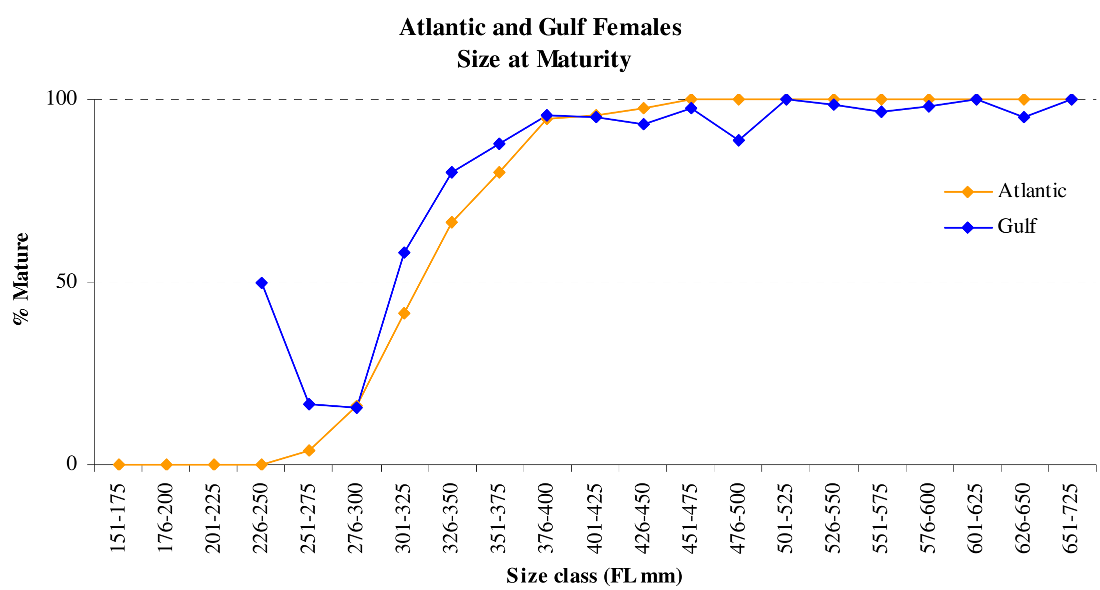


Figure 2.6. Size at maturity of female Spanish mackerel from the Atlantic and Gulf; Finucane and Collins (1986), MARMAP, PCLAB, and SEAMAP combined data sets.

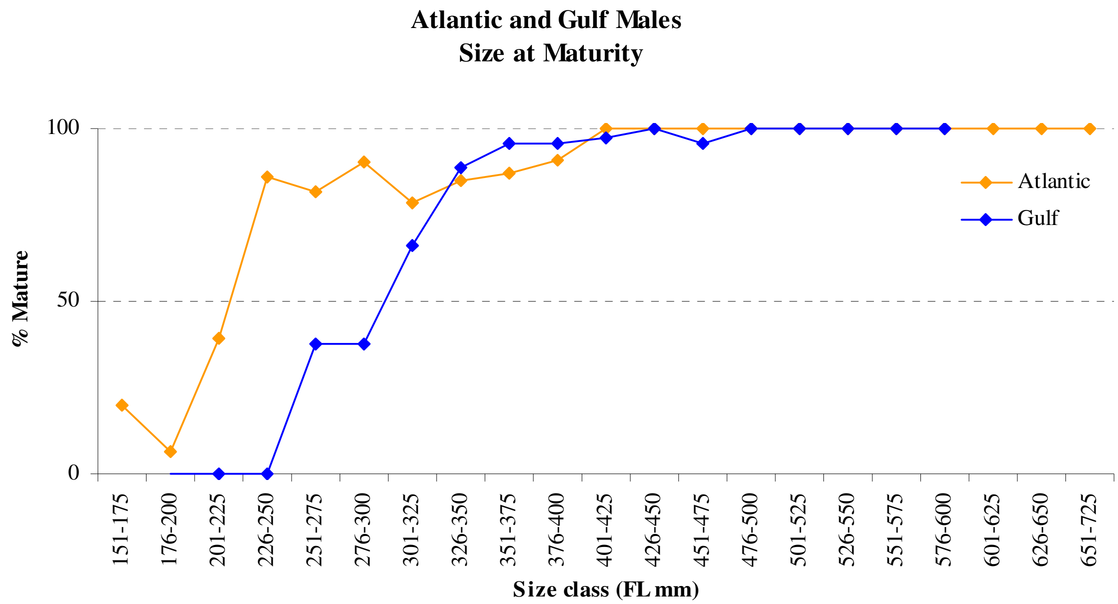


Figure 2.7. Size at maturity of male Spanish mackerel from the Atlantic and Gulf; Finucane and Collins (1986), MARMAP, PCLAB, and SEAMAP combined data sets.

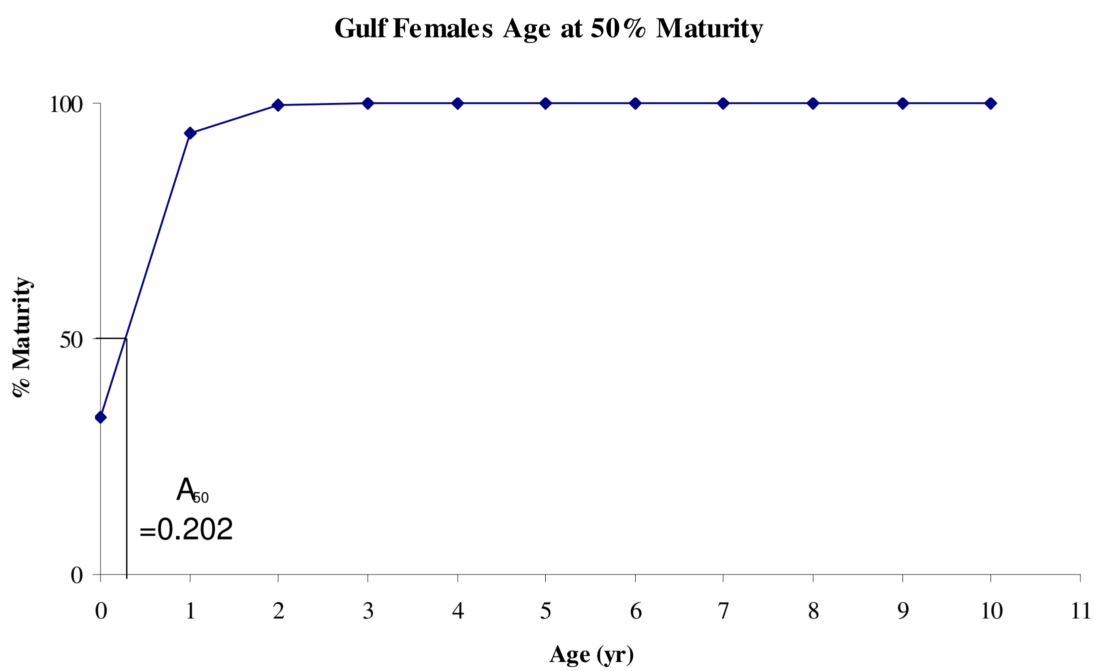


Figure 2.8. Age at 50% maturity of Gulf females from the PCLAB data set.

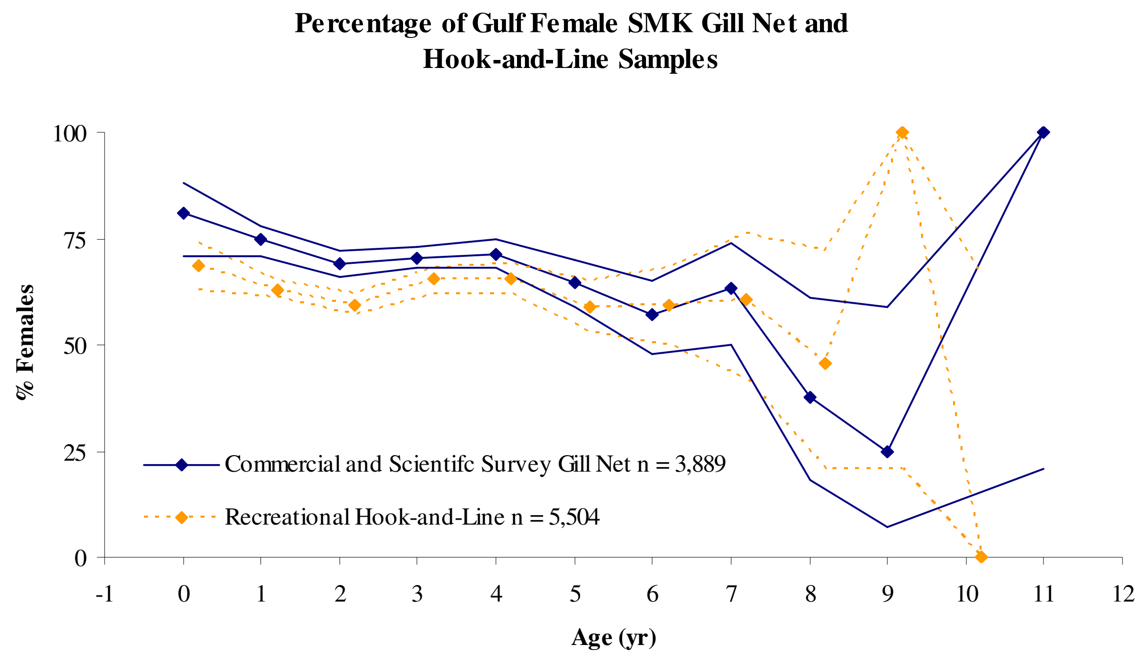


Figure 2.9. Percentage by age of Gulf female Spanish mackerel commercial and scientific survey gill nets, and recreational hook-an-line samples in the PCLAB data set; 5% and 95% confidence intervals.

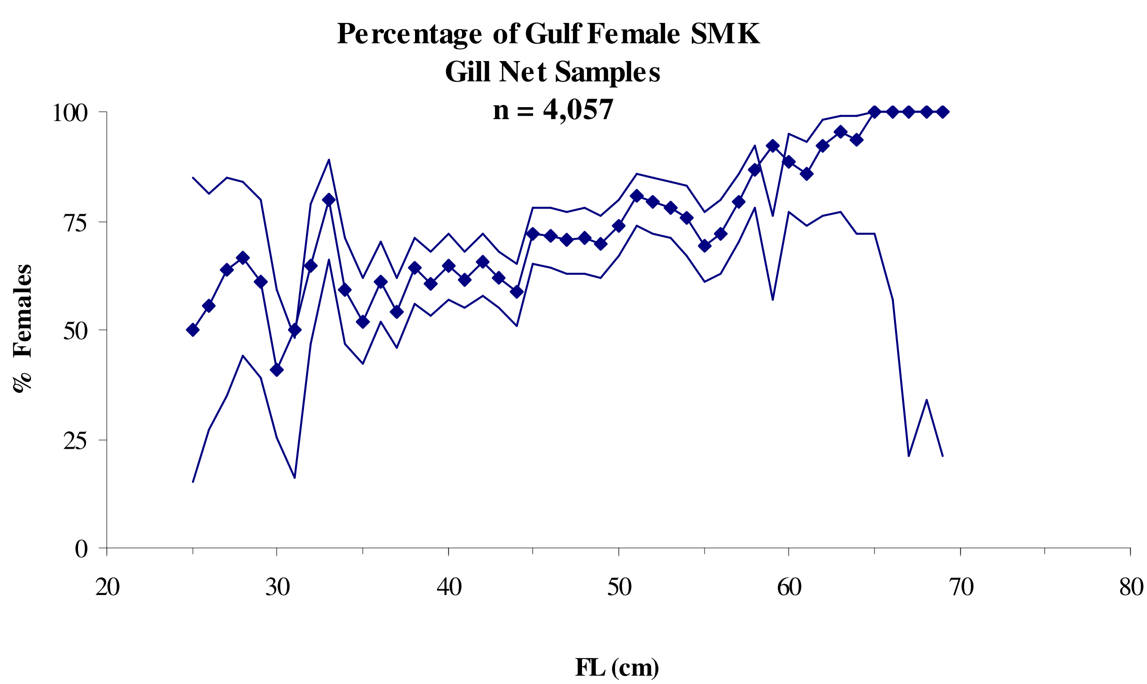


Figure 2.10. Percentage by size of Gulf females by size in the PCLAB data set from commercial and scientific survey gill nets; 5% 95% confidence intervals.

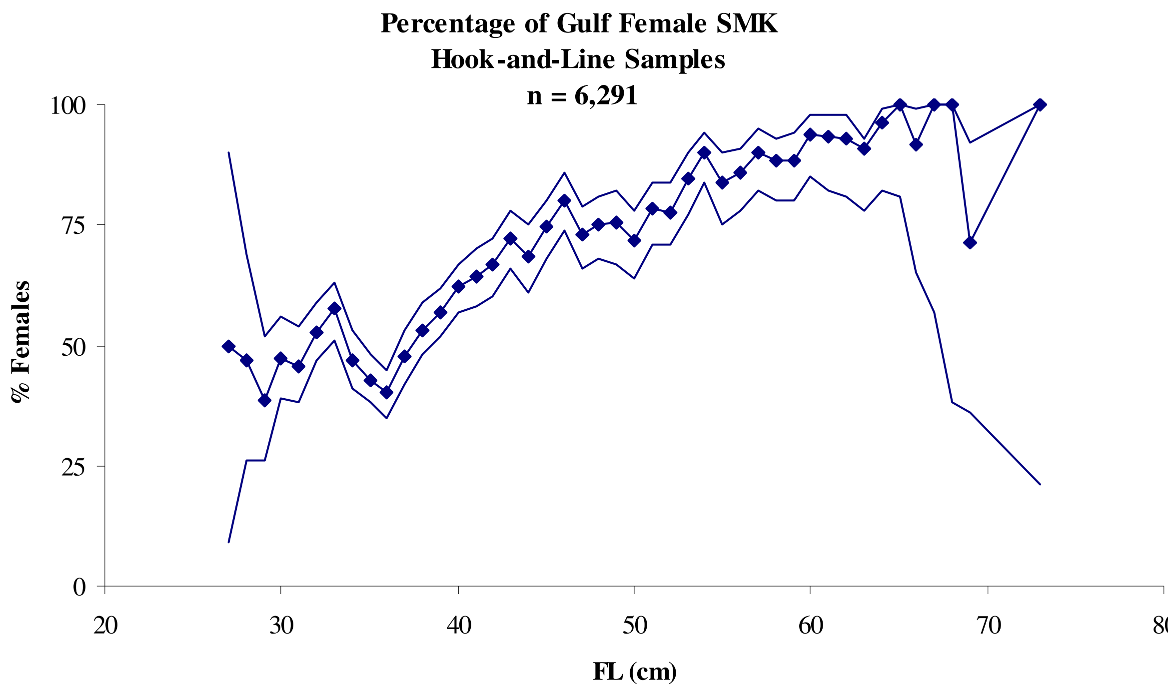


Figure 2.11. Percentage by size of Gulf females by size in the PCLAB data set from recreational hook-and-line samples; 5% and 95% confidence intervals.

3 Commercial Fishery Statistics

3.1 Overview

Commercial landings for the U.S. Gulf of Mexico (GoM) Spanish mackerel stock were developed by gear (gill net, hand lines, and miscellaneous) in whole weight for the period 1890–2010 based on federal and state databases. Corresponding landings in numbers were based on mean weights estimated from the Trip Interview Program (TIP) by gear, state, and year.

Commercial discards were calculated from vessels fishing in the US Gulf of Mexico and reporting to the NMFS Coastal Logbook Program. Shrimp bycatch of Spanish mackerel was estimated from observer data and SEAMAP trawl data and scaled using shrimping effort.

Sampling intensity for lengths and ages by gear and year were considered, and length and age compositions were developed by gear and year for which samples were available.

3.1.1 Participants Commercial Workgroup

David Gloeckner, NMFS, Miami, FL (co-leader)
Kyle Shertzer, NMFS, Beaufort, NC (co-leader)
Donna Bellais, GulfFIN, Ocean Springs, MS
Steve Brown, FL FWC, St. Petersburg, FL
Joe Cimino, VMRC, Newport News, VA
Julie Defilippi, ACCSP, Arlington, VA
Amy Dukes, SCDNR, Charleston, SC
Stephanie McInerny, NCDMF, Morehead City, NC (rapporteur)
Tim Sartwell, ACCSP, Arlington, VA

Other contributors: Katie Andrews, Meaghan Bryan, Rob Cheshire, Ben Hartig, Rusty Hudson, Kevin McCarthy, Julie Califf, Liz Scott-Denton

3.1.2 Issues Discussed at the Data Workshop

The Workgroup (WG) discussed several issues that needed to be resolved before data could be compiled. The major issues discussed included: stock boundaries, length of time series, primary gears, discard estimates from the directed fishery and shrimp fishery, as well as length composition adequacy for characterizing size of the catch. All decisions are described in more detail in the following sections.

3.1.3 Map of Fishing Area

A map of the council boundaries is presented in Figure 3.1. The GoM Spanish mackerel fishery is considered to include the area north of the Florida Keys around to the Texas/ Mexico border.

3.2 Review of Working Papers

The WG reviewed four working papers. All four of these papers were focused on GoM stocks.

SEDAR28-DW6: This working paper described a Bayesian approach to estimating shrimp bycatch in the GoM of both cobia and Spanish mackerel. The group found the methods to be sound, but questioned whether sample sizes for cobia were adequate to support the Bayesian model.

SEDAR28-DW7: This working paper described length frequency distributions of Spanish mackerel from commercial and recreational fleets in the GoM. Length frequencies of commercial landings were compiled from TIP data, and these data were considered adequate for use in the assessment.

SEDAR28-DW8: This working paper described length frequency distributions of cobia from commercial and recreational fleets in the GoM. Length frequencies of commercial landings were compiled from TIP data, and these data were considered adequate for use in the assessment.

SEDAR28-DW04: This working paper described the calculation of Spanish mackerel discard from the commercial gillnet, vertical line, and trolling fisheries. Discards were calculated as the product of gear-specific self-reported discard rates and total effort.

3.3 Commercial Landings

3.3.1 Time Series Duration

The WG made the decision to examine landings as far back in time as possible, because the longer time period might shed light on stock resilience and potential. Landings were compiled starting in 1880, the first year of available data, but the reliability of information improved substantially in 1950 with several additional improvements since (described along with methods).

> **Decision 1:** Landings will be presented from the earliest available year to the agreed upon terminal year. This was accepted by the plenary.

The terminal year considered for this report was 2010. However, the intent is to provide data through 2011 in time for the assessment workshop. Several data streams (e.g., discards) depend on statistics computed across years and could therefore change throughout the time series with the inclusion of 2011.

> **Decision 2:** Terminal year will be 2010 for this report, but the intent is to update with 2011 data for input to the assessment model. This decision was accepted by the plenary.

3.3.2 Fishing Year vs. Calendar Year

The WG recommended that commercial landings be aligned to the calendar year running from January 1 through December 31 because fishing years can change over time and calendar year will facilitate easier comparisons over time.

Decision 3: The data will be compiled by calendar year. This was accepted by the plenary.

3.3.3 Stock Boundaries

Commercial landings were compiled from FL through TX. The eastern boundary was the FL Keys along the South Atlantic and Gulf of Mexico Council Boundary. Landings north and west of the Keys to the TX/Mexico border were considered to be from the Gulf of Mexico stock, and landings south of the Keys were considered to be from the Atlantic stock (Figures 3.1 and 3.2).

Data reported as north and west of the Keys (ALS fishing areas: 0018, 0020, 0028, 0030-0219, 7441, 7481, 1121-1202, 2121-5189, 8141-9202) were included in the GoM stock. If an area fished was not specified (ALS fishing areas 0000, 9999, 7994) then the landing was assigned to the Gulf of Mexico if it was landed on the FL West Coast, AL, MS, LA or TX (ALS states 11, 01, 21, 27, 46).

Decision 4: Eastern boundary is the South Atlantic/Gulf of Mexico Fisheries Management Council boundary along the Florida Keys and the western boundary is the Texas/Mexico border. This was accepted by the plenary.

3.3.4 Identification Issues

The conclusion from the SEDAR 17 Spanish mackerel assessment was not revisited. The SEDAR 17 report states: "There was discussion about whether small king mackerel are mis-identified as Spanish mackerel, and vice versa (SEDAR, 2008). This was not thought to be an issue. The recent king mackerel assessment made a similar judgment in the SEDAR 16 data workshop. Currently, a landings category does not exist for unclassified mackerels. Further, Spanish mackerels have been identified as such historically back to the 1800s."

Decision 5: There is not a misidentification issue with Spanish mackerel. This was accepted by the plenary.

3.3.5 Commercial Gears

The WG evaluated the distribution of gears in the landings and in the TIP data, and concluded that the data supported grouping commercial landings into two primary gears and one miscellaneous group. Thus, commercial landings were apportioned into: gill net, hand line (including trolling), and miscellaneous (including longline) (Table 3.1). Gill nets were the dominant gear type. The WG recommended that, for the assessment model, landings from the miscellaneous gear might be distributed among the other two gears according to their annual proportions of total landings.

Decision 6: Landings will be aggregated by gill net, hand line and miscellaneous (other) gears. For the assessment model, the miscellaneous gears should be proportioned into gill net and hand line gears based on the annual proportions of landings by those gears. This was accepted by the plenary.

Data on commercial landings from 1926-1961 are housed in a database in the National Marine Fisheries Service's Office of Science and Technology (S&T). Historical commercial landings (1962 to present) for all species on the GoM coast are maintained in the Accumulated Landings System (ALS) at the Southeast Fisheries Science Center (SEFSC). Data prior to 1968 were collected by the Bureau of Commercial Fisheries or US Fish and Fisheries Commission and are available from the database at the NMFS office of Science and Technology (NMFS personal communication). Original reports from the Bureau are available at:
http://docs.lib.noaa.gov/rescue/cof/data_rescue_fish_commission_annual_reports.html. These historical landings are also reported in NMFS, 1990.

The data collected prior to the advent of the trip ticket programs in each state are generally referred to as the NMFS General Canvass data. General Canvass data were collected by port agents stationed in each county. The port agents would collect total landings from dealers and use local knowledge to proportion the landings into the proper fishing areas and gears. The ALS uses trip level data after the advent of trip ticket programs in each state.

Data from state trip ticket programs begin in various years, depending on the state. In the Gulf of Mexico, trip ticket data were available directly from the state trip ticket program or through the Gulf of Mexico Fisheries Information Network (GulfFIN) housed at the Gulf States Marine Fisheries Commission (GSMFC). Where data were available from state trip ticket programs, those data were used in lieu of data from ALS. Data are presented using the gear categories as determined at the workshop. The specific NMFS gears in each category are listed in Table 3.1. Commercial landings in pounds (whole weight) were developed based on methodologies for gear as defined by the WG for each state as available by gear for 1890-2010.

A precipitous drop in landings occurred in 1977 following a cold weather event in Florida during 1976 and 1977. After these cold weather events, landings remained much lower than previous years. There is evidence that this cold weather event affected other coastal migratory species as well (Fable et al., 1981).

Florida – Prior to 1986, Florida commercial landings data were collected through the NMFS General Canvass via monthly dealer reports. In 1984, the state of Florida instituted a mandatory trip level reporting program to report harvest of commercial marine fisheries products in Florida via a marine fisheries trip ticket. The program requires seafood dealers to report all transactions of marine fisheries products purchased from commercial fishers, and to interview fishers for pertinent effort data. Trip tickets are required to be received monthly, or weekly for federally managed species. Data reported on trip tickets include participant identifiers, dates of activity, effort and location data, gear used, as well as composition and disposition of catch. The program encompasses commercial fishery activity in waters of the Gulf of Mexico and South Atlantic from the Alabama-Florida border to the Florida-Georgia border. The first full year of available data from Florida trip tickets is 1986.

A data set was provided to the commercial WG of summarized Spanish mackerel landings by year and gear with pounds (whole weight) from Florida Gulf of Mexico waters (Monroe county landings were assigned to the Gulf when catch area indicated a Gulf catch area; Monroe county landings were assigned to Gulf if no catch area was reported). Gear categories include gill net, hand line (including trolling), and miscellaneous (including longline). Gear was not accurately reported on trip ticket data from 1986 to 1996, so for those years the landings by gear from the NMFS General Canvass data were used.

NMFS logbook data were evaluated and it was decided to use Florida trip ticket data from 1997 forward for landings, area, and gear distributions, and NMFS General Canvass landings data prior to 1997. All vessels permitted for coastal species were not required to submit logbooks until 1993, and while gear distributions were similar to Florida trip ticket landings data, logbook did not account for inshore landings of Spanish mackerel, and total landings of Spanish mackerel were significantly less than trip ticket landings from 1993 to 2010.

Alabama – Alabama trip ticket data have been collected since 2000. These data are recoded in the FIN format and copied to the GulfFIN database every few months. GulfFIN provided the Spanish mackerel landings data from AL for 2000-2010. ALS data were used for 1962-1999.

Mississippi –Mississippi finfish landings are currently collected by a NMFS port agent and housed in the ALS. Mississippi intends to begin a state trip ticket program for finfish during 2012. All MS landings for Spanish mackerel were compiled from the ALS 1962-2010.

Louisiana – Louisiana trip ticket data has been collected since 1993, however, gear and fishing area were not required. In 1998 LA began to require information on gear and area of capture. Data collected since 2000 are recoded in the FIN format and copied to the GulfFIN database every few months. GulfFIN provided the Spanish mackerel landings data from LA for 2000-2010. ALS data were used for 1962-1999.

Texas – Texas trip ticket data have been collected since 2009, however, TX is still developing quality control procedures to allow the data to be edited for errors before transfer to GulfFIN. Prior to the beginning of the TX trip ticket program, NMFS port agents had collected TX landings data. Because the NMFS data collection method has been in place since the 1970s, ALS was used for TX Spanish mackerel landings from 1962-2010.

Gulf of Mexico Spanish mackerel landings by gear and year are presented in Table 3.2 and Figure 3.3. The distribution of catches reported on coastal logbooks are presented in Figures 3.6 and 3.7.

Decision 7: The WG made the following decisions for reporting of commercial landings:

- Landings would be presented by calendar year/gear across all states.
- Final landings data would come from the following sources:
  - FL:
  - 1890-1949 (Bureau of Commercial Fisheries reports)
  - 1950-1961 (S&T)
  - 1962-1996 (ALS)

- 1997-2010 (FLFWC)
- AL:
- 1890-1949 (Bureau of Commercial Fisheries reports)
- 1950-1961 (S&T)
- 1962-1999 (ALS)
- 2000-2010 (GulfFIN)
- MS:
- 1890-1949 (Bureau of Commercial Fisheries reports)
- 1950-1961 (S&T)
- 1962-2010 (ALS)
- LA:
- 1890-1949 (Bureau of Commercial Fisheries reports)
- 1950-1961 (S&T)
- 1962-1999 (ALS)
- 2000-2010 (GulfFIN)
- TX:
- 1890-1949 (Bureau of Commercial Fisheries reports)
- 1950-1961 (S&T)
- 1962-2010 (ALS)

Whole vs Gutted Weight – The Commercial WG discussed the topic of what units to use to report commercial landings. Spanish mackerel are typically landed whole, therefore for this analysis, landings were provided in whole weight.

> **Decision 8:** Landings will be presented in pounds whole weight. This was accepted by the plenary.

Confidentiality Issues – The Commercial WG agreed that it was necessary to hide commercial landings with fewer than three submitters. The WG recommended that landings be hidden if they fail to meet the rule of 3.

> **Decision 9:** Landings with fewer than 3 submitters should be hidden for years when the number of submitters is known. This was accepted by the plenary.

3.3.6 Converting Landings in Weight to Landings in Numbers

The weight in pounds for each sample was calculated, as was the mean weight by gear and year (weighted by: weight of fish in the sample in pounds whole weight, trip weight in pounds whole weight, and strata landing weight in pounds whole weight). Where the sample size was less than 20, the mean across all years for that gear was used, if the sample size was less than 20 across all years for the gear, then the mean across all gears and years was used (Table 3.3). It was suggested by the lead analyst that 50 be considered as the cutoff for minimum sample size, as was done in previous assessments by SEFSC. This was examined, but resulted in an average difference of only 0.02 pounds between the 20 fish minimum and the 50 fish minimum size, so 20 fish was used as the minimum sample size. The landings in pounds whole weight were divided by the mean weight for that stratum to derive landings in numbers (Table 3.4 and Figure 3.4).

3.4 Commercial Discards

3.4.1 Discards from Commercial Finfish Operations

Spanish mackerel discards from the commercial vertical line, trolling, and gillnet fisheries were calculated for the US South Atlantic (statistical areas 2300-3700; Table 3.5) and Gulf of Mexico (statistical areas 1-21; Table 3.5). A map of logbook areas is presented in Figure 3.5. The number of trips that reported discards of Spanish mackerel was very low (Table 3.5), limiting the complexity of any analysis. Methods for calculating discards are detailed in SEDAR28-DW04 and are summarized below.

Spanish mackerel discard rates were calculated as the mean nominal discard rate among all trips (by gear) that reported to the discard logbook program during the period 2002–2010. Rates were separately calculated for vertical line, trolling, and gill net gears. Yearly gear specific discards were calculated as the product of the gear specific discard rate and gear specific yearly total effort (vertical line and trolling effort = total hook-hours fished; gill net effort = square yard hours fished) reported to the coastal logbook program. Discards were calculated for the years 1998–2010. Prior to 1998, federal permits were not required to land Spanish mackerel caught in federal waters. Total Spanish mackerel fishing effort, particularly for trolling vessels, was not reported to the coastal logbook program by all commercial vessels, and thus any estimates of total discards would have been erroneously low for years prior to 1998.

Approximately 1.3 percent of all Spanish mackerel discard reports for the period 2002–2010 were from trips reporting fishing gears other than vertical lines, trolling, and gill nets. Data reported for those other gears were not included in the discard calculations.

Yearly total gear specific discards (calculated in number of fish) from the Gulf of Mexico are provided in Table 3.6. Those totals include all discards reported to the discard logbook program including those reported as “kept, not sold”.

The yearly calculated Spanish mackerel discards from the commercial fishery (of vessels with federal permits reporting to the coastal logbook program) were relatively low. During the 13 years included in the analysis, fewer than 20,000 Spanish mackerel were discarded in the Gulf of Mexico per year. The number of trips upon which the calculations were based, however, was very small. An additional concern was the possible under-reporting of commercial discards. The percentage of fishers returning discard logbooks with reports of “no discards” has been much greater than the percentage of observer reports of “no discards” on commercial fishing trips suggesting that under-reporting of discards may be occurring. These results should, therefore, be used with caution. Discards calculated here may represent the minimum number of discards from the commercial fishery.

A high percentage of Spanish mackerel discards were reported as “dead” or “majority dead” in the South Atlantic gill net fishery (Table 3.7). The vertical line and trolling fisheries in both regions report many fish that may have otherwise been discards as “kept” (Table 3.7). Many of those “kept” fish may have been used as bait.

Decision 10: The Commercial WG supports the methodology of calculating discards and recommends the use of these data. However, the discards reported as "kept, not sold" should be added to the landings, not included with the discards. This was accepted by the plenary.

3.4.2 Discards from the Shrimp Fishery

The WG considered the estimates of Spanish mackerel bycatch in the Gulf of Mexico shrimp fishery presented in SEDAR28-DW06 as prepared by Brian Linton. This method used a Bayesian approach to estimating bycatch, developed by Scott Nichols for the SEDAR 7 Gulf Red Snapper Assessment. The methods used and preliminary results are repeated below.

The data used in this analysis came from various shrimp observer programs, the SEAMAP groundfish survey, shrimp effort estimates, and the Vessel Operating Units file. The primary data on CPUE in the shrimp fishery came from a series of shrimp observer programs, which began in 1972 and extend to the current shrimp observer program. Additional CPUE data were obtained from the SEAMAP groundfish survey. Only data from 40 ft trawls by the Oregon II were used in this analysis, because these trawls were identified as being most similar to trawls conducted by the shrimp fishery. Point estimates and associated standard errors of shrimp effort were generated by the NMFS Galveston Lab using their SN-pooled method of effort estimation (Nance 2004). Most observer program CPUE data were expressed in numbers per net-hour, while the shrimp effort data were expressed in vessel-hours. Therefore, data from the NMFS Vessel Operating Units file were used to estimate the average number of nets per vessel for the shrimp fishery.

The following Bayesian model was used to estimate shrimp bycatch (i.e., model 02 from Nichols 2004a):

$$Ln(CPUE)_{ijklm} = year_i + season_j + area_k + depth_l + data\_set_m + local_{ijklm}.$$

The factor levels for the main effects are presented in Table 3.8. Catch in numbers for each cell was assumed to follow a negative binomial distribution. The main effects and local term, as expressed above (i.e, on the log-scale), were assigned normal prior distributions. A lognormal hyperprior was assigned to the precision ($1/\sigma 2$) parameter of the local term. Therefore, the data determined the distribution of the local term in cells with data, while the distribution of the local term defaulted to the prior with fitted precision for cells without data. In effect, the local term became a fixed effect for cells with data and a random effect for cells without data.

The shrimp bycatch estimation model was fit using WinBUGS version 1.4.3. Markov Chain Monte Carlo (MCMC) methods were used to estimate the marginal posterior distributions of the parameters and important derived quantities. Two parallel chains of 29,000 iterations each were run. The first 4,000 iterations of each chain were dropped as a burn-in period, to remove the effects of the initial parameter values. A thinning interval of five iterations (i.e., only every fifth iteration was used) was applied to each chain, to reduce autocorrelation in parameter estimates and derived quantities. The marginal posterior distributions were calculated from the remaining 10,000 iterations. Convergence of the chains was determined by visual inspection of trace plots, marginal posterior density plots, and Gelman-Rubin statistic (Brooks and Gelman, 1998) plots.

Annual observed bycatch is reported in Table 3.9. Annual estimates (predicted) of total Spanish mackerel bycatch in the Gulf of Mexico shrimp fishery are presented in Table 3.10. The CVs associated with these estimates ranged from 25% to 911%. Ten of the 39 years had CVs below 100%. The marginal posterior densities of the estimates showed a high degree of skew in every year, with 2008 having the least amount of skew.

Although there were some years with small sample sizes, the WG felt the method was adequate for estimating Spanish mackerel bycatch in the Gulf of Mexico shrimp fishery.

> **Decision 11:** The Commercial WG supports the methodology of calculating Spanish mackerel bycatch in the Gulf of Mexico shrimp fishery and recommends the use of these data. This was accepted by the plenary.

3.5 Commercial Effort

The distribution of commercial effort in trips by year was compiled from the Coastal Logbook Program for 1990-2010 and supplied here for informational purposes. These data are presented in Figures 3.8 and 3.9.

3.6 Biological Sampling

Biological sample data were obtained from the TIP sample data at NMFS/SEFSC. Data that were not already in the TIP database were also incorporated from NCDMF, as well as sample data from VMRC covering Virginia commercial fisheries. Data were filtered to eliminate those records that included a size or effort bias, were known to be collected non-randomly, were not from commercial trips, were selected by quota sampling, or were not collected shore-side (observer data). These data were further limited to those that could be assigned a year, gear, and state. Data that had an unknown landing year, gear, or state were deleted from the file. Additionally, samples were removed if they were drawn from market categories. This was due to the potential for bias in sampling, although a review of length data during SEDAR 17 indicated only trivial difference in the length distributions if the market categories were excluded. Further, only lengths from fish caught in the Gulf were included in the analysis.

The group reviewed the distribution of sample size to size of the catch to determine if trip weighting was needed. For Spanish mackerel there was not a significant relationship between catch size and sample size, indicating that sampling fraction varied by trip, thus the WG recommended weighting the length data by trip. Where no trip landings data were available, the sample weight was used as a proxy, as the sample weight gives a minimum weight landed for the species. If there was no landing weight or sample weight recorded for the sample, the length sample was dropped. Length data were also weighted spatially by the landings for the particular year, state and gear stratum, and thus were limited to where those strata could be identified in the corresponding landings. Landings and biological data were assigned a state based on landing location or sample location if there was no landing location assigned.

> **Decision 12:** The Commercial WG recommends weighting the length samples by trip weight to overcome any sampling bias arising from differences in sampling fractions across trips. This was accepted by the plenary.

3.6.1 Sampling Intensity for Lengths

The number of trips with samples used in the length compositions ranged from a high of 21 for hand line gear in 2010 to a low of zero for many strata (Table 3.11). The number of trips with samples used in the length compositions was consistently greater than 10 trips for hand line gear since 2008. The number of trips with samples used averaged 10 for gill net gear since 2005. Trips using other miscellaneous gear were rarely sampled. Table 3.11 displays number of trips with samples with unbiased samples and number of trips with samples used (trip weights and landings available).

The number of fish sampled had a high of 794 for gill net gear in 2006 and lows of zero for many of the strata (Table 3.12). The number of lengths sampled was consistently greater than 100 for gill net gear since 2004. Hand line gear had over 100 lengths available for only years within 2006-2008. For other miscellaneous gears, the numbers of length samples available were above 100 for 1992, 2004 and 2006-2008. Table 3.12 displays the number of valid samples and number of samples used (trip weights and landings available).

3.6.2 Length/Age Distribution

All lengths were converted to fork length (FL) in mm using the formula provided in the Spanish mackerel Life History section of the SEDAR 28 Data Workshop Report and binned into one centimeter groups with a floor of 0.6 cm and a ceiling of 0.5 cm. Length was converted to weight (whole weight in pounds) using conversions provided by the life history group. The length data and landings data were divided into gill net, hand line, and other miscellaneous gears. Length compositions were weighted by the trip landings in numbers and the landings in numbers by strata (state, year, gear). Annual length compositions of Spanish mackerel are summarized in Figures 3.10-3.12.

Observer samples were provided from the Reeffish Observer Program by the NMFS Galveston Lab. These data were filtered to remove non-random samples. Of the remaining data, only two Spanish mackerel were reported as discarded (43 cm FL, and 45 cm FL).

Sample size of Spanish mackerel ages are summarized by gear from commercial landings in the U.S. Gulf of Mexico for 1983-2010 (Table 3.13). Age compositions were developed for gill net (1988-2010 with exceptions in Figure 3.13), hand line (1988-2010, Figure 3.14), and other miscellaneous (1988-2010, Figure 3.15) gear types. The commercial group suggests ages are weighted by the length composition with the formula:

$$RW_i = \frac{NLi \big/ TN}{OLi \big/ TO},$$

where *NLi* is the number of fish measured with length *i*, *TN* is the total number of fish measured in that strata, *OLi* is the number of ages sampled at length *i,* and *TO* is the total number of ages sampled within the strata and RW_i is the weight to apply to the age (Chih, 2009). This weighting corrects for a potential sampling bias of age samples relative to length samples (SEDAR, 2006). Weighting by length composition was not done at this time, pending resolution of how to correct the age data when length compositions are not available for the given year and gear strata. The age compositions presented in Figures 3.13-3.15 are unweighted.

3.7 Comments on Adequacy of Data for Assessment Analyses

Landings data appear to be adequate to support the assessment, with landings reports beginning in the 1880s. Landings have greatest certainty since the individual state's trip ticket programs were initiated. Landings prior to 1950 are considered highly uncertain.

Discard estimates have greater uncertainty than the landings, as there are very few trips where Spanish mackerel discards were observed by the Reeffish Observer Program. Additionally, the NMFS logbook doesn't capture the entire fishery, so the discards reported to this program should be considered a minimum estimate. Bycatch in the shrimp fishery is difficult to determine given the low encounter rate between shrimp trawls and Spanish mackerel, and because of irregular observer coverage. As a consequence, the annual variability in shrimp bycatch may be poorly estimated, although the estimated mean bycatch may be at the appropriate scale.

Commercial discards and shrimp bycatch are based on estimated encounter rates and effort. In years when multi-year averages are used to compute encounter rates, these estimates do not account for year-specific age structure in the Spanish mackerel stock.

Sample sizes for developing length compositions were inadequate for a considerable number of year and gear strata. This may impact the ability in those years to use length compositions to correct for potential biases in age compositions. In some year and gear strata, sample sizes appeared adequate, although a small proportion of the overall catch was sampled. The annual proportion of commercial trips sampled for lengths was typically less than 1% in all years (Table 3.14).

3.8 Literature Cited

Chih, C. 2009. The effects of otolith sampling methods on the precision of growth curves. North American Journal of Fisheries Management 29: 1519-1528.

Fable, F.A., Brusher, H.A., Trent, L., and J. Finnegan. 1981. Possible temperature effect on charter boat catches of king mackerel and other coastal pelagic species in northwest Florida. Marine Fisheries Review 43(8): 21-26.

Nance, J. 2004. Estimation of effort in the offshore shrimp trawl fishery of the Gulf of Mexico. NOAA Southeast Fisheries Science Center, Galveston Laboratory. SEDAR7-DW24.

Nichols, S. 2004a. Some Bayesian approaches to estimation of shrimp fleet bycatch. NOAA Southeast Fisheries Science Center, Pascagoula Laboratory. SEDAR7-DW03.

Nichols, S. 2004b. Update for the Bayesian estimation of shrimp fleet bycatch. NOAA Southeast Fisheries Science Center, Pascagoula Laboratory. SEDAR7-DW54.

NMFS (National Marine Fisheries Service). 1990. Historical Catch Statistics, Atlantic and Gulf Coast States: 1879-1989; Current Fishery Statistics No. 9010; Historical Series Nos. 5-9 revised. Washington, DC: U.S. Government Printing Office.

SEDAR. 2006. SEDAR 10 Stock Assessment Report1 South Atlantic Gag Grouper. (http://www.sefsc.noaa.gov/sedar/download/S10_SAR1_SA_Gag_updated_ALL.pdf?id=DOCUMENT).

SEDAR. 2008. SEDAR 17 Stock Assessment Report South Atlantic Spanish Mackerel. (http://www.sefsc.noaa.gov/sedar/download/S17%20SM%20SAR%201.pdf?id=DOCUMENT).

U.S. Fish and Fisheries Commission. 2012. Report of the Commissioner. (http://docs.lib.noaa.gov/rescue/cof/data_rescue_fish_commission_annual_reports.html).

==

Addendum to Commercial Landings (Section 3.3):

NMFS SEFIN 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 late1800s (first year varies by species). Fairly serious collection activity began in the 1920s. The data set maintained by the Southeast Fisheries Science Center (SEFSC) in the SEFIN database management system is a continuous data set 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 SEFIN 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 SEFIN database.

1960 - Late 1980s

================
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 SEFIN 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.

Alabama
=======

Data collection in Alabama is voluntary and is conducted by state and federal port agents that visit dealers and docks monthly. Summaries of the total landings (pounds) and value for species or market category are recorded. Port agents provide information on gear and fishing area from their knowledge of the fisheries and interaction with fishermen and dealers. As of mid- 2000, the State of Alabama required fishermen and dealers to report all commercial landings data through a trip ticket system. As of 2001 the ALS system relies solely on the Alabama trip ticket data to create the ALS landings data for Alabama.

Mississippi
===========

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

Louisiana
===========

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

Beginning in January 1993, the Department of Wildlife and Fisheries, State of Louisiana began to enforce the states' mandatory reporting requirement. Dealers have to be licensed by the State and are required to submit monthly summaries of the purchases that were made for individual species or market categories. With the implementation of the State statute, Federal port agents did not participate in the collection of commercial fishery statistics.

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

Texas
=====

The State has a mandatory reporting requirement for dealers licensed by the State. Dealers are required to submit monthly summaries of the quantities (pounds) and value of the purchases that were made for individual species or market categories.

Information on gear, area and distance from shore are added to the state data by SEFSC personnel. Furthermore, landings of species that are unloaded in Texas, but transported to locations in other states are added to the commercial landings statistics by SEFSC personnel.

NMFS SEFIN 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 commercial landings data base 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.

3.9 Tables

Table 3.1. NMFS gears in each gear category for Spanish mackerel commercial landings.

NMFS GEAR CODE	GEAR DESCRIPTION	GEAR CATEGORY
000	Not Coded	OTHER
020	Haul Seines, Beach	OTHER
030	Haul Seines, Long	OTHER
032	Haul Seines, Long(Danish)	OTHER
040	Stop Seines	OTHER
050	Stop Nets	OTHER
100	Encircling Nets (Purse)	OTHER
103	Purse Seines, Anchovy	OTHER
105	Purse Seines, Barracuda	OTHER
110	Purse Seines, Herring	OTHER
120	Purse Seines, Mackerel	OTHER
125	Purse Seines, Menhaden	OTHER
130	Purse Seines, Salmon	OTHER
135	Purse Seines, Sardine	OTHER
140	Purse Seines, Tuna	OTHER
145	Purse Seines, Other	OTHER
150	Nets Unc, Hawaii	OTHER
151	Nets, excluding trawls	OTHER
155	Lampara & Ring Nets, Mackerel	OTHER
160	Lampara & Ring Nets, Sardine	OTHER
165	Lampara & Ring Nets, Squid	OTHER
170	Lampara & Ring Nets, Tuna	OTHER
175	Lampara & Ring Nets, Other	OTHER
180	Bag Nets	OTHER
185	Paranella Nets	OTHER
187	Skimmer Nets	OTHER
189	Butterfly Nets	OTHER
191	Beam Trawls, Crab	OTHER
192	Beam Trawls, Shrimp	OTHER
193	Beam Trawls, Other	OTHER
194	BEAM TRAWLS, CHOPSTICKS	OTHER
200	Trawls, Unspecified	OTHER
205	Otter Trawl Bottom, Crab	OTHER
210	Otter Trawl Bottom, Fish	OTHER
212	Otter Trawl Bottom, Lobster	OTHER
214	Otter Trawl Bottom, Scallop	OTHER
215	Otter Trawl Bottom, Shrimp	OTHER

217	Otter Trawl Bottom, Twin	OTHER
220	Otter Trawl Bottom, Other	OTHER
230	Otter Trawl Midwater	OTHER
233	Trawl Midwater, Paired	OTHER
235	Trawl Bottom, Paired	OTHER
240	Scottish Seine	OTHER
250	Weirs	OTHER
275	Pound Nets, Fish	OTHER
280	Pound Nets, Crab	OTHER
285	Pound Nets, Horseshoe Crab	OTHER
289	Pound Nets, Other	OTHER
290	Trap Nets	OTHER
295	Floating Traps (Shallow)	OTHER
300	Pots And Traps, Cmb	OTHER
305	Fyke And Hoop Nets, Crab	OTHER
310	Fyke And Hoop Nets, Fish	OTHER
315	Fyke And Hoop Nets, Turtle	OTHER
320	Fyke Net, Other	OTHER
325	Pots And Traps, Conch	OTHER
330	Pots And Traps, Crab, Blue	OTHER
331	Pots And Traps, Crab, Dungens	OTHER
332	Pots And Traps, Crab, King	OTHER
333	Pots And Traps, Crab, Other	OTHER
334	Pots and Traps, Crab, Blue Peeler	OTHER
335	Pots And Traps,Crayfsh(frhwa)	OTHER
340	Pots And Traps, Eel	OTHER
345	Pots And Traps, Fish	OTHER
350	Pots And Traps, Lobster Inshore	OTHER
351	Pots And Traps, Lobster Ofshore	OTHER
355	Pots And Traps, Spiny Lobster	OTHER
360	Pots And Traps, Octopus	OTHER
365	Pots And Traps, Perwkle Or Ckle	OTHER
370	Pots And Traps, Shrimp	OTHER
375	Pots And Traps, Turtle	OTHER
379	Pots And Traps, Other	OTHER
380	Pots And Traps, Box Trap	OTHER
385	Pots And Traps, Wire Baskets	OTHER
387	Pots, Unclassified	OTHER
390	Slat Traps (Virginia)	OTHER
400	Entangling Nets (Gill) Unspc	GILL NET
405	Gill Nets, California Halibut	GILL NET
410	Gill Nets, Crab	GILL NET
415	Gill Nets, Salmon	GILL NET

420	Gill Nets, Sea Bass	GILL NET
425	Gill Nets, Other	GILL NET
430	Gill Nets, Sink/Anchor, Other	GILL NET
450	Gill Nets, Drift, Barracuda	GILL NET
455	Gill Nets, Drift, Salmon	GILL NET
460	Gill Nets, Drift, Sea Bass	GILL NET
465	Gill Nets, Drift, Shad	GILL NET
470	Gill Nets, Drift, Other	GILL NET
475	Gill Nets, Drift, Runaround	GILL NET
480	Gill Nets, Stake	GILL NET
490	Gill Nets, Gl Shoal	GILL NET
500	Gill Nets, Gl 1 - 2 Inch	GILL NET
505	Gill Nets, Gl 2 - 4 Inch	GILL NET
510	Gill Nets, Gl 4 - 7 Inch	GILL NET
515	Gill Nets, Gl 7 - 14 Inch	GILL NET
520	Gill Nets, Drift Large Pelagic	GILL NET
530	Trammel Nets	OTHER
600	Troll & Hand Lines Cmb	HAND LINE
601	Lines Hand, Albacore	HAND LINE
605	Lines Hand, Rockfish	HAND LINE
607	Lines Hand, Yellowfish	HAND LINE
610	Lines Hand, Other	HAND LINE
611	Rod and Reel	HAND LINE
612	Reel, Manual	HAND LINE
613	Reel, Electric or Hydraulic	HAND LINE
614	BUOY GEAR, VERTICAL	OTHER
616	Rod and Reel, Electric (Hand)	HAND LINE
621	Lines Jigging Machine	HAND LINE
650	Lines Troll, Salmon	HAND LINE
651	Lines Power Troll Salmon	HAND LINE
655	Lines Troll, Tuna	HAND LINE
656	Lines Power Troll Tuna	HAND LINE
657	LINES TROLL, GREEN-STICK	HAND LINE
660	Lines Troll, Other	HAND LINE
661	Lines Power Troll Other	HAND LINE
665	Lines Troll, Mackerel	HAND LINE
675	Lines Long Set With Hooks	OTHER
676	Lines Long, Reef Fish	OTHER
677	Lines Long, Shark	OTHER
678	Lines Long Drift With Hooks	OTHER
680	Lines Trot With Baits	OTHER
685	Lines Snag	OTHER
690	Lines Electrical Devices	OTHER

703	Dip Nets, Common	OTHER
705	Dip Nets, Drop	OTHER
710	Brail Or Scoop	OTHER
715	Lift Net	OTHER
720	Reef Net	OTHER
725	Push Net	OTHER
730	Wheels	OTHER
735	Cast Nets	OTHER
751	Harpoons, Swordfish	OTHER
752	Harpoons, Turtle	OTHER
753	Harpoons, Whale	OTHER
754	Harpoons, Other	OTHER
760	Spears	OTHER
765	Powerheads (Bangsticks)	OTHER
770	Scrapes	OTHER
781	Water Pump,Sand Shrimp	OTHER
785	Barge Kelp	OTHER
802	Dredge Clam Hydraulic	OTHER
803	Dredge Clam	OTHER
804	Dredge Conch	OTHER
805	Dredge Crab	OTHER
810	Dredge Mussel	OTHER
815	Dredge Oyster, Common	OTHER
820	Dredge Oyster, Suction	OTHER
823	Dredge Scallop, Bay	OTHER
825	Dredge Scallop, Sea	OTHER
827	Dredge Urchin, Sea	OTHER
830	Dredge Other	OTHER
840	Tongs and Grabs, Oyster	OTHER
841	Tongs Patent, Oyster	OTHER
845	Tongs and Grabs, Other	OTHER
846	Tongs Patent, Clam Other	OTHER
853	Rakes, Oyster	OTHER
855	Rakes, Other	OTHER
860	Hoes	OTHER
865	Forks	OTHER
870	Shovels	OTHER
875	Picks	OTHER
880	Brush Trap	OTHER
890	Crowfoot Bars	OTHER
895	Frog Grabs	OTHER
925	Hooks, Sponge	OTHER
930	Hooks, Abalone	OTHER

935	Hooks, Other	OTHER
941	Diving Outfits, Abalone	OTHER
942	Diving Outfits, Sponge	OTHER
943	Diving Outfits, Other	OTHER
944	Diving with Nets	OTHER
951	By Hand, Oyster	OTHER
955	By Hand, Other	OTHER
966	Other Gear, Hawaii	OTHER
967	Various Gear, Fishponds Hawaii	OTHER
989	Unspecified Gear	OTHER
999	Combined Gears	OTHER

Table 3.2. Spanish mackerel landings (pounds whole weight) by gear from the U.S. Gulf of Mexico, 1880-2010.

	GEAR		
YEAR	GILL NET	HAND LINE	OTHER
1880			
1881			
1882			
1883			
1884			
1885			
1886			
1887	124,613	7,544	27,843
1888	242,995	14,711	54,294
1889	465,740	28,196	104,064
1890	539,729	32,675	120,596
1891			
1892			
1893			
1894			
1895			
1896			
1897	584,901	35,410	130,689
1898			
1899			
1900			
1901			
1902	1,233,667	74,686	275,648
1903			
1904			
1905			
1906			
1907			
1908	1,157,341	70,065	258,594
1909			
1910			
1911			
1912			
1913			
1914			
1915			
1916			
1917			

1918	2,743,039	166,062	612,898
1919			
1920			
1921			
1922			
1923	3,010,178	182,235	672,587
1924			
1925			
1926			
1927	3,716,484	224,987	830,395
1928	2,573,232	155,777	574,952
1929	2,784,325	168,556	622,117
1930	3,267,511	197,807	730,079
1931	1,853,856	112,228	414,217
1932	2,285,394	138,352	510,639
1934	2,753,561	166,694	615,244
1936	4,100,885	248,258	916,284
1937	3,103,491	187,878	693,431
1938	3,204,253	193,978	715,944
1939	3,341,472	202,285	746,604
1940	2,877,597	174,203	642,958
1945	72,198	4,371	16,132
1948	698,846	42,307	156,147
1949	3,018,910	182,758	674,532
1950	2,019,590	122,261	451,248
1951	5,070,822	306,976	1,133,002
1952	3,518,064	212,975	786,061
1953	2,324,192	140,701	519,307
1954	2,248,178	136,099	502,323
1955	1,267,472	76,730	283,198
1956	2,273,412	137,627	507,961
1957	2,841,726	172,031	634,943
1958	3,013,692	182,442	673,366
1959	3,653,581	221,179	816,340
1960	4,258,500	257,800	951,501
1961	3,126,701	189,283	698,616
1962	5,644,600	116,000	1,150,300
1963	4,538,400	68,100	840,700
1964	3,479,100	160,000	316,800
1965	4,159,400	257,600	488,500
1966	6,070,600	301,500	694,200
1967	4,745,000	235,700	995,400
1968	5,849,800	215,400	1,166,200

1969	7,079,500	190,100	1,072,600
1970	6,650,500	220,000	1,399,200
1971	5,907,900	219,500	1,530,600
1972	4,524,700	335,400	1,671,900
1973	5,370,100	120,000	704,200
1974	6,972,000	646,700	648,500
1975	4,527,900	739,800	353,600
1976	6,619,600	790,900	372,500
1977	1,805,690	580,377	250,351
1978	964,343	511,574	229,130
1979	1,712,868	57,728	351,376
1980	1,415,870	75,811	440,165
1981	2,772,772	157,368	778,927
1982	2,823,398	155,258	476,935
1983	1,752,312	123,738	389,939
1984	3,281,759	49,140	174,816
1985	1,744,186	55,486	257,023
1986	2,534,583	29,282	168,292
1987	2,570,864	219,854	58,722
1988	2,155,022	24,134	136,357
1989	2,845,737	53,464	218,525
1990	2,312,456	16,210	249,192
1991	2,972,476	145,310	323,905
1992	3,357,279	34,455	354,716
1993	2,371,091	26,445	206,101
1994	2,511,070	20,743	245,888
1995	1,323,496	19,152	166,447
1996	350,340	26,362	30,261
1997	486,266	39,634	14,086
1998	345,020	44,375	72,293
1999	747,682	55,126	69,308
2000	815,645	39,180	56,128
2001	984,247	71,016	127,664
2002	855,151	36,098	57,047
2003	1,345,072	42,359	40,667
2004	999,017	40,274	37,311
2005	1,446,003	34,262	14,906
2006	1,163,146	53,596	199,389
2007	898,808	28,785	13,906
2008	1,129,503	83,865	21,091
2009	1,717,062	75,316	23,638
2010	1,065,323	139,223	45,203

** = indicates confidential data withheld.

Table 3.3. Mean weights in pounds whole weight used to derive landings in numbers by year and gear. Source indicates the level of aggregation used: GEAR_MEANS = mean weight for the gear across all years, STRATA = mean weight within the gear and year strata.

	GEAR								
	GILL NET			HAND LINE			OTHER		
YEAR	MEAN WEIGHT	STANDARD DEVIATION	SOURCE	MEAN WEIGHT	STANDARD DEVIATION	SOURCE	MEAN WEIGHT	STANDARD DEVIATION	SOURCE
1880	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1881	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1882	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1883	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1884	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1885	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1886	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1887	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1888	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1889	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1890	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1891	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1892	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1893	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1894	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1895	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1896	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1897	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1898	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1899	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1900	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1901	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1902	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1903	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS

1904	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1905	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1906	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1907	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1908	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1909	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1910	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1911	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1912	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1913	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1914	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1915	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1916	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1917	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1918	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1919	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1920	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1921	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1922	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1923	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1924	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1925	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1926	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1927	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1928	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1929	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1930	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1931	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1932	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1933	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1934	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS

1935	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1936	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1937	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1938	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1939	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1940	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1941	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1942	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1943	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1944	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1945	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1946	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1947	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1948	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1949	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1950	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1951	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1952	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1953	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1954	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1955	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1956	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1957	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1958	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1959	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1960	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1961	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1962	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1963	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1964	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1965	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS

1966	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1967	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1968	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1969	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1970	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1971	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1972	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1973	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1974	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1975	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1976	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1977	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1978	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1979	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1980	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1981	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1982	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1983	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1984	2.808	1.951	GEAR_MEANS	5.869	4.472	STRATA	3.099	2.459	GEAR_MEANS
1985	2.808	1.951	GEAR_MEANS	15.216	35.299	STRATA	3.099	2.459	GEAR_MEANS
1986	2.808	1.951	STRATA	5.265	7.977	GEAR_MEANS	1.161	0.809	STRATA
1987	2.483	1.296	STRATA	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1988	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1989	1.612	1.035	STRATA	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1990	1.882	1.139	STRATA	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1991	1.580	0.708	STRATA	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1992	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	1.016	0.599	STRATA
1993	1.533	0.631	STRATA	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1994	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1995	2.978	1.276	STRATA	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1996	3.468	1.352	STRATA	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS

1997	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1998	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
1999	2.808	1.951	GEAR_MEANS	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
2000	2.063	0.842	STRATA	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
2001	1.820	0.547	STRATA	5.265	7.977	GEAR_MEANS	3.099	2.459	GEAR_MEANS
2002	2.808	1.951	GEAR_MEANS	5.120	3.098	STRATA	2.488	1.295	STRATA
2003	1.983	0.770	STRATA	5.497	3.121	STRATA	3.099	2.459	GEAR_MEANS
2004	3.317	2.465	STRATA	5.265	7.977	GEAR_MEANS	3.630	5.766	STRATA
2005	2.893	2.160	STRATA	4.386	3.280	STRATA	3.099	2.459	GEAR_MEANS
2006	2.462	1.778	STRATA	5.222	3.601	STRATA	2.799	1.834	STRATA
2007	2.962	2.115	STRATA	3.321	3.119	STRATA	3.168	2.355	STRATA
2008	3.004	2.183	STRATA	3.967	3.316	STRATA	2.977	1.623	STRATA
2009	2.968	2.012	STRATA	4.675	3.325	STRATA	2.869	1.297	STRATA
2010	2.369	1.705	STRATA	5.476	4.515	STRATA	1.645	0.410	STRATA

Table 3.4. Gulf of Mexico Spanish mackerel commercial landings by gear and year in numbers (thousands)

	GEAR		
YEAR	GILL NET	HAND LINE	OTHER
1880	0	0	0
1881	0	0	0
1882	0	0	0
1883	0	0	0
1884	0	0	0
1885	0	0	0
1886	0	0	0
1887	44	1	9
1888	87	3	18
1889	166	5	34
1890	192	6	39
1891	0	0	0
1892	0	0	0
1893	0	0	0
1894	0	0	0
1895	0	0	0
1896	0	0	0
1897	208	7	42
1898	0	0	0
1899	0	0	0
1900	0	0	0
1901	0	0	0
1902	439	14	89
1903	0	0	0
1904	0	0	0
1905	0	0	0
1906	0	0	0
1907	0	0	0
1908	412	13	83
1909	0	0	0
1910	0	0	0
1911	0	0	0
1912	0	0	0
1913	0	0	0
1914	0	0	0
1915	0	0	0
1916	0	0	0

1917	0	0	0
1918	977	32	198
1919	0	0	0
1920	0	0	0
1921	0	0	0
1922	0	0	0
1923	1,072	35	217
1924	0	0	0
1925	0	0	0
1926	0	0	0
1927	1,323	43	268
1928	916	30	186
1929	991	32	201
1930	1,163	38	236
1931	660	21	134
1932	814	26	165
1933	0	0	0
1934	980	32	199
1935	0	0	0
1936	1,460	47	296
1937	1,105	36	224
1938	1,141	37	231
1939	1,190	38	241
1940	1,025	33	207
1941	0	0	0
1942	0	0	0
1943	0	0	0
1944	0	0	0
1945	26	1	5
1946	0	0	0
1947	0	0	0
1948	249	8	50
1949	1,075	35	218
1950	719	23	146
1951	1,806	58	366
1952	1,253	40	254
1953	828	27	168
1954	801	26	162
1955	451	15	91
1956	810	26	164
1957	1,012	33	205
1958	1,073	35	217
1959	1,301	42	263

1960	1,516	49	307
1961	1,113	36	225
1962	2,010	22	371
1963	1,616	13	271
1964	1,239	30	102
1965	1,481	49	158
1966	2,162	57	224
1967	1,690	45	321
1968	2,083	41	376
1969	2,521	36	346
1970	2,368	42	451
1971	2,104	42	494
1972	1,611	64	539
1973	1,912	23	227
1974	2,483	123	209
1975	1,612	140	114
1976	2,357	150	120
1977	643	110	81
1978	343	97	74
1979	610	11	113
1980	504	14	142
1981	987	30	251
1982	1,005	29	154
1983	624	23	126
1984	1,169	8	56
1985	621	4	83
1986	903	6	145
1987	1,035	42	19
1988	767	5	44
1989	1,766	10	71
1990	1,229	3	80
1991	1,881	28	105
1992	1,195	7	349
1993	1,547	5	66
1994	894	4	79
1995	444	4	54
1996	101	5	10
1997	173	8	5
1998	123	8	23
1999	266	10	22
2000	395	7	18
2001	541	13	41
2002	304	7	23

2003	678	8	13
2004	301	8	10
2005	500	8	5
2006	472	10	71
2007	303	9	4
2008	376	21	7
2009	579	16	8
2010	450	25	27

** = indicates confidential data withheld

Table 3.5. Number of trips reporting Spanish mackerel discards by region and gear fished; all years combined (2002-2010). "Other species" totals include all other reports to the discard logbook program. Also included in "other species" totals are trips with no reported discards. Trips with multiple gears fished reported or that fished in both regions may be counted more than once. Totals include only those vessels with federal fishing permits.

Region	Species	Gillnet	Vertical line	Trolling	All other gears
GOM	Spanish Mackerel	0	39	17	0
	Other species (sm boundaries)	73	14,423	1,342	2,532
SA	Spanish Mackerel	37	84	46	confidential
	Other species (sm boundaries)	2,470	23,990	14,079	3,541

Table 3.6. Spanish mackerel yearly total calculated discards from commercial gill net, vertical line, and trolling vessels with federal fishing permits in the Gulf of Mexico. Discards are reported as number of fish. No Spanish mackerel discards were reported from gill net trips in the Gulf of Mexico, although discards of other species were reported.

Year	Gill net	Vertical line	Trolling	Calculated discards
1998	0	16,808	623	17,431
1999	0	18,918	611	19,528
2000	0	17,995	363	18,358
2001	0	16,746	385	17,131
2002	0	17,559	337	17,897
2003	0	18,962	345	19,307
2004	0	17,018	251	17,269
2005	0	16,350	168	16,518
2006	0	15,909	279	16,187
2007	0	15,075	295	15,370
2008	0	13,207	217	13,425
2009	0	16,529	218	16,747
2010	0	15,244	153	15,397

Table 3.7. Self-reported discard mortality/disposition of Spanish mackerel caught on commercial fishing vessels with federal fishing permits, 2002-2010. No Spanish mackerel discards were reported from gill net vessels in the Gulf of Mexico.

Region	Gear	Disposition							Number of fish
		All Dead	Majority Dead	All Alive	Majority Alive	Kept	Unable to Determine	Unreported	
South Atlantic	Gillnet	71%	24%	0%	0%	5%	0%	0%	398
	Hand line/Electric	3%	3%	21%	4%	47%	23%	0%	577
	Trolling	1%	0%	33%	8%	58%	0%	0%	722
Gulf of Mexico	Gill net	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0
	Hand line/Electric	12%	4%	3%	31%	41%	0%	9%	625
	Trolling	1%	0%	19%	21%	59%	0%	0%	126

Table 3.8. List of factor levels for the main effects of the shrimp bycatch estimation model.

Main Effect	Levels	Description
Year	39	1972-2010
Season	3	Jan-Apr, May-Aug, Sep-Dec
Area	4	Stat grids 1-9, 10-12, 13-17, 18-21
Depth	2	Inside 10 fm, Outside 10 fm
Data Set	2	Observer program, Research vessel

Table 3.9. Observed shrimp bycatch of Spanish mackerel in the Gulf of Mexico from the observer program and SEAMAP groundfish survey. Bycatch is reported in numbers of fish.

Year	Spanish Mackerel bycatch
1972	57
1973	111
1974	96
1975	338
1976	739
1977	1,228
1978	526
1979	76
1980	2,048
1981	275
1982	165
1983	41
1984	554
1985	13
1986	69
1987	29
1988	92
1989	129
1990	181
1991	140
1992	1,787
1993	6,164
1994	790
1995	242
1996	115
1997	55
1998	83
1999	79
2000	156
2001	1,243
2002	2,968
2003	2,444
2004	17,407
2005	11,432
2006	64
2007	3,545
2008	7,096
2009	5,027
2010	5,351

Table 3.10. Predicted annual shrimp bycatch (millions of fish) of Spanish mackerel in the Gulf of Mexico.

year	mean	sd	MC error	2.50%	25.00%	median	75.00%	97.50%	start	sample
1972	22.05	53.44	0.981	1.194	4.487	9.378	20.59	122.6	4001	10000
1973	2.035	4.095	0.06811	0.2053	0.6094	1.096	2.125	9.168	4001	10000
1974	5.957	23.65	0.3076	0.4607	1.411	2.686	5.483	29.74	4001	10000
1975	5.087	9.934	0.1324	0.9573	2.052	3.216	5.501	19.29	4001	10000
1976	7.031	5.969	0.0854	2.433	4.135	5.682	8.142	19.2	4001	10000
1977	20.24	18.72	0.2544	5.826	10.36	15.02	23.01	67.97	4001	10000
1978	22.96	37.12	0.5091	5.326	10.02	14.85	24.01	86.13	4001	10000
1979	68.18	620.9	7.318	2.5	9.513	20.86	50.7	340.1	4001	10000
1980	17.2	11.11	0.1539	6.621	10.88	14.53	20.31	42.55	4001	10000
1981	9.979	27.39	0.3813	1.346	2.768	4.567	8.762	52.79	4001	10000
1982	15.48	43.81	0.577	0.9467	3.19	6.35	13.92	84.47	4001	10000
1983	13.8	56.97	0.8974	0.8958	2.932	5.925	12.87	73.64	4001	10000
1984	32.54	82.47	1.225	2.278	7.124	14.03	30.82	173.1	4001	10000
1985	7.824	24.26	0.3157	0.4689	1.663	3.354	7.241	39.12	4001	10000
1986	20	56.73	0.6918	1.118	3.989	8.151	18	104.5	4001	10000
1987	17.9	54.35	0.675	0.958	3.627	7.335	16.42	96.49	4001	10000
1988	31	105.2	1.292	1.796	6.149	12.63	27.54	162.4	4001	10000
1989	45.25	211	2.662	2.594	8.899	17.75	38.1	253.6	4001	10000
1990	63.69	340.5	3.603	3.792	12.67	25.75	56.09	335	4001	10000
1991	44.37	124.5	1.61	2.809	9.5	18.97	40.88	240.9	4001	10000
1992	23.91	15.12	0.1936	9.944	15.71	20.53	27.57	58.61	4001	10000
1993	69.27	61.61	0.7912	21.34	36.96	53.08	80.59	214.9	4001	10000
1994	12.89	42.35	0.5414	1.423	3.123	5.479	11.02	66.6	4001	10000
1995	12.8	32.24	0.3707	1.09	3.095	5.826	12.11	65.56	4001	10000
1996	11.69	38.36	0.472	0.7456	2.502	4.969	10.62	61.63	4001	10000
1997	12.84	34.18	0.4091	0.871	2.82	5.561	11.75	67.04	4001	10000

1998	17.97	62.92	0.6922	1.043	3.58	7.443	16.39	96.55	4001	10000
1999	12.81	35.74	0.4432	0.7573	2.738	5.555	12.06	65.19	4001	10000
2000	31.68	140.5	1.66	1.807	6.258	12.94	28.21	161.4	4001	10000
2001	14.4	36.56	0.4504	1.925	4.005	7.007	13.54	70.56	4001	10000
2002	8.296	13.72	0.1602	2.393	3.953	5.718	8.95	28.61	4001	10000
2003	15.9	15.84	0.1806	4.245	7.811	11.49	18.17	54.36	4001	10000
2004	23.01	18.39	0.2313	11.44	15.83	19.32	24.64	56.29	4001	10000
2005	26.84	20.9	0.2839	11.36	17.32	22.66	30.67	64.84	4001	10000
2006	12.21	34.85	0.3982	0.7668	2.592	5.3	11.44	64.48	4001	10000
2007	10.34	6.653	0.1023	4.164	6.683	8.831	12.12	25.27	4001	10000
2008	4.105	4.462	0.05798	2.099	2.7	3.204	4.069	11.8	4001	10000
2009	2.873	0.7141	0.008543	1.77	2.371	2.766	3.268	4.527	4001	10000
2010	2.913	1.05	0.01266	1.762	2.32	2.723	3.244	5.229	4001	10000

Table 3.11. Number of Gulf of Mexico trips from logbooks landing any amount of Spanish mackerel, where Spanish mackerel was targeted (Spanish mackerel was at least 30% of catch) and the number of trips with valid samples (no biases) and number of trips with samples usable for analysis (trip weights available) by year and gear.

	GEAR											
	GILL NET				HAND LINE				OTHER			
YEAR	ALL LOGBOOK TRIPS	TARGETED LOGBOOK TRIPS	SAMPLES USED	VALID SAMPLES	ALL LOGBOOK TRIPS	TARGETED LOGBOOK TRIPS	SAMPLES USED	VALID SAMPLES	ALL LOGBOOK TRIPS	TARGETED LOGBOOK TRIPS	SAMPLES USED	VALID SAMPLES
1983	0	0	0	0	0	0	3	3	0	0	0	0
1984	0	0	0	0	0	0	12	12	0	0	2	2
1985	0	0	0	0	0	0	12	12	0	0	2	2
1986	0	0	0	1	0	0	0	1	0	0	2	2
1987	0	0	0	2	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	2	2	0	0	0	0	0	0	0	0
1990	0	0	1	1	13	0	0	0	**	0	0	0
1991	0	0	0	2	18	0	0	25	**	0	2	2
1992	0	0	0	9	141	**	0	37	**	**	6	6
1993	0	0	3	5	267	**	3	29	33	**	3	3
1994	**	0	4	13	356	**	0	28	58	**	2	2
1995	**	**	4	11	365	26	0	13	25	**	0	0
1996	24	23	3	6	370	49	2	5	**	**	0	0
1997	48	32	0	2	398	98	0	1	**	**	0	0
1998	62	55	0	0	519	124	1	3	**	0	0	0
1999	145	129	2	2	622	139	0	1	14	**	2	2
2000	98	86	3	3	704	145	0	0	13	0	0	0
2001	86	82	2	2	663	192	0	1	22	**	0	0
2002	46	34	0	0	578	85	4	4	27	**	0	1
2003	52	48	1	3	526	99	10	11	16	**	0	0
2004	31	29	8	8	384	86	6	6	13	**	4	4
2005	45	45	14	14	314	65	14	14	**	0	0	0

2006	23	20	11	11	337	62	13	13	**	**	2	2
2007	44	44	9	9	286	57	8	8	**	0	11	11
2008	39	36	10	10	394	60	17	17	**	0	5	5
2009	91	82	6	6	474	84	19	20	20	**	0	1
2010	24	24	11	11	550	91	21	21	21	**	1	1

**=data deemed confidential have been removed

Table 3.12. Number of length samples used for analysis and number of valid (no biases) length samples collected by year and gear.

	GEAR					
	GILL NET		HAND LINE		OTHER	
YEAR	SAMPLES USED	VALID SAMPLES	SAMPLES USED	VALID SAMPLES	SAMPLES USED	VALID SAMPLES
1983	0	0	7	7	0	0
1984	0	0	23	23	19	19
1985	0	0	178	178	41	41
1986	0	17	0	1	96	96
1987	0	557	0	0	0	0
1988	0	0	0	0	0	0
1989	62	62	0	0	0	0
1990	66	66	0	0	0	0
1991	0	54	0	197	5	5
1992	0	447	0	235	152	152
1993	72	82	28	119	25	25
1994	443	496	0	109	2	2
1995	212	279	0	38	0	0
1996	256	296	10	22	0	0
1997	0	12	0	1	0	0
1998	0	0	6	16	0	0
1999	17	17	0	1	19	19
2000	38	38	0	0	0	0
2001	23	23	0	1	0	0
2002	0	0	21	21	0	97
2003	28	31	35	37	0	0
2004	484	484	16	16	413	413
2005	636	636	78	78	0	0
2006	794	794	100	100	192	192
2007	381	381	207	207	342	342
2008	462	462	209	209	105	105
2009	153	153	70	79	0	32
2010	457	457	67	67	20	20

Table 3.13. U.S. Gulf of Mexico commercial Spanish mackerel age samples by gear and year.

	GEAR		
YEAR	GILL NET	HAND LINE	OTHER
1988	32	3	0
1989	0	117	0
1990	245	160	89
1991	198	177	1
1992	508	117	27
1993	178	63	16
1994	452	23	0
1995	213	18	14
1996	243	8	0
1997	0	5	0
1998	0	10	0
1999	0	2	0
2000	21	0	0
2001	37	12	0
2002	0	13	0
2003	0	36	0
2004	12	5	0
2005	0	28	113
2006	0	11	0
2007	0	19	0
2008	0	22	0
2009	0	35	0
2010	0	38	0

Table 3.14. Gulf of Mexico Spanish mackerel commercial length sampling fractions (length samples used/landings in numbers) by gear and year.

	GEAR		
YEAR	GILL NET	HAND LINE	OTHER
1983	0.000	0.000	0.000
1984	0.000	0.003	0.000
1985	0.000	0.049	0.000
1986	0.000	0.000	0.001
1987	0.000	0.000	0.000
1988	0.000	0.000	0.000
1989	0.000	0.000	0.000
1990	0.000	0.000	0.000
1991	0.000	0.000	0.000
1992	0.000	0.000	0.000
1993	0.000	0.006	0.000
1994	0.000	0.000	0.000
1995	0.000	0.000	0.000
1996	0.003	0.002	0.000
1997	0.000	0.000	0.000
1998	0.000	0.001	0.000
1999	0.000	0.000	0.001
2000	0.000	0.000	0.000
2001	0.000	0.000	0.000
2002	0.000	0.003	0.000
2003	0.000	0.005	0.000
2004	0.002	0.002	0.040
2005	0.001	0.010	0.000
2006	0.002	0.010	0.003
2007	0.001	0.024	0.078
2008	0.001	0.010	0.015
2009	0.000	0.004	0.000
2010	0.001	0.003	0.001

3.10 Figures

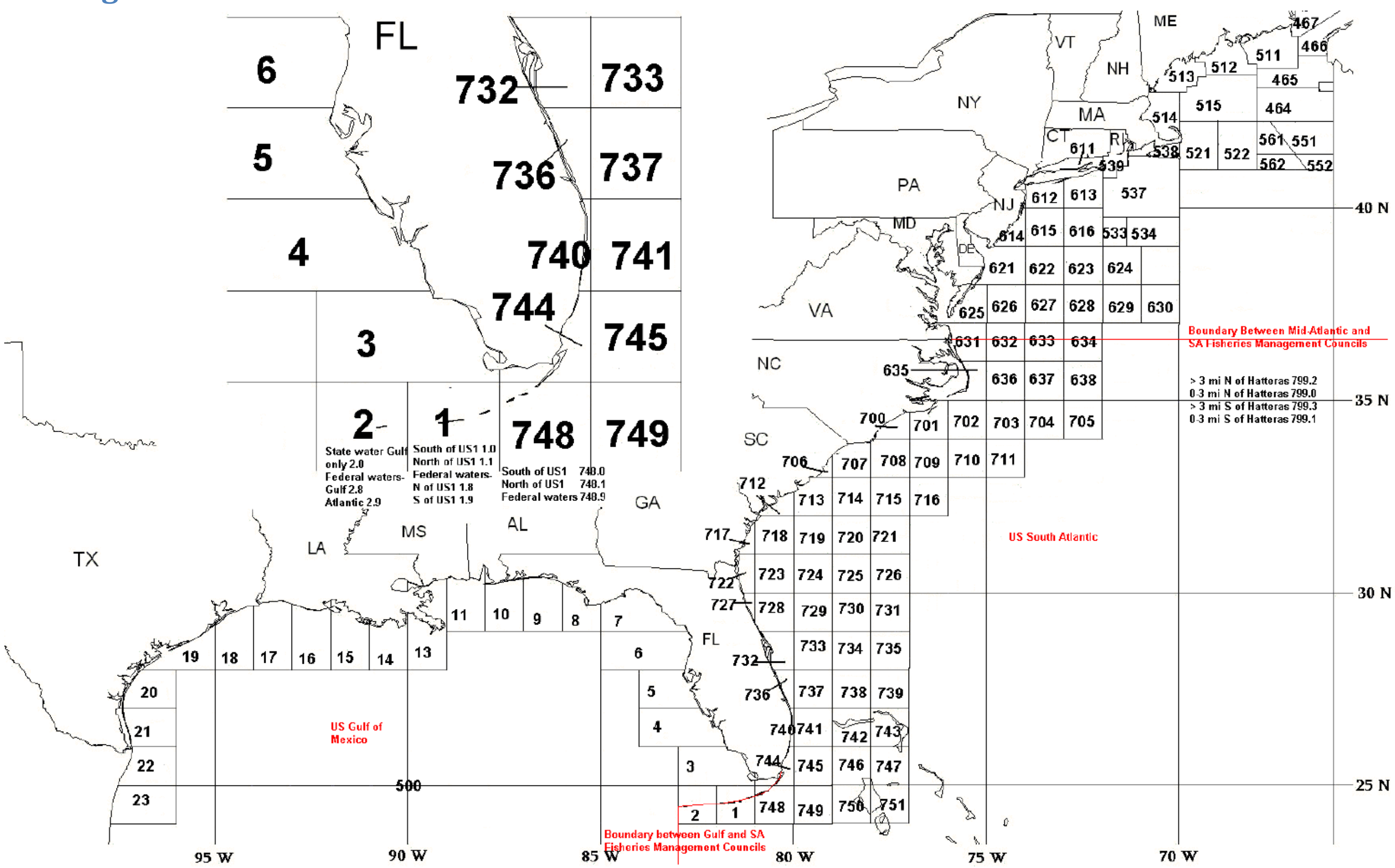


Figure 3.1. Map of U.S. Atlantic and Gulf coast with shrimp area designations and council boundaries. Boundary used for Gulf and Atlantic Spanish Mackerel is the SAFMC/GMFMC boundary along the FL Keys.

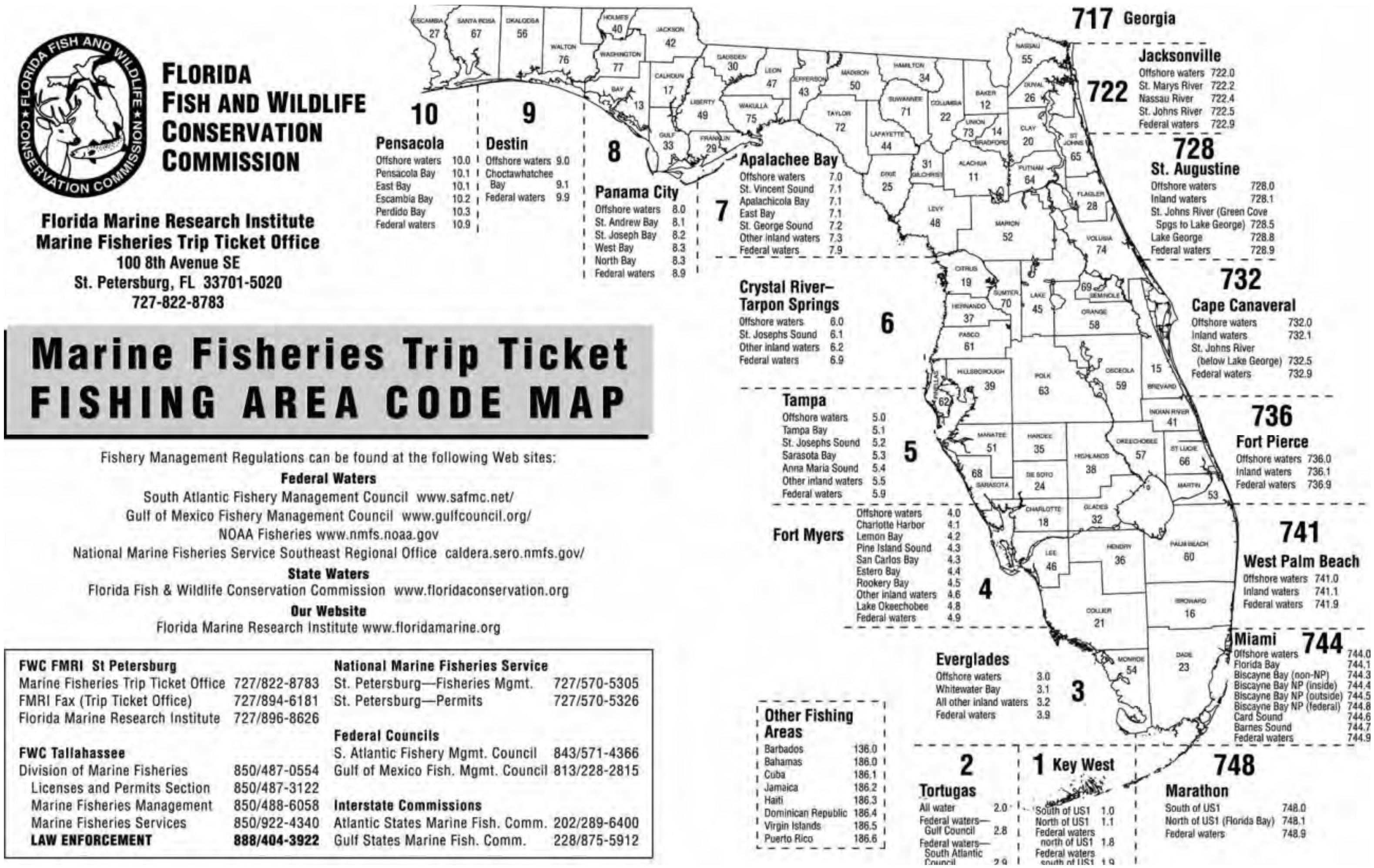


Figure 3.2. Map showing marine fisheries trip ticket fishing area code map for Florida.

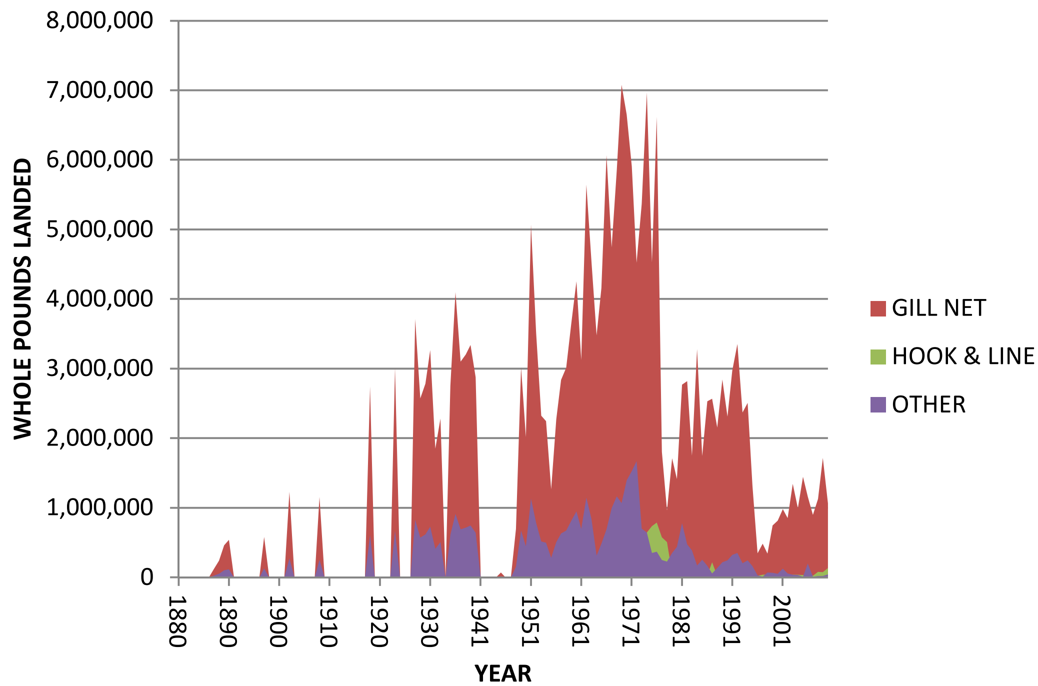


Figure 3.3. Spanish mackerel landings in pounds (whole weight) by gear (gill net, hand line, and other) from the Gulf of Mexico, 1880-2010.

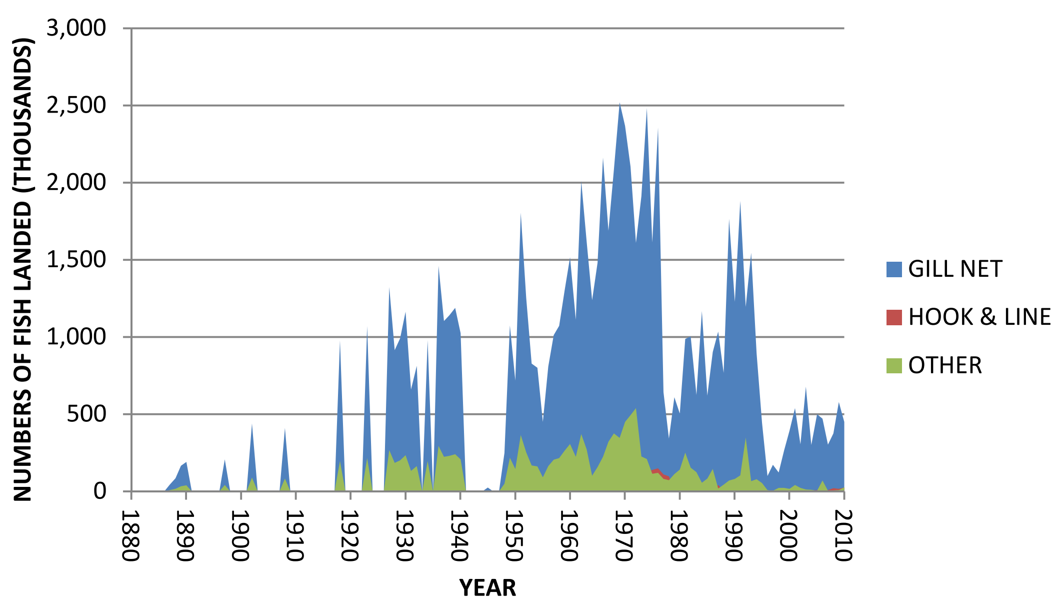


Figure 3.4. Spanish mackerel landings in numbers of fish (thousands) by gear (gill net, hand line, and other) from the Gulf of Mexico, 1880-2010.

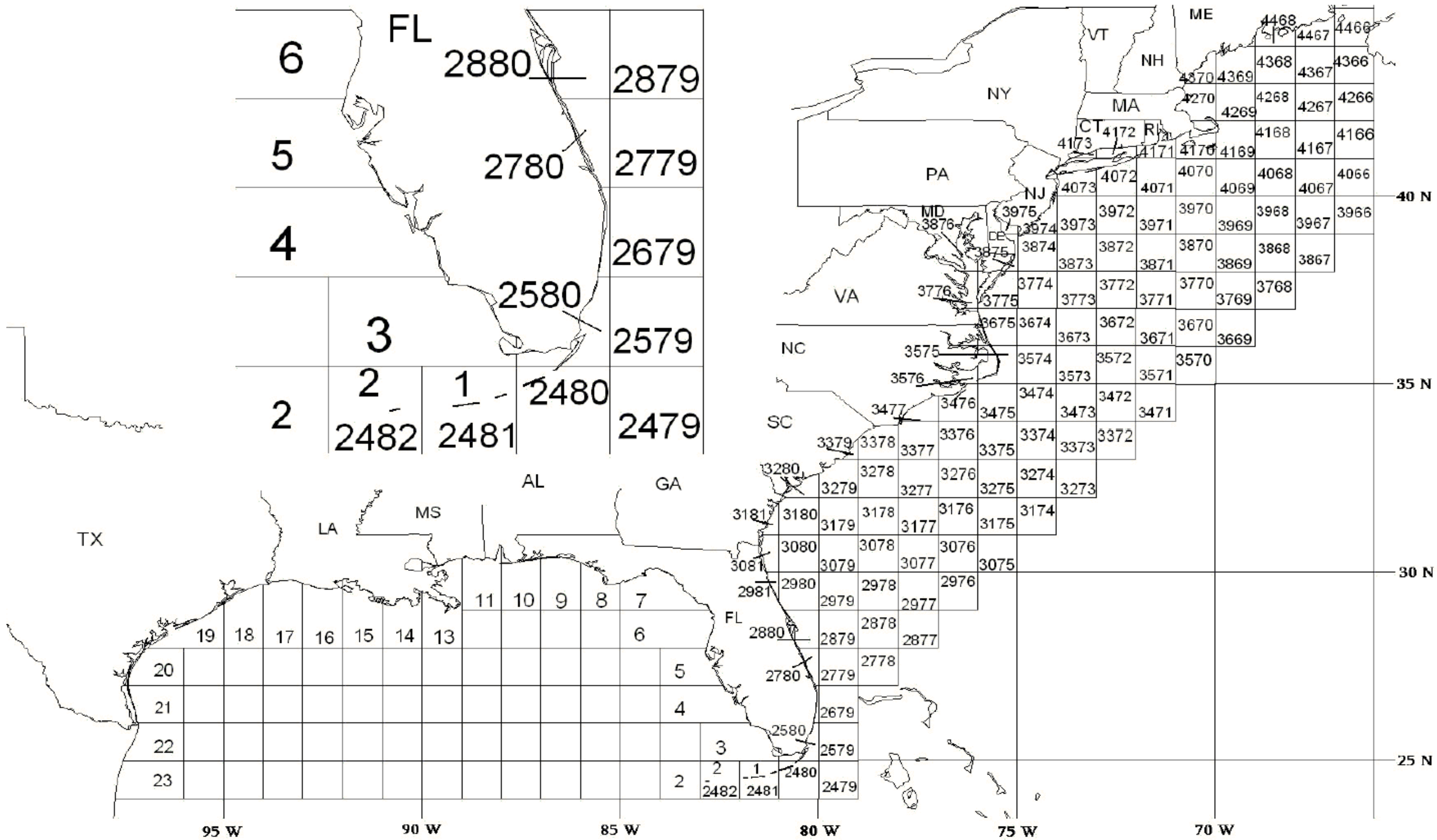


Figure 3.5. Map of U.S. Atlantic and Gulf coast logbook areas.

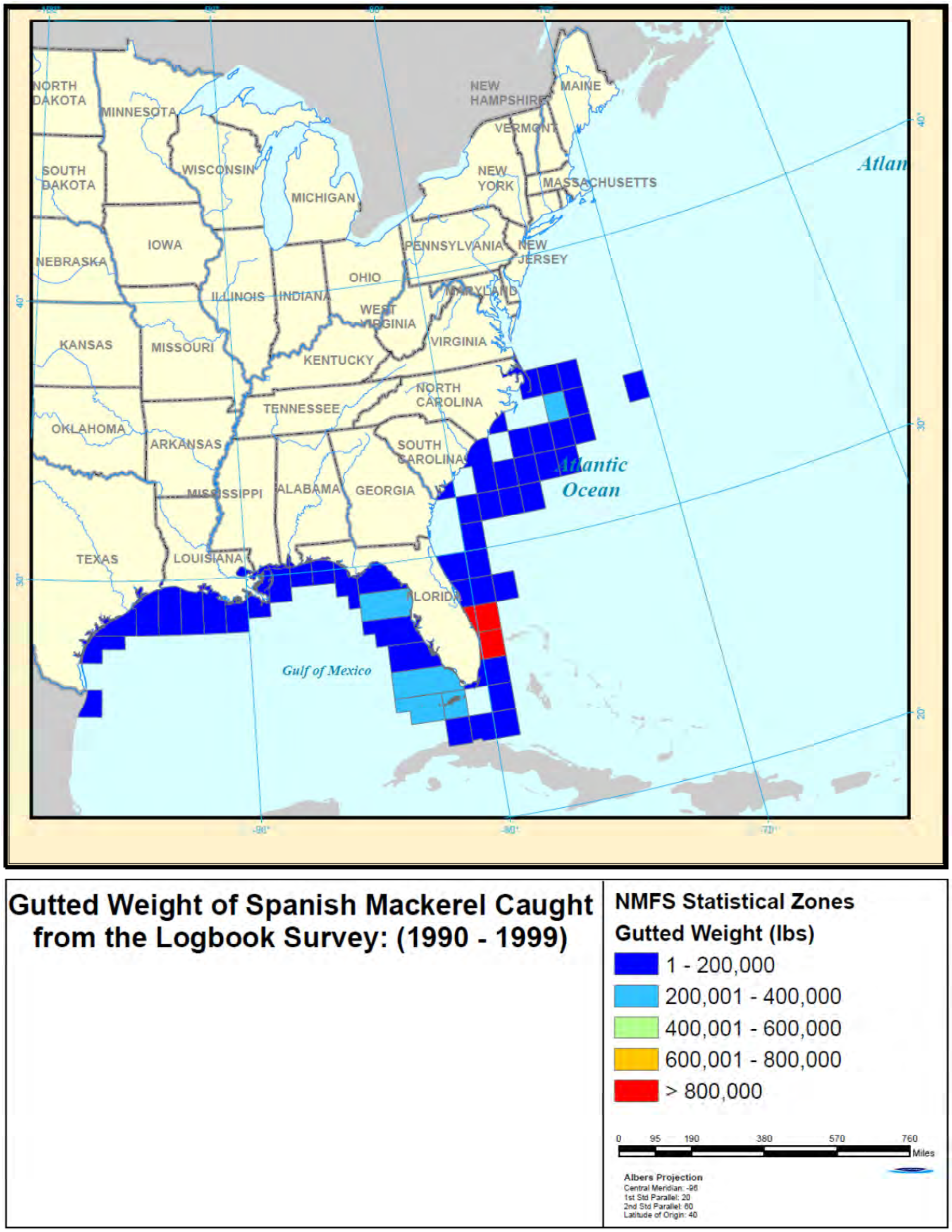


Figure 3.6. Map of Spanish mackerel catches reported to the Coastal Logbook Program for the U.S. Atlantic and Gulf coast areas (1990-1999).

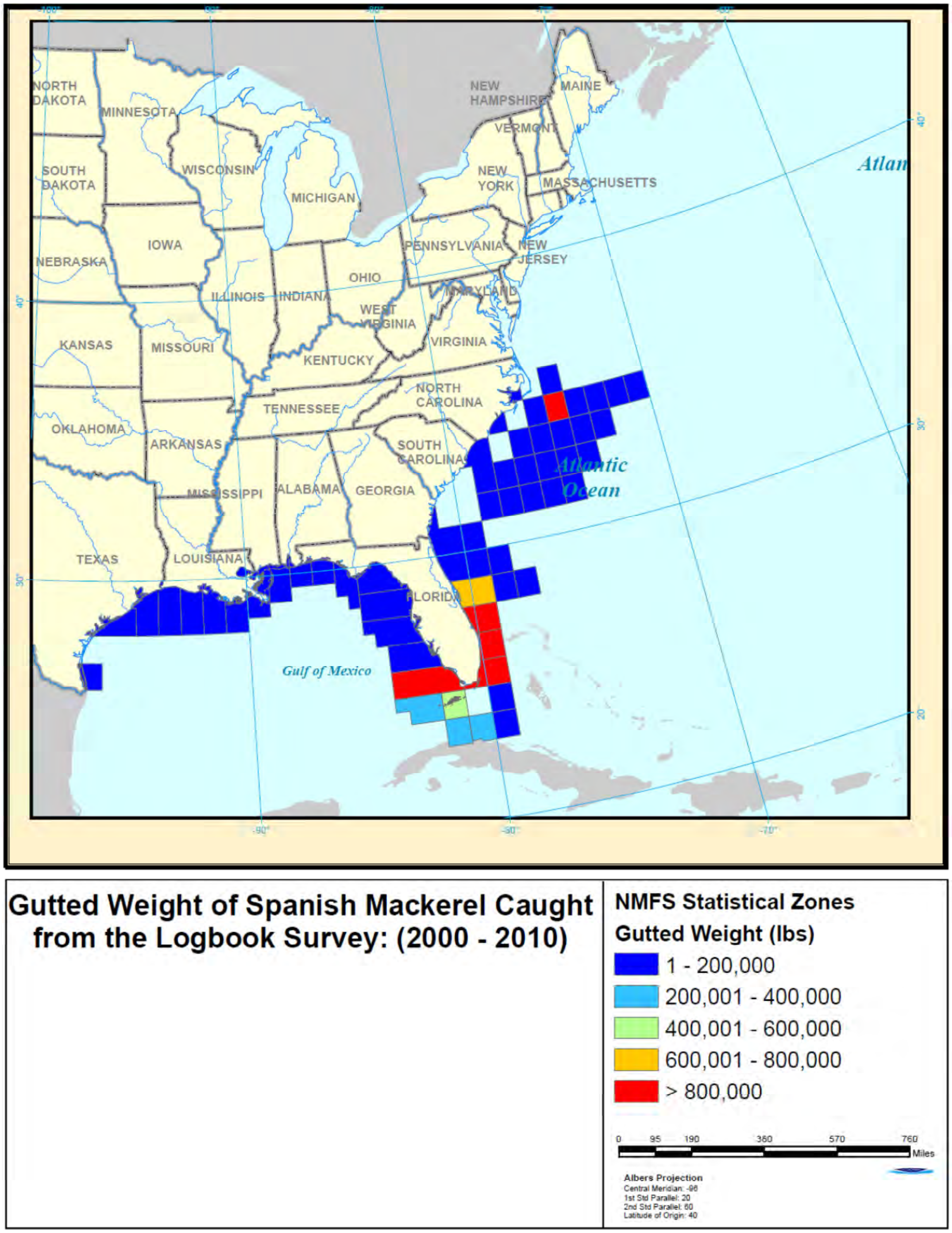


Figure 3.7. Map of Spanish mackerel catches reported to the Coastal Logbook Program for the U.S. Atlantic and Gulf coast areas (2000-2010).

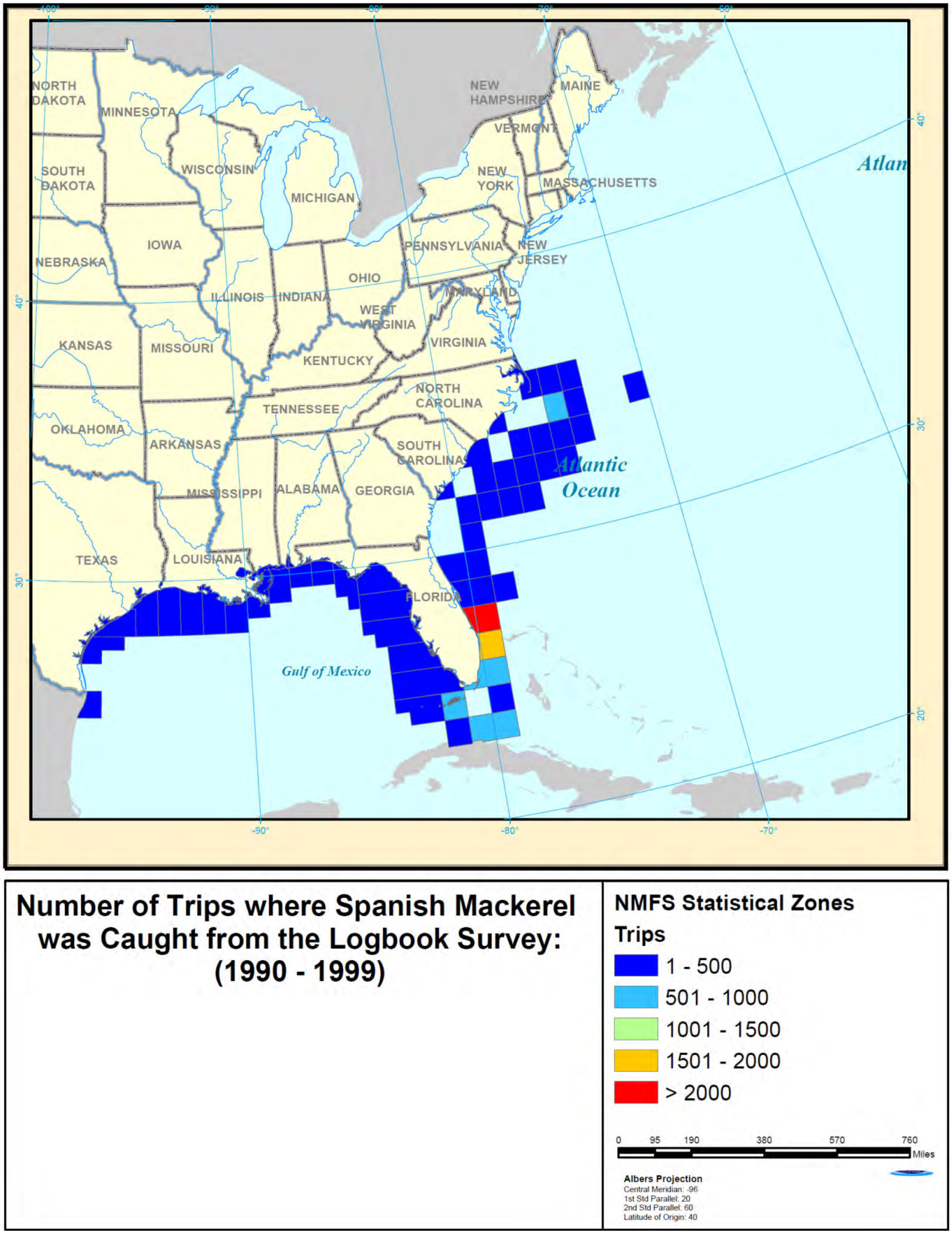


Figure 3.8. Map of Spanish mackerel trips reported to the Coastal Logbook Program for the U.S. Atlantic and Gulf coast areas (1990-1999).

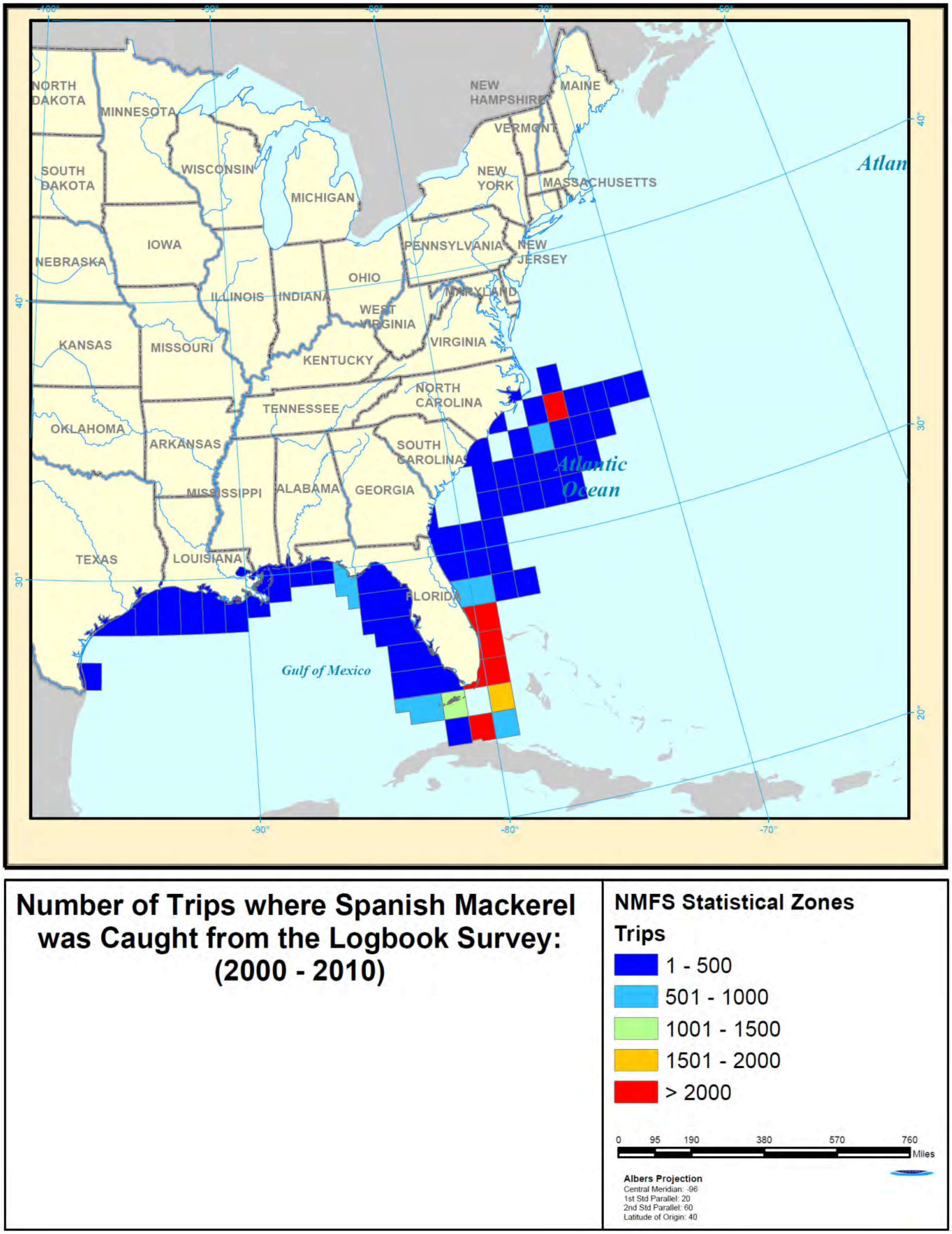


Figure 3.9. Map of Spanish mackerel trips reported to the Coastal Logbook Program for the U.S. Atlantic and Gulf coast areas (2000-2010).

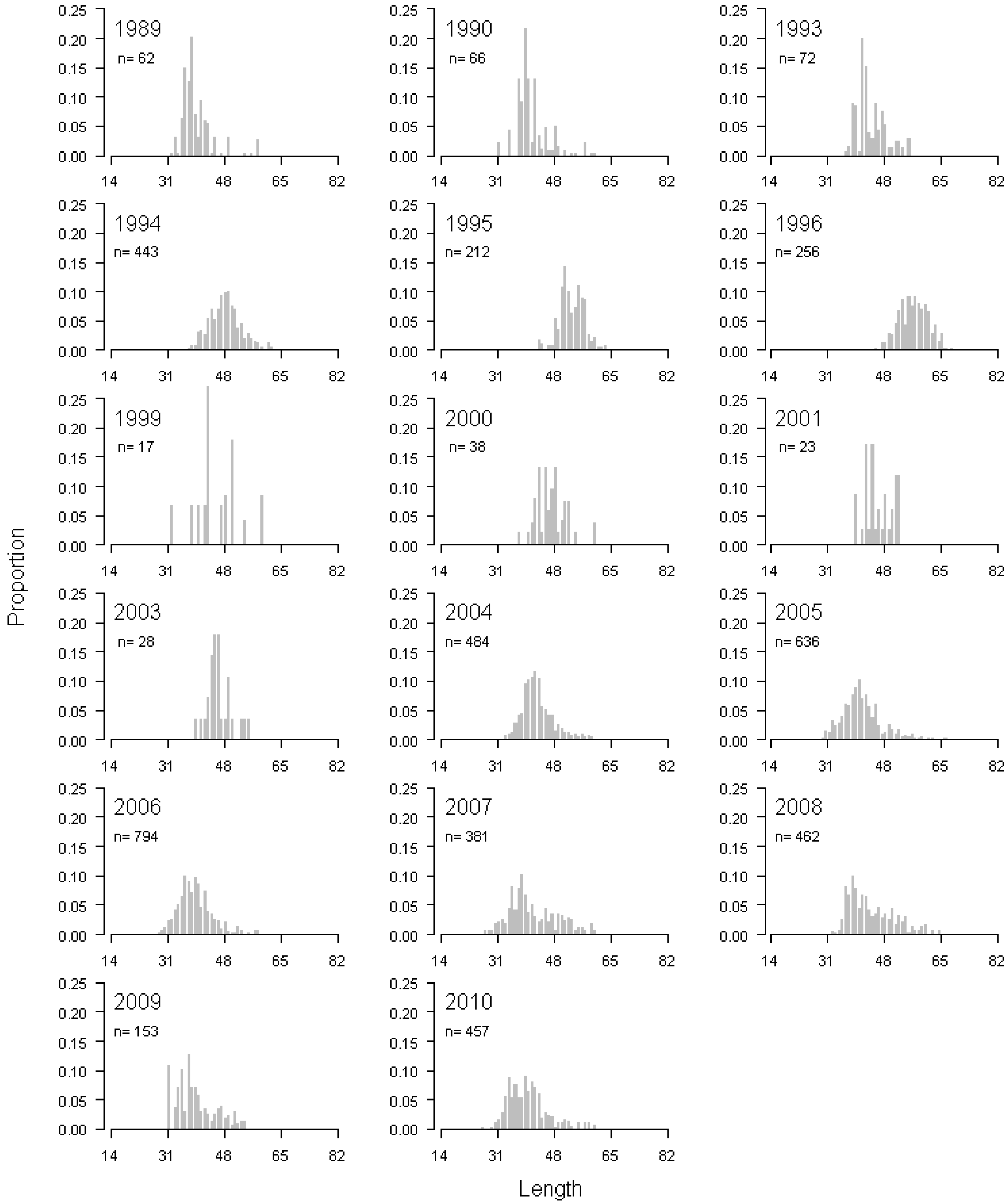


Figure 3.10. Relative length composition of commercial length (FL in mm) samples by year for gill net gear (n = number of fish).

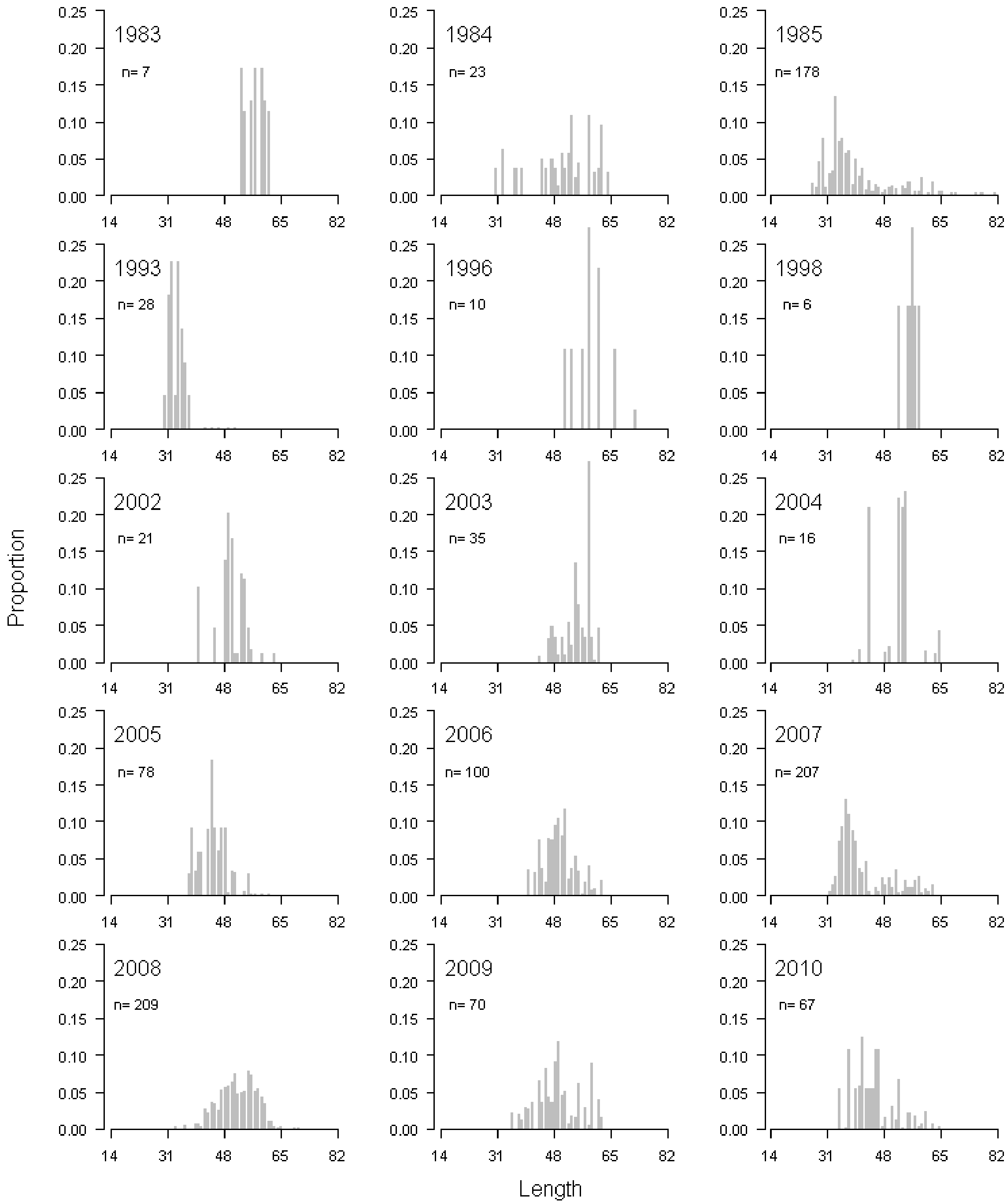


Figure 3.11. Relative length composition of commercial length (FL in mm) samples by year for hand line gear (n = number of fish).

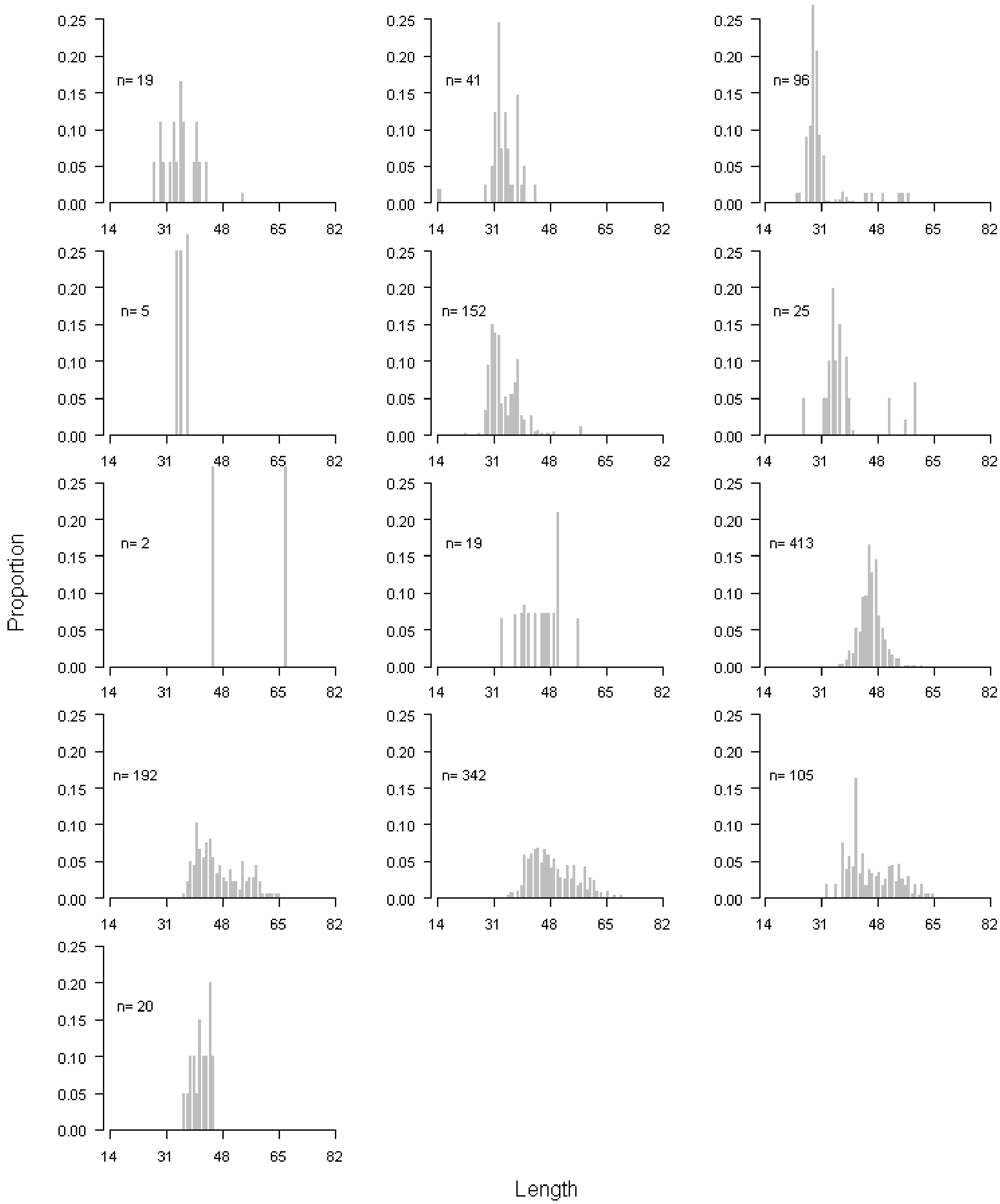


Figure 3.12. Relative length composition of commercial length (FL in mm) samples by year for other miscellaneous gear (n = number of fish).

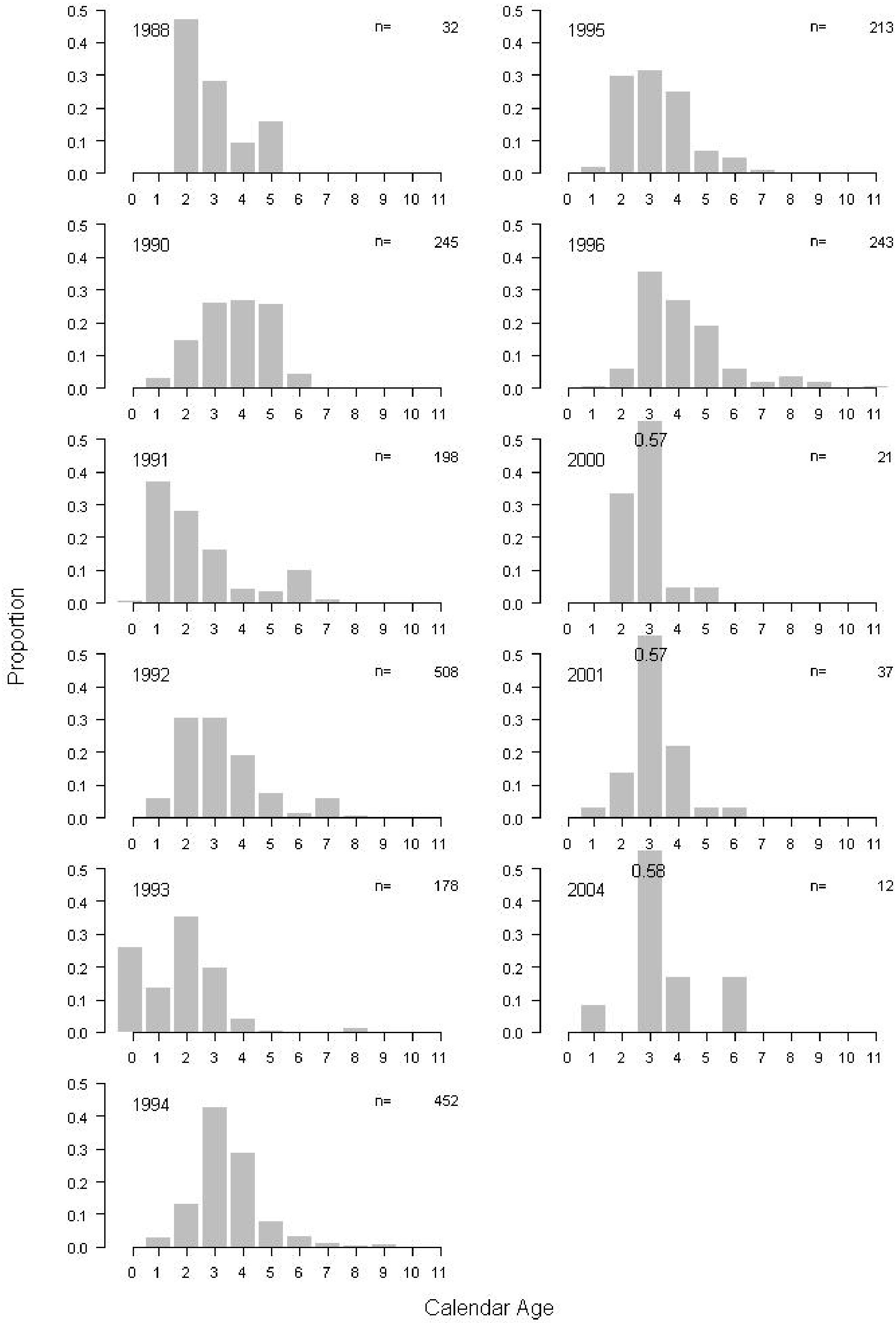


Figure 3.13. Unweighted relative age composition of commercial age (calendar years) samples by year for gill net gear (n = number of fish).

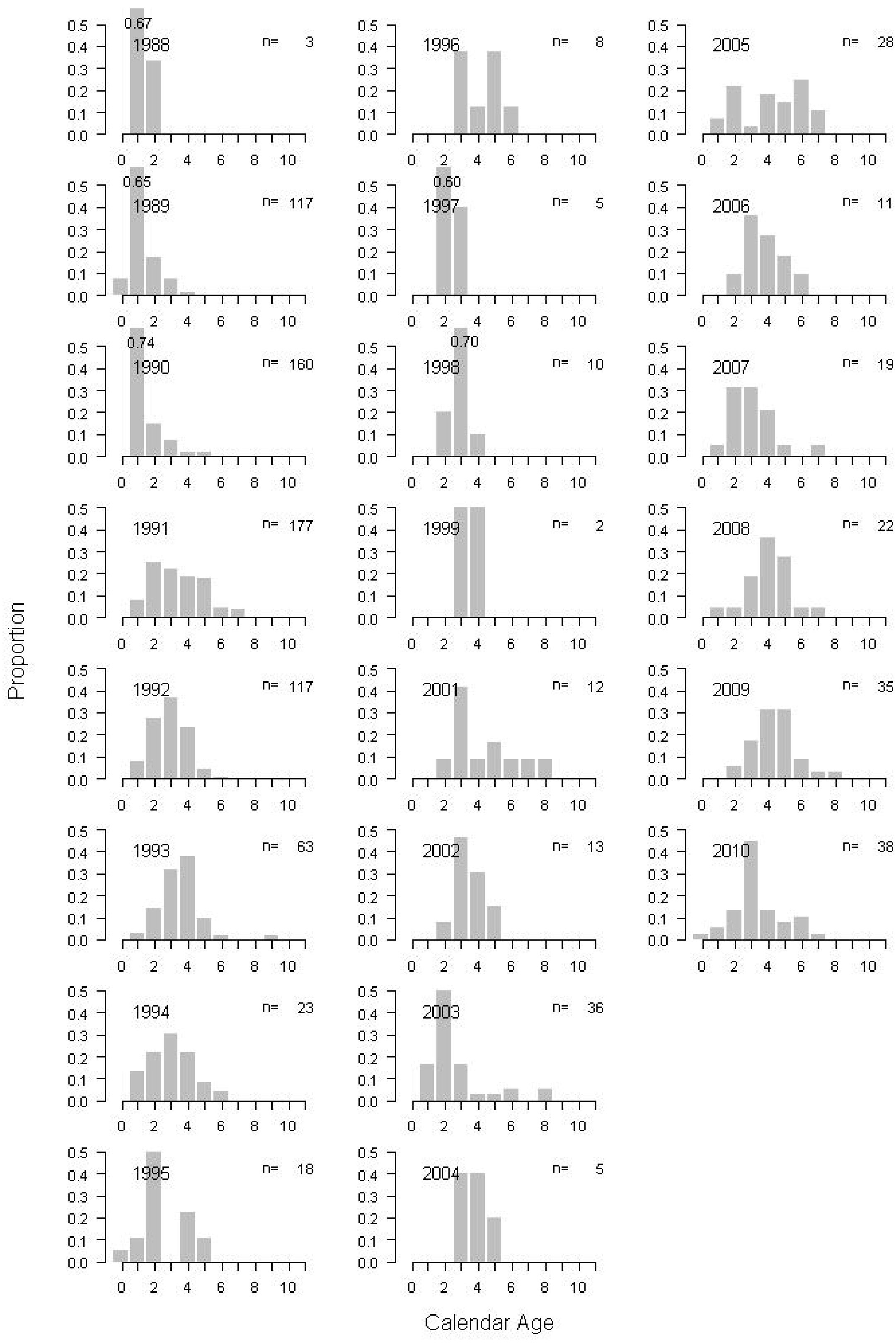


Figure 3.14. Unweighted relative age composition of commercial age (calendar years) samples by year for hand line gear (n = number of fish).

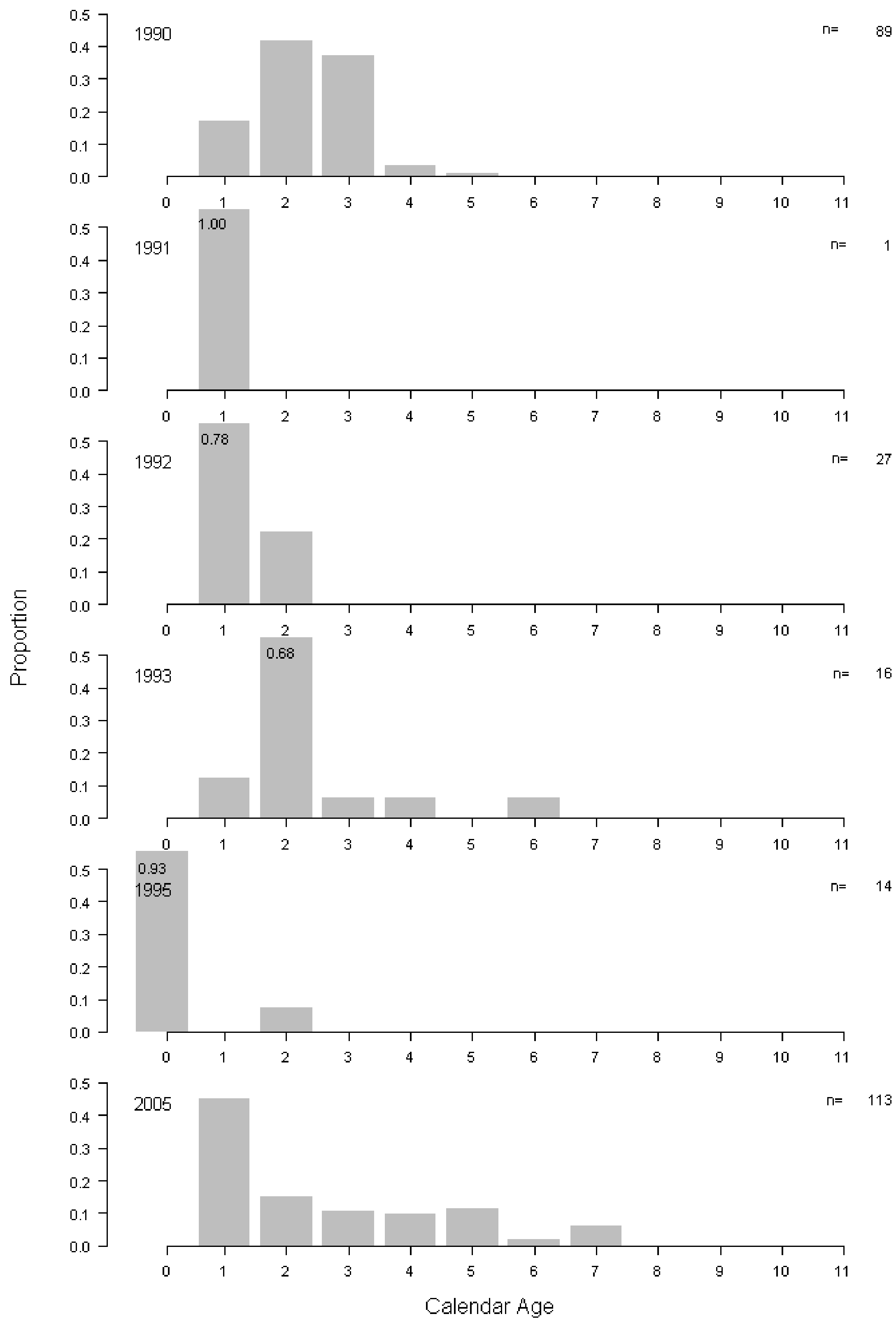


Figure 3.15. Unweighted relative age composition of commercial age (calendar years) samples by year for other miscellaneous gear (n = number of fish).

4 Recreational Fishery Statistics

4.1 Overview

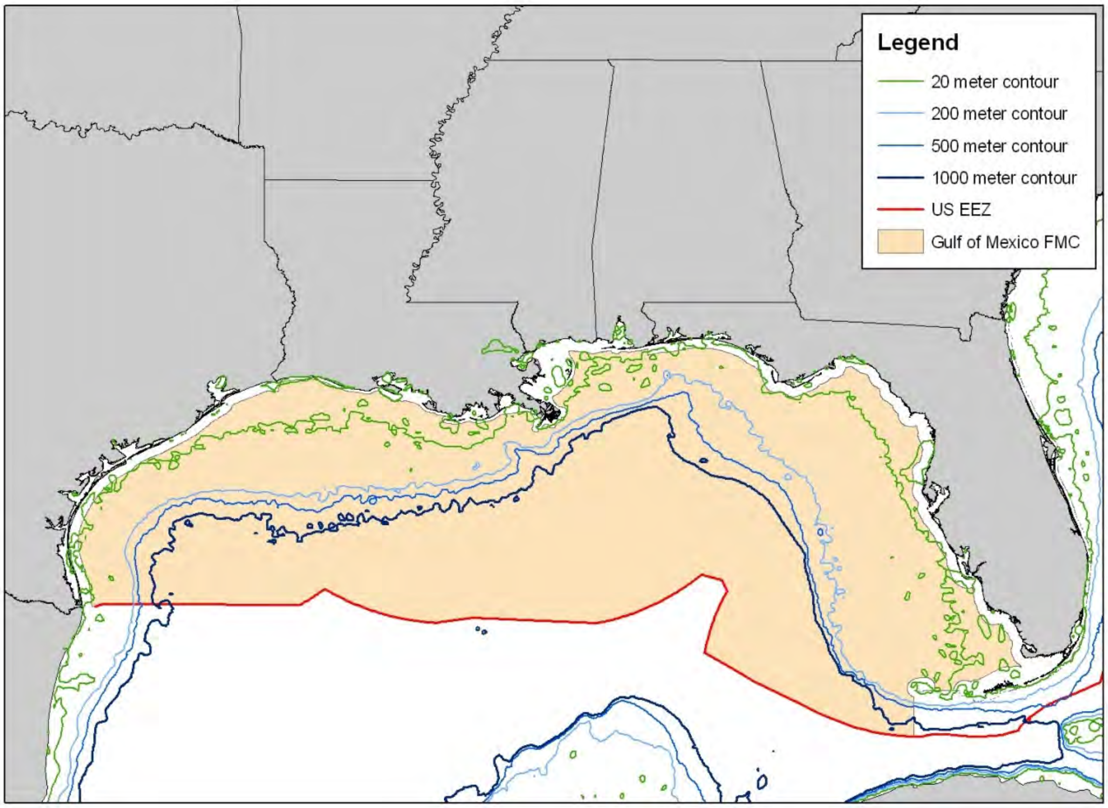
4.1.1 Group membership

Members- Ken Brennan (Leader South Atlantic\NMFS Beaufort), Julia Byrd (SCDNR), Kelly Fitzpatrick (NMFS Beaufort), Eric Hiltz (SCDNR), Robert Johnson (SAFMC Appointee\ Industry rep FL), Vivian Matter (Leader Gulf of Mexico\NMFS SEFSC), Bill Parker (SAFMC Appointee/Industry rep SC), Tom Ogle (SAFMC Appointee/Industry rep SC), Bob Zales (GMFMC Appointee/Industry rep FL).

4.1.2 Issues

1) Allocation of Monroe county catches to the Atlantic or the Gulf of Mexico: may vary by data source depending on differing spatial resolutions of the datasets.
2) Missing weight estimates for some recreational “cells” (i.e., specific year, state, fishing mode, wave combinations).
3) Headboat discards. Data are available from the SRHS since 2004. Review whether they are reliable for use, and determine if there are other sources of data prior to 2004 that could be used as a proxy to estimate headboat discards.
4) Charter boat landings: MRFSS charter survey methods changed in 1998 in the Gulf of Mexico.
5) New MRIP weighted estimates are available for 2004-2011: Determine appropriate use of datasets to cover the entire period from 1981-2011.
6) Texas estimates in the MRFSS is only available from 1981-1985 and is sporadic, not covering all modes and waves.
7) TPWD survey does not estimate landings in weight or discards.
8) Usefulness of historical data sources such as the 1960, 1965, and 1970 U.S. Fish and Wildlife Service (FWS) surveys to generate estimates of landings prior to 1981. Review whether other data sources also available.

4.1.3 Gulf of Mexico Fishery Management Council Jurisdictional Boundaries



4.2 Review of Working Papers

SEDAR28-DW12, *Estimated conversion factors for calibrating MRFSS charter boat landings and effort estimates for the South Atlantic and Gulf of Mexico in 1981-1985 with For Hire Survey estimates with application to Spanish mackerel and cobia landings. Vivian M. Matter, Nancie Cummings, John Jeffrey Isely, Kenneth Brennan, and Kelly Fitzpatrick.*

This working paper presents correction factors to calibrate the traditional MRFSS charter boat/headboat combined mode estimates with the For-Hire Survey for 1981-1985. These calibration factors are based on equivalent units of effort and consistent methodologies across both sub regions.

SEDAR28-DW14, *Recreational Survey Data for Spanish Mackerel and Cobia in the Atlantic and the Gulf of Mexico from the MRFSS and TPWD Surveys. Vivian Matter*

This working paper presents recreational survey data for Spanish mackerel and cobia from the Marine Recreational Fishery Statistics Survey (MRFSS) and the Texas Parks and Wildlife Department (TPWD) surveys in the Atlantic and the Gulf of Mexico. Issues addressed include the allocation of the Spanish mackerel landings in the Keys into the Gulf of Mexico or Atlantic

Ocean, the split of cobia landings along the east coast of Florida, the calibration of MRFSS charter boat estimates back in time, 1981-1985 adjustments and substitutions, MRIP vs MRFSS estimates for 2004-2011, and estimating recreational landings in weight from the surveys.

4.3 Recreational Landings

4.3.1 Marine Recreational Fisheries Statistics Survey (MRFSS)

Introduction

The Marine Recreational Fisheries Statistics Survey (MRFSS) provides a long time series of estimated catch per unit effort, total effort, landings, and discards for six two-month periods (waves) each year. The survey 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 were included in the for-hire mode, but were excluded after 1985 to avoid overlap with the Southeast Region Headboat Survey (SRHS) conducted by the NMFS Beaufort, NC lab.

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

The MRFSS 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 charter boat operators (captains or owners) to obtain the trip information with only one-week recall period. These effort data and estimates are aggregated to produce the wave estimates. 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 on the MRFSS website 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 has improved through increased sample quotas and additional sampling (requested and funded by the states) to the intercept portion of the survey. It was also recognized that the random household telephone survey was intercepting relatively few anglers in the for-hire fishing mode and the For-Hire Telephone Survey (FHS) was developed to estimate effort in the for-hire mode. The new method draws a random sample of known for-hire charter and guide vessels each week and vessel operators are called and asked directly to report their fishing activity. The FHS was pilot tested in the Gulf of Mexico in 1998 and officially adopted in 2000. The two pilot years' estimates are considered unofficial but have been used in many SEDARs (SEDAR 7 red snapper, SEDAR 16 king mackerel, etc). The FHS was pilot tested in east Florida in 2000 and officially adopted in 2003.

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: 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 charter boat estimates

Conversion factors have been estimated to calibrate the traditional MRFSS charter boat estimates with the FHS for 1986-1997 in the Gulf of Mexico (SEDAR7-AW03, Diaz and Phares, 2004), for 1986-2003 in the South Atlantic (SEDAR16-DW15, Sminkey, 2008), and for 1981-2003 in the mid-Atlantic (SEDAR17-Data Workshop Report, 2008). 1986-2003 South Atlantic calibration factors were updated in 2011 (SEDAR25-Data Workshop Report, 2011). These calibration factors are tabulated in SEDAR 28-DW14. The relationship between the old charter boat method estimates of angler trips and the FHS estimates of angler trips was used to estimate the conversion factors. Since these factors are based on effort, they can be applied to all species' landings. In the Gulf of Mexico and South Atlantic, 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 charter boat and headboat as a single combined mode in both regions. Thus, in order to properly calibrate the estimates from 1981-1985, headboat data from the Southeast Region Head-boat Survey (SRHS) must be included in the analysis. To calibrate the MRFSS combined charter boat 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 (SEDAR 28-DW12).

New MRIP weighted estimates

Revised catch and effort estimates, based on an improved estimation method, were released on January 25, 2012. These estimates are available for the Atlantic and Gulf Coasts for January 2004 through October 2011. This new estimation method, developed as part of the Marine Recreational Information Program (MRIP), provides more accurate data by removing potential biases that were included in the previous estimates. Since new MRIP estimates are only available for a portion of the recreational time series that the MRFSS covers, calibration factors between the MRFSS estimates and the MRIP estimates must be developed in order to maintain one consistent time series for the recreational estimates. To that end a calibration workshop is planned for the spring that will address this important data need.

Figure 4.12.1 shows the comparison of the MRIP and MRFSS estimates for 2004-2011. At the SEDAR 28 DW plenary, the MRFSS estimates were identified as the best available data for 1981-2003. The MRIP estimates were identified as the best available data for 2004-2011. If the calibration workshop is able to produce correction factors that can be applied to the data in time for the SEDAR 28 Assessment Workshop in May, then these correction factors will be used to adjust the MRFSS estimates from 1981-2003. If the calibration workshop is not able to produce results in time then MRFSS estimates will be used from 1981-2003 and MRIP estimates will be used from 2004-2011.

Monroe County

Monroe County landings 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. Although Monroe county estimates can be separated using this process, they cannot be partitioned into those from the Atlantic Ocean and those from the Gulf of Mexico. Anecdotal information from recreational fishermen revealed most, if not all, recreational Spanish mackerel fishing in the Florida Keys occurs in the Gulf of Mexico. Therefore, the recreational workgroup decided to leave the Monroe county landings in the Gulf of Mexico as part of the official MRFSS West Florida estimate.

Missing cells in MRFSS weight estimates

MRFSS landings estimates in weight must be treated with caution due to the occurrence of missing fish mean weight estimates in some strata. MRFSS weight estimates are calculated by multiplying the estimated number harvested in a cell (year/wave/state/mode/area/species) by the mean weight of the measured fish in that cell. When there are no fish measured in the cell (fish were gutted or too big for the sampler to weigh, harvest was all self-reported, etc.) estimates of landings in number are provided but there are no corresponding estimates of landings in weight.

The MRFSS Spanish mackerel estimates of landings in weight are used when provided by the survey. In cases where there is an estimate of landings in number but not weight, the Southeast Fisheries Science Center has used the MRFSS sample data to obtain an average weight using the following hierarchy: species, region, year, state, mode, and wave (SEDAR 22-DW16). The minimum number of weights used at each level of substitution is 30 fish, except for the final species level, where the minimum is 1 fish. In some cases, the MRFSS sample data records length, but not weight. These lengths were converted to weights using length weight equations developed by the Life History Working Group. These converted weights were used only in cases where having these additional converted weights would increase the number of weights available at each hierarchy level to meet the 30 fish minimum. Average weights are then multiplied by the landings estimates in number to obtain estimates of landings in weight. These estimates are provided in pounds whole weight.

1981, wave 1

MRFSS began in 1981, wave 2. In the Gulf of Mexico and east coast of Florida, catch needs to be estimated for 1981, wave 1. This gap was filled by determining the proportion of wave 1 to other waves in years 1982-1984 by fishing mode and area. These proportions were then used to estimate wave 1 in 1981 from the estimated catches in other waves of that year. (SEDARs 10 and 12 gag and red grouper).

Texas

Texas data from the MRFSS is only available from 1981-1985 and is sporadic, not covering all modes and waves. Boat mode estimates from Texas were eliminated from the MRFSS. Instead, TPWD data, which covers charter and private modes, was used to fill in theses modes prior to the start of the TPWD survey in May 1983. This method has been used in past SEDARs (king mackerel, red snapper). The only shore mode estimates available from Texas from any data source are from the MRFSS. These estimates seemed reasonable and were kept. Hurricane Alicia in 1983 may have affected the shore mode landings in Texas in 1984 and 1985. The lack of shore mode estimates from Texas 1986+ was discussed but there is no reasonable method available to fill in that gap.

Catch Estimates

Final MRFSS/MRIP landings estimates are shown in tables 4.11.1 and 4.11.2 by year and mode and in Figure 4.12.2.

Maps

Figures 4.12.3, 4.12.4, and 4.12.5 show the number of Spanish mackerel intercepted by the MRFSS from 1981-1989, 1990-1999, and 2000-2010 respectively. Numbers of fish mapped are intercepted by the survey as an A fish (seen by the interviewer) or a B1 fish (reported dead but not seen by the interviewer). Latitude and longitudes of the intercept site are mapped when available; otherwise, the mid-point of the county of intercept is mapped. Intercepted fish are shown for the Gulf of Mexico and Atlantic Ocean.

4.3.2 Southeast Region Headboat Survey (SRHS)

Introduction

The Southeast Region Headboat Survey estimates landings and effort for headboats in the South Atlantic and Gulf of Mexico. The Headboat Survey was started in 1972 but only included vessels from North Carolina and South Carolina until 1975. In 1976 the survey was expanded to northeast Florida (Nassau-Indian River counties) and Georgia, followed by southeast Florida (St. Lucie-Monroe counties) in 1978. The SRHS began in the Gulf of Mexico in 1986 and extends from Naples, FL to South Padre Island, TX. Due to headboat area definitions, West Florida and Alabama landings are combined. The South Atlantic and Gulf of Mexico Headboat Surveys generally include 70-80 vessels participating in each region annually.

The Headboat Survey incorporates two components for estimating catch and effort. 1) Information about the size of fishes landed are collected by port samplers during dockside sampling, where fish are measured to the nearest mm and weighed to the nearest 0.01 kg. These data are used to generate mean weights for all species by area and month. Port samplers also collect otoliths for ageing studies during dockside sampling events. 2) Information about total catch and effort are collected via the logbook, a form filled out by vessel personnel and containing total catch and effort data for individual trips. These logbooks are summarized by vessel to generate estimated landings by species, area, and time strata.

Issue 1: Gulf of Mexico Spanish mackerel headboat landings prior to 1986: From 1981-1985 headboat landings were combined with MRFSS charter boat landings for FLW to LA.

Option 1: Start headboat time series in 1986 when the SRHS began in the Gulf of Mexico.

Option 2: Use combined MRFSS charter\headboat mode estimates for FLW to LA to take headboat estimates back to 1981 for recreational Spanish mackerel landings in the Gulf of Mexico.

Decision: Option 2

Issue 2: Texas Spanish mackerel headboat landings 1981 to 1985: From 1981 to 1985 Texas was not included in the MRFSS charter\headboat combined landings 1981 -1985.

Option 1: Use the average Texas headboat landings for Spanish mackerel from 1986 to 1988 for years prior to the start of the SRHS, 1981 to 1985.

Option 2: Start headboat landings time series in 1986 when the SRHS began in the Gulf of Mexico.

Decision: Option 1

Catch Estimates

Final SRHS landings estimates are shown in Table 4.11.3 by year and state and in Figure 4.12.6 SRHS areas 18-28 are included in the Gulf of Mexico Spanish mackerel stock. Figures 4.12.7, 4.12.8, and 4.12.9 show the Gulf of Mexico Spanish mackerel headboat landings from 1986-1989, 1990-1999, and 2000-2011 respectively. Headboat landings of Spanish mackerel in the Gulf of Mexico, from the 1980's to present, have mostly been concentrated in three areas: southwest Florida, Louisiana, and Texas. Catch of Spanish mackerel was evenly distributed between these areas in the 1980s (Figure 4.12.7), however, since 1990 headboat landings of Spanish mackerel have declined and shifted between these areas in the Gulf of Mexico (Figures 4.12.8 and 4.12.9).

Mississippi headboats were added to the SRHS in 2010. These headboats are smaller vessels that carry 10-15 anglers and combine trolling trips with bottom fishing trips. The MS vessels running these types of trips accounted for the increased landings of Spanish mackerel in the GOM for 2011.

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 includes information on catch, effort and length composition of the catch for sampled boat-trips. These data are used by TPWD to generate recreational catch and effort estimates. The survey is designed to estimate landings and effort by high-use (May 15-November 20) and low-use seasons (November 21-May 14). SEFSC personnel disaggregates the TPWD seasonal estimates into waves (2 month period) using the TPWD intercept data, in order to be compatible with MRFSS. Only private boat and charter boat fishing are surveyed. Most of the sampled trips are private boats fishing in bay/pass because these represent most of the fishing effort, but all trips (private, charter boat, ocean, bay/pass) are sampled. Charter boat 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. TPWD length-weight equations were applied to the lengths in order to obtain weights. In order to obtain estimated landings in weight, a similar method used to fill in the missing weights in MRFSS (described above) is applied to the TPWD landings. The hierarchy used for TPWD is expanded to include area fished (species, region, year, state, mode, wave, and area). This is equivalent to the MRFSS estimate of weight provided by that survey.

1981-1983 Texas estimates

The TPWD survey begins with the high-use season in 1983 (May15, 1983). Charter and private mode estimates need to be filled in for this state and these modes back to 1981. Averages from TPWD 1983-1985 were used by mode and wave to fill in the missing estimates. In addition, headboat landings from TX from 1981-1985 are not covered by any survey. As discussed above, SRHS 1986-1988 average landings were used to fill in this time period.

Catch Estimates

Final TPWD landings estimates are shown in table 4.11.4 by year and mode and in Figure 4.12.10.

Maps

Figures 4.12.11, 4.12.12, and 4.12.13 show the number of Spanish mackerel intercepted by the TPWD from 1983-1989, 1990-1999, and 2000-2010 respectively. Numbers of fish intercepted by the survey are mapped by Texas major bay areas. They are Sabine Lake, Galveston, Matagorda, San Antonio, Aransas, Corpus Christi, Upper Laguna Madre, and Lower Laguna Madre.

4.3.4 Historic Recreational Landings

Introduction

The historic recreational landings time period is defined as pre-1981 for the charter boat, headboat, private boat, and shore fishing modes, which represents the start of the Marine Recreational Fisheries Statistics Survey (MRFSS) and availability of landings estimates for Spanish mackerel. The Recreational Working Group was tasked with evaluating other potential historical sources and methods to compile landings of Spanish mackerel prior to the available time series of MRFSS and headboat estimated landings.

The sources of historical landings that were reviewed for potential use are as follows:

- Salt Water Angler Surveys (SWAS),1960, 1965 &1970.

- The U.S Fish and Wildlife Service (USFWS), 2001 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation Survey (FHWAR).

SWAS
During the SEDAR 28 data workshop the RWG reviewed the Salt Water Angler Surveys (SWAS) from 1960, 1965 &1970. The workgroup noted that the salt-water angling survey estimates for Spanish mackerel are on the order of 6 times those in recent years. These high estimates have been attributed to recall bias and possible exaggeration of catches by anglers (SWAS 1960). This may have been compounded further by the small sample size of salt water angler interviews conducted in these surveys. The average interview sample size for the three surveys was 0.0002% of total estimated saltwater anglers in the United States. The changes in methodology were also discussed by the RWG as part of the overall discussion of using this method.

FHWAR census method
The 2001 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation Survey presented summary tables of U.S. population estimates, along with estimates of hunting and fishing participation and effort from surveys conduct by the USFWS every 5 years from 1955 to 1985. (Table 4.11.5). This information was used to develop an alternative method for estimating recreational landings prior to 1981.

The two key components from these FHWAR surveys that were used in the census method were the estimates of U.S. saltwater anglers and the estimates of U.S. saltwater days. The first objective was to determine the total saltwater anglers and saltwater days for the Gulf of Mexico (GOM) by using the summary information of U.S. anglers and U.S. saltwater anglers from the FHWAR surveys. The ratio of U.S saltwater anglers to the total U.S anglers was applied to the total number of anglers for the GOM to yield the total saltwater anglers for the GOM. The same method was used to calculate the total saltwater days for the GOM from the FHWAR surveys from 1955-1985.

The FHWAR surveys included the entire state of Florida, east and west coasts, and the South Atlantic. In order to address the management boundaries for Spanish mackerel the saltwater angler days for Florida's west coast (FLW) were separated from Florida's east coast (FLE) saltwater angler days using the ratio of the MRFSS total angler trips for FLW to the MRFSS total angler trips for the GOM (TX to AL). The average ratio from 1983-1985 was applied to the total saltwater days for the 1955-1985 to include FLW effort.

Similar to the SWAS there was a 12 month recall period for respondents, which resulted in greater reporting bias. Research concluded this bias resulted in overestimates of both the catch and effort estimates in the FHWAR surveys from 1955 to 1985. Consequently, an adjustment for recall bias was necessary. The total saltwater days for the GOM 1955-1985 were adjusted for recall bias in the FHWAR surveys. The MRFSS total angler trips for the GOM 1983 to1985 was averaged and divided by the total saltwater days for 1985 from the FHWAR survey. This multiplier was then applied to the total GOM saltwater days 1955-1985 to adjust for recall bias.

The mean CPUE for Spanish mackerel in the Gulf of Mexico from the MRFSS estimates from 1981 to 1985 was then applied to the adjusted saltwater angler days for the GOM 1955-1985 to estimate the historical Spanish mackerel landings for those years (Table 4.11.5).

A bootstrap analysis was used to capture the range of uncertainty in the historic recreational catch estimates. More specifically, the historic catch estimates are based on the average CPUE and the ratio of MRFSS effort to historic effort estimates. These two quantities were bootstrapped 200 times using the empirical estimates that went into each of them. The 5th and 95th percentiles were then computed from the distribution of bootstrap estimates to characterize the uncertainty (Figure 4.12.14).

Issue: Available historical Spanish mackerel landings limited 1950-1980.

Option 1: Use the Adjusted SWAS Spanish mackerel estimated landings.

Option 2: Use average ratio from entire time series (1981-2010) applied to commercial landings to estimate recreational landings (1950-1980).

Option 3: Use available recreational time series for the MRFSS\MRIP and headboat estimates 1981- 2010.

Option 4: Total Spanish mackerel landings using the FHWAR census method (GOM 1955-1980) are presented with the total estimated Spanish mackerel landings (MRFSS/MRIP and SRHS landings) (GOM 1981-2011) in Table 4.11.6 and Figure 4.12.15.

Decision: *Option 4*

4.4 Recreational Discards

4.4.1 MRFSS discards

Discarded live fish are reported by the anglers interviewed by the MRFSS so both the identity and quantities reported are unverified. Discarded fish size is unknown for all modes of fishing covered by the MRFSS. At-sea sampling of headboat discards was initiated as part of the improved for-hire surveys to characterize the size distribution of live discarded fishes in the headboat fishery, however, the Beaufort, NC Logbook program (SRHS) produces estimates of total discards in the headboat fishery since that class of caught fish was added to their logbook (2004). All estimates of live released fish (B2 fish) in charter or charter boat/headboat combined mode were adjusted in the same manner as the landings (calibration factors, substitutions, etc. described above in section 4.3.1). Size or weight of discarded fishes is not estimated by the MRFSS. Final MRFSS/MRIP discard estimates are shown in Table 4.11.7 by year and mode and in Figure 4.12.16.

4.4.2 Headboat Logbook Discards

The Southeast Region Headboat Survey logbook form was modified in 2004 to include a category to collect self-reported discards for each reported trip. This category is described on the form as the number of fish by species released alive and number released dead. Port agents instructed each captain on criteria for determining the condition of discarded fish. A fish is considered "released alive" if it is able to swim away on its own. If the fish floats off or is obviously dead or unable to swim, it is considered "released dead". These self-reported data are currently not validated within the Headboat Survey. Due to low Spanish mackerel sample sizes in the MRFSS At-Sea Observer Headboat program, it was determined that the logbook discard data would be used from 2004-2011. The RWG further concluded that a proxy should be used to estimate the headboat Spanish mackerel discards for previous years. The RWG considered the following two possible data sources to be used as a proxy for estimated headboat discards for 1981-2003 (Figure 4.12.17).

- MRFSS charter boat discard estimates (corrected for FHS adjustment) applied– Extend back to 1981.
- MRFSS private boat discard ratio estimates– Extend back to 1981 and follows the pattern exhibited in the Southeast Region Headboat Survey in later years.

Issue: Proxy for estimated headboat discards from 1981-2003.

Option 1: Apply the MRFSS charter boat discard:landings ratio to estimated headboat landings in order to estimate headboat discards from 1981-2003.
Option 2: Apply the MRFSS private boat discard:landings ratio to estimated headboat landings in order to estimate headboat discards from 1981-2003.
Option 3: Calculate a ratio of the mean ratio of SRHS discard:landings (2004-2011) to the mean ratio of MRFSS CH discard:landings (2004-2011). Apply this ratio to the yearly MRFSS charter boat discard:landings ratio (1981-2003) in order to estimate the yearly SRHS discard:landings ratio (1981-2003). This ratio is then applied to the SRHS landings (1981-2003) in order to estimate headboat discards (1981-2003).

Decision: Option 3. Calculate a ratio of the mean ratio of SRHS discard:landings (2004-2010) to the mean MRFSS CH discard:landings ratio (2004-2010). Apply this ratio to the yearly MRFSS charter boat discard:landings ratio (1981-2003) in order to estimate the yearly SRHS discard:landings ratio (1981-2003). This ratio is then applied to the SRHS landings (1981-2003) in order to estimate headboat discards (1981-2003). The MRFSS charter boat discard estimates followed the pattern exhibited in the SRHS in later years. Because the MRFSS charter boat discard ratio was greater than the SRHS discard ratio, using the MRFSS charter boat ratio without the adjustment described in Option 3 could result in overestimating the SRHS discards. Headboat discard estimates for Texas in 1981-1985 were estimated in the same manner as the landings, using the mean of the resulting discard estimates from 1986-1988.

Final discard estimates from the SRHS are shown in Table 4.11.8 by year and state and in Figure 4.12.18.

4.4.3 Headboat At-Sea Observer Survey Discards

An observer survey of the recreational headboat fishery was run in some Gulf region states to collect more detailed information on recreational headboat catch, particularly for discarded fish.

The survey was conducted in Alabama from 2004 to 2007, in West Florida from 2005-2007, and in East Florida from 2005 to the present. Headboat vessels are randomly selected throughout the year in each state, and the east coast of Florida is further stratified into northern and southern sample regions. Biologists board selected vessels with permission from the captain and observe anglers as they fish on the recreational trip. Data collected include number and species of fish landed and discarded, size of landed and discarded fish, and the release condition of discarded fish (FL only). Biological samples such as scales, otoliths, spines, stomachs and gonads, are not typically collected as part of this protocol. Data are also collected on the 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 run trips that span more than 24 hours are also sampled to collect information on trips that fish farther offshore and for longer durations, primarily in the vicinity of the Dry Tortugas. Due to low Spanish mackerel sample sizes the MRFSS At-Sea Observer data was not used in this assessment.

4.4.4 Texas Parks and Wildlife Department Discards

The TPWD recreational survey does not estimate discards. The recreational workgroup looked at the data available and decided to use a Gulf wide ratio from the MRFSS by mode (charter and private) and apply it to the TPWD landings in order to estimate discards from Texas. Similar methods have been used in past SEDARs (red snapper). Discard estimates for Texas charter and private modes are shown in Table 4.11.9 by year and mode and in Figure 4.12.19.

4.4.5 Alternatives for characterizing discards

Due to low Spanish mackerel sample sizes in the MRFSS At-Sea Observer data it was concluded that the headboat logbook discard estimates should be used from 2004-2011 for the Gulf of Mexico headboat fishery. Further, the group decided to use the charter mode as a proxy to calculate headboat discards for 1981-2003, since the discard rates from the longer time series of MRFSS reflect historic changes in discard rates. These rates include the impacts from changes in recreational size limits and bag limits for Spanish mackerel over time.

4.5 Biological Sampling

4.5.1 Sampling Intensity Length/Age/Weight

MRFSS Charter, Private, and Shore

The MRFSS' angler intercept survey includes the collection 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, e.g., Spanish mackerel, and in those fish that do not have a forked tail it would typically be referred to as a total length with the exception of some fishes that have a single, or few, caudal fin rays that extend further. Weights are typically collected for the same fish measured although weights are preferred when time is constrained. Ageing structures and other biological samples are not collected during MRFSS assignments because of concerns over the introduction of bias to survey data collection.

The number of Spanish mackerel measured or weighed in the Gulf of Mexico (FLW-TX) in the MRFSS charter fleet, private-rental mode, and shore mode are summarized by year and state in tables 4.11.10, 4.11.11, and 4.11.12, respectively. The number of angler trips with measured or weighed Spanish mackerel in the Gulf of Mexico (FLW-TX) in the MRFSS charter fleet, private-rental mode, and shore mode are summarized by year and state in tables 4.11.13, 4.11.14, and 4.11.15, respectively. The number of MRFSS intercept trips conducted in the Gulf of Mexico (FLW-TX) and the percentage of intercepts that encountered Spanish mackerel are summarized by year and mode in Table 4.11.16. Dockside mean weights of Spanish mackerel weighed from the MRFSS in the Gulf of Mexico (FLW-TX) are tabulated for 1981-2011 in Table 4.11.17.

Headboat Survey Biological Sampling

Lengths were collected from 1986 to 2011 by headboat dockside samplers in the Gulf of Mexico. Mississippi was added to the survey 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.

Annual numbers of Spanish mackerel measured for length in the headboat fleet and the number of trips from which Spanish mackerel were measured are summarized in Table 4.11.18. The number of Spanish mackerel aged from the headboat fleet by year and state are summarized in Table 4.11.19. Dockside mean weights for the headboat fishery are tabulated for 1986-2011 in Table 4.11.20.

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. Weight of sampled fish is not recorded.

The number of Spanish mackerel measured in the TPWD charter and private-rental modes are summarized by year in table 4.11.21. The number of trips with measured Spanish mackerel in the TPWD charter and private-rental modes are summarized by year in table 4.11.22. The number of TPWD intercept trips conducted in Texas and the percentage of intercepts that encountered Spanish mackerel are summarized by year and mode in Table 4.11.23.

Aging data

The number of Spanish mackerel aged from the SRHS by year and state is summarized in Table 4.11.19. Age samples collected from the private/rental boat, charter boat, and shore modes are not typically collected as part of the MRFSS sampling protocol. These samples come from a number of sources including state agencies, special projects, and sometimes as add-ons to the MRFSS survey. The number of Spanish mackerel aged from the charter boat fleet by year and state is summarized in Table 4.11.24. The number of Spanish mackerel aged from the private fleet by year and state is summarized in Table 4.11.25. The number of Spanish mackerel aged from the recreational fishery (mode unknown) by year and state is summarized in Table 4.11.26. In some cases mode of catch was either not recorded or the samples were taken from tournament weigh stations where trip information was not collected. It was not possible to determine the number of trips from which age samples were taken for approximately half of the age samples. Therefore number of trips with age samples was not reported.

4.5.2 Length – Age distributions

MRFSS and TPWD Length Frequency Analysis Protocol

The angler intercept survey is stratified by wave (2-month period), state, and fishing mode (shore, charter boat, party boat, private or rental boat) so simple aggregations of fish lengths across strata cannot be used to characterize a regional, annual length distribution of landed fish; a weighting scheme is needed to representatively include the distributions of each stratum value. The MRFSS' angler intercept length frequency analysis produces unbiased estimates of length-class frequencies for more than one stratum by summing respectively weighted relative length-class frequencies across strata. The steps used are:

1) Output a distribution of measured fish among state/mode /wave strata,
2) Output a distribution of estimated catch among state/mode/wave strata,
3) Calculate and output relative length-class frequencies for each state/mode/wave stratum,
4) Calculate appropriate relative weighting factors to be applied to the length-class frequencies for each state/mode/ wave stratum prior to pooling among strata,
5) Sum across strata as defined, e.g., annual, sub-region length frequencies, by year in 1-cm length bins.
6) Convert to annual proportion in each size bin (Figure 4.12.20).

Lengths were taken from the MRFSS (charter boat, private/rental boat, and shore modes) during 1981 to 2011. The number of vessel trips sampled were not available from the MRFSS. Lengths from the TPWD survey were converted to fork length using the equation FL = 0.8816*(TL) – 11.82 as recommended by the SEDAR 28 DW panel.

Southeast Region Headboat Survey Length Frequency Analysis Protocol

Headboat landings (1983 to 2011) were pooled across five time intervals (Jan-May, Jun, July, Aug, Sep-Dec) because landings were not estimated by month until 1996. Spatial weighting was developed by region for the headboat survey by pooling landings by region; western FL and AL, MS, LA, and TX. For each measured fish a landings value was assigned based on month of capture and region. The landings associated with each length measurement were summed by year in 1-cm length bins. These landings are typically then converted to annual proportion in each size bin (Figure 4.12.21).

Recreational Age Frequency

Age compositions were calculated for the charter, private/rental, and recreational (unknown mode) fisheries (Figure 4.12.22) and for the headboat fishery (Figure 4.12.23). Ages 0-10 were plotted for the charter, private/rental, and recreational (unknown mode) fisheries. Ages 0-7 were plotted for the headboat fishery.

It was not possible to determine the number of trips from which age samples were taken for approximately half of the age samples. Therefore number of trips with age samples was not reported.

4.6 Recreational Catch-at-Age/Length; directed and discard

Catch at age is handled within the assessment model and does not require discussion or presentation here.

4.7 Recreational Effort

4.7.1 MRFSS Recreational & Charter Effort

Effort estimation for the recreational fishery surveys are produced via telephone surveys of both anglers (private/rental boats and shore fishers) and for-hire boat operators (charter boat 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). Angler trip estimates are tabulated in table 4.11.27 by year and mode. An angler-trip is a single day of fishing in the specified mode, not to exceed 24 hours.

Figures 4.12.24, 4.12.25, and 4.12.26 show the number of angler trips that intercepted Spanish mackerel from the MRFSS from 1981-1989, 1990-1999, and 2000-2010 respectively. Latitude and longitudes of the intercept site are mapped when available; otherwise, the mid-point of the county of intercept is mapped. Intercepted trips that caught Spanish mackerel are shown for the Gulf of Mexico and Atlantic Ocean.

4.7.2 Headboat Effort

Catch and effort data are reported on logbooks provided to all headboats in the survey. These forms are completed by the captain or designated crew member after each trip and represent the total number and weight of all the species kept, along with the total number of fish discarded for each species. Data on effort are provided as number of anglers on a given trip. 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). 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.

Figures 4.12.27, 4.12.28, and 4.12.29 show the Gulf of Mexico Spanish mackerel positive headboat trips from 1980-1989, 1990-1999, and 2000-2011 respectively. During the 1980s and 1990s, Louisiana and north Texas also showed concentrations of Spanish mackerel positive trips on headboats (Figures 4.12.27 and 4.12.28). In more recent years from 2000-2011, positive

Spanish mackerel trips were concentrated off Louisiana and the west coast of Florida (Figures 4.12.29).

Estimated headboat angler days have decreased in the Gulf of Mexico in recent years (Table 4.11.28). The most obvious factor which impacted the headboat fishery in both the Atlantic and Gulf of Mexico was the high price of fuel. This coupled with the economic down turn starting in 2008 has resulted in a marked decline in angler days in the Gulf of Mexico headboat fishery. Reports from industry staff, captains\owners, and port agents indicated fuel prices, the economy and fishing regulations are the factors that most affected the amount of trips, number of passengers, and overall fishing effort. Also important to note, is the noticeable decrease in effort in Louisiana, Alabama and west Florida due to the Deepwater Horizon oil spill in the Gulf of Mexico in 2010.

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 boat and charter boat fishing are surveyed. Most of the sampled trips are private boats fishing in bay/pass because these represent most of the fishing effort, but all trips (private, charter boat, ocean, bay/pass) are sampled. Charter boat trips in ocean waters are the least encountered in the survey.

Estimates of TPWD angler trips are shown in table 4.11.29 by year, season, and mode. Figures 4.12.30, 4.12.31, and 4.12.32 show the number of angler hours from trips that intercepted Spanish mackerel from the TPWD from 1983-1989, 1990-1999, and 2000-2010 respectively. Angler hours are mapped by Texas major bay areas. They are Sabine Lake, Galveston, Matagorda, San Antonio, Aransas, Corpus Christi, Upper Laguna Madre, and Lower Laguna Madre.

4.8 Comments on adequacy of data for assessment analyses

Regarding the adequacy of the available recreational data for assessment analyses, the RWG discussed the following:

- Landings, as adjusted, appear to be adequate for the time period covered.
- Size data appear to adequately represent the landed catch for the charter and headboat sector.

4.9 Literature Cited

Matter, V. and S. Turner 2010. Estimated Recreational Catch in Weight: Method for Filling in Missing Weight Estimates from the Recreational Surveys with Application to Yellowedge Grouper, Tilefish (golden), and Blueline Tilefish (SEDAR 22-DW16), National Marine Fisheries Service, Southeast Fisheries Science Center, Sustainable Fisheries Division (SFD-2010-003).

Historical Fisheries Working Group (HFWG) 2010. SEDAR24-DW11, Estimation of Historic Recreational Landings 2010.

Clark, J.R. 1962. The 1960 Salt-Water Angling Survey. U.S. Department of the Interior, Bureau of Sport Fisheries and Wildlife, Circular 153, 36 pp.

Deuel, D.G. 1973. The 1970 Salt-Water Angling Survey. U.S. Department of Commerce, National Marine Fisheries Service, Current Fishery Statistics No. 6200, 54 pp.

Deuel, D.G. and J.R. Clark. 1968. The 1965 Salt-Water Angling Survey. U.S. Department of the Interior, Bureau of Sport Fisheries and Wildlife, Resource Publication 67, 51 pp.

4.10 Tables

Table 4.11.1. Gulf of Mexico (FLW-LA) Spanish mackerel landings (numbers of fish and whole weight in pounds) for charter boat mode and charter boat/headboat mode (MRFSS, NMFS, 1981-2003; MRIP, NMFS, 2004-2011). CH and CH/HB mode adjusted for FHS conversion prior to 1997. CH/HB mode landings from 1981-1985 only. 2011 data is preliminary and through October.

	Estimated CH Landings			Estimated CH/HB Landings		
YEAR	Number	CV	Pounds	Number	CV	Pounds
1981				942,170	0.33	999,274
1982				1,569,489	0.29	1,846,794
1983				582,555	0.39	826,316
1984				385,137	0.25	503,035
1985				388,053	0.25	533,690
1986	354,699	0.25	482,316			
1987	335,781	0.22	495,719			
1988	125,666	0.36	205,167			
1989	196,290	0.22	305,182			
1990	203,674	0.25	370,623			
1991	86,893	0.21	211,477			
1992	99,051	0.26	158,410			
1993	76,330	0.24	125,521			
1994	166,952	0.23	220,634			
1995	337,320	0.24	532,316			
1996	130,534	0.27	190,518			
1997	159,434	0.38	333,330			
1998	127,348	0.09	234,461			
1999	121,573	0.10	238,184			
2000	213,272	0.11	366,095			
2001	170,786	0.09	278,357			
2002	131,692	0.10	254,485			
2003	171,765	0.10	302,770			
2004	146,385	0.20	194,663			
2005	68,578	0.20	123,791			
2006	307,135	0.20	562,234			
2007	179,424	0.18	327,774			
2008	226,053	0.23	350,013			
2009	226,333	0.24	305,900			
2010	131,864	0.16	250,844			
2011	275,494	0.12	427,721			

Table 4.11.2. Gulf of Mexico (FLW-TX) Spanish mackerel landings (numbers of fish and whole weight in pounds) for private/rental boat mode and shore mode (MRFSS, NMFS, 1981-2003; MRIP, NMFS, 2004-2011). TX landings for shore mode from 1981-1985 only. 2011 data is preliminary and through October.

	Estimated PR Landings			Estimated SH Landings		
YEAR	Number	CV	Pounds	Number	CV	Pounds
1981	793,825	0.22	935,490	353,215	0.28	349,489
1982	1,576,510	0.29	1,569,107	283,874	0.18	391,016
1983	1,222,084	0.24	1,441,054	614,142	0.23	787,227
1984	272,316	0.27	395,700	272,610	0.34	386,743
1985	532,221	0.17	626,199	246,748	0.26	321,479
1986	2,536,448	0.12	2,590,750	3,498,704	0.25	3,703,806
1987	824,869	0.09	1,509,214	608,050	0.18	829,874
1988	1,070,955	0.10	1,555,563	258,849	0.19	359,773
1989	694,372	0.09	1,106,122	236,696	0.17	210,012
1990	703,798	0.10	1,241,017	678,748	0.13	860,659
1991	1,043,554	0.09	1,592,566	576,463	0.16	734,535
1992	988,084	0.05	1,588,078	1,296,872	0.08	1,737,928
1993	356,467	0.10	696,190	1,050,065	0.09	1,098,361
1994	424,917	0.08	624,728	817,555	0.07	974,511
1995	313,021	0.14	688,173	396,766	0.14	489,486
1996	463,174	0.11	781,511	638,295	0.12	727,071
1997	494,843	0.15	1,039,336	591,042	0.12	704,404
1998	404,157	0.11	821,234	632,420	0.12	840,299
1999	630,435	0.09	1,085,320	823,952	0.09	1,017,865
2000	584,505	0.10	1,185,553	916,551	0.09	1,383,914
2001	772,196	0.09	1,313,957	1,534,160	0.09	1,957,295
2002	721,118	0.09	1,480,183	1,109,254	0.09	1,467,450
2003	572,993	0.08	1,189,324	759,608	0.11	1,122,474
2004	834,347	0.11	1,314,717	1,144,339	0.17	1,239,844
2005	665,629	0.15	1,097,404	457,444	0.24	539,439
2006	677,614	0.11	1,182,120	773,926	0.28	755,261
2007	557,693	0.10	977,828	593,883	0.17	715,410
2008	1,027,872	0.22	1,961,999	642,929	0.31	631,962
2009	681,267	0.18	1,105,777	595,596	0.22	661,319
2010	606,458	0.12	1,012,579	826,898	0.16	1,282,606
2011	520,844	0.15	728,938	611,632	0.16	767,059

Table 4.11.3. Estimated headboat landings of Spanish mackerel in the Gulf of Mexico 1981-2011. Due to headboat area definitions, West Florida and Alabama landings are combined.

	FLW/AL		MS*		LA**		TX†		Gulf of Mexico	
Year	Number	Weight (lb)	Number	Weight (lb)	Number	Weight (lb)	Number	Weight (lb)	Number	Weight (lb)
1981							153	478	153	478
1982							153	478	153	478
1983							153	478	153	478
1984							153	478	153	478
1985							153	478	153	478
1986	278	546			29	18	84	305	391	869
1987	455	1,215			671	1,808	204	551	1,330	3,574
1988	44	133			113	300	170	484	327	918
1989	201	184			150	292	211	492	562	967
1990	639	1,543			137	361	101	261	877	2,165
1991	489	708			845	1,600	385	3,238	1,719	5,546
1992	480	1,169			558	1,526	304	823	1,342	3,517
1993	277	628			80	191	212	486	569	1,305
1994	815	2,246			382	978	406	993	1,603	4,217
1995	147	476			550	1,859	183	585	880	2,921
1996	198	471			231	388	212	598	641	1,457
1997	187	407			303	1,071	50	139	540	1,617
1998	277	444			41	143	18	73	336	659
1999	359	1,068			44	116	71	202	474	1,386
2000	411	1,230			46	167	60	178	517	1,576
2001	169	434			14	38	28	86	211	559
2002	169	448			14	27	82	164	265	639
2003	194	373			-	-	77	145	271	518
2004	241	418					20	32	261	449
2005	230	774					52	171	282	945
2006	264	639			-	-	128	314	392	953
2007	425	1,446			3	11	106	361	534	1,817
2008	542	1,367			22	50	70	179	634	1,596
2009	560	1,097			29	20	104	181	693	1,298
2010	279	294	1,288	1,318	-	-	30	31	1,597	1,642
2011	528	1,302	4,513	8,200	-	-	220	543	5,261	10,046

*MS added to survey in 2010.
**LA not sampled during 2004-2005 due to Hurricane Katrina.
†TX 1981-1985 landings estimated using the mean landings 1986-1988.

Table 4.11.4 Texas Spanish mackerel landings (numbers of fish and whole weight in pounds) for charter boat mode and private mode (TPWD). 2011 data is through mid-May.

	Estimated CH Landings		Estimated PR Landings		Total Landings	
year	Number	Pounds	Number	Pounds	Number	Pounds
1981	303	611	3,922	8,226	4,225	8,837
1982	303	611	3,922	8,226	4,225	8,837
1983	801	1,633	2,952	6,044	3,753	7,677
1984	98	180	5,472	11,096	5,570	11,276
1985	40	79	3,353	7,556	3,393	7,635
1986	76	157	2,448	5,117	2,524	5,274
1987	378	649	7,797	12,296	8,175	12,944
1988	95	179	1,291	2,432	1,386	2,610
1989	34	51	2,526	4,142	2,560	4,193
1990	172	296	3,274	5,547	3,446	5,843
1991	357	737	9,626	23,599	9,983	24,336
1992			2,561	6,996	2,561	6,996
1993	223	444	1,417	2,692	1,640	3,136
1994	186	372	5,336	11,554	5,522	11,927
1995	86	231	8,401	24,231	8,487	24,462
1996	15	35	9,234	24,111	9,249	24,146
1997	264	543	5,070	11,475	5,334	12,018
1998	27	66	5,545	13,953	5,572	14,018
1999	223	529	4,403	11,888	4,626	12,417
2000	262	601	5,119	13,934	5,381	14,535
2001	7	14	1,465	2,937	1,472	2,951
2002	896	1,909	3,685	7,814	4,581	9,723
2003	214	523	4,356	10,851	4,570	11,374
2004	43	90	8,293	18,133	8,336	18,223
2005	232	529	7,926	18,657	8,158	19,185
2006	823	2,286	9,336	21,381	10,159	23,667
2007	603	2,037	6,529	14,810	7,132	16,847
2008	133	266	2,443	5,554	2,576	5,820
2009	64	142	4,912	11,313	4,976	11,455
2010	264	451	11,175	22,361	11,439	22,812
2011	880	1,203	474	648	1,354	1,850

Table 4.11.5. FHWAR estimation method for historical recreational Spanish mackerel landings in the Gulf of Mexico (1955-1985).

Year	US saltwater angler days	Proportion anglers GOM	Saltwater angler days (GOM)	Mean CPUE (MRFSS 1981-1985)	Recall bias adjustment	Adjusted saltwater days (GOM)	Adjusted Spanish mackerel landings (n)
1955	58,621,000	0.19	17,551,372	0.11	0.40	7,034,684	774,329
1960	80,602,000	0.21	27,144,209	0.11	0.40	10,879,544	1,197,544
1965	95,837,000	0.19	29,581,307	0.11	0.40	11,856,346	1,305,064
1970	113,694,000	0.20	35,428,990	0.11	0.40	14,200,129	1,563,051
1975	167,499,000	0.19	51,531,494	0.11	0.40	20,654,099	2,273,458
1980	164,040,000	0.20	51,984,003	0.11	0.40	20,835,467	2,293,422
1985	171,055,000	0.20	54,291,623	0.11	0.40	21,760,373	2,395,229

Table 4.11.6. Gulf of Mexico estimated recreational Spanish mackerel landings (number) using FHWAR census method (1955-1980), MRFSS (1981-2003), MRIP (2004-2011),TPWD (81-11), and SRHS (81-11) estimation methods.

Year	Estimated landings (n)	Year	Estimated landings (n)
1955	774,329	1984	935,785
1956	858,972	1985	1,170,567
1957	943,615	1986	6,392,766
1958	1,028,258	1987	1,778,205
1959	1,112,901	1988	1,457,183
1960	1,197,544	1989	1,130,480
1961	1,219,048	1990	1,590,542
1962	1,240,552	1991	1,718,612
1963	1,262,056	1992	2,387,911
1964	1,283,560	1993	1,485,071
1965	1,305,064	1994	1,416,548
1966	1,356,661	1995	1,056,474
1967	1,408,258	1996	1,241,893
1968	1,459,856	1997	1,251,192
1969	1,511,453	1998	1,169,834
1970	1,563,051	1999	1,581,061
1971	1,705,132	2000	1,720,226
1972	1,847,214	2001	2,478,825
1973	1,989,295	2002	1,966,911
1974	2,131,377	2003	1,509,207
1975	2,273,458	2004	2,133,669
1976	2,277,451	2005	1,200,092
1977	2,281,444	2006	1,769,226
1978	2,285,437	2007	1,338,667
1979	2,289,429	2008	1,900,065
1980	2,293,422	2009	1,508,864
1981	2,093,589	2010	1,578,256
1982	3,434,252	2011	1,414,585
1983	2,422,686		

Table 4.11.7. Gulf of Mexico (FLW-TX) Spanish mackerel discards for the recreational fishing modes by year (MRFSS, NMFS, 1981-2003; MRIP, NMFS, 2004-2011. CH and CH/HB mode adjusted for FHS conversion prior to 1997. CH/HB mode discards from 1981-1985 only. 2011 data is preliminary and through October. TX estimates for 1981-1985 shore mode only.

	Estimated CH Discards		Estimated CH/HB Discards		Estimated PR Discards		Estimated SH Discards	
YEAR	Number	CV	Number	CV	Number	CV	Number	CV
1981			6,371	1.00	28,533	0.46	42,872	0.43
1982			33,938	0.73	20,734	0.52	483,958	0.51
1983			0	0.00	33,953	0.46	1,144,786	0.61
1984			9,794	0.58	36,422	0.75	13,898	0.54
1985			393	1.00	76,648	0.45	63,611	0.45
1986	34,884	0.35			1,477,188	0.16	2,497,470	0.33
1987	11,982	0.88			208,933	0.16	191,520	0.36
1988	22,312	0.43			541,171	0.16	154,673	0.35
1989	81,812	0.37			279,559	0.22	134,107	0.34
1990	55,639	0.63			533,147	0.21	1,579,443	0.18
1991	10,840	0.37			409,828	0.14	813,299	0.27
1992	65,660	0.59			489,251	0.08	1,125,772	0.14
1993	51,089	0.48			185,858	0.15	812,998	0.13
1994	17,571	0.54			229,742	0.14	409,293	0.14
1995	49,663	0.39			256,240	0.46	257,388	0.23
1996	11,968	0.49			273,371	0.12	404,150	0.22
1997	48,643	0.38			263,843	0.15	541,915	0.18
1998	71,196	0.18			218,006	0.14	457,726	0.18
1999	23,635	0.18			479,096	0.10	731,813	0.09
2000	41,917	0.19			574,323	0.43	880,679	0.15
2001	41,348	0.30			633,266	0.09	1,170,206	0.11
2002	49,595	0.37			550,088	0.08	1,320,444	0.10
2003	38,521	0.13			789,883	0.10	1,382,511	0.13
2004	55,788	0.24			1,222,939	0.20	1,037,331	0.15
2005	21,159	0.20			809,693	0.21	542,023	0.23
2006	55,502	0.37			1,101,592	0.13	1,697,021	0.32
2007	53,778	0.25			705,093	0.14	1,345,546	0.32
2008	26,193	0.27			584,706	0.13	1,430,259	0.28
2009	99,643	0.50			799,311	0.14	736,605	0.17
2010	111,390	0.22			717,842	0.11	1,646,305	0.22
2011	97,599	0.22			704,535	0.14	911,046	0.27

Table 4.11.8. Estimated Gulf of Mexico Spanish mackerel discards for SRHS by year and state.† Due to headboat area definitions, West Florida and Alabama discards are combined.

Year	FLW\AL	MS*	LA**	TX†	Gulf of Mexico
1981				2	2
1982				2	2
1983				2	2
1984				2	2
1985				2	2
1986	-		-	-	-
1987	10		-	2	12
1988	0		-	-	0
1989	6		-	3	9
1990	29		-	-	29
1991	13		-	-	13
1992	8		-	1	8
1993	27		-	2	29
1994	72		-	-	72
1995	1		-	-	1
1996	4		-	1	5
1997	3		-	-	3
1998	16		-	0	16
1999	31		-	-	31
2000	9		-	0	9
2001	4		-	-	4
2002	5		-	1	5
2003	9		-	1	10
2004	-			-	-
2005	4			-	4
2006	15		-	4	19
2007	48		-	4	52
2008	11		-	-	11
2009	20		-	-	20
2010	8	10	-	-	18
2011	13	24	-	-	37

*MS added to survey in 2010.
**LA not sampled during 2004-2005 due to Hurricane Katrina.
†TX 1981-1985 discards estimated using the mean discards 1986-1988.

Table 4.11.9 Texas Spanish mackerel discards (numbers of fish) for charter boat mode and private mode (TPWD). 2011 data is through mid-May.

year	Estimated CH Discards	Estimated PR Discards	Total Discards
1981	1	271	272
1982	1	271	272
1983	0	87	87
1984	5	273	278
1985	0	456	457
1986	7	1,233	1,240
1987	11	1,202	1,213
1988	71	311	381
1989	11	815	825
1990	31	1,381	1,413
1991	54	3,235	3,288
1992		1,039	1,039
1993	51	524	574
1994	150	3,055	3,205
1995	58	5,341	5,399
1996	2	4,566	4,568
1997	58	1,966	2,024
1998	8	2,901	2,909
1999	28	2,960	2,988
2000	45	3,984	4,028
2001	1	921	922
2002	255	2,506	2,760
2003	40	4,140	4,180
2004	13	9,450	9,463
2005	44	7,033	7,077
2006	142	11,080	11,222
2007	203	5,420	5,623
2008	29	1,460	1,489
2009	25	3,959	3,984
2010	136	10,484	10,619
2011	464	659	1,123

Table 4.11.10. Number of Spanish mackerel measured or weighed in the Gulf of Mexico (FLW-LA) in the MRFSS charter fleet by year and state.

YEAR	LA	MS	AL	FLW	TOTAL
1981		53	17	34	104
1982		91	10	4	105
1983	1	250		35	286
1984	2	361		3	366
1985	2	146	5		153
1986	4	400	46	163	613
1987	6	271	81	211	569
1988	5	302	33	46	386
1989	2	337	44	62	445
1990	8	331	12	39	390
1991	24	248	36	26	334
1992	13	288	23	42	366
1993	5	20	18	57	100
1994	3	56	13	59	131
1995	11	34	7	200	252
1996	2	55	20	40	117
1997	6	113	7	321	447
1998	5	138	132	350	625
1999	4	475	550	475	1,504
2000	1	397	374	1,294	2,066
2001		332	162	1,799	2,293
2002	4	209	48	792	1,053
2003	5	182	42	807	1,036
2004	6	190	74	842	1,112
2005	1	71	31	373	476
2006	5	70	19	406	500
2007	6	140	108	450	704
2008	3	201	129	449	782
2009	15	210	89	345	659
2010		107	108	666	881
2011	2	197	227	907	1,333
Grand Total	151	6,275	2,465	11,297	20,188

Table 4.11.11. Number of Spanish mackerel measured or weighed in the Gulf of Mexico (FLW-TX) in the MRFSS private fleet by year and state. TX data for 1981-1985 only.

YEAR	TX	LA	MS	AL	FLW	TOTAL
1981	2	5	42	77	46	172
1982		45	77	73	53	248
1983		9	18	33	36	96
1984		11	8	19	5	43
1985	1	20	12	27	18	78
1986		8	16	147	121	292
1987		22	37	219	260	538
1988		34	28	56	133	251
1989		50	6	48	121	225
1990		32	4	92	138	266
1991		45	35	119	234	433
1992		107	54	212	613	986
1993		23	6	63	117	209
1994		11	16	61	199	287
1995		16	6	24	73	119
1996		16	5	72	258	351
1997		14	31	41	185	271
1998		2	18	49	382	451
1999		17	14	331	477	839
2000		10	14	134	323	481
2001		1	4	248	429	682
2002		5	8	89	498	600
2003		2	5	68	417	492
2004		3	4	126	557	690
2005		7	8	71	275	361
2006		13	6	87	429	535
2007		3	1	37	499	540
2008		6	6	67	407	486
2009		3	14	43	386	446
2010				67	519	586
2011		2	1	34	564	601
Grand Total	3	542	504	2,834	8,772	12,655

Table 4.11.12. Number of Spanish mackerel measured or weighed in the Gulf of Mexico (FLW-TX) in the MRFSS shore mode by year and state. TX data for 1981-1985 only.

YEAR	TX	LA	MS	AL	FLW	TOTAL
1981	1	2		2	28	33
1982	2	17	1	8	60	88
1983	1	4		103	29	137
1984	2			30	6	38
1985				1	35	36
1986				3	123	126
1987			1	51	93	145
1988				16	38	54
1989			1	43	33	77
1990		1		85	71	157
1991		1		50	46	97
1992		8	3	70	271	352
1993		6	7	35	235	283
1994		4		42	256	302
1995		5		13	64	82
1996				5	110	115
1997		3		11	201	215
1998		2		3	176	181
1999		1	1	38	325	365
2000				44	196	240
2001		1		34	388	423
2002			1	24	309	334
2003		1			184	185
2004		7		28	264	299
2005		1	1	13	154	169
2006		1		13	172	186
2007				15	243	258
2008					225	225
2009		3	1	4	275	283
2010			2	38	258	298
2011		1	1	35	272	309
Grand Total	6	69	20	857	5,140	6,092

Table 4.11.13. Number of angler trips with measured or weighed Spanish mackerel in the Gulf of Mexico (FLW-LA) in the MRFSS charter fleet by year and state.

YEAR	LA	MS	AL	FLW	TOTAL
1981		10	3	7	20
1982		14	1	3	18
1983	1	32		5	38
1984	1	44		2	47
1985	2	18	4		24
1986	3	51	10	26	90
1987	2	36	21	49	108
1988	5	47	13	21	86
1989	1	56	9	17	83
1990	5	61	6	10	82
1991	10	35	9	12	66
1992	9	35	13	15	72
1993	1	7	4	16	28
1994	3	9	7	12	31
1995	7	5	3	24	39
1996	1	11	4	16	32
1997	6	47	6	82	141
1998	3	22	24	103	152
1999	2	83	81	149	315
2000	1	51	64	297	413
2001		46	27	170	243
2002	3	25	10	146	184
2003	4	30	7	166	207
2004	5	28	13	185	231
2005	1	13	10	98	122
2006	2	11	8	64	85
2007	4	25	23	103	155
2008	2	25	20	98	145
2009	6	29	31	70	136
2010		12	15	109	136
2011	2	23	29	154	208
Grand Total	92	941	475	2,229	3,737

Table 4.11.14. Number of angler trips with measured or weighed Spanish mackerel in the Gulf of Mexico (FLW-TX) in the MRFSS private fleet by year and state. TX data for 1981-1985 only.

YEAR	TX	LA	MS	AL	FLW	TOTAL
1981	1	3	10	21	20	55
1982		16	27	37	17	97
1983		5	4	11	16	36
1984		2	3	14	5	24
1985	1	6	3	13	14	37
1986		7	10	41	43	101
1987		8	9	60	134	211
1988		14	14	16	70	114
1989		24	6	11	53	94
1990		14	2	28	69	113
1991		24	7	27	98	156
1992		48	20	43	247	358
1993		11	2	21	64	98
1994		9	9	24	100	142
1995		13	4	10	46	73
1996		6	2	15	117	140
1997		7	6	17	93	123
1998		2	9	20	161	192
1999		6	8	80	193	287
2000		5	9	66	152	232
2001		1	4	52	189	246
2002		4	5	38	232	279
2003		2	1	21	202	226
2004		3	2	33	238	276
2005		4	4	19	138	165
2006		4	6	27	168	205
2007		2	1	15	251	269
2008		3	6	15	191	215
2009		3	7	25	169	204
2010				22	207	229
2011		1	1	11	213	226
Grand Total	2	257	201	853	3,910	5,223

Table 4.11.15. Number of angler trips with measured or weighed Spanish mackerel in the Gulf of Mexico (FLW-TX) in the MRFSS shore mode by year and state. TX data for 1981-1985 only.

YEAR	TX	LA	MS	AL	FLW	TOTAL
1981	1	2		2	13	18
1982	2	5	1	7	31	46
1983	1	1		26	18	46
1984	2			12	4	18
1985				1	13	14
1986				1	30	31
1987			1	23	29	53
1988				5	19	24
1989			1	7	16	24
1990		1		19	31	51
1991		1		14	23	38
1992		1	3	19	93	116
1993		6	3	7	69	85
1994		3		18	98	119
1995		1		3	28	32
1996				3	42	45
1997		2		5	59	66
1998		1		3	63	67
1999		1	1	9	115	126
2000				11	65	76
2001		1		14	122	137
2002			1	10	95	106
2003		1			53	54
2004		2		11	78	91
2005		1	1	7	54	63
2006		1		10	49	60
2007				5	72	77
2008					70	70
2009		1	1	2	92	96
2010			2	13	86	101
2011		1	1	7	80	89
Grand Total	6	33	16	274	1,710	2,039

Table 4.11.16. Number of MRFSS intercept trips conducted in the Gulf of Mexico (FLW-TX) by year and mode with the percentage of intercepts that encountered Spanish mackerel. TX data for 1981-1985 only.

	Shore			Cbt			Priv		
YEAR	TOT int	SM int	%sm	TOT int	SM int	%sm	TOT int	SM int	%sm
1981	2,106	55	2.61%	360	33	9.17%	1,970	95	4.82%
1982	3,971	85	2.14%	329	37	11.25%	4,146	216	5.21%
1983	2,739	72	2.63%	713	45	6.31%	1,822	73	4.01%
1984	3,130	39	1.25%	847	70	8.26%	2,301	52	2.26%
1985	3,679	40	1.09%	543	63	11.60%	2,792	84	3.01%
1986	2,108	92	4.36%	2,601	214	8.23%	9,597	416	4.33%
1987	2,323	92	3.96%	2,421	191	7.89%	8,951	433	4.84%
1988	3,771	62	1.64%	1,952	143	7.33%	9,343	325	3.48%
1989	3,060	89	2.91%	1,510	130	8.61%	6,304	252	4.00%
1990	2,641	185	7.00%	1,145	157	13.71%	5,480	259	4.73%
1991	3,096	106	3.42%	1,778	140	7.87%	6,203	309	4.98%
1992	6,162	385	6.25%	3,243	203	6.26%	14,523	742	5.11%
1993	8,408	365	4.34%	1,825	67	3.67%	10,676	227	2.13%
1994	9,625	436	4.53%	1,909	77	4.03%	12,644	320	2.53%
1995	8,768	179	2.04%	1,731	102	5.89%	10,945	175	1.60%
1996	6,324	202	3.19%	1,966	80	4.07%	14,013	363	2.59%
1997	6,241	205	3.28%	3,193	198	6.20%	14,027	318	2.27%
1998	7,009	296	4.22%	6,272	289	4.61%	16,086	408	2.54%
1999	9,162	584	6.37%	10,759	500	4.65%	20,494	722	3.52%
2000	7,410	340	4.59%	13,493	582	4.31%	16,887	525	3.11%
2001	7,650	473	6.18%	11,546	366	3.17%	18,399	634	3.45%
2002	7,648	482	6.30%	11,550	347	3.00%	19,901	740	3.72%
2003	8,277	356	4.30%	12,298	447	3.63%	19,054	644	3.38%
2004	7,539	429	5.69%	12,746	476	3.73%	20,872	936	4.48%
2005	7,532	239	3.17%	10,589	288	2.72%	18,478	570	3.08%
2006	7,121	343	4.82%	8,319	211	2.54%	19,601	753	3.84%
2007	7,604	420	5.52%	8,543	315	3.69%	20,215	750	3.71%
2008	7,715	379	4.91%	7,914	300	3.79%	21,008	707	3.37%
2009	8,193	177	2.16%	6,754	147	2.18%	21,518	374	1.74%
2010	8,141	544	6.68%	6,898	387	5.61%	19,973	899	4.50%

Table 4.11.17. Mean weight (lb) of Spanish mackerel weighed from the MRFSS in the Gulf of Mexico (FLW-TX) by year and mode, 1981-2011. TX data for 1981-1985 only.

	Cbt				Priv				Shore			
YEAR	N	Mean (lbs)	Min (lbs)	Max (lbs)	N	Mean (lbs)	Min (lbs)	Max (lbs)	N	Mean (lbs)	Min (lbs)	Max (lbs)
1981	99	1.11	0.44	2.65	171	1.34	0.22	3.31	33	1.10	0.66	5.95
1982	97	0.90	0.22	3.31	231	1.42	0.22	5.73	88	1.23	0.22	4.41
1983	286	1.49	0.44	3.75	96	1.24	0.44	3.09	134	1.33	0.22	3.97
1984	363	1.32	0.44	4.41	42	1.63	0.44	4.19	38	1.18	0.44	4.85
1985	153	1.45	0.88	4.41	78	1.46	0.22	5.07	36	1.14	0.22	2.20
1986	608	1.38	0.22	5.07	289	1.22	0.22	5.51	126	1.05	0.44	1.98
1987	564	1.60	0.22	7.05	529	1.72	0.44	7.50	140	1.35	0.44	4.41
1988	331	1.53	0.44	5.29	248	1.71	0.44	5.29	53	1.26	0.22	4.41
1989	445	1.23	0.44	5.51	215	1.61	0.44	6.61	77	0.76	0.22	1.98
1990	346	1.38	0.44	5.07	244	1.78	0.22	5.73	144	1.09	0.22	4.19
1991	309	1.80	0.44	7.72	416	1.61	0.44	11.24	85	1.02	0.22	3.09
1992	355	1.47	0.44	10.14	963	1.56	0.22	27.56	342	1.34	0.44	5.51
1993	98	1.99	0.44	5.73	199	1.87	0.22	5.73	278	1.08	0.44	4.85
1994	109	1.66	0.55	5.29	276	1.49	0.44	6.17	269	1.22	0.22	6.61
1995	237	1.57	0.44	4.41	114	1.87	0.44	5.29	76	1.25	0.33	3.53
1996	115	1.47	0.22	4.85	316	1.79	0.44	5.95	111	1.12	0.44	3.97
1997	407	2.63	0.22	18.52	243	2.10	0.44	13.23	212	1.18	0.33	4.19
1998	607	1.85	0.44	7.72	438	2.09	0.11	6.50	177	1.28	0.22	3.53
1999	1,489	1.73	0.33	6.61	827	1.65	0.22	6.50	356	1.21	0.11	4.72
2000	2,028	1.59	0.11	6.06	466	2.05	0.51	7.28	230	1.54	0.44	5.75
2001	2,219	1.34	0.35	6.11	661	1.65	0.31	6.17	402	1.29	0.33	5.69
2002	1,033	1.88	0.29	6.00	586	1.99	0.44	6.17	331	1.36	0.40	4.59
2003	960	1.85	0.24	7.72	472	2.03	0.24	12.13	178	1.39	0.31	4.74
2004	1,065	1.80	0.33	9.92	669	1.56	0.33	7.05	282	1.24	0.35	4.76
2005	468	1.79	0.42	10.71	353	1.67	0.44	5.51	159	1.05	0.22	4.45
2006	472	1.71	0.49	7.72	514	1.72	0.40	5.75	185	1.12	0.40	4.08
2007	690	1.57	0.13	6.06	516	1.69	0.40	5.91	247	1.25	0.44	5.73
2008	725	1.61	0.31	6.22	412	1.85	0.49	6.61	162	1.06	0.22	5.07
2009	633	1.59	0.40	7.32	411	1.70	0.44	5.62	259	1.14	0.26	3.73
2010	815	1.76	0.37	6.70	574	1.66	0.33	6.17	290	1.34	0.35	5.07
2011	1,222	1.39	0.22	5.78	526	1.46	0.44	5.86	258	1.14	0.40	4.06

Table 4.11.18. Number of Spanish mackerel measured and positive trips in the SRHS by year and area. Due to headboat area definitions, West Florida and Alabama data are combined.

	Fish(N)					Trips(N)				
YEAR	FLW/AL	MS*	LA**	TX	Total	FLW/AL	MS*	LA**	TX	Total
1986	14	-	-	4	18	10	-	-	4	14
1987	1	-	6	8	15	1	-	4	8	13
1988	-	-	5	12	17	-	-	1	8	9
1989	15	-	29	32	76	11	-	18	13	42
1990	7	-	58	5	70	7	-	3	3	13
1991	12	-	49	36	97	7	-	8	8	23
1992	3	-	28	33	64	3	-	12	7	22
1993	4	-	21	16	41	4	-	13	8	25
1994	9	-	24	36	69	7	-	11	17	35
1995	1	-	48	14	63	1	-	14	13	28
1996	2	-	32	23	57	2	-	14	8	24
1997	19	-	75	-	94	12	-	24	-	36
1998	15	-	33	-	48	12	-	10	-	22
1999	5	-	29	4	38	5	-	14	1	20
2000	5	-	33	-	38	5	-	15	-	20
2001	3	-	19	6	28	3	-	14	3	20
2002	12	-	73	-	85	12	-	8	-	20
2003	7	-	27	-	34	5	-	11	-	16
2004	5	-	-	8	13	5	-	-	2	7
2005	1	-	2	1	4	1	-	2	1	4
2006	6	-	-	1	7	4	-	-	1	5
2007	11	-	-	1	12	7	-	-	1	8
2008	13	-	-	-	13	10	-	-	-	10
2009	23	-	-	1	24	10	-	-	1	11
2010	4	-	-	1	5	4	-	-	1	5
2011	1	52	-	1	54	1	3	-	1	5

*MS added to survey in 2010.
**LA not sampled during 2004-2005 due to Hurricane Katrina.

Table 4.11.19. Number of Gulf of Mexico Spanish mackerel aged from the SRHS by year and state. Due to headboat area definitions, West Florida and Alabama data are combined.

Year	FLW/AL	MS*	LA**	TX	Total
1981	-	-	-	-	-
1982	-	-	-	-	-
1983	-	-	-	-	-
1984	-	-	-	-	-
1985	-	-	-	-	-
1986	-	-	-	-	-
1987	-	-	-	-	-
1988	-	-	-	1	1
1989	-	-	-	68	68
1990	-	-	-	10	10
1991	6	-	-	75	81
1992	16	7	-	21	44
1993	2	-	-	2	4
1994	-	-	-	-	-
1995	-	-	-	-	-
1996	-	-	-	-	-
1997	-	-	-	-	-
1998	-	-	-	-	-
1999	2	-	-	-	2
2000	-	-	-	-	-
2001	-	-	-	-	-
2002	1	-	-	-	1
2003	-	-	-	-	-
2004	-	-	-	-	-
2005	-	-	-	-	-
2006	-	-	-	-	-
2007	1	-	-	-	1
2008	3	-	-	-	3
2009	3	-	-	-	3
2010	-	-	-	-	-
2011	2	-	-	-	2

*MS added to survey in 2010.
**LA not sampled during 2004-2005 due to Hurricane Katrina.

Table 4.11.20. Mean weight (kg) of Spanish mackerel measured in the SRHS by year and state, 1986-2011. Due to headboat area definitions, West Florida and Alabama data are combined.

	FLW/AL				MS*				LA**				TX			
Year	N	Mean (kg)	Min (kg)	Max (kg)	N	Mean (kg)	Min (kg)	Max (kg)	N	Mean (kg)	Min (kg)	Max (kg)	N	Mean (kg)	Min (kg)	Max (kg)
1986	14	0.79	0.32	1.89	-	-	-	-	-	-	-	-	4	1.65	1.30	2.00
1987	1	1.10	1.10	1.10	-	-	-	-	6	0.86	0.53	1.40	8	1.40	0.34	2.60
1988	-	-	-	-	-	-	-	-	5	1.05	0.60	1.60	12	1.20	0.17	2.10
1989	15	0.44	0.00	0.99	-	-	-	-	29	0.76	0.01	3.06	32	1.08	0.22	2.10
1990	7	0.69	0.33	1.02	-	-	-	-	58	1.19	0.30	2.25	5	0.92	0.29	2.29
1991	12	0.58	0.30	0.99	-	-	-	-	49	1.04	0.40	10.19	36	3.64	0.48	7.80
1992	3	1.20	0.87	1.52	-	-	-	-	28	1.18	0.33	2.32	33	3.56	0.79	8.66
1993	4	1.00	0.65	1.40	-	-	-	-	21	1.01	0.28	1.89	16	1.02	0.45	1.57
1994	9	1.24	0.50	2.90	-	-	-	-	24	1.19	0.32	2.12	36	1.11	0.41	2.24
1995	1	0.95	0.95	0.95	-	-	-	-	48	1.28	0.45	2.69	14	1.44	0.52	2.21
1996	2	1.22	0.63	1.80	-	-	-	-	32	0.88	0.32	2.22	23	2.06	0.67	5.29
1997	19	1.07	0.28	2.97	-	-	-	-	75	1.21	0.32	2.73	-	-	-	-
1998	15	0.72	0.32	1.84	-	-	-	-	33	1.20	0.48	2.44	-	-	-	-
1999	5	0.92	0.45	1.40	-	-	-	-	29	1.28	0.37	3.21	4	1.09	0.81	1.43
2000	5	1.33	0.46	2.56	-	-	-	-	33	1.36	0.29	4.39	-	-	-	-
2001	3	1.26	0.72	2.06	-	-	-	-	19	1.54	0.53	9.01	6	1.68	0.97	2.33
2002	12	1.30	0.55	2.57	-	-	-	-	73	0.85	0.42	1.82	-	-	-	-
2003	7	0.82	0.52	1.05	-	-	-	-	27	0.90	0.41	1.84	-	-	-	-
2004	5	1.36	0.63	1.91	-	-	-	-	-	-	-	-	8	0.40	0.17	0.71
2005	1	0.92	0.92	0.92	-	-	-	-	2	2.30	2.19	2.40	1	0.86	0.86	0.86
2006	6	1.14	0.41	1.90	-	-	-	-	-	-	-	-	1	2.16	2.16	2.16
2007	11	0.72	0.23	1.34	-	-	-	-	-	-	-	-	1	2.30	2.30	2.30
2008	13	0.73	0.26	1.46	-	-	-	-	-	-	-	-	-	-	-	-
2009	23	0.82	0.22	2.89	-	-	-	-	-	-	-	-	1	1.19	1.19	1.19
2010	4	0.68	0.37	1.41	-	-	-	-	-	-	-	-	1	0.59	0.59	0.59
2011	1	0.37	0.37	0.37	52	0.69	0.03	1.79	-	-	-	-	1	1.87	1.87	1.87

*MS added to survey in 2010. **LA not sampled during 2004-2005 due to Hurricane Katrina.

Table 4.11.21. Number of Spanish mackerel measured in Texas in the TPWD survey by year and mode. 2011 data is through mid-May.

YEAR	Cbt	Priv	Grand Total
1983	8	125	133
1984	1	94	95
1985	2	169	171
1986	1	55	56
1987	13	239	252
1988	4	136	140
1989	3	221	224
1990	13	230	243
1991	22	307	329
1992	6	163	169
1993	8	178	186
1994	13	276	289
1995	2	423	425
1996	8	479	487
1997	13	245	258
1998	3	214	217
1999	4	171	175
2000	8	320	328
2001	4	111	115
2002	22	163	185
2003	7	196	203
2004	20	295	315
2005	12	441	453
2006	47	640	687
2007	34	312	346
2008	41	348	389
2009	14	328	342
2010	32	255	287
2011	2	5	7
Grand Total	367	7,139	7,506

Table 4.11.22. Number of trips with measured Spanish mackerel in Texas from the TPWD survey by year and mode. 2011 data is through mid-May.

YEAR	Cbt	Priv	Grand Total
1983	6	79	85
1984	1	46	47
1985	2	97	99
1986	1	41	42
1987	6	105	111
1988	3	60	63
1989	2	87	89
1990	7	111	118
1991	11	146	157
1992	3	101	104
1993	3	100	103
1994	5	136	141
1995	2	206	208
1996	6	214	220
1997	9	127	136
1998	3	103	106
1999	4	109	113
2000	3	157	160
2001	4	59	63
2002	8	101	109
2003	7	102	109
2004	10	135	145
2005	7	180	187
2006	19	299	318
2007	17	133	150
2008	17	161	178
2009	10	166	176
2010	10	110	120
2011	2	5	7
Grand Total	188	3,476	3,664

Table 4.11.23 Number of TPWD intercept trips conducted in Texas by year and mode with the percentage of intercepts that encountered Spanish mackerel.

	Cbt			Priv			Total		
YEAR	TOT int	SM int	%sm	TOT int	SM int	%sm	TOT int	SM int	%sm
1983	367	6	1.63%	14,223	79	0.56%	14,590	85	0.58%
1984	247	1	0.40%	9,149	46	0.50%	9,396	47	0.50%
1985	403	2	0.50%	12,149	97	0.80%	12,552	99	0.79%
1986	474	1	0.21%	12,306	41	0.33%	12,780	42	0.33%
1987	498	6	1.20%	16,333	105	0.64%	16,831	111	0.66%
1988	570	3	0.53%	14,929	60	0.40%	15,499	63	0.41%
1989	665	2	0.30%	12,285	87	0.71%	12,950	89	0.69%
1990	425	7	1.65%	9,740	111	1.14%	10,165	118	1.16%
1991	694	11	1.59%	12,090	146	1.21%	12,784	157	1.23%
1992	991	3	0.30%	15,294	101	0.66%	16,285	104	0.64%
1993	968	3	0.31%	16,538	100	0.60%	17,506	103	0.59%
1994	1,045	5	0.48%	18,654	136	0.73%	19,699	141	0.72%
1995	1,089	2	0.18%	17,727	206	1.16%	18,816	208	1.11%
1996	1,264	6	0.47%	16,780	214	1.28%	18,044	220	1.22%
1997	1,194	9	0.75%	17,032	127	0.75%	18,226	136	0.75%
1998	1,355	3	0.22%	17,064	103	0.60%	18,419	106	0.58%
1999	1,538	4	0.26%	20,017	109	0.54%	21,555	113	0.52%
2000	1,731	3	0.17%	18,950	157	0.83%	20,681	160	0.77%
2001	1,861	4	0.21%	16,853	59	0.35%	18,714	63	0.34%
2002	1,561	8	0.51%	15,623	100	0.64%	17,184	108	0.63%
2003	1,799	7	0.39%	17,339	102	0.59%	19,138	109	0.57%
2004	1,703	10	0.59%	17,175	135	0.79%	18,878	145	0.77%
2005	1,705	7	0.41%	16,632	179	1.08%	18,337	186	1.01%
2006	2,072	19	0.92%	18,468	298	1.61%	20,540	317	1.54%
2007	2,067	17	0.82%	16,864	133	0.79%	18,931	150	0.79%
2008	1,797	17	0.95%	17,045	161	0.94%	18,842	178	0.94%
2009	1,891	10	0.53%	18,204	166	0.91%	20,095	176	0.88%
2010	1,963	10	0.51%	16,796	110	0.65%	18,759	120	0.64%

Table 4.11.24. Number of Spanish mackerel aged in the Gulf of Mexico (FLW-TX) from the charter boat fleet by year and state.

Year	FLW/AL	MS	LA	TX	Total
1981	-	-	-	-	-
1982	-	-	-	-	-
1983	-	-	-	-	-
1984	-	-	-	-	-
1985	-	-	-	-	-
1986	-	-	-	-	-
1987	-	-	-	-	-
1988	-	-	-	-	-
1989	27	47	-	42	116
1990	216	125	-	43	384
1991	78	-	2	22	102
1992	168	-	-	13	181
1993	42	-	-	2	44
1994	98	-	-	-	98
1995	46	-	-	-	46
1996	245	-	-	-	245
1997	109	-	-	-	109
1998	108	-	-	-	108
1999	156	196	-	-	352
2000	153	-	-	-	153
2001	105	-	-	-	105
2002	342	-	-	-	342
2003	458	-	-	-	458
2004	270	-	-	-	270
2005	52	-	-	-	52
2006	132	-	-	-	132
2007	186	-	-	-	186
2008	329	-	-	-	329
2009	101	-	-	-	101
2010	209	-	-	-	209
2011	266	-	-	-	266

Table 4.11.25. Number of Spanish mackerel aged in the Gulf of Mexico (FLW-TX) from the private/rental fleet by year and state.

Year	FLW/AL	MS	LA	TX	Total
1981	-	-	-	-	-
1982	-	-	-	-	-
1983	-	-	-	-	-
1984	-	-	-	-	-
1985	-	-	-	-	-
1986	-	-	-	-	-
1987	-	-	-	-	-
1988	-	-	-	-	-
1989	-	-	-	-	-
1990	-	1	-	1	2
1991	12	-	-	-	12
1992	16	-	-	-	16
1993	31	-	-	-	31
1994	3	-	-	-	3
1995	62	-	-	-	62
1996	3	-	-	-	3
1997	1	-	-	-	1
1998	21	-	-	-	21
1999	6	129	-	-	135
2000	-	-	-	-	-
2001	-	-	-	-	-
2002	86	-	-	-	86
2003	128	-	-	-	128
2004	71	-	-	-	71
2005	6	-	-	-	6
2006	1	-	-	-	1
2007	20	-	-	-	20
2008	70	-	-	-	70
2009	8	-	-	-	8
2010	21	-	-	-	21
2011	11	-	-	-	11

Table 4.11.26. Number of Spanish mackerel aged in the Gulf of Mexico (FLW-TX) from the recreational fishery (mode unknown) by year and state.

Year	FLW/AL	MS	LA	TX	Total
1981	-	-	-	-	-
1982	-	-	-	-	-
1983	-	-	-	-	-
1984	-	-	-	-	-
1985	-	-	-	-	-
1986	-	-	-	-	-
1987	-	-	-	-	-
1988	1	107	21	6	135
1989	32	-	2	-	34
1990	2	-	44	-	46
1991	-	-	-	-	-
1992	-	-	-	-	-
1993	-	-	-	-	-
1994	-	-	-	-	-
1995	-	-	-	-	-
1996	-	-	-	-	-
1997	-	-	-	-	-
1998	-	-	-	-	-
1999	-	-	-	-	-
2000	-	-	-	-	-
2001	-	-	-	-	-
2002	-	-	-	-	-
2003	-	-	-	-	-
2004	-	-	-	-	-
2005	-	-	-	-	-
2006	-	-	-	-	-
2007	-	-	-	-	-
2008	-	-	-	-	-
2009	-	-	-	-	-
2010	-	-	-	-	-
2011	-	-	-	-	-

Table 4.11.27. Gulf of Mexico (FLW-TX) estimated number of angler trips for charter boat mode, charter boat/headboat mode, private/rental mode, and shore mode (MRFSS, NMFS, 1981-2003; MRIP, NMFS, 2004-2011). CH and CH/HB mode adjusted for FHS conversion prior to 1997. CH/HB mode estimates from 1981-1985 only. TX estimates for 1981-1985 only. 2011 data is preliminary and through October.

	Estimated CH Angler Trips		Estimated CH/HB Angler Trips		Estimated PR Angler Trips		Estimated SH Angler Trips	
YEAR	Trips	CV	Trips	CV	Trips	CV	Trips	CV
1981			341,346	0.10	7,764,455	0.20	7,119,118	0.09
1982			843,916	0.08	5,438,965	0.07	10,051,388	0.07
1983			672,312	0.10	6,841,641	0.06	16,623,065	0.11
1984			547,252	0.10	7,506,796	0.07	13,709,706	0.10
1985			796,565	0.09	8,314,889	0.08	10,268,895	0.10
1986	513,342	0.13			8,136,242	0.05	10,405,962	0.07
1987	546,764	0.16			8,517,788	0.04	6,923,388	0.12
1988	559,513	0.12			10,698,532	0.03	8,524,356	0.05
1989	524,157	0.13			8,712,307	0.03	6,419,667	0.06
1990	426,134	0.15			7,216,506	0.03	5,706,778	0.05
1991	449,908	0.12			9,086,738	0.03	8,642,251	0.04
1992	469,662	0.10			9,373,254	0.02	8,265,502	0.03
1993	788,055	0.08			9,041,306	0.02	7,642,451	0.02
1994	860,370	0.07			9,384,801	0.02	7,293,305	0.02
1995	1,020,387	0.07			9,570,896	0.02	6,925,453	0.02
1996	990,457	0.07			9,351,017	0.02	6,800,513	0.03
1997	1,091,871	0.08			10,195,083	0.02	7,423,022	0.03
1998	760,667	0.03			8,938,905	0.02	6,861,289	0.03
1999	683,768	0.03			9,097,803	0.02	5,918,885	0.03
2000	811,634	0.03			11,728,464	0.02	8,477,685	0.03
2001	742,386	0.03			12,371,138	0.02	9,776,174	0.03
2002	764,222	0.03			11,635,095	0.02	7,266,262	0.03
2003	691,362	0.03			14,110,007	0.02	8,155,304	0.03
2004	831,069	0.03			15,644,093	0.03	9,954,045	0.05
2005	690,735	0.03			13,585,144	0.03	9,013,928	0.05
2006	836,049	0.03			13,620,320	0.03	8,836,552	0.05
2007	851,757	0.03			14,980,146	0.03	8,457,361	0.05
2008	819,045	0.03			15,194,949	0.03	8,775,859	0.05
2009	822,266	0.03			13,442,881	0.03	8,332,102	0.05
2010	580,190	0.03			12,684,738	0.03	7,782,505	0.05
2011	698,725	0.03			11,024,029	0.03	7,800,767	0.05

Table 4.11.28. Gulf of Mexico headboat estimated angler days by year and state, 1986-2011.

Year	FLW/AL	MS*	LA**	TX
1986	480,154		11,782	113,136
1987	434,098		12,724	126,726
1988	391,896		15,382	140,792
1989	416,650		5,734	126,778
1990	427,812		13,796	116,288
1991	348,624		12,746	119,938
1992	369,604		19,822	152,436
1993	415,793		22,512	161,809
1994	409,123		25,302	201,555
1995	364,821		20,996	180,929
1996	309,826		21,976	183,706
1997	298,884		18,016	164,415
1998	370,666		15,709	155,303
1999	352,234		16,052	116,470
2000	318,662		9,904	116,790
2001	314,486		12,444	110,722
2002	283,662		12,444	133,902
2003	288,422		13,272	127,164
2004	316,860			129,980
2005	260,466			119,714
2006	248,125		10,010	141,577
2007	273,755		5,044	127,524
2008	260,349		5,889	82,373
2009	284,873		6,536	101,470
2010	222,035	995	434	94,304
2011	314,046	3,541	3,772	94,566

*MS added to survey in 2010.
**LA not sampled during 2004-2005 due to Hurricane Katrina.

Table 4.11.29. Texas estimated angler trips by year, season, and mode, 1983-2011.

	Estimated CH trips		Estimated PR trips		Total
year	High	Low	High	Low	
1983	31,710		637,416		669,126
1984	19,292	3,287	540,420	172,321	735,321
1985	23,578	6,852	587,673	254,969	873,072
1986	23,137	6,772	553,830	346,804	930,542
1987	24,636	11,866	751,020	350,008	1,137,530
1988	23,674	4,778	705,650	335,498	1,069,600
1989	35,518	9,580	678,535	234,013	957,645
1990	30,298	4,319	620,597	215,878	871,092
1991	38,340	10,997	637,275	214,490	901,102
1992	35,486	11,501	730,467	252,919	1,030,374
1993	40,419	15,111	681,545	313,340	1,050,415
1994	73,902	17,829	719,053	375,014	1,185,798
1995	51,984	21,696	675,113	404,477	1,153,270
1996	58,813	19,753	741,427	357,446	1,177,440
1997	80,733	19,298	694,991	305,589	1,100,611
1998	90,497	22,903	668,794	303,733	1,085,927
1999	91,571	25,287	796,383	407,326	1,320,566
2000	109,834	53,419	718,916	441,329	1,323,498
2001	109,895	53,006	681,733	306,038	1,150,672
2002	116,305	25,583	632,336	332,565	1,106,789
2003	96,782	26,336	665,238	343,297	1,131,654
2004	85,355	35,320	665,287	340,596	1,126,558
2005	86,159	22,429	616,715	336,175	1,061,479
2006	121,298	41,601	602,954	390,877	1,156,730
2007	120,344	33,387	599,832	304,208	1,057,770
2008	122,555	28,351	557,073	349,425	1,057,404
2009	88,148	33,703	619,872	293,770	1,035,493
2010	97,303	25,859	604,487	259,673	987,323
2011		35,471		346,716	382,188

4.11 Figures

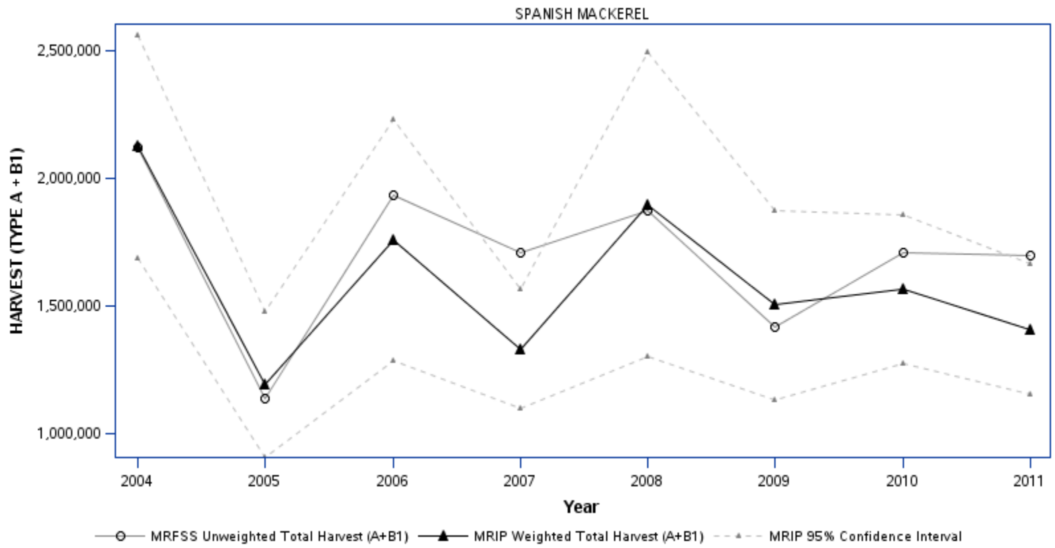


Figure 4.12.1. Comparison of MRIP and MRFSS landings (A+B1) for Gulf of Mexico Spanish mackerel (FLW-LA).

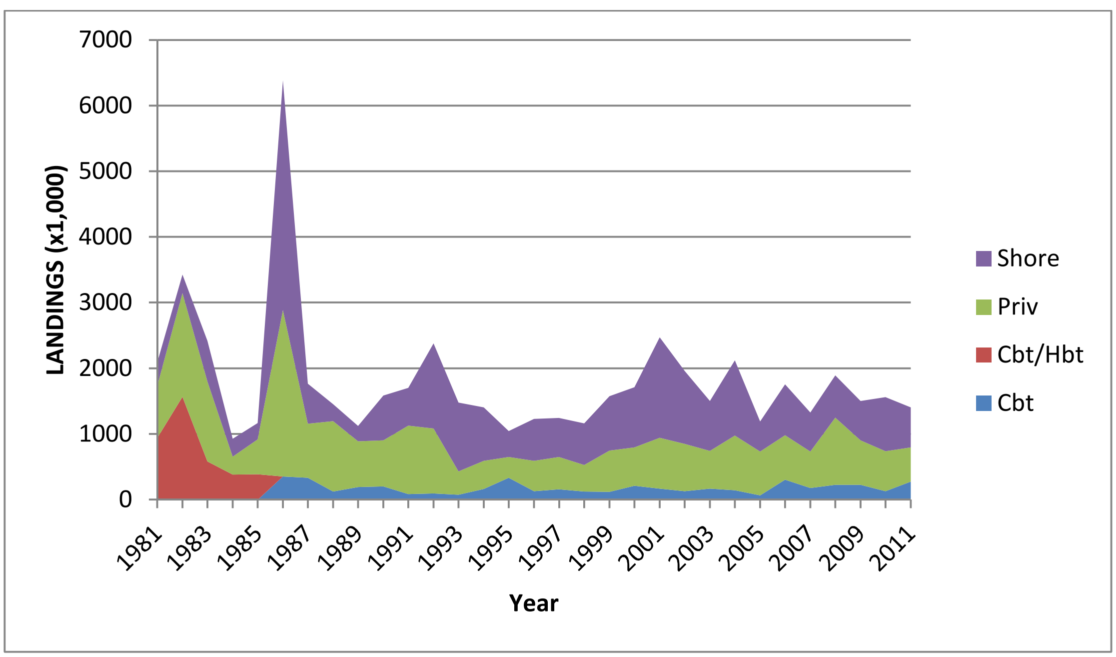


Figure 4.12.2. Gulf of Mexico (FLW-TX) Spanish mackerel landings (numbers of fish) by year and mode (MRFSS, NMFS, 1981-2003; MRIP, NMFS, 2004-2011). 2011 data is preliminary and through October. TX estimates for 1981-1985 shore mode only.

Figure 4.12.3. The number of Spanish mackerel intercepted by the MRFSS from 1981-1989.

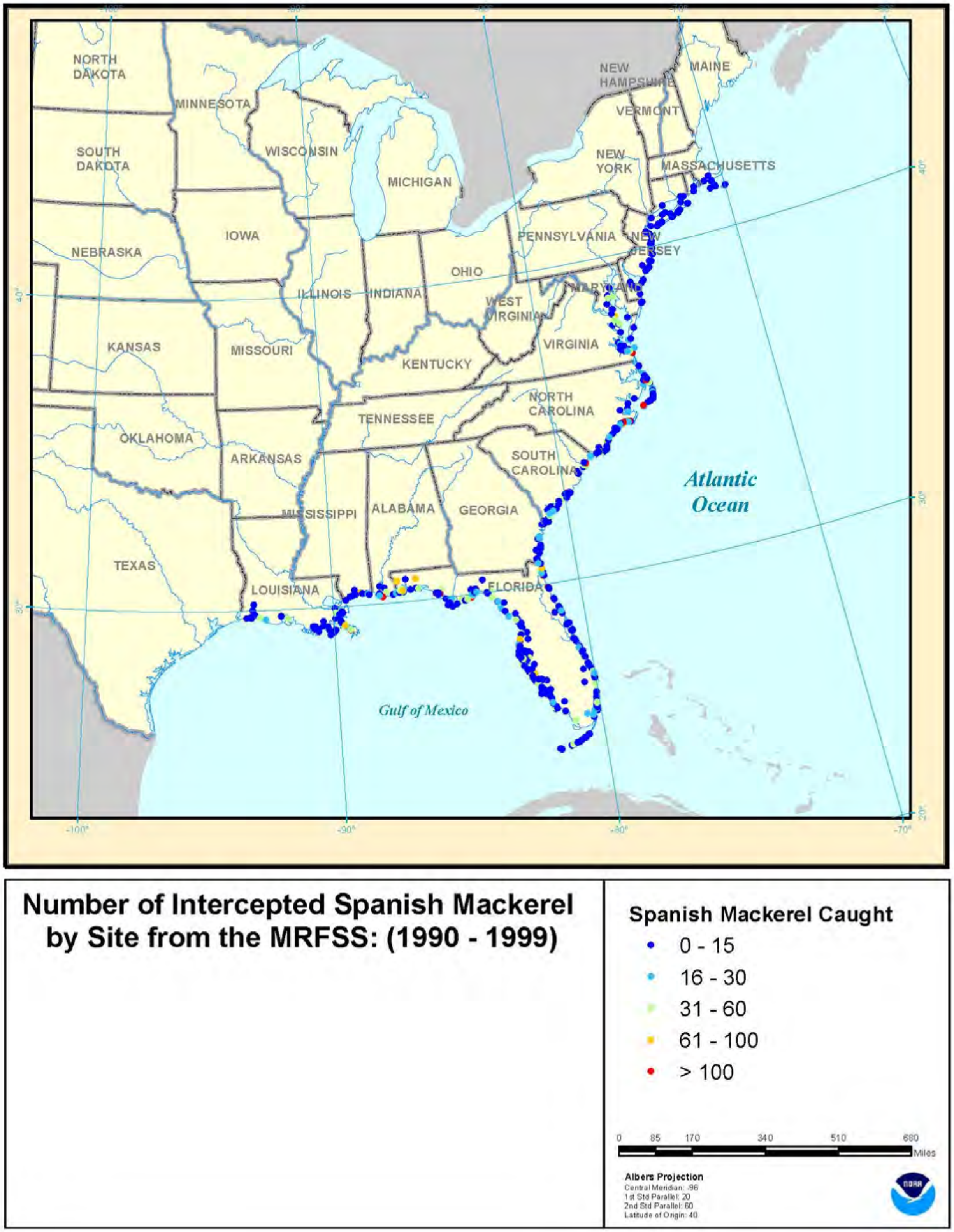


Figure 4.12.4. The number of Spanish mackerel intercepted by the MRFSS from 1990-1999.

Figure 4.12.5. The number of Spanish mackerel intercepted by the MRFSS from 2000-2010.

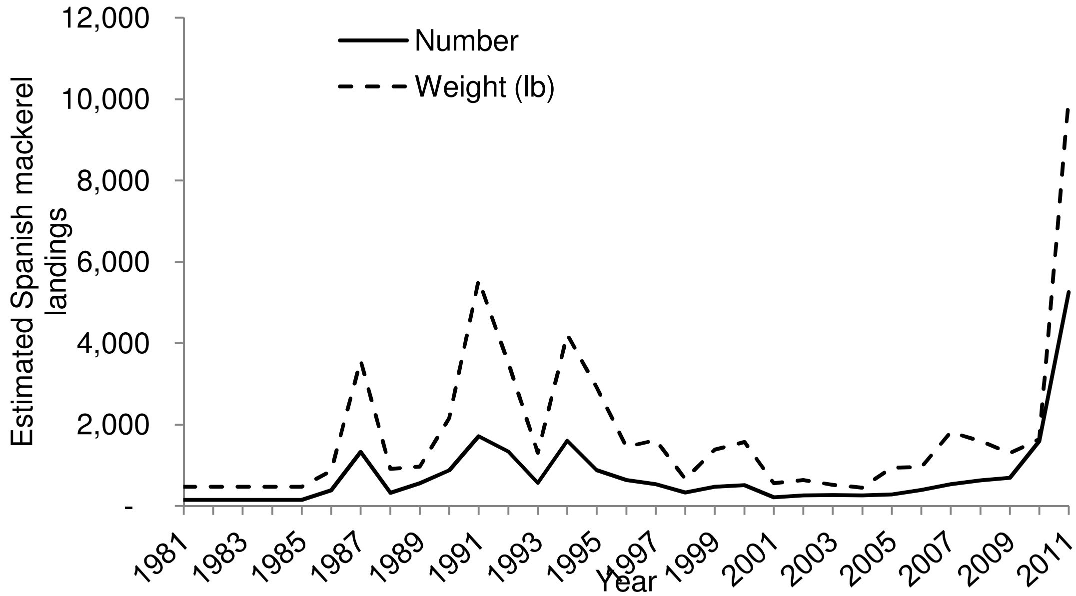


Figure 4.12.6. Gulf of Mexico estimated Spanish mackerel landings (number and pounds) for the headboat fishery, 1981-2011.

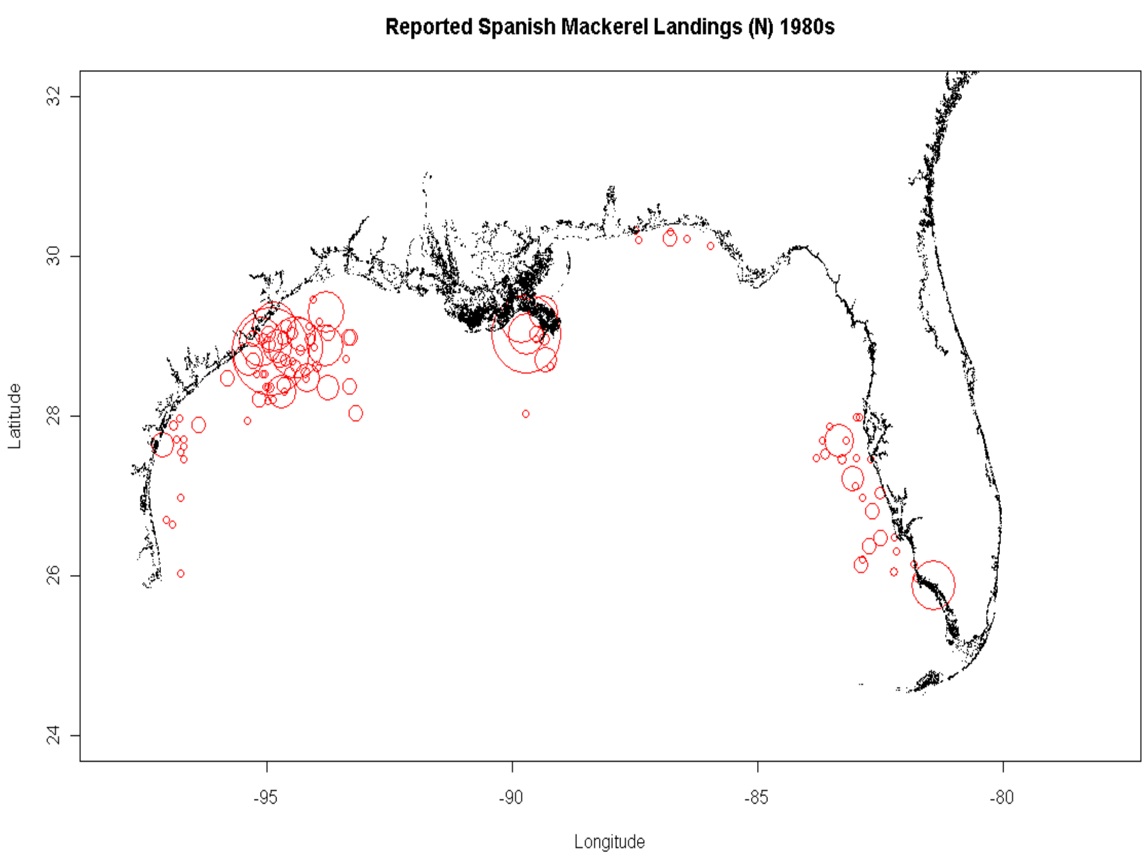


Figure 4.12.7. Reported Spanish mackerel landings (numbers of fish) from SRHS, 1986-1989. The size of each point is proportional to the reported landings (N) at the given location.

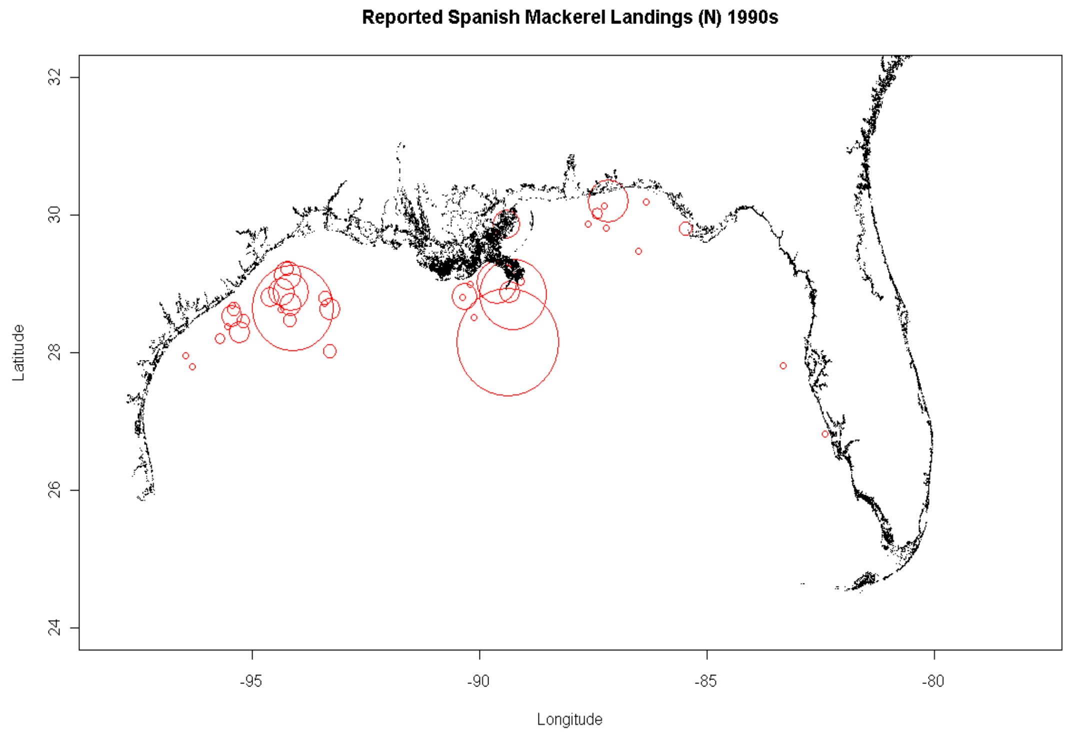


Figure 4.12.8. Reported Spanish mackerel landings (numbers of fish) from SRHS, 1990-1999. The size of each point is proportional to the reported landings (N) at the given location.

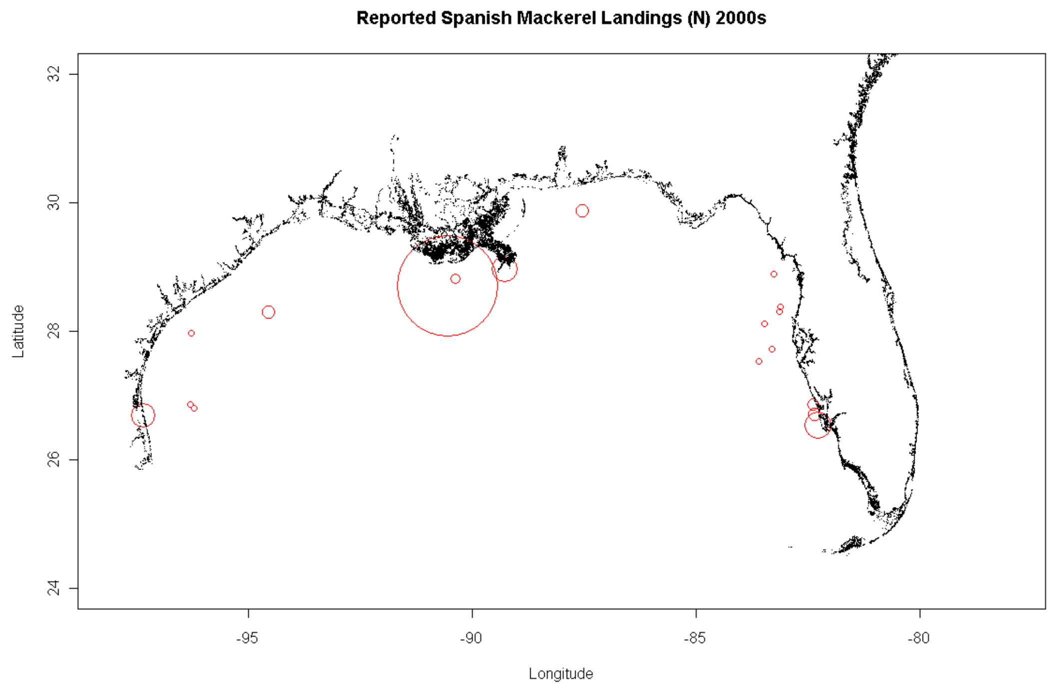


Figure 4.12.9. Reported Spanish mackerel landings (numbers of fish) from SRHS, 2000-2011. The size of each point is proportional to the reported landings (N) at the given location.

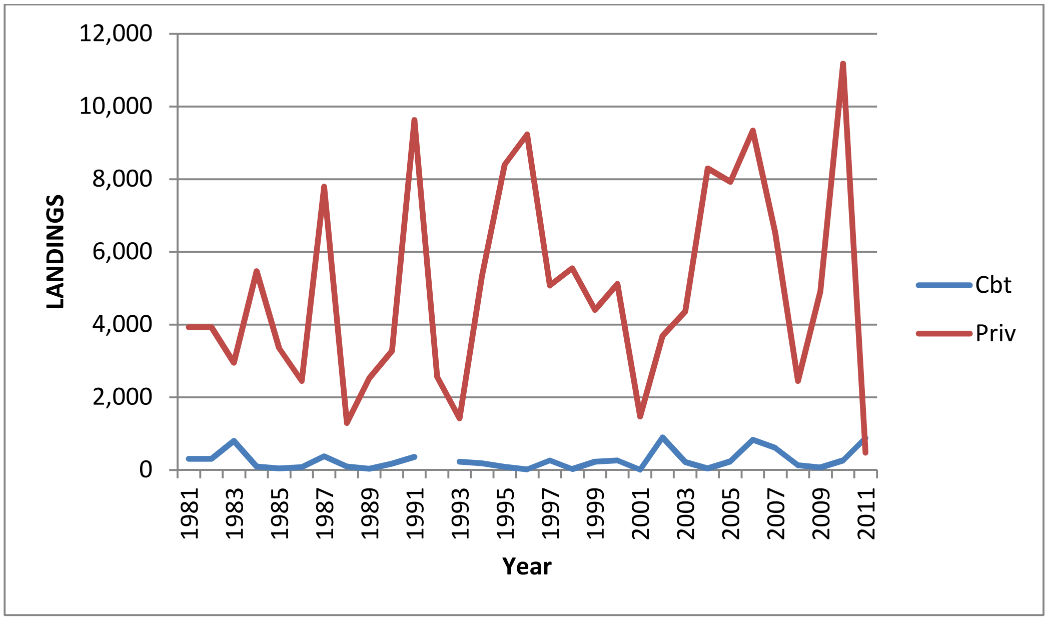


Figure 4.12.10 Texas Spanish mackerel landings (numbers of fish) for charter boat mode and private mode (TPWD). 2011 data is through mid-May.

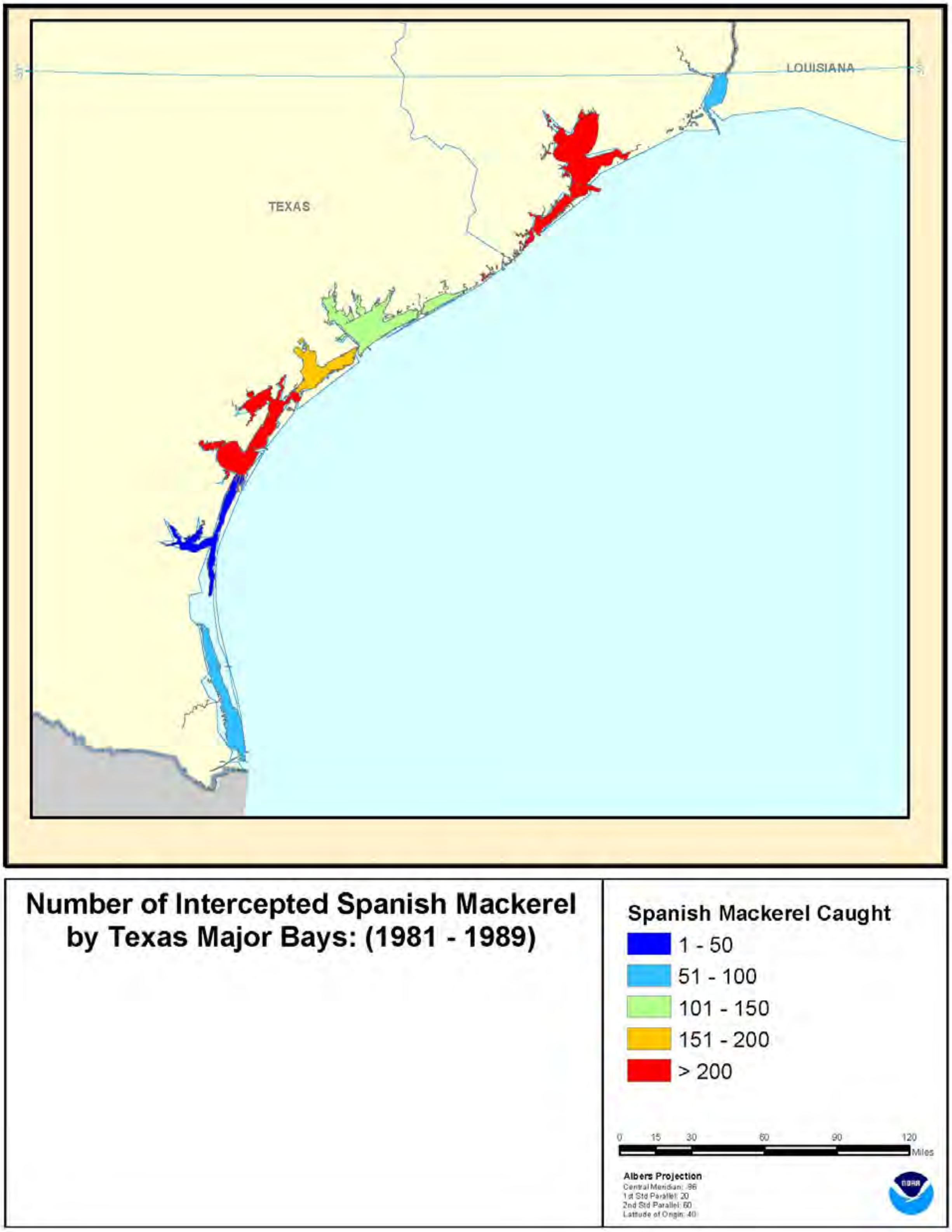


Figure 4.12.11. The number of Spanish mackerel intercepted by the TPWD from 1983-1989.

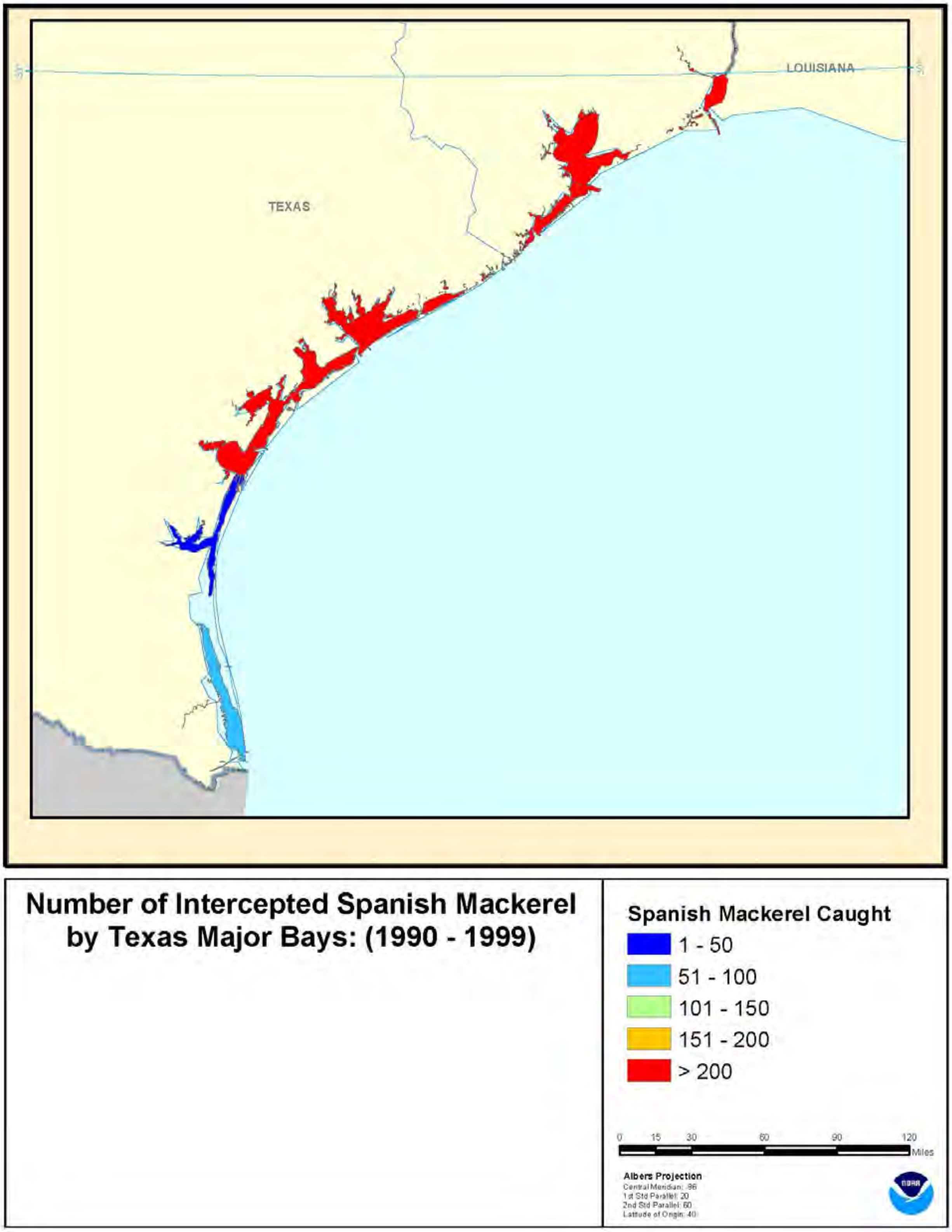


Figure 4.12.12. The number of Spanish mackerel intercepted by the TPWD from 1990-1999.

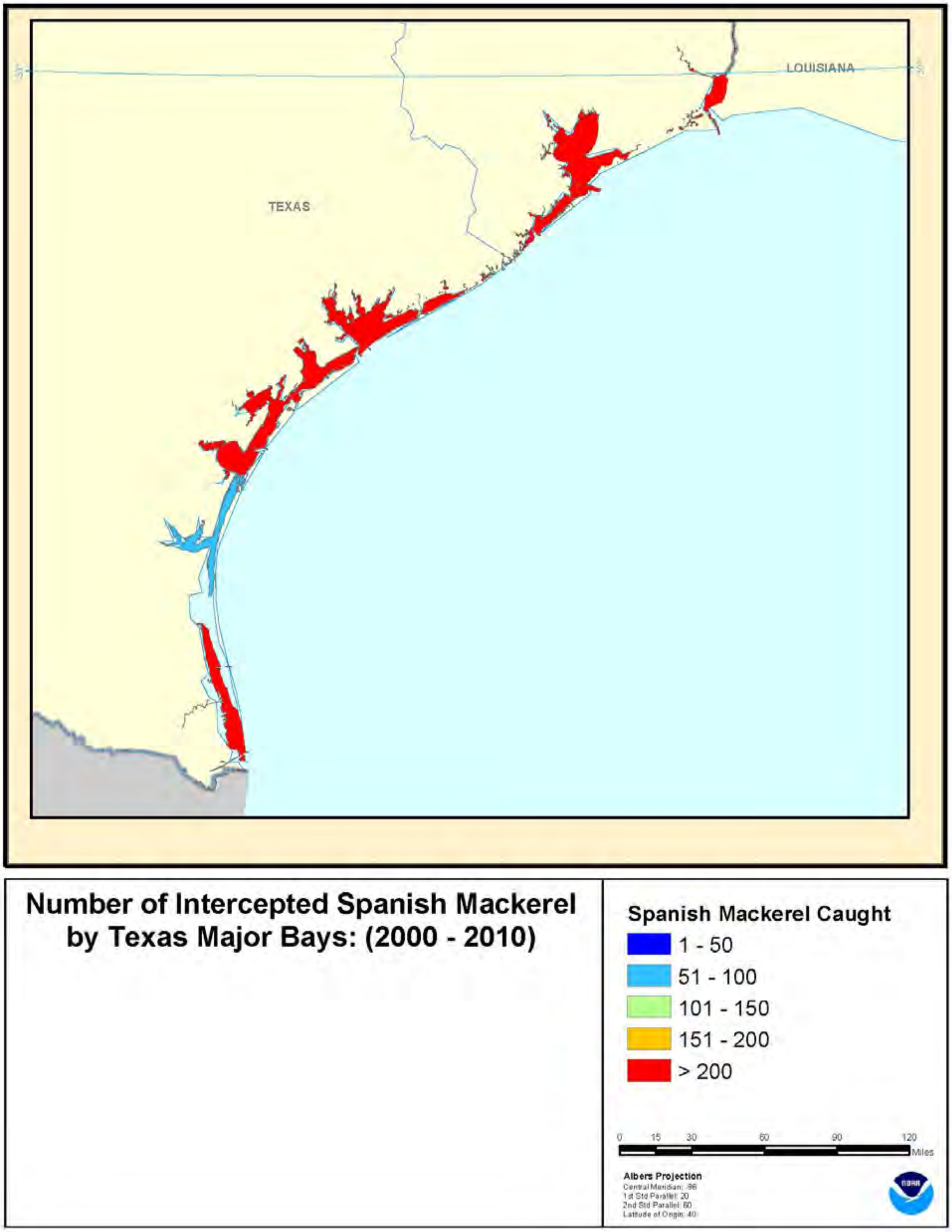


Figure 4.12.13. The number of Spanish mackerel intercepted by the TPWD from 2000-2010.

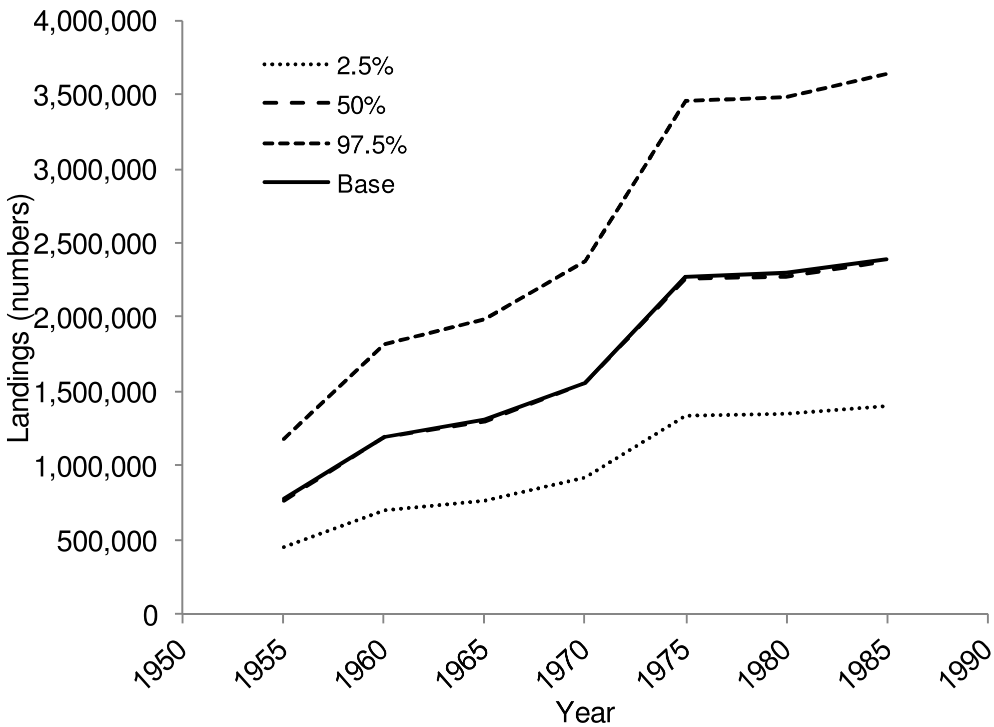


Figure 4.12.14. Bootstrap analysis of FHWAR census method (1955-1984) Gulf of Mexico Spanish mackerel landings estimates.

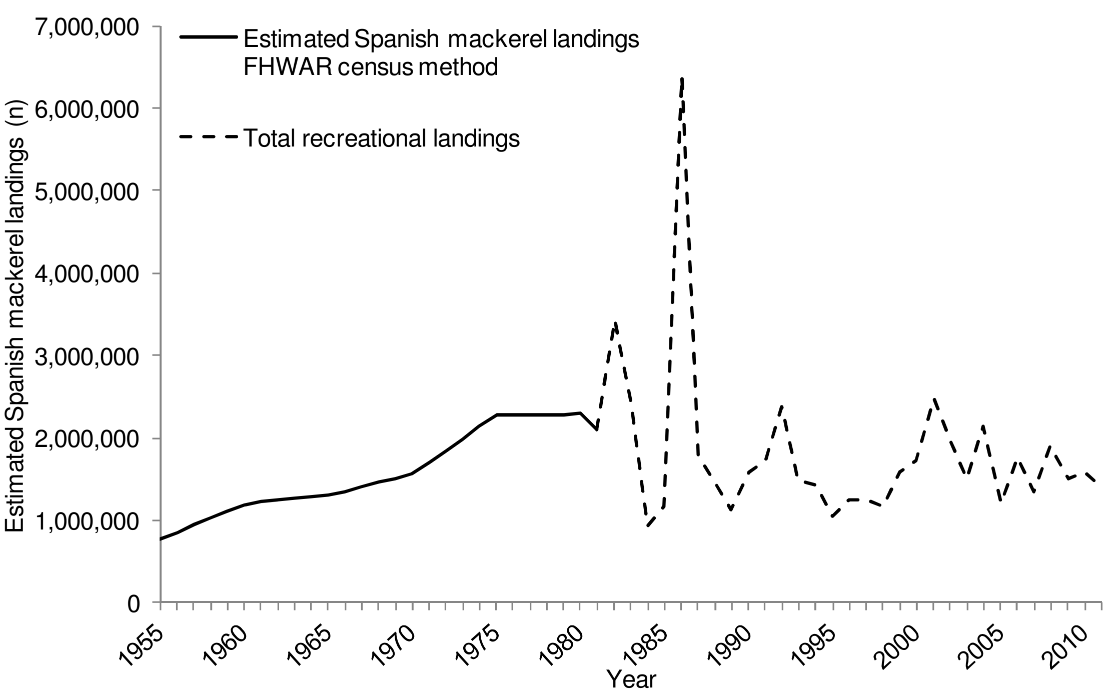


Figure 4.12.15. Estimated Spanish mackerel landings (number) using FHWAR census method (1955-1980), MRFSS (1981-2003), MRIP (2004-2011), TPWD (81-11), and SRHS (81-11) estimation methods.

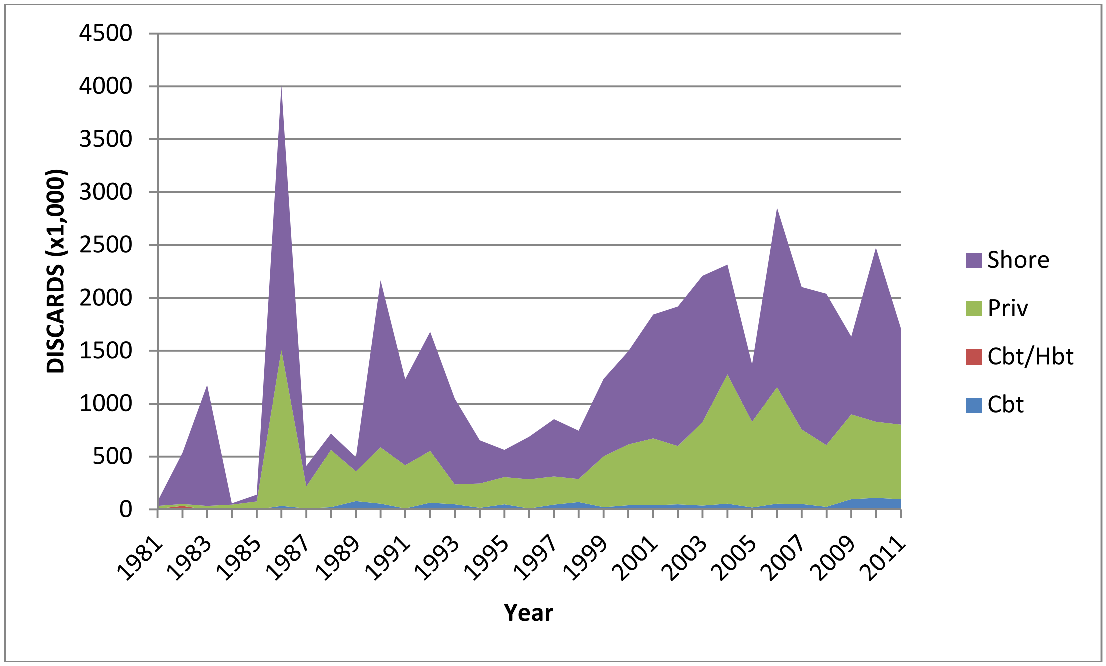


Figure 4.12.16. Gulf of Mexico (FLW-TX) Spanish mackerel discards (numbers of fish) by year and mode (MRFSS, NMFS, 1981-2003; MRIP, NMFS, 2004-2011). 2011 data is preliminary and through October. TX estimates for 1981-1985 shore mode only.

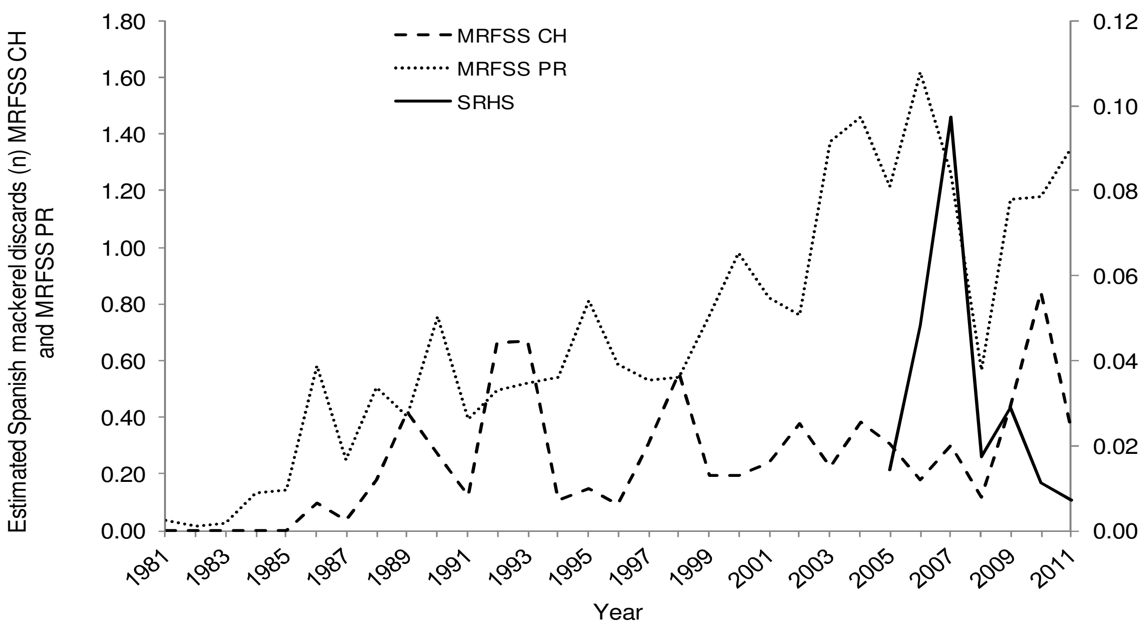


Figure 4.12.17. Percentage of Spanish mackerel discards in the recreational fishery, 1981-2011.

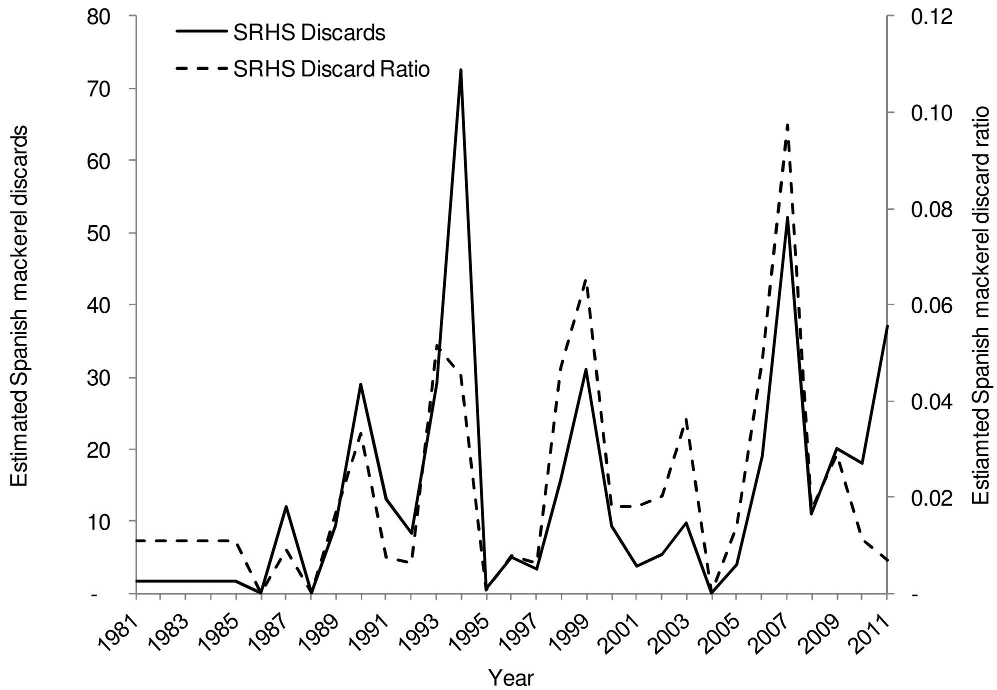


Figure 4.12.18. Gulf of Mexico estimated Spanish mackerel discards and discard ratio for the headboat fishery (MRFSS proxy 1981-2003; SRHS 2004-2011).

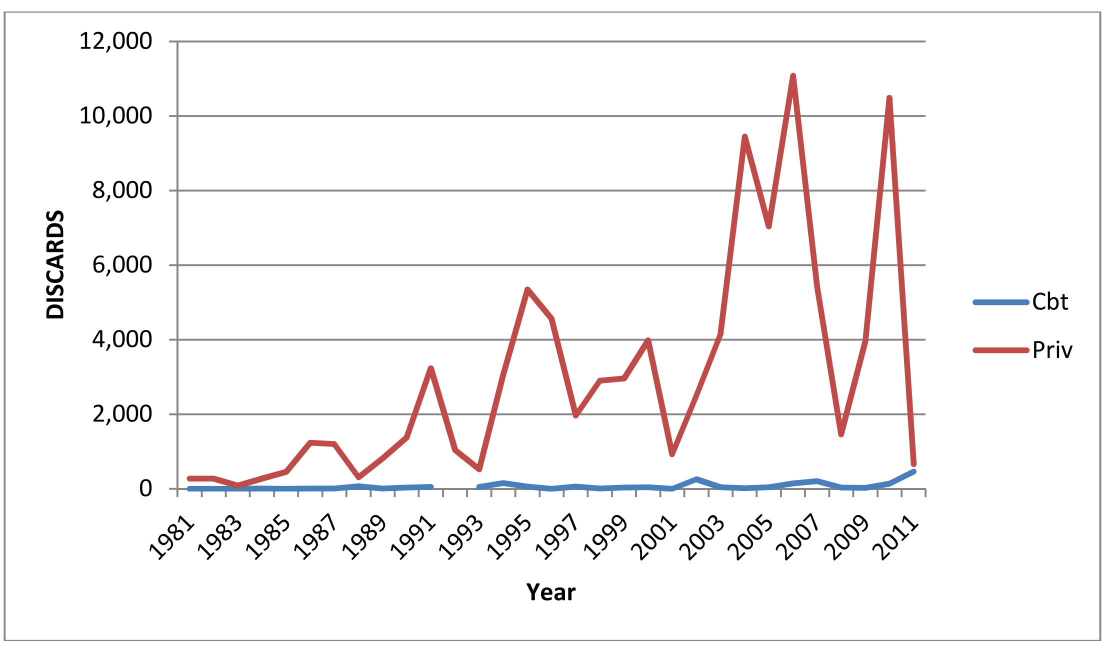


Figure 4.12.19 Texas Spanish mackerel discards (numbers of fish) for charter boat mode and private mode (TPWD). 2011 data is through mid-May.

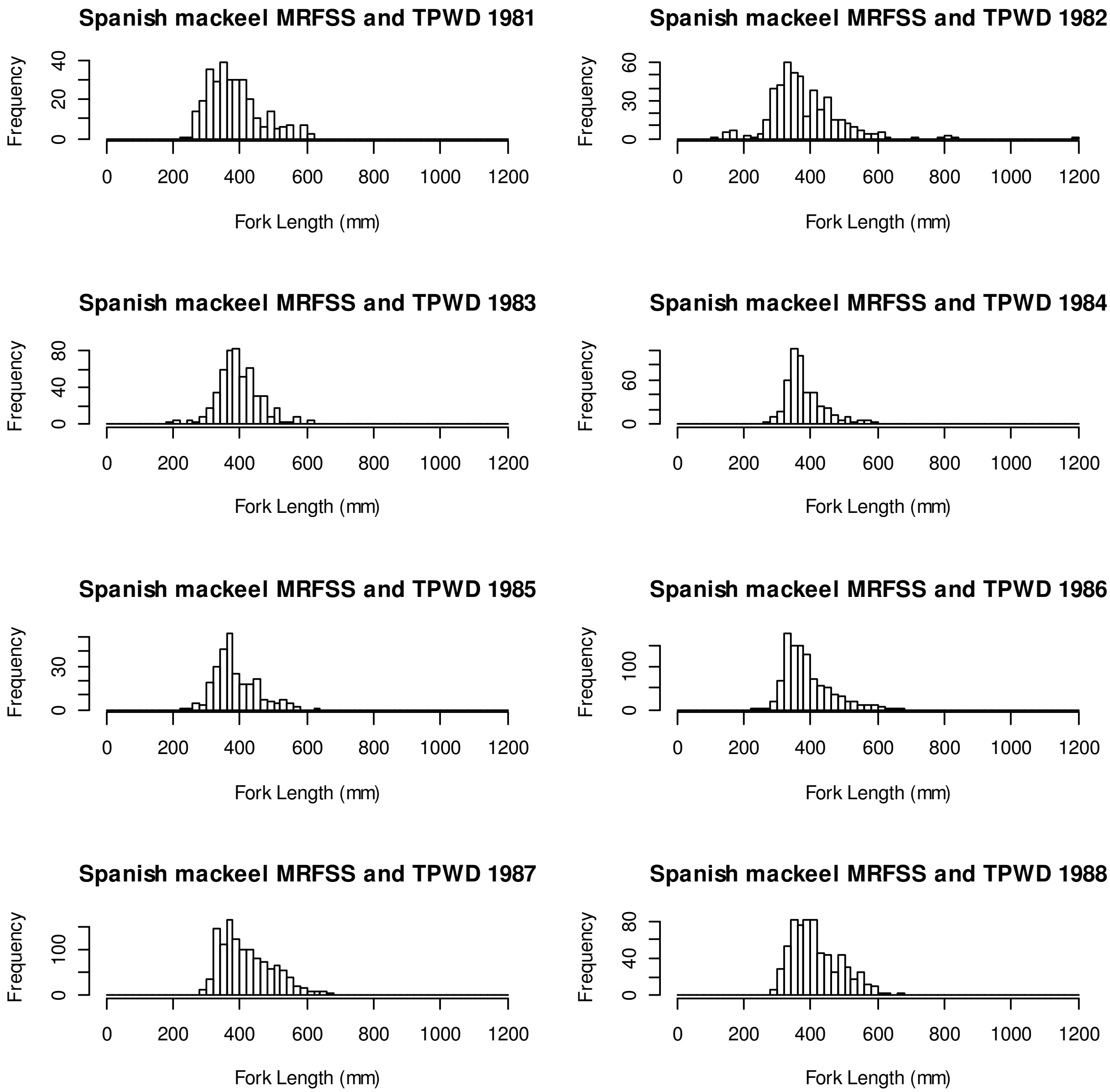


Figure 4.12.20. Length composition from the MRFSS (1981-2011) and TPWD (1983-2011).

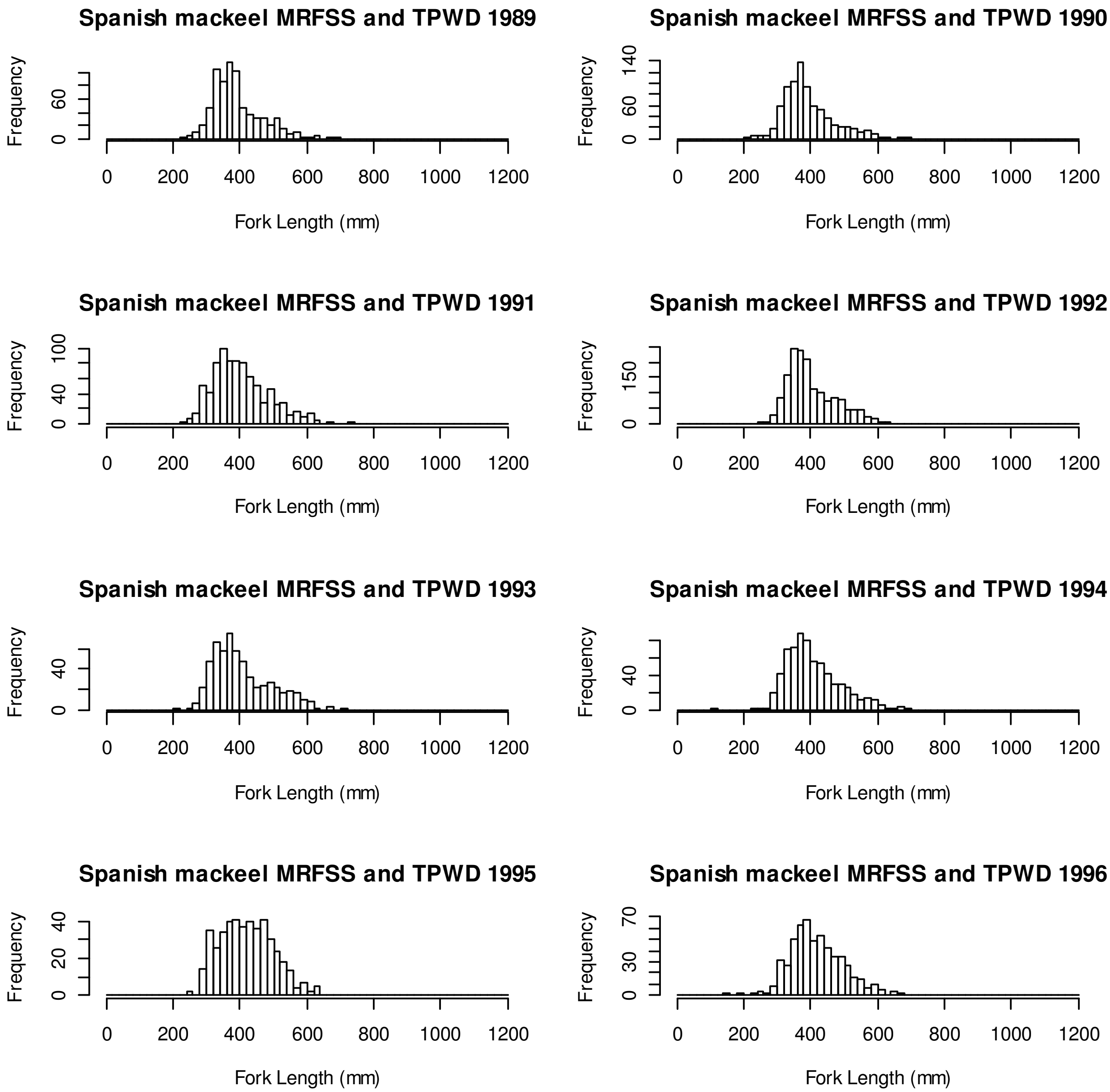


Figure 4.12.20. Length composition from the MRFSS (1981-2011) and TPWD (1983-2011) (continued).

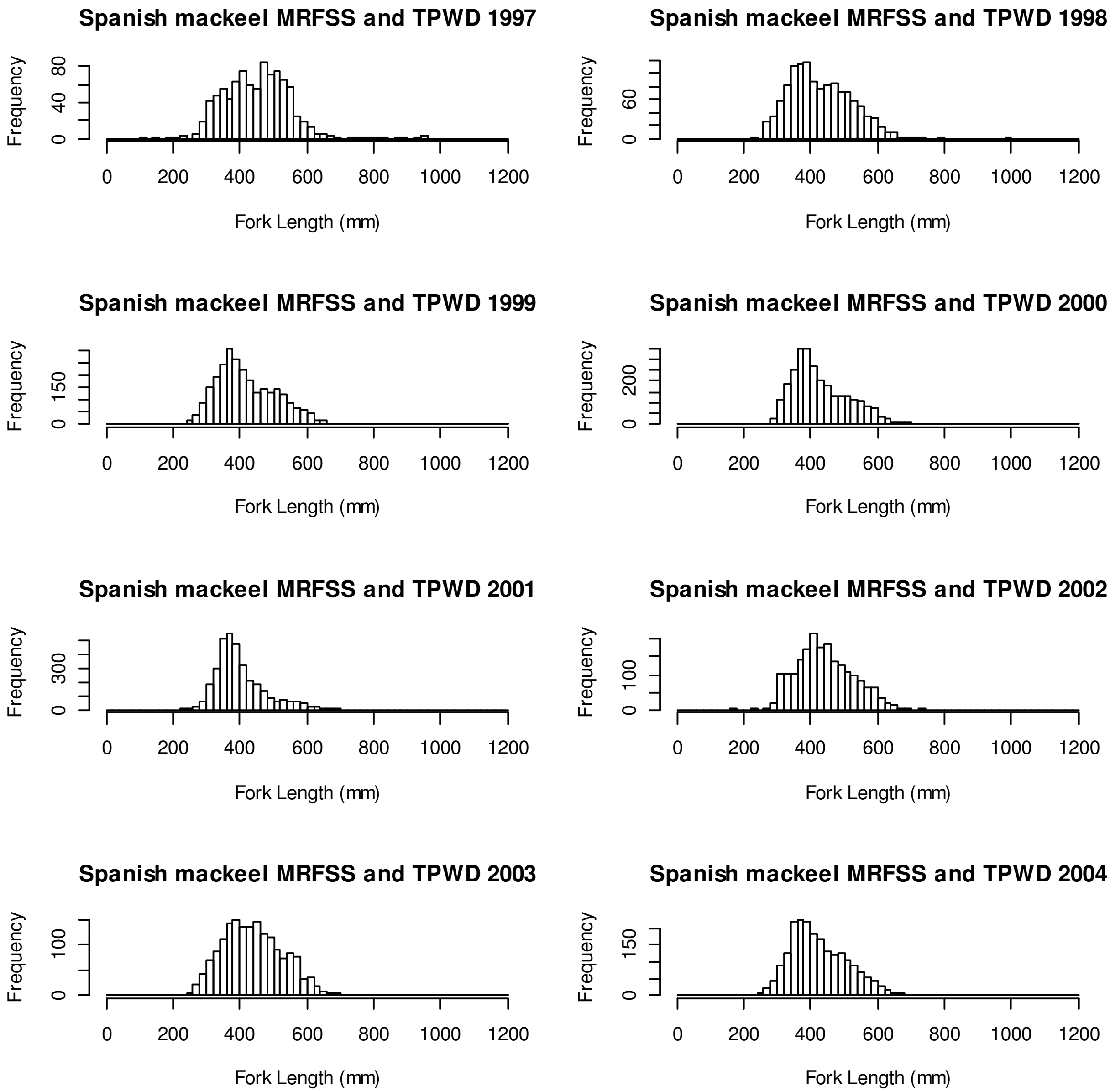


Figure 4.12.20. Length composition from the MRFSS (1981-2011) and TPWD (1983-2011) (continued).

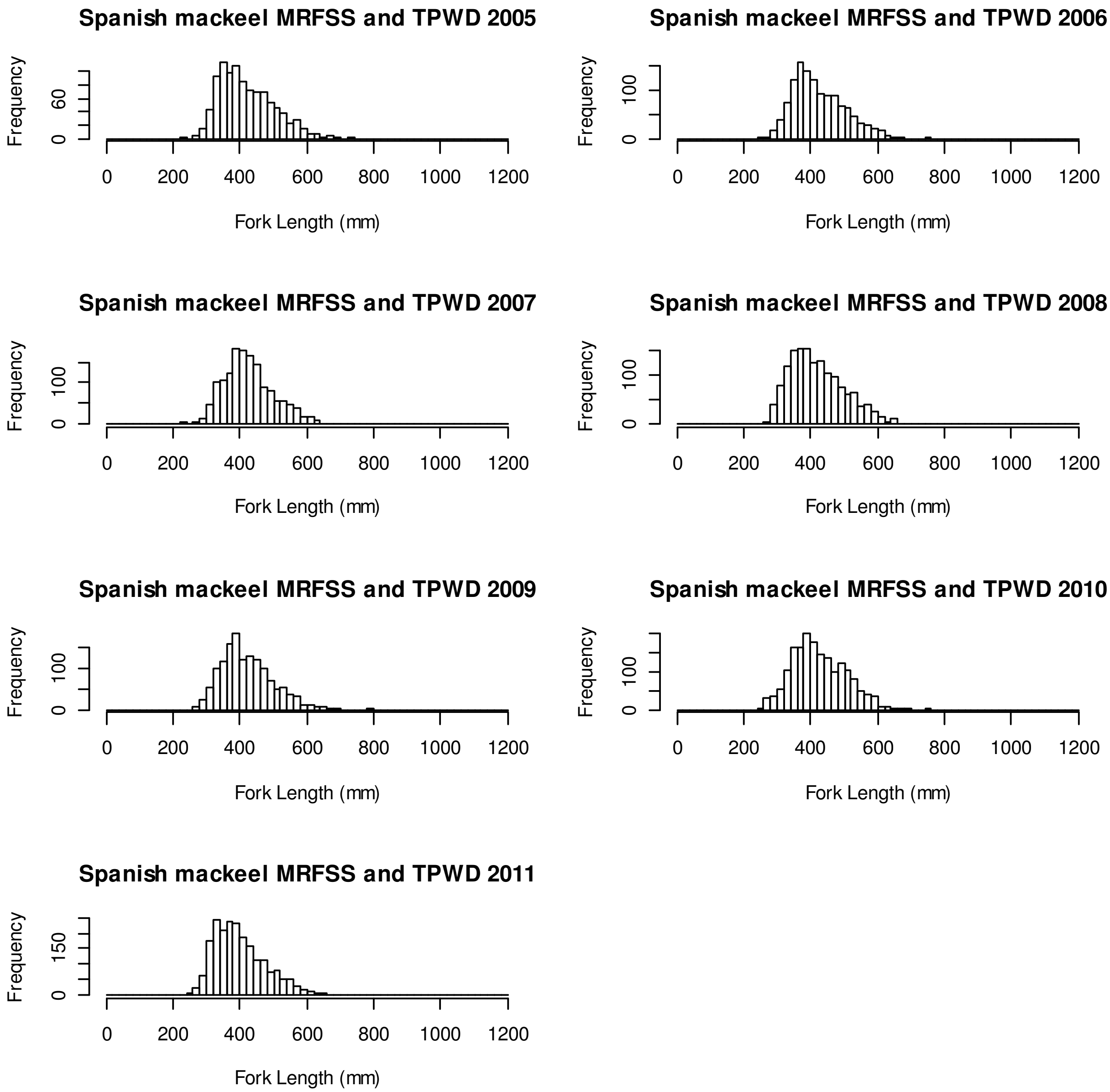


Figure 4.12.20. Length composition from the MRFSS (1981-2011) and TPWD (1983-2011) (continued).

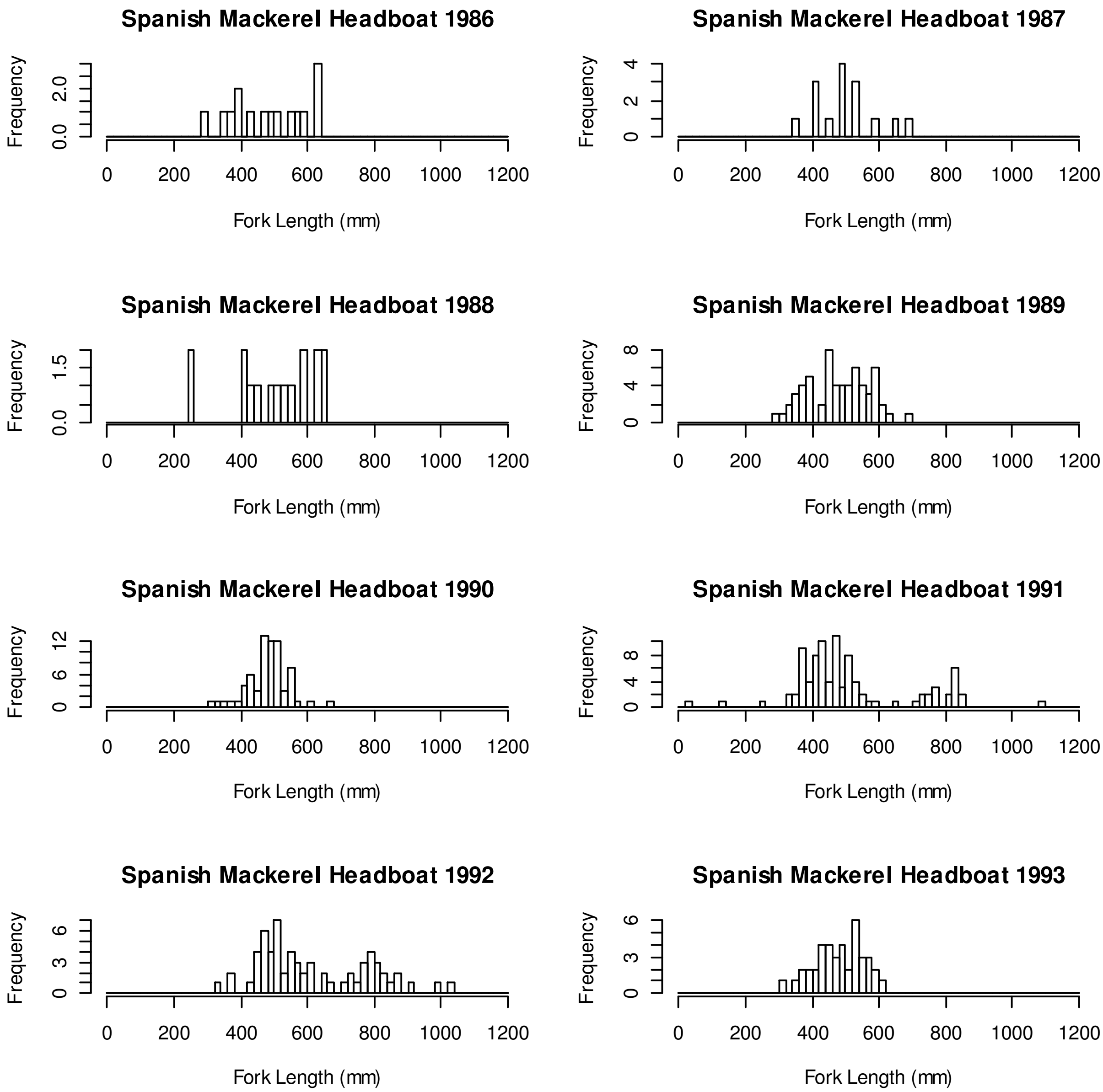


Figure 4.12.21. Headboat length composition 1986-2011.

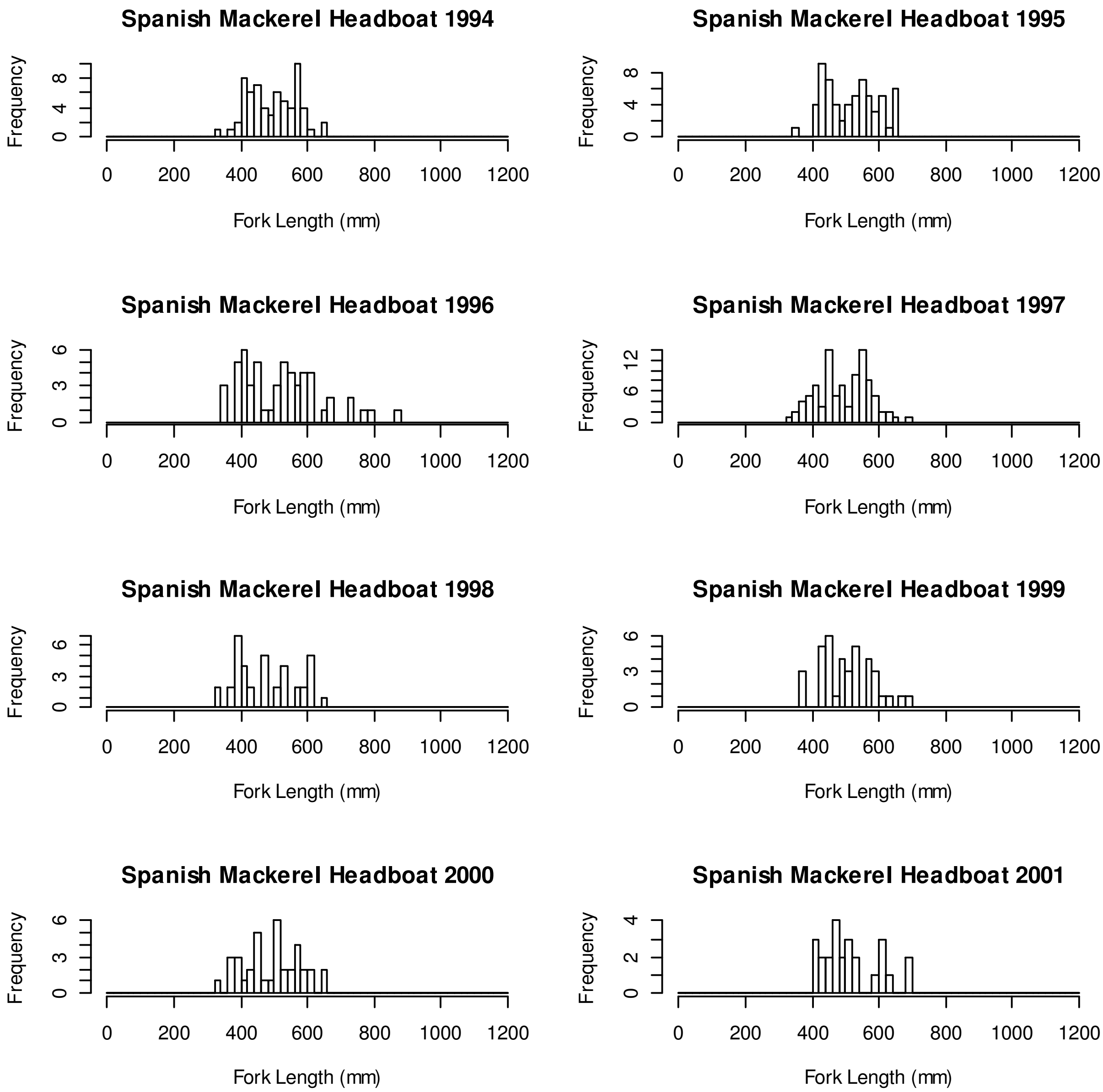


Figure 4.12.21. Headboat length composition 1981-2011 (Continued).

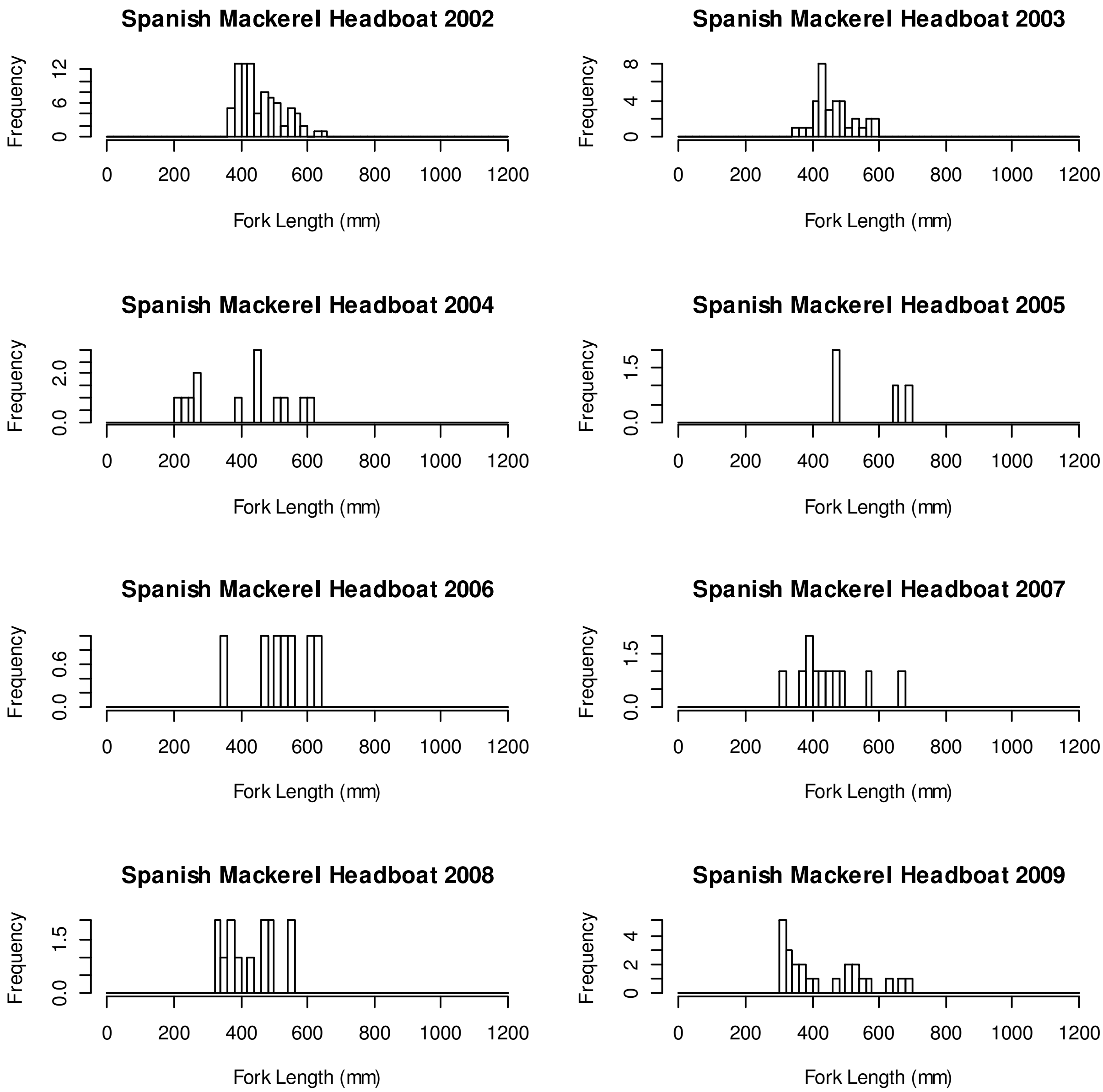


Figure 4.12.21. Headboat length composition 1981-2011 (Continued).

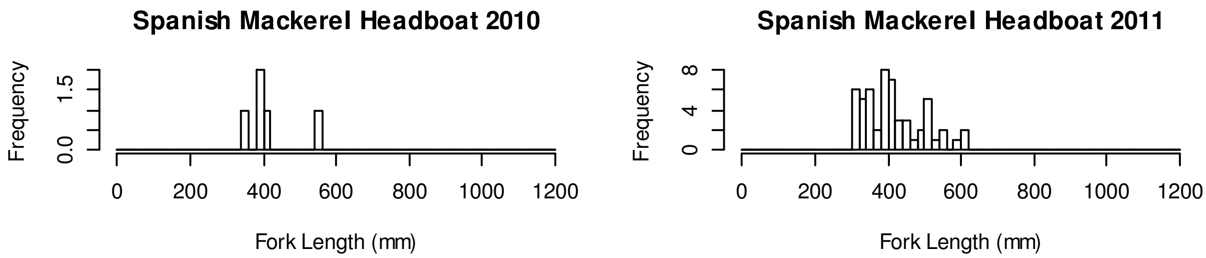


Figure 4.12.21. Headboat length composition 1981-2011 (Continued).

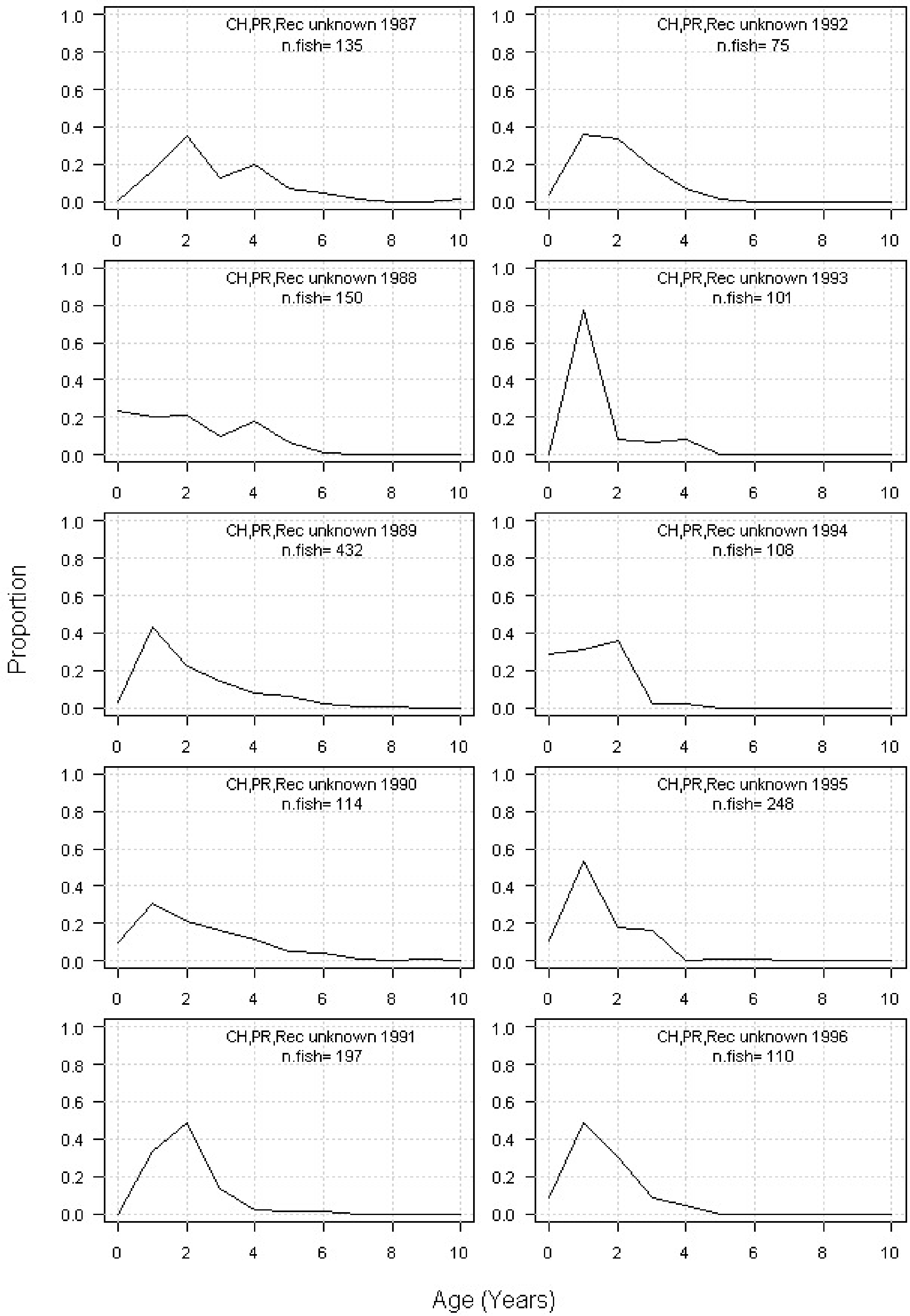


Figure 4.12.22. Age composition of Spanish mackerel from the charter boat, private/rental boat, and recreational (mode unknown) modes (1987-2002, 2004-2011).

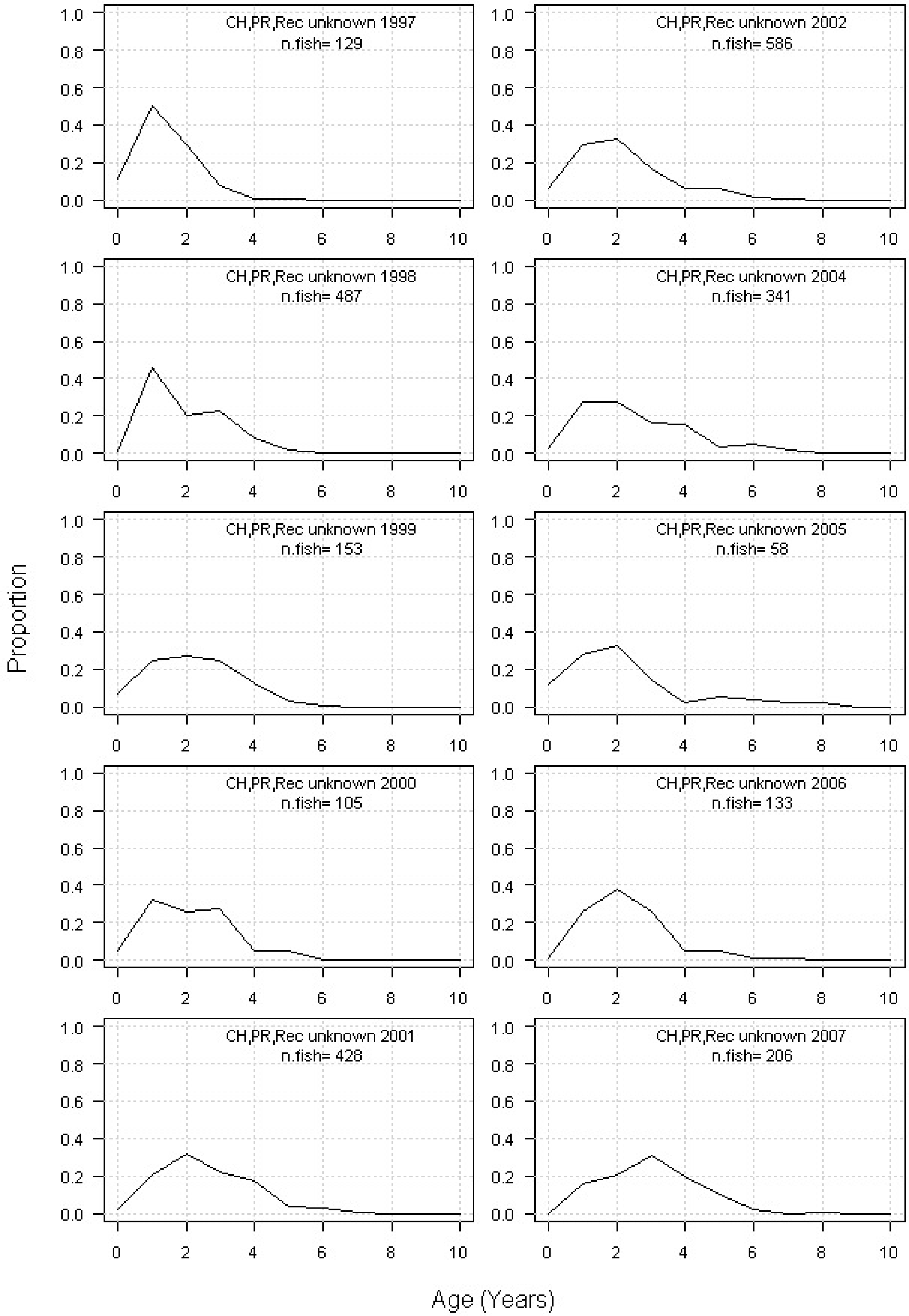


Figure 4.12.22. Age composition of Spanish mackerel from the charter boat, private/rental boat, and recreational (mode unknown) modes (1987-2002, 2004-2011).

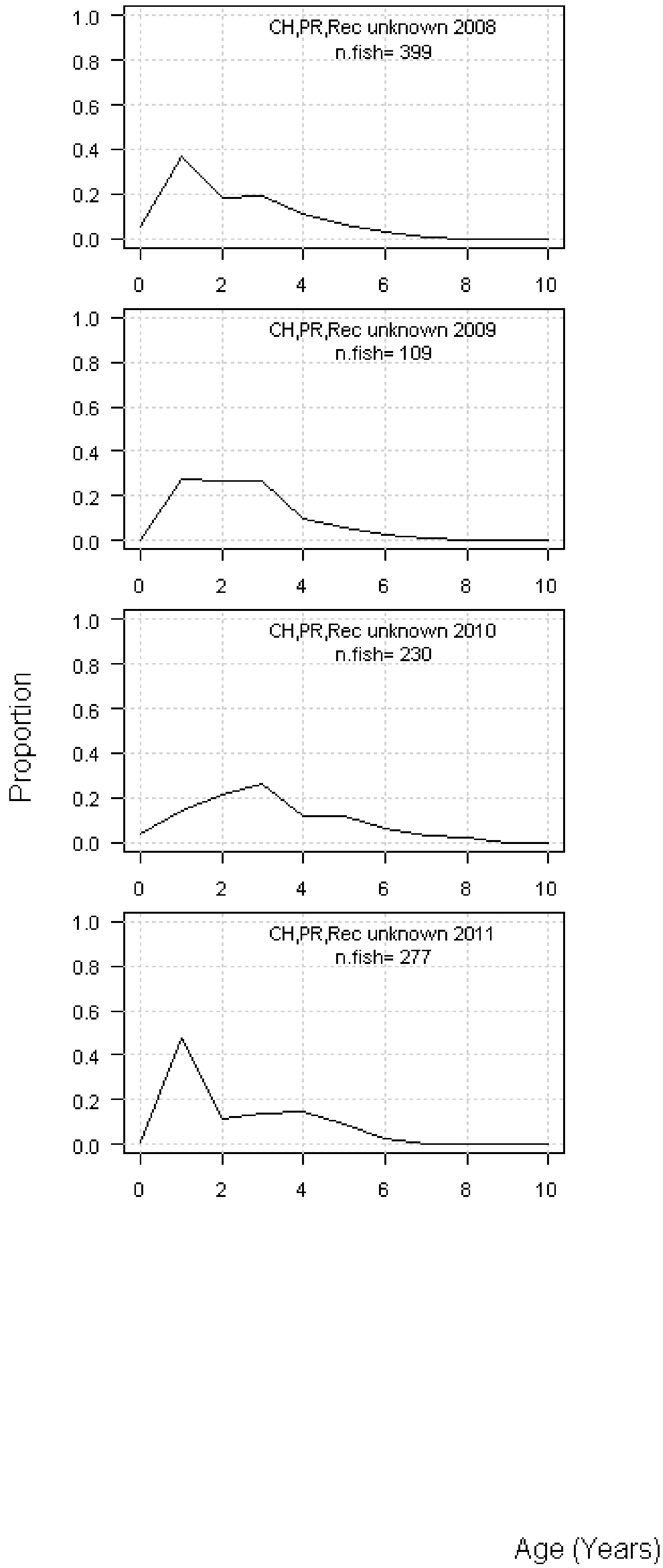


Figure 4.12.22. Age composition of Spanish mackerel from the charter boat, private/rental boat, and recreational (mode unknown) modes (1987-2002, 2004-2011) (continued).

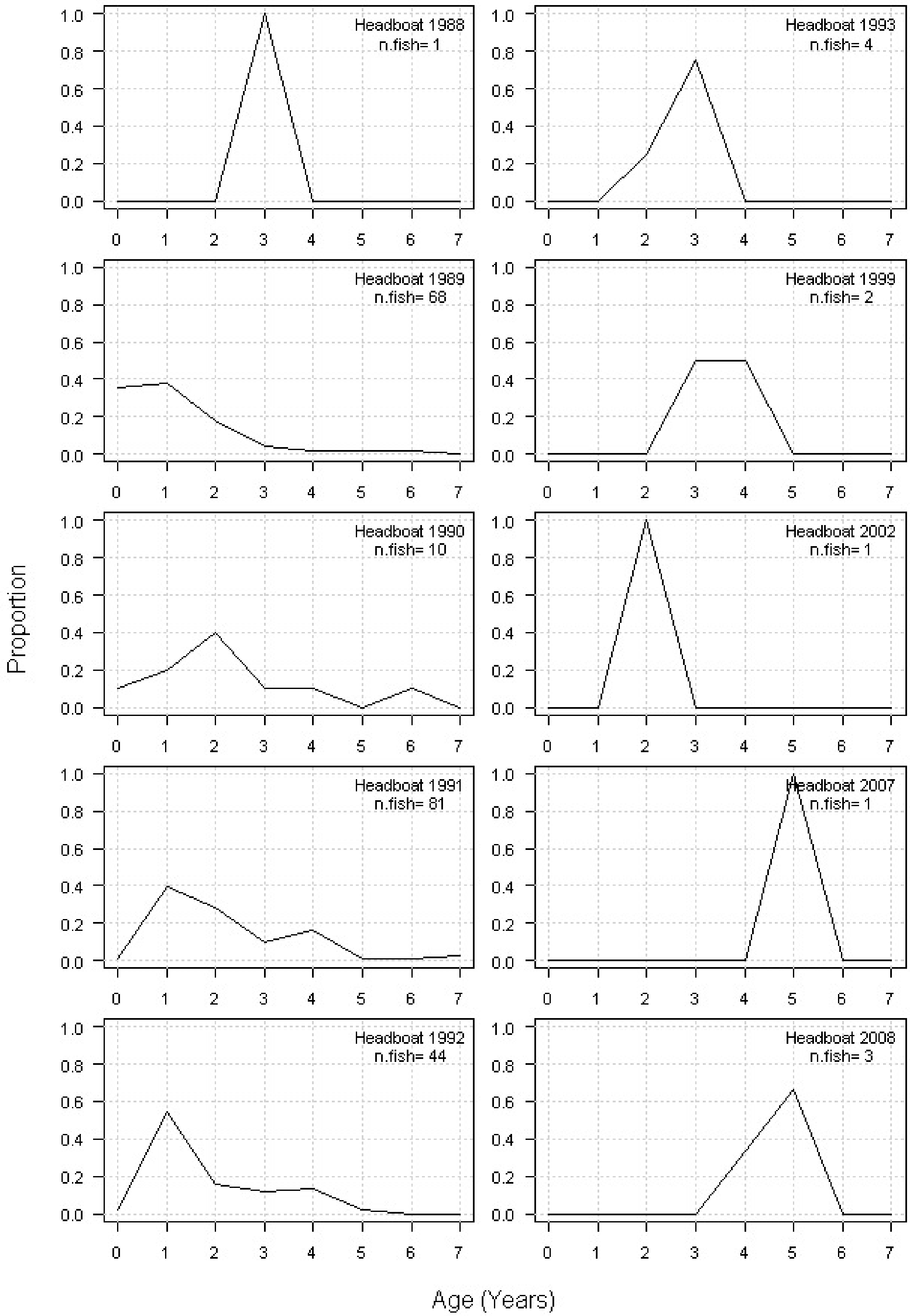


Figure 4.12.23. Age composition of Spanish mackerel from the headboat fleet during 1988-1993, 1999, 2002, 2007-2009, and 2011.

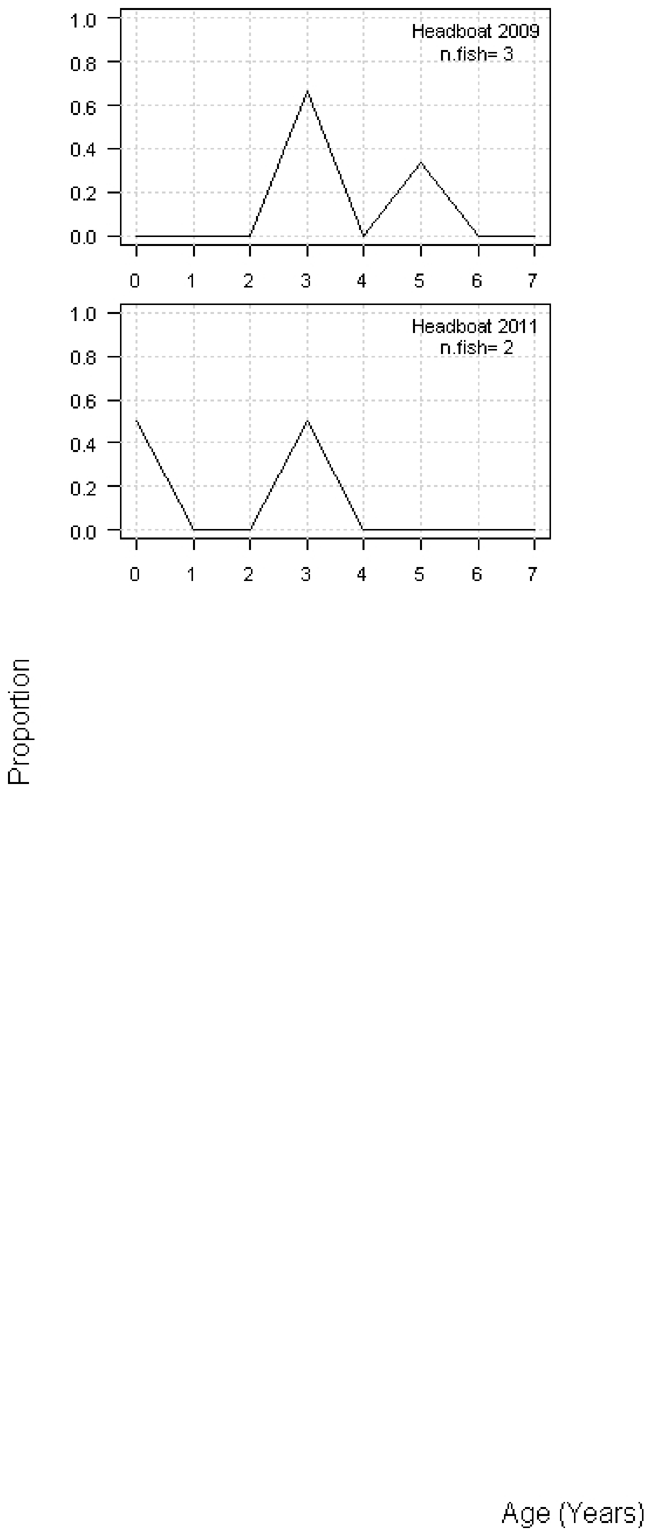


Figure 4.12.23. Age composition of Spanish mackerel from the headboat fleet during 1988-1993, 1999, 2002, 2007-2009, and 2011 (continued).

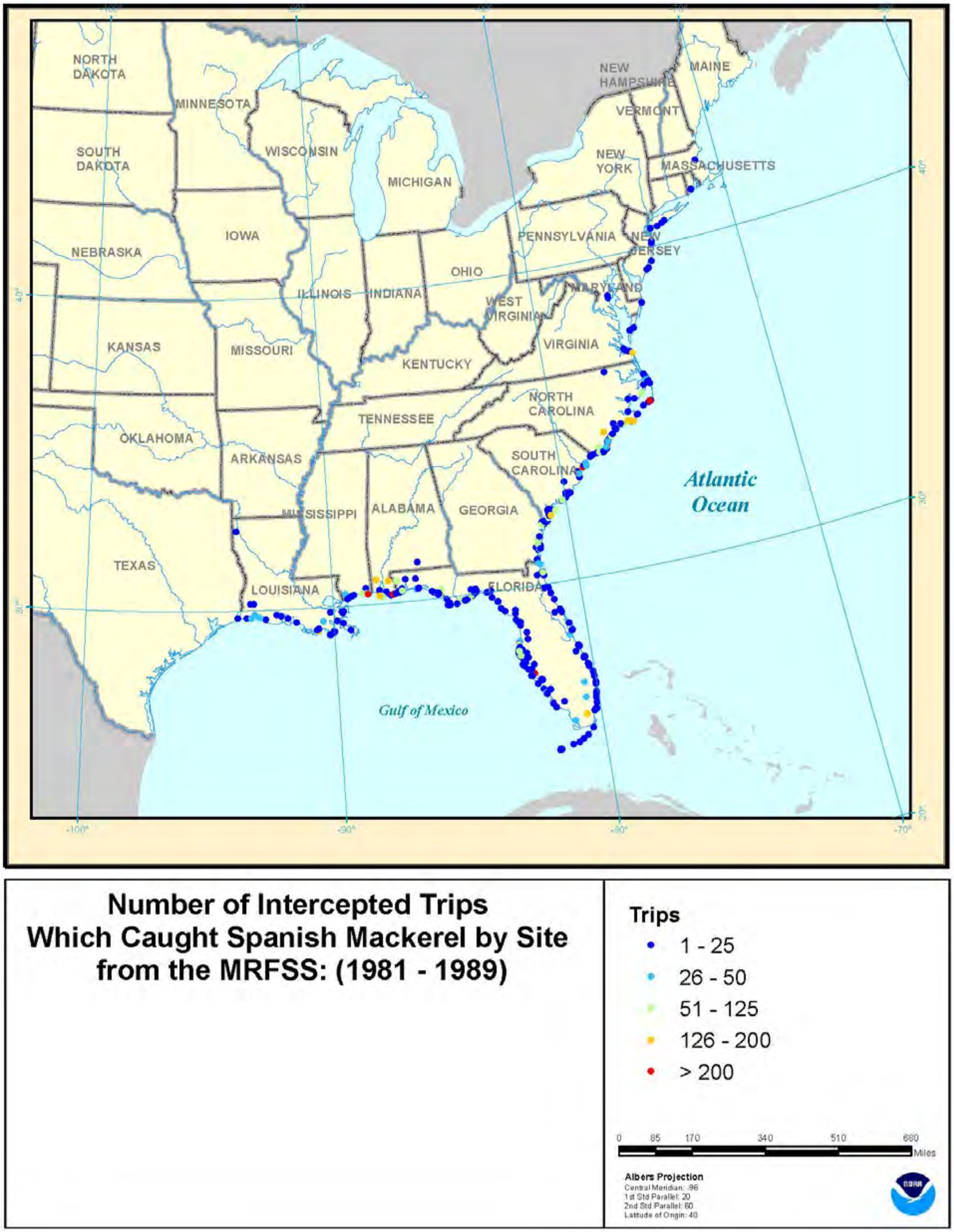


Figure 4.12.24. The number MRFSS intercepted trips which caught Spanish mackerel from 1981-1989.

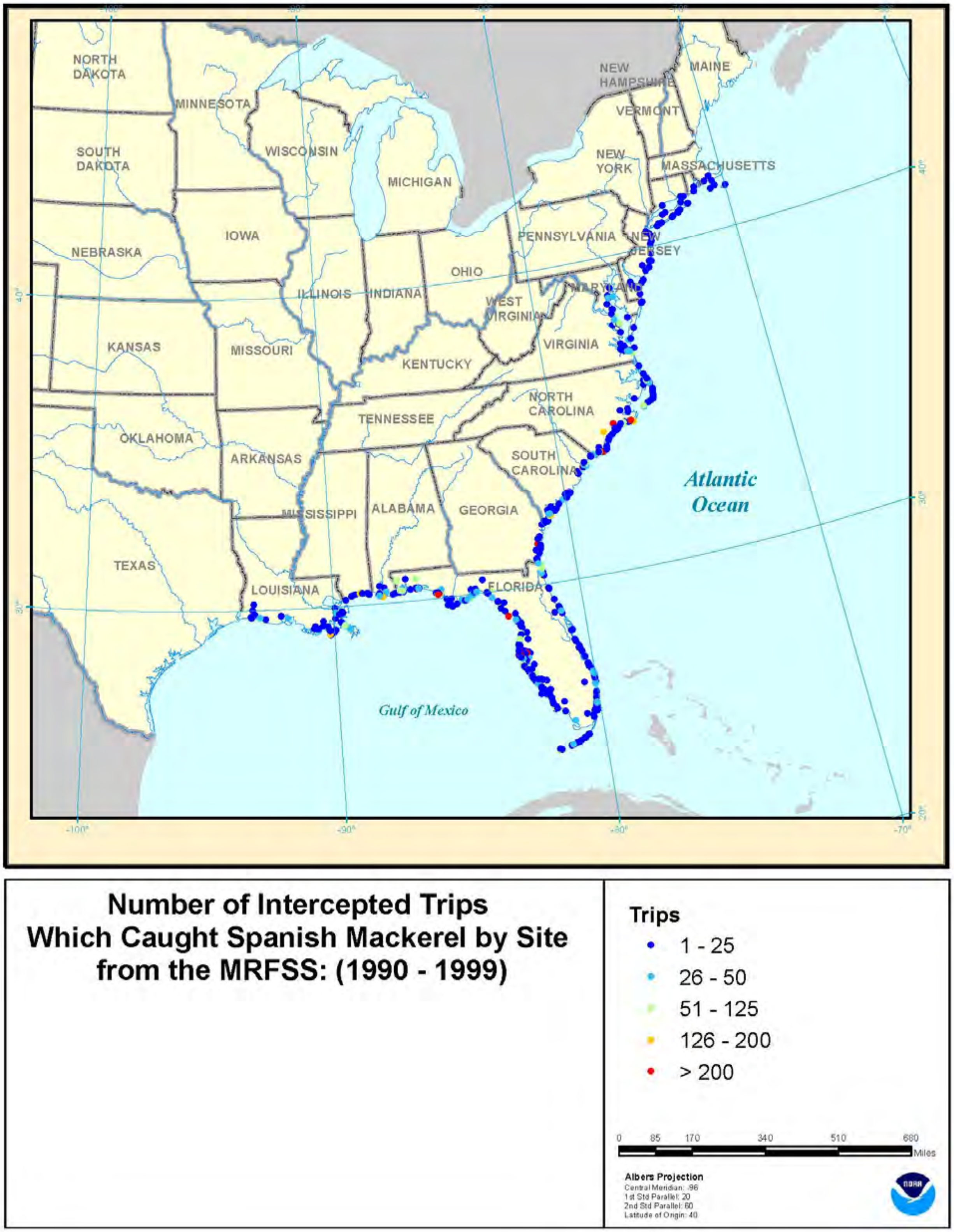


Figure 4.12.25. The number MRFSS intercepted trips which caught Spanish mackerel from 1990-1999.

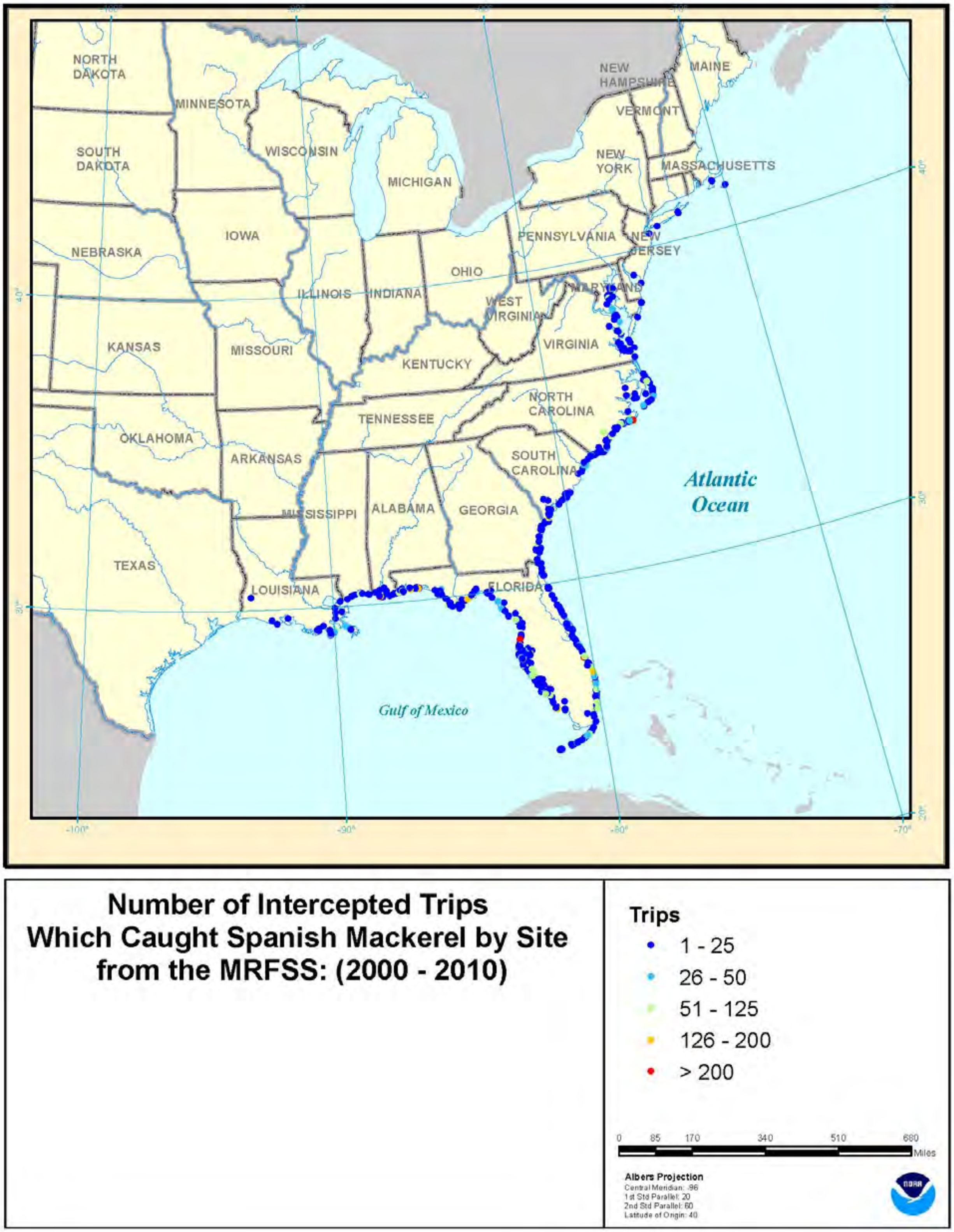


Figure 4.12.26. The number MRFSS intercepted trips which caught Spanish mackerel from 2000-2010.

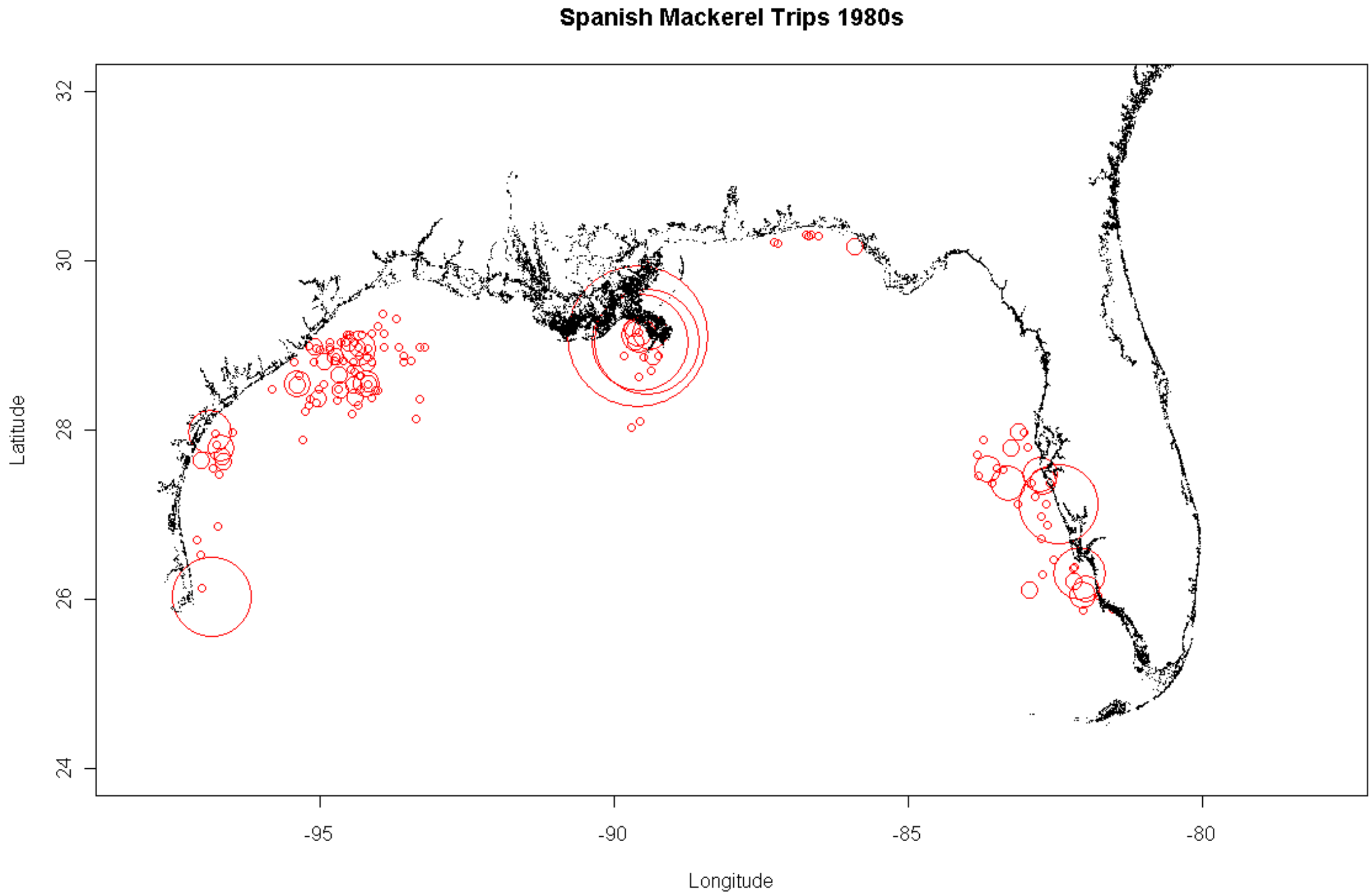


Figure 4.12.27. Reported Spanish mackerel trips from SRHS, 1986-1989. The size of each point is proportional to the frequency of reported trips at the given location.

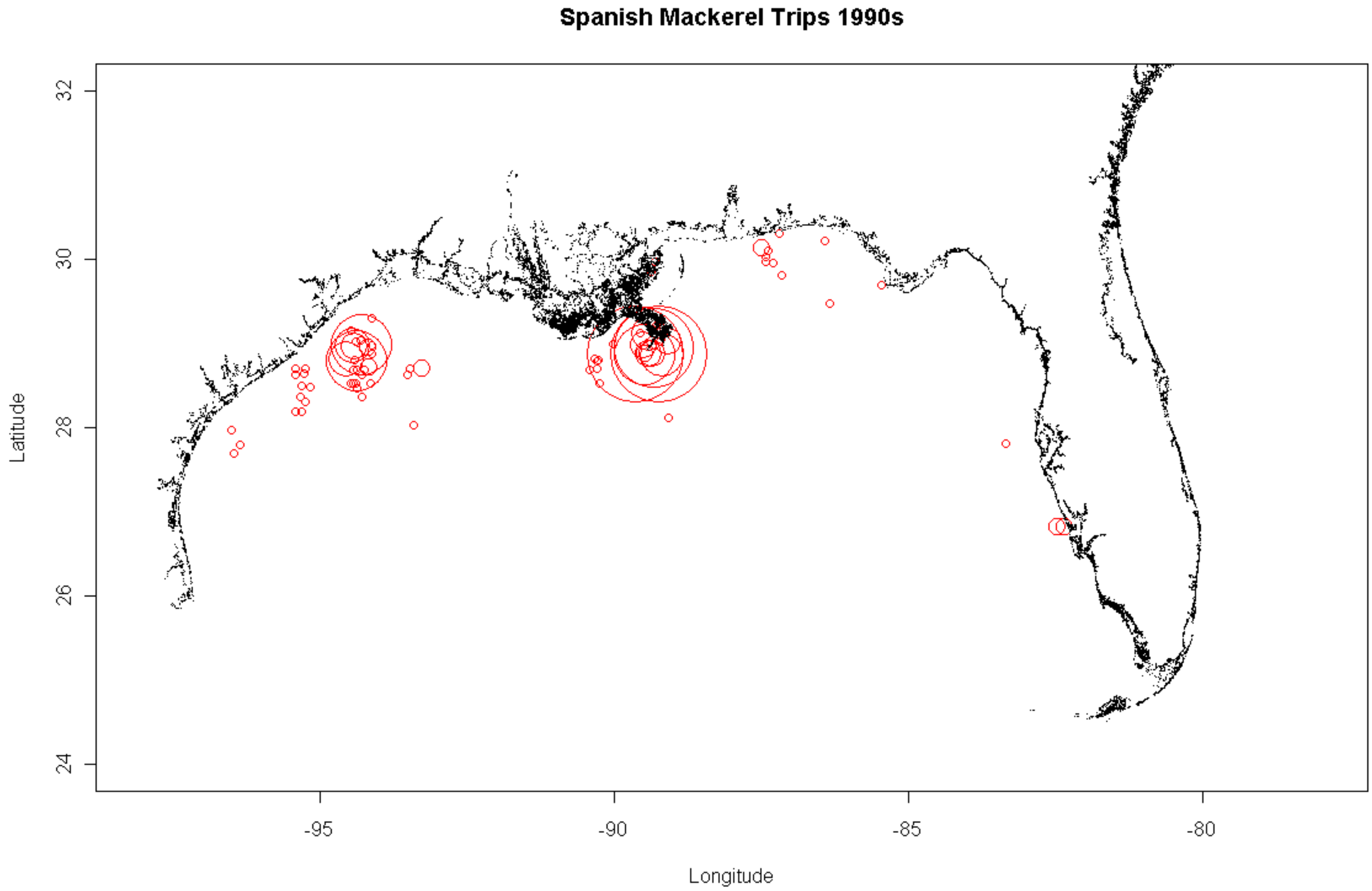


Figure 4.12.28. Reported Spanish mackerel trips from SRHS, 1990-1999. The size of each point is proportional to the frequency of reported trips at the given location.

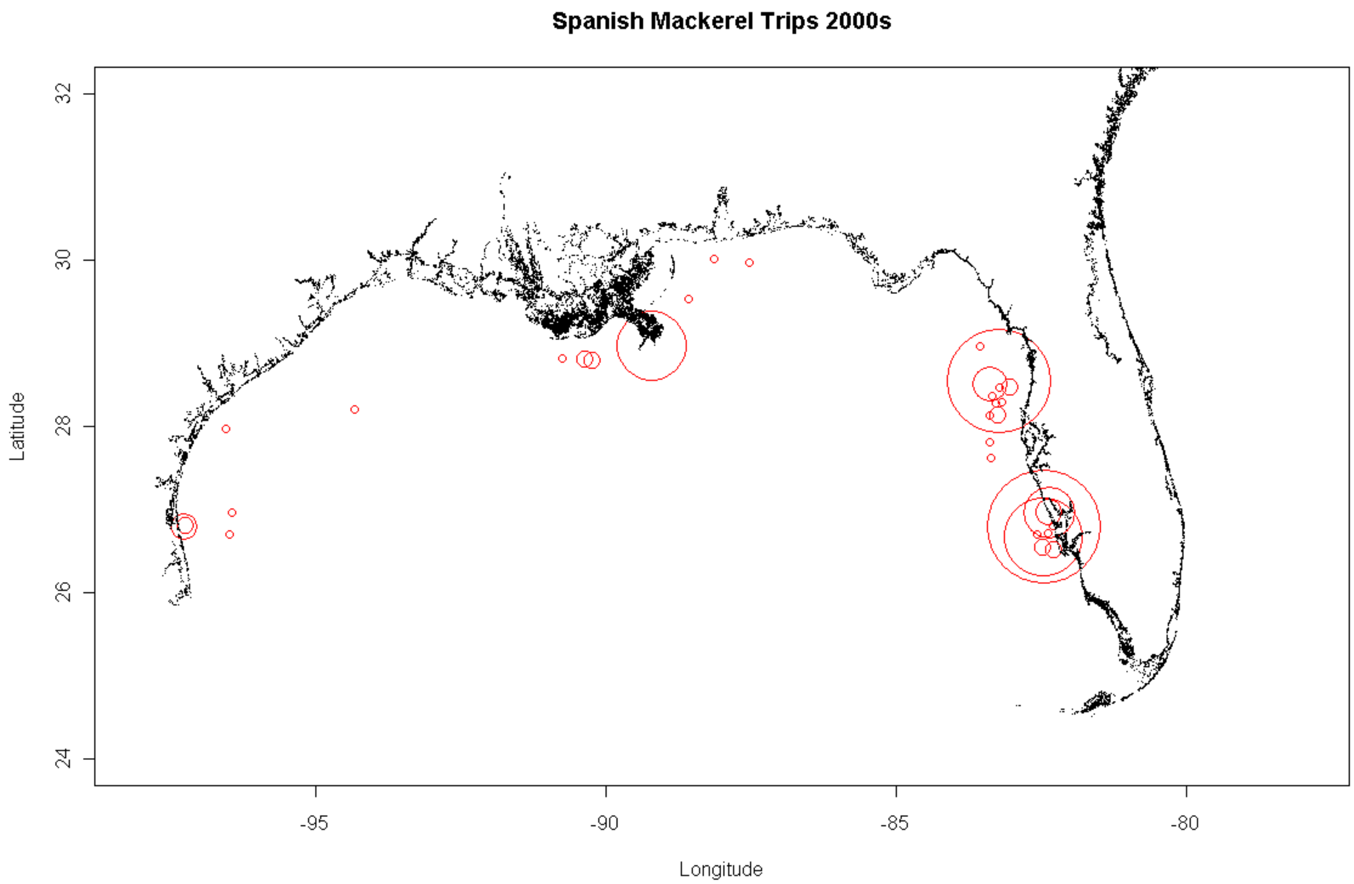


Figure 4.12.29. Reported Spanish mackerel trips from SRHS, 2000-2011. The size of each point is proportional to the frequency of reported trips at the given location.

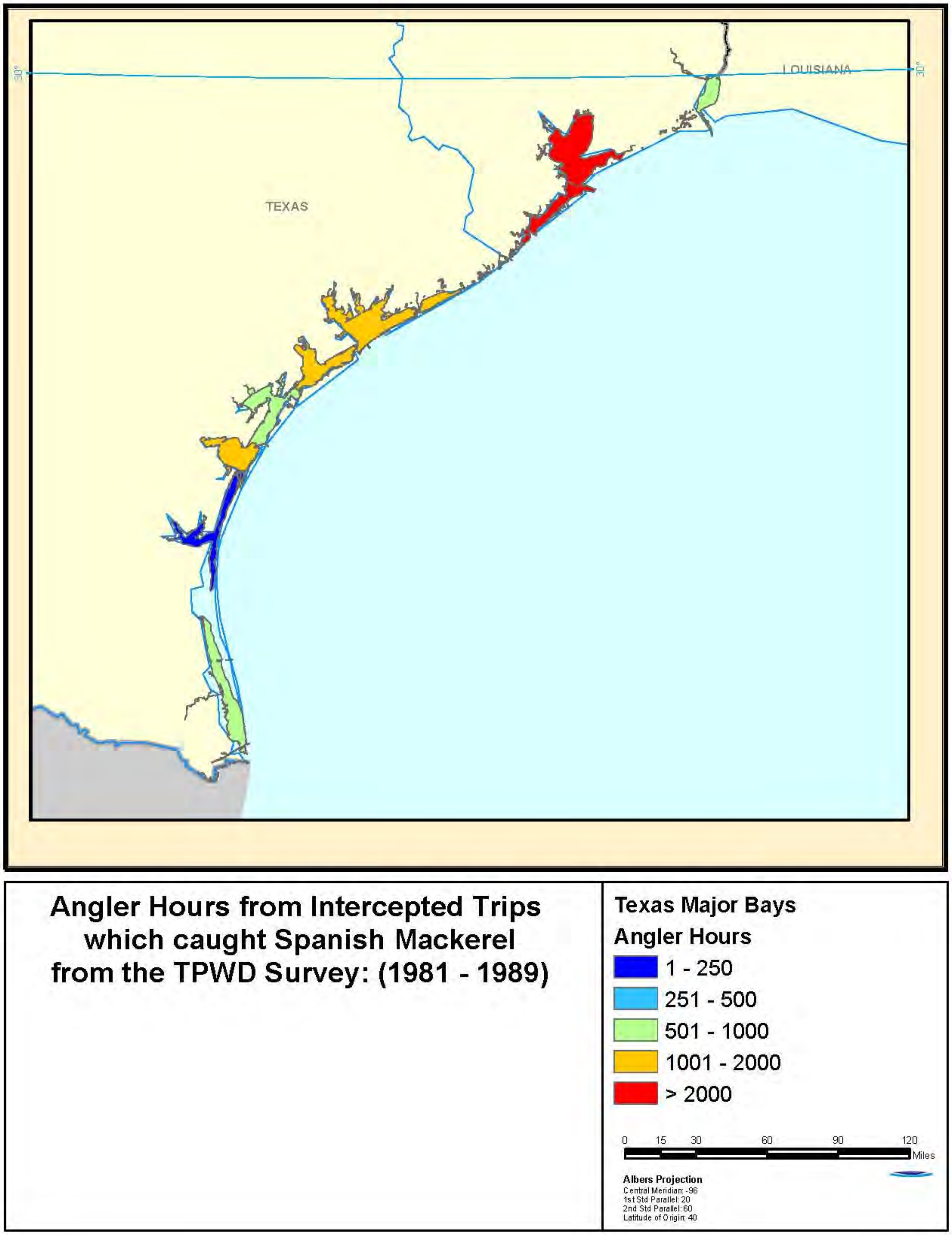


Figure 4.12.30 Angler hours from trips which intercepted Spanish mackerel in the TPWD, 1983-1989.

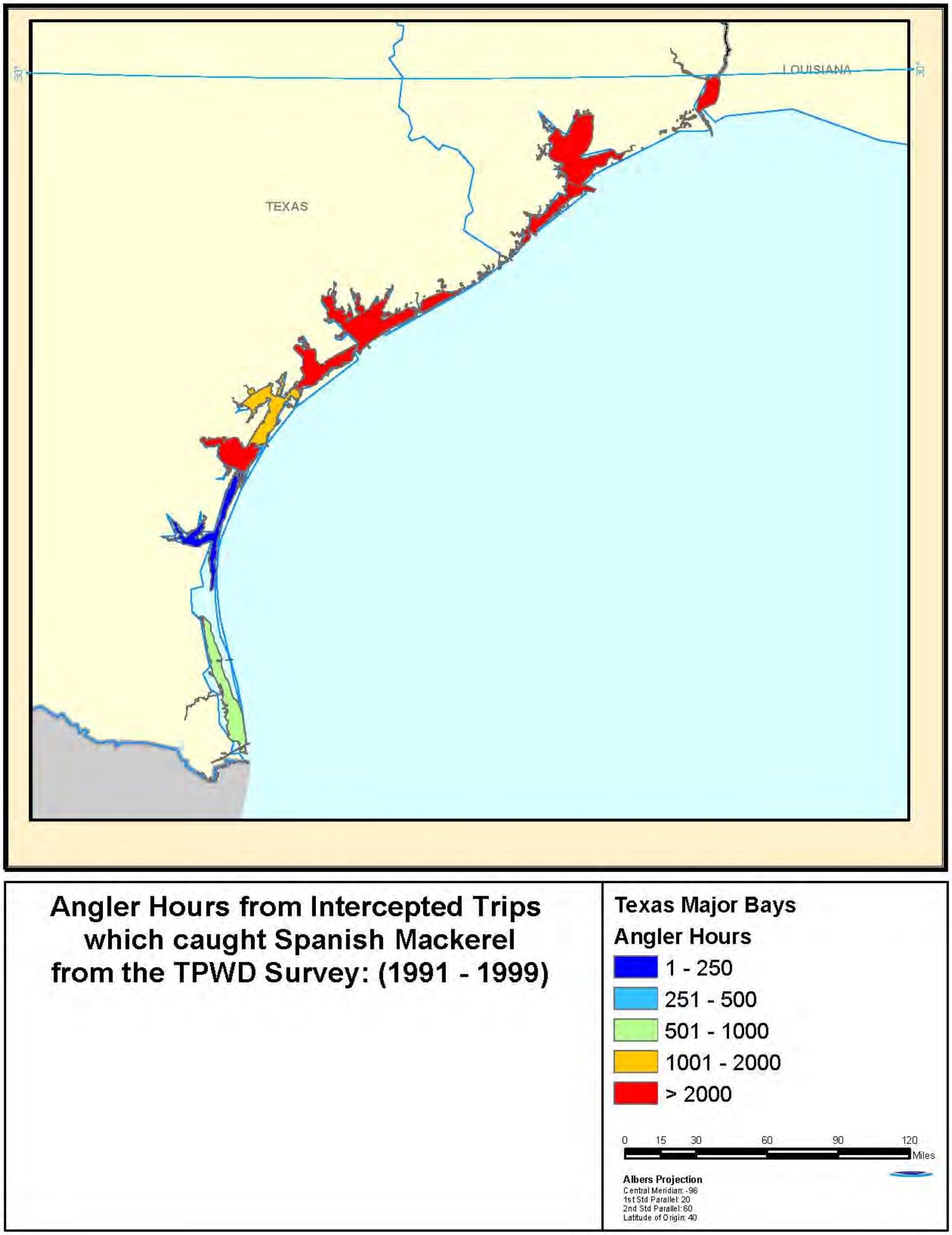


Figure 4.12.31 Angler hours from trips which intercepted Spanish mackerel in the TPWD, 1991-1999.

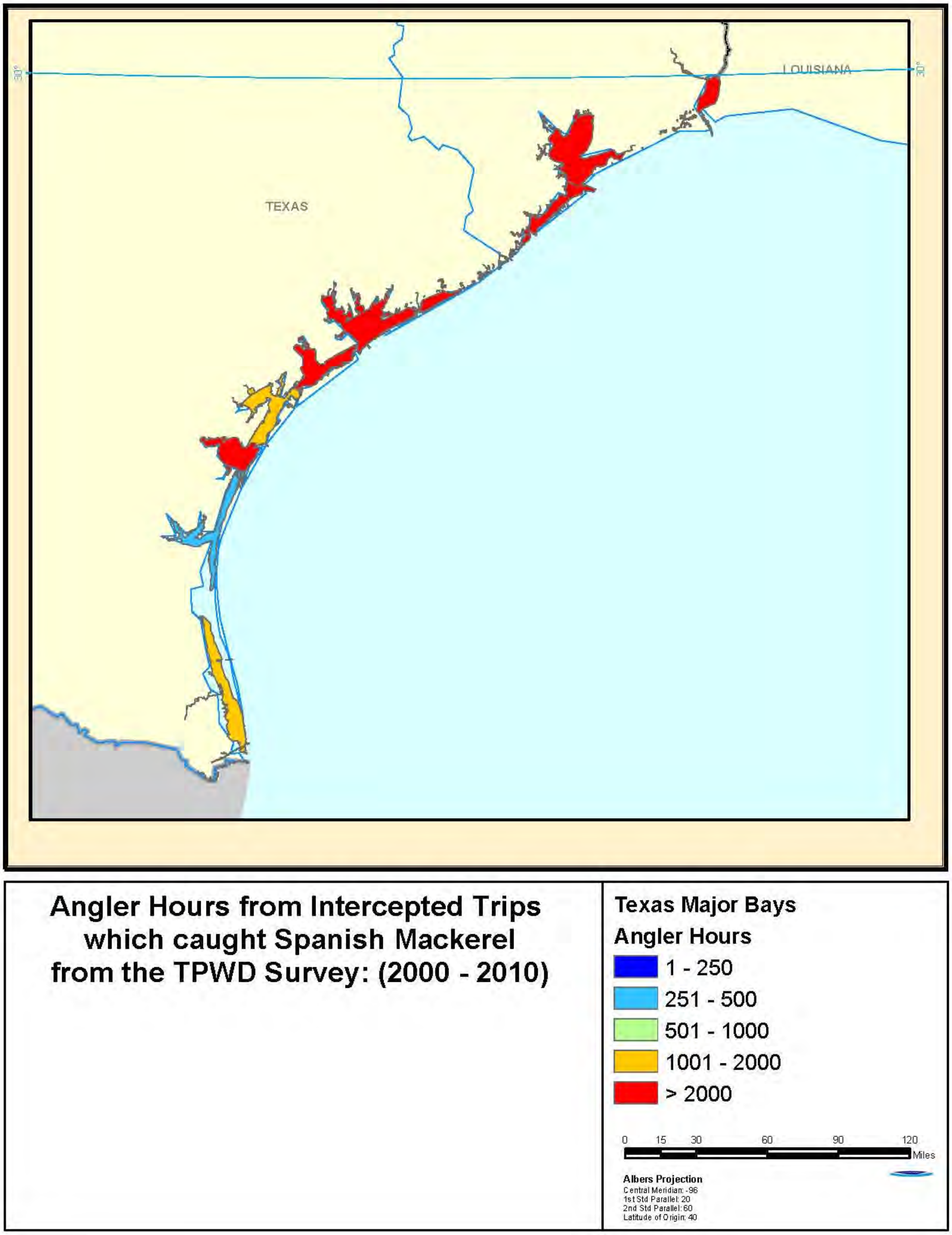


Figure 4.12.32 Angler hours from trips which intercepted Spanish mackerel in the TPWD, 2000-2010.

5 Measures of Population Abundance

5.1 Overview

Analytical results of nine data sets were presented to the Index Working Group (IWG). Eight of the data sets were of fishery-dependent origin and one was of fishery-independent origin. These data sets are listed here along with recommendations by the IWG of whether or not to use the resulting indices in the stock assessment model:

- SEAMAP groundfish survey (*Recommended for use*)
- Texas sport boat angler survey (*Not recommended for use*)
- Commercial logbooks – vertical lines (*Not recommended for use*)
- Commercial logbooks – gillnet (*Not recommended for use*)
- Headboat (*Not recommended for use*)
- MRFSS (*Recommended for use*)
- FL trip ticket – castnet (*Not recommended for use*)
- FL trip ticket – handline/trolling (*Recommended for use*)
- FL trip ticket – gillnet (*Not recommended for use*)

The ranking of indices for Gulf Spanish mackerel by the IWG was 1) SEAMAP 2) trip ticket 3) MRFSS. Also, index adequacies and inadequacies are in report card comments.

Group Membership
IWG members included, Walter Ingram, Jeanne Boylan, Pearse Webster, Clay Porch, Neil Baertlein, Kevin McCarthy, Steve Saul, Meaghan Bryan, Katie Andrews, Kevin Craig, Michael Schirripa, Nancie Cummings, Julia Byrd, Amy Schueller, Eric Fitzpatrick and Mike Errigo, and included other DW participants as needed for discussions throughout the week.

5.2 Review of Working Papers

Not identified.

5.3 Fishery Independent Indices

5.3.1 SEAMAP Groundfish Survey

The Southeast Fisheries Science Center (SEFSC) Mississippi Laboratories have conducted standardized groundfish surveys under the Southeast Area Monitoring and Assessment Program (SEAMAP) in the Gulf of Mexico (GOM) since 1987. SEAMAP is a collaborative effort between federal, state and university programs, designed to collect, manage and distribute fishery independent data throughout the region. The primary objective of this trawl survey is to collect data about the abundance and distribution of demersal organisms in the northern GOM. This survey, which is conducted semi-annually (summer and fall), provides an important source of fisheries independent information on many commercially and recreationally important species throughout the GOM.

A full review of the survey design and methodologies are described in SEDAR28-DW03. The appendix of the document provides an additional index for Spanish mackerel, which was requested by the data working group that only includes data from the federal vessels, since complete state data for 2011 was not available at the time for analysis. We caution using this index (1987-2011, federal only), especially under the new survey design since the states make up a larger portion of the survey (2009: 645 vs. 506 total stations; 2010: 389 vs. 286 total stations). A significant about of data is lost east of the Mississippi River, since MS and AL sample about 60 stations a year. It is also important to note that the majority of the state stations are the shallower stations that get included in the analysis due to the depth distribution of Spanish mackerel.

5.3.1.1 Methods of Estimation

Data Filtering Techniques

Based upon the limited recent sampling that has taken place in shrimp statistical zones 3-9 (Table 5.3.1.1), it was decided to limit the data for this analysis to only zones 10-21 (note that zone 12 is completely outside of the depth range of this survey (5 to 60 fathoms), therefore it is not sampled). Of the 495 stations sampled, only 3 occurrences of Spanish mackerel were reported from these statistical zones. Upon examining the depth zone distribution of occurrences of Spanish mackerel (Table 5.3.1.2), the data were also limited by depth zone, in addition to the aforementioned shrimp statistical zones. For the full model run, all depth zones greater than 35 fathoms were excluded from the analysis. These depth zones accounted for less than 1% of all Spanish mackerel occurrence overall, in addition to not having occurrences greater than 1 % individually.

Based upon the recommendations of the Data Working Group, in addition to the indices from the combined summer and fall surveys, individual indices were prepared from summer and fall surveys. For the fall survey, the same depth zones and statistical zones as the full model run were excluded. However, during the summer months, Spanish mackerel were found in shallower depths overall, with only 6 stations outside of 20 fathoms having a positive occurrence, therefore it was necessary to exclude all depth zones greater than 20 fathoms from the analysis.

Standardization

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

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

Submodel Variables

Year: 1987-2010
Area: Texas (statistical zones 18-21), West Delta (statistical zones 13-17),

East Delta (statistical zones 10-11)

Depth Zone: 5-6, 6-7, 7-8, 8-9, 9-10, 10-11, 11-12, 12-13, 13-14, 14-15, 15-16, 16-17, 17-18, 18-19, 19-20, 20-22, 22-25, 25-30, 30-35
Time of Day: Day, Night
Season: Summer, Fall
Survey: Old, New

Annual Abundance Indices
For a full review of the backward selection procedure for each submodel and diagnostic plots, refer to SEDAR28-DW03.

In the full model (summer and fall surveys), year, area, depth zone, time of day and season were retained in the binomial submodel. The variables retained in the lognormal submodel were year, area, depth zone and time of day. The AIC for the binomial and lognormal submodels were 56,581.5 and 1999.9, respectively. The AIC for the binomial submodel increased slightly when the survey variable was removed from the submodel, however, based upon the p-value (0.2844), it was determined that the slight increase was acceptable. However, the AIC for the lognormal submodel was the lowest of all the model runs.

For the summer model, year, area, depth zone and time of day were retained in the binomial submodel. The variable retained in the lognormal submodel was year. The AIC for the binomial and lognormal submodels were 23,424.2 and 627.0, respectively. Since all the variables were significant in the binomial submodel the AIC remained unchanged. However, the AIC value increased slightly when variables were removed from the lognormal submodel. Based upon the p-values for area, depth zone and time of day (0.9707, 0.2587 and 0.0691, respectively), it was determined that the slight increase was acceptable.

For the fall model, year, area, depth zone and time of day were retained in both the binomial and lognormal submodels. The AIC for the binomial and lognormal submodels were 27,218.7 and 1300.5, respectively. Since all variables were significant in the both submodels the AIC remained unchanged.

5.3.1.2 Sampling Intensity
A total of 11,433 stations were sampled from 1987- 2010 (Figure 5.3.1.1).

5.3.1.3 Size/Age Data
The sizes of Spanish mackerel represented in this index are presented in Table 5.3.1.3 and Figures 5.3.1.2.

5.3.1.4 Catch Rates
Standardized catch rates are presented in Tables 5.3.1.4 - 5.3.1.6.

5.3.1.5 Uncertainty and Measures of Precision
Annual CVs of catch rates are presented in Tables 5.3.1.4 - 5.3.1.6.

5.3.1.6 Comments on Adequacy for Assessment

The IWG recommended this index for Spanish mackerel for use in the assessment model, due to the fact that it is a fisheries independent survey across a long time series (1987-2010), with very good spatial converge (TX/Mexico border to Mobile Bay).

5.4 Fishery Dependent Indices

5.4.1 Texas Parks and Wildlife Departments Sport-boat Angling Survey

Information on catch per unit of effort for recreational coastal sport-boat fisheries in Texas was summarized. These data were evaluated for the use of calculating catch per unit of effort (CPUE) abundance trends for Spanish mackerel in the Gulf of Mexico for use in SEDAR 28 stock evaluations. The Texas Parks and Wildlife Departments Sport-boat Angling Survey (TPWD) index included interviews from May through September, private and charterboat modes, Gulf areas off major bay systems in nearshore and offshore waters only. Observations of recreational catch and effort were available for sport-boat fisheries in Texas from 1983 - 2010. The TPWD Sport-boat Angling Survey samples fishing trips made by sport-boat anglers fishing in Texas marine waters; these include private and charterboat fisheries. All sampling takes place at recreational boat access sites. The primary focus of the TPWD survey is on private boats fishing in bays and passes because this accounts for most of the coastwide fishing pressure and landings in TX (78% of fishing effort and 67% of landings during May15, 2002 to May 14, 2003). Private boats in gulf waters (7% of effort), charterboats in bays and passes (14% of effort), and charterboats in gulf waters (<2% of effort) are also included in the TPWD survey, but special surveys are added to increase the precision of trips fishing in gulf areas since they are not encountered frequently in the normal survey. In addition, the survey is designed to estimate landings and effort by high-use seasons (May15-November 20) and low-use seasons (November 21-May 14). More details regarding the TPWD sport-boat fishing surveys are provided in Appendices I and II. For all analyses CPUE was calculated as catch (number fish caught) divided by effort (number anglers x triplength).

The development of the CPUE index is described in more detail in SEDAR28-DW09. The appendix to the working paper describes decisions made by the SEDAR 28 DW panel with updated tables and figures. The SEDAR 28 DW index working group decisions summarized in SEDAR28-DW09 (Appendix 1).

5.4.1.1 Methods of Estimation

Data Filtering Techniques

While exploring TPWD data to develop a standardized index for Spanish mackerel in the Gulf of Mexico, the following methods were investigated.

Stephens & McCall

First the Stephens and MacCall (2004) method was explored in an attempt to identify directed Spanish mackerel trips in the complete TPWD recreational data CPUE data set. This method uses the species composition information on a trip to subset the complete data or to help identify trips or set to only those trips on which the species of interest (the target species, Spanish mackerel in this case) would occur. The analysis involves fitting a logistic regression to the presence-absence of each trip's species catch. Routinely, the species composition included in the regression includes only those species occurring in at least 1% of all the trips combined. The analysis results include a critical probability value that predicts the target species presence and/or absence in the study data set which is used to select trips on an objective basis. In the Stephens and MacCall analysis of the TPWD data 329,616 unique trips were evaluated for Spanish mackerel targeting preference. The species that occurred in at least 1% of all the trips were TPWD species codes: 614, 629, 616, 625, 613, 602, 621, 772, 758, 818, 611, and 681 (Spanish mackerel). These species were then included in the logistic regression with Spanish mackerel included as the target species. The results of the Stephens MacCall analyses of the TPWD recreational CPUE data were not successful in identifying a suite of trips targeting Spanish mackerel. We found that on the majority of the 329, 616 fishing trips only one or two species were caught making it difficult to identify a group of species that might associate with the target species (Spanish mackerel). In total, across all the time series, 1983-2010, Spanish mackerel occurred on only 1.1% (n=3,653) of all trips. Thus, we considered two datasets for the CPUE standardization analyses. The first set of observations included all the data. The second data set that was evaluated for CPUE was formed by excluding inshore fishing trips from the CPUE SEDAR28-DW09 2 standardizations. We found that the majority of the recreational fishing effort for Spanish mackerel did not occur inshore but rather in waters <10 miles (TTS, NEWAREA 3) or in waters >10 miles (EEZ, NEWAREA area 4) thus inshore effort in the bays and passes (NEWAREA 5) was excluded from subsequent analyses. The total number of trips in these two areas waters <10 miles and waters >10 miles) was 25, 337 of which Spanish mackerel occurred in 308 or 1.2% across all years. The exclusion of bays and passes is consistent with the previous MSAP 2003 analysis. For each analysis data set (Set 1: all observations (n=329, 616 trips) and Set 2: NEWAREAS 3 and 4 (n=25,337 trips) we then attempted to construct standardized CPUE indices were explored using the delta-lognormal modeling approach (Lo et al. 1992). This method applies two separate models, fitting a lognormal model to the positive CPUE observations and a separate binomial (logistic) model to the proportion of successful (positive) observations and combines results from the two models to obtain a single index. Parameter estimates were obtained using a general linear modeling (GLM) procedure (SAS GLIMMIX and MIXED procedures; SAS v.9.2 2004 of the SAS System, SAS Institute Inc.; Cary, NC, USA) to develop the binomial and lognormal sub models. Factor (covariate) significance was evaluated using Type 3 residual analysis and overall performance was assessed from residual analysis graphics. Residuals by year were plotted and reviewed and QQ plots of the residuals against a normal distribution were plotted. In applying the GLM procedure we assumed the proportion of successful trips per stratum approximated a binomial distribution, where the estimated probability was a linearized function of the fixed factors. We used a second generalized linear model to examine the influence the fixed factors on log(CPUE) of successful trips assuming a normal error distribution for the positive catch rates. As defined earlier, catch rate was calculated as number fish caught divided by (number anglers x triplength). Model Construction A forward stepwise procedure was used to quantify the relative importance of the factors that influenced catch rates. Factors evaluated were: YEAR, MONTH, NEWAREA (3 = <10 miles (TTS), 4 = >10 miles (EEZ), 5 = inshore (bays and passes), major bay (1 = Sabine Lake, 2 = Galveston, 3 = Matagorda, 4 = San Antonio, 5 = Aransas, 6 = Corpus Christi, 7 = Upper Laguna Madre, 8 = lower Laguna Madre), mode (3 = charterboat, 4 = private boat). First the null model was run. These results reflect the distribution of the nominal data. Next we added each potential factor to the null model one at a time, and examined the resulting reduction in deviance per degree of freedom. The factor that caused the greatest reduction in deviance per degree of freedom was added to the base model if the factor was significant ($p<0.05$) based upon a Chi-Square test, and the reduction in deviance per degree of freedom was >1%. This model then became the base model, and the process was repeated, adding factors and interactions individually until no factor or interaction met the criteria for incorporation into the final model. Year was always included in the model, regardless of its importance because it is required to calculate the standardized catch index for each year. After the models were identified, they were fit to the proper response variables using the SAS macro GLIMMIX (c/o Russ Wolfinger, SAS Institute Inc.). All factors and interactions were treated as fixed effects except year*factor interactions, which were treated as random effects. Interaction effects at the first level were considered for all the fixed factors.

Positive Trips

Applying methods described by Stephens & MacCall (2004) to Spanish mackerel resulted in a 67% reduction in positive Spanish mackerel trips while identifying approximately 11,000 trips that were unsuccessful at catching Spanish mackerel. A large reduction in positive Spanish mackerel trips and an inflation of zero Spanish mackerel trips was anticipated due to the infrequency of Spanish mackerel in the Texas nearshore fishery, therefore a more appropriate method was pursued.

Analytic Approach

For each analysis data set (Set 1: all observations (n=329, 616 trips) and Set 2: areas 3 and 4 only (n=25,337 trips) we then attempted to construct standardized CPUE indices were explored using the delta-lognormal modeling approach (Lo et al. 1992). This method applies two separate models, fitting a lognormal model to the positive CPUE observations and a separate binomial (logistic) model to the proportion of successful (positive) observations and combines results from the two models to obtain a single index. Parameter estimates were obtained using a general linear modeling (GLM) procedure (SAS GLIMMIX and MIXED procedures; SAS v.9.2 2004 of the SAS System, SAS Institute Inc.; Cary, NC, USA) to develop the binomial and lognormal sub models. Factor (covariate) significance was evaluated using Type 3 residual analysis and overall performance was assessed from residual analysis graphics. Residuals by year were plotted and reviewed and QQ plots of the residuals against a normal distribution were plotted. In applying the GLM procedure we assumed the proportion of successful trips per stratum approximated a binomial distribution, where the estimated probability was a linearized function of the fixed factors. We used a second generalized linear model to examine the influence the fixed factors on log(CPUE) of successful trips assuming a normal error distribution for the positive catch rates. As defined earlier, catch rate was calculated as number fish caught divided by (number anglers x triplength).

5.4.1.2 Sampling Intensity

The resulting data set contained n=329, 616 trips for all areas, and n=25,337 trips for areas 3 and 4 only.

5.4.1.3 Size/Age data

The sizes/ages represented in this index should be the same as those of landings from the corresponding fleet.

5.4.1.4 Catch Rates
Standardized catch rates and associated error bars are shown in SEDAR28-DW09.

5.4.1.6 Comments on Adequacy for Assessment
The index of abundance created from the TPWD data was considered by the indices working group to be inadequate for potential use in the Spanish mackerel assessment. Although the data set has an adequately large sample size and has a long enough time series to provide potentially meaningful information for the assessment, the survey covers only a small portion of the stock as described for the Gulf of Mexico and mostly surveys an area where Spanish mackerel are not abundant or targeted. In addition, catch rates were extremely low and the index was derived from fishery dependent data.

5.4.2 Commercial Vertical line Index
Using the Coastal Fisheries Logbook Program's (CFLP) available catch per unit effort (CPUE) data, indices of abundance of Spanish mackerel were constructed for the U.S. Gulf of Mexico from 1998 through 2010. The indices were constructed using data submitted by Federally permitted commercial vertical line vessels. Commercial fishing activity reported by fishers to the CFLP is at the trip level. For each fishing trip, the CFLP database includes a unique trip identifier, the landing date, fishing gear deployed, areas, number of days at sea, number of crew, gear specific fishing effort, species caught and weight of the landings.

Using only positive trips, a lognormal model was used for the construction of the vertical line index of abundance. The catch per unit effort for vertical line was defined as gutted pounds per hook hour fished. Complete details concerning the methods and results of the analyses are described in SEDAR28-DW15.

5.4.2.1 Methods
Data Filtering Techniques
Multiple areas fished and multiple gears fished may be recorded for a single fishing trip. In such cases, assigning catch and effort to specific locations or gears was not always possible; therefore, only trips which reported one area category and one gear fished were included in these analyses. Data were further restricted to include only those trips with landings and effort data received by the CFLP within 45 days of the completion of the trip. Reporting delays beyond 45 days likely results in less accurate effort data. Trips in which errant or missing data were present were removed from the analyses. These included missing number lines, number of hooks, and hours fished for vertical gear. Vertical gear trips reporting 24 or more hours per day fishing were also excluded.

Following the exclusion of trips listed above, outliers were removed in which number of lines, and hooks fell outside the upper 99.5 percentile.

Subsetting trips
For the vertical gear analysis, only positive Spanish mackerel trips were used from 1998 through 2010.

Model Input
Significant effects on the CPUE of positive trips were tested using general linear model (GLM) analysis. For the analysis of catch rates on successful trips, a type-3 model assuming lognormal error distribution was examined. The linking function selected was "normal", and the response variable was log(CPUE). The response variable of data was calculated as: log(CPUE) = ln(pounds of Spanish mackerel/hook hour). All 2-way interactions among significant main effects were examined. Higher order interaction terms were not examined.
The final model for the lognormal on CPUE of successful trips was:
Vertical Line:
LOG(CPUE) = Year + Days_at_sea + Subregion + Quarter + Days_at_sea*Subregion + Subregion*Quarter

Standardization
For vertical trips, only positive trips were included and a lognormal model was used for index construction. The lognormal model was fit using a PROC MIXED SAS procedure (Version 9.2 SAS Institute). All factors were modeled as fixed effects except two-way interaction terms containing YEAR which were examined as random effects to be included in the final model. Selection of the final mixed model was based on the Akaike's Information Criterion (AIC), Schwarz's Bayesian Criterion (BIC), and a chi-square test of the difference between the –2 log likelihood statistics between successive model formulations (Littell et al. 1996). For comparison, a relative index and relative nominal CPUE series were calculated by dividing each value in the series by the mean value of the series.
The standardized indices of abundance, number of trips, and relative nominal CPUE for vertical are shown in Table 5.4.2.1. The relative nominal CPUE and standardized index, with 95% confidence intervals, are shown in Figure 5.4.2.1.

5.4.2.2 Sampling Intensity
The final dataset for the vertical line index contained 4,628 trips, all of which were positive trips.

5.4.2.3 Size/Age data
The sizes/ages represented in these indices would likely be reflective of those in the GOM commercial landings.

5.4.2.4 Catch Rates
The relative nominal CPUE and standardized indices, with 95% confidence intervals, are shown in Figure 5.4.2.1.

5.4.2.5 Comments on Adequacy for Assessment
Despite covering the entire Gulf of Mexico, the working group recommended to not use the vertical line index. It was recommended that the Florida Trip Ticket index be used instead as it showed the same general trend during the common years (1998-2010), but had a much longer time series dating back to 1986. Confidence in the Florida Trip Ticket index was reinforced by the fact that Florida possesses the majority of the Gulf of Mexico Spanish Mackerel fishery. For exploratory purposes, an additional vertical line index was constructed with CFLP data for all areas west of the Florida panhandle as the Florida Trip Ticket program would not capture this data.

5.4.3 Commercial Gillnet Index

Using the Coastal Fisheries Logbook Program's (CFLP) available catch per unit effort (CPUE) data, indices of abundance of Spanish mackerel were constructed for the U.S. Gulf of Mexico from 1998 through 2010. The index was constructed using data submitted by Federally permitted commercial gillnet vessels. Commercial fishing activity reported by fishers to the CFLP is at the trip level. For each fishing trip, the CFLP database includes a unique trip identifier, the landing date, fishing gear deployed, areas, number of days at sea, number of crew, gear specific fishing effort, species caught and weight of the landings.

A delta-lognormal was model was used for the construction of the gillnet index. The proportion of positive trips for gillnet ranged from 37-79%. Gillnet CPUE was defined as gutted pounds per square yard hour fished. Complete details concerning the methods and results of the analyses are described in SEDAR28-DW15.

5.4.3.1 Methods

Data Filtering Techniques

Multiple areas fished and multiple gears fished may be recorded for a single fishing trip. In such cases, assigning catch and effort to specific locations or gears was not always possible; therefore, only trips which reported one area category and one gear fished were included in these analyses. Data were further restricted to include only those trips with landings and effort data received by the CFLP within 45 days of the completion of the trip. Reporting delays beyond 45 days likely results in less accurate effort data. Trips in which errant or missing data were present were removed from the analyses. Gillnet trips with missing net length, depth (i.e. width), or hours fished were excluded.

Following the exclusion of trips listed above, records were dropped when gillnet length or gillnet depth (width) were below the 0.5 percentile or above the 99.5 percentile. Additional gillnet trips were removed from consideration when stake gillnet was reported or when shark landings were reported as this fishing effort were unlikely to land any Spanish mackerel.

Subsetting trips

All gillnet trips from 1998 through 2010 were considered for the gillnet index. Gillnet trips were also categorized as having, or not having, a king mackerel gillnet endorsement. Catchability of those vessels likely differs from other gillnet vessels.

Model Input

Significant effects on the proportion of positive trips and on the CPUE of positive trips were tested using general linear model (GLM) analyses. For the GLM analysis of proportion positive trips, a type-3 model was fit, a binomial error distribution was assumed, and the logit link was selected. The response variable was proportion successful trips. For the analysis of catch rates on successful trips, a type-3 model assuming lognormal error distribution was examined. The linking function selected was "normal", and the response variable was log(CPUE). The response variable of data was calculated as: log(CPUE) = ln(pounds of Spanish mackerel/square yard hours). All 2-way interactions among significant main effects were examined. Higher order interaction terms were not examined.

The final models for the binomial on proportion positive trips (PPT) and the lognormal on CPUE of successful trips were:

Gillnet:

PPT = Year + Total_effort + GN_Endorsement + Subregion + Total_effort*GN_Endorsement

LOG(CPUE) = Year + Subregion + Year*Subregion

Standardization

For gillnet, the final delta-lognormal model was fit using a SAS macro, GLMMIX (Russ Wolfinger, SAS Institute). All factors were modeled as fixed effects except two-way interaction terms containing YEAR which were examined as random effects to be included in the final model. Selection of the final mixed model was based on the Akaike's Information Criterion (AIC), Schwarz's Bayesian Criterion (BIC), and a chi-square test of the difference between the –2 log likelihood statistics between successive model formulations (Littell et al. 1996). For comparison, a relative index and relative nominal CPUE series were calculated by dividing each value in the series by the mean value of the series.

The standardized index of abundance, number of trips, and relative nominal CPUE for gillnet are shown in Table 5.4.3.1. The relative nominal CPUE and standardized index, with 95% confidence intervals, are shown in Figure 5.4.3.1.

5.4.3.2 Sampling Intensity

There were 855 gillnet trips used in the construction of the gillnet index. Proportion positive gillnet trips ranged from 37-79%.

5.4.3.3 Size/Age data

The sizes/ages represented in these indices would likely be reflective of those in the GOM commercial landings.

5.4.3.4 Catch Rates

The relative nominal CPUE and standardized indices, with 95% confidence intervals, are shown in Figure 5.4.3.1.

5.4.3.5 Comments on Adequacy for Assessment

The working group decided against recommending the gillnet index as the method of targeting Spanish mackerel schools and using a runaround gillnet to capture them would like cause 'hyper-stability' in the index and would not be a true reflection of abundance.

5.4.4 Recreational Headboat Index – Spanish mackerel

The Headboat Survey covers the Gulf of Mexico headboats starting in 1986 and was used develop standardized catch per unit effort (CPUE) indices of abundance. This work uses the catch and effort observations from the Headboat Survey to develop standardized catch per unit effort (CPUE) indices of abundance for the recreational fishery for Spanish mackerel (*Scomberomorus maculatus*) in the Gulf of Mexico (GOM). A delta lognormal modeling approach was used to develop these indices. The Species Association Approach (Stephens and

MacCall 2004) was explored to identify directed Spanish mackerel trips, while balancing these subsets of the data with sample size.

5.4.4.1 Methods for Estimation

The Headboat Survey data were looked at across different strata to assess the sample size of total trips and positive trips within each of the strata. The datasets were spatially partitioned according to the decisions that were made during the SEDAR 28 data workshop plenary sessions. For Spanish mackerel, the stock boundary dividing the Gulf of Mexico from the South Atlantic stock during the data workshop was determined to be the Florida Keys. For Spanish mackerel, the headboat dataset was partitioned where fish surveyed in areas 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 14, 15, and 17 (all the areas shown on the map in Figure 5.4.4.1).

Data filtering techniques

Stephens and MacCall

The Stephens and MacCall (2004) approach was explored to identify Spanish mackerel directed trips. This approach resulted in a large reduction in the Spanish mackerel trips and was therefore not used.

All trips versus positive trips

The SEDAR 28 data workshop Indices Working Group and panel evaluated and discussed the various alternatives to identifying targeted trips, and agreed that they served little utility for the GOM subset of the data. The working group also noted that there was little difference in the indices that were estimated for the entire dataset and the indices estimated for the subset of only positive trips. Therefore, it was decided at the data workshop, that fishing effort for Spanish mackerel would be based on all trips. This decision was made because Spanish mackerel represent an opportunistically captured fish while targeting other species. Therefore, most trips in the Headboat database represents potential fishing effort for Spanish mackerel.

Model Input

Response and explanatory variables

CPUE- catch per unit effort (CPUE) has units of the number of caught to the number of fish caught on a given trip divided by the effort, where effort was calculated as the product of the number of people on the headboat and the hours fished.

Year – A summary of the total number of trips, the number of positive trips, and the percent of positive trips per year is presented in Table 5.4.4.1.

Month –The total number of trips, the number of positive trips, and the percent of positive trips per month and year were summarized due to the significant interaction between month and year however tables cannot be displayed for confidentiality reasons.

Area – The total number of trips, the number of positive trips, and the percent of positive trips per area and year were summarized due to the significant interaction between these factors however tables cannot be displayed for confidentiality reasons.

Standardization

For the indices constructed on the complete datasets, the delta lognormal model approach (Lo et al. 1992) was used. This method combines separate generalized linear model (GLM) analyses of the proportion of successful trips (trips that landed Spanish mackerel) and the catch rates on successful trips to construct a single standardized CPUE index. Parameterization of each model was accomplished using a GLM procedure (GENMOD; Version 8.02 of the SAS System for Windows © 2000. SAS Institute Inc., Cary, NC, USA). To estimate the response variable, the proportion of positive trips, a binomial model was used. The GLM procedure was fitted to the observed proportion positive trips using a type-3 model with a binomial error distribution and a logit link function. The second component of the delta lognormal approach is to estimate the natural log of the CPUE using a type-3 model with a lognormal error distribution and a normal link function.

A stepwise approach was used to quantify the relative importance of the explanatory factors. First a GLM model was fit on year. These results reflect the distribution of the nominal data. Next, each potential explanatory factor was added to the null model sequentially and the resulting reduction in deviance per degree of freedom was examined. The factor that caused the greatest reduction in deviance per degree of freedom was added to the base model if the factor was significant based upon a Chi-Square test ($p<0.05$), and the reduction in deviance per degree of freedom was ≥1%. This model then became the base model, and the process was repeated, adding factors and interactions individually until no factor or interaction met the criteria for incorporation into the final model. All 2-way interactions among significant main effects were examined, however higher order interaction terms were not examined. The final delta-lognormal model was fit using a SAS macro, GLIMMIX (Russ Wolfinger, SAS Institute). All factors were modeled as fixed effects except two-way interaction terms containing year which were modeled as random effects. To facilitate visual comparison, a relative standardized index and relative nominal CPUE series were calculated by dividing each value in the series by the mean value of the entire time-series.

5.4.4.2 Sampling Intensity

The resulting data set contained 186,184 trips with 38.89% positive Spanish mackerel trips (Table 5.4.4.1).

5.4.4.3 Size/Age data

The sizes/ages represented in this index should be the same as those of landings from the corresponding fleet.

5.4.4.4 Catch Rates

Standardized catch rates and confidence intervals are shown in Figure 5.4.4.2 and tabulated in Table 5.4.4.3. Figure 5.4.4.3 shows the Q-Q plot of the CPUE observations and Figure 5.4.4.4 shows the binomial fit to the observed proportion positive Spanish mackerel trips.

5.4.4.5 Uncertainty and Measures of Precision

95% confidence intervals were calculated from the mean square error output from the GLM procedures.

5.4.4.6 Comments on Adequacy for Assessment

The WG group decided that this index was suitable for assessment.

5.4.5 Recreational MRFSS Index – Spanish mackerel

MRFSS provides information on participation, effort, and species-specific catch. Data are collected to provide catch and effort estimates in two-month periods ("waves") for each recreational fishing mode (shore fishing, private/rental boat, charterboat, or headboat/charterboat combined) and area of fishing (inshore, state Territorial Seas, U.S. Exclusive Economic Zone) in each state, except TX. MRFSS was conducted in TX through 1985 and did not include all modes in all years. Starting in 1986, MRFSS no longer covered headboats in the Gulf of Mexico and South Atlantic. Catch estimates are made for strata used in the intercepts: fish landed whole and observed by the samplers ("Type A"), fish reported as killed by the fishers ("Type B1") and fish reported as released alive by the fishers ("Type B2").

This work uses the catch and effort observations from the MRFSS database to develop standardized catch per unit effort (CPUE) indices of abundance for the recreational fishery for Spanish mackerel (*Scomberomorus maculatus*) in the Gulf of Mexico (GOM). A delta lognormal modeling approach was used to develop these indices.

The MRFSS data set was evaluated across different strata to assess the sample size of total trips and positive trips within each of the strata. Data from Texas, present in the years 1981 through 1985, were removed from the MRFSS data because the State of Texas has its own survey. In addition, data from the headboat mode in MRFSS, also present in the years 1981 through 1985, was removed because this information is covered by the Headboat Survey program.

The dataset was partitioned according to the decisions that were made during the SEDAR 28 data workshop during the plenary sessions. The stock boundary for GOM Spanish mackerel was determined to be the Florida Keys at the Monroe County line.

For the MRFSS data, if there were anglers on a trip that actively fished but were not interviewed, the data were adjusted to account for the catch and effort of these non-interviewed anglers. This adjustment was made by dividing the total catch made by those individuals who were interviewed by the number of people interviewed. This average catch per person was then multiplied by the number of anglers that were not interviewed and the resulting catch was then added to the total catch for that trip.

5.4.5.1 Methods for Estimation

Data filtering techniques

Stephens and MacCall

The Stephens and MacCall (2004) approach was explored to identify Spanish mackerel directed trips. This approach resulted in a large reduction in the Spanish mackerel trips and was therefore not used.

All trips versus positive trips

The SEDAR 28 data workshop Indices Working Group and panel evaluated and discussed the various alternatives to identifying targeted trips, and agreed that they served little utility for the GOM subset of the data. The working group also noted that there was little difference in the indices that were estimated for the entire dataset and the indices estimated for the subset of only positive trips. Therefore, it was decided at the data workshop, that fishing effort for Spanish mackerel would be based on all trips. This decision was made because Spanish mackerel represent an opportunistically captured fish while targeting other species. Therefore, most trips in the MRFSS database represent potential fishing effort for Spanish mackerel.

Model Input

Response and explanatory variables

CPUE- catch per unit effort (CPUE) has units of the number of caught to the number of fish caught on a given trip divided by the effort, where effort was calculated as the product of the number of people on the headboat and the hours fished.

Year – A summary of the total number of trips, the number of positive trips, and the percent of positive trips per year is presented in Table 5.4.5.1.

Month – Tables 5.4.5.2-5.4.5.4 summarize the total number of trips, the number of positive trips, and the percent of positive trips per month and year due to the significant interaction between month and year.

Mode – Table 5.4.5.5 summarizes the total number of trips, the number of positive trips, and the percent of positive trips per mode and year.

State – Table 5.4.5.6 summarizes the total number of trips, the number of positive trips, and the percent of positive trips per state and year due to their significant interaction.

Standardization

For the indices constructed on the complete datasets, the delta lognormal model approach (Lo et al. 1992) was used. This method combines separate generalized linear model (GLM) analyses of the proportion of successful trips (trips that landed Spanish mackerel) and the catch rates on successful trips to construct a single standardized CPUE index. Parameterization of each model was accomplished using a GLM procedure (GENMOD; Version 8.02 of the SAS System for Windows © 2000. SAS Institute Inc., Cary, NC, USA). To estimate the response variable, the proportion of positive trips, a binomial model was used. The GLM procedure was fitted to the observed proportion positive trips using a type-3 model with a binomial error distribution and a logit link function. The second component of the delta lognormal approach is to estimate the natural log of the CPUE using a type-3 model with a lognormal error distribution and a normal link function.

A stepwise approach was used to quantify the relative importance of the explanatory factors. First a GLM model was fit on year. These results reflect the distribution of the nominal data. Next, each potential explanatory factor was added to the null model sequentially and the resulting reduction in deviance per degree of freedom was examined. The factor that caused the greatest reduction in deviance per degree of freedom was added to the base model if the factor was significant based upon a Chi-Square test ($p<0.05$), and the reduction in deviance per degree of freedom was $\geq 1\%$. This model then became the base model, and the process was repeated, adding factors and interactions individually until no factor or interaction met the criteria for incorporation into the final model. All 2-way interactions among significant main effects were examined, however higher order interaction terms were not examined. The final delta-lognormal model was fit using a SAS macro, GLIMMIX (Russ Wolfinger, SAS Institute). All factors were modeled as fixed effects except two-way interaction terms containing year which were modeled as random effects. To facilitate visual comparison, a relative standardized index and relative nominal CPUE series were calculated by dividing each value in the series by the mean value of the entire time-series.

The model used for standardization was:

$$Success = \mu + (Year)\alpha_1 + (Month)\alpha_2 + \varepsilon$$

$$\ln(CPUE) = \mu + (Year)\alpha_1 + (Mode)\alpha_2 + (State)\alpha_3 + (Month)\alpha_4 + (Year * Month)\alpha_5 + (Year * State)\alpha_6 + \varepsilon$$

5.4.5.2 Sampling Intensity

The resulting data set contained 559,659 trips with 4.77% positive Spanish mackerel trips (Table 5.4.5.1).

5.4.5.3 Size/Age data

The sizes/ages represented in this index should be the same as those of landings from the corresponding fleet.

5.4.5.4 Catch Rates

Standardized catch rates and confidence intervals are shown in Figure 5.4.5.1 and tabulated in Table 5.4.4.3. Figure 5.4.5.2 shows the Q-Q plot of the CPUE observations and Figure 5.4.5.3 shows the binomial fit to the observed proportion positive Spanish mackerel trips.

5.4.5.5 Uncertainty and Measures of Precision

95% confidence intervals were calculated from the mean square error output from the GLM procedures.

5.4.5.6 Comments on Adequacy for Assessment

The WG group decided that this index was suitable for assessment.

5.4.6 Florida Trip Ticket

There were eight indices for Spanish mackerel developed from Florida trip tickets: Atlantic Coast (ATL) gill nets for 1986-June 30, 1995 (ATL_GN_early), ATL gill nets for July 1, 1995 to 2010 (ATL_GN_after), ATL cast nets for 1996-2010 (ATL_CN), ATL hook and line gears for 1985-2010 (ATL_HL), Gulf of Mexico (GULF) gill nets for 1986-June 30, 1995 (GULF_GN_early), GULF gill nets for July 1, 1995 to 2010 (GULF_GN_after), GULF cast nets for 1996-2010 (GULF_CN), GULF hook and line gears for 1985-2010 (GULF_HL). Each of the GN and CN indices were analyzed during time periods when trip limits allowed more than 1,500 pounds of Spanish mackerel to be landed, and each of the HL indices used data for time periods when trip limits allowed greater than 500 pounds of Spanish mackerel to be landed. The logic behind these choices for trip limits was that it was less likely for the landings from these trips using these gears to exceed the prevailing trip limit and therefore the landing may be more likely to reflect the availability of fish on that trip.

Introduction

Established by the Florida Legislature in Florida Statute (F.S.) 370.026 during 1983, the Florida Marine Fisheries Commission in conjunction with the Department of Natural Resources (DNR) [1]

[1] The Department of Natural Resources was established by the Florida Legislature in 1968, and incorporated the Florida Board of Conservation into it's structure. Later, in 1993, Governor Lawton Chiles combined the Department of Natural Resources and the Department of Environmental Regulation into a single agency called the Department

was charged with conserving and managing Florida's marine fisheries. In late-1984, the DNR implemented the mandatory reporting of detailed trip-level commercial fishery landings data by wholesale and retail seafood dealers using marine fisheries trip tickets. Prior to this time, commercial fisheries data was collected from seafood dealers on a monthly basis by the National Marine Fisheries Service (NMFS). Data were collected by both the NMFS and the DNR trip ticket system during 1985 to enable a comparison of the new data collection system. After determinations that the monthly dealer summaries and the detailed trip ticket information were comparable, the trip ticket system became the official commercial fisheries landings data collection system in Florida.

Wholesale and retail dealers operating in Florida are required to purchase dealer licenses, and wholesale dealers that purchase saltwater products (marine fish, invertebrates, live marine specimens, etc.) from commercial fishermen or wholesale and retail dealers that catch saltwater products themselves for sale in Florida are required to report these amounts on marine fisheries trip tickets to the Florida Fish and Wildlife Conservation Commission. Exceptions to the reporting requirements are: 1) restaurants who harvest their own catch for consumption on their premises; 2) transshipments of saltwater products after landing in Florida for destinations outside of the state for which no purchase occurred (e.g., a corporate vessel landing saltwater products at a Florida port without receiving payment and shipping product to another state). Fishermen who harvest saltwater products commercially are required to purchase Saltwater Products Licenses and sell only to licensed wholesale seafood dealers or sell their catches directly to the public if they have a retail dealer license. Fishermen may also be required to have additional license endorsements and federal permits for the legal harvest and sale of some species (e.g., Spanish mackerel).

Trip tickets have been used by wholesale and retail seafood dealers for the reporting of fish and invertebrates purchased in Florida from fishermen since the system's inception in 1984. There have been revisions to the trip ticket fields and the mandatory nature of some fields over time, as well as additions of new species codes, gear codes, and reporting units. Seafood dealers are required to report the preceding month's purchases from fishermen by the tenth day of the month following transaction. In the case of quota-managed species like Spanish mackerel, weekly reporting is required. Time lags for data entry of submitted paper forms is approximately four weeks after forms are received. Editing of computerized data typically takes two to three weeks. Computerized reporting of trip tickets, which eliminates the time lag for data entry, has occurred as early as 1987, and there has been considerable growth in level of computerized reporting by seafood dealers over the years.

5.4.6.1. Methods of Estimation

Geographic range

---

of Environmental Protection. During the 1998 general election, a majority Florida voters approved an amendment to the Florida Constitution which combined the Florida Game and Freshwater Fish Commission, the Florida Marine Fisheries Commission, and portions (chiefly, most of the Division of Marine Resources and most of the Florida Marine Patrol) of the Department of Environmental Protection into a single commission. The Florida Legislature, on July 1, 1999, formed the new Florida Fish and Wildlife Conservation Commission in fulfillment of that amendment.

All commercial harvests landed and sold in Florida are required to be reported on Florida marine fisheries trip tickets. Reports are required to have all mandatory information submitted with the landings data. The area fished information required on trip tickets is based on the NMFS' shrimp grid zones (see SEDAR28 –AW01). Additional areas fished for locations outside of Florida are available, and supplied to dealers upon request.

Assignment of fishing gears to trips:

At the time of applying for or renewing Saltwater Products License (SPL), fishermen were asked to indicate their use of fishing gears for the upcoming license year. Many license holders indicated more than one gear on their annual license application or renewal, and some did not indicate any gear at all. From the inception of the Florida trip ticket program until February of 1990, a "gear fished" field was not on the trip ticket so analysts inferred the gear used by a combination of the reported catch (species, amounts) and the gear fields on a fisherman's SPL license application. Beginning in 1990, the trip ticket was revised to include the gear fished field which consisted of rather generic "check boxes" for gears and a 4-digit gear code if the reporting of a more specific gear was desired. Old trip tickets were still in use for a couple of years, so not all records from 1990 to 1992 contained gear information. As the old stocks of trip tickets were used up by dealers, the reporting of gear used by trip increased.

Gear related to trip tickets was retrieved from the Saltwater Products (SPL) license record for the 1986 to 1992 license years during the editing of trip tickets, and this "gear" record was retained in the trip ticket data base. The SPL number was prohibited from being retained on the trip ticket by the Florida legislature when then trip ticket program was initially approved, but later was allowed to be retained in the trip ticket data base in late 1986.

For trip tickets from 1986-1992, gear was assigned from the commercial fishing license application database (which was retained on the edited trip ticket record) based on a species/gear hierarchy from later years where gear was reported by trip. Target species and species groups were identified on trips where gear was reported from 1991-1994. The species-gear associations from these data were ranked from most common to least common and applied to the trip ticket data from 1986-1992. The target species (defined as the species with the highest poundage) and species groups were identified on trips where gears was not reported by trip from 1986-1992. Gear was assigned to each trip based on matching the species-license gear association with the species-ticket gear association from the 1991-1994 data. Gears by trip for these analyses were grouped into gill net, cast net, trawls, hook and line gears, and other. If gears were not determined for a trip (no license-gear information in the 1986-1992 period, or missing from the trip ticket from 1993-2011), the trip ticket was dropped from the analyses. The majority of Spanish mackerel landings were categorized as one of these gear types, and analyses for gill nets, cast nets, and hook and line gears are provided in this report.

At the Data Workshop, the Indices workgroup examined the preliminary results and suggested that the hook-and-line gear assignments for the 1986-1992 period may have included some landings exceeding reasonable limits for trips using this gear. Trips for this period were re-analyzed and landings in excess of the 99^{th} percentile were excluded from the analyses. For the Florida Atlantic coast Spanish mackerel trips, those with landings greater than 840 pounds were excluded. For Florida Gulf coast Spanish mackerel trips, those with landings greater than 1,223 pounds were excluded. Trips from 1991-1994 where gear was reported on the trip ticket were also analyzed for maximum landings of Spanish mackerel on hook-and-line trips. The results from those years verified the 99^{th} percentiles calculated from 1986-1992. The analyses in this report incorporate the recommendations of the Indices workgroup.

Species and species groups
As in SEDAR 17, trip tickets with Spanish mackerel ("positive" trips) were selected for analyses. A suitable method for selecting a universe of trips to evaluate (i.e., all trips which could have caught Spanish mackerel – zeros as well as positives) has not been developed yet, but possibly could be done using clustering techniques (e.g., Shertzer and Williams 2008) or other selection procedure (e.g., Stephens and MacCall 2004).

Species were assigned to fishery groups based upon fishery characteristics. The pounds landed by fishery group were summed for a trip ticket. Spanish mackerel was assigned to its own "group" since this was the species of interest for developing indices. For the purposes of developing the indices, a fishery group was classed as present or absent for the analyses.

Trip limits
Limits on harvest (pounds) of Spanish mackerel per trip during specific periods of the year would potentially affect the observed catch per trip, so the trip limits that were in effect during these periods were added to the trip ticket records. The dates for these trip limits for Atlantic Group Spanish mackerel were taken from SEDAR 17 (index code from Paul Conn, NMFS Beaufort Laboratory, personal communication) and from Sue Gerhart (NMFS SERO, personal communication). Some of the trip limits were based on day of the week. Gill net and cast net trips with trip limits greater than 1,500 pounds and hook and line trips with trip limits greater than 500 pounds were selected for analyses as in SEDAR 17. There were no periods on the Florida Gulf of Mexico Coast when trips were limited as to the number of pounds harvested or landed.

Unit measure of abundance:
Pounds of Spanish mackerel landed on a trip was the response variable for most models (gamma models), and in a few cases the pounds of Spanish mackerel were log transformed (lognormal models).

Trips with Spanish mackerel (pounds whole weight landed) were selected by coast, gear, time period, and trip limit in effect. The pounds of other species landed on the same trip ticket were grouped by fishery code, and converted to '1' or '0' to indicate presence or absence from the landings for a trip. Year, month, Florida sub-region, and fishery codes were the twelve classification variables used to examine for trends in the amount (pounds) of Spanish mackerel landed.

A general linear model [GENMOD procedure (SAS Institute Inc. 2008)] using a forward stepwise selection technique was used to estimate trends in catch per trip by gear and coast. Two types of model probability distributions were explored: gamma (with a log link function) and lognormal. When the lognormal distribution was used, the pounds of Spanish mackerel landed were log-transformed and the model used a normal probability distribution with an identity link function. The forward selection process analyzes the null model (no class variables chosen), and then each class variable added singly in the model. If the GLM successfully converged, the reduction in deviance from the null model is assessed for each of these runs, and the class variable with the largest percentage reduction in deviance, a significant χ^2 (Chi-square) value, and a lower AICc than other class variables is selected for the model. The next series of model runs includes the variable selected in the previous series along with each of the remaining variables (one at a time), and each of the resulting two variable models are assessed for model convergence, the largest percentage reduction in deviance from the null model and significance criteria (χ^2, AICc) as before. This process continues until the percentage reduction in deviance becomes less than some desired level. For these model runs, a 0.25% reduction in deviance from the null model was the selected level of acceptance for a suite of class variables. If there were cases when the variable of interest (in this case, year was important) failed to be selected, it would have been included in the model statement so that a year effect could be estimated. However, all of the models included year using the criteria described. Annual values (and associated coefficients of variation) were estimated using the least squares mean method (SAS Institute Inc. 2008) for the year effect.

The model results from the forward stepwise selection of variables for the linear models are in SEDAR28-AW01, and the diagnostic plots (standardized residuals by year, q-q plot, and standardized residuals versus the fitted distribution) and scaled index values (index values scaled to their means) over time are also in SEDAR28-AW01. The adjusted average catch rates (pounds per trip), coefficient of variation (as a percentage of the mean), and the scaled index values are in Tables 5.4.6.1-5.4.6.2. Nominal average catch rates (simple averages) and adjusted averages by gear, and a comparison of the annual scaled index values by gear are detailed in SEDAR28-AW01.

5.4.6.2. Sampling Intensity

Temporal and spatial resolution:

Quotas for Spanish mackerel are managed by the NMFS for the South Atlantic Fishery Management Council (SAFMC) and the Gulf of Mexico Fishery Management Council (GMFMC). The boundary separating the SAFMC and GMFMC in Florida for Spanish mackerel is the line dividing Monroe County (Florida Keys) and Miami-Dade County. For SEDAR 28, discussions during a conference call expressed the desire, if possible, to divide the landings by US 1 in the Florida Keys which corresponds to the councils' jurisdictional boundaries rather than the boundaries used for managing Spanish mackerel quotas.

The separation of landings of Spanish mackerel to coincide with the council jurisdictions rather than how they are currently managed was approximate. Landings were first assigned to a migratory group based upon the area fished (if present on the trip ticket) or county landed corresponding to the quota management regime (separated at the Monroe County and Miami-Dade County boundary) so that any trip limits in effect could be assigned to the records. Once the migratory group was determined, landings were categorized based on the quota management boundaries as either Atlantic Coast or Gulf Coast, and separately by area fished (if present on the trip ticket) and county landed for SEDAR 28. Gulf group Spanish mackerel, if reported from areas 748 or 1 (Florida Keys) were classed as Atlantic Coast landings for SEDAR 28, while those in area 2 were considered Gulf Coast landings. If area fished was not reported on trip tickets from Monroe County (especially prior to 1992 when the reporting of this field was optional), the landings were considered to belong to the Gulf Coast. [There is a portion of area 2 that is in the SAFMC jurisdiction, but dividing catches into each council jurisdiction for area 2 is difficult to accomplish unless there are gear restrictions (e.g., SAFMC long line regulations)]. Additionally, the county of landing for Spanish mackerel was grouped into Florida subregions for these analyses. The subregion groupings were Nassau to Brevard (subregion 5), Indian River to Miami-Dade (subregion 4), Monroe County (subregion 3), Collier-Levy (subregion 2), and Dixie-Escambia (subregion 1). Landings may occur in a county in some years but not in others, and this situation can lead to missing cells in the general models that could result in model instability or inappropriate estimates for class variables. Two subregion groupings were devised. The first was based solely on county landed (corresponding to the usual subdivision of Florida landings in the NMFS commercial landings (Nassau County to Miami-Dade County landings are assigned to the Florida Atlantic Coast, and Monroe County to Escambia County are assigned to the Florida Gulf of Mexico Coast). A second subregion grouping modified the subregion based upon area fished (if reported on the trip ticket) as outlined in the preceding paragraph.

Series period:
Florida trip tickets reported for the time period of 1986 to 2010 were used for developing the indices. The hook and line indices were developed over the entire period by coast. Because of the entangling net limitations implemented in Florida on July 1, 1995, trip tickets with the reported or assigned gear of gill nets were split into groups before and after this date by coast. Trip tickets where cast nets were the reported gear were only used after this date because of the rare use of this gear type prior to the net limitation date.

5.4.6.3. Size/Age Data

Not included as part of this index analysis**.**

5.4.6.4. Catch Rates – Number and Biomass

See Tables 5.4.6.1-5.4.6.2.

5.4.6.5. Uncertainty and Measures of Precision

Gill net and cast net trips were problematic. There are different methods to deploy gill nets (which may have different mesh sizes, lengths, and panels) and each method targets and catches fish differently which can affect the amounts of catch. The highest catches on trips were from run-around gill nets, where a school or portion of a school of fish is surrounded by an actively fished gill net and the fish are “startled” into the net by noise (e.g., by jumping on the bottom of the boat or some other method). If the target species was Spanish mackerel, landings could be in the thousands to tens of thousands of pounds. If the target species was not Spanish mackerel, there may only be a few pounds (i.e., Spanish mackerel may have been part of the retained bycatch). Gill nets may also be fished anchored to the bottom (stab nets, anchored gill nets) as a more passively fished gear, or may drift on the current (drift gill nets). There have also been restrictions on the amount of soak time in some years (e.g., to reduce the potential encounter with marine turtles), and on transfers of catch at sea. The specific type of gill net deployment is not often provided on trip tickets. Prior to July 1, 1995, gill nets could be used in state as well as in federal waters. After Florida’s net limitations (Article X of the Florida Constitution) went into effect on July 1, 1995, usage of entangling nets was limited to federal waters only, and other nets (seines, trawls, cast nets) usable in state waters were limited to 500 square feet or smaller in mesh area. Changes in the way gears are designed (mesh sizes, panels, depth, etc.), used (deployment method, soak time, etc.), and non-specific gear identification (e.g., "gill nets") make interpretation of patterns observed in the data more complex especially when trying to develop indices of abundance.

In retrospect, there were issues with the choice of the time period analyzed for the gill net indices. Because the four GN indices (2 ATL and 2 GULF) included only a partial year for 1995, the model may not give an appropriate "annual" value for 1995 since it would be based on only 6 months of the year. It may be more appropriate, if these indices are accepted for use, to drop all of the 1995 data from the GN indices.

Catches of Spanish mackerel were infrequent from cast nets until after Florida's net limitations. Several years after the passage of Article X, some fishermen on the southeastern coast of Florida developed a thrown net effective at catching Spanish mackerel especially in an area of shallow offshore hard bottom [offshore of "Peck's Lake", about 3-5 miles southeast of St. Lucie Inlet, Martin County (Hartig, 2007)]. While called a cast net, it is not the typical cast net used for bait fish or mullet. It is of larger mesh, more heavily weighted to sink more quickly, and when retrieved the net does not "purse" in the usual way. In southwest Florida, this type of modified cast net is not being used, and cast net-caught Spanish mackerel are a bycatch species from other nearshore fisheries.

The more important limitation to all of the indices produced is that they are based upon only "positive" trips (i.e., trips when Spanish mackerel were landed). Ideally, an index of abundance includes a component estimating the probability of encountering the target species on a trip ("zero" trips on which the target species might have been caught but was not, and "positive" trips on which the species was caught) as well as a component estimating the rate of capture on a trip (the number or weight of the target species caught on "positive" trips). Including "zero trips" (trips which could have but did not land Spanish mackerel) would be a refinement that would enhance an index's potential value as an indicator of abundance.

5.4.6.6. Comments on Adequacy for Assessment

The indices produced had reasonable fits to the distributions used and most had relatively modest coefficients of variation. The period of time covered by the indices were relatively long (ten years for gill nets over the 1986-1995 period, sixteen years for gill nets for the 1995-2010 period, fifteen years for cast nets over 1996-2010, and 25 years for hook and line gears over 1986-2010). The hook-and-line gears index may be more reliable indicator of abundance because of selectivity issues that complicate the interpretation of data from trips using gill nets (e.g., deployment methods, mesh sizes, configuration of panels, and changes in state/federal waters restrictions) and cast nets (e.g., configuration, depth, bottom types).

Cast Net Index

This index was not recommended for use. It's potentially useful as a year class indicator, but has gear saturation effects, limited spatial extent, and hyperstability issues since it's targeting large schools. Only trips that did not hit up against the trip limits were included in the analysis.

Gillnet Index

This index was not recommended for use. This index is from a longer time series than the commercial logbook data, and similar trends to the logbook data. But it has hyperstability issues and concerns regarding spatial overlap between gear and population. Changes in the way gill nets are designed and used, and non-specific gear identification on trip tickets (e.g. "gill nets") make interpretation of patterns observed in the data more complex. Only trips that did not hit up against the trip limits were included in the analysis.

Handline/Trolling Index
This index was recommended for use. The data used for this index occurs over a long time series and has similar trends to the commercial logbook data. It also samples the entire fishery, both inshore and offshore.

5.5 Literature Cited

Lo, N.C.H., L.D. Jacobson, and J.L. Squire. 1992. Indices of relative abundance from fish spotter data based on delta-lognormal models. *Canadian Journal of Fisheries and Aquatic Science* 49:2515-2526.

Ortiz, M. 2006. Standardized catch rates for gag grouper (*Mycteroperca microlepis*) from the marine recreational fisheries statistical survey (MRFSS). Southeast Data Assessment and Review (SEDAR) Working Document S10 DW-09.

5.6 Tables

Table 5.3.1.1. Number of stations sampled by shrimp statistical zone during the Summer (top) and Fall (bottom) SEAMAP groundfish survey from 1987-2010.

	Shrimp Statistical Zone																		
Year	3	4	5	6	7	8	9	10	11	13	14	15	16	17	18	19	20	21	Total
1987								30	66	6	20	19	25	20	16	25	28	19	*274*
1988								19	49	5	4	3	19	24	14	25	28	23	*213*
1989								23	30		3	18	25	7	15	20	29	24	*194*
1990									68	11	20	15	23	16	20	23	24	20	*240*
1991									46	12	24	13	23	22	24	18	23	26	*231*
1992								1	45	2	20	24	20	25	12	31	26	20	*226*
1993									45	10	19	17	24	19	14	29	24	22	*223*
1994									61	6	17	22	25	17	20	22	26	22	*238*
1995									44	10	16	18	22	23	13	27	26	21	*220*
1996									46	14	12	19	22	18	17	21	26	25	*220*
1997									44		12	16	22	23	10	28	26	26	*207*
1998									35	2	14	21	25	18	14	22	36	17	*204*
1999									44	7	20	19	20	23	13	25	32	20	*223*
2000									45	2	19	15	19	27	8	29	31	21	*216*
2001									36	7	18	18	13	3	10	9	17	21	*152*
2002									44	11	14	21	27	19	15	25	29	22	*227*
2003									44	9	10	8	2	17	20	22	26	23	*181*
2004									39	11	18	17	20	25	21	19	25	21	*216*
2005									32	10	9	11	16	21	5	28	22	27	*181*
2006									45	11	21	12	20	23	17	23	31	18	*221*
2007									41		6	15	22	23	7	29	32	21	*196*
2008		1	8	11	6	11	8	11	43	24	19	27	23	22	17	24	21	29	*305*
2009		25	17	29	15	16	18	25	68	25	21	38	39	47	55	34	30	24	*526*
2010	31	24	17	24	10	12	14	15	22	5	20	16	21	33	34	27	27	19	*371*
Total	*31*	*50*	*42*	*64*	*31*	*39*	*40*	*124*	*1082*	*200*	*376*	*422*	*517*	*515*	*411*	*585*	*645*	*531*	*5705*

	Shrimp Statistical Zone																		
Year	3	4	5	6	7	8	9	10	11	13	14	15	16	17	18	19	20	21	Total
1987								16	28	15	14	16	17	15	15	15	18	3	*172*
1988								8	28	7	22	17	18	26	19	21	31	20	*217*
1989									43	12	19	17	22	20	17	22	25	26	*223*
1990									52	14	12	23	22	19	18	22	19	27	*228*
1991									47	6	24	14	20	25	24	19	25	22	*226*
1992									33	7	23	14	25	18	17	27	30	18	*212*
1993									72	10	19	17	26	18	16	25	28	18	*249*
1994									50	9	16	21	25	20	21	23	24	20	*229*
1995									40	10	17	18	24	19	14	26	30	19	*217*
1996									45	9	18	19	17	28	13	25	29	24	*227*
1997									44	10	17	20	26	19	18	23	22	24	*223*
1998									44	10	22	14	34	11	15	24	29	22	*225*
1999									42	10	17	18	29	18	12	28	29	22	*225*
2000									43	10	14	22	20	26	12	30	25	21	*223*
2001									21	10	17	19	26	20	14	27	28	23	*205*
2002								1	51	10	13	22	22	23	14	26	30	21	*233*
2003								1	76	9	16	21	24	22	20	23	25	23	*260*
2004									43		11	18	17	27	14	24	30	21	*205*
2005									44	11	20	16	33	18	14	23	24	27	*230*
2006								1	47	7	22	14	18	28	13	23	32	19	*224*
2007									32	9	20	17	18	28	17	20	18	26	*205*
2008			15	14	4	4	3	4	36	18	28	34	42	46	44	19	36	20	*367*
2009		20	21	25	10	21	13	12	49	12	23	23	31	49	48	31	36	24	*448*
2010		9	10	11	18			14	16	7	15	18	26	31	29	18	19	14	*255*
Total		*29*	*46*	*50*	*32*	*25*	*16*	*57*	*1026*	*232*	*439*	*452*	*582*	*574*	*458*	*564*	*642*	*504*	*5728*

Table 5.3.1.2. Number of stations with a positive occurrence of Spanish mackerel by depth zone during the Summer (top) and Fall (bottom) SEAMAP groundfish survey from 1987-2010.

Year	Depth Zone																						Total
	0506	0607	0708	0809	0910	1011	1112	1213	1314	1415	1516	1617	1718	1819	1920	2022	2225	2530	3035	3540	4045	4550	5060	
1987	1	1	1	2	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	*7*
1988	2	1	0	1	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	1	0	0	0	*8*
1989	3	1	1	0	2	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	*11*
1990	2	3	1	2	1	2	1	3	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	*18*
1991	3	1	2	0	1	0	1	2	2	0	0	1	0	1	0	1	0	0	0	0	0	0	0	*15*
1992	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*3*
1993	1	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	*5*
1994	2	0	0	0	0	0	1	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	*8*
1995	3	2	1	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	*9*
1996	1	1	2	0	0	2	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*8*
1997	1	1	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*5*
1998	2	2	0	2	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*9*
1999	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	*3*
2000	1	1	1	3	1	2	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	*11*
2001	0	1	0	1	2	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*6*
2002	0	0	2	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	*4*
2003	1	1	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*5*
2004	2	1	0	0	0	1	2	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	*9*
2005	4	2	0	0	1	2	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	*11*
2006	1	3	3	2	1	0	0	1	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	*13*
2007	2	3	0	1	1	0	0	2	1	1	1	1	2	0	2	0	0	0	0	0	0	0	0	*17*
2008	2	3	2	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	*10*
2009	0	0	1	0	1	1	5	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	*10*
2010	0	0	3	1	0	0	1	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	*8*
Total	*36*	*28*	*24*	*17*	*17*	*12*	*17*	*10*	*13*	*9*	*5*	*6*	*5*	*4*	*4*	*2*	*2*	*0*	*1*	*1*	*0*	*0*	*0*	*213*

Year	Depth Zone																						Total
	0506	0607	0708	0809	0910	1011	1112	1213	1314	1415	1516	1617	1718	1819	1920	2022	2225	2530	3035	3540	4045	4550	5060	
1987	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	*5*
1988	2	2	2	1	3	1	2	2	1	0	1	1	2	1	0	0	2	0	0	0	0	0	0	*23*
1989	1	2	3	2	2	1	1	0	2	0	0	1	0	0	0	0	0	1	1	0	0	0	0	*17*
1990	3	0	4	1	0	1	1	3	2	1	0	2	0	0	1	0	0	0	0	0	0	0	0	*19*
1991	2	1	2	1	2	2	1	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	*14*
1992	2	1	2	2	0	1	4	1	0	1	1	3	0	0	0	1	1	1	0	1	0	0	0	*22*
1993	4	2	3	5	1	3	1	1	0	1	1	3	1	1	1	2	0	1	1	2	1	0	1	*36*
1994	2	3	1	0	0	1	0	1	2	0	2	0	0	0	0	0	1	0	0	0	0	0	0	*13*
1995	3	2	0	1	1	1	0	2	1	2	0	0	2	2	0	1	2	2	1	0	0	0	0	*23*
1996	0	3	3	2	1	0	0	1	0	0	1	0	0	1	1	0	0	0	2	0	0	0	0	*15*
1997	0	0	1	1	2	0	0	3	0	1	0	0	0	1	0	0	1	1	1	1	0	1	0	*14*
1998	1	1	0	0	1	2	0	1	0	1	1	4	1	0	1	0	0	1	0	0	0	0	1	*16*
1999	3	4	3	1	2	2	1	1	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	*20*
2000	3	1	2	4	2	3	2	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	*19*
2001	0	2	2	0	2	2	1	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	*12*
2002	0	2	0	0	2	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	*7*
2003	0	0	6	6	5	4	3	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	*25*
2004	0	0	0	0	1	2	2	1	1	1	0	1	2	0	1	1	0	1	1	0	0	0	0	*15*
2005	2	1	4	2	3	1	5	2	2	2	1	0	2	1	2	1	1	3	1	0	0	0	1	*37*
2006	2	2	1	2	1	3	1	2	0	2	1	2	0	0	0	0	1	0	0	0	0	0	0	*20*
2007	0	2	2	1	2	4	3	1	1	1	1	1	1	2	0	0	0	0	0	0	0	0	0	*22*
2008	0	0	1	1	1	1	1	1	0	1	3	0	0	2	0	1	0	1	0	0	0	0	0	*14*
2009	0	2	4	1	7	9	5	5	3	3	4	1	3	1	2	1	0	0	0	0	0	0	0	*51*
2010		1	2	5	3	4	1	1	0	0	1	0	0	0	1	1	0	1	1	0	0	0	0	*22*
Total	*30*	*34*	*48*	*40*	*45*	*49*	*35*	*32*	*16*	*17*	*18*	*20*	*15*	*15*	*10*	*10*	*11*	*15*	*12*	*4*	*1*	*1*	*3*	*481*

Table 5.3.1.3. Summary of the Spanish mackerel data used in these analyses collected by NOAA Fisheries during Summer and Fall SEAMAP groundfish surveys conducted between 1987 and 2010.

Survey Year	Number of Stations	Number Collected	Number Measured	Minimum Total Length (mm)	Maximum Total Length (mm)	Mean Total Length (mm)	Standard Deviation
1987	385	32	14	120	380	237	94
1988	360	104	82	108	406	255	80
1989	358	129	93	116	370	199	53
1990	405	231	137	100	415	196	76
1991	382	147	107	90	422	311	67
1992	363	123	98	130	530	252	84
1993	403	199	138	92	409	234	72
1994	387	78	61	94	389	197	88
1995	371	99	89	51	518	268	95
1996	372	140	78	154	498	267	74
1997	359	34	34	56	378	246	81
1998	357	67	61	55	432	227	74
1999	374	85	68	80	430	234	85
2000	369	156	97	102	371	204	64
2001	302	90	68	73	435	165	60
2002	384	35	28	149	454	264	96
2003	379	193	129	137	369	213	48
2004	356	61	54	98	362	238	75
2005	363	487	166	105	380	205	58
2006	382	82	75	137	407	271	65
2007	347	203	124	51	441	218	68
2008	489	132	100	75	436	225	83
2009	645	204	161	137	405	216	59
2010	389	112	64	70	382	253	80
Total Number of Years	Total Number of Stations	Total Number Collected	Total Number Measured			Overall Mean Total Length (mm)	
24	9281	3223	2127			230	

Table 5.3.1.4. Indices of Spanish mackerel (full model) developed using the delta-lognormal model for 1987-2010. The nominal frequency of occurrence, the number of samples (*N*), the DL Index (number per trawl-hour), the DL indices scaled to a mean of one for the time series, the coefficient of variation on the mean (CV), and lower and upper confidence limits (LCL and UCL) for the scaled index are listed.

Survey Year	Frequency	*N*	DL Index	Scaled Index	CV	LCL	UCL
1987	0.03117	385	0.10039	0.31226	0.67432	0.09178	1.06238
1988	0.08333	360	0.33883	1.05392	0.28133	0.60686	1.83033
1989	0.07821	358	0.45726	1.42231	0.29306	0.80108	2.52530
1990	0.09136	405	0.53600	1.66725	0.28593	0.95171	2.92076
1991	0.07592	382	0.28553	0.88814	0.33637	0.46143	1.70944
1992	0.06612	363	0.18879	0.58722	0.31427	0.31786	1.08487
1993	0.09181	403	0.51389	1.59848	0.25684	0.96421	2.64997
1994	0.05426	387	0.23166	0.72057	0.43390	0.31400	1.65358
1995	0.08625	371	0.35457	1.10289	0.28118	0.63524	1.91482
1996	0.06183	372	0.31361	0.97551	0.37302	0.47394	2.00786
1997	0.04735	359	0.09861	0.30674	0.49132	0.12102	0.77745
1998	0.06723	357	0.17563	0.54631	0.34927	0.27717	1.07678
1999	0.06150	374	0.24460	0.76083	0.33175	0.39868	1.45194
2000	0.08130	369	0.36328	1.12998	0.34691	0.57580	2.21755
2001	0.05960	302	0.25269	0.78600	0.38920	0.37086	1.66583
2002	0.02865	384	0.10442	0.32480	0.60282	0.10667	0.98902
2003	0.07916	379	0.45133	1.40387	0.26920	0.82715	2.38271
2004	0.06742	356	0.14970	0.46564	0.29732	0.26016	0.83339
2005	0.12948	363	0.74764	2.32555	0.25517	1.40725	3.84308
2006	0.08639	382	0.28682	0.89216	0.29229	0.50321	1.58175
2007	0.11239	347	0.56336	1.75234	0.28765	0.99706	3.07977
2008	0.04499	489	0.24844	0.77279	0.38643	0.36645	1.62970
2009	0.09457	645	0.33117	1.03011	0.18099	0.71935	1.47512
2010	0.07455	389	0.37753	1.17432	0.26837	0.69299	1.98997

Table 5.3.1.5. Indices of Spanish mackerel (summer model) developed using the delta-lognormal model for 1987-2010. The nominal frequency of occurrence, the number of samples (*N*), the DL Index (number per trawl-hour), the DL indices scaled to a mean of one for the time series, the coefficient of variation on the mean (CV), and lower and upper confidence limits (LCL and UCL) for the scaled index are listed.

Survey Year	Frequency	*N*	DL Index	Scaled Index	CV	LCL	UCL
1987	0.03784	185	0.18625	0.46182	0.89668	0.09938	2.14620
1988	0.04930	142	0.23456	0.58162	0.73493	0.15626	2.16494
1989	0.07857	140	1.34106	3.32531	0.46395	1.37506	8.04159
1990	0.10465	172	1.40658	3.48777	0.41285	1.57749	7.71131
1991	0.09150	153	0.60189	1.49245	0.52590	0.55551	4.00965
1992	0.02013	149	0.09337	0.23153	1.20364	0.03488	1.53671
1993	0.02685	149	0.19434	0.48189	0.86371	0.10827	2.14481
1994	0.05229	153	0.36121	0.89565	0.86398	0.20116	3.98779
1995	0.06122	147	0.38049	0.94347	0.59443	0.31401	2.83476
1996	0.05479	146	0.39826	0.98753	0.60307	0.32418	3.00825
1997	0.03650	137	0.03294	0.08167	1.29947	0.01117	0.59685
1998	0.06618	136	0.28571	0.70846	0.58943	0.23768	2.11170
1999	0.02041	147	0.04729	0.11726	1.70488	0.01136	1.21085
2000	0.06338	142	0.27592	0.68418	0.57334	0.23557	1.98716
2001	0.05660	106	0.65155	1.61558	0.60729	0.52682	4.95446
2002	0.02703	148	0.10513	0.26067	1.63964	0.02653	2.56104
2003	0.04000	125	0.19127	0.47428	0.79479	0.11702	1.92227
2004	0.06164	146	0.26634	0.66042	0.57553	0.22658	1.92497
2005	0.07746	142	0.48427	1.20081	0.49449	0.47123	3.05996
2006	0.08000	150	0.29427	0.72967	0.52206	0.27334	1.94782
2007	0.12687	134	1.24088	3.07690	0.47541	1.24746	7.58927
2008	0.04372	183	0.29391	0.72879	0.63276	0.22833	2.32618
2009	0.03831	261	0.12175	0.30190	0.69478	0.08605	1.05923
2010	0.04930	142	0.18968	0.47034	0.97410	0.09181	2.40950

Table 5.3.1.6. Indices of Spanish mackerel (fall model) developed using the delta-lognormal model for 1987-2010. The nominal frequency of occurrence, the number of samples (*N*), the DL Index (number per trawl-hour), the DL indices scaled to a mean of one for the time series, the coefficient of variation on the mean (CV), and lower and upper confidence limits (LCL and UCL) for the scaled index are listed.

Survey Year	Frequency	*N*	DL Index	Scaled Index	CV	LCL	UCL
1987	0.03268	153	0.04749	0.12163	0.97095	0.02383	0.62068
1988	0.12778	180	0.56827	1.45531	0.34682	0.74169	2.85555
1989	0.09140	186	0.26759	0.68529	0.37082	0.33427	1.40490
1990	0.09794	194	0.21522	0.55116	0.39663	0.25661	1.18381
1991	0.07407	189	0.19748	0.50574	0.41327	0.22857	1.11901
1992	0.12000	175	0.33683	0.86261	0.34460	0.44142	1.68569
1993	0.14884	215	0.86505	2.21538	0.27656	1.28719	3.81290
1994	0.06806	191	0.14301	0.36624	0.50194	0.14191	0.94514
1995	0.12500	184	0.53668	1.37442	0.34304	0.70536	2.67811
1996	0.07979	188	0.26482	0.67819	0.43130	0.29689	1.54921
1997	0.06417	187	0.17352	0.44438	0.54814	0.15942	1.23867
1998	0.07979	188	0.22838	0.58487	0.49573	0.22903	1.49355
1999	0.10638	188	0.49804	1.27546	0.37277	0.61995	2.62408
2000	0.10053	189	0.32053	0.82088	0.36157	0.40721	1.65478
2001	0.07186	167	0.21556	0.55205	0.51677	0.20864	1.46068
2002	0.03571	196	0.13674	0.35020	0.78728	0.08731	1.40453
2003	0.11312	221	0.74927	1.91886	0.28751	1.09209	3.37152
2004	0.08721	172	0.21528	0.55133	0.42316	0.24485	1.24147
2005	0.18462	195	1.09266	2.79826	0.29318	1.57568	4.96947
2006	0.10309	194	0.36455	0.93360	0.39451	0.43632	1.99764
2007	0.12155	181	0.32770	0.83924	0.32478	0.44548	1.58106
2008	0.05224	268	0.25678	0.65760	0.46635	0.27081	1.59688
2009	0.17057	299	0.65631	1.68079	0.19864	1.13408	2.49107
2010	0.12291	179	0.69368	1.77651	0.30726	0.97427	3.23934

Table 5.4.2.1. Gulf of Mexico vertical line relative nominal CPUE, number of trips, and relative abundance index

YEAR	Relative Nominal CPUE	Trips	Proportion Successful Trips	Standardized Index	Lower 95% CI (Index)	Upper 95% CI (Index)	CV (Index)
1998	0.896733	407	1.0	1.110020	0.916881	1.343842	0.095796
1999	0.676905	484	1.0	0.818040	0.685334	0.976443	0.088676
2000	0.959316	602	1.0	0.821822	0.698381	0.967081	0.081515
2001	1.277024	475	1.0	0.928847	0.776205	1.111506	0.089945
2002	0.627930	442	1.0	0.839362	0.697565	1.009984	0.092722
2003	0.624959	409	1.0	0.912561	0.753036	1.105879	0.096293
2004	1.008903	296	1.0	1.067666	0.856744	1.330516	0.110380
2005	1.390524	246	1.0	1.085462	0.853211	1.380934	0.120814
2006	1.328267	219	1.0	1.229151	0.955510	1.581158	0.126418
2007	1.224061	182	1.0	1.006811	0.764985	1.325084	0.137994
2008	0.841146	242	1.0	0.915937	0.718186	1.16814	0.122061
2009	0.969648	323	1.0	0.961957	0.777388	1.190346	0.106818
2010	1.174585	301	1.0	1.302363	1.043055	1.626136	0.111356

Table 5.4.3.1. Gulf of Mexico gillnet relative nominal CPUE, number of trips, proportion positive trips, and relative abundance indices

YEAR	Relative Nominal CPUE	Trips	Proportion Successful Trips	Standardized Index	Lower 95% CI (Index)	Upper 95% CI (Index)	CV (Index)
1998	1.31587	66	0.77273	0.56137	0.09827	3.2068	1.06611
1999	0.85971	153	0.75163	0.36191	0.07981	1.6411	0.87785
2000	0.66704	105	0.66667	0.25462	0.05378	1.2054	0.91108
2001	0.59857	89	0.77528	0.80905	0.19655	3.3302	0.80595
2002	0.45216	62	0.66129	0.07050	0.00871	0.5705	1.40818
2003	1.26842	43	0.62791	2.19239	0.51953	9.2518	0.82409
2004	1.56015	41	0.58537	2.06259	0.48658	8.7433	0.82740
2005	1.17250	47	0.65957	2.37125	0.56209	10.0034	0.82386
2006	0.82636	25	0.60000	0.19907	0.04456	0.8892	0.86644
2007	0.79055	49	0.69388	0.70306	0.16638	2.9709	0.82508
2008	0.95515	46	0.52174	0.56617	0.12659	2.5321	0.86735
2009	1.59290	102	0.79412	0.57952	0.13959	2.4059	0.81215
2010	0.94061	27	0.37037	2.26850	0.47157	10.9126	0.92363

Table 5.4.4.1. Total number of trips, positive trips, and the percent positive trips by year in the Gulf of Mexico from the Headboat Survey data for Spanish mackerel.

Year	Total Trips	Positive Trips	Percent Positive Trips
1986	4459	134	3.01
1987	4597	186	4.05
1988	6288	95	1.51
1989	6920	123	1.78
1990	10336	270	2.61
1991	9111	381	4.18
1992	10273	322	3.13
1993	10755	232	2.16
1994	10691	334	3.12
1995	9001	166	1.84
1996	8417	166	1.97
1997	8288	143	1.73
1998	7675	90	1.17
1999	6665	125	1.88
2000	6421	181	2.82
2001	6229	73	1.17
2002	6420	132	2.06
2003	6339	101	1.59
2004	6823	131	1.92
2005	6527	133	2.04
2006	5896	143	2.43
2007	6404	262	4.09
2008	6622	325	4.91
2009	8401	325	3.87
2010	6626	215	3.24
Total	186184	4788	38.89

Table 5.4.4.2. Total number of trips by month and year in the Gulf of Mexico from the Headboat Survey for Spanish mackerel.

Year	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.
1986	218	211	327	320	315	594	762	567	342	300	271	232
1987	205	246	341	418	532	575	653	562	323	272	235	235
1988	223	283	438	582	757	892	1002	779	309	445	265	313
1989	381	437	542	644	710	728	891	860	559	544	363	261
1990	543	601	907	948	895	1161	1250	1204	835	775	656	561
1991	583	638	712	789	797	1062	1189	1015	710	653	473	490
1992	496	573	835	864	1025	1148	1425	1213	802	788	540	564
1993	650	677	858	887	1007	1199	1563	1231	866	799	532	486
1994	462	683	969	1026	1126	1181	1374	1260	823	734	569	484
1995	410	539	789	903	931	1221	1397	1054	753	352	378	274
1996	298	417	497	666	845	1116	1327	1152	789	544	364	402
1997	449	563	735	544	753	1071	1125	1126	747	550	432	193
1998	466	392	642	703	923	970	1317	937	383	433	293	216
1999	325	554	615	633	772	868	945	744	371	347	260	231
2000	239	381	504	643	747	906	1002	731	423	475	210	160
2001	172	365	430	663	742	787	1010	768	492	436	202	162
2002	249	295	478	605	633	895	1078	832	408	505	245	197
2003	223	318	470	546	763	891	958	764	449	508	243	206
2004	323	393	691	721	837	999	1069	690	328	426	181	165
2005	333	342	484	601	923	984	906	698	351	416	264	225
2006	281	333	565	509	711	811	826	612	438	361	279	170
2007	263	334	613	552	688	1016	1011	683	403	377	222	242
2008	178	328	504	678	712	1051	1125	662	278	455	313	338
2009	381	406	648	679	797	1359	1516	1057	471	461	334	292
2010	271	289	588	726	644	917	846	620	427	652	408	238
Total	8622	10598	15182	16850	19585	24402	27567	21821	13080	12608	8532	7337

Table 5.4.4.3. Standardized indices and corresponding 95% confidence intervals.

	HEADBOAT SURVEY								MRFSS SURVEY							
	Cobia				Spanish Mackerel				Cobia				Spanish Mackerel			
Year	Index	Lower CI	Uppder CI	CV	Index	Lower CI	Uppder CI	CV	Index	Lower CI	Uppder CI	CV	Index	Lower CI	Uppder CI	CV
1981									0.705	0.349	1.424	0.363	0.974	0.523	1.814	0.318
1982									0.898	0.546	1.476	0.252	1.292	0.784	2.131	0.254
1983									0.627	0.324	1.211	0.339	0.826	0.451	1.515	0.310
1984									0.605	0.335	1.092	0.302	0.631	0.325	1.223	0.340
1985									0.532	0.278	1.018	0.333	0.701	0.380	1.293	0.313
1986	0.576	0.411	0.808	0.170	0.816	0.432	1.544	0.327	0.495	0.316	0.775	0.227	1.906	1.256	2.892	0.211
1987	0.560	0.402	0.780	0.166	1.624	0.894	2.949	0.305	0.604	0.394	0.926	0.216	1.395	0.920	2.115	0.210
1988	0.563	0.403	0.785	0.168	0.505	0.263	0.970	0.335	0.860	0.554	1.336	0.223	0.802	0.514	1.252	0.225
1989	0.541	0.384	0.764	0.173	0.789	0.419	1.486	0.324	0.889	0.558	1.417	0.236	1.138	0.717	1.807	0.234
1990	0.709	0.513	0.979	0.162	0.998	0.556	1.793	0.299	1.350	0.885	2.059	0.213	1.851	1.199	2.856	0.219
1991	0.799	0.587	1.089	0.155	2.023	1.145	3.572	0.290	1.505	1.034	2.191	0.190	1.350	0.871	2.092	0.222
1992	0.910	0.700	1.183	0.132	1.288	0.722	2.301	0.296	1.032	0.747	1.425	0.163	1.408	0.976	2.031	0.185
1993	1.259	0.982	1.612	0.124	0.960	0.533	1.732	0.301	1.007	0.695	1.459	0.187	0.657	0.427	1.011	0.218
1994	1.136	0.879	1.467	0.129	1.292	0.726	2.298	0.294	1.440	1.021	2.030	0.173	0.613	0.406	0.926	0.208
1995	1.194	0.914	1.561	0.135	0.777	0.423	1.427	0.311	0.673	0.446	1.014	0.207	0.420	0.262	0.673	0.239
1996	1.147	0.860	1.530	0.145	0.777	0.422	1.431	0.313	1.406	1.004	1.970	0.170	0.736	0.477	1.134	0.219
1997	1.309	0.995	1.723	0.138	0.685	0.367	1.279	0.320	1.734	1.274	2.360	0.155	0.627	0.414	0.950	0.210
1998	1.069	0.801	1.427	0.145	0.353	0.181	0.686	0.342	1.241	0.914	1.686	0.154	0.772	0.521	1.146	0.199
1999	0.955	0.687	1.327	0.165	0.705	0.374	1.329	0.325	1.129	0.852	1.495	0.141	1.315	0.922	1.875	0.179
2000	0.777	0.554	1.089	0.170	1.044	0.568	1.916	0.311	0.915	0.679	1.233	0.150	0.960	0.667	1.383	0.184
2001	1.043	0.750	1.450	0.166	0.401	0.201	0.801	0.357	1.019	0.765	1.356	0.144	0.998	0.688	1.449	0.188
2002	0.980	0.702	1.367	0.168	0.789	0.421	1.481	0.323	1.030	0.777	1.365	0.142	0.912	0.630	1.320	0.186
2003	0.931	0.657	1.319	0.176	0.569	0.292	1.108	0.343	1.158	0.870	1.542	0.144	0.987	0.676	1.440	0.191
2004	1.005	0.718	1.408	0.169	0.523	0.273	1.003	0.334	0.978	0.729	1.312	0.148	1.063	0.738	1.532	0.184
2005	1.271	0.939	1.719	0.152	0.542	0.285	1.031	0.330	0.967	0.705	1.325	0.159	0.712	0.478	1.059	0.201
2006	1.105	0.802	1.522	0.161	1.011	0.544	1.880	0.318	0.889	0.650	1.216	0.158	0.871	0.594	1.277	0.193
2007	1.205	0.884	1.641	0.155	1.552	0.861	2.798	0.301	0.984	0.721	1.343	0.156	0.902	0.620	1.310	0.189
2008	1.153	0.845	1.575	0.157	1.961	1.099	3.498	0.296	1.164	0.864	1.569	0.150	1.003	0.687	1.464	0.191
2009	1.304	0.992	1.714	0.137	1.916	1.088	3.374	0.289	0.960	0.693	1.330	0.164	0.822	0.570	1.187	0.185
2010	1.498	1.133	1.981	0.140	1.098	0.603	2.001	0.307	1.205	0.871	1.666	0.163	1.354	0.923	1.987	0.193

Table 5.4.5.1. Total trips, positive trips, and percentage of positive trips that encountered Spanish mackerel from the MRFSS database as subset for Spanish mackerel.

Year	Total Trips	Positive Trips	Percentage Positive Trips
1981	3760	177	4.71
1982	6633	331	4.99
1983	4286	185	4.32
1984	5200	149	2.87
1985	5930	181	3.05
1986	10551	693	6.57
1987	10506	689	6.56
1988	12467	506	4.06
1989	8968	436	4.86
1990	7723	540	6.99
1991	8568	511	5.96
1992	18782	1243	6.62
1993	17628	636	3.61
1994	20027	758	3.78
1995	18023	413	2.29
1996	18652	622	3.33
1997	19110	682	3.57
1998	22447	930	4.14
1999	30760	1701	5.53
2000	27005	1380	5.11
2001	27225	1391	5.11
2002	28550	1470	5.15
2003	29287	1317	4.50
2004	29978	1704	5.68
2005	27006	1000	3.70
2006	26818	1217	4.54
2007	28081	1415	5.04
2008	28436	1276	4.49
2009	29071	1482	5.10
2010	28181	1637	5.81
	559659	26672	4.77

Table 5.4.5.2. Total number of trips by month and year in the Gulf of Mexico from MRFSS for Spanish mackerel.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1981				208	275	330	323	825	327	719	538	215
1982			354	642	1024	800	1061	1003	213	778	443	315
1983	107	103	462	647	498	592	401	376	261	440	156	243
1984	167	482	434	381	675	552	568	239	616	444	458	184
1985	150	275	372	549	552	585	645	503	545	642	552	560
1986	255	647	710	871	918	1120	1189	1031	1038	1017	917	838
1987	463	701	842	1091	1128	1047	1461	834	1060	952	685	242
1988	541	601	707	584	1035	744	1324	1501	1340	1804	1262	1024
1989	889	424	913	513	1249	549	905	978	937	634	688	289
1990	136	735	669	822	740	787	701	682	701	467	780	503
1991	357	707	629	717	786	1091	789	600	763	848	785	496
1992	933	1593	1358	2345	2274	1103	1915	973	1343	2083	1851	1011
1993		1776	1903	1137	1807	1712	1840	1978	1414	1367	1636	1058
1994	1330	1768	1681	1574	1813	2239	2204	1811	1599	1319	1456	1233
1995	1494	1258	1655	1484	1695	1829	1799	1743	1671	1114	1250	1031
1996	954	1041	1342	1728	1671	1809	1586	1998	1429	2205	1562	1327
1997	1143	1175	1505	1435	1917	1882	1796	1670	1949	1876	1774	988
1998	1513	1282	1540	1535	1924	1699	2409	2478	882	2196	2483	2506
1999	3076	2892	3587	3978	2192	2337	3012	2552	1683	1978	1911	1562
2000	1608	2185	2322	2774	2736	2936	2663	2257	2033	2193	1714	1584
2001	1750	1998	2306	2631	2655	2743	2571	2503	2529	1931	2003	1605
2002	1753	1794	2640	2690	2990	3113	2550	2724	2122	2350	2044	1780
2003	1742	2573	2725	2715	3089	3021	3001	2441	2208	2021	2238	1513
2004	1788	1810	2865	2828	3038	3177	3086	2662	1921	2980	1935	1888
2005	2094	1933	2541	2898	3073	2806	2562	2286	1458	1762	1889	1704
2006	1753	1582	2176	2458	2462	2689	2688	2492	2437	2202	1864	2015
2007	1497	1653	2316	2471	2861	3075	2736	2550	2418	2160	2306	2038
2008	1704	2209	2671	2223	2703	2887	2883	2163	1995	2581	2548	1869
2009	2067	1758	2245	2845	3338	2811	2887	2480	2586	2393	2222	1439
2010	1497	1437	2142	2859	3182	2734	2578	2441	2653	2803	2396	1459
Total	32761	38392	47612	51633	56300	54799	56133	50774	44131	48259	44346	34519

Table 5.4.5.3. Number of positive trips that caught Spanish mackerel by month and year in the Gulf of Mexico from MRFSS for Spanish mackerel.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1981				10	31	11	16	50	20	27	9	3
1982			7	42	72	49	33	83	4	35	4	2
1983	1	0	0	31	29	24	36	17	16	31	0	0
1984	0	2	4	3	10	52	40	1	13	20	3	1
1985	1	0	1	32	19	33	41	12	4	20	13	5
1986	1	5	12	98	86	111	82	82	77	62	72	5
1987	7	2	16	60	145	80	97	80	125	60	17	0
1988	1	4	15	63	96	49	56	84	44	62	25	7
1989	1	7	8	34	49	9	70	132	77	34	15	0
1990	0	16	43	63	34	37	48	96	98	66	35	4
1991	9	8	27	83	61	65	55	43	78	60	12	10
1992	15	52	162	309	224	65	85	56	59	157	53	6
1993		11	17	62	46	70	31	72	148	81	83	15
1994	3	66	55	115	79	82	59	114	83	45	50	7
1995	3	15	25	36	31	24	30	52	110	52	27	8
1996	1	2	17	96	87	56	75	85	82	80	27	14
1997	11	36	72	51	47	48	72	40	131	96	60	18
1998	14	8	13	62	76	66	108	165	59	125	140	94
1999	69	60	143	284	190	154	149	168	144	182	103	55
2000	24	66	171	182	158	153	142	161	136	113	64	10
2001	8	44	58	208	137	137	94	184	226	105	111	79
2002	16	15	99	229	174	159	120	206	150	192	76	34
2003	13	31	197	162	102	69	76	160	173	170	149	15
2004	20	64	287	246	195	147	118	180	83	201	134	29
2005	22	18	57	176	291	125	84	99	39	42	37	10
2006	4	2	19	131	148	222	175	176	129	109	61	41
2007	41	12	130	264	170	135	112	84	119	127	122	99
2008	21	73	122	165	106	126	104	130	138	158	98	35
2009	18	29	117	111	269	131	107	149	184	181	130	56
2010	8	14	50	265	196	124	176	150	214	289	141	10
Total	332	662	1944	3673	3358	2613	2491	3111	2963	2982	1871	672

Table 5.4.5.4. Percentage of positive trips that caught Spanish mackerel by month and year in the Gulf of Mexico from MRFSS for Spanish mackerel.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1981	0.00	0.00	0.00	4.81	11.27	3.33	4.95	6.06	6.12	3.76	1.67	1.40
1982	0.00	0.00	1.98	6.54	7.03	6.13	3.11	8.28	1.88	4.50	0.90	0.63
1983	0.93	0.00	0.00	4.79	5.82	4.05	8.98	4.52	6.13	7.05	0.00	0.00
1984	0.00	0.41	0.92	0.79	1.48	9.42	7.04	0.42	2.11	4.50	0.66	0.54
1985	0.67	0.00	0.27	5.83	3.44	5.64	6.36	2.39	0.73	3.12	2.36	0.89
1986	0.39	0.77	1.69	11.25	9.37	9.91	6.90	7.95	7.42	6.10	7.85	0.60
1987	1.51	0.29	1.90	5.50	12.85	7.64	6.64	9.59	11.79	6.30	2.48	0.00
1988	0.18	0.67	2.12	10.79	9.28	6.59	4.23	5.60	3.28	3.44	1.98	0.68
1989	0.11	1.65	0.88	6.63	3.92	1.64	7.73	13.50	8.22	5.36	2.18	0.00
1990	0.00	2.18	6.43	7.66	4.59	4.70	6.85	14.08	13.98	14.13	4.49	0.80
1991	2.52	1.13	4.29	11.58	7.76	5.96	6.97	7.17	10.22	7.08	1.53	2.02
1992	1.61	3.26	11.93	13.18	9.85	5.89	4.44	5.76	4.39	7.54	2.86	0.59
1993	0.00	0.62	0.89	5.45	2.55	4.09	1.68	3.64	10.47	5.93	5.07	1.42
1994	0.23	3.73	3.27	7.31	4.36	3.66	2.68	6.29	5.19	3.41	3.43	0.57
1995	0.20	1.19	1.51	2.43	1.83	1.31	1.67	2.98	6.58	4.67	2.16	0.78
1996	0.10	0.19	1.27	5.56	5.21	3.10	4.73	4.25	5.74	3.63	1.73	1.06
1997	0.96	3.06	4.78	3.55	2.45	2.55	4.01	2.40	6.72	5.12	3.38	1.82
1998	0.93	0.62	0.84	4.04	3.95	3.88	4.48	6.66	6.69	5.69	5.64	3.75
1999	2.24	2.07	3.99	7.14	8.67	6.59	4.95	6.58	8.56	9.20	5.39	3.52
2000	1.49	3.02	7.36	6.56	5.77	5.21	5.33	7.13	6.69	5.15	3.73	0.63
2001	0.46	2.20	2.52	7.91	5.16	4.99	3.66	7.35	8.94	5.44	5.54	4.92
2002	0.91	0.84	3.75	8.51	5.82	5.11	4.71	7.56	7.07	8.17	3.72	1.91
2003	0.75	1.20	7.23	5.97	3.30	2.28	2.53	6.55	7.84	8.41	6.66	0.99
2004	1.12	3.54	10.02	8.70	6.42	4.63	3.82	6.76	4.32	6.74	6.93	1.54
2005	1.05	0.93	2.24	6.07	9.47	4.45	3.28	4.33	2.67	2.38	1.96	0.59
2006	0.23	0.13	0.87	5.33	6.01	8.26	6.51	7.06	5.29	4.95	3.27	2.03
2007	2.74	0.73	5.61	10.68	5.94	4.39	4.09	3.29	4.92	5.88	5.29	4.86
2008	1.23	3.30	4.57	7.42	3.92	4.36	3.61	6.01	6.92	6.12	3.85	1.87
2009	0.87	1.65	5.21	3.90	8.06	4.66	3.71	6.01	7.12	7.56	5.85	3.89
2010	0.53	0.97	2.33	9.27	6.16	4.54	6.83	6.15	8.07	10.31	5.88	0.69
Total	1.01	1.72	4.08	7.11	5.96	4.77	4.44	6.13	6.71	6.18	4.22	1.95

Table 5.4.5.5. Total trips, positive trips, and the percentage of positive trips that caught Spanish mackerel by mode and year in the Gulf of Mexico from MRFSS for Spanish mackerel.

Year	Total Number of Trips			Positive Trips			Percentage Positive Trips		
	Shore	Charter	Private/ Rental	Shore	Charter	Private/ Rental	Shore	Charter	Private/ Rental
1981	1937	232	1591	54	32	91	2.79	13.79	5.72
1982	3488	177	2968	83	37	211	2.38	20.90	7.11
1983	2530	362	1394	72	43	70	2.85	11.88	5.02
1984	2955	442	1803	39	59	51	1.32	13.35	2.83
1985	3415	326	2189	39	63	79	1.14	19.33	3.61
1986	1930	1303	7318	89	201	403	4.61	15.43	5.51
1987	2166	1014	7326	90	184	415	4.16	18.15	5.66
1988	3536	1017	7914	62	132	312	1.75	12.98	3.94
1989	2900	770	5298	87	107	242	3.00	13.90	4.57
1990	2449	592	4682	177	118	245	7.23	19.93	5.23
1991	2880	696	4992	105	118	288	3.65	16.95	5.77
1992	5704	1322	11756	375	174	694	6.57	13.16	5.90
1993	7799	901	8928	356	60	220	4.56	6.66	2.46
1994	8935	885	10207	394	68	296	4.41	7.68	2.90
1995	8325	709	8989	173	72	168	2.08	10.16	1.87
1996	6009	883	11760	200	72	350	3.33	8.15	2.98
1997	5881	1484	11745	199	184	299	3.38	12.40	2.55
1998	6691	2539	13217	292	249	389	4.36	9.81	2.94
1999	8693	4859	17208	561	462	678	6.45	9.51	3.94
2000	7093	5480	14432	334	544	502	4.71	9.93	3.48
2001	7284	4259	15682	458	332	601	6.29	7.80	3.83
2002	7322	4376	16852	468	305	697	6.39	6.97	4.14
2003	8008	4997	16282	342	373	602	4.27	7.46	3.70
2004	7281	4966	17731	418	418	868	5.74	8.42	4.90
2005	7271	4043	15692	223	243	534	3.07	6.01	3.40
2006	6872	3218	16728	333	178	706	4.85	5.53	4.22
2007	7355	3394	17332	411	295	709	5.59	8.69	4.09
2008	7423	3345	17668	365	259	652	4.92	7.74	3.69
2009	7863	2873	18335	427	272	783	5.43	9.47	4.27
2010	7858	3077	17246	520	290	827	6.62	9.42	4.80
Total	169853	64541	325265	7746	5944	12982	4.56	9.21	3.99

Table 5.4.5.6. Total number of trips, positive trips, and the percentage of positive trips that caught Spanish mackerel by state and year in the Gulf of Mexico from MRFSS for Spanish mackerel.

Year	Total Number of Trips				Positive Trips				Percentage Positive Trips			
	LA	MS	LA	FL West	LA	MS	LA	FL West	LA	MS	LA	FL West
1981	568	367	422	2403	5	33	48	91	0.88	8.99	11.37	3.79
1982	952	1084	1101	3496	26	71	139	95	2.73	6.55	12.62	2.72
1983	873	544	768	2101	11	40	73	61	1.26	7.35	9.51	2.90
1984	1090	855	723	2532	4	56	58	31	0.37	6.55	8.02	1.22
1985	1603	449	803	3075	9	48	51	73	0.56	10.69	6.35	2.37
1986	3811	1056	884	4800	15	81	105	492	0.39	7.67	11.88	10.25
1987	1563	1035	1276	6632	20	93	153	423	1.28	8.99	11.99	6.38
1988	2254	1243	1060	7910	33	81	55	337	1.46	6.52	5.19	4.26
1989	1659	1040	906	5363	33	73	99	231	1.99	7.02	10.93	4.31
1990	1501	882	771	4569	30	97	118	295	2.00	11.00	15.30	6.46
1991	1746	1020	1172	4630	50	78	91	292	2.86	7.65	7.76	6.31
1992	3869	1977	1630	11306	84	163	106	890	2.17	8.24	6.50	7.87
1993	2645	1173	1129	12681	24	28	64	520	0.91	2.39	5.67	4.10
1994	3013	1547	1388	14079	24	32	83	619	0.80	2.07	5.98	4.40
1995	2649	1204	1112	13058	29	32	69	283	1.09	2.66	6.21	2.17
1996	2732	1414	1392	13114	14	37	90	481	0.51	2.62	6.47	3.67
1997	3059	1411	1319	13321	43	65	60	514	1.41	4.61	4.55	3.86
1998	3178	1526	1711	16032	15	94	93	728	0.47	6.16	5.44	4.54
1999	4325	2106	2065	22264	28	124	226	1323	0.65	5.89	10.94	5.94
2000	4390	1743	1873	18999	42	81	187	1070	0.96	4.65	9.98	5.63
2001	4048	1470	1964	19743	15	61	140	1175	0.37	4.15	7.13	5.95
2002	4314	1362	1781	21093	33	43	81	1313	0.76	3.16	4.55	6.22
2003	4076	1571	1786	21854	20	47	72	1178	0.49	2.99	4.03	5.39
2004	4551	1511	1543	22373	23	38	99	1544	0.51	2.51	6.42	6.90
2005	4018	1074	1960	19954	31	22	62	885	0.77	2.05	3.16	4.44
2006	4718	1602	1679	18819	41	23	80	1073	0.87	1.44	4.76	5.70
2007	4753	1650	2028	19650	24	36	79	1276	0.50	2.18	3.90	6.49
2008	5135	1689	2026	19586	21	46	69	1140	0.41	2.72	3.41	5.82
2009	4698	1703	2218	20452	35	60	82	1305	0.74	3.52	3.70	6.38
2010	4056	1462	1901	20762	6	22	106	1503	0.15	1.50	5.58	7.24
Total	91847	38770	42391	386651	788	1805	2838	21241	0.86	4.66	6.69	5.49

Table 5.4.6.1. Atlantic Coast Spanish mackerel adjusted average pounds per trip for various gears, the coefficient of variation (cv), and index values scaled to mean. Commercial fishery data reported on Florida trip tickets.

Atlantic Coast, Florida Trip Ticket indices

Year	Gill nets, 1986-1995			Gill nets, 1995-2010			Cast Nets, 1996-2010			Hook-and-Line Gears		
	index (adjusted mean pounds/trip)	cv (%)	index scaled to mean	index (adjusted mean pounds/trip)	cv (%)	index scaled to mean	index (adjusted mean pounds/trip)	cv (%)	index scaled to mean	index (adjusted mean pounds/trip)	cv (%)	index scaled to mean
1986	293.08	3.66	1.164							20.6	3.89	0.554
1987	261.54	3.77	1.039							24.8	4.19	0.667
1988	260.30	3.78	1.034							30.5	4.85	0.819
1989	318.60	3.81	1.265							27.4	4.81	0.735
1990	222.98	3.36	0.885							29.8	3.97	0.800
1991	220.92	3.38	0.877							22.2	3.14	0.596
1992	196.23	3.23	0.779							27.3	4.01	0.733
1993	317.52	8.14	1.261							31.7	4.27	0.851
1994	268.34	7.30	1.066							22.6	4.58	0.606
1995	413.17	6.97	1.641	140.04	17.47	1.089				32.2	4.03	0.865
1996				176.33	10.30	1.371	3.84	12.55	0.266	28.1	3.31	0.753
1997				87.60	10.55	0.681	9.31	10.70	0.643	27.5	2.93	0.737
1998				124.92	14.34	0.971	0.80	30.09	0.055	26.7	3.02	0.716
1999				115.57	9.83	0.898	1.77	17.21	0.123	32.6	3.10	0.874
2000				121.39	8.93	0.944	9.45	8.05	0.653	33.9	2.83	0.911
2001				116.63	8.24	0.907	11.12	6.99	0.768	33.8	2.81	0.908
2002				103.10	9.20	0.802	10.25	6.78	0.709	32.3	2.69	0.867
2003				132.28	10.62	1.028	16.84	6.18	1.163	34.9	3.03	0.937
2004				77.32	10.17	0.601	19.11	6.24	1.321	45.3	3.01	1.216
2005				149.37	9.09	1.161	15.53	6.94	1.073	44.0	2.73	1.181
2006				155.75	8.71	1.211	15.89	6.50	1.098	47.1	2.80	1.264
2007				144.42	8.98	1.123	10.01	6.49	0.692	40.8	2.58	1.096
2008				143.07	9.13	1.112	12.01	6.39	0.830	42.1	2.42	1.129
2009				128.61	9.09	1.000	12.59	6.19	0.870	55.7	2.24	1.496
2010				103.42	9.50	0.804	20.29	6.24	1.402	47.9	2.25	1.286

Table 5.4.6.2. Gulf Coast Spanish mackerel adjusted average pounds per trip for various gears, the coefficient of variation (cv), and index values scaled to mean. Commercial fishery data reported on Florida trip tickets.

Gulf Coast, Florida Trip Ticket indices

Year	Gill nets, 1986-1995			Gill nets, 1995-2010			Cast Nets, 1996-2010			Hook-and-Line Gears		
	index (adjusted mean pounds/trip)	cv (%)	index scaled to mean	index (adjusted mean pounds/trip)	cv (%)	index scaled to mean	index (adjusted mean pounds/trip)	cv (%)	index scaled to mean	index (adjusted mean pounds/trip)	cv (%)	index scaled to mean
1986	153.66	2.96	0.602							29.1	4.41	0.694
1987	167.59	2.63	0.656							22.8	4.12	0.545
1988	208.84	3.07	0.818							30.8	4.54	0.735
1989	202.50	2.90	0.793							64.4	5.37	1.539
1990	202.82	2.45	0.794							41.7	4.97	0.996
1991	276.62	2.33	1.083							45.8	4.85	1.095
1992	312.84	2.29	1.225							45.9	5.71	1.097
1993	316.03	2.64	1.238							25.3	6.41	0.604
1994	340.55	2.50	1.334							43.6	5.93	1.042
1995	253.04	3.47	0.991	91.92	32.56	0.449				39.7	7.41	0.949
1996				176.80	15.64	0.864	70.22	32.49	0.937	30.4	6.10	0.727
1997				84.12	18.36	0.411	28.41	33.48	0.379	33.2	7.31	0.794
1998				84.41	15.62	0.412	63.69	33.40	0.850	48.3	7.34	1.155
1999				141.49	17.34	0.691	72.52	34.57	0.967	40.1	7.05	0.958
2000				104.05	15.60	0.508	69.03	32.37	0.921	31.8	6.73	0.760
2001				265.83	17.14	1.299	137.15	32.24	1.830	59.7	6.48	1.427
2002				355.52	23.53	1.737	93.54	32.50	1.248	46.0	6.46	1.100
2003				324.07	22.02	1.583	55.96	32.86	0.747	54.0	6.56	1.289
2004				630.82	27.22	3.082	43.78	36.05	0.584	66.7	7.46	1.594
2005				459.92	22.91	2.247	49.32	33.68	0.658	46.9	7.56	1.119
2006				221.10	22.75	1.080	103.91	33.52	1.386	62.4	6.98	1.490
2007				233.38	21.61	1.140	37.92	36.85	0.506	49.1	6.75	1.173
2008				173.62	18.50	0.848	51.93	34.80	0.693	45.4	7.83	1.086
2009				527.11	20.22	2.575	59.25	34.57	0.790	59.9	5.85	1.431
2010				307.85	22.80	1.504	148.04	35.58	1.975	66.7	5.89	1.594

5.7 Figures

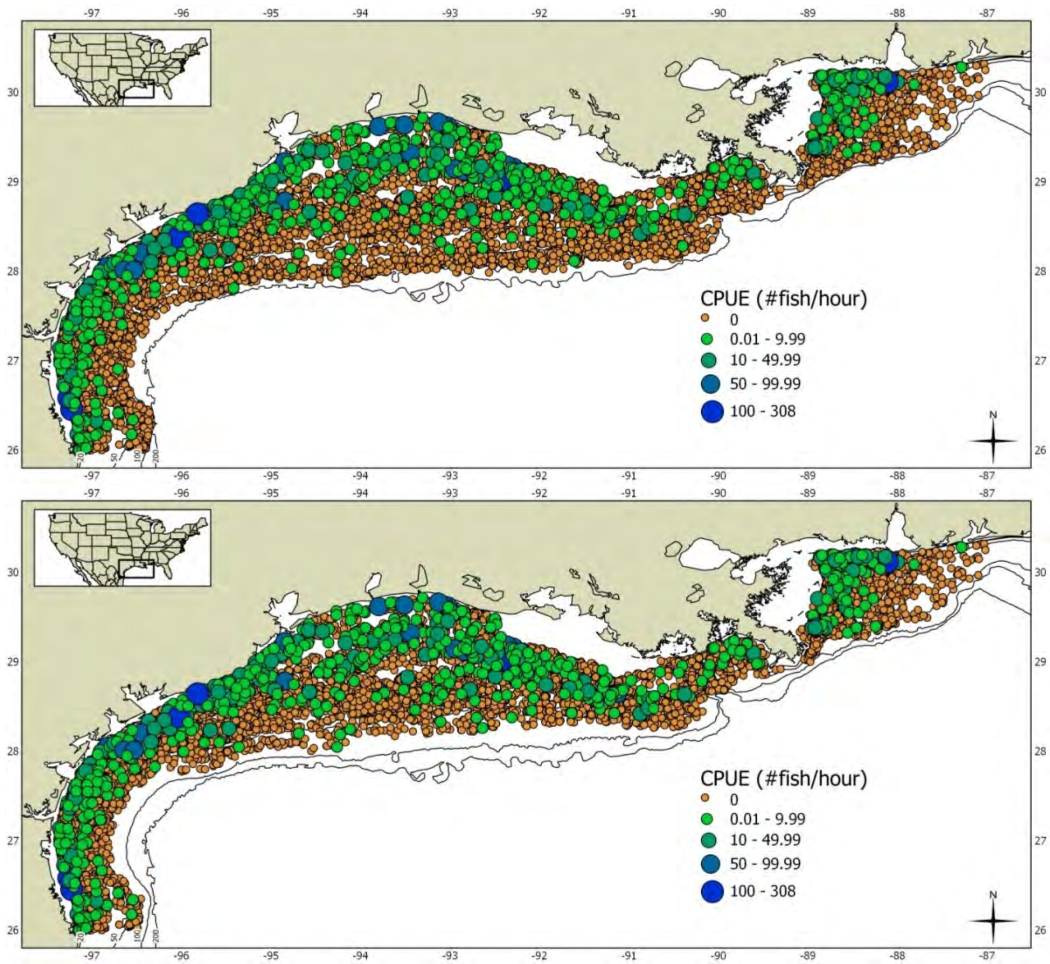


Figure 5.3.1.1. Stations sampled from 1987 to 2010 during the Summer and Fall SEAMAP Groundfish Survey with the CPUE for Spanish mackerel. Top figure has stations from all depth zones, bottom figure has only stations used for the analysis.

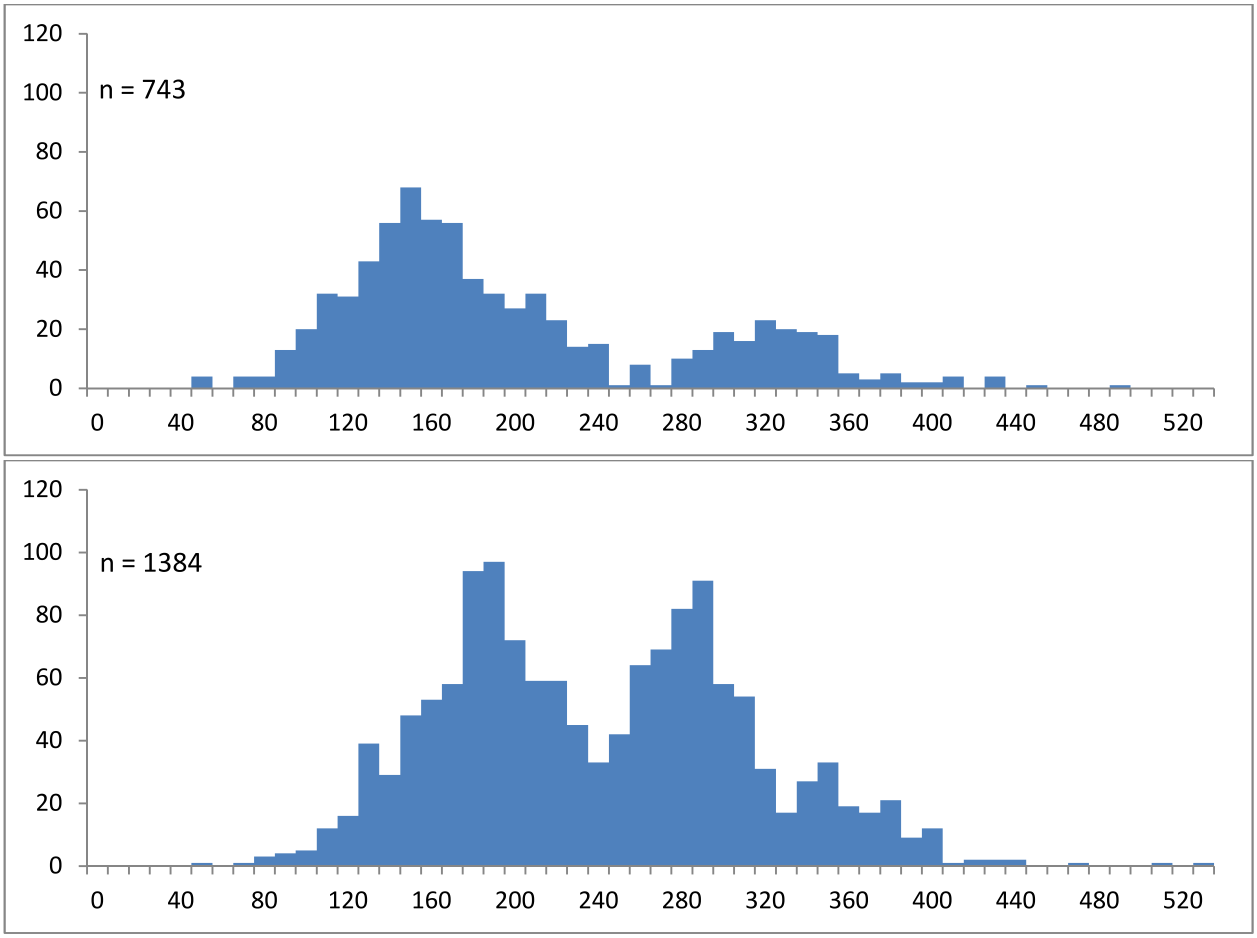


Figure 5.3.1.2. Length frequency distribution for Spanish mackerel caught during the Summer (top) and Fall (bottom) SEAMAP Groundfish Survey from 1987 to 2010.

Figure 5.4.2.1. Spanish mackerel nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dashed lines) for vessels fishing **(a)** Vertical line gear in the Gulf of Mexico.

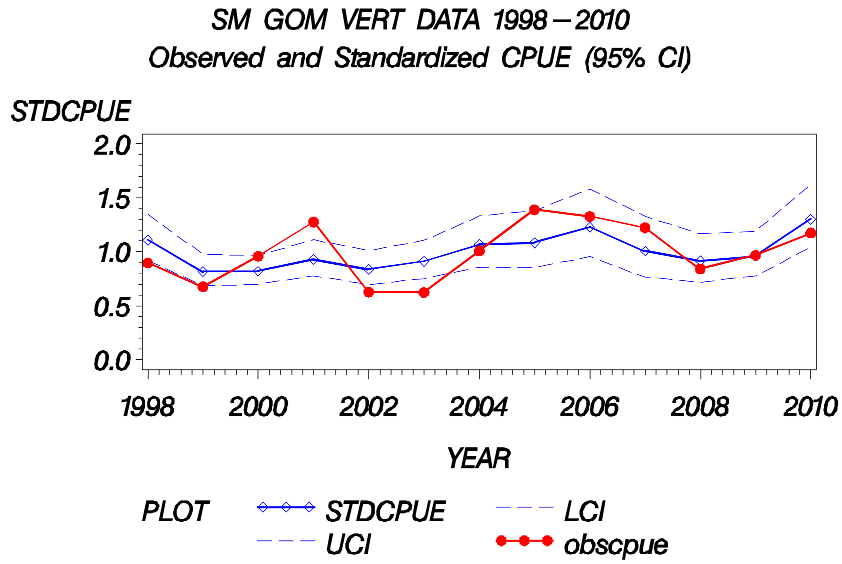


Figure 5.4.3.1. Spanish mackerel nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dashed lines) for vessels fishing Gillnet gear in the Gulf of Mexico.

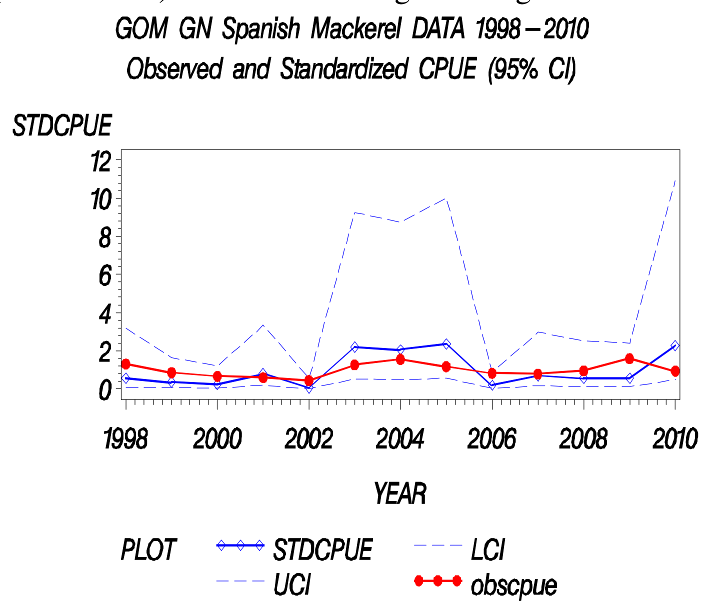


Figure 5.4.4.1. Map of headboat statistical areas.

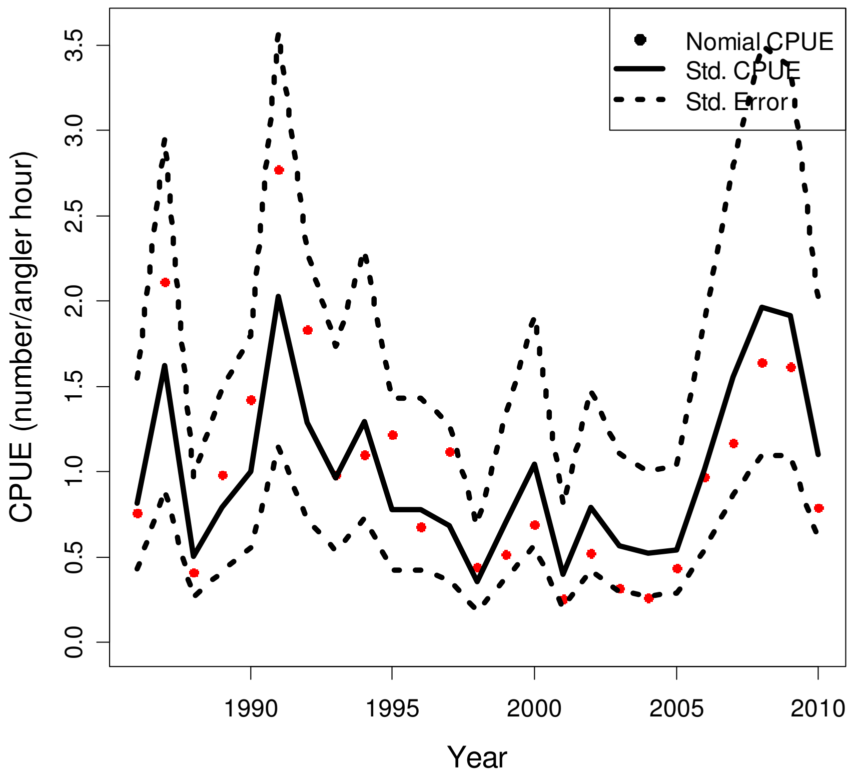


Figure 5.4.4.2. Nominal (observed) and standardized CPUE and the 95% confidence intervals for Spanish mackerel from the Headboat Survey in the GOM. CPUE values were normalized by the mean.

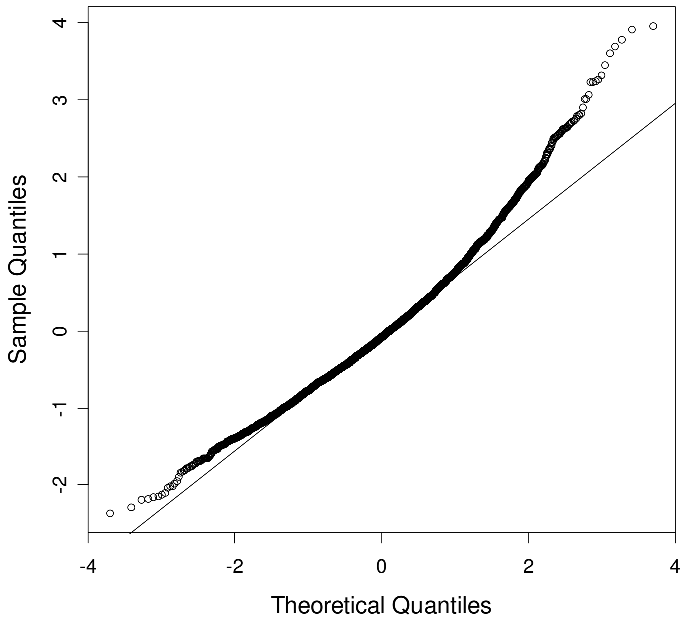


Figure 5.4.4.3. Q-Q plot of CPUE for Spanish mackerel in the GOM for the Headboat Survey.

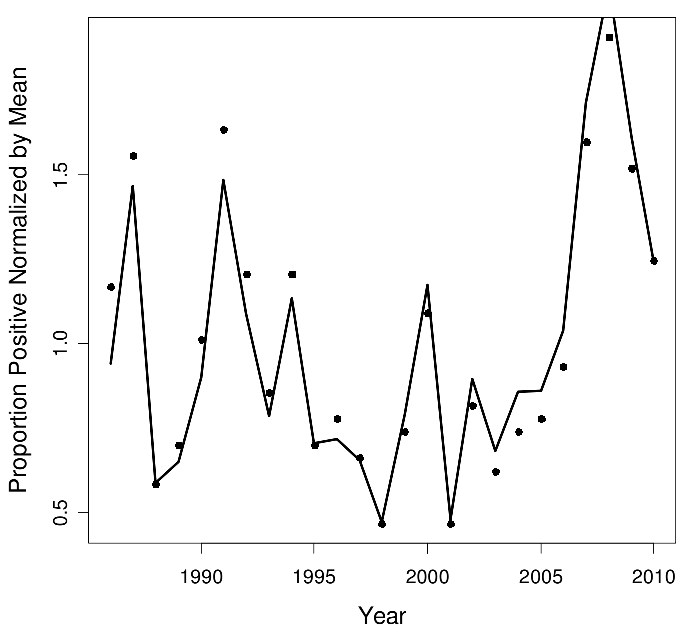


Figure 5.4.4.4. Observed proportion of trips catching Spanish mackerel (black points) and the binomial model fit (blue line) to the data normalized by the mean for the Headboat Survey.

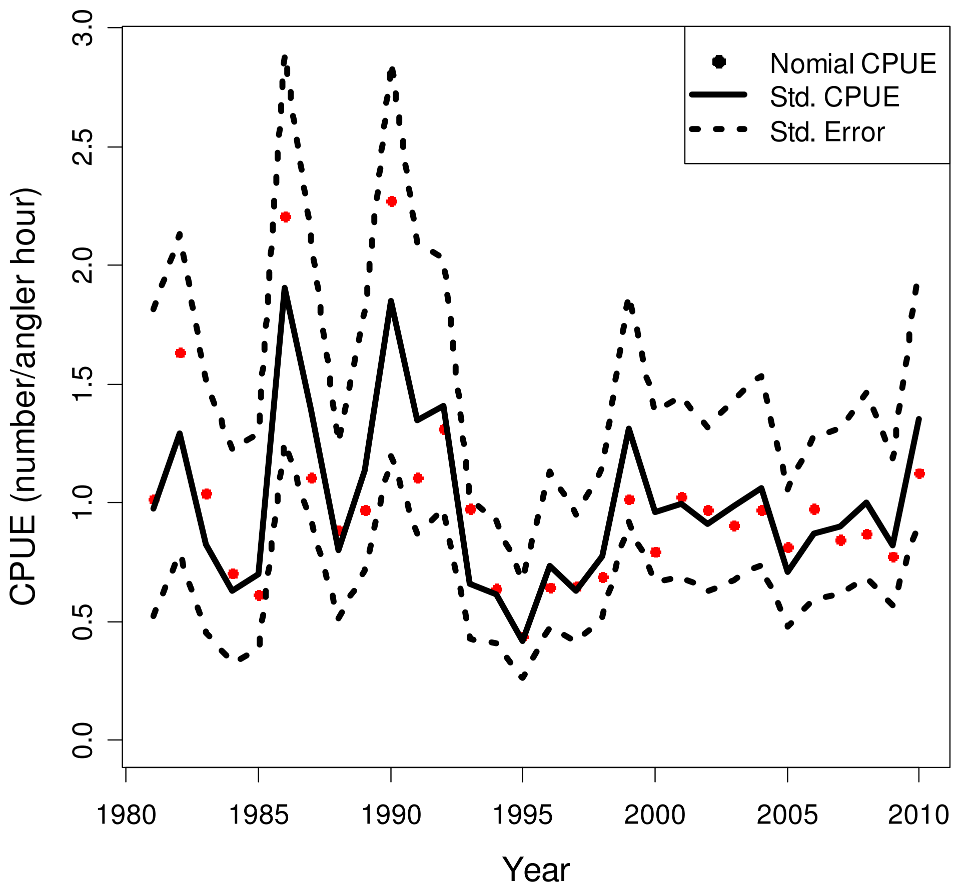


Figure 5.4.5.1. Nominal (observed) and standardized CPUE and the 95% confidence intervals for Spanish mackerel from MRFSS in the GOM. CPUE values were normalized by the mean.

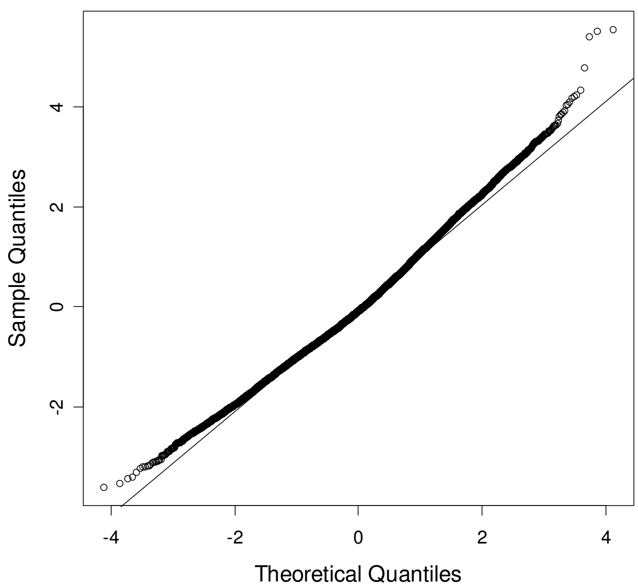


Figure 5.4.5.2. Q-Q plot of CPUE for Spanish mackerel in the GOM MRFSS Survey.

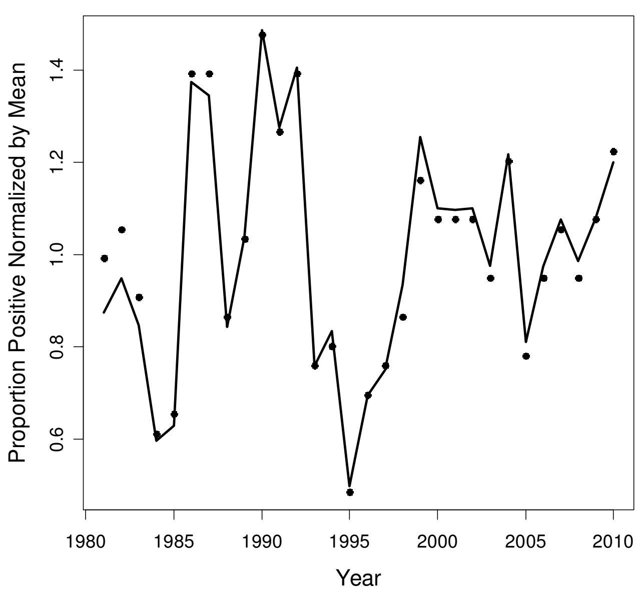


Figure 5.4.5.3. Observed proportion of trips catching Spanish mackerel (black points) and the binomial model fit (line) to the data normalized by the mean for MRFSS.

6 Analytic Approach

Recommended Analytic Approach – Gulf of Mexico Spanish mackerel

During the SEDAR28 Data Workshop available data, data quality and data sufficiency were discussed. Commercial and recreational landings data were complete from 1981 through 2010, and that preliminary landings for 2011 should be available for the assessment workshop. The panel concluded that size composition and age composition data were sufficient to consider an age and size structured model. The panel also concluded that a substantial commercial and recreational fishery existed prior to the period when abundance indices are available. Consequently, the analysts recommended that updated population analyses should be conducted using Stock Synthesis III (SS3, Methot 2000) as a first modeling approach Spanish mackerel in the Gulf of Mexico. SS3 is an integrated statistical catch-at-age model widely used for stock assessments in the United States. SS3 incorporates landings, size and age data inputs and can incorporate many important processes (mortality, selectivity, growth, etc.) that operate in conjunction to produce estimated catch, size and age composition and abundance. Because many inputs can be \correlated, they are jointly considered in the model process accounting for uncertainties in the input data. SS3 also has the ability to incorporate an early, data poor time period for which only catch data are available and a more recent, data-rich time period for which indices and length and age observations are available. Because SS3 assumes no uncertainty in landings, model conclusions should be verified using an alternative simple production model such as ASPIC (ASPIC 5.0 Suite of software).

A note on the assessment models
Forward-projecting age-structured assessment models will be attempted for both Gulf of Mexico and Atlantic Spanish mackerel. The Gulf of Mexico Spanish mackerel will be modeled using the Stock Synthesis 3 model, and the Atlantic Spanish mackerel will be conducted using the Beaufort Assessment Model. While the specific model platforms have some differences, fundamentally they can produce the same output if given the same input. The two analytical teams have experience working with their respective model platform and time and resource limitations dictate that they use the modeling platform with which they have the most familiarity and efficiency.

7 Research Recommendations

7.1 Life History

None provided.

7.2 Commercial Statistics

Decision 10. The WG determined the following recommendations be added to any pending recommendations issued in SEDAR 17 that have not been addressed.

•Need expanded observer coverage for the fisheries for Spanish mackerel.

  – 5-10% allocated by strata within states
  – get maximum information from fish
- Need research methods that capture Spanish mackerel in large enough numbers to create a reasonable index for young (age 0) Spanish mackerel.
- Expand TIP sampling to better cover all statistical strata.
  – Predominantly from Florida and by gillnet
  – Greater emphasis on collecting unbiased samples
- Establish a mechanism for identifying age samples that were collected by length or market categories, so as to better address any potential bias in age compositions.
- Need better information on migration patterns.
- Need to address issue of fish retained for bait (undersized) or used for food by crew (how to capture in landings).
- Compiling commercial data is surprisingly complex. As this is the 28th SEDAR, one might expect that many of the complications would have been resolved by now through better coordination among NMFS, ACCSP, and the states. Increased attention should be given toward the goal of "one-stop shopping" for commercial data.

7.3 Recreational Statistics

1) Increase proportion of fish with biological data within MRFSS sampling.

2) Continue to develop methods to collect a higher degree of information on released fish (length, condition, etc.) in the recreational fishery.

3) Require mandatory reporting for all charter boats state and federal.

4) Continue development of electronic mandatory reporting for for-hire sector.

5) Continued research efforts to incorporate/require logbook reporting from recreational anglers.

6) Establish a review panel to evaluate methods for reconstructing historical landings (SWAS, FWS, etc.).

7) Quantify historical fishing photos for use in reconstructing recreational historical landings.

8) Narrow down the sampling universe. Identify angler preference and effort. Require a reef fish stamp for anglers targeting reef fish, pelagic stamp for migratory species, and deep-water complex stamp for deep-water species. The program would be similar to the federal duck stamp required of hunters. This would allow the managers to identify what anglers were fishing for.

9) Continue and expand fishery dependent at-sea-observer surveys to collect discard information, which would provide for a more accurate index of abundance.

7.4 Indices

None provided.

Section 5 Appendix – Index Report Cards

Appendix 5.1 SEAMAP Groundfish Trawl
Appendix 5.2 Texas Parks and Wildlife
Appendix 5.3 Commercial Vertical Line
Appendix 5.4 Commercial Gillnet
Appendix 5.5 Headboat
Appendix 5.6 MRFSS
Appendix 5.7 Florida Trip Ticket – Castnet
Appendix 5.8 Florida Trip Ticket – Handline
Appendix 5.9 Florida Trip Ticket – Gillnet

Appendix 5.1
Gulf of Mexico Spanish Mackerel
SEAMAP Index

DESCRIPTION OF THE DATA SOURCE

1. Fishery Independent Indices

	Not Applicable	Absent	Incomplete	Complete
A. Describe the survey design (e.g. fixed sampling sites, random stratified sampling), location, seasons/months and years of sampling.				✓
B. Describe sampling methodology (e.g. gear, vessel, soak time etc.)				✓
C. Describe any changes in sampling methodology (e.g. gear, vessel, sample design etc.)				✓
D. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.).				✓
E. What species or species assemblages are targeted by this survey (e.g. red snapper, reef fish, pelagic).				✓
F. Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available.				✓

2. Fishery Dependent Indices

	Not Applicable	Absent	Incomplete	Complete
A. Describe the data source and type of fishery (e.g. commercial handline, commercial longline, recreational hook and line etc.).	✓			
B. Describe any changes to reporting requirements, variables reported, etc.	✓			
C. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.).	✓			
D Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available.	✓			

METHODS

1. Data Reduction and Exclusions

	Not Applicable	Absent	Incomplete	Complete
A. Describe any data exclusions (e.g. gears, fishing modes, sampling areas etc.). Report the number of records removed and justify removal.				✓
B. Describe data reduction techniques (if any) used to address targeting (e.g. Stephens and MacCall, 2004; gear configuration, species assemblage etc).	✓			
C. Discuss procedures used to identify outliers. How many were identified? Were they excluded?	✓			

Working Group Comments:

SEDAR28-DW03

SEAMAP Groundfish Survey

2. Management Regulations (for FD Indices)

	Not Applicable	Absent	Incomplete	Complete
A. Provide (or cite) history of management regulations (e.g. bag limits, size limits, trip limits, closures etc.).	✓			
B. Describe the effects (if any) of management regulations on CPUE	✓			
C. Discuss methods used (if any) to minimize the effects of management measures on the CPUE series.	✓			

3. Describe Analysis Dataset (after exclusions and other treatments)

	Not Applicable	Absent	Incomplete	Complete
A. Provide tables and/or figures of number of observations by factors (including year, area, etc.) and interaction terms.		✓		
B. Include tables and/or figures of number of positive observations by factors and interaction terms.		✓		
C. Include tables and/or figures of the proportion positive observations by factors and interaction terms.		✓		
D. Include tables and/or figures of average (unstandardized) CPUE by factors and interaction terms.		✓		
E. Include annual maps of locations of survey sites (or fishing trips) and associated catch rates ***OR*** supply the raw data needed to construct these maps (Observation, Year, Latitude, Longitude (or statistical grid, area), Catch, Effort).				✓
F. Describe the effort variable and the units. If more than one effort variable is present in the dataset, justify selection.				✓
G. What are the units of catch (e.g. numbers or biomass, whole weight, gutted weight, kilograms, pounds).				✓

4. Model Standardization

	Not Applicable	Absent	Incomplete	Complete
A. Describe model structure (e.g. delta-lognormal)				✓
B. Describe construction of GLM components (e.g. forward selection from null etc.)				✓
C. Describe inclusion criteria for factors and interactions terms.				✓
D. Were YEAR*FACTOR interactions included in the model? If so, how (e.g. fixed effect, random effect)? Were random effects tested for significance using a likelihood ratio test?				✓
E. Provide a table summarizing the construction of the GLM components.				✓
F. Summarize model statistics of the mixed model formulation(s) (e.g. log likelihood, AIC, BIC etc.)				✓
G. Report convergence statistics.				✓

Working Group Comments:

3A-D. Available On Demand

4A. Lo et al. method

4G. Available On Demand.

MODEL DIAGNOSTICS

Comment: Other model structures are possible and acceptable. Please provide appropriate diagnostics to the CPUE indices working group.

	Not Applicable	Absent	Incomplete	Complete	Working Group Comments:
1. Binomial Component					
A. Include plots of the chi-square residuals by factor.				✓	
B. Include plots of predicted and observed proportion of positive trips by year and factor (e.g. year*area)		✓			
C. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom).				✓	
2. Lognormal/Gamma Component					
A. Include histogram of log(CPUE) or a histogram of the residuals of the model on CPUE. Overlay the expected distribution.				✓	
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor.				✓	
C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution.				✓	
D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.				✓	
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.				✓	
F. Include plots of the residuals by factor				✓	
3. Poisson Component					
A. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom).	✓				
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor.	✓				
C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution.	✓				
D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.	✓				
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.	✓				***The feasibility of this diagnostic is still under review.***
4. Zero-inflated model					
A. Include ROC curve to quantify goodness of fit.	✓				
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor).	✓				
C. Include QQ-plot (e.g. Student dev. residuals vs. theoretical quantiles), Overlay expected distribution.	✓				

MODEL DIAGNOSTICS (CONT.)

	Not Applicable	Absent	Incomplete	Complete	Working Group Comments:

D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.	✓			
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.	✓			

MODEL RESULTS

A. Tables of Nominal CPUE, Standardized CPUE, Observations, Positive Observations, Proportion Positive Observations and Coefficients of Variation (CVs). Other statistics may also be appropriate to report				✓
B. Figure of Nominal and Standardized Indices with measure of variance (i.e. CVs).				✓

IF MULTIPLE MODEL STRUCTURES WERE CONSIDERED:

(***Note: this is always recommended but required when model diagnostics are poor***.)

1. Plot of resulting indices and estimates of variance	✓			
2. Table of model statistics (e.g. AIC criteria)	✓			

	Date Received	*Workshop Recommendation*	*Revision Deadline* ***	*Author and Rapporteur Signatures*
First Submission	02/06/2012	accept as prepared	N/A	
Revision				

The revision deadline is negotiated by the author, the SEDAR coordinator and the CPUE rapporteur. The author ***DOES NOT*** *commit to any* ***LEGAL OBLIGATION*** *by agreeing to submit a manuscript before this deadline. The maximum penalty for failure to submit a revised document prior to the submission deadline is rejection of the CPUE series.*

Justification of Working Group Recommendation

This index for Spanish mackerel was recommended for use. It is a fisheries independent survey across a long time series (1987-2010), with very good spatial converge (TX/Mexico border to Mobile Bay).

Reset Fields

Appendix 5.2
Gulf of Mexico Spanish Mackerel
Texas Parks and Wildlife Index

DESCRIPTION OF THE DATA SOURCE

1. Fishery Independent Indices

Item	Not Applicable	Absent	Incomplete	Complete	Working Group Comments:
A. Describe the survey design (e.g. fixed sampling sites, random stratified sampling), location, seasons/months and years of sampling.	✓				
B. Describe sampling methodology (e.g. gear, vessel, soak time etc.)	✓				
C. Describe any changes in sampling methodology (e.g. gear, vessel, sample design etc.)	✓				
D. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.).	✓				
E. What species or species assemblages are targeted by this survey (e.g. red snapper, reef fish, pelagic).	✓				
F. Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available.	✓				

2. Fishery Dependent Indices

Item	Not Applicable	Absent	Incomplete	Complete	Working Group Comments:
A. Describe the data source and type of fishery (e.g. commercial handline, commercial longline, recreational hook and line etc.).				✓	Rec, bay, creel, TX
B. Describe any changes to reporting requirements, variables reported, etc.				✓	consistent
C. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.).				✓	date, catch, effort
D Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available.				✓	see size comp report

METHODS

1. Data Reduction and Exclusions

Item	Not Applicable	Absent	Incomplete	Complete	Working Group Comments:
A. Describe any data exclusions (e.g. gears, fishing modes, sampling areas etc.). Report the number of records removed and justify removal.				✓	eliminated bays
B. Describe data reduction techniques (if any) used to address targeting (e.g. Stephens and MacCall, 2004; gear configuration, species assemblage etc).				✓	Ran w/ and w/o Stephens and McCall
C. Discuss procedures used to identify outliers. How many were identified? Were they excluded?				✓	Plotted, 2 SE.

2. Management Regulations (for FD Indices)

Item	Not Applicable	Absent	Incomplete	Complete	Working Group Comments:
A. Provide (or cite) history of management regulations (e.g. bag limits, size limits, trip limits, closures etc.).				✓	Management was constant over index period
B. Describe the effects (if any) of management regulations on CPUE				✓	
C. Discuss methods used (if any) to minimize the effects of management measures on the CPUE series.				✓	

3. Describe Analysis Dataset (after exclusions and other treatments)

Item	Not Applicable	Absent	Incomplete	Complete	Working Group Comments:
A. Provide tables and/or figures of number of observations by factors (including year, area, etc.) and interaction terms.				✓	Data set description provided.
B. Include tables and/or figures of number of positive observations by factors and interaction terms.				✓	
C. Include tables and/or figures of the proportion positive observations by factors and interaction terms.				✓	
D. Include tables and/or figures of average (unstandardized) CPUE by factors and interaction terms.				✓	
E. Include annual maps of locations of survey sites (or fishing trips) and associated catch rates ***OR*** supply the raw data needed to construct these maps (Observation, Year, Latitude, Longitude (or statistical grid, area), Catch, Effort).				✓	
F. Describe the effort variable and the units. If more than one effort variable is present in the dataset, justify selection.				✓	
G. What are the units of catch (e.g. numbers or biomass, whole weight, gutted weight, kilograms, pounds).				✓	

4. Model Standardization

Item	Not Applicable	Absent	Incomplete	Complete	Working Group Comments:
A. Describe model structure (e.g. delta-lognormal)				✓	
B. Describe construction of GLM components (e.g. forward selection from null etc.)			✓		Details provided upon questioning.
C. Describe inclusion criteria for factors and interactions terms.				✓	
D. Were YEAR*FACTOR interactions included in the model? If so, how (e.g. fixed effect, random effect)? Were random effects tested for significance using a likelihood ratio test?				✓	
E. Provide a table summarizing the construction of the GLM components.		✓			
F. Summarize model statistics of the mixed model formulation(s) (e.g. log likelihood, AIC, BIC etc.)				✓	
G. Report convergence statistics.				✓	

MODEL DIAGNOSTICS

Comment: Other model structures are possible and acceptable. Please provide appropriate diagnostics to the CPUE indices working group.

Item	Not Applicable	Absent	Incomplete	Complete	Working Group Comments:
1. Binomial Component					
A. Include plots of the chi-square residuals by factor.				✓	
B. Include plots of predicted and observed proportion of positive trips by year and factor (e.g. year*area)				✓	
C. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom).				✓	
2. Lognormal/Gamma Component					
A. Include histogram of log(CPUE) or a histogram of the residuals of the model on CPUE. Overlay the expected distribution.				✓	
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor.				✓	
C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution.				✓	
D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.				✓	
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.				✓	
F. Include plots of the residuals by factor				✓	
3. Poisson Component					
A. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom).	✓				Poisson component not explored.
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor.	✓				
C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution.	✓				
D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.	✓				
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.	✓				***The feasibility of this diagnostic is still under review.***
4. Zero-inflated model					
A. Include ROC curve to quantify goodness of fit.	✓				
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor).	✓				
C. Include QQ-plot (e.g. Student dev. residuals vs. theoretical quantiles), Overlay expected distribution.	✓				

MODEL DIAGNOSTICS (CONT.)

	Not Applicable	Absent	Incomplete	Complete	Working Group Comments:

D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.	✓			
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.	✓			

MODEL RESULTS

A. Tables of Nominal CPUE, Standardized CPUE, Observations, Positive Observations, Proportion Positive Observations and Coefficients of Variation (CVs). Other statistics may also be appropriate to report				✓
B. Figure of Nominal and Standardized Indices with measure of variance (i.e. CVs).				✓

IF MULTIPLE MODEL STRUCTURES WERE CONSIDERED:

(***Note: this is always recommended but required when model diagnostics are poor***.)

1. Plot of resulting indices and estimates of variance	✓			
2. Table of model statistics (e.g. AIC criteria)	✓			

	Date Received	*Workshop Recommendation*	*Revision Deadline ****	*Author and Rapporteur Signatures*
First Submission	2/15/2012	Do not include		
Revision				

The revision deadline is negotiated by the author, the SEDAR coordinator and the CPUE rapporteur. The author ***DOES NOT*** *commit to any* ***LEGAL OBLIGATION*** *by agreeing to submit a manuscript before this deadline. The maximum penalty for failure to submit a revised document prior to the submission deadline is rejection of the CPUE series.*

Justification of Working Group Recommendation

The TPWD Survey is dominated by bay samples. However, few Spanish mackerel were identified in the survey. The Species Association Approach (Stephens and McCall 2004) was explored to try and identify directed Spanish mackerel trips; however, this approach did not converge. A number of “ad hoc” approaches to subset directed trips for Spanish mackerel from TPWD Survey data were explored; however, these approaches were abandoned because either appropriate subsets could not be identified, they eliminated too many trips leading to the same conclusion as the Species Association Approach, or were not thought to be empirically defensible. An index was constructed using the Delta lognormal approach for the database of all trips, and an index was constructed using a subset of only positive trips using a lognormal model.

The number of Spanish mackerel observed in the survey was extremely small. Consequently, the addition or deletion of a single fish had a drastic impact on the index. Due to the low cpue and high sensitivity of the index, the working group voted to not include the index in the assessment.

Appendix 5.3
Gulf of Mexico Spanish Mackerel
Commercial Vertical line Index

DESCRIPTION OF THE DATA SOURCE

1. Fishery Independent Indices

	Not Applicable	Absent	Incomplete	Complete
A. Describe the survey design (e.g. fixed sampling sites, random stratified sampling), location, seasons/months and years of sampling.	✓			
B. Describe sampling methodology (e.g. gear, vessel, soak time etc.)	✓			
C. Describe any changes in sampling methodology (e.g. gear, vessel, sample design etc.)	✓			
D. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.).	✓			
E. What species or species assemblages are targeted by this survey (e.g. red snapper, reef fish, pelagic).	✓			
F. Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available.	✓			

2. Fishery Dependent Indices

	Not Applicable	Absent	Incomplete	Complete
A. Describe the data source and type of fishery (e.g. commercial handline, commercial longline, recreational hook and line etc.).				✓
B. Describe any changes to reporting requirements, variables reported, etc.				✓
C. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.).				✓
D Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available.	✓			

METHODS

1. Data Reduction and Exclusions

	Not Applicable	Absent	Incomplete	Complete
A. Describe any data exclusions (e.g. gears, fishing modes, sampling areas etc.). Report the number of records removed and justify removal.				✓
B. Describe data reduction techniques (if any) used to address targeting (e.g. Stephens and MacCall, 2004; gear configuration, species assemblage etc).				✓
C. Discuss procedures used to identify outliers. How many were identified? Were they excluded?				✓

Working Group Comments:

2D unknown, data are pounds landed no size data reported - presume legal size with few sublegal

2. Management Regulations (for FD Indices)

	Not Applicable	Absent	Incomplete	Complete
A. Provide (or cite) history of management regulations (e.g. bag limits, size limits, trip limits, closures etc.).				✓
B. Describe the effects (if any) of management regulations on CPUE				✓
C. Discuss methods used (if any) to minimize the effects of management measures on the CPUE series.		✓		

3. Describe Analysis Dataset (after exclusions and other treatments)

	Not Applicable	Absent	Incomplete	Complete
A. Provide tables and/or figures of number of observations by factors (including year, area, etc.) and interaction terms.			✓	
B. Include tables and/or figures of number of positive observations by factors and interaction terms.			✓	
C. Include tables and/or figures of the proportion positive observations by factors and interaction terms.	✓			
D. Include tables and/or figures of average (unstandardized) CPUE by factors and interaction terms.			✓	
E. Include annual maps of locations of survey sites (or fishing trips) and associated catch rates ***OR*** supply the raw data needed to construct these maps (Observation, Year, Latitude, Longitude (or statistical grid, area), Catch, Effort).			✓	
F. Describe the effort variable and the units. If more than one effort variable is present in the dataset, justify selection.				✓
G. What are the units of catch (e.g. numbers or biomass, whole weight, gutted weight, kilograms, pounds).				✓

4. Model Standardization

	Not Applicable	Absent	Incomplete	Complete
A. Describe model structure (e.g. delta-lognormal)				✓
B. Describe construction of GLM components (e.g. forward selection from null etc.)				✓
C. Describe inclusion criteria for factors and interactions terms.				✓
D. Were YEAR*FACTOR interactions included in the model? If so, how (e.g. fixed effect, random effect)? Were random effects tested for significance using a likelihood ratio test?		✓		
E. Provide a table summarizing the construction of the GLM components.				✓
F. Summarize model statistics of the mixed model formulation(s) (e.g. log likelihood, AIC, BIC etc.)				✓
G. Report convergence statistics.			✓	

Working Group Comments:

3A-E. confidential data.
3C. Only positive trips were used.

4G. Available on demand

MODEL DIAGNOSTICS

Comment: Other model structures are possible and acceptable. Please provide appropriate diagnostics to the CPUE indices working group.

Item	Not Applicable	Absent	Incomplete	Complete
1. Binomial Component				
A. Include plots of the chi-square residuals by factor.	✓			
B. Include plots of predicted and observed proportion of positive trips by year and factor (e.g. year*area)	✓			
C. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom).	✓			
2. Lognormal/Gamma Component				
A. Include histogram of log(CPUE) or a histogram of the residuals of the model on CPUE. Overlay the expected distribution.				✓
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor.			✓	
C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution.				✓
D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.			✓	
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.			✓	
F. Include plots of the residuals by factor				✓
3. Poisson Component				
A. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom).	✓			
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor.	✓			
C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution.	✓			
D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.	✓			
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.	✓			
4. Zero-inflated model				
A. Include ROC curve to quantify goodness of fit.	✓			
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor).	✓			
C. Include QQ-plot (e.g. Student dev. residuals vs. theoretical quantiles), Overlay expected distribution.	✓			

Working Group Comments:

1. positive trips only

2B,D,E. Available on demand

The feasibility of this diagnostic is still under review.

MODEL DIAGNOSTICS (CONT.)

	Not Applicable	Absent	Incomplete	Complete

Working Group Comments:

D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.	✓			
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.	✓			

MODEL RESULTS

A. Tables of Nominal CPUE, Standardized CPUE, Observations, Positive Observations, Proportion Positive Observations and Coefficients of Variation (CVs). Other statistics may also be appropriate to report				✓
B. Figure of Nominal and Standardized Indices with measure of variance (i.e. CVs).				✓

IF MULTIPLE MODEL STRUCTURES WERE CONSIDERED:

(***Note: this is always recommended but required when model diagnostics are poor***.)

1. Plot of resulting indices and estimates of variance	✓			
2. Table of model statistics (e.g. AIC criteria)	✓			

	Date Received	*Workshop Recommendation*	*Revision Deadline* ***	*Author and Rapporteur Signatures*
First Submission	2/6/12	not recommended		
Revision				

The revision deadline is negotiated by the author, the SEDAR coordinator and the CPUE rapporteur. The author ***DOES NOT*** *commit to any* ***LEGAL OBLIGATION*** *by agreeing to submit a manuscript before this deadline. The maximum penalty for failure to submit a revised document prior to the submission deadline is rejection of the CPUE series.*

Justification of Working Group Recommendation

This index was not recommended for use. Most of the Gulf of Mexico Spanish mackerel positive trips were reported from Florida. The Florida trip ticket index, which included all the Florida trips in the coastal logbook data set and was a longer time series, was recommended.

To support the decision to go with the Florida trip ticket index, a Western GOM only index was recommended for comparison.

Reset Fields

Appendix 5.4
Gulf of Mexico Spanish Mackerel
Commercial Gillnet Index

DESCRIPTION OF THE DATA SOURCE

1. Fishery Independent Indices

	Not Applicable	Absent	Incomplete	Complete
A. Describe the survey design (e.g. fixed sampling sites, random stratified sampling), location, seasons/months and years of sampling.	✓			
B. Describe sampling methodology (e.g. gear, vessel, soak time etc.)	✓			
C. Describe any changes in sampling methodology (e.g. gear, vessel, sample design etc.)	✓			
D. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.).	✓			
E. What species or species assemblages are targeted by this survey (e.g. red snapper, reef fish, pelagic).	✓			
F. Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available.	✓			

2. Fishery Dependent Indices

	Not Applicable	Absent	Incomplete	Complete
A. Describe the data source and type of fishery (e.g. commercial handline, commercial longline, recreational hook and line etc.).				✓
B. Describe any changes to reporting requirements, variables reported, etc.				✓
C. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.).				✓
D Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available.	✓			

METHODS

1. Data Reduction and Exclusions

	Not Applicable	Absent	Incomplete	Complete
A. Describe any data exclusions (e.g. gears, fishing modes, sampling areas etc.). Report the number of records removed and justify removal.				✓
B. Describe data reduction techniques (if any) used to address targeting (e.g. Stephens and MacCall, 2004; gear configuration, species assemblage etc).				✓
C. Discuss procedures used to identify outliers. How many were identified? Were they excluded?				✓

Working Group Comments:

2D unknown, data are pounds landed no size data reported - presume legal size with few sublegal

	Not Applicable	Absent	Incomplete	Complete
2. Management Regulations (for FD Indices)				
A. Provide (or cite) history of management regulations (e.g. bag limits, size limits, trip limits, closures etc.).				✓
B. Describe the effects (if any) of management regulations on CPUE				✓
C. Discuss methods used (if any) to minimize the effects of management measures on the CPUE series.		✓		
3. Describe Analysis Dataset (after exclusions and other treatments)				
A. Provide tables and/or figures of number of observations by factors (including year, area, etc.) and interaction terms.			✓	
B. Include tables and/or figures of number of positive observations by factors and interaction terms.			✓	
C. Include tables and/or figures of the proportion positive observations by factors and interaction terms.			✓	
D. Include tables and/or figures of average (unstandardized) CPUE by factors and interaction terms.			✓	
E. Include annual maps of locations of survey sites (or fishing trips) and associated catch rates ***OR*** supply the raw data needed to construct these maps (Observation, Year, Latitude, Longitude (or statistical grid, area), Catch, Effort).			✓	
F. Describe the effort variable and the units. If more than one effort variable is present in the dataset, justify selection.				✓
G. What are the units of catch (e.g. numbers or biomass, whole weight, gutted weight, kilograms, pounds).				✓
4. Model Standardization				
A. Describe model structure (e.g. delta-lognormal)				✓
B. Describe construction of GLM components (e.g. forward selection from null etc.)				✓
C. Describe inclusion criteria for factors and interactions terms.				✓
D. Were YEAR*FACTOR interactions included in the model? If so, how (e.g. fixed effect, random effect)? Were random effects tested for significance using a likelihood ratio test?				✓
E. Provide a table summarizing the construction of the GLM components.				✓
F. Summarize model statistics of the mixed model formulation(s) (e.g. log likelihood, AIC, BIC etc.)				✓
G. Report convergence statistics.			✓	

Working Group Comments:

3A-E. confidential data.

4G. Available on demand

MODEL DIAGNOSTICS

Comment: Other model structures are possible and acceptable. Please provide appropriate diagnostics to the CPUE indices working group.

1. Binomial Component

	Not Applicable	Absent	Incomplete	Complete
A. Include plots of the chi-square residuals by factor.				✓
B. Include plots of predicted and observed proportion of positive trips by year and factor (e.g. year*area)			✓	
C. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom).			✓	

2. Lognormal/Gamma Component

	Not Applicable	Absent	Incomplete	Complete
A. Include histogram of log(CPUE) or a histogram of the residuals of the model on CPUE. Overlay the expected distribution.				✓
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor.			✓	
C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution.				✓
D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.			✓	
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.			✓	
F. Include plots of the residuals by factor				✓

3. Poisson Component

	Not Applicable	Absent	Incomplete	Complete
A. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom).	✓			
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor.	✓			
C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution.	✓			
D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.	✓			
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.	✓			

4. Zero-inflated model

	Not Applicable	Absent	Incomplete	Complete
A. Include ROC curve to quantify goodness of fit.	✓			
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor).	✓			
C. Include QQ-plot (e.g. Student dev. residuals vs. theoretical quantiles), Overlay expected distribution.	✓			

Working Group Comments:

1.B,C. Available on demand

2B,D,E. Available on demand

The feasibility of this diagnostic is still under review.

MODEL DIAGNOSTICS (CONT.)

	Not Applicable	Absent	Incomplete	Complete

Working Group Comments:

D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.	✓			
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.	✓			

MODEL RESULTS

A. Tables of Nominal CPUE, Standardized CPUE, Observations, Positive Observations, Proportion Positive Observations and Coefficients of Variation (CVs). Other statistics may also be appropriate to report				✓
B. Figure of Nominal and Standardized Indices with measure of variance (i.e. CVs).				✓

IF MULTIPLE MODEL STRUCTURES WERE CONSIDERED:

(***Note: this is always recommended but required when model diagnostics are poor***.)

1. Plot of resulting indices and estimates of variance	✓			
2. Table of model statistics (e.g. AIC criteria)	✓			

	Date Received	*Workshop Recommendation*	*Revision Deadline* ***	*Author and Rapporteur Signatures*
First Submission	2/6/12	not recommended		
Revision				

*The revision deadline is negotiated by the author, the SEDAR coordinator and the CPUE rapporteur. The author **DOES NOT** commit to any **LEGAL OBLIGATION** by agreeing to submit a manuscript before this deadline. The maximum penalty for failure to submit a revised document prior to the submission deadline is rejection of the CPUE series.*

Justification of Working Group Recommendation

This index was not recommended for use. Most gillnet trips were thought to be run-around drift nets, which would like cause hyperstability in the index.

Reset Fields

Appendix 5.5
Gulf of Mexico Spanish Mackerel
Headboat Index

DESCRIPTION OF THE DATA SOURCE

1. Fishery Independent Indices

	Not Applicable	Absent	Incomplete	Complete
A. Describe the survey design (e.g. fixed sampling sites, random stratified sampling), location, seasons/months and years of sampling.	✓			
B. Describe sampling methodology (e.g. gear, vessel, soak time etc.)	✓			
C. Describe any changes in sampling methodology (e.g. gear, vessel, sample design etc.)	✓			
D. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.).	✓			
E. What species or species assemblages are targeted by this survey (e.g. red snapper, reef fish, pelagic).	✓			
F. Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available.	✓			

2. Fishery Dependent Indices

	Not Applicable	Absent	Incomplete	Complete
A. Describe the data source and type of fishery (e.g. commercial handline, commercial longline, recreational hook and line etc.).				✓
B. Describe any changes to reporting requirements, variables reported, etc.				✓
C. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.).				✓
D Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available.		✓		

METHODS

1. Data Reduction and Exclusions

	Not Applicable	Absent	Incomplete	Complete
A. Describe any data exclusions (e.g. gears, fishing modes, sampling areas etc.). Report the number of records removed and justify removal.				✓
B. Describe data reduction techniques (if any) used to address targeting (e.g. Stephens and MacCall, 2004; gear configuration, species assemblage etc).				✓
C. Discuss procedures used to identify outliers. How many were identified? Were they excluded?				✓

Working Group Comments:

4D Available on Demand

	Not Applicable	Absent	Incomplete	Complete
2. Management Regulations (for FD Indices)				
A. Provide (or cite) history of management regulations (e.g. bag limits, size limits, trip limits, closures etc.).		✓		
B. Describe the effects (if any) of management regulations on CPUE				✓
C. Discuss methods used (if any) to minimize the effects of management measures on the CPUE series.				✓
3. Describe Analysis Dataset (after exclusions and other treatments)				
A. Provide tables and/or figures of number of observations by factors (including year, area, etc.) and interaction terms.		✓		
B. Include tables and/or figures of number of positive observations by factors and interaction terms.		✓		
C. Include tables and/or figures of the proportion positive observations by factors and interaction terms.		✓		
D. Include tables and/or figures of average (unstandardized) CPUE by factors and interaction terms.		✓		
E. Include annual maps of locations of survey sites (or fishing trips) and associated catch rates ***OR*** supply the raw data needed to construct these maps (Observation, Year, Latitude, Longitude (or statistical grid, area), Catch, Effort).				✓
F. Describe the effort variable and the units. If more than one effort variable is present in the dataset, justify selection.				✓
G. What are the units of catch (e.g. numbers or biomass, whole weight, gutted weight, kilograms, pounds).				✓
4. Model Standardization				
A. Describe model structure (e.g. delta-lognormal)				✓
B. Describe construction of GLM components (e.g. forward selection from null etc.)				✓
C. Describe inclusion criteria for factors and interactions terms.				✓
D. Were YEAR*FACTOR interactions included in the model? If so, how (e.g. fixed effect, random effect)? Were random effects tested for significance using a likelihood ratio test?				✓
E. Provide a table summarizing the construction of the GLM components.				✓
F. Summarize model statistics of the mixed model formulation(s) (e.g. log likelihood, AIC, BIC etc.)		✓		
G. Report convergence statistics.				✓

Working Group Comments:

3A-D Confidential Data

MODEL DIAGNOSTICS

Comment: Other model structures are possible and acceptable. Please provide appropriate diagnostics to the CPUE indices working group.

Working Group Comments:

1. Binomial Component

	Not Applicable	Absent	Incomplete	Complete
A. Include plots of the chi-square residuals by factor.				✓
B. Include plots of predicted and observed proportion of positive trips by year and factor (e.g. year*area)				✓
C. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom).				✓

2. Lognormal/Gamma Component

	Not Applicable	Absent	Incomplete	Complete
A. Include histogram of log(CPUE) or a histogram of the residuals of the model on CPUE. Overlay the expected distribution.		✓		
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor.				✓
C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution.				✓
D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.				✓
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.				✓
F. Include plots of the residuals by factor				✓

3. Poisson Component

	Not Applicable	Absent	Incomplete	Complete
A. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom).	✓			
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor.	✓			
C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution.	✓			
D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.	✓			
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.	✓			

The feasibility of this diagnostic is still under review.

4. Zero-inflated model

	Not Applicable	Absent	Incomplete	Complete
A. Include ROC curve to quantify goodness of fit.	✓			
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor).	✓			
C. Include QQ-plot (e.g. Student dev. residuals vs. theoretical quantiles), Overlay expected distribution.	✓			

MODEL DIAGNOSTICS (CONT.)

Not Applicable	Absent	Incomplete	Complete

Working Group Comments:

D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.	✓			
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.	✓			

MODEL RESULTS

A. Tables of Nominal CPUE, Standardized CPUE, Observations, Positive Observations, Proportion Positive Observations and Coefficients of Variation (CVs). Other statistics may also be appropriate to report				✓
B. Figure of Nominal and Standardized Indices with measure of variance (i.e. CVs).				✓

IF MULTIPLE MODEL STRUCTURES WERE CONSIDERED:

(***Note: this is always recommended but required when model diagnostics are poor***.)

1. Plot of resulting indices and estimates of variance	✓			
2. Table of model statistics (e.g. AIC criteria)	✓			

	Date Received	*Workshop Recommendation*	*Revision Deadline ****	*Author and Rapporteur Signatures*
First Submission	02/06/2012	accept as prepared		
Revision				

*The revision deadline is negotiated by the author, the SEDAR coordinator and the CPUE rapporteur. The author **DOES NOT** commit to any **LEGAL OBLIGATION** by agreeing to submit a manuscript before this deadline. The maximum penalty for failure to submit a revised document prior to the submission deadline is rejection of the CPUE series.*

Justification of Working Group Recommendation

The Species Association Approach (Stephens and McCall 2004) was explored to try and identify directed Spanish mackerel trips however this approach did not properly converge for either of these species and eliminated too many trips indiscriminately. Some possible reasons for this could be because Spanish mackerel are often not targeted by the headboat fleet   A number of “ad hoc” approaches to subset directed trips for Spanish mackerel from the Headboat Survey data were explored by the Indices Group at the data workshop, however, these approaches were abandoned because either appropriate subsets could not be identified, they eliminated too many trips leading to the same conclusion as the Species Association Approach, or were not thought to be empirically defensible. Due to the inability to use this approach, an index was constructed using the Delta lognormal approach for the entire database of all trips, and an index was constructed using a subset of only positive trips using a lognormal model. The proportion of positive observations that caught Spanish mackerel was determined to be too small, therefore the Indices Group decided NOT to recommend the use of this data set to develop an index for Spanish Mackerel.

Appendix 5.6
Gulf of Mexico Spanish Mackerel
MRFSS Index

DESCRIPTION OF THE DATA SOURCE

1. Fishery Independent Indices

	Not Applicable	Absent	Incomplete	Complete
A. Describe the survey design (e.g. fixed sampling sites, random stratified sampling), location, seasons/months and years of sampling.	✓			
B. Describe sampling methodology (e.g. gear, vessel, soak time etc.)	✓			
C. Describe any changes in sampling methodology (e.g. gear, vessel, sample design etc.)	✓			
D. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.).	✓			
E. What species or species assemblages are targeted by this survey (e.g. red snapper, reef fish, pelagic).	✓			
F. Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available.	✓			

2. Fishery Dependent Indices

	Not Applicable	Absent	Incomplete	Complete
A. Describe the data source and type of fishery (e.g. commercial handline, commercial longline, recreational hook and line etc.).				✓
B. Describe any changes to reporting requirements, variables reported, etc.				✓
C. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.).				✓
D Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available.				✓

METHODS

1. Data Reduction and Exclusions

	Not Applicable	Absent	Incomplete	Complete
A. Describe any data exclusions (e.g. gears, fishing modes, sampling areas etc.). Report the number of records removed and justify removal.				✓
B. Describe data reduction techniques (if any) used to address targeting (e.g. Stephens and MacCall, 2004; gear configuration, species assemblage etc).				✓
C. Discuss procedures used to identify outliers. How many were identified? Were they excluded?				✓

Working Group Comments:

Working Group Comments:

2. Management Regulations (for FD Indices)

	Not Applicable	Absent	Incomplete	Complete
A. Provide (or cite) history of management regulations (e.g. bag limits, size limits, trip limits, closures etc.).				✓
B. Describe the effects (if any) of management regulations on CPUE				✓
C. Discuss methods used (if any) to minimize the effects of management measures on the CPUE series.				✓

3. Describe Analysis Dataset (after exclusions and other treatments)

	Not Applicable	Absent	Incomplete	Complete
A. Provide tables and/or figures of number of observations by factors (including year, area, etc.) and interaction terms.				✓
B. Include tables and/or figures of number of positive observations by factors and interaction terms.				✓
C. Include tables and/or figures of the proportion positive observations by factors and interaction terms.				✓
D. Include tables and/or figures of average (unstandardized) CPUE by factors and interaction terms.				✓
E. Include annual maps of locations of survey sites (or fishing trips) and associated catch rates ***OR*** supply the raw data needed to construct these maps (Observation, Year, Latitude, Longitude (or statistical grid, area), Catch, Effort).				✓
F. Describe the effort variable and the units. If more than one effort variable is present in the dataset, justify selection.				✓
G. What are the units of catch (e.g. numbers or biomass, whole weight, gutted weight, kilograms, pounds).				✓

4. Model Standardization

	Not Applicable	Absent	Incomplete	Complete
A. Describe model structure (e.g. delta-lognormal)				✓
B. Describe construction of GLM components (e.g. forward selection from null etc.)				✓
C. Describe inclusion criteria for factors and interactions terms.				✓
D. Were YEAR*FACTOR interactions included in the model? If so, how (e.g. fixed effect, random effect)? Were random effects tested for significance using a likelihood ratio test?				✓
E. Provide a table summarizing the construction of the GLM components.				✓
F. Summarize model statistics of the mixed model formulation(s) (e.g. log likelihood, AIC, BIC etc.)				✓
G. Report convergence statistics.				✓

MODEL DIAGNOSTICS

Comment: Other model structures are possible and acceptable. Please provide appropriate diagnostics to the CPUE indices working group.

	Not Applicable	Absent	Incomplete	Complete	Working Group Comments:
1. Binomial Component					
A. Include plots of the chi-square residuals by factor.				✓	
B. Include plots of predicted and observed proportion of positive trips by year and factor (e.g. year*area)				✓	
C. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom).				✓	
2. Lognormal/Gamma Component					
A. Include histogram of log(CPUE) or a histogram of the residuals of the model on CPUE. Overlay the expected distribution.		✓			
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor.				✓	
C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution.				✓	
D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.				✓	
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.				✓	
F. Include plots of the residuals by factor				✓	
3. Poisson Component					
A. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom).	✓				
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor.	✓				
C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution.	✓				
D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.	✓				
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.	✓				***The feasibility of this diagnostic is still under review.***
4. Zero-inflated model					
A. Include ROC curve to quantify goodness of fit.	✓				
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor).	✓				
C. Include QQ-plot (e.g. Student dev. residuals vs. theoretical quantiles), Overlay expected distribution.	✓				

MODEL DIAGNOSTICS (CONT.)

	Not Applicable	Absent	Incomplete	Complete	Working Group Comments:

D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.	✓			
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.	✓			

MODEL RESULTS

A. Tables of Nominal CPUE, Standardized CPUE, Observations, Positive Observations, Proportion Positive Observations and Coefficients of Variation (CVs). Other statistics may also be appropriate to report				✓
B. Figure of Nominal and Standardized Indices with measure of variance (i.e. CVs).				✓

IF MULTIPLE MODEL STRUCTURES WERE CONSIDERED:

(***Note: this is always recommended but required when model diagnostics are poor***.)

1. Plot of resulting indices and estimates of variance	✓			
2. Table of model statistics (e.g. AIC criteria)	✓			

	Date Received	*Workshop Recommendation*	*Revision Deadline* ***	*Author and Rapporteur Signatures*
First Submission	02/06/2012	accept as prepared		
Revision				

The revision deadline is negotiated by the author, the SEDAR coordinator and the CPUE rapporteur. The author ***DOES NOT*** *commit to any* ***LEGAL OBLIGATION*** *by agreeing to submit a manuscript before this deadline. The maximum penalty for failure to submit a revised document prior to the submission deadline is rejection of the CPUE series.*

Justification of Working Group Recommendation

The Species Association Approach (Stephens and McCall 2004) was explored to try and identify directed Spanish mackerel trips however this approach did not properly converge for either of these species and eliminated too many trips indiscriminately. A number of "ad hoc" approaches to subset directed trips for Spanish mackerel from the MRFSS Survey data were explored by the Indices Group at the data workshop, however, these approaches were abandoned because either appropriate subsets could not be identified, they eliminated too many trips leading to the same conclusion as the Species Association Approach, or were not thought to be empirically defensible. Due to the inability to use this approach, an index was constructed using the Delta lognormal approach for the entire database of all trips, and an index was constructed using a subset of only positive trips using a lognormal model. The Indices Group decided to use the indices of all trips and accepted the Spanish mackerel MRFSS index for recommendation. This index was particularly favored because it presents a long time series.

Appendix 5.7
Gulf of Mexico Spanish Mackerel
Florida Trip Ticket - Castnet

DESCRIPTION OF THE DATA SOURCE

1. Fishery Independent Indices

	Not Applicable	Absent	Incomplete	Complete
A. Describe the survey design (e.g. fixed sampling sites, random stratified sampling), location, seasons/months and years of sampling.	✓			
B. Describe sampling methodology (e.g. gear, vessel, soak time etc.)	✓			
C. Describe any changes in sampling methodology (e.g. gear, vessel, sample design etc.)	✓			
D. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.).	✓			
E. What species or species assemblages are targeted by this survey (e.g. red snapper, reef fish, pelagic).	✓			
F. Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available.	✓			

2. Fishery Dependent Indices

	Not Applicable	Absent	Incomplete	Complete
A. Describe the data source and type of fishery (e.g. commercial handline, commercial longline, recreational hook and line etc.).				✓
B. Describe any changes to reporting requirements, variables reported, etc.				✓
C. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.).				✓
D Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available.	✓			

METHODS

1. Data Reduction and Exclusions

	Not Applicable	Absent	Incomplete	Complete
A. Describe any data exclusions (e.g. gears, fishing modes, sampling areas etc.). Report the number of records removed and justify removal.				✓
B. Describe data reduction techniques (if any) used to address targeting (e.g. Stephens and MacCall, 2004; gear configuration, species assemblage etc).				✓
C. Discuss procedures used to identify outliers. How many were identified? Were they excluded?				✓

Working Group Comments:

1.F. No size information in the data set. Commercial size and age data are collected at the fish houses, independent of trip tickets.

2. Management Regulations (for FD Indices)

	Not Applicable	Absent	Incomplete	Complete
A. Provide (or cite) history of management regulations (e.g. bag limits, size limits, trip limits, closures etc.).				✓
B. Describe the effects (if any) of management regulations on CPUE				✓
C. Discuss methods used (if any) to minimize the effects of management measures on the CPUE series.				✓

3. Describe Analysis Dataset (after exclusions and other treatments)

	Not Applicable	Absent	Incomplete	Complete
A. Provide tables and/or figures of number of observations by factors (including year, area, etc.) and interaction terms.				✓
B. Include tables and/or figures of number of positive observations by factors and interaction terms.				✓
C. Include tables and/or figures of the proportion positive observations by factors and interaction terms.				✓
D. Include tables and/or figures of average (unstandardized) CPUE by factors and interaction terms.				✓
E. Include annual maps of locations of survey sites (or fishing trips) and associated catch rates ***OR*** supply the raw data needed to construct these maps (Observation, Year, Latitude, Longitude (or statistical grid, area), Catch, Effort).				✓
F. Describe the effort variable and the units. If more than one effort variable is present in the dataset, justify selection.				✓
G. What are the units of catch (e.g. numbers or biomass, whole weight, gutted weight, kilograms, pounds).				✓

4. Model Standardization

	Not Applicable	Absent	Incomplete	Complete
A. Describe model structure (e.g. delta-lognormal)				✓
B. Describe construction of GLM components (e.g. forward selection from null etc.)				✓
C. Describe inclusion criteria for factors and interactions terms.				✓
D. Were YEAR*FACTOR interactions included in the model? If so, how (e.g. fixed effect, random effect)? Were random effects tested for significance using a likelihood ratio test?				✓
E. Provide a table summarizing the construction of the GLM components.				✓
F. Summarize model statistics of the mixed model formulation(s) (e.g. log likelihood, AIC, BIC etc.)				✓
G. Report convergence statistics.				✓

Working Group Comments:

MODEL DIAGNOSTICS

Comment: Other model structures are possible and acceptable. Please provide appropriate diagnostics to the CPUE indices working group.

	Not Applicable	Absent	Incomplete	Complete
1. Binomial Component				
A. Include plots of the chi-square residuals by factor.	✓			
B. Include plots of predicted and observed proportion of positive trips by year and factor (e.g. year*area)	✓			
C. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom).	✓			
2. Lognormal/Gamma Component				
A. Include histogram of log(CPUE) or a histogram of the residuals of the model on CPUE. Overlay the expected distribution.				✓
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor.			✓	
C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution.				✓
D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.			✓	
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.			✓	
F. Include plots of the residuals by factor				✓
3. Poisson Component				
A. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom).	✓			
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor.	✓			
C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution.	✓			
D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.	✓			
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.	✓			
4. Zero-inflated model				
A. Include ROC curve to quantify goodness of fit.	✓			
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor).	✓			
C. Include QQ-plot (e.g. Student dev. residuals vs. theoretical quantiles), Overlay expected distribution.	✓			

Working Group Comments:

2.B,D,E-available on demand if needed.

The feasibility of this diagnostic is still under review.

MODEL DIAGNOSTICS (CONT.)

Not Applicable	Absent	Incomplete	Complete

Working Group Comments:

D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.	✓			
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.	✓			

MODEL RESULTS

A. Tables of Nominal CPUE, Standardized CPUE, Observations, Positive Observations, Proportion Positive Observations and Coefficients of Variation (CVs). Other statistics may also be appropriate to report				✓
B. Figure of Nominal and Standardized Indices with measure of variance (i.e. CVs).				✓

IF MULTIPLE MODEL STRUCTURES WERE CONSIDERED:

(***Note: this is always recommended but required when model diagnostics are poor***.)

1. Plot of resulting indices and estimates of variance				✓
2. Table of model statistics (e.g. AIC criteria)				✓

	Date Received	*Workshop Recommendation*	*Revision Deadline* ***	*Author and Rapporteur Signatures*
First Submission	02/17/2012			
Revision				

The revision deadline is negotiated by the author, the SEDAR coordinator and the CPUE rapporteur. The author ***DOES NOT*** *commit to any* ***LEGAL OBLIGATION*** *by agreeing to submit a manuscript before this deadline. The maximum penalty for failure to submit a revised document prior to the submission deadline is rejection of the CPUE series.*

Justification of Working Group Recommendation

This index was not recommended for use. It's potentially useful as a year class indicator, but has gear saturation effects, limited spatial extent, and hyperstability issues since it's targeting large schools. Only trips that did not hit up against the trip limits were included in the analysis.

Appendix 5.8
Gulf of Mexico Spanish Mackerel
Florida Trip Ticket - Handline

DESCRIPTION OF THE DATA SOURCE

1. Fishery Independent Indices

Item	Not Applicable	Absent	Incomplete	Complete
A. Describe the survey design (e.g. fixed sampling sites, random stratified sampling), location, seasons/months and years of sampling.	✓			
B. Describe sampling methodology (e.g. gear, vessel, soak time etc.)	✓			
C. Describe any changes in sampling methodology (e.g. gear, vessel, sample design etc.)	✓			
D. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.).	✓			
E. What species or species assemblages are targeted by this survey (e.g. red snapper, reef fish, pelagic).	✓			
F. Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available.	✓			

2. Fishery Dependent Indices

Item	Not Applicable	Absent	Incomplete	Complete
A. Describe the data source and type of fishery (e.g. commercial handline, commercial longline, recreational hook and line etc.).				✓
B. Describe any changes to reporting requirements, variables reported, etc.				✓
C. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.).				✓
D Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available.	✓			

METHODS

1. Data Reduction and Exclusions

Item	Not Applicable	Absent	Incomplete	Complete
A. Describe any data exclusions (e.g. gears, fishing modes, sampling areas etc.). Report the number of records removed and justify removal.				✓
B. Describe data reduction techniques (if any) used to address targeting (e.g. Stephens and MacCall, 2004; gear configuration, species assemblage etc).				✓
C. Discuss procedures used to identify outliers. How many were identified? Were they excluded?				✓

Working Group Comments:

1.F. No size information in the data set. Commercial size and age data are collected at the fish houses, independent of trip tickets.

1.C. Outliers ID'd and removed during workshop; result of gear assignments from license data, 1986-1992

Working Group Comments:

2. Management Regulations (for FD Indices)

	Not Applicable	Absent	Incomplete	Complete
A. Provide (or cite) history of management regulations (e.g. bag limits, size limits, trip limits, closures etc.).				✓
B. Describe the effects (if any) of management regulations on CPUE				✓
C. Discuss methods used (if any) to minimize the effects of management measures on the CPUE series.				✓

3. Describe Analysis Dataset (after exclusions and other treatments)

	Not Applicable	Absent	Incomplete	Complete
A. Provide tables and/or figures of number of observations by factors (including year, area, etc.) and interaction terms.				✓
B. Include tables and/or figures of number of positive observations by factors and interaction terms.				✓
C. Include tables and/or figures of the proportion positive observations by factors and interaction terms.				✓
D. Include tables and/or figures of average (unstandardized) CPUE by factors and interaction terms.				✓
E. Include annual maps of locations of survey sites (or fishing trips) and associated catch rates ***OR*** supply the raw data needed to construct these maps (Observation, Year, Latitude, Longitude (or statistical grid, area), Catch, Effort).				✓
F. Describe the effort variable and the units. If more than one effort variable is present in the dataset, justify selection.				✓
G. What are the units of catch (e.g. numbers or biomass, whole weight, gutted weight, kilograms, pounds).				✓

4. Model Standardization

	Not Applicable	Absent	Incomplete	Complete
A. Describe model structure (e.g. delta-lognormal)				✓
B. Describe construction of GLM components (e.g. forward selection from null etc.)				✓
C. Describe inclusion criteria for factors and interactions terms.				✓
D. Were YEAR*FACTOR interactions included in the model? If so, how (e.g. fixed effect, random effect)? Were random effects tested for significance using a likelihood ratio test?				✓
E. Provide a table summarizing the construction of the GLM components.				✓
F. Summarize model statistics of the mixed model formulation(s) (e.g. log likelihood, AIC, BIC etc.)				✓
G. Report convergence statistics.				✓

MODEL DIAGNOSTICS

Comment: Other model structures are possible and acceptable. Please provide appropriate diagnostics to the CPUE indices working group.

Item	Not Applicable	Absent	Incomplete	Complete	Working Group Comments:
1. Binomial Component					
A. Include plots of the chi-square residuals by factor.	✓				
B. Include plots of predicted and observed proportion of positive trips by year and factor (e.g. year*area)	✓				
C. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom).	✓				
2. Lognormal/Gamma Component					
A. Include histogram of log(CPUE) or a histogram of the residuals of the model on CPUE. Overlay the expected distribution.				✓	2.B,D,E-available on demand if needed.
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor.			✓		
C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution.				✓	
D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.			✓		
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.			✓		
F. Include plots of the residuals by factor				✓	
3. Poisson Component					
A. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom).	✓				
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor.	✓				
C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution.	✓				
D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.	✓				
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.	✓				***The feasibility of this diagnostic is still under review.***
4. Zero-inflated model					
A. Include ROC curve to quantify goodness of fit.	✓				
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor).	✓				
C. Include QQ-plot (e.g. Student dev. residuals vs. theoretical quantiles), Overlay expected distribution.	✓				

MODEL DIAGNOSTICS (CONT.)

	Not Applicable	Absent	Incomplete	Complete	Working Group Comments:

D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.	✓			
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.	✓			

MODEL RESULTS

A. Tables of Nominal CPUE, Standardized CPUE, Observations, Positive Observations, Proportion Positive Observations and Coefficients of Variation (CVs). Other statistics may also be appropriate to report				✓
B. Figure of Nominal and Standardized Indices with measure of variance (i.e. CVs).				✓

IF MULTIPLE MODEL STRUCTURES WERE CONSIDERED:

(***Note: this is always recommended but required when model diagnostics are poor***.)

1. Plot of resulting indices and estimates of variance				✓
2. Table of model statistics (e.g. AIC criteria)				✓

	Date Received	*Workshop Recommendation*	*Revision Deadline ****	*Author and Rapporteur Signatures*
First Submission	02/17/2012			
Revision				

The revision deadline is negotiated by the author, the SEDAR coordinator and the CPUE rapporteur. The author ***DOES NOT*** *commit to any* ***LEGAL OBLIGATION*** *by agreeing to submit a manuscript before this deadline. The maximum penalty for failure to submit a revised document prior to the submission deadline is rejection of the CPUE series.*

Justification of Working Group Recommendation

This index was recommended for use. The data used for this index occurs over a long time series and has similar trends to the commercial logbook data. It also samples the entire fishery, both inshore and offshore.

Appendix 5.9
Gulf of Mexico Spanish Mackerel
Florida Trip Ticket - Gillnet

DESCRIPTION OF THE DATA SOURCE

	Not Applicable	Absent	Incomplete	Complete
1. Fishery Independent Indices				
A. Describe the survey design (e.g. fixed sampling sites, random stratified sampling), location, seasons/months and years of sampling.	✓			
B. Describe sampling methodology (e.g. gear, vessel, soak time etc.)	✓			
C. Describe any changes in sampling methodology (e.g. gear, vessel, sample design etc.)	✓			
D. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.).	✓			
E. What species or species assemblages are targeted by this survey (e.g. red snapper, reef fish, pelagic).	✓			
F. Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available.	✓			
2. Fishery Dependent Indices				
A. Describe the data source and type of fishery (e.g. commercial handline, commercial longline, recreational hook and line etc.).				✓
B. Describe any changes to reporting requirements, variables reported, etc.				✓
C. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.).				✓
D Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available.	✓			

METHODS

	Not Applicable	Absent	Incomplete	Complete
1. Data Reduction and Exclusions				
A. Describe any data exclusions (e.g. gears, fishing modes, sampling areas etc.). Report the number of records removed and justify removal.				✓
B. Describe data reduction techniques (if any) used to address targeting (e.g. Stephens and MacCall, 2004; gear configuration, species assemblage etc).				✓
C. Discuss procedures used to identify outliers. How many were identified? Were they excluded?				✓

Working Group Comments:

1,F. No size information in the data set. Commercial size and age data are collected at the fish houses, independent of trip tickets.

	Not Applicable	Absent	Incomplete	Complete
2. Management Regulations (for FD Indices)				
A. Provide (or cite) history of management regulations (e.g. bag limits, size limits, trip limits, closures etc.).				✓
B. Describe the effects (if any) of management regulations on CPUE				✓
C. Discuss methods used (if any) to minimize the effects of management measures on the CPUE series.				✓
3. Describe Analysis Dataset (after exclusions and other treatments)				
A. Provide tables and/or figures of number of observations by factors (including year, area, etc.) and interaction terms.				✓
B. Include tables and/or figures of number of positive observations by factors and interaction terms.				✓
C. Include tables and/or figures of the proportion positive observations by factors and interaction terms.				✓
D. Include tables and/or figures of average (unstandardized) CPUE by factors and interaction terms.				✓
E. Include annual maps of locations of survey sites (or fishing trips) and associated catch rates ***OR*** supply the raw data needed to construct these maps (Observation, Year, Latitude, Longitude (or statistical grid, area), Catch, Effort).				✓
F. Describe the effort variable and the units. If more than one effort variable is present in the dataset, justify selection.				✓
G. What are the units of catch (e.g. numbers or biomass, whole weight, gutted weight, kilograms, pounds).				✓
4. Model Standardization				
A. Describe model structure (e.g. delta-lognormal)				✓
B. Describe construction of GLM components (e.g. forward selection from null etc.)				✓
C. Describe inclusion criteria for factors and interactions terms.				✓
D. Were YEAR*FACTOR interactions included in the model? If so, how (e.g. fixed effect, random effect)? Were random effects tested for significance using a likelihood ratio test?				✓
E. Provide a table summarizing the construction of the GLM components.				✓
F. Summarize model statistics of the mixed model formulation(s) (e.g. log likelihood, AIC, BIC etc.)				✓
G. Report convergence statistics.				✓

Working Group Comments:

MODEL DIAGNOSTICS

Comment: Other model structures are possible and acceptable. Please provide appropriate diagnostics to the CPUE indices working group.

1. Binomial Component

Item	Not Applicable	Absent	Incomplete	Complete
A. Include plots of the chi-square residuals by factor.	✓			
B. Include plots of predicted and observed proportion of positive trips by year and factor (e.g. year*area)	✓			
C. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom).	✓			

2. Lognormal/Gamma Component

Item	Not Applicable	Absent	Incomplete	Complete
A. Include histogram of log(CPUE) or a histogram of the residuals of the model on CPUE. Overlay the expected distribution.				✓
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor.			✓	
C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution.				✓
D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.			✓	
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.			✓	
F. Include plots of the residuals by factor				✓

3. Poisson Component

Item	Not Applicable	Absent	Incomplete	Complete
A. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom).	✓			
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor.	✓			
C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution.	✓			
D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.	✓			
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.	✓			

4. Zero-inflated model

Item	Not Applicable	Absent	Incomplete	Complete
A. Include ROC curve to quantify goodness of fit.	✓			
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor).	✓			
C. Include QQ-plot (e.g. Student dev. residuals vs. theoretical quantiles), Overlay expected distribution.	✓			

Working Group Comments:

2.B,D,E-available on demand if needed.

The feasibility of this diagnostic is still under review.

MODEL DIAGNOSTICS (CONT.)

	Not Applicable	Absent	Incomplete	Complete

Working Group Comments:

D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.	✓			
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.	✓			

MODEL RESULTS

A. Tables of Nominal CPUE, Standardized CPUE, Observations, Positive Observations, Proportion Positive Observations and Coefficients of Variation (CVs). Other statistics may also be appropriate to report				✓
B. Figure of Nominal and Standardized Indices with measure of variance (i.e. CVs).				✓

IF MULTIPLE MODEL STRUCTURES WERE CONSIDERED:

(***Note: this is always recommended but required when model diagnostics are poor***.)

1. Plot of resulting indices and estimates of variance				✓
2. Table of model statistics (e.g. AIC criteria)				✓

	Date Received	*Workshop Recommendation*	*Revision Deadline* ***	*Author and Rapporteur Signatures*
First Submission	02/17/2012			
Revision				

The revision deadline is negotiated by the author, the SEDAR coordinator and the CPUE rapporteur. The author ***DOES NOT*** *commit to any* ***LEGAL OBLIGATION*** *by agreeing to submit a manuscript before this deadline. The maximum penalty for failure to submit a revised document prior to the submission deadline is rejection of the CPUE series.*

Justification of Working Group Recommendation

This index was not recommended for use. This index is from a longer time series than the commercial logbook data, and similar trends to the logbook data. But it has hyperstability issues and concerns regarding spatial overlap between gear and population. Changes in the way gill nets are designed and used, and non-specific gear identification on trip tickets (e.g. "gill nets") make interpretation of patterns observed in the data more complex. Only trips that did not hit up against the trip limits were included in the analysis.

SEDAR

Southeast Data, Assessment, and Review

SEDAR 28

Gulf of Mexico Spanish mackerel

SECTION III: Assessment Workshop Report

December 2012

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

Table of Contents

1. Workshop Proceedings

1.1. Introduction

1.1.1 Workshop Time and Place

The SEDAR 28 Assessment Workshop for Gulf of Mexico and South Atlantic Spanish Mackerel (*Scomberomorus maculatus*) and Cobia (*Rachycentron canadum*) was conducted as a workshop held May 7-11 2012 at the Courtyard by Marriott in Miami, FL and eleven webinars. Webinars were held on May 22, June 19, July 10, July 24, August 9, August 17, August 30, September 12th, October 23rd, November 8th, and December 10th, 2012.

1.1.2 Terms of Reference

1. Review and provide justifications for any changes in data following the data workshop and any analyses suggested by the data workshop. Summarize data as used in each assessment model.
2. Recommend a model configuration which is deemed most reliable for providing management advice using available compatible data. Document all input data, assumptions, and equations.
3. Incorporate known applicable environmental covariates into the selected model, and provide justification for why any of those covariates cannot be included at the time of the assessment.
4. Provide estimates of stock population parameters
   - Include fishing mortality, abundance, biomass, selectivity, stock-recruitment relationship, and other parameters as appropriate given data availability and modeling approaches
   - Include appropriate and representative measures of precision for parameter estimates.
5. Characterize uncertainty in the assessment and estimated values
   - Consider components such as input data, modeling approach, and model configuration.
   - Provide appropriate measures of model performance, reliability, and 'goodness of fit'.
6. Provide yield-per-recruit, spawner - recruit, and stock-recruitment evaluations.
7. Provide estimates of stock status relative to management criteria consistent with applicable FMPs, proposed FMPs and Amendments, other ongoing or proposed management programs, and National Standards for each model run presented for review.
8. Project future stock conditions and develop rebuilding schedules if warranted; include estimated generation time. Develop stock projections in accordance with the following:

   A) If stock is overfished:
      F=0, F=current, F=Fmsy, Ftarget (OY),
      F=Frebuild (max that rebuild in allowed time)
   B) If stock is undergoing overfishing
      F=Fcurrent, F=Fmsy, F= Ftarget (OY)

C) If stock is neither overfished nor overfishing
F=Fcurrent, F=Fmsy, F=Ftarget (OY)
D) If data limitations preclude classic projections (i.e. A, B, C above), explore alternate models to provide management advice

9. Provide a probability distribution function for the base model, or a combination of models that represent alternate states of nature, presented for review.
    - Determine the yield associated with a probability of exceeding OFL at P* values of 30% to 50% in single percentage increments for use with the Tier 1 ABC control rule
    - Provide justification for the weightings used in producing combinations of models
10. Provide recommendations for future research and data collection. Be as specific as possible in describing sampling design and intensity, and emphasize items which will improve assessment capabilities and reliability. Recommend the interval and type for the next assessment.
11. Prepare a spreadsheet containing all model parameter estimates and all relevant population information resulting from model estimates and projection and simulation exercises. Include all data included in assessment report tables and all data that support assessment workshop figures.
12. Complete the Assessment Workshop Report (Section III: SEDAR Stock Assessment Report).

1.1.3 List of Participants

Panelists

Katie Andrews	Kevin Craig	Nancie Cummings	Jeff Isely
Rob Cheshire	Meaghan Bryan	Eric Fitzpatrick	Mike Denson
Read Hendon	Marcel Reichert	Scott Crosson	Bob Muller
Clay Porch	Sean Powers	Joe Powers	Greg Stunz
John Walter	John Ward	Erik Williams	

Appointed Observers

Rusty Hudson	Tom Ogle	Bill Parker

Council Members

Ben Hartig

Observers

Erik Hiltz	Peter Barile	Tanya Darden	Joe Cimino
Chris Kalinowsky	Jim Franks	Julia Byrd	Karl Brenkert
Donna Bellais	Stephanie McInerny	Tim Sartwell	Jeanne Boylan
Jason Adriance	Danielle Chesky	Pearce Webster	Julie Defilippi
Justin Yost	Matt Perkinson	Liz Scott-Denton	Matt Cieri
Roberto Koenecke	Jake Tetzlaff		

Staff and Agency

Kari Fenske	Ryan Rindone	Mike Errigo	Sue Gerhart
John Carmichael	Rick Leard	Jack McGovern	Andy Strelcheck
Gregg Waugh	Mike Larkin	Lew Coggins	Ken Brennan
Kelley Fitzpatrick	Kyle Shertzer	Amy Schueller	Jennifer Potts
Vivian Matter	David Gloeckner	Doug DeVries	Chris Palmer
Steve Saul	Adam Pollack	Kevin McCarthy	Neil Baertlein
Michael Schirripa	Todd Gedamke	Walt Ingram	Shannon Calay
Andrea Grabman			

1.1.4 List of Assessment Workshop Working Papers

Documents Prepared for the Assessment Workshop		
SEDAR28-AW01	Florida Trip Tickets	S. Brown
SEDAR28-AW02	SEDAR 28 Spanish mackerel bycatch estimates from US Atlantic coast shrimp trawls	NMFS Beaufort

1.2. Panel Recommendations and Comment on Terms of Reference

1.2.1 Term of Reference 1

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

All revisions to the data following the SEDAR 28 Data Workshop (DW) are reviewed in Section 2. The primary changes include 1) aggregating landings, discard, and length composition data into four fishing fleets; commercial gillnet, commercial line gears, recreational, and shrimping bycatch and 2) making the age – length observation data conditional on length.

1.2.2 Term of Reference 2

Recommend a model configuration which is deemed most reliable for providing management advice using available compatible data. Document all input data, assumptions, and equations.

A fully integrated length based statistical-catch-at-age model configured using Stock Synthesis (Methot 2011) was used for the assessment. The model description and configuration are described in Sections 3.1.1 and 3.1.3. Section 2 and Section 3.1.2 provides a complete description of all data inputs. Appendices C-F includes all input files necessary that were used to run the Stock Synthesis (SS) model.

A secondary model was explored, ASPIC a stock production model however results were deemed not useful for providing management advice for the Gulf of Mexico Spanish Mackerel resource therefore the ASPIC model was not pursued further.

1.2.3 Term of Reference 3

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

At the time of the SEDAR 29 stock assessment, no applicable environmental covariates were recommended by the data or assessment workshop panels.

1.2.4 Term of Reference 4

Provide estimates of stock population parameters

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

Estimates of assessment model parameters and their associated standard errors are reported in Section 3.2.2 and Tables 3.1 and 3.2 for SS. Estimates of stock biomass, spawning stock biomass, recruitment, fishing mortality, and stock- recruitment relationship are presented in Tables 3.4 and Table 3.5 and Figures 3.36 – 3.42.

1.2.5 Term of Reference 5

Characterize uncertainty in the assessment and estimated values

- *Consider components such as input data, modeling approach, and model configuration.*
- *Provide appropriate measures of model performance, reliability, and 'goodness of fit'.*

Model performance and reliability are characterized in Section 3.2.7 and Section 3.2. Uncertainty in the assessment and estimated values was characterized using a sensitivity analysis and a parametric bootstrap approach. Results of the sensitivity analysis and retrospective analysis are characterized in Section 3.2.7 and Table 3.6 and Figures 3.43 - 3.46. Uncertainty in the assessment parameters and estimated values is characterized in Section 3.2 and Table 3.7.

1.2.6 Term of Reference 6

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

Yield-per-recruit, spawner-per-recruit, and stock-recruitment evaluations are provided in Section 3.2.8 and Figure 3.40

1.2.7 Term of Reference 7

Provide estimates of stock status relative to management criteria consistent with applicable FMPs, proposed FMPs and Amendments, other ongoing or proposed management programs, and National Standards for each model run presented for review.

Stock status relative to a management criteria of $F_{SPR30\%}$, F_{OY} and $F_{current}$ are presented in Table 3.9 and Figures 3.47 – 3.53.

1.2.8 Term of Reference 8

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

A) If stock is overfished:
F=0, FCurrent, FMSY, FOY
F=FRebuild (max that permits rebuild in allowed time)
B) If stock is undergoing overfishing:
F= FCurrent, FMSY, FOY
C) If stock is neither overfished nor undergoing overfishing:
F= FCurrent, FMSY, FOY
D) If data limitations preclude classic projections (i.e. A, B, C above), explore alternate models to provide management advice

Stock biomass and yield projections for 2013-2022 are presented in Section 3.2.9 and Table 3.9. Projections were carried out for three levels of fishing mortality: 1) $F_{SPR30\%}$ (F_{MSY} proxy), 2) F_{OY}, and $F_{CURRENT}$ (geometric mean of F 2009-2011.

1.2.9 Term of Reference 9

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

Ten sensitivity runs were presented to characterize uncertainty in model specification. Of the ten runs presented, one primary run (Run 3) was used for stochastic projections. Probability distribution functions will be developed for the subset of model recommended by the SEDAR AP for projections (Run 3, steepness = 0.8, $M=0.38y^{-1}$) and made available to the Scientific and Statistical Committee (SSC) for the development of management advice, including OFL and ABC.

1.2.10 Term of Reference 10

Provide recommendations for future research and data collection. Be as specific as possible in describing sampling design and intensity, and emphasize items which will improve assessment capabilities and reliability. Recommend the interval and type for the next assessment.

Recommendations for future research and data collection were made in the SEDAR 82 Data Workshop (DW) report. Additional recommendations are made in Section 3.3.

1.2.11 Term of Reference 11

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

All assessment model inputs are presented in Appendix C-F. All model parameter estimates and their associated standard errors are reported in Table 3.1 and Table 3.2. Model uncertainty is presented in Figures 3.34 and 3.35 and Figures 3.43 – 3.46.

2 Data Review and Update

The primary data components utilized in this stock assessment are described in the SEDAR 28 Gulf of Mexico Spanish mackerel Data Workshop (DW) Report (SEDAR 2012). A number of the data inputs used in the SEDAR 28 Gulf of Mexico Spanish Mackerel stock evaluations were updated and finalized after the DW. Final data for 2011 were not available at the time of the DW for these components: recreational and commercial landings, recreational size frequencies, and bycatch from the Gulf of Mexico shrimp fishery. In addition, all of the indices of abundance were updated to include 2011 data after the DW (i.e., MRFSS recreational index, commercial FWC Vertical Line fishery abundance index, and the SEAMAP abundance index). These updates and any other necessary modifications to the data provided at the DW are detailed in the following sections.

2.1 Life history

The weight length relation estimated as: Weight (Kg) =1.50E-05 * Fork-Length(cm)$^{2.8617}$ was provided by the DW (Table 2.1a, Figure 3.1a). Per the DW, age specific natural mortality was modeled according to the Lorenzen model and for the stock assessment model runs, scaled to the Hoenig point estimate (M = 0.38 y^{-1}) for fully recruited ages, 2-11 (Table 2.1.b). Age was modeled according to a single sex von Bertalanffy function internally in the stock assessment model (Stock Synthesis) using the age length observations from the SEDAR DW. Sex ratio at the start time of the population analysis (1886) was assumed to be 1:1 as recommended by the SEDAR 28 DW. Fish were assumed to be fully mature at age 1 (SEDAR 28 DW). The fecundity schedule was assumed directly proportional to the weight of females in the assessment model. The discard mortality rate was assumed to be 20% for the recreational and 10% for the commercial fisheries as recommended by the DW. Natural mortality was input into the model as an age specific vector developed from inputs provided by the SEDAR 29 DW. The M at-age vector was developed according to a declining Lorenzen function and scaled to fully recruited fish ages 4-11 by the point estimate of the Hoenig maximum age natural mortality estimator recommended by the SEDAR 28 DW of 0.38 y^{-1}. Table 2.1 provides life history input metrics.

The primary model used in the Gulf of Mexico Spanish mackerel evaluation was the Stock Synthesis (SS, Methot 2011) model. In the stock assessment, several of the life history parameters were estimated by the model and not fixed. Therefore, further discussions of pertinent life history metrics (i.e., growth, natural mortality) are also addressed in both the Model Configuration and in the Parameters Estimated section (3.1.3 and 3.1.4) of the SEDAR 28 Assessment Report."

2.2 Landings

2.2.1 Commercial landings

Commercial landings data were provided through the SEDAR 28 DW; these data were assimilated into three main categories: commercial gillnet (COM_GN), commercial line fisheries (i.e., hook and line, vertical line, rod and reel = COM_RR). There were some minor landings reported for "miscellaneous" commercial gears (traps, trawls, seines); these "miscellaneous" commercial landings were apportioned into commercial gillnet and commercial line gears according to the annual representation of each. Commercial landings data were input into SS as metric tons, whole weight. Table 2.2 and Figure 2.1 present commercial landings data.

2.2.2 Recreational landings
Recreational landings data (REC) were provided through the SEDAR 28 DW and were aggregated across all fishery categories: a) MRFSS/MRIP estimates of landings from charter, private angler, b) Texas Parks and Wildlife (charter, private and headboat), and the c) for hire headboat fishery. Table 2.2 and Figure 2.1 present recreational landings data.

2.3 Discards

2.3.1 Commercial discards
Estimates of discards were available from commercial gears (handline and trolling) in numbers of fish. Commercial discards in numbers were converted to pounds using the average weight of fish at the minimum size limit (12 inches). Commercial line gear (COM_RR) discards were input into the SS model as the fraction of the total catch (native units-commercial as pounds of discards of total pounds. It was thought that the estimated commercial discards are highly uncertain owing to low reporting rates for commercial line gear fleet. For use in the stock assessment model (Stock Synthesis), the commercial line gear discard fractions were averaged across all years and input into the SS model as a single super period. Tables 2.3 and 2.4 and provide the time series of commercial discard fractions available for the Gulf Spanish mackerel stock evaluation.

2.3.2 Recreational discards
Discards from the recreational fishery (REC) were available as numbers of fish and for use in SS were input in the same units. Recreational discards were input into the SS model as the fraction of the total catch (native units-commercial as pounds of discards of total pounds, recreational as numbers of total catch). It was thought that the estimated discards are highly uncertain owing to low intercept rates (recreational), and also changes in quality control and assurance that occurred in the recreational catch survey (MRFSS/MRIP) time series (1981-2011). For use in SS, the recreational discard fractions were partitioned into three periods and input into SS as three super periods. It was believed that the recreational discards showed a general increasing trend over the time series and that three separate periods were evident thus three super periods were used to characterize the recreational discards. Partitioning the recreational discards as three super periods also corresponded to points in time associated with improvements in field procedures in the recreational data collection survey, and particularly so for the first period (1981-1990). Tables 2.3 and 2.4 provide the time series of discards available for the Gulf Spanish mackerel stock evaluation.

2.3.3 Shrimp discards
Estimates of Spanish mackerel caught by Gulf of Mexico shrimp trawlers were available for 1972-2010 at the time of the DW. After the completion of the DW, the time series was updated to include 2011. Because of the large uncertainty in the estimates of annual shrimp bycatch (SEDAR 28 DW-06, Table 6 and DW-06 Figure 6 and SEDAR 28 RD-05 Table 2 and Figure 2), it was thought that an average discard value across the time series best reflected the magnitude of removals of Spanish mackerel in the Gulf of Mexico shrimp fishery, so the bycatch discards were also input as a single super period with the mean value from 1972-2011 in 1,000s of fish used to describe the annual discards. Table 2.5 provides shrimp discards.

2.4 Length composition

Length composition data were provided by the SEDAR 28 DW. Length composition data used in the assessment are presented in Figures 2a-2d and Appendix A. Lengths are in units of fork length in centimeters. Following the DW, length compositions were computed as numbers at length using the length data from the combined commercial, recreational and fishery independent databases. Length data were aggregated into 2-cm length bins. Length bins ranged from 4 cm to 99 cm, where the bin size represents the minimum size of the bin (e.g., the 4-cm length bin contains fish greater than or equal to 4 cm and less than 5 cm). Length data were stratified by calendar year, fishery/survey (commercial gillnet fleet (COM_GN), commercial line gears (COM_RR), and recreational all fisheries combined (headboat, private angler, charter, shore = REC). Length composition sample sizes were capped at a maximum effective sample size of 100 fish to prevent the length composition data from driving the model fitting process due to large sample sizes (reference). For strata with fewer than 100 length observations the sample size was set equal to the number of observations measured. Figures 2.2a – 2.2d provide length composition data used in the SS evaluation.

2.4.1 Commercial length composition

As summarized above, commercial length composition data were stratified by calendar year, fishery/survey (i.e., commercial gillnet fleet (COM_GN) and commercial vertical line gears (COM_RR) corresponding to the primary fisheries considered for the stock assessment. Each separate length composition sample was then aggregated into 2-cm length bins for use in SS. Length bins ranged from 4 cm to 99 cm, where the bin size represents the minimum size of the bin (e.g., the 4-cm length bin contains fish greater than or equal to 4 cm and less than 5 cm). Figures 2.2a – 2.2d provide length composition data used in the SS evaluation.

2.4.2 Recreational length composition

As summarized above, recreational length composition data of Gulf of Mexico Spanish mackerel were stratified by calendar year, fishery/survey (i.e., commercial gillnet fleet (COM_GN) and commercial vertical line gears (COM_RR) corresponding to the primary fisheries considered for the stock assessment. Each separate length composition sample was then aggregated into 2-cm length bins for use in SS. Length bins ranged from 4 cm to 99 cm, where the bin size represents the minimum size of the bin (e.g., the 4-cm length bin contains fish greater than or equal to 4 cm and less than 5 cm). Figures 2.2a – 2.2d provide length composition data used in the SS evaluation.

2.4.3 Survey length composition

Length composition data sample of Gulf of Spanish mackerel from the SEAMAP trawl survey were provided by the SEDAR 28 DW. Length composition samples were handled identically to the recreational and commercial length composition samples. Observations of length were partitioned by year and aggregated by 2-cm length bins similarly as described above. Figures 2.2a – 2.2d provide length composition data used in the SS evaluation.

2.5 Conditional age-length composition

Observations of Spanish mackerel annular age at length were provided by the SEDAR 28 DW for the stock assessment and presented in Figures 2.3a – 2.3i and Appendix B. Age data were available for the commercial and recreational fisheries. Following the SEDAR 29 DW, age-length compositions were computed as the numbers at age within length intervals using age data from the DW. Thus, the age observations used in the stock assessment were assumed to be conditional on length. A separate age-length composition was specified for each 2-cm length bin containing fish whose ages had been estimated thus providing a link between the length composition data and the age-length data. This linkage provides allows more detailed information on the size-age relationship to be incorporated into the growth model fitting process. This approach provides more detailed information to inform the variance of size-at-age; (Methot 2011). The age-length data were stratified by calendar year, fishery/survey (commercial gillnet, commercial line gear, and recreational all modes combined). Figures 2.3a – 2.3i provides the conditional age-length composition data used in the SS evaluation for Gulf of Mexico Spanish mackerel. Methot notes that "where age data are collected in a length-stratified program, the conditional age'-at-length approach can directly match the protocols of the sampling program". Historically, age samples for Spanish mackerel have followed a two stage sampling protocol (Nancie Cummings, personal communication).

An age estimation error matrix was developed following the DW to account for errors in the estimation of ages for Gulf Spanish mackerel (Table 2.6). The matrix includes mean coded ages and their associated standard deviations. The standard deviations were obtained from an analysis of Spanish mackerel ages estimated by two independent readers for a limited sample of n=73 fish.

In the stock assessment model used in this assessment (SS) fish are age 1 when they first reach the month of January regardless of time of birth. Internally, SS assumes that all the recorded age observation data accurately reflects the adjustment to age 1 so that all the age of fish increments to the next age on January 1. SEDAR 28 DW-23 described the procedures used for age determinations of Spanish mackerel data used in this assessment. Spawning in Gulf of Mexico Spanish mackerel occurs during spring coinciding with the time of annulus deposition. The procedures for Spanish mackerel age determinations incorporated: the advancing of increment count (i.e., annulus age) based on annuli number, otolith edge-type and capture-date, typically advancing increment counts for spring collected samples.

2.6 Indices

Three indices **o**f abundance and one index of fishing effort were recommended by the SEDAR 28 DW for use in the stock assessment (Table 2.7 and Figure 2.4). These were: 1) the shrimp effort index (1946-2011), 2) the MRFSS/MRIP catch per angler hour abundance index, 3) the FWC Trip Ticket Vertical line pounds per trip abundance index, and 4) the SEAMAP trawl survey abundance index. The standardized indices (point estimates) and the coefficient of variation (CV) of each, updated through 2011 for each series was incorporated into the population modeling using SS. The CVs were converted to log-scale standard errors for input into SS, adjusted as:

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

The shrimp effort index was used to derive an estimate of annual fishing mortality for the shrimp fishery bycatch of Spanish mackerel discards. Figures 2.4a -2.4d provides the indices of abundance and associated CV's and the shrimp effort index as used in the SS model evaluation.

Estimates of shrimp effort used in the SS model are provided in Table 2.7. The shrimp effort series was used in SS to develop estimates of annual fishing mortality for the shrimp bycatch fleet.

2.7 Tables

Table 2.1a. Weight at length meristic for Gulf Spanish mackerel used in the SEDAR 28 stock evaluations. Source = SEDAR 28 DW Report Table 2.7

SEX-SPECIFIC WEIGHT AT LENGTH1	Region	RECOMMENDED										
Data Source	**Area**	**Dep. Var.**	**Ind. Var.**	**a**	**b**	**r2**	**n**	**LEN SE**	**WT SE**	**Length Range**	**Units**	**Function**
Female	S. Atl.	Weight	FL	7.4558e-9	3.0244	0.9514	2,896	1.2412	0.0068	218-753	kg mm	Power
Male	S. Atl.	Weight	FL	1.6486e-8	2.8934	0.9091	2,141	0.9747	0.0039	252-605	kg mm	Power
Female	Gulf	Weight	FL	2.5969e-8	2.8310	0.9123	320	4.9400	0.0300	294-687	kg mm	Power
Male	Gulf	Weight	FL	5.1469e-9	3.0884	0.9657	124	7.1702	0.0395	298-640	kg mm	Power
Female	Combined	Weight	FL	7.9232e-9	3.0155	0.9464	3,216	1.2514	0.0070	218-753	kg mm	Power
Male	Combined	Weight	FL	1.0511e-8	2.9694	0.9280	2,265	1.0274	0.0044	252-640	kg mm	Power
Sexes Combined	Combined	Weight	FL	2.154E-08	2.8534	0.9161	88,067	0.2688	0.0015	110-900	kg mm	Power

Table 2.1b. Point estimates of natural mortality (M) for the Gulf stock of Spanish mackerel based on maximum age = 11 years and von Bertalanffy parameter estimates:

t0 = -0.5, k = 0.61, and L∞ = 560. Source = SEDAR 28 DW Table 2.1.		
Alverson & Carney	tmax	0.16
Beverton	k, am	3.44
$Hoenig_{fish}$	tmax	0.38
$Hoenig_{alltaxa}$	tmax	0.4
Pauly		1.03
Ralston	k	1.28
Ralston (geometric mean)	k	2.20
Ralston (method II)	k	2.11
Hewitt & Hoenig	tmax	0.36
Jensen	k	0.92
Rule of thumb	tmax	0.27
Alagaraja	survivorship to tmax: 0.1	0.42
Alagaraja	survivorship to tmax: 0.2	0.36
Alagaraja	survivorship to tmax: 0.5	0.27

Table 2.2. Commercial and recreational landings data used in the SEDAR 28 Gulf of Mexico Spanish mackerel stock assessment. COM_GN = commercial gillnet, COM_RR = commercial line gears, and REC = recreational all modes (charter, private, shore, headboat). Units are whole weight (mtons) commercial, numbers of fish (recreational, 1,000's of fish).

YEAR	COM_GN	COM_RR	REC
1886	34	2	
1887	68	4	
1888	133	8	
1889	256	15	
1890	296	18	
1891	310	2	
1892	310	2	
1893	310	2	
1894	310	2	
1895	310	2	
1896	310	2	
1897	321	19	
1898	417	25	
1899	417	25	
1900	417	25	
1901	417	25	
1902	677	41	
1903	656	39	
1904	656	39	
1905	656	39	
1906	656	39	
1907	656	39	
1908	636	38	
1909	668	45	
1910	776	50	
1911	884	55	
1912	992	61	
1913	1,100	66	
1914	1,208	71	
1915	1,316	77	
1916	1,424	82	
1917	1,486	88	
1918	1,506	91	
1919	1,535	93	
1920	1,585	93	
1921	1,639	98	

1922	1,643	99	
1923	1,653	100	
1924	1,751	104	
1925	1,863	110	
1926	1,976	115	
1927	2,041	124	
1928	1,413	86	
1929	1,529	93	
1930	1,794	109	
1931	1,018	62	
1932	1,255	76	
1933	1,374	82	
1934	1,512	92	
1935	1,868	110	
1936	2,252	136	
1937	1,704	103	
1938	1,760	107	
1939	1,835	111	
1940	1,580	96	
1941	36	22	
1942	36	22	
1943	36	22	
1944	36	22	
1945	40	2	
1946	36	22	
1947	36	22	
1948	384	23	
1949	1,658	100	
1950	1,109	67	
1951	2,785	169	
1952	1,932	117	
1953	1,276	77	
1954	1,235	75	
1955	696	42	774
1956	1,248	76	859
1957	1,561	94	944
1958	1,655	100	1,028
1959	2,006	121	1,113
1960	2,339	142	1,198
1961	1,717	104	1,219
1962	3,072	63	1,241

1963	2,434	37	1,262
1964	1,715	79	1,284
1965	2,095	130	1,305
1966	3,053	152	1,357
1967	2,582	128	1,408
1968	3,164	116	1,460
1969	3,685	99	1,511
1970	3,631	120	1,563
1971	3,349	124	1,705
1972	2,758	204	1,847
1973	2,748	61	1,989
1974	3,432	318	2,131
1975	2,192	358	2,273
1976	3,153	377	2,277
1977	905	291	2,281
1978	505	268	2,285
1979	931	31	2,289
1980	832	45	2,293
1981	1,592	90	2,102
1982	1,486	82	3,443
1983	960	68	2,430
1984	1,567	23	947
1985	904	29	1,177
1986	1,225	14	6,398
1987	1,191	102	1,795
1988	1,039	12	1,460
1989	1,388	26	1,136
1990	1,161	8	1,597
1991	1,488	73	1,739
1992	1,682	17	2,393
1993	1,168	13	1,488
1994	1,250	10	1,428
1995	675	10	1,073
1996	172	13	1,260
1997	226	18	1,262
1998	186	24	1,181
1999	368	27	1,590
2000	394	19	1,731
2001	500	36	2,482
2002	413	17	1,976
2003	628	20	1,518

2004	469	19	2,150
2005	662	16	1,216
2006	614	28	1,790
2007	414	13	1,353
2008	521	39	1,905
2009	789	35	1,519
2010	501	66	1,601
2011	546	54	1,547

.

Table 2.3. Time series of discards for commercial (COM_RR) and recreational (REC) fisheries available for the SEDAR 28 Gulf of Mexico Spanish mackerel stock evaluations. COM_RR average for 1998-2011 super period = 0.1767 Recreational super period averages are: 1) 1981-1990=0.24473, 2) 1991-2002=0.4062, 3) 2003-2011=0.5635. COM_RR discards calculated in weight units, REC discards calculated in numbers of fish units.

Year	COM_RR	REC
1981		0.04
1982		0.14
1983		0.33
1984		0.06
1985		0.11
1986		0.39
1987		0.19
1988		0.33
1989		0.30
1990		0.58
1991		0.42
1992		0.41
1993		0.41
1994		0.32
1995		0.35
1996		0.36
1997		0.40
1998	0.20	0.39
1999	0.18	0.44
2000	0.24	0.46
2001	0.12	0.43
2002	0.26	0.49
2003	0.24	0.59
2004	0.22	0.52
2005	0.25	0.53
2006	0.16	0.62
2007	0.28	0.61
2008	0.08	0.52
2009	0.12	0.52
2010	0.06	0.61
2011	0.07	0.56

Table 2.4. Calculated discard fraction according to super period designations for the directed fisheries as input into the SS model for Gulf of Mexico Spanish mackerel. Commercial discard fraction calculated as discard weight divided by total reported landings weight. Recreational discard fraction calculated as discard numbers divided by total estimated recreational catch number.

Fleet	Super period	Fraction
COM_RR	1998-2011	0.17665
REC	1981-1990	0.24473
REC	1991-2002	0.4062
REC	2003-2011	0.5635

Table 2.5. Time series of discards shrimp bycatch for Gulf of Mexico Spanish mackerel for the SEDAR 28 stock assessment. The calculated value for the 1972-2011 super period value used in the SS model was 9,096 million fish.

Year	Discard Numbers (1,000s)
1972	7,700
1973	916
1974	2,230
1975	2,774
1976	5,264
1977	13,750
1978	13,400
1979	16,510
1980	13,870
1981	4,028
1982	5,582
1983	4,506
1984	8,033
1985	2,654
1986	6,586
1987	5,911
1988	9,566
1989	14,530
1990	20,020
1991	14,960
1992	19,070
1993	48,680
1994	4,856
1995	4,555
1996	4,026
1997	4,586
1998	5,672
1999	4,289
2000	9,968
2001	5,797
2002	5,258
2003	10,850
2004	18,680
2005	21,590
2006	3,903
2007	8,264
2008	2,797
2009	2,621
2010	2,945
2011	2,632

Table 2.6. Age error matrix for Gulf of Mexico Spanish mackerel used in the SEDAR 28 stock assessment. Data Source: Chris Palmer (NOAA, NMFS, SEFSC Panama City Laboratory, personal communication).

				AGE (Years)								
Mean age	0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5
SD (Age)	0.01	0.01	0.06	0.08	0.11	0.11	0.37	0.37	0.37	0.37	0.37	0.37

Table 2.7. Time series of indices of abundance data for Gulf Spanish mackerel used in the SEDAR 28 stock evaluations. Series included are: shrimp effort, MRFSS/MRIP, commercial FWC vertical line index, and SEAMAP survey. Source: SEDAR 28 DW. Units are: MRFSS- number fish caught per hour fished, FWC Vertical line- pounds per trip, and SEAMAP- number per trawl hour.

	MRFSS	MRFSS	COM_FWC_VERT_LINE		SEAMAP Trawl Survey	
Year	***Std CPUE***	***log SE***	***Std CPUE***	***log SE***	***Std CPUE***	***log SE***
1981	0.8981	0.4377				
1982	1.2552	0.7935				
1983	0.8820	0.6986				
1984	0.6564	0.6170				
1985	0.7353	0.5893				
1986	2.6980	0.8561	0.6870	0.1901		
1987	1.1851	0.7114	0.5370	0.1854	0.2963	0.6224
1988	0.8780	0.6646	0.7290	0.1943	1.1645	0.4463
1989	1.0244	0.6841	1.5290	0.2029	1.4515	0.4503
1990	1.9452	0.8619	0.9790	0.2027	1.6314	0.4452
1991	1.3235	0.7116	1.0890	0.2005	0.8900	0.4792
1992	1.4129	0.7470	1.0830	0.2158	0.6126	0.4670
1993	0.7096	0.6855	0.5950	0.2220	1.7174	0.4257
1994	0.6942	0.5974	1.0320	0.2187	0.6990	0.5265
1995	0.4094	0.5214	0.9330	0.2325	1.1066	0.4422
1996	0.6716	0.5985	0.7210	0.2284	0.9789	0.4968
1997	0.6881	0.6000	0.7820	0.2340	0.3372	0.5634
1998	0.7264	0.6124	1.1450	0.2360	0.5403	0.4832
1999	1.1596	0.6931	0.9550	0.2350	0.8557	0.4801
2000	0.7170	0.6426	0.7520	0.2411	1.1816	0.4850
2001	0.8873	0.6959	1.4160	0.2290	0.8205	0.5069
2002	0.8451	0.6840	1.0870	0.2317	0.3274	0.5947
2003	0.8580	0.6690	1.2810	0.2227	1.4923	0.4371
2004	0.9920	0.6841	1.5680	0.2428	0.4669	0.4575
2005	0.5725	0.6475	1.0970	0.2556	2.5180	0.4260
2006	0.9179	0.6852	1.4750	0.2365	0.9222	0.4536
2007	0.9469	0.6546	1.1610	0.2384	1.6153	0.4463
2008	0.9681	0.6606	1.0560	0.2425	0.7950	0.5053
2009	0.9646	0.6375	1.4080	0.2213	1.1412	0.3707
2010	1.0875	0.7155	1.5670	0.2192	1.2501	0.4371
2011	1.2902	0.7083	1.4010	0.2311	0.1880	0.5505

Table 2.8. Shrimp bycatch fishery effort time series used in the SEDAR 28 Gulf of Mexico Spanish mackerel stock assessment. Source of data: Brian Linton, NMFS, SEFSC Miami Laboratory, personal communication and SEDAR 28 RD 05). Effort series scaled to the average Days Fished across the series.

Year	Days Fished	Scaled Effort
1945	0	0.0000
1946	284	0.0047
1947	1,448	0.0238
1948	3,804	0.0626
1949	6,147	0.1011
1950	10,959	0.1802
1951	13,897	0.2285
1952	16,410	0.2699
1953	16,935	0.2785
1954	22,046	0.3625
1955	21,819	0.3588
1956	28,008	0.4606
1957	32,692	0.5376
1958	42,331	0.6962
1959	45,525	0.7487
1960	45,499	0.7482
1961	28,091	0.4620
1962	48,445	0.7967
1963	54,816	0.9015
1964	64,601	1.0624
1965	41,836	0.6880
1966	35,305	0.5806
1967	42,367	0.6967
1968	49,673	0.8169
1969	54,379	0.8943
1970	38,200	0.6282
1971	43,275	0.7117
1972	60,507	0.9951
1973	61,572	1.0126
1974	63,546	1.0450
1975	48,783	0.8022
1976	67,809	1.1151
1977	84,191	1.3846
1978	117,210	1.9276
1979	123,387	2.0291
1980	90,717	1.4919

1981	93,669	1.5404
1982	89,604	1.4736
1983	97,007	1.5953
1984	99,486	1.6361
1985	107,160	1.7623
1986	112,829	1.8555
1987	131,122	2.1563
1988	99,077	1.6294
1989	118,390	1.9470
1990	115,261	1.8955
1991	110,218	1.8126
1992	95,737	1.5744
1993	89,589	1.4733
1994	98,076	1.6129
1995	84,232	1.3852
1996	90,320	1.4853
1997	92,288	1.5177
1998	100,228	1.6483
1999	104,433	1.7174
2000	93,384	1.5357
2001	90,675	1.4912
2002	80,352	1.3214
2003	65,451	1.0764
2004	50,458	0.8298
2005	30,345	0.4990
2006	40,321	0.6631
2007	39,499	0.6496
2008	34,113	0.5610
2009	39,735	0.6535
2010	28,164	0.4632
2011	26,366	0.4336

2.8 Figures

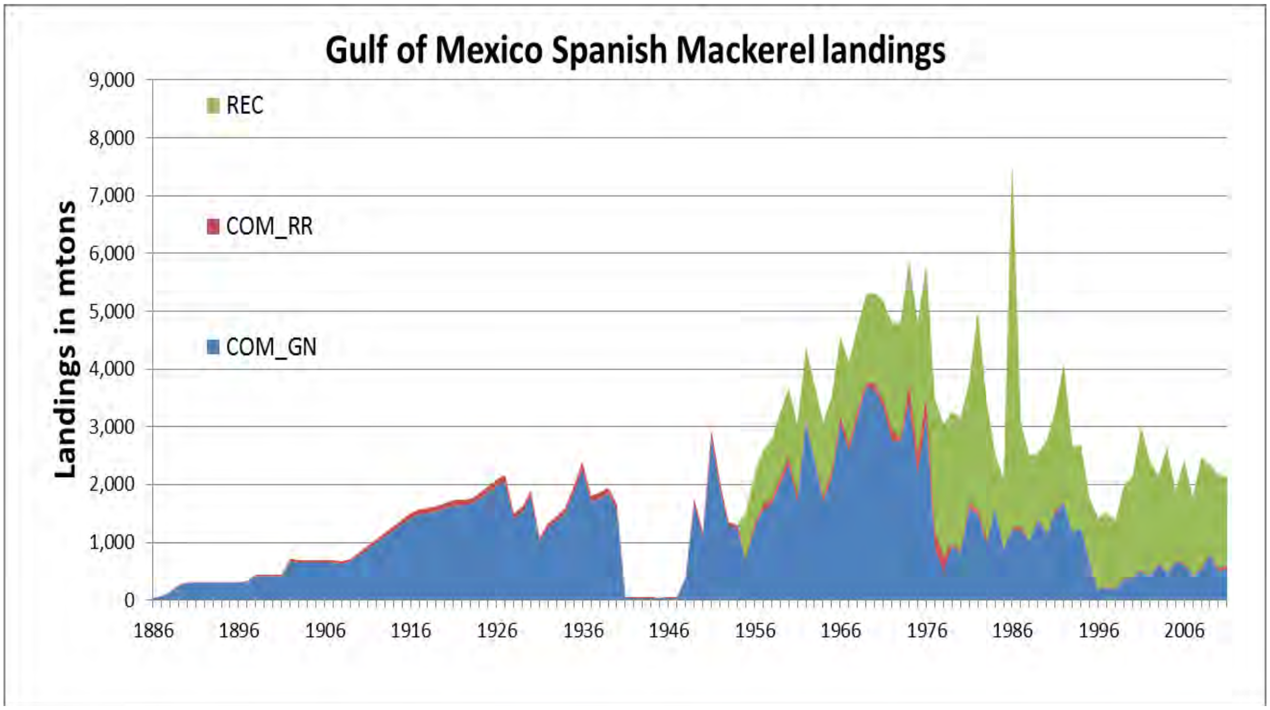
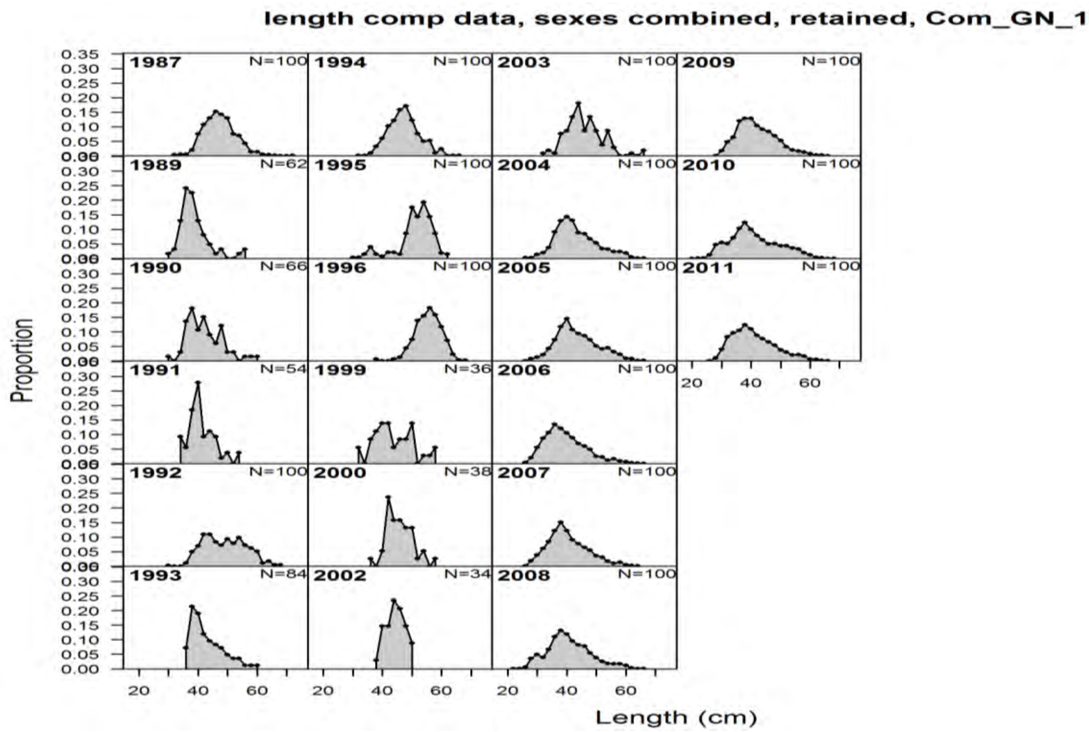


Figure 2.1. Commercial landings (mtons, whole weight) for Gulf of Mexico Spanish mackerel. Landings are partitioned into three fisheries: commercial gillnet (COM_GN), commercial line gears (COM_RR), and recreational modes combined (REC=charter, private angler, shore and headboat).

A.



B.

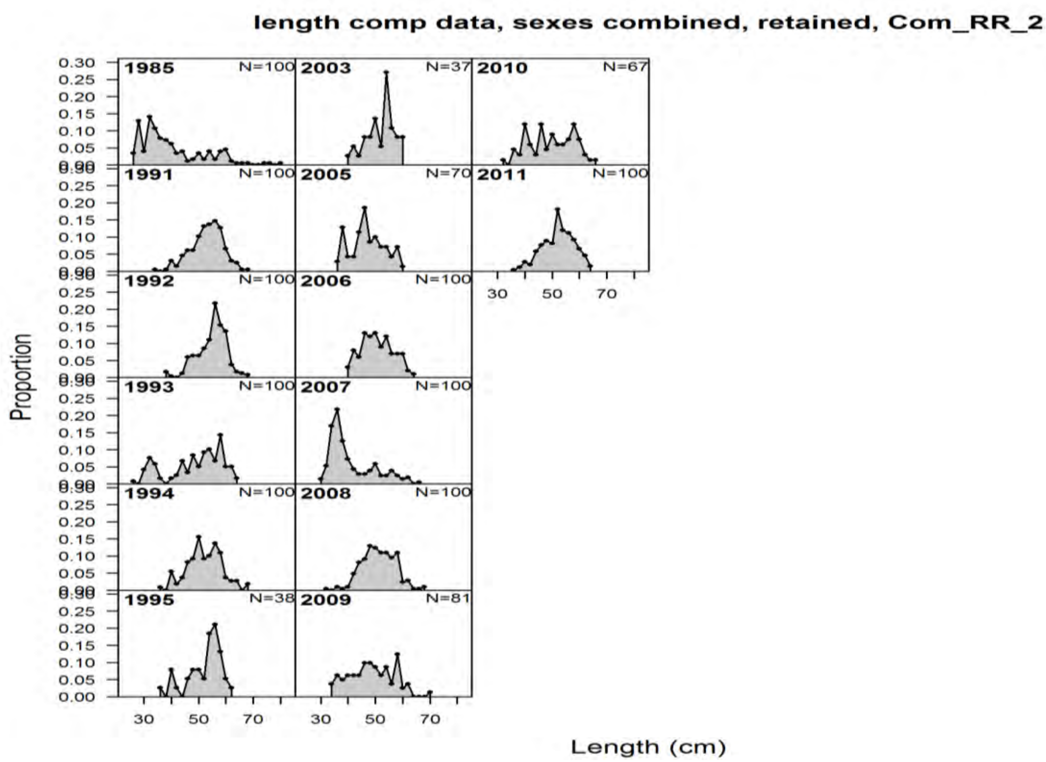
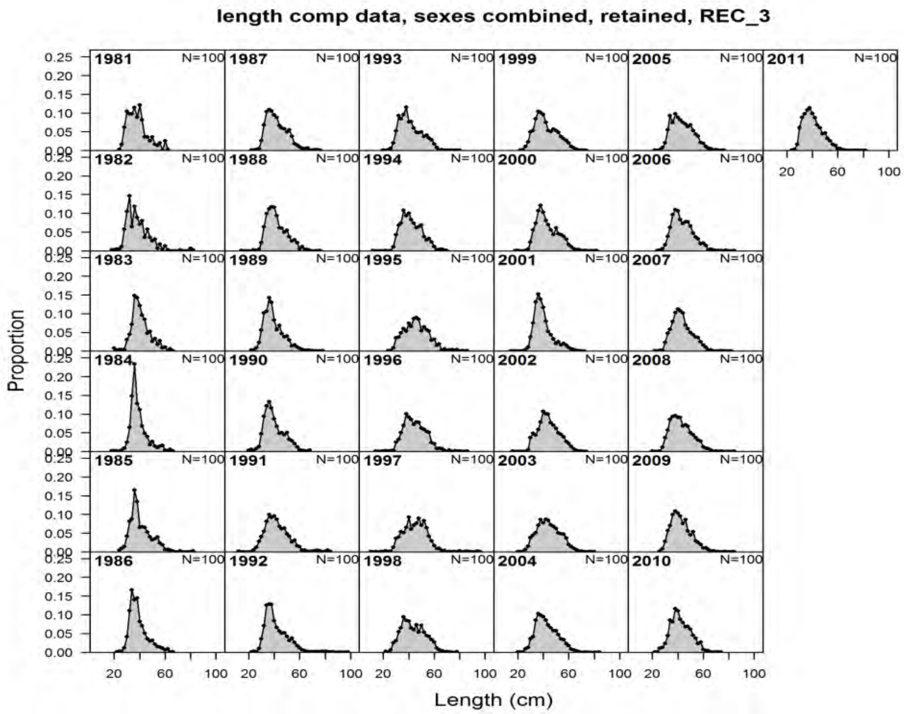


Figure 2.2a,b. Proportion of numbers at length for Gulf of Mexico Spanish mackerel in the a) commercial gillnet (COM_GN) and b) Commercial line gear fishery (COM_RR) of the Gulf of Mexico.

C.



D.

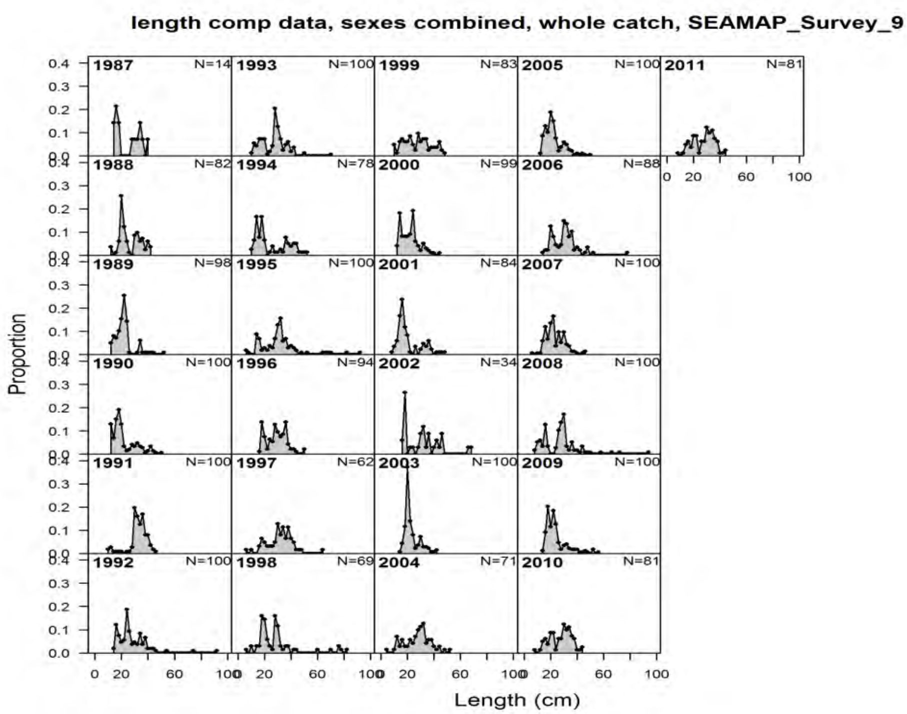


Figure 2.2c, d. Proportion of numbers at length for Gulf of Mexico Spanish mackerel in the recreational combined modes (REC=charter, private angler, shore, and headboat) fisher and c) the SEAMAP trawl survey.

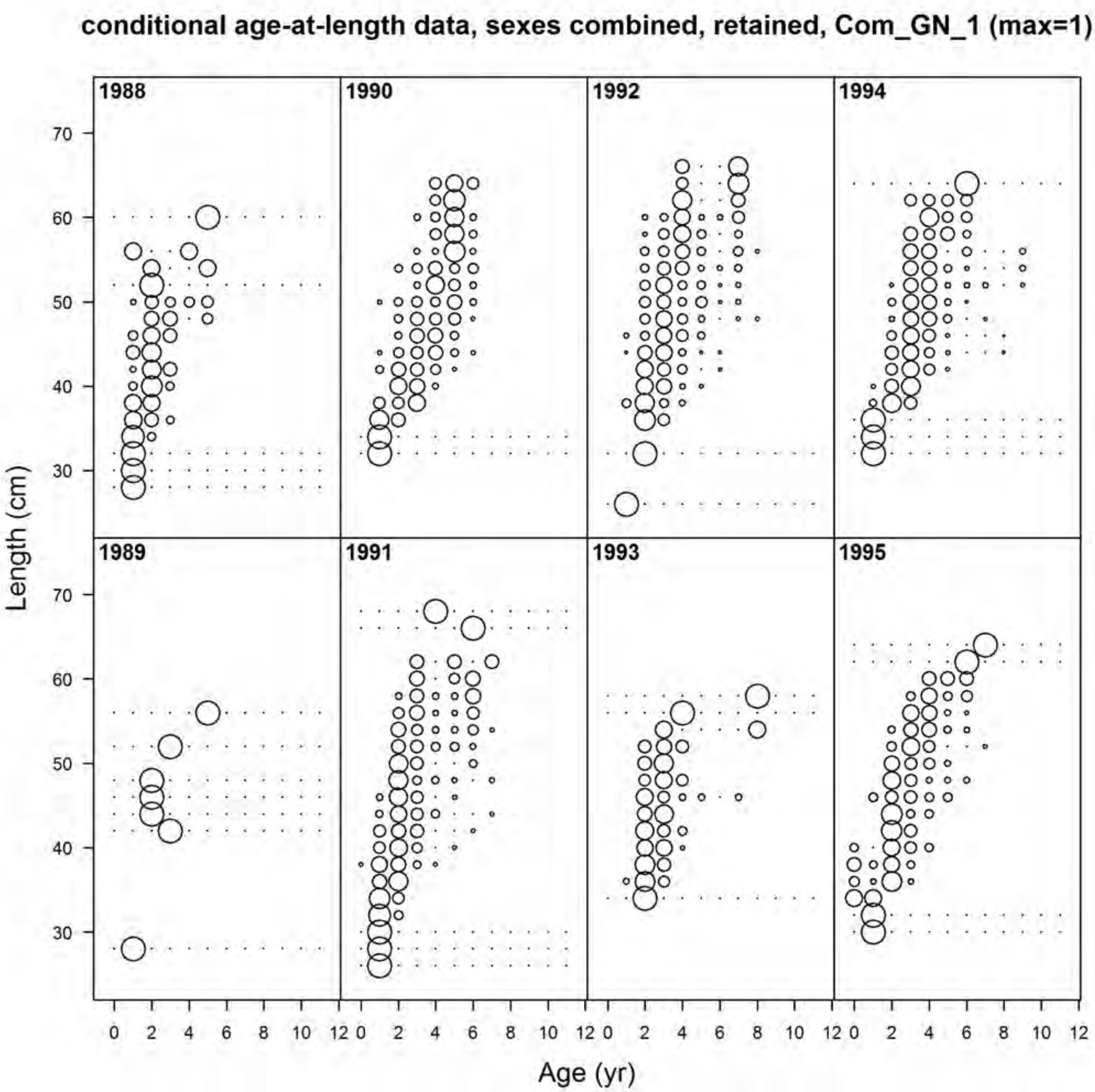


Figure 2.3a. Conditional age at length data, sexes combined, commercial gillnet fishery (COM_GN) for Gulf of Mexico Spanish mackerel.

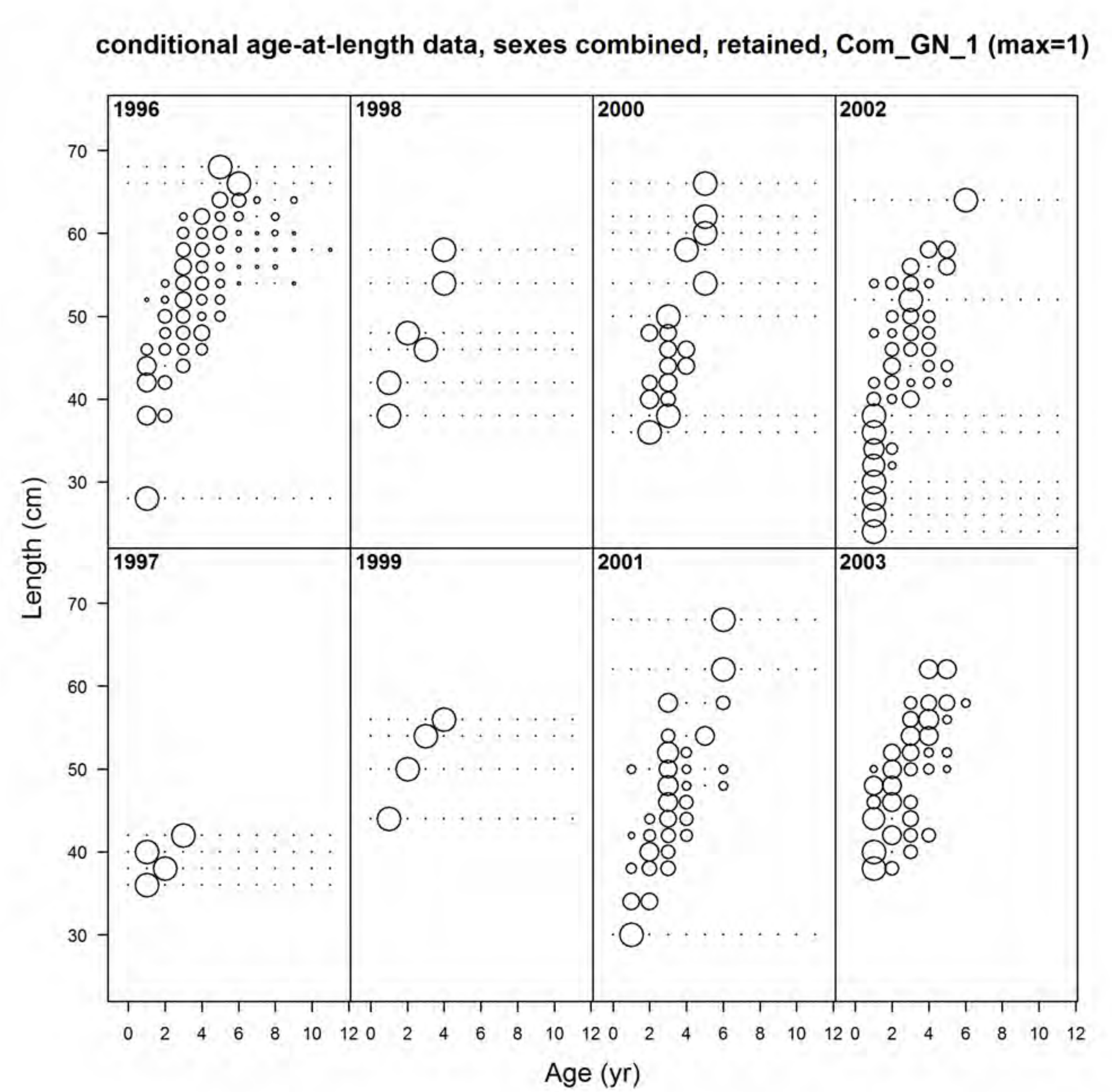


Figure 2.3b. Conditional age at length data, sexes combined, commercial gillnet fishery (COM_GN)) for Gulf of Mexico Spanish mackerel.

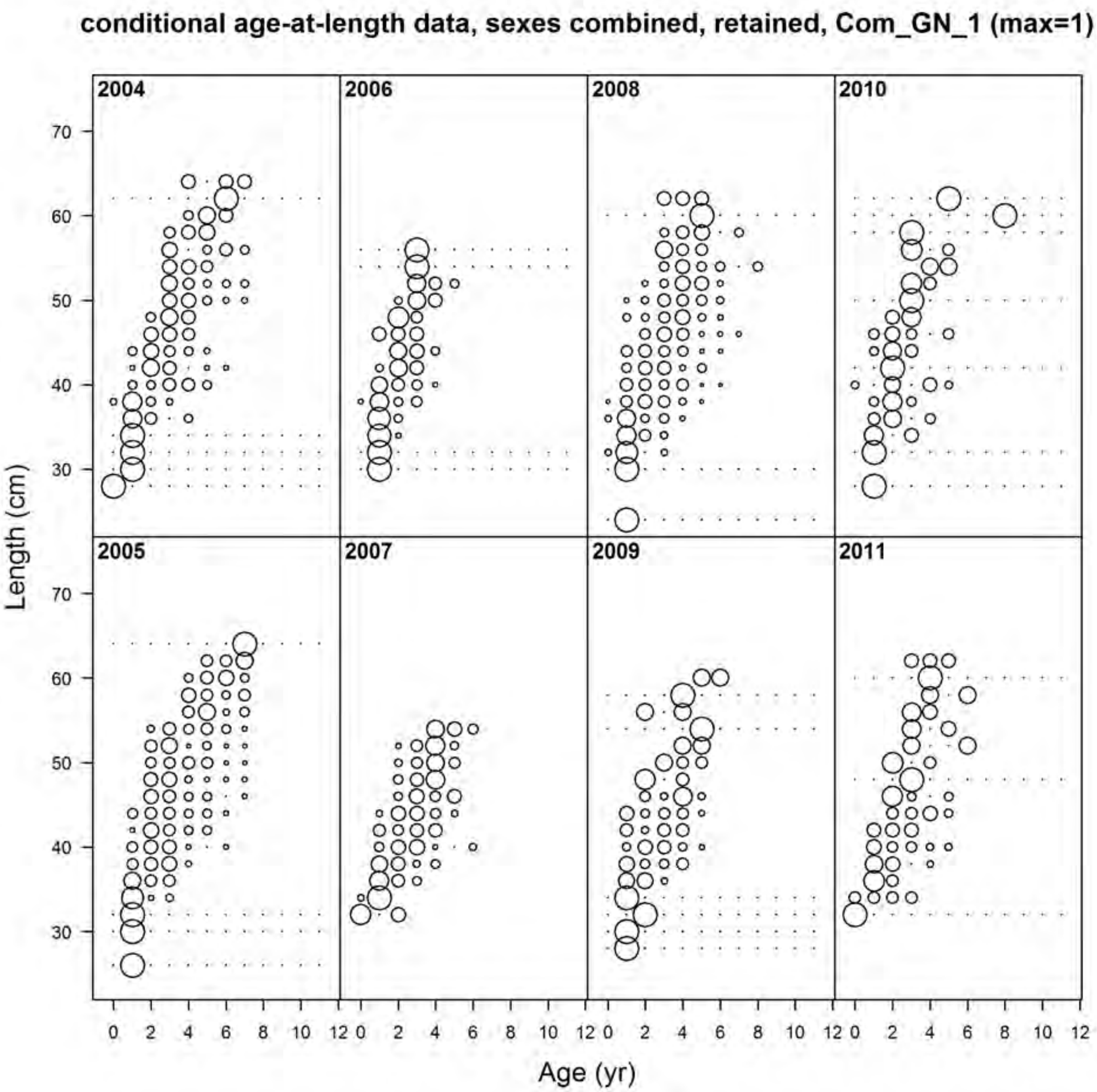


Figure 2.3c. Conditional age at length data, sexes combined, commercial gillnet fishery (COM_GN)) for Gulf of Mexico Spanish mackerel.

.

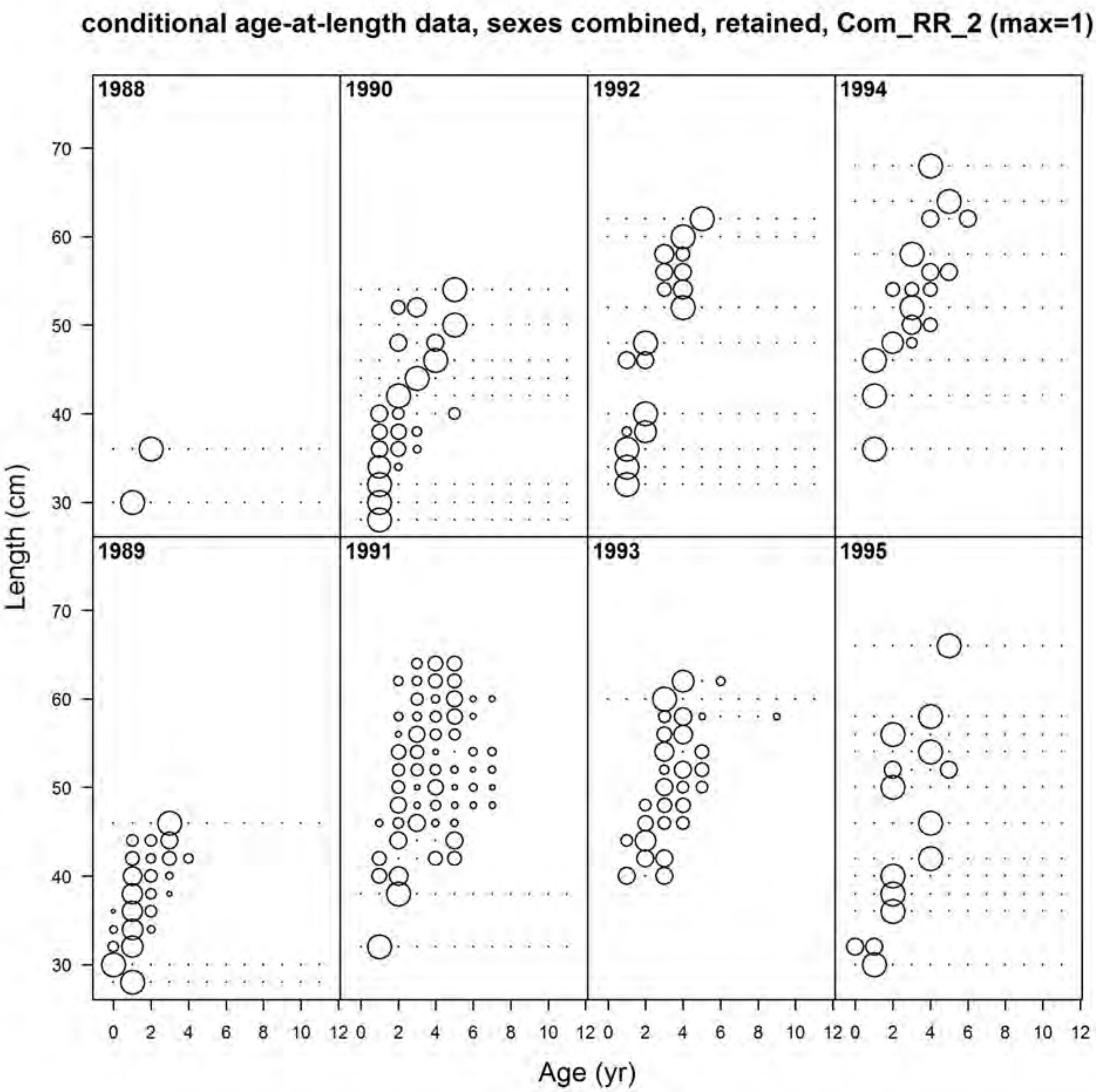


Figure 2.3d. Conditional age at length data, sexes combined, commercial line gear fishery (COM_RR)) for Gulf of Mexico Spanish mackerel.

.

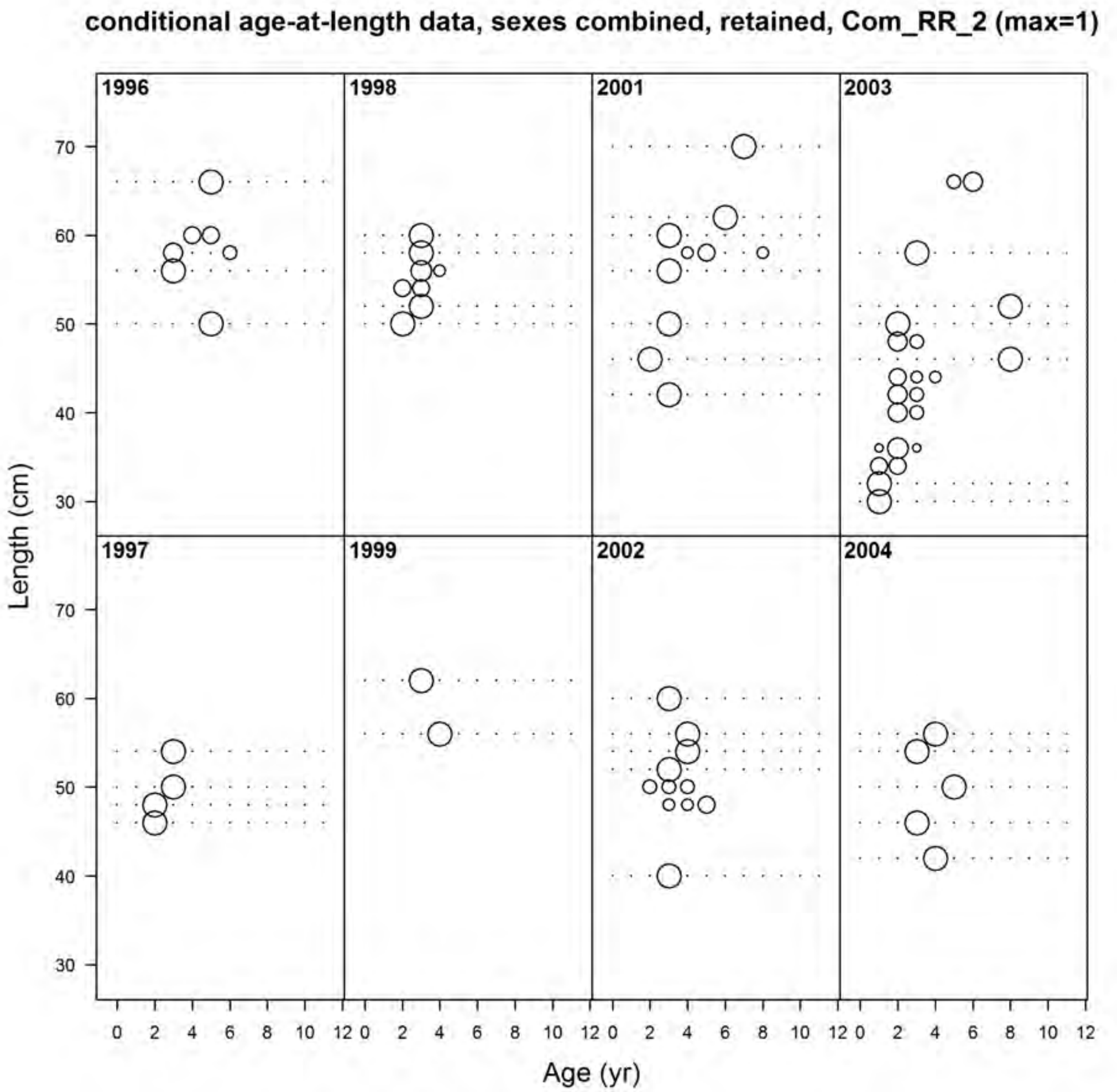


Figure 2.3e. Conditional age at length data, sexes combined, commercial line gear fishery (COM_RR)) for Gulf of Mexico Spanish mackerel.

.

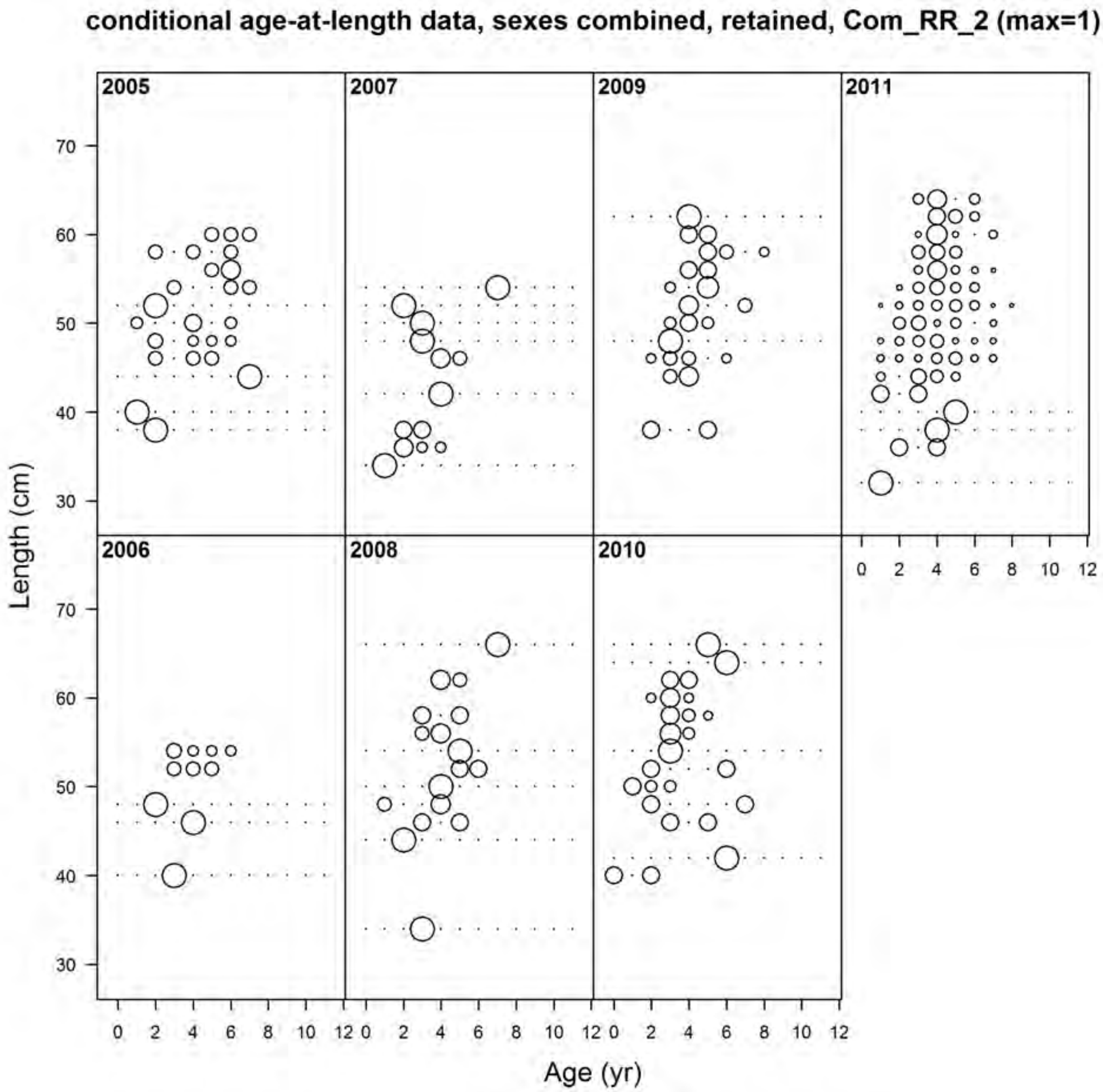


Figure 2.3f. Conditional age at length data, sexes combined, commercial line gear fishery (COM_RR)) for Gulf of Mexico Spanish mackerel.

.

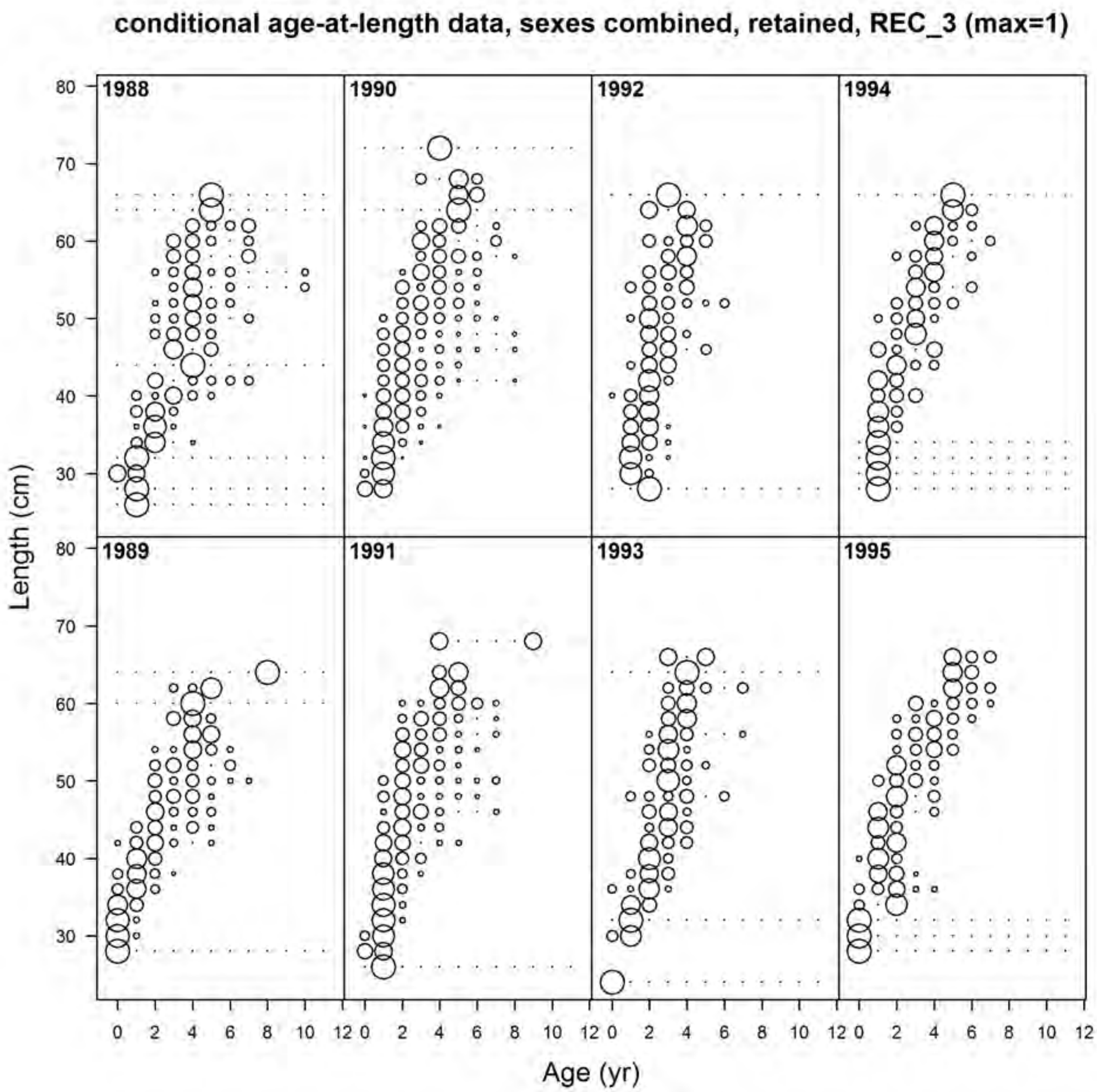


Figure 2.3g. Conditional age at length data, sexes combined, recreational fisheries all modes (REC=shore, charter, private angler, headboat)) for Gulf of Mexico Spanish mackerel.

.

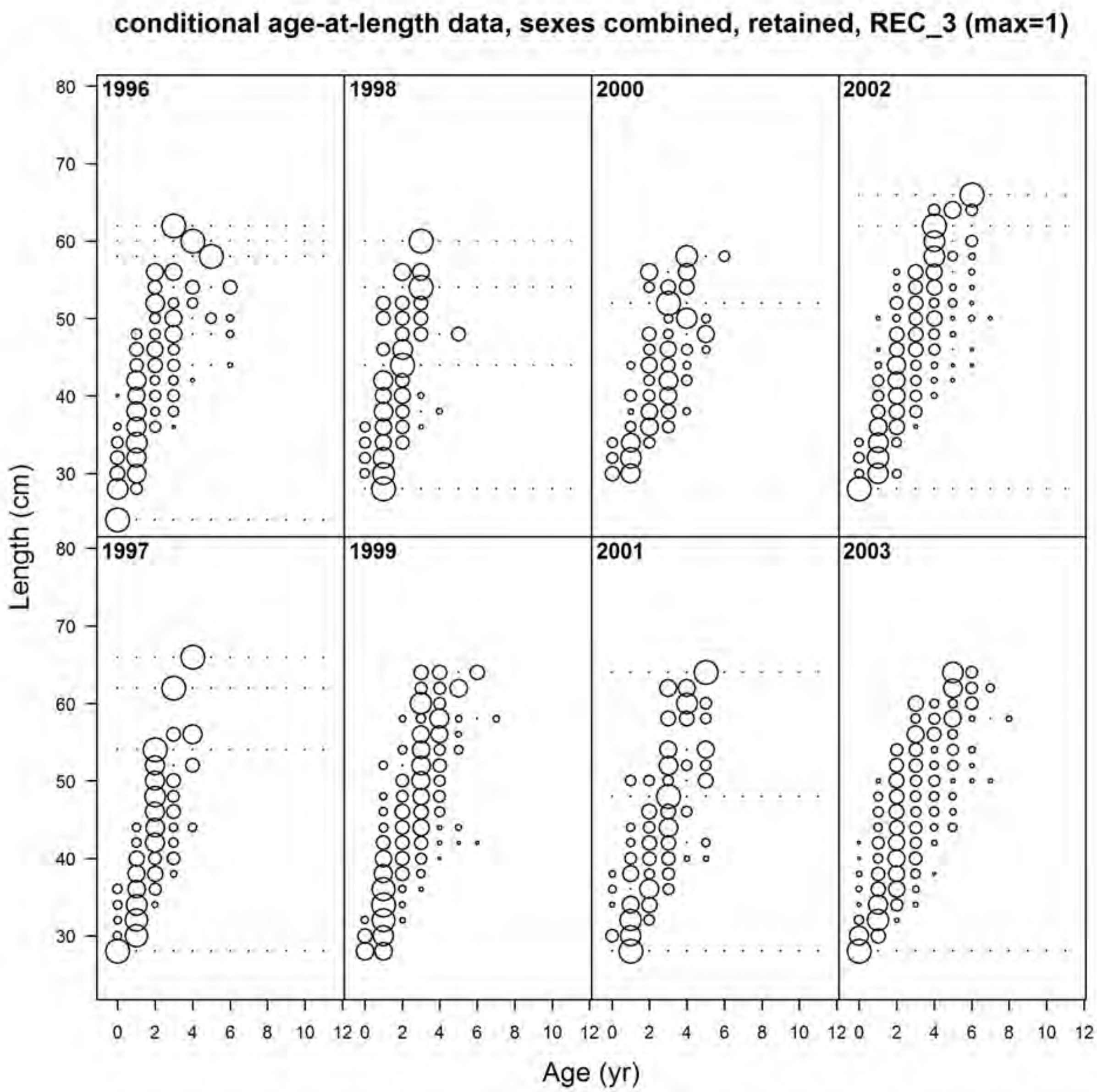


Figure 2.h. Conditional age at length data, sexes combined, recreational fisheries all modes (REC=shore, charter, private angler, headboat)) for Gulf of Mexico Spanish mackerel.

.

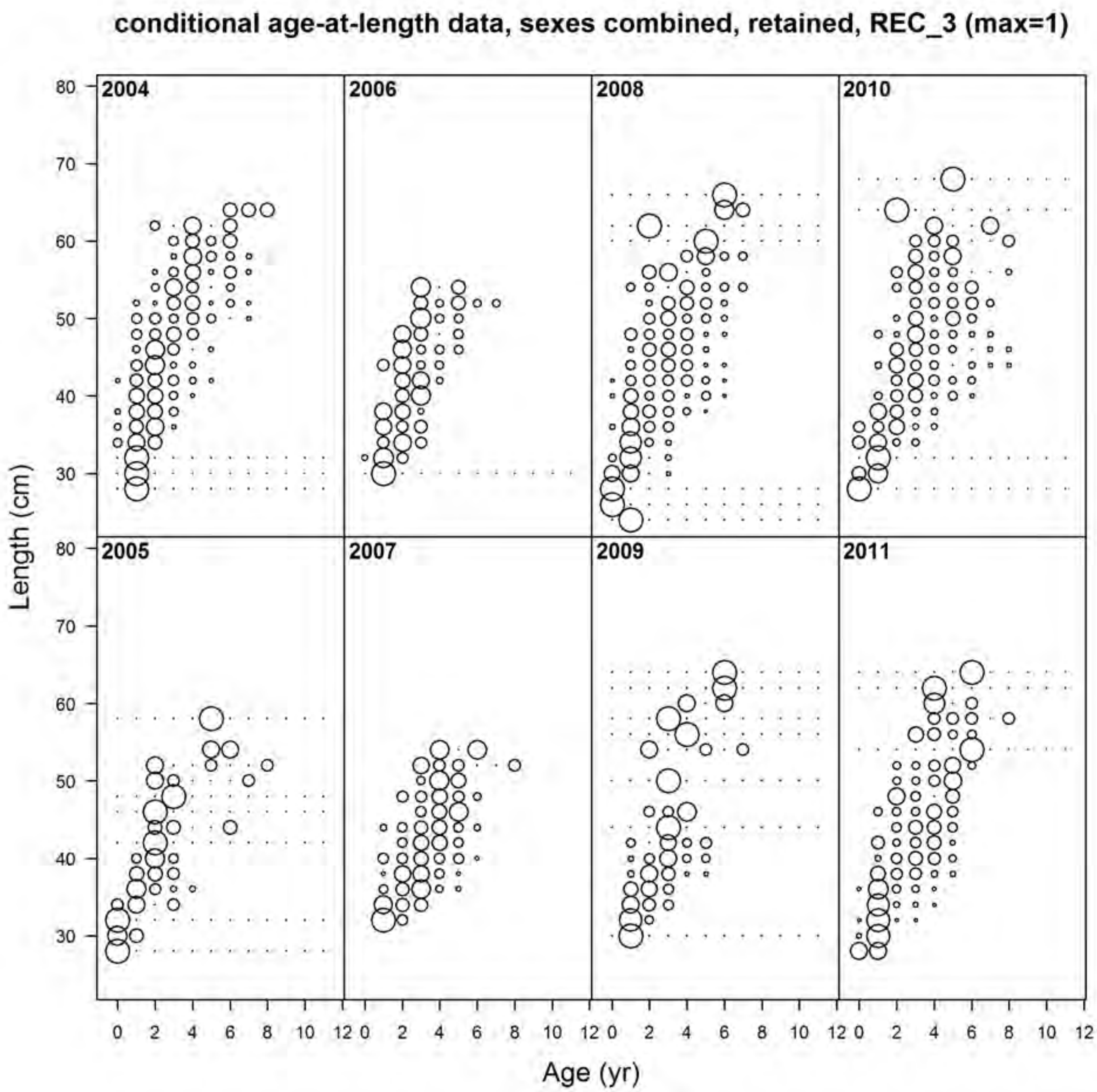


Figure 2.3i. Conditional age at length data, sexes combined, recreational fisheries all modes (REC=shore, charter, private angler, headboat)) for Gulf of Mexico Spanish mackerel.

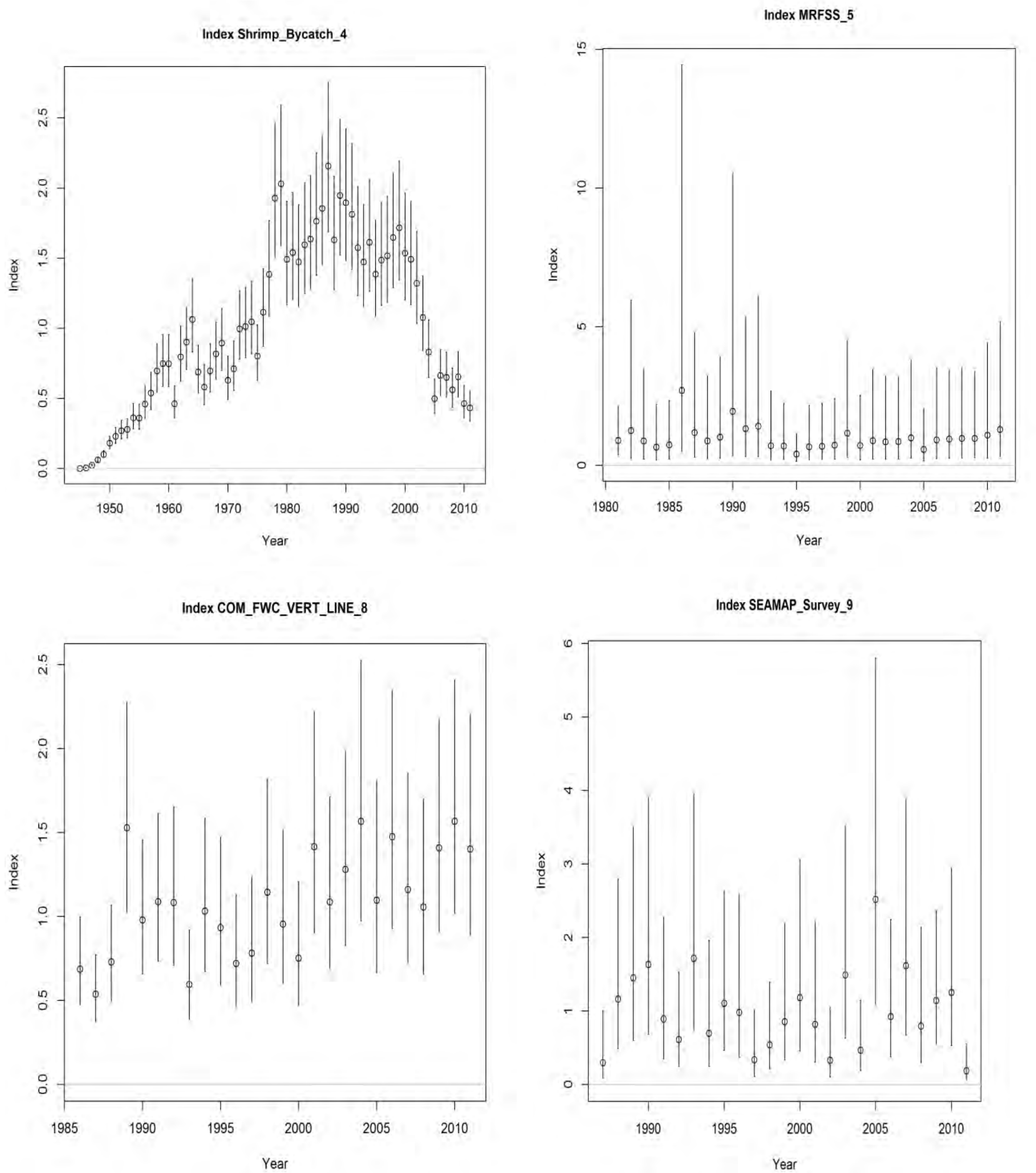


Figure 2.4. Standardized indices of relative abundance and associated coefficients of variation and the index of shrimp effort for Gulf of Mexico. The indices are from the shrimp effort series, b) MRFSS recreational survey (MRFSS), c) commercial line gear fishery (FWC Vertical line index), and d) the SEAMAP trawl survey (SEAMAP). Source: SEDAR 28 DW. Units are: MRFSS- number fish caught per hour fished, FWC Vertical line- pounds per trip, SEAMAP- number per trawl hour.

3 Stock Assessment Models and Results

3.1 Stock Synthesis

3.1.1 Overview

Stock Synthesis (SS) is an integrated statistical catch-at-age model which is widely used for stock assessments in the United States and throughout the world. SS takes relatively unprocessed input data and incorporates many of the important processes (mortality, selectivity, growth, etc.) that operate in conjunction to produce observed catch, size and age composition and CPUE indices. In addition, SS can incorporate time series of environmental data. Because many of these inputs are correlated, the concept behind SS is that they should be modeled together, which helps to ensure that uncertainties in the input data are properly accounted for in the assessment. SS has the ability to incorporate an early, data poor time period for which only catch data are available and a more recent, data-rich time-period for which indices of abundance and length and age-length or age composition observations are available.

The primary assessment model selected for the Gulf of Mexico Spanish mackerel stock evaluation assessment was stock Synthesis (Methot 2010) version 3.24h (beta). Stock Synthesis has been widely used and tested for assessment evaluations, particularly in the US west coast NMFS centers (Methot 2010). Descriptions of SS algorithms and options are available in the SS user's manual (Methot 2010) and at the NOAA Fisheries Toolbox website (http://nft.nefsc.noaa.gov/). During the course of the SEDAR 28 assessment the lead analysts collaborated frequently with the model developer (Rick Methot, personal communication) on a variety of model issues but particularly as relates the handling of discards into the model. Traditionally, discards have been input into SS applications by adding the discard magnitude to the total landings of each fishery component. In this assessment, discards were input as discards corresponding to super periods (one super period (1) for the commercial line gear fleet, three (3) super periods for the recreational fleets) along with a small CV, thus allowing the model to incorporate variance about the discard level. Section 2.3 presented estimates of discards.

The r4ss software (www.cran.r-project.org/web/packages/**r4ss**/index.html) was utilized extensively to develop various graphics for the SS outputs and also was used to summarize various SS output files and to initially conduct the parametric bootstrap.

The "Fishery Simulation" Graphics User Interface (GUI) tool developed by Lee et al. (2012), see https://fisherysimulation.codeplex.com/) was the approach used to characterize the uncertainty in final model estimates and projections of future caches for a variety of alternative scenarios recommended by the Assessment Panel (AP). This tool is based on parametric bootstrap analyses used with the integrated fishery stock assessment model, Stock Synthesis (SS, Methot R.D. 2011). Applications of the method to fisheries evaluations using SS are described in Lee *et al.* 2011, Piner et al. 2011, and Lee *et al.* 2012).

3.1.2 Data Sources

The SS model was fitted to landings, discards, length composition, conditional age-length observations, and indices of abundance. These categories of data included: annual landings (mtons), directed fishery discards (recreational and commercial fractions entered as super periods), shrimp fishery bycatch (dead discards as numbers in 1,000s), and standardized indices of relative abundance (recreational (MRFSS), commercial line gear fishery (FWC Vertical line fishery), SEAMAP Independent fishery trawl survey, and a time series of estimated shrimping effort (shrimp fishery). Although annual estimates of release mortality were not available, some information was available to characterize relative amounts of dead discards from the directed commercial line gear and recreational all modes fisheries as described in the SEDAR 29 DW report. The detailed data used in the SS model fitting are as described in Section 2.

3.1.3 Model Configuration and Equations

The stock was assumed to be in equilibrium at the beginning of the data series, 1886. The terminal year of data was 2011. SEDAR 28 DW provides details and a characterization of the fisheries for Spanish mackerel in the Gulf of Mexico since the late 1800s. The history of commercial landings exists since 1886. Recreational fishery removals were available since 1981 and were hindcast from 1955 to 1980 by the SEDAR 28 DW. It was generally thought that recreational removals of Spanish mackerel prior to 1955 were not large. Shrimp discards were available since 1972 and an index of shrimping effort in the Gulf of Mexico inside 15 fathoms was available since 1945. The stock assessment model, SS, was configured to include removals from three directed fisheries representing removals from the commercial gillnet (COM_GN), commercial vertical line gears (Com_RR) and recreational charter, private, headboat and shore anglers (REC). As described above in the Data Section (2), there were some minor landings reported for “miscellaneous” commercial gears (traps, trawls, seines); these “miscellaneous” commercial landings were apportioned into commercial gillnet and commercial line gears according to the annual representation of each. Three abundance surveys were incorporated representing the commercial line gears (Com_RR) and recreational charter, private, headboat and shore anglers (REC), and the SEAMAP trawl survey (SEAMAP). Initial exploitation rate was assumed to be zero for each fleet. Data inputs also included a time series of fishing effort for the shrimp fishery.

Parameter values for the weight-length relationship, maturity schedule, and fecundity were fixed at the values given in the DW Workshop report (SEDAR 28 DW Report- Section 2.10, Table 2.7) and are presented in Figure 3.1a (this report, weight-length relation). Maturity was input as a fixed logistic function of age with full maturity set for ages 1 plus.

For the initial model configuration natural mortality was modeled as a declining ‘Lorenzen’ function of size constant over time, as recommended by the DW (DW Report-Section 2.4, Table 2.1). Operationally, the age specific Lorenzen M vector was obtained via a two-step process, by first running SS specifying the input M value and the reference age for scaling the Lorenzen M to the Hoenig maximum age estimator point estimate. For the Lorenzen M curve in SS, a parameter describing the natural mortality at a specified reference age (i.e., “REF age”) is defined. Natural mortality values for the remaining ages are scaled according to the estimated growth curve. The REF age for the initial Model run was set equal to age 4 (DW Report- Section 2.4). This was done in SS (internally) by specifying the M type switch in the SS control file to ‘2’ Lorenzen and then specifying in the SS control file the age at which the M intersected the Hoenig point estimate, this occurred at ‘REF-age = 4. The resulting vector of M at-age was then input into the SS model (via specifying this vector of M at-age in the SS control file) for the Base (or Sensitivity) model run. This two-step procedure was reported for the sensitivity runs vs.

different values of M or a different REF age. One additional adjustment of the input M at-age vector was necessary to account for the approach that SS advances ages to age 1 when they first reach January 1, irrespective of time of birth. Spanish mackerel undergo spring spawning thus in SS are advanced to age 1 at ~ 0.5 years of life. Thus, the input value of M for 'age 0' fish from the Lorenzen function was reduced by 0.5. The remaining values of M at-age did not require adjusting. Throughout the stock assessment the impact on model results from assumptions on M (at age) were explored by varying the input M value corresponding to a range of point estimates, re-running the SS model to estimate M at-age and subsequently inputting the new sensitivity M at-age vector into SS. Figure 3.1c (this report) presents the SS Model M at-age and the alternative M at-age characterizations used in the stock assessment. Three sensitivity runs around M were considered, two assuming the DW recommended CV around M of 0.54 corresponding to an M value estimate of M of 0.27 y^{-1} and 0.49 y^{-1} (DW Report- Section 2.4) and another using the DW point estimate of M (0.38 y^{-1}) and set the input REF age = 3. Figure 3.1c provides the characterizations of natural mortality explored in the stock assessment.

Growth was modeled internally in SS as both sexes combined with a three parameter von Bertalanffy equation (L_{min}, L_{max}, and K) (Figure 3.1a). In SS, when fish recruit at the real age of 0.0 the body size at length is set equal to the lower edge of the first population bin (L_{bin}; fixed at 2-cm FL for the Spanish mackerel stock assessment). Then, individuals grow linearly until they reach a real age equal to the input value of A_{min} (growth age for L_{min}) and have a size equal to the L_{min}. Then, as fish advance in age, the size at age is then characterized according to a von Bertalanffy growth equation. The value of A_{min} was fixed at 0.5 which is representative of a fractional age of ~ 0.5 representing the midpoint of the spawning period (May-August). The Lmin value was selected for A_{min} based on empirical size at age observations by month, from the age 0 fish provided in the age-length data. L_{max} was specified as equivalent to L_{∞}. Variation in the size-at-age was estimated by SS for the growth model for ages 0.5 and 11. For intermediate ages a linear interpolation of the CV on mean size-at-age is used.

The SS model can also incorporate information on age at length (i.e., similar to age length key) in the model estimation process thus estimating the distribution of age within a length interval (Methot 2011). Methot points out that "this approach avoids redundancy of using fish for both age and size information in the model estimation since the age observation is conditional on length". As described in Section 2.5 the age at length data from the SEDAR 29 DW was stratified into age (from age 0 to age 11) by 2-cm length bins ranging from 4 to 99 cm, with age 11 representing a plus group.

Size based selectivity patterns were specified for each fishery and survey in SS. Double normal functions were used to model selectivity, because of the flexibility this functional form provides. The double normal can model dome-shaped selectivity, but it also can model asymptotic selectivity by holding several of the function's parameters at fixed values. Four selectivity patterns were defined in SS corresponding to each fishery and survey: 1) commercial gillnet (COM_GN), 1) commercial line gear (COM_RR), 3) recreational combined modes (private, charter, headboat-REC), and the 4) SEAMAP trawl survey (SEAMAP). The SEDAR 28 AP decided to constrain the commercial line gear fishery and the recreational fishery selectivity patterns to be asymptotic, because there was no strong evidence of dome-shaped selectivity and the fit of the model was not substantially improved when specifying a dome selectivity function.

The MRFSS abundance survey mirrored the recreational combined fisheries (REC) selectivity. The commercial line gear abundance index (from the FWC Vertical line gear fishery) mirrored the commercial line gear fleet (COM_RR).

Retention curves were used to account for discards in the size composition and to adjust for impacts of fishery minimum size regulations implanted in 1993 (12 inch fork length). The retention function was specified as a two parameter logistic function. SS can incorporate time varying parameter estimation thus two time blocks were assumed in modeling the retention function for the COM_RR and Rec fleets corresponding to the size limit, 1992 and earlier and 1993 – 2011.

For the assessment, the SS model configuration assumed a single Beverton-Holt stock-recruitment function and two of the three stock recruitment ("S/R") parameters were estimated: log of unfished equilibrium recruitment (R0) and steepness (h). A third parameter representing the standard deviation in recruitment (*sigmaR*) was input as a fixed value of 0.7.

Stock synthesis is hard-coded to model recruits as age 0 fish. Annual deviations from the stock-recruit function were estimated in SS as a vector of deviations forced to sum to zero. Stock synthesis assumes a lognormal error structure for recruitment. Therefore, expected recruitments were bias adjusted. Methot (2010) recommends that the full bias adjustment only be applied to data-rich years in the assessment therefore the estimates are very precise (σ^2=0). Therefore, no bias adjustment was applied prior to 1985, when only catch data are available. Prior to 1984, recruitment is estimated as a function of spawning stock biomass based on the stock-recruit parameters. This is done so SS will apply the full bias-correction only to those recruitment deviations that have enough data to inform the model about the full range of recruitment variability (Method 2011). Full bias adjustment was used from 1985 to 2010 when length and age composition data are available. Bias adjustment was phased in from no bias adjustment prior to 1972 to full bias adjustment in 1984 linearly. Bias adjustment was phased out over the last two years (2010-2011), decreasing from full bias adjustment to no bias adjustment, because the age composition data contains little information on recruitments for those years. The years selected for full bias adjustment were estimated following the methods of Methot and Taylor (2011.

During the stock assessment, an update to the SS model was provided that allowed the shrimp fishery discards to be modeled as a bycatch fishery. As mentioned above in the Section 2.3.2 and 2.6, previously, discards were incorporated into the Spanish mackerel stock assessments as a component of the landings and assumed to be precisely estimated. For this stock assessment as recommended by the SEDAR 28 AP, the magnitude of discards was assumed proportional to shrimp fishing effort within 10 fathoms. SS assumes the level of annual fishing mortality and thus Spanish mackerel bycatch is directly proportional to the annual shrimp effort index. The annual median estimates of Spanish mackerel shrimp bycatch for 1972 -2011 were input as a super year and the scaled effort for 1945-2011 time series was input into SS to obtain estimates of total annual fishing mortality by the shrimp fleet and predicted total Spanish mackerel bycatch. In the estimation, a catchability parameter (Q) is used to scale the effort series to the estimate of bycatch. In SS, since the shrimp bycatch was input as the median estimate across the entire time series (i.e., as a super year), the median estimate of bycatch is assumed as the observed value over the time period, 1945-2011. Estimated Spanish mackerel bycatch is then derived from the annual levels of shrimp effort.

For the initial model runs all data inputs (abundance indices, length compositions, and age compositions) were equally weighted and no prior density was assumed for estimated parameters

The SS input files are presented in Appendices C-F.

3.1.4 Parameters Estimated

Table 3.1 provides a listing of all parameters estimated in SS. Results included are predicted parameter values and their associated standard errors from SS, initial parameter values, minimum and maximum values a parameter could take, and prior densities assigned to parameters. Table 3.1 presents the model estimates for Final Model recommended by the SEDAR 28 AP for Gulf Spanish mackerel.

As mentioned in Section 3.1.1.3, growth was estimated internally in SS (using conditional age length data provided by the SEDAR 28 DW). Initial parameter estimates for the growth relationship (i.e., for the Lmin, Lmax, Amin parameters) were guided by external growth model fits using the empirical age length data developed by the DW. Figure 3.1b presents the estimated growth curve from the SS model used in the stock assessment.

Initial starting guesses for the size selectivity patterns were first specified by fitting the observed length compositions and visually inspecting the resulting fits characterizations of either the asymptotic (COM_RR or REC) or dome shaped (COM_GN, SEAMAP). For the asymptotic function, two of the retention parameters were fixed at the input values to force an asymptotic function. SS allows use of time varying selectivity to incorporate effects of size limits (implemented in1993) on selectivity. Time blocks were specified for the two fisheries for which discards were reported from: commercial line gears (COM_RR) and the recreational all modes (REC) as: 1) a pre- 1993 period and 2) a 1993-2011 period corresponding to the time of implementation of a 12 inch fork length size limit. This provided for the possibility of estimation of both retention and selectivity functions for the two different time blocks for these fisheries. Attempts to estimate both retention and selectivity functions for these two fisheries (COM_RR and REC) were not satisfactory and produced unreasonable functions. Length composition data were only available for the retained catch therefore efforts were focused on estimating the retention function as recommended by the SS model developer (R. Methot, personal communication). For the REC fishery it was possible to estimate both the inflection and shape (slope) retention- function parameters for both time blocks. For the COM_RR fishery it was necessary to fix the slope parameter (P2) for period 1, prior to 1993. Selectivity for the remaining fleets, COM_GN and the SEAMAP survey were characterized estimated using the double normal. Efforts were initially made to model the COM_GN selectivity as a single time period however, lack of fit was particularly high in later years, after 2006. Follow up research by the lead analyst to federal and state port samplers confirmed that around 2006, sampling intensity increased significantly in Alabama and in particular observations of fish less than 30 cm fork length, occurred in the time series after that time. Fish less than 30 cm fork length were not previously recorded observed in the gillnet samples. Addition of a selectivity time block for the COM_GN fleet resulted in much improved fits to the COM_GN length composition data.

As mentioned in the model configuration section (Virgin recruitment (R0) and steepness parameters were estimated in SS. Results from attempting to estimate steepness produced a low value (0.52) which suggested very low productivity for the stock. The AP panel had considerable questions on the ability of the model to estimate steepness so the analyst conducted profiling of the steepness and virgin recruitment parameters. The standard deviation parameter (sigmaR) for recruitment was fixed at the initial input value (0.7) and set based on review from other SS examinations. A profile of sigmaR was also carried out and did not indicate disparity in the initial input value choice of 0.7 so this parameter remained fixed throughout the stock assessment at 0.7.

Additional fishing mortality rates used for recommending future harvest levels are estimated conditionally on other outputs from the model. For example, the values corresponding to the *F30%SPR*, and *FMSY* harvest rates are found by satisfying the constraint that given age specific population parameters (e.g., selectivity, maturity, mortality, weight-at-age), unique values exist that correspond to these fishing mortality rates.

In all, 376 parameters were included in the SS model: five (5) to model growth, 26 to characterize the selectivity and/or retention functions, one (1) parameter to estimate the shrimp bycatch fishery catchability coefficient, 28 annual recruitment deviations, and 376 annual fleet specific fishing mortality parameters.

3.1.5 Model Convergence

Uncertainty in the Gulf of Mexico Spanish mackerel stock assessment was examined using multiple approaches.

Uncertainty in model parameter estimation performance was also addressed through an internal SS parameter "jitter" option which randomly changes the input parameter by a specified value. A jitter value of 10% was input for this assessment and 100 runs were made. SS carries out the jitter exercise by randomly changing the initial starting values of the parameters by 10% thus altering the starting estimates across many runs. The purpose in changing the parameter starting estimates across numerous models is to explore the model's ability to reach a global solution (i.e., minima) from starting at different places along the likelihood space.

3.1.6 Uncertainty and Measures of Precision

Uncertainty in parameter estimates was quantified by computing asymptotic standard errors for each parameter (Table 3.1). Asymptotic standard errors are calculated by inverting the Hessian matrix (i.e., the matrix of second derivatives) after the model fitting process. Asymptotic standard errors provide a minimum estimate of uncertainty in parameter values.

The "Fishery Simulation" Graphics User Interface (GUI) tool developed by Lee et al. (2012, https://fisherysimulation.codeplex.com/) was the approach used to characterize the uncertainty in final model estimates and projections of future caches for a variety of alternative scenarios recommended by the Assessment Panel (AP). This tool is based on the bootstrap analyses used the integrated fishery stock assessment model, Stock Synthesis (SS, Methot R.D. 2011). General application to other assessment model or other field has not been explored. Applications to the fishery using SS can be referred (Lee *et al.* 2011; Piner et al. 2011; Lee *et al.* 2012). Lee et al. (2012) present detailed steps in the GUI tool. Briefly, within the GUI tool, SS is fit to the model of choice and N new data sets (bootstrap sets) are created based on the original model (all parameters either fixed or estimated the same as the original model) and parametric sampling of the errors (Lee et al. 2012). Using the GUI tool then, the resulting N bootstrap files can be summarized to provide information on uncertainty in the model estimates and other additional output (derived estimates). Lee et al. (2012) discuss the utility of using the Fishery Simulation tool to provide another way to construct a distribution of likely parameter values for a complex fisheries population model.

In the Spanish mackerel assessment, the GUI tool was used to evaluate the uncertainty in model parameters (e.g., growth parameters, selectivity parameters, recruitment deviations) and other key quantities of interest (e.g., total virgin biomass, spawning biomass (SSB), current SSB, etc..).

3.1.7 Sensitivity Analysis

Uncertainty in data inputs and model configuration assumptions was examined through various sensitivity analyses. In all, results of 12 separate SS3 model runs are included in this report describing the initial SS model configuration, sensitivity analyses, data exclusions, and reweighting runs conducted to evaluate a) assumptions on steepness, b) assumptions of input M at-age, c) impact of the elimination of abundance indices on model estimates, and d) consideration of the assumption on release mortality of discards from the directed fisheries (COM_RR and REC). Over the course of the stock assessment, many additional sensitivity analyses were explored. It is the main intent to present here those runs that best explored the sensitivity of key model parameters and/or demonstrated discord (or agreement) in model estimates between runs. Table 3.2 describes the SS Model runs made in the stock assessment and all the alternative (sensitivity, reweighting, retrospective) analyses made for the stock assessment.

Two sensitivity analyses on M were made by varying the level of M from that of the initial model trial (Run 1) configuration. As described earlier, the initial model run M at-age vector was calculated assuming the Hoenig point estimate of M = 0.38y^{-1} for the Lorenzen function. Two additional M sensitivities ((M = 0.27 y^{-1} and 0.49 y^{-1}) were considered corresponding to a CV of 54% on the input base M value (0.38y^{-1}). In addition, an additional sensitivity analysis on M was specified by varying the reference age (REF age) for the Lorenzen function from ‘REF age = 4” to “REF age = 3”.

The assumption of the stock recruitment relationship used in the SS model was considered. First the Beverton – Holt steepness parameter was profiled by varying the input value from 0.4 to 1.0 and incrementing by 0.01. Second, three sensitivity runs were made by fixing the steepness parameter: varying the value fixed from 0.7 to 0.9 (by 0.1).

In addition to evaluating impacts on the SS Model from assumptions on steepness and M, the assumptions of data inputs were considered through 1) varying the discard level release mortality and 2) through removing complete suites of data (e.g., abundance indices). The impacts on model estimates from the inclusion of individual data components were addressed through sequentially dropping individual indices (i.e., MRFSS, FWC Fish Ticket, and SEAMAP Survey) from the initial base model run.

A sensitivity analysis was also carried out to determine the influence of 1) the length-frequency and age sample size and b) the impact of variance reweighting of the abundance indices on model results. McAllister and Ianelli (1997) used an analytical method to determine the effective sample size for catch at- age data based on the observed and predicted proportional catch at age. They used a method of iteratively modifying the sample size based on this calculation until the change in sample size was small. In this assessment, the internal procedure within SS was used to determine new sample sizes for each set (fishery and time period) of length-frequency data. The original sample size for the surface gears used in the base case was based on number of observations (lengths or ages) and was capped at 100. SS estimates the effective sample size (N), the model is rerun with variance adjustment factor equal to effective sample size /input N. This is repeated until the effective sample size and input N are equal. Index reweighting was also examined using the internal reweighting option in SS. Survey (index) reweighting is performed by adding the variance adjustment to the survey standard deviation and the model re-run until the model variance and the input standard deviation + the variance adjustment factor are equal. For this sensitivity run, the model assumed the configuration of the initial model run (Run 1) and also estimated steepness.

A complete characterization of all the sensitivity and alternative models explored for the stock assessment were as below and further detailed in Table 3.2:

Run 1: Initial Model
Estimated growth, M=0.38y^{-1} input into Lorenzen and scaled to Reference Age 4, estimate steepness, estimate virgin stock (R0), estimate recruitment deviations (1985-2010), input discards as discards (thousands of fish 1 super period (shrimp bycatch fishery), fractions directed fishery (1 super period commercial line gears (COM_RR), 3 super periods (recreational (REC)), 2 time varying selectivity/retention blocks commercial line gear (COM_RR) and recreational all modes (REC): pre-1993, 1993-2011, 2 time varying selectivity blocks commercial gillnet fleet (COM_GN) pre-2006, 2006-2011.

Run 2: Run 1 Configuration, M = 0.38 y^{-1}, except the Beverton and Holt steepness parameter fixed at 0. 9.

Run 3: Run 1 Configuration, M = 0.38 y^{-1}, except the Beverton and Holt steepness parameter fixed at 0.8.

Run 4: Run 1 Configuration, M = 0.38 y^{-1}, except the Beverton and Holt steepness parameter fixed at 0.7.

Run 5: Run 3 Model Configuration (Beverton and Holt steepness parameter steepness = 0.8) and M SENS HI (M = 0.49 y^{-1}) sensitivity with M value input into Lorenzen function.

Run 6: Run 3 Model Configuration (Beverton and Holt steepness parameter = 0.8) and M SENS LO (M = 0.27 y^{-1}) sensitivity with M value input into Lorenzen function.

Run 7: Run 3 Model Configuration (Beverton and Holt steepness parameter = 0.8) and M = 0.38 y^{-1}), Lorenzen scaling "REF Age = 3".

Run 8: Run 3 Model Configuration (Beverton and Holt steepness parameter = 0.8) and M = 0.38y^{-1}, discard release mortality varied from 10% to 20% for COM_RR fleet discards and from 20% to 40% for REC fleet discards)

Run 9: Run 3 Model Configuration (Beverton and Holt steepness parameter = 0.8), and M = 0.38y^{-1}, exclusion of MRFSS index.

Run 10: Run 3 Model Configuration (Beverton and Holt steepness parameter steepness = 0.8) and M = 0.38 y^{-1}, exclusion of FWC Trip Ticket index.

Run 11: Run 3 Model Configuration (Beverton and Holt steepness parameter = 0.8) and M = 0.38y^{-1}, exclusion of SEAMAP Survey Index.

Run 12: Run 1 configuration (Initial Model run), and M (0.38 y^{-1}), with SS reweighting of abundance indices, age composition, and length composition components. The Beverton and Holt steepness parameter estimated in this run as in Run 1.

Other alternative models were also explored in this stock assessment. These considered the impacts on model estimates from removing complete data years on estimates of terminal year metrics:

Run 13: Run 3 Model Configuration (Steepness = 0.8, M =0.38y^{-1}), "RETROSPECTIVE 2010", assumes 2011 data excluded.

Run 14: Run 3 Model Configuration (Steepness = 0.8, M =0.38y^{-1}), "RETROSPECIVE 2009", assumes 2010-2011 data excluded.

Run 15: Run 3 Model Configuration (Steepness = 0.8, M =0.38y^{-1}), "RETROSPECTIVE 2008", assumes 2009-2011 data excluded.

Run 16: Run 3 Model Configuration (Steepness = 0.8, M =0.38y^{-1}), "RETROSPECTIVE 2008", assumes 2009-2011 data excluded.

Run 17: Run 3 Model Configuration (Steepness = 0.8, M =0.38y^{-1}), "RETROSPECTIVE 2006", 2007-2011 data excluded.

3.1.8 Retrospective Analysis

Model performance was also addressed using retrospective analysis of the model configuration recommended by the SEDAR 8 AP for the Run 3 configuration. As described above, Run 3 was the same as the Run 1 model except that the Beverton and Holt steepness parameter was fixed at 0.8. The AP felt that this value of steepness was more reasonable for this species that that estimated by model (0.52). In all five retrospective analyses of the base model were made. For these runs, the model was refit while sequentially dropping the last five years of data (i.e., 2011, 2010-2011, 2009-2011, 2008-2011, 2007-2011, and 2006-2010). Retrospective analysis is used to look for systematic bias in estimates of key model output quantities over time.

3.1.9 Benchmark/Reference points methods

Various stock status benchmarks and reference points are calculated in SS. The user can select reference points based on maximum sustainable yield (MSY), spawning potential ratio (SPR), and spawning stock biomass (SSB). Stock Synthesis calculates SPR as the equilibrium spawning biomass per recruit that would result from a given year's pattern and the levels of F's and selectivity's. For SPR-based reference points, SS searches for an F that will produce the specified level of spawning biomass per recruit relative to the un-fished value. For spawning biomass-based reference points, SS searches for an F that produces the specified level of spawning biomass relative to the un-fished value. Both MSY and spawning biomass-based reference points are dependent on the stock-recruit relationship.

For the Gulf of Mexico Spanish mackerel benchmarks and reference point calculations, SPR30% was the reference. MSST is defined as (1-M) * SSB_MSY (F30% SPR) where the M values used was the point estimate of M for fully recruited ages, resulting from the Hoenig maximum age natural mortality estimator recommended by the SEDAR 28 Data Workshop (i.e., $M = 0.38y^{-1}$). MFMT is defined as F30%SPR. Overfished is defined as $SSB_{Current}$ / SSB@MSST and Overfishing is defined as $F_{Current}$ > MFMT (or FMSY, where the proxy for FMSY for this assessment is F30%SPR. For purposes of calculating FC_{urrent}, "current time period" is defined as the geometric mean of Fs for 2009-2011. $SSB_{Current}$ is the model estimated SSB for calendar year 2011. Recruitment deviations are not calculated for the forecast years; recruitment is derived from the model estimated stock-recruitment relationship.

Because of the problems associated with estimating the steepness parameter for the Gulf of Mexico Spanish mackerel stock assessment (see 3.1.1.5), benchmarks based on two levels of steepness (0.8 and 0.9) were developed assuming the M at-age from the Lorenzen function for the Hoenig point estimate ($M = 0.38y^{-1}$). In addition, benchmarks were also computed for the alternative level of M_Hi at-age ($M = 0.49y^{-1}$). One alternative set of projections was made for the M HI scenario, $M = 0.49\ y^{-1}$.

3.1.10 Projection Methods

A standard set of projections is required for each stock managed under Tiers 1, 2, or 3, of Gulf of Mexico Fishery Management Council Coastal Migratory Fishery Management Plan Amendment 18 (http://www.gulfcouncil.org/docs/amendments/Mackerel%20Amendment%2018%20Amendment%20Guide%20Booklet%2011-2-11.pdf). This set of projections encompasses four harvest scenarios designed to satisfy the requirements of Amendment 18, the National Environmental

Policy Act, and the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA). These guidelines were used to set ABC for Spanish mackerel for Amendment 18. The standard projection model requires knowledge of future uncertainty in FMSY or the proxy for FMSY.

For this stock assessment, deterministic projections were carried out to evaluate stock status for a period of 20 years beginning in 2013 using the "forecast" option in SS. The terminal year of data for the stock assessment was 2011 therefore in order to initialize the projection at 2013; the 2012 landings were characterized as the landings from the most recent three years (2009-2011). SS estimates the fishing mortality rate to achieve the input 2012 catch value and estimates age 0 recruits from the estimated-spawner recruit model and the 2012 estimate of SSB.

Since the SEDAR 28 AP had concerns regarding what was the logical value to assume for the stock-recruit relationship parameter and also the level of M, this stock assessment conducted projections at two levels of these parameters. Deterministic projections were made for two levels of steepness (0.8 and 0.9) assuming the point estimate of M recommended by the DW for to natural mortality assumption (Base Lorenzen Input ($M = 0.38y^{-1)}$. A second set of projections were made for each level of steepness (0.8, 0.9) for each level of M ($0.38y^{-1}$, $0.49y^{-1}$). The evaluations were made according to these MSRA criteria:

A) If stock is overfished:
  F=0, FCurrent, FMSY, FOY
  F=FRebuild (max that permits rebuild in allowed time)

B) If stock is undergoing overfishing:
  F= FCurrent, FMSY, FOY

C) If stock is neither overfished nor undergoing overfishing:
  F= FCurrent, FMSY, FOY

Uncertainty in the projections was also evaluated using the "Fishery Simulation" Graphics User Interface (GUI)" tool discussed in Section 3.1.1.5 (Uncertainty and Model Precision). Through the GUI tool, multiple sets of the data bootstrapped from the Base Model (Run 1) were developed and the SS model fitted to each simulated data set independently. The procedure was to identical to that used to characterize the base model uncertainty with the only difference being that the run was extended to include the period of projections. The stochastic projections were made for each of two steepness levels (0.8, 0.9) assuming the input point estimate of natural mortality ($M=0.^{38y-1).}$

3.2 Model Results

3.2.1 Measures of overall model fit

3.2.1.1 Landings

Stock Synthesis effectively treats the landings data as being known without error. Therefore, the landings are fit precisely.

3.2.1.2 Indices

In general SS fit the three indices of abundance only fairly well (Figure 3.2). Observed CPUE from the standardized abundance indices varied without trend over the time series for each abundance survey. The only exception was a slight increase in observed abundance in recent years (2003 - 2011) for the FWC Vertical Line Index. There was some apparent trending in the predicted index fits for all three surveys (MRFSS, COM_FWC_VERT_LINE, and SEAMAP_Survey). All of the abundance indices exhibited large variability and in general the predicted fits indicated relatively flat unchanging trends over each of their respective abundance time series. The large variances associated with the directed fishery indices could have contributed to the overall poor fits. The COM_FWC_ VERT_Line was the only abundance index that showed any departure from the average trend, tending to predict a slight increase in abundance after 2003. The observed shrimp effort index showed a linear increase in effort from the beginning of the time series (1946) through around the mid 1980's, a moderate decline through 2000, followed by a sharp decline in shrimp effort between 2000 and the current period. SS fit the shrimp effort index reasonably well (Figure 3.2).

3.2.1.3 Discards

SS fit the super period discards (fractions for the directed fishery and numbers for the bycatch fishery) reasonably well (Figure 3.3 a - c). As noted above (Section 2.3) for this assessment discards were incorporated into the assessment as super periods discards. This is a departure from previous stock evaluations (VPA, SS, or stock production models (e.g., ASPIC)) for this stock as to the approach in which discards have been analytically incorporated into the population model, for the shrimp bycatch fishery and also the directed fishery. In this evaluation, discards were treated as discards and input with a small CV, thus allowing some variability around the estimate to be incorporated into the model estimation. In addition, it was thought that the actual trend of the discards was more representative of the level of discards than the actual annual estimates thus "super periods" were used to quantify (characterize) the discard removal levels over the time series, or as with the REC discards across each of the three super periods. Section 2.3 reviewed discard data inputs and the specific time periods for each fishery (bycatch, commercial line gear (COM_RR) and recreational all modes combined (REC). Figure 3.3 a, b presents SS predicted discard fraction for the directed fisheries. Figure 3.3c provides the SS predicted discards (thousands of fish) for the shrimp bycatch fishery.

The observed annual discards showed large variability for both the directed fisheries (fractions) and the shrimp bycatch fishery (numbers of fish). Estimates of recreational discards and their associated CV values are presented in the SEDAR 28 DW (Table 4.11.7). The SEDAR 28 DW noted that "Commercial discards and shrimp bycatch are based on estimated encounter rates and effort. In years when multi-year averages are used to compute encounter rates, these estimates do not account for year-specific age structure in the Spanish mackerel stock". In addition, the SEDAR 28 DW noted that other factors contributing to uncertainty in commercial discards were from low coverage of the logbook survey (SEDAR 28 DW Table 3.11). Shrimp fishery discards in particular had low encounter rates of Spanish mackerel thus estimation is hampered by dealing with large number of zero observations. The SEDAR 28 DW noted that although the annual catch of Spanish mackerel by the shrimp fishery was very variable the mean bycatch could reflect the overall scale of bycatch across the time series. These concerns add additional support to the use of super periods in the SS model to characterize the magnitude of removals.

3.2.1.4 Length composition

SS fit the individual yearly fishery length compositions reasonably well (Figures 3.4 - 3.11). In general length composition sample sizes were lowest for the commercial line gears (COM_RR) and largest for recreational all modes fleet (REC) (Appendix A and Figures 3.4-3.12). There were no striking issues with patterns in residuals.

Initially, for the COM_GN fleet, when only a single time block was specified, a discernible lack of fit was present in the later years (2006+) length compositions. Adding a time block for 2006-2011 cleared up this issue. As noted earlier, 2006 corresponded to a change in the intensity of sampling of the gillnet fishery off Alabama and when a noticeable quantity of smaller size Spanish mackerel were observed in the samples. The poorest fits for the COM_GM length composition correspond to years when the sampling intensity was very low (< n= 75 fish per year sampled). Overall, the fits to the fleet year/fishery strata represented by larger sample sizes, such as characterized by the recreational all modes (REC) compositions in most years, were noticeably superior to other fleet-year strata.

Fits for the commercial line gear (COM_RR) were in general represented by very low sample sizes and poorer length composition fits than for the other fleets and the survey length composition fits. This was not surprising given the low sample sizes in general with some years not represented at all in the length composition. Length composition samples from the COM_RR fleet do not appear before 1985. SS underestimated fish greater than 50cm in several years, since 2008. SS underestimated fish between 30-40 cm in 2008. Spanish mackerel in general are not actively targeted by the Gulf of Mexico commercial line gear fishery so the absence of samples over several sequential years (1986-1990 and 1996-2002) and very low sample sizes for many years is not particularly surprising.

SS fits to the REC length composition was overall quite good with little to no indication of fitting problems. There was a slight pattern in residuals for small fish, about the time of the implementation of the size limit (1993) and for a few subsequent years, indicating that some fish below the minimum size were still being retained through about 1997. The 1993 – 1998 length composition contained a number of fish above 80cm; these samples are in question as they appear much larger than previously reported for Spanish mackerel harvested by the recreational sector. Overall though, SS fit the recreational fleet length composition reasonably well.

SS fit the SEAMAP length composition reasonably well; however there was some tendency of the model to always underestimate the proportion of fish larger than 40 cm.

3.2.1.5 Conditional age-length composition

The model fits to the conditional age-length age composition samples are presented in Figures 3.12 - 3.23. The conditional age composition fits represent the estimates of age composition within length interval (bin) and in many cases the number of age observations within a bin interval was very low adding difficulty to the fitting process. Low sample sizes and high variability in observed size at age added to the fitting complexity.

Figure 3.1b and c presents the SS estimated von Bertalanffy growth equation, the growth curve estimated by the DW and mean size at age for the observed otolith age observations used in developing the conditional age-length compositions.

3.2.2 Parameter estimates & associated measures of uncertainty

Table 3.1 provides a listing of all parameters estimated in SS for the model recommended by the panel for final projections and status determinations; this was the model Run 3 configuration which was identical to Run 1 except steepness parameter was set at 0.8. This recommendation was based on extensive discussion and review of all of the sensitivity runs, the retrospective analyses, the results of profiling the steepness parameter, and inspection of the uncertainty results from the bootstrap analyses. These results will be detailed in the text below. Table 3.1 includes predicted parameter values and their associated standard errors from SS, initial parameter values, minimum and maximum values a parameter could take, and prior densities assigned to parameters. Parameters designated as fixed were held at their initial values.

Asymptotic standard errors are obtained in SS by inverting the Hessian matrix that is the matrix of second derivatives, after the final model fitting process. The standard errors of most of the parameters are low. The main exception is for the standard errors for some of the selectivity parameters (COM_GN, Shrimp Bycatch P2) (Table 3.1).

Table 3.3 presents summary means and asymptotic standard errors for the parameters estimated for N = 1,000 bootstrap runs on the Run 3 model which assumed steepness = 0.8 and the base M value ($0.38y^{-1}$). As mentioned in Section 3.1.6, the Fishery Simulation" Graphics User Interface (GUI) tool developed by Lee et al. (2012,) was used to carry out bootstrapping to examine model uncertainty. This procedure applies the SS bootstrap option to generate N=1,000 replicate data sets from the 'original input model (Run 3). The bootstrap files are produced by using the parameter error inputs and sample sizes from the original run (Run 3); after generating the 1,000 bootstrap files, the GUI tool then runs the SS model separately on each bootstrap file. In general the results were very similar to that of the

Model convergence was examined by the SS jitter option. Summary results are presented in Table 3.4 and Figures 3.24 - 3.26 for the 100 jitter runs that were run against the SS model configuration for Run 3. Of the 100 runs, ninety-six model runs resulted in likelihood values that were almost identical to that of the Run 3 model value (4,226.76) (Figure 3.24). Results of the model runs that converged on nearly identical solutions predict very similar levels of SSB_REF and SPR in 2011 and Fcurrent and F_REF (Figure 3.27).

3.2.3 Fishery Selectivity

Predicted size selectivity and retention patterns are presented in Figures 3.27 – Figures 3.30 for the Run 3 model configuration (steepness = 0.8 and M = $0.38y^{-1}$).. The FWC Fish Ticket abundance index was assumed to have the same pattern as the COM_RR fleet and the SEAMAP survey pattern was mirrored to the shrimp bycatch fishery.

Two retention functions (logistic in form) were modeled for the COM_RR and the REC fisheries to account for the minimum size limit that was implemented in 1993. The selectivity function was very steep for both COM_RR and the REC fishery. There were no length composition samples to characterize the discards length composition selectivity so more focus was placed on modeling the retention function. It was difficult to model the COM_RR fleet selectivity and retention function at the same time. Other contributing factors included very low sample sizes, truncated distributions, and the appearance of many large fish in some years. When the selectivity function was modeled, SS attempted to push the peak of the curve to very large sizes, and hitting the upper bound of this parameter (99 cm FL). When only the retention function was modeled and the peak for the selectivity function was fixed (at 55cm), improved fits resulted. Insufficient samples lead to overall lack of fit for this fleet selectivity/retention pattern. Several attempts were made using a range of peak (50, 55, 60, and 65 cm FL) values for the COM_RR peak selectivity parameter before the AP decided on 55cm.

The standard errors for some of the COM_GN selectivity parameters were very high and indicate that this selectivity pattern was not well estimated. Initial work to model the gillnet fishery selectivity show lack of fit particularly with estimating selectivity of some small fish that appeared after 2006. An addition of a separate time block (for 2006 -2011) resulted in much improved fits.

The selectivity/retention patterns for the REC fleet were reasonably well behaved and overall produced superior length composition fits.. The REC fleet in general caught smaller fish than the COM_RR fleet but small fish also appeared in the COM_GN fleet during many years. The selectivity pattern was steeper for the REC fleet than the COM_RR. SS predicted that some fish above the size limit would be released however the proportion was fairly low. This is reasonable given the bag limit regulation for the Spanish mackerel. The fishery abundance indices for the MRFSS were assumed to have the same selectivity pattern as the REC fleet pattern

Size selectivity for the shrimp fishery was modeled using a 6 parameter double-normal function and two of the parameters were fixed (Table 3.1). The length composition from the SEAMAP survey shows that fish from about 4 cm to 54 cm were captured by the survey.

3.2.4 Recruitment

The SS model had difficulty estimating the steepness parameter for the Beverton – Holt stock recruitment (S/R) relationship that was assumed for the Spanish mackerel stock assessment. Profiling of the steepness parameter is presented in Figure 3.31 for the Run 1 model configuration ($M = 0.38y^{-1}$). Steepness was estimated to be 0.52 for the initial model (Run 1) and this value was considered quite low for this species. SS was able to estimate the S/R parameter, R0 (log of virgin recruitment level) without difficulty for the Run 1 model which assumed $M = 0.38y^{-1}$ and also estimated steepness (Figure 3.32). SS estimated ln(R0) to be 11.33 from the Run 1 model. Also SS estimated sigmaR, the standard error of log recruitment without difficult (Figure 3.33). After many different runs examining the model's ability to estimate steepness over varying assumptions of natural mortality and also examining the bootstrap results, the AP recommended to use steepness = 0.8 (Run 3) for subsequent summaries of key parameters and in projections and status determinations.

Figure 3.34 presents summary results for 496 bootstrap runs for the Spanish mackerel SS Run 1 model in which steepness parameter was estimated (assuming $M = 0.38y^{-1}$). These results show the difficulty the model had with estimation of this parameter. The bootstrap summary plot shows that there are some runs which produced very low estimates of steepness as low as 0.36 and also the estimate of steepness approached the top bound (1.0) in 37% of the bootstrap runs. Steepness was estimated across the 500 bootstraps at 0.70 and the model estimate was 0.52. The distribution of virgin recruitment level (R_VIRGIN in the Figure 3.34 plot) was quite broad indicating large uncertainty in the estimate of virgin recruitment for the Run 1 model that estimated steepness. Also, the distribution of virgin Biomass across the 500 bootstraps was broad and showed a bimodal distribution. The SEDAR 29 AP felt that the low values of steepness were not logical for this species and recommended using a steepness value of 0.8 for status determinations and projections.

Figure 3.35 presents summary results for 1,000 bootstrap runs for steepness =0.8 (assuming M = $0.38y^{-1}$). Fourteen runs reached solutions which resulted in large convergence values and illogical estimates of virgin biomass (Figure 3.35). The summarized bootstrap runs for steepness = 0.8 produce much more reasonable distributions of virgin biomass and virgin recruitment and the bimodality in virgin biomass is not present for the steepness = 0.8 run (Run 3 model).

The spawner-recruit relationship as estimated from SS for the Run 3 model configuration (assuming steepness = 0.8 and M =$0.38y^{-1}$) is shown in Figure 3.36. Estimated recruit deviations varied without trend over the time series except during recent years, since 2008 (Figure 3.37). The recent years, since 2008 contain less information from which to estimate the level of recruitment as not all cohorts have fully contributed to the fishery

Predicted abundance at age is presented in Figure 3.38 for the Run 3 model configuration (M = $0.38y^{-1}$, steepness=0.8). Predicted age-0 recruits are also presented in Table 3.5 and Figure 3.39 for the Run 3 model configuration. Recent years (2005-2010) annual recruitments have been lower than the mean recruitment over the period 1985-2010 and estimated deviations of annual recruitment are much larger in the most recent years (2009-2010) which is not surprising since the more recent years are not as data rich as not all cohorts have contributed fully at this point in time. In general however, the predicted trend for recruitment of Spanish mackerel is fairly flat over the time series. Figure 3.37 presented annual recruitment deviations.

Figure 3.40 presents SS estimated YPR and SPR for Gulf of Mexico Spanish mackerel as estimated for the Run 1 model configuration (with steepness =0.8 and M = $0.38y^{-1}$).

3.2.5 Stock Biomass

Predicted total biomass and spawning biomass are presented in Table 3.5 and Figure 3. 41 for the Run 3 model (M = $0.38y^{-1}$, steepness=0.8). Total biomass and spawning biomass show steady trends from the late 1880's through the early 1940's. Significant declines in biomass are evident beginning in the late 1940's and continuing through the late 1980's. Increases in total and spawning stock biomass are predicted by SS beginning in the late 1990s.

Predicted abundance at age was presented in Figure 3.38 for the Run 3 model (M = $0.38y^{-1}$, steepness=0.8). SS predicted the mean age of Gulf of Mexico Spanish mackerel to be ~ 1.9 in the unfished state in 1886. The population mean age remained fairly stable until the early 1950's varying from ~ 1.7-1.9. After the early 1950's, predicted mean age shows a significant decline through about 1998 with several periods of oscillation beginning around mid-1970. The decline in mean age beginning in the 1950's corresponds to periods of increasing landings by the commercial gill net fleet. Also, from the mid 1970's through about 1998, predicted mean age shows large up and down swings; this period corresponds to increasing shrimp effort and increasing landings from the gillnet and recreational fisheries. SS predicted an increase in mean age between the late 1980's through 1994 followed by a sharp decline through 1998. The increase in mean age in the late 1980's corresponds to implementation of fishery regulations for Gulf Spanish mackerel (e.g., implementation of Fishery Management Plan in 1987 and quotas, and implementation of size limits. The increase in mean age in the late 1990's corresponds to the enactment of a gill net gear ban in Florida territorial waters (1995). SS predicted mean age from 1886 to 2011 to be 1.6 and mean age in 2011 to be 1.34.

3.2.6 Fishing Mortality

Exploitation rate (catch in weight including discards / total biomass) was used as the proxy for annual fishing mortality rate in this assessment. Predicted annual fishing mortality rates are presented in Table 3.6 and Figure 3.42 (top panel) for the SS Run 3 model configuration (steepness = 0.8 and M =$0.38y^{-1}$). Predicted annual fishing mortality estimates (all fleets combined) shows flat and low levels of F through the late 1940s. Between the early 1950's and continuing through the mid 1980's, steady increasing trend in F are predicted. Since the mid 1980's estimated total annual F's have continued to decline.

The trend in annual instantaneous fishing mortality (F) by fleet is variable particularly since the years of implementation of fishery regulations (1987) (Table 3.6, Figure 3.42, lower panel). In particular, annual F's for the COM_GN fleet declined significantly since the early 1990s and have been stable since about 1997. Estimated annual Fs from the shrimp fleet increased steadily through 1990 however show significant declines since around 1999; the trend in estimated F for shrimp bycatch has been stable since 2005. Annual estimated Fs for the recreational all modes fleet (combined private, charter, headboat, shore= REC) show continued increases until 1986 and predicted trends in REC F since have been variable. Estimated REC F decline sharply in 1986 through 1989, increased through 2001, and declined again between 2001 and 2004, and REC Fs have been stable since 2004. In general annual Fs for the commercial line gear fishery (COM_RR fleet) have remained stable and low throughout the time series, with one exception of an increasing trend from 1971-1978.

The more recent years of declines in estimated F since the mid to late 1980's correspond to various management actions associated with the Gulf of Mexico Spanish mackerel fisheries including: a) implementation of the Fishery Management Plan for coastal Migratory Pelagic Resources of the Gulf of Mexico (1983) under which Spanish mackerel were managed, b) implementation of quotas in 1987, c) implementation of size limits (1983) and bag limits (year 1987) for the recreational fisheries and d) enactment of a gill net gear ban in Florida territorial waters (1995). Since the implementation of TACs in 1987 there have been a number of varying annual TACS (2.5 million pounds (MP) in 1987, 5.0 MP in 1988, 5.25 MP in 1989, 8.6 MP 1991, 7.0 1996). In addition to these management actions, varying bag limits have been in place since the initial time of implementation in 1987.

3.2.7 Evaluation of Uncertainty

Tables 3.1 presents' estimates of asymptotic standard errors for all SS estimated parameters for the Gulf of Mexico Spanish mackerel stock assessment for the Run 3 model configuration (steepness = 0.8, M = 0.38 y^{-1}). Table 3.2 provides a listing of all the sensitivity runs carried out for the stock assessment. Table 3.3 and Figures 3.43 - 3.45 provides results of all the sensitivity analyses considered for the stock assessment. Table 3.3 provides a complete listing of the mean and standard deviation from the summaries of the 1,000 bootstrap runs that were made for the Run 3 model (input M= 0.38y^{-1}, steepness = 0.8). Detailed results are summarized in the following sections for the various sensitivity and retrospective and alternative run configurations that were conducted to further examine impacts on model results from varying assumptions on steepness, natural mortality, data exclusion, data weighting and discard release mortality.

The estimated standard errors estimated from the bootstrap analysis are generally low for most parameters estimated in the stock assessment indicating that for most of the estimated parameters model precision of parameters estimated is reasonable (Table 3.3). Figure 3.37 presents estimates of the asymptotic standard errors for annual recruitment deviations. Annual Estimated asymptotic errors for the annual recruitment deviations ranged from 0.05 to 0.11 over the time series estimated. In general, many of the standard errors associated with the selectivity parameters had standard errors larger than 0.25 (Tables 3.1, 3.3).

Because of the concerns around estimating the steepness parameter profiling of steepness and the virgin stock level (R0), and the recruitment standard deviation (sigmaR SS parameter), profiling of these parameters was carried out. Figures 3.31 – 3.32 present profiles for R0 and steepness for the initial model configuration (Run 1, steepness estimated and M = 0.37y^{-1}). Figure 3.33 presents profiling of the recruitment standard deviation parameter (sigmaR). The results did not indicate any major deviance from the input value specified for this parameter (0.7) thus this model parameter value was not further adjusted.

Figures 3.34 and 3.35 present the results of the bootstrap runs that were made for two models (Run 1 model estimated steepness and assumed M = 0.38y^{-1}, Run 3 model assumed a fixed value of steepness =0.8 and M =0.38y^{-1}). The two models were identical in all other aspects of their configuration. The results show that SS had difficulties in estimating steepness for the Gulf of Mexico Spanish mackerel stock. The model estimated steepness was 0.5; the bootstrap summary estimated a range of steepness from about 0.4 to 1.0 hitting the upper bound on about 37% of the bootstrap runs. The SEDAR 28 AP felt that a steepness of around 0.5 was not reasonable for this species. The bootstrap summary results also show bimodality in the estimation of virgin biomass. The bootstrap summary results for the Run 3 model, assuming steepness = 0.8 and the same level of M as for Run 1 (0.38y^{-1}) are shown in Figure 3.35.

Figure 3.43 and Table 3.7 presents results of sensitivity analyses for the value of natural mortality input into the Lorenzen function. All comparisons were against the SS Run 3 model configuration which assumed steepness = 0.8. Key model output quantities were examined including: 1) total biomass (virgin, current biomass) 2) spawning biomass (virgin, current), and recruitment (virgin, current). The trend results suggested that the model was insensitive to input assumptions regarding the level of natural mortality at age. The exception however, is for the M_LO scenario (M = 0.27) which results in higher levels of virgin biomass. Estimated virgin total and virgin recruitment for the scenarios assuming the low value of the range suggested a very different level of virgin biomass than either for the Run 3 model input value (0.38 into the Lorenzen function) or for the model assuming the high end of the range (0.49) input into the Lorenzen function. Neither varying the input level of M from the initial base level (0.38) nor changing the scaling reference age (REF Age) from age 4 to age 3 altered the SS estimated current stock status from that of the Run 3 model relative to SPR30% (Table 3).

Figure 3.44 presents results of impacts on key quantities output from SS from varying steepness in response to concern over the model's ability to estimate this parameter. As shown earlier, SS had difficulties estimating steepness for this stock assessment. For the sensitivity examination, steepness was fixed at 3 levels (0.7, 0.8, and 0.9 assuming M from the Run 3 model = 0.38y $^{-1}$). Results of the sensitivity analyses to the steepness parameter are summarized in Table 3.7 and Figure 3.43. For sensitivity runs that considered the alternative steepness scenarios (0.7, 0.8, 0.9) the level of M assumed was that of the initial model run (Run 1, Table 3.2, M = 0.38 $^{y-1}$ as input into the Lorenzen M at-age function. Changes in steepness from 0.8 to 0.7 or 0.9 did not impact the SS estimated current stock status from that of the Run 3 model relative to SPR30% (Table 3.7).

Table 3.7 and Figure 3.45 present results from evaluating the impact of data component through excluding indices of abundance and from alternative assumptions on the level of discard mortality assumed for the recreational line gear fishery and the recreational all modes (REC) fleet. In general when either reweighting of indices or the length or age composition data was incorporated into the model little change in resulting estimates of biomass or recruitment of SPR was predicted. Exclusion of individual indices of abundance (MRFS, FWC Trip Ticket, SEAMAP Survey) from the model also did not have alter the perception of the current stock status from the Run 3 model relative to SPR30%, as neither did increasing the level of discard mortality from 10% to 20% for the commercial line gear and from 20% to 40% for the REC fleet (Table 3.7).

Figure 3.46 presents results of retrospective analyses for 2006-2011. Three model output quantities shown in the plots are: 1) spawning biomass, 2) recruitment, and 3) spawning potential ratio (SPR). There was some variability in model estimate of the terminal year of data for these key parameters as years of data were dropped from the assessment but no strong systematic bias was either discernible nor did SS predict any large divergence in the estimates for any of the three parameters observed. Eliminating sequential years of data did not alter the SS estimated current stock status from the Run 3 model relative to SPR30%.

As described earlier, the Fishery Simulator GUI Tool previously described in Section 3.1.6 (Methods) and 3.2.7 (Results, Uncertainty) was used to further explore uncertainty in the SS model assumptions. For the initial model run (Run 1, M = 0.38 $^{y-1}$) and for the Run 3 model (steepness = 0.8) the parametric bootstrap procedure was carried out. Due to time constraints 500 bootstraps were made for Run 1 while 1,000 bootstraps were made for Run 3. Figures 3.34 and 3.35 present the results for various key quantities estimated by SS.

3.2.8 Benchmarks/Reference points

Benchmarks for the SPR30% reference point are presented in Table 3.8. The SPR30% reference point was used as a proxy for FMSY as recommended in the SEDAR 28 Gulf Spanish Mackerel TORs. The maximum fishing mortality threshold (MFMT) was the fishing mortality rate that produced a SPR of 30%, $F_{SPR30\%}$. The minimum stock size threshold (MSST) was calculated as (1-*M*) * $SSB_{SPR30\%}$. Figure 3.47 presents a phase plot of the SPR30% reference point for the stock assessment for the Run 3 model and each alternative model examined corresponding to varying assumptions of natural mortality at age and steepness. Table 3.2 presented details of each of the varying model configurations examined in the Spanish mackerel stock assessment. Figures 3.48 and 3.49 present estimates of reference points for status determinations of the overfished and overfishing states (SSB_REF, _REF) from the bootstrap runs for the Run 3 model (steepness = 0.8, M = 0.$^{38y-}$1). These results in total suggest that the Gulf of Mexico Spanish mackerel stock is not overfished under any of the model scenarios examined and the stock is not undergoing overfishing under any of the scenarios examined.

3.2.9 Projections

According to the SEDAR 28 Terms of Reference evaluations were made according to these MSRA criteria:

A) If stock is overfished:
F=0, FCurrent, FMSY, FOY
F=FRebuild (max that permits rebuild in allowed time)

B) If stock is undergoing overfishing:
F= FCurrent, FMSY, FOY

C) If stock is neither overfished nor undergoing overfishing:
F= FCurrent, FMSY, FOY

3.2.9.1 Deterministic

Projection results for forecasted retained catches (mtons) for 2013-2022 are presented in Table 3.9 corresponding to varying to the recommended level of steepness (0.8) and one alternative level (0.8) is provided. Deterministic projections are also presented in Figures 3.50 - 3.52 for the Run 3 model configuration requested by the SEDAR 28 AP. Metrics included are spawning stock biomass (SSB), SSB and F relative to $SSB_{SPR30\%}$ and FSPR30%. Projections are presented for the requested model (Run 3, steepness =0.8) and also one alternative scenario of steepness (0.8). Both runs assumed $M = 0.38y^{-1}$) input into the Lorenzen function.

3.2.9.2 Stochastic

Stochastic projections were made using the “Fishery Simulator GUI tool” previously described in Section 3.1.5.

3.3 Discussion and Recommendations

Gulf of Mexico Spanish mackerel has a lengthy history of exploitation dating to the early late 1800s. Directed commercial gillnet fisheries have operated on this resource for well over a hundred years and recreational fisheries more than 65 years. However detailed catch statistics on size and individual weight of removals only exists for the recent time period, since the mid to late 1980’s. In addition, management measures including size limits (30.5 cm FL beginning 1983) and quotas (beginning in 1987) have resulted in discards for both fisheries.

Gulf of Mexico Spanish mackerel are not a directed target of the commercial line gear fisheries (COM_RR fleet) therefore extensive samples for length and/or age-length key characterizations are not available. Efforts should be made to obtain samples from this fleet in order to better inform future stock assessment evaluations as relates length composition and discard levels. In particular, a review of the sampling protocols for length and age – length collections is needed to better characterize the catch length and age at length compositions. In addition, attention is needed to evaluate optimal spatial sampling factors in relation to overall removals throughout the year and region.

The magnitude of discards from the recreational fleet is high and very variable over the time series for which estimates exist from the MRFSS/MRIP survey (1981 forward). Hind casting was used to develop estimates of recreational removals and discards prior to 1981 however information on uncertainty in the hind casting was not incorporated into the stock assessment. Future assessments should consider uncertainty around hind casted data.

The indices of abundance are generally flat but variable yielding little information with which to characterize abundance. In addition the additional observations of length and conditional age at length are more recent thus providing only limited history of data with which to estimate the spawner- recruit relationship during the early part of the time period. The quantity and quality of length and age composition information directly impacts the ability to estimate recruitment.

There was difficulties with estimating steepness thus the AW felt that providing benchmarks at several levels and making projections using several levels of steepness was needed.

3.4 Acknowledgements

Contributions by numerous researchers lead to the completion of this stock assessment. Significant assistance to learning the SS model was provided by Richard Methot, Ian Taylor Michael Schirripa, Brian Linton. Jeff Isely and Jakob Tetzlaff were part of the SEDAR 28 analyst team and provided significant input along the way. Additional assistance with carrying out the bootstrap analyses was provided by Hua-hui Lee and Ian Taylor. The contents of the Assessment report were improved by input from Clay Porch, Shannon Cass-Calay, and Robert Muller

3.5 References

Lee, H.H., Maunder, M.N., Piner, K.P. and Methot, R.D. 2012. Can steepness of the stock-recruitment relationship be estimated in fishery stock assessment models? Fisheries Research. 125-126:254-261.

Lee, Hua-hui; Robert Cheng-Yu Yang; and Ian Taylor. 2012. User manual for Fishery Simulation Tool. Joint Institute for Marine and Atmospheric Research, University of Hawaii, Pacific Islands Fisheries Science Center, NOAA Fisheries Honolulu, HI USA, 7pg.

Lee, H.H., Maunder, M.N., Piner, K.P. and Methot, R.D. 2011. Estimating natural mortality within a fisheries stock assessment model: an evaluation using simulation analysis based on twelve stock assessments. Fisheries Research. 109:89-94.

Methot, R.D. 2011. User manual for stock synthesis. Model Version 3.23b. Northwest Fisheries Science Center.

Piner, K.P., Lee, H.H., Maunder, M.N. and Methot, R.D. 2011. A simulation-based method to determine model misspecification: examples using natural mortality and population dynamics models. Marine and Coastal Science. 3:336-343.

3.6 Tables

Table 3.1. Listing of parameters from the SS model used for the Gulf of Mexico Spanish mackerel stock assessment. The list includes predicted parameter values and their associated standard errors from SS Base Model Run, initial parameter values, minimum and maximum values a parameter could take, and prior densities assigned to parameters. Parameters designated as fixed were held at their initial values. Table represents model selected by the SEDAR 28 Assessment Panel as the final base model (Base natural Mortality level = of 0.38 y^{-1} input into Lorenzen function and Beverton and Holt steepness parameter value = 0.8.

	Parameter										
	Predicted					**Prior**					
Label	**Value**	**Parm_StDev**	**Initial**	**Min**	**Max**	**PR_type**	**Prior**	**Pr_SD**	**Status**	**Active / Not Active Parameter**	**Description**
L_at_Amin_Fem_GP_1	18.7935	0.4711	10	2	30	No_prior	_	_	Estimated	A	Size at age 0.5
L_at_Amax_Fem_GP_1	60.8046	0.8493	56	40	90	No_prior	_	_	Estimated	A	von Bertalanffy Linfintiy
VonBert_K_Fem_GP_1	0.3008	0.0136	0.61	0.1	1.2	No_prior	_	_	Estimated	A	von Bertalanffy K
CV_young_Fem_GP_1	7.1038	0.2140	10	0.001	20	No_prior	_	_	Estimated	A	Young growth CV
CV_old_Fem_GP_1	9.1385	0.2794	10	0.001	45	No_prior	_	_	Estimated	A	Old growth CV
Wtlen_1_Fem	0.0000	_	1.50E-05	0.1	1	No_prior	_	_	Fixed	NA	Weight length a parameter
Wtlen_2_Fem	2.8617	_	2.8617	2	4	No_prior	_	_	Fixed	NA	weight length b parameter
Mat50%_Fem	31.0000	_	31	25	100	No_prior	_	_	Fixed	NA	Maturity inflection point
Mat_slope_Fem	-0.0650	_	-0.065	-1	0	No_prior	_	_	Fixed	NA	Maturity slope
Eggs/kg_inter_Fem	1.0000	_	1	-3	3	No_prior	_	_	Fixed	NA	Fecundity scalar
Eggs/kg_slope_wt_Fem	0.0000	_	0	-3	3	No_prior	_	_	Fixed	NA	Fecundity slope
SR_LN(R0)	10.7684	0.0200	10	1	20	No_prior	_	_	Estimated	A	Virgin recruit
SR_BH_steep	0.8000	_	0.8	0.2	1	No_prior	_	_	Estimated	A	Steepness
SR_sigmaR	0.7000	_	0.7	0	2	No_prior	_	_	Fixed	NA	Stock recruit standard deviation
SR_envlink	0.1000	_	0.1	-5	5	No_prior	_	_	Fixed	NA	Stock recruit environmental link

SR_R1_offset	0.0000	_	0	-5	5	No_prior	_	_	Fixed	NA	Stock recruit offset
SR_autocorr	0.0000	_	0	0	0	No_prior	_	_	Fixed	NA	Stock recruit autocorrelation
Main_RecrDev_1985	0.3958	0.0866	_	_	_	dev	_	_	Estimated	A	1985 recruit deviation
Main_RecrDev_1986	-0.0918	0.0774	_	_	_	dev	_	_	Estimated	A	1986 recruit deviation
Main_RecrDev_1987	-0.2902	0.0705	_	_	_	dev	_	_	Estimated	A	1987 recruit deviation
Main_RecrDev_1988	-0.1137	0.0622	_	_	_	dev	_	_	Estimated	A	1988 recruit deviation
Main_RecrDev_1989	0.3761	0.0573	_	_	_	dev	_	_	Estimated	A	1989 recruit deviation
Main_RecrDev_1990	0.3481	0.0629	_	_	_	dev	_	_	Estimated	A	1990 recruit deviation
Main_RecrDev_1991	0.4491	0.0576	_	_	_	dev	_	_	Estimated	A	1991 recruit deviation
Main_RecrDev_1992	-0.4735	0.0808	_	_	_	dev	_	_	Estimated	A	1992 recruit deviation
Main_RecrDev_1993	-0.1720	0.0738	_	_	_	dev	_	_	Estimated	A	1993 recruit deviation
Main_RecrDev_1994	-0.8238	0.0953	_	_	_	dev	_	_	Estimated	A	1994 recruit deviation
Main_RecrDev_1995	-0.0042	0.0764	_	_	_	dev	_	_	Estimated	A	1995 recruit deviation
Main_RecrDev_1996	0.0506	0.0783	_	_	_	dev	_	_	Estimated	A	1996 recruit deviation
Main_RecrDev_1997	-0.1920	0.0792	_	_	_	dev	_	_	Estimated	A	1997 recruit deviation
Main_RecrDev_1998	0.4302	0.0640	_	_	_	dev	_	_	Estimated	A	1998 recruit deviation
Main_RecrDev_1999	-0.0312	0.0734	_	_	_	dev	_	_	Estimated	A	1999 recruit deviation
Main_RecrDev_2000	0.1050	0.0637	_	_	_	dev	_	_	Estimated	A	2000 recruit deviation
Main_RecrDev_2001	0.0482	0.0614	_	_	_	dev	_	_	Estimated	A	2001 recruit deviation
Main_RecrDev_2002	-0.0556	0.0625	_	_	_	dev	_	_	Estimated	A	2002 recruit deviation
Main_RecrDev_2003	0.1911	0.0594	_	_	_	dev	_	_	Estimated	A	2003 recruit deviation
Main_RecrDev_2004	0.1043	0.0623	_	_	_	dev	_	_	Estimated	A	2004 recruit deviation
Main_RecrDev_2005	0.0194	0.0623	_	_	_	dev	_	_	Estimated	A	2005 recruit deviation
Main_RecrDev_2006	-0.3295	0.0708	_	_	_	dev	_	_	Estimated	A	2006 recruit deviation
Main_RecrDev_2007	0.2449	0.0652	_	_	_	dev	_	_	Estimated	A	2007 recruit deviation
Main_RecrDev_2008	-0.0129	0.0813	_	_	_	dev	_	_	Estimated	A	2008 recruit deviation
Main_RecrDev_2009	-0.2906	0.1062	_	_	_	dev	_	_	Estimated	A	2009 recruit deviation
Main_RecrDev_2010	0.4441	0.1121	_	_	_	dev	_	_	Estimated	A	2010 recruit deviation

Main_RecrDev_2011	-0.3260	0.2249	_	_	_	dev	_	_	Estimated	A	2011 recruit deviation
InitF_1Com_GN_1	0.0000	_	0	0	1	No_prior	_	_	Fixed	NA	COM_GN initial F
InitF_2Com_RR_2	0.0000	_	0	0	1	No_prior	_	_	Fixed	NA	COM_RR initial F
InitF_3REC_3	0.0000	_	0	0	1	No_prior	_	_	Fixed	NA	REC initial F
InitF_4Shrimp_Bycatch_4	0.0000	_	0	0	1	No_prior	_	_	Fixed	NA	Shrimp Bycatch initial F
F_fleet_1_YR_1886_s_1	0.0008	0.0001	_	0	8	F	_	_	Estimated	A	F_COM_GN 1886
F_fleet_1_YR_1887_s_1	0.0016	0.0001	_	0	8	F	_	_	Estimated	A	F_COM_GN 1887
F_fleet_1_YR_1888_s_1	0.0032	0.0001	_	0	8	F	_	_	Estimated	A	F_COM_GN 1888
F_fleet_1_YR_1889_s_1	0.0062	0.0002	_	0	8	F	_	_	Estimated	A	F_COM_GN 1889
F_fleet_1_YR_1890_s_1	0.0072	0.0002	_	0	8	F	_	_	Estimated	A	F_COM_GN 1890
F_fleet_1_YR_1891_s_1	0.0076	0.0003	_	0	8	F	_	_	Estimated	A	F_COM_GN 1891
F_fleet_1_YR_1892_s_1	0.0076	0.0003	_	0	8	F	_	_	Estimated	A	F_COM_GN 1892
F_fleet_1_YR_1893_s_1	0.0076	0.0003	_	0	8	F	_	_	Estimated	A	F_COM_GN 1893
F_fleet_1_YR_1894_s_1	0.0076	0.0003	_	0	8	F	_	_	Estimated	A	F_COM_GN 1894
F_fleet_1_YR_1895_s_1	0.0076	0.0003	_	0	8	F	_	_	Estimated	A	F_COM_GN 1895
F_fleet_1_YR_1896_s_1	0.0076	0.0003	_	0	8	F	_	_	Estimated	A	F_COM_GN 1896
F_fleet_1_YR_1897_s_1	0.0079	0.0003	_	0	8	F	_	_	Estimated	A	F_COM_GN 1897
F_fleet_1_YR_1898_s_1	0.0103	0.0004	_	0	8	F	_	_	Estimated	A	F_COM_GN 1898
F_fleet_1_YR_1899_s_1	0.0103	0.0004	_	0	8	F	_	_	Estimated	A	F_COM_GN 1899
F_fleet_1_YR_1900_s_1	0.0103	0.0004	_	0	8	F	_	_	Estimated	A	F_COM_GN 1900
F_fleet_1_YR_1901_s_1	0.0104	0.0004	_	0	8	F	_	_	Estimated	A	F_COM_GN 1901
F_fleet_1_YR_1902_s_1	0.0169	0.0006	_	0	8	F	_	_	Estimated	A	F_COM_GN 1902
F_fleet_1_YR_1903_s_1	0.0164	0.0006	_	0	8	F	_	_	Estimated	A	F_COM_GN 1903
F_fleet_1_YR_1904_s_1	0.0165	0.0006	_	0	8	F	_	_	Estimated	A	F_COM_GN 1904
F_fleet_1_YR_1905_s_1	0.0166	0.0006	_	0	8	F	_	_	Estimated	A	F_COM_GN 1905
F_fleet_1_YR_1906_s_1	0.0166	0.0006	_	0	8	F	_	_	Estimated	A	F_COM_GN 1906
F_fleet_1_YR_1907_s_1	0.0166	0.0006	_	0	8	F	_	_	Estimated	A	F_COM_GN 1907
F_fleet_1_YR_1908_s_1	0.0161	0.0006	_	0	8	F	_	_	Estimated	A	F_COM_GN 1908

F_fleet_1_YR_1909_s_1	0.0170	0.0006	_	0	8	F	_	_	Estimated	A	F_COM_GN 1909
F_fleet_1_YR_1910_s_1	0.0198	0.0007	_	0	8	F	_	_	Estimated	A	F_COM_GN 1910
F_fleet_1_YR_1911_s_1	0.0226	0.0008	_	0	8	F	_	_	Estimated	A	F_COM_GN 1911
F_fleet_1_YR_1912_s_1	0.0255	0.0009	_	0	8	F	_	_	Estimated	A	F_COM_GN 1912
F_fleet_1_YR_1913_s_1	0.0285	0.0010	_	0	8	F	_	_	Estimated	A	F_COM_GN 1913
F_fleet_1_YR_1914_s_1	0.0315	0.0011	_	0	8	F	_	_	Estimated	A	F_COM_GN 1914
F_fleet_1_YR_1915_s_1	0.0346	0.0012	_	0	8	F	_	_	Estimated	A	F_COM_GN 1915
F_fleet_1_YR_1916_s_1	0.0377	0.0014	_	0	8	F	_	_	Estimated	A	F_COM_GN 1916
F_fleet_1_YR_1917_s_1	0.0397	0.0014	_	0	8	F	_	_	Estimated	A	F_COM_GN 1917
F_fleet_1_YR_1918_s_1	0.0406	0.0015	_	0	8	F	_	_	Estimated	A	F_COM_GN 1918
F_fleet_1_YR_1919_s_1	0.0416	0.0015	_	0	8	F	_	_	Estimated	A	F_COM_GN 1919
F_fleet_1_YR_1920_s_1	0.0433	0.0016	_	0	8	F	_	_	Estimated	A	F_COM_GN 1920
F_fleet_1_YR_1921_s_1	0.0450	0.0016	_	0	8	F	_	_	Estimated	A	F_COM_GN 1921
F_fleet_1_YR_1922_s_1	0.0453	0.0017	_	0	8	F	_	_	Estimated	A	F_COM_GN 1922
F_fleet_1_YR_1923_s_1	0.0458	0.0017	_	0	8	F	_	_	Estimated	A	F_COM_GN 1923
F_fleet_1_YR_1924_s_1	0.0488	0.0018	_	0	8	F	_	_	Estimated	A	F_COM_GN 1924
F_fleet_1_YR_1925_s_1	0.0522	0.0019	_	0	8	F	_	_	Estimated	A	F_COM_GN 1925
F_fleet_1_YR_1926_s_1	0.0557	0.0021	_	0	8	F	_	_	Estimated	A	F_COM_GN 1926
F_fleet_1_YR_1927_s_1	0.0580	0.0022	_	0	8	F	_	_	Estimated	A	F_COM_GN 1927
F_fleet_1_YR_1928_s_1	0.0402	0.0015	_	0	8	F	_	_	Estimated	A	F_COM_GN 1928
F_fleet_1_YR_1929_s_1	0.0432	0.0016	_	0	8	F	_	_	Estimated	A	F_COM_GN 1929
F_fleet_1_YR_1930_s_1	0.0507	0.0019	_	0	8	F	_	_	Estimated	A	F_COM_GN 1930
F_fleet_1_YR_1931_s_1	0.0286	0.0011	_	0	8	F	_	_	Estimated	A	F_COM_GN 1931
F_fleet_1_YR_1932_s_1	0.0349	0.0013	_	0	8	F	_	_	Estimated	A	F_COM_GN 1932
F_fleet_1_YR_1933_s_1	0.0380	0.0014	_	0	8	F	_	_	Estimated	A	F_COM_GN 1933
F_fleet_1_YR_1934_s_1	0.0418	0.0015	_	0	8	F	_	_	Estimated	A	F_COM_GN 1934
F_fleet_1_YR_1935_s_1	0.0518	0.0019	_	0	8	F	_	_	Estimated	A	F_COM_GN 1935
F_fleet_1_YR_1936_s_1	0.0632	0.0023	_	0	8	F	_	_	Estimated	A	F_COM_GN 1936

F_fleet_1_YR_1937_s_1	0.0482	0.0018	_	0	8	F	_	_	Estimated	A	F_COM_GN 1937
F_fleet_1_YR_1938_s_1	0.0498	0.0019	_	0	8	F	_	_	Estimated	A	F_COM_GN 1938
F_fleet_1_YR_1939_s_1	0.0521	0.0019	_	0	8	F	_	_	Estimated	A	F_COM_GN 1939
F_fleet_1_YR_1940_s_1	0.0448	0.0017	_	0	8	F	_	_	Estimated	A	F_COM_GN 1940
F_fleet_1_YR_1941_s_1	0.0010	0.0000	_	0	8	F	_	_	Estimated	A	F_COM_GN 1941
F_fleet_1_YR_1942_s_1	0.0010	0.0000	_	0	8	F	_	_	Estimated	A	F_COM_GN 1942
F_fleet_1_YR_1943_s_1	0.0010	0.0000	_	0	8	F	_	_	Estimated	A	F_COM_GN 1943
F_fleet_1_YR_1944_s_1	0.0009	0.0000	_	0	8	F	_	_	Estimated	A	F_COM_GN 1944
F_fleet_1_YR_1945_s_1	0.0010	0.0000	_	0	8	F	_	_	Estimated	A	F_COM_GN 1945
F_fleet_1_YR_1946_s_1	0.0009	0.0000	_	0	8	F	_	_	Estimated	A	F_COM_GN 1946
F_fleet_1_YR_1947_s_1	0.0009	0.0000	_	0	8	F	_	_	Estimated	A	F_COM_GN 1947
F_fleet_1_YR_1948_s_1	0.0096	0.0003	_	0	8	F	_	_	Estimated	A	F_COM_GN 1948
F_fleet_1_YR_1949_s_1	0.0421	0.0015	_	0	8	F	_	_	Estimated	A	F_COM_GN 1949
F_fleet_1_YR_1950_s_1	0.0290	0.0010	_	0	8	F	_	_	Estimated	A	F_COM_GN 1950
F_fleet_1_YR_1951_s_1	0.0762	0.0027	_	0	8	F	_	_	Estimated	A	F_COM_GN 1951
F_fleet_1_YR_1952_s_1	0.0556	0.0021	_	0	8	F	_	_	Estimated	A	F_COM_GN 1952
F_fleet_1_YR_1953_s_1	0.0379	0.0014	_	0	8	F	_	_	Estimated	A	F_COM_GN 1953
F_fleet_1_YR_1954_s_1	0.0375	0.0014	_	0	8	F	_	_	Estimated	A	F_COM_GN 1954
F_fleet_1_YR_1955_s_1	0.0217	0.0008	_	0	8	F	_	_	Estimated	A	F_COM_GN 1955
F_fleet_1_YR_1956_s_1	0.0402	0.0016	_	0	8	F	_	_	Estimated	A	F_COM_GN 1956
F_fleet_1_YR_1957_s_1	0.0530	0.0021	_	0	8	F	_	_	Estimated	A	F_COM_GN 1957
F_fleet_1_YR_1958_s_1	0.0598	0.0025	_	0	8	F	_	_	Estimated	A	F_COM_GN 1958
F_fleet_1_YR_1959_s_1	0.0783	0.0035	_	0	8	F	_	_	Estimated	A	F_COM_GN 1959
F_fleet_1_YR_1960_s_1	0.0991	0.0047	_	0	8	F	_	_	Estimated	A	F_COM_GN 1960
F_fleet_1_YR_1961_s_1	0.0771	0.0038	_	0	8	F	_	_	Estimated	A	F_COM_GN 1961
F_fleet_1_YR_1962_s_1	0.1454	0.0074	_	0	8	F	_	_	Estimated	A	F_COM_GN 1962
F_fleet_1_YR_1963_s_1	0.1239	0.0066	_	0	8	F	_	_	Estimated	A	F_COM_GN 1963
F_fleet_1_YR_1964_s_1	0.0925	0.0051	_	0	8	F	_	_	Estimated	A	F_COM_GN 1964

F_fleet_1_YR_1965_s_1	0.1180	0.0068	_	0	8	F	_	_	Estimated	A	F_COM_GN 1965
F_fleet_1_YR_1966_s_1	0.1787	0.0105	_	0	8	F	_	_	Estimated	A	F_COM_GN 1966
F_fleet_1_YR_1967_s_1	0.1556	0.0093	_	0	8	F	_	_	Estimated	A	F_COM_GN 1967
F_fleet_1_YR_1968_s_1	0.1970	0.0119	_	0	8	F	_	_	Estimated	A	F_COM_GN 1968
F_fleet_1_YR_1969_s_1	0.2441	0.0153	_	0	8	F	_	_	Estimated	A	F_COM_GN 1969
F_fleet_1_YR_1970_s_1	0.2558	0.0167	_	0	8	F	_	_	Estimated	A	F_COM_GN 1970
F_fleet_1_YR_1971_s_1	0.2442	0.0163	_	0	8	F	_	_	Estimated	A	F_COM_GN 1971
F_fleet_1_YR_1972_s_1	0.2063	0.0139	_	0	8	F	_	_	Estimated	A	F_COM_GN 1972
F_fleet_1_YR_1973_s_1	0.2120	0.0145	_	0	8	F	_	_	Estimated	A	F_COM_GN 1973
F_fleet_1_YR_1974_s_1	0.2812	0.0201	_	0	8	F	_	_	Estimated	A	F_COM_GN 1974
F_fleet_1_YR_1975_s_1	0.1875	0.0138	_	0	8	F	_	_	Estimated	A	F_COM_GN 1975
F_fleet_1_YR_1976_s_1	0.2777	0.0207	_	0	8	F	_	_	Estimated	A	F_COM_GN 1976
F_fleet_1_YR_1977_s_1	0.0803	0.0059	_	0	8	F	_	_	Estimated	A	F_COM_GN 1977
F_fleet_1_YR_1978_s_1	0.0435	0.0031	_	0	8	F	_	_	Estimated	A	F_COM_GN 1978
F_fleet_1_YR_1979_s_1	0.0798	0.0055	_	0	8	F	_	_	Estimated	A	F_COM_GN 1979
F_fleet_1_YR_1980_s_1	0.0713	0.0049	_	0	8	F	_	_	Estimated	A	F_COM_GN 1980
F_fleet_1_YR_1981_s_1	0.1406	0.0096	_	0	8	F	_	_	Estimated	A	F_COM_GN 1981
F_fleet_1_YR_1982_s_1	0.1455	0.0107	_	0	8	F	_	_	Estimated	A	F_COM_GN 1982
F_fleet_1_YR_1983_s_1	0.1023	0.0078	_	0	8	F	_	_	Estimated	A	F_COM_GN 1983
F_fleet_1_YR_1984_s_1	0.1713	0.0130	_	0	8	F	_	_	Estimated	A	F_COM_GN 1984
F_fleet_1_YR_1985_s_1	0.0971	0.0070	_	0	8	F	_	_	Estimated	A	F_COM_GN 1985
F_fleet_1_YR_1986_s_1	0.1389	0.0095	_	0	8	F	_	_	Estimated	A	F_COM_GN 1986
F_fleet_1_YR_1987_s_1	0.1502	0.0102	_	0	8	F	_	_	Estimated	A	F_COM_GN 1987
F_fleet_1_YR_1988_s_1	0.1389	0.0091	_	0	8	F	_	_	Estimated	A	F_COM_GN 1988
F_fleet_1_YR_1989_s_1	0.1968	0.0130	_	0	8	F	_	_	Estimated	A	F_COM_GN 1989
F_fleet_1_YR_1990_s_1	0.1636	0.0111	_	0	8	F	_	_	Estimated	A	F_COM_GN 1990
F_fleet_1_YR_1991_s_1	0.1944	0.0134	_	0	8	F	_	_	Estimated	A	F_COM_GN 1991
F_fleet_1_YR_1992_s_1	0.2054	0.0147	_	0	8	F	_	_	Estimated	A	F_COM_GN 1992

F_fleet_1_YR_1993_s_1	0.1441	0.0106	_	0	8	F	_	_	Estimated	A	F_COM_GN 1993
F_fleet_1_YR_1994_s_1	0.1692	0.0131	_	0	8	F	_	_	Estimated	A	F_COM_GN 1994
F_fleet_1_YR_1995_s_1	0.1031	0.0085	_	0	8	F	_	_	Estimated	A	F_COM_GN 1995
F_fleet_1_YR_1996_s_1	0.0272	0.0023	_	0	8	F	_	_	Estimated	A	F_COM_GN 1996
F_fleet_1_YR_1997_s_1	0.0336	0.0027	_	0	8	F	_	_	Estimated	A	F_COM_GN 1997
F_fleet_1_YR_1998_s_1	0.0255	0.0020	_	0	8	F	_	_	Estimated	A	F_COM_GN 1998
F_fleet_1_YR_1999_s_1	0.0462	0.0035	_	0	8	F	_	_	Estimated	A	F_COM_GN 1999
F_fleet_1_YR_2000_s_1	0.0455	0.0034	_	0	8	F	_	_	Estimated	A	F_COM_GN 2000
F_fleet_1_YR_2001_s_1	0.0564	0.0042	_	0	8	F	_	_	Estimated	A	F_COM_GN 2001
F_fleet_1_YR_2002_s_1	0.0459	0.0035	_	0	8	F	_	_	Estimated	A	F_COM_GN 2002
F_fleet_1_YR_2003_s_1	0.0667	0.0051	_	0	8	F	_	_	Estimated	A	F_COM_GN 2003
F_fleet_1_YR_2004_s_1	0.0460	0.0037	_	0	8	F	_	_	Estimated	A	F_COM_GN 2004
F_fleet_1_YR_2005_s_1	0.0565	0.0046	_	0	8	F	_	_	Estimated	A	F_COM_GN 2005
F_fleet_1_YR_2006_s_1	0.0432	0.0032	_	0	8	F	_	_	Estimated	A	F_COM_GN 2006
F_fleet_1_YR_2007_s_1	0.0290	0.0023	_	0	8	F	_	_	Estimated	A	F_COM_GN 2007
F_fleet_1_YR_2008_s_1	0.0345	0.0029	_	0	8	F	_	_	Estimated	A	F_COM_GN 2008
F_fleet_1_YR_2009_s_1	0.0499	0.0044	_	0	8	F	_	_	Estimated	A	F_COM_GN 2009
F_fleet_1_YR_2010_s_1	0.0316	0.0030	_	0	8	F	_	_	Estimated	A	F_COM_GN 2010
F_fleet_1_YR_2011_s_1	0.0309	0.0031	_	0	8	F	_	_	Estimated	A	F_COM_GN 2011
F_fleet_2_YR_1886_s_1	0.0001	0.0000	_	0	8	F	_	_	Estimated	A	F_COM_RR_1886
F_fleet_2_YR_1887_s_1	0.0001	0.0000	_	0	8	F	_	_	Estimated	A	F_COM_RR_1887
F_fleet_2_YR_1888_s_1	0.0002	0.0000	_	0	8	F	_	_	Estimated	A	F_COM_RR_1888
F_fleet_2_YR_1889_s_1	0.0004	0.0000	_	0	8	F	_	_	Estimated	A	F_COM_RR_1889
F_fleet_2_YR_1890_s_1	0.0005	0.0000	_	0	8	F	_	_	Estimated	A	F_COM_RR_1890
F_fleet_2_YR_1891_s_1	0.0001	0.0000	_	0	8	F	_	_	Estimated	A	F_COM_RR_1891
F_fleet_2_YR_1892_s_1	0.0001	0.0000	_	0	8	F	_	_	Estimated	A	F_COM_RR_1892
F_fleet_2_YR_1893_s_1	0.0001	0.0000	_	0	8	F	_	_	Estimated	A	F_COM_RR_1893
F_fleet_2_YR_1894_s_1	0.0001	0.0000	_	0	8	F	_	_	Estimated	A	F_COM_RR_1894

F_fleet_2_YR_1895_s_1	0.0001	0.0000	_	0	8	F	_	_	Estimated	A	F_COM_RR_1895
F_fleet_2_YR_1896_s_1	0.0001	0.0000	_	0	8	F	_	_	Estimated	A	F_COM_RR_1896
F_fleet_2_YR_1897_s_1	0.0005	0.0000	_	0	8	F	_	_	Estimated	A	F_COM_RR_1897
F_fleet_2_YR_1898_s_1	0.0007	0.0000	_	0	8	F	_	_	Estimated	A	F_COM_RR_1898
F_fleet_2_YR_1899_s_1	0.0007	0.0000	_	0	8	F	_	_	Estimated	A	F_COM_RR_1899
F_fleet_2_YR_1900_s_1	0.0007	0.0000	_	0	8	F	_	_	Estimated	A	F_COM_RR_1900
F_fleet_2_YR_1901_s_1	0.0007	0.0000	_	0	8	F	_	_	Estimated	A	F_COM_RR_1901
F_fleet_2_YR_1902_s_1	0.0012	0.0000	_	0	8	F	_	_	Estimated	A	F_COM_RR_1902
F_fleet_2_YR_1903_s_1	0.0011	0.0000	_	0	8	F	_	_	Estimated	A	F_COM_RR_1903
F_fleet_2_YR_1904_s_1	0.0011	0.0000	_	0	8	F	_	_	Estimated	A	F_COM_RR_1904
F_fleet_2_YR_1905_s_1	0.0011	0.0000	_	0	8	F	_	_	Estimated	A	F_COM_RR_1905
F_fleet_2_YR_1906_s_1	0.0011	0.0000	_	0	8	F	_	_	Estimated	A	F_COM_RR_1906
F_fleet_2_YR_1907_s_1	0.0011	0.0000	_	0	8	F	_	_	Estimated	A	F_COM_RR_1907
F_fleet_2_YR_1908_s_1	0.0011	0.0000	_	0	8	F	_	_	Estimated	A	F_COM_RR_1908
F_fleet_2_YR_1909_s_1	0.0013	0.0000	_	0	8	F	_	_	Estimated	A	F_COM_RR_1909
F_fleet_2_YR_1910_s_1	0.0015	0.0000	_	0	8	F	_	_	Estimated	A	F_COM_RR_1910
F_fleet_2_YR_1911_s_1	0.0016	0.0001	_	0	8	F	_	_	Estimated	A	F_COM_RR_1911
F_fleet_2_YR_1912_s_1	0.0018	0.0001	_	0	8	F	_	_	Estimated	A	F_COM_RR_1912
F_fleet_2_YR_1913_s_1	0.0020	0.0001	_	0	8	F	_	_	Estimated	A	F_COM_RR_1913
F_fleet_2_YR_1914_s_1	0.0021	0.0001	_	0	8	F	_	_	Estimated	A	F_COM_RR_1914
F_fleet_2_YR_1915_s_1	0.0023	0.0001	_	0	8	F	_	_	Estimated	A	F_COM_RR_1915
F_fleet_2_YR_1916_s_1	0.0025	0.0001	_	0	8	F	_	_	Estimated	A	F_COM_RR_1916
F_fleet_2_YR_1917_s_1	0.0027	0.0001	_	0	8	F	_	_	Estimated	A	F_COM_RR_1917
F_fleet_2_YR_1918_s_1	0.0028	0.0001	_	0	8	F	_	_	Estimated	A	F_COM_RR_1918
F_fleet_2_YR_1919_s_1	0.0029	0.0001	_	0	8	F	_	_	Estimated	A	F_COM_RR_1919
F_fleet_2_YR_1920_s_1	0.0029	0.0001	_	0	8	F	_	_	Estimated	A	F_COM_RR_1920
F_fleet_2_YR_1921_s_1	0.0031	0.0001	_	0	8	F	_	_	Estimated	A	F_COM_RR_1921
F_fleet_2_YR_1922_s_1	0.0031	0.0001	_	0	8	F	_	_	Estimated	A	F_COM_RR_1922

F_fleet_2_YR_1923_s_1	0.0032	0.0001	_	0	8	F	_	_	Estimated	A	F_COM_RR_1923
F_fleet_2_YR_1924_s_1	0.0033	0.0001	_	0	8	F	_	_	Estimated	A	F_COM_RR_1924
F_fleet_2_YR_1925_s_1	0.0035	0.0001	_	0	8	F	_	_	Estimated	A	F_COM_RR_1925
F_fleet_2_YR_1926_s_1	0.0037	0.0001	_	0	8	F	_	_	Estimated	A	F_COM_RR_1926
F_fleet_2_YR_1927_s_1	0.0041	0.0001	_	0	8	F	_	_	Estimated	A	F_COM_RR_1927
F_fleet_2_YR_1928_s_1	0.0028	0.0001	_	0	8	F	_	_	Estimated	A	F_COM_RR_1928
F_fleet_2_YR_1929_s_1	0.0030	0.0001	_	0	8	F	_	_	Estimated	A	F_COM_RR_1929
F_fleet_2_YR_1930_s_1	0.0035	0.0001	_	0	8	F	_	_	Estimated	A	F_COM_RR_1930
F_fleet_2_YR_1931_s_1	0.0020	0.0001	_	0	8	F	_	_	Estimated	A	F_COM_RR_1931
F_fleet_2_YR_1932_s_1	0.0024	0.0001	_	0	8	F	_	_	Estimated	A	F_COM_RR_1932
F_fleet_2_YR_1933_s_1	0.0026	0.0001	_	0	8	F	_	_	Estimated	A	F_COM_RR_1933
F_fleet_2_YR_1934_s_1	0.0029	0.0001	_	0	8	F	_	_	Estimated	A	F_COM_RR_1934
F_fleet_2_YR_1935_s_1	0.0035	0.0001	_	0	8	F	_	_	Estimated	A	F_COM_RR_1935
F_fleet_2_YR_1936_s_1	0.0044	0.0002	_	0	8	F	_	_	Estimated	A	F_COM_RR_1936
F_fleet_2_YR_1937_s_1	0.0034	0.0001	_	0	8	F	_	_	Estimated	A	F_COM_RR_1937
F_fleet_2_YR_1938_s_1	0.0035	0.0001	_	0	8	F	_	_	Estimated	A	F_COM_RR_1938
F_fleet_2_YR_1939_s_1	0.0036	0.0001	_	0	8	F	_	_	Estimated	A	F_COM_RR_1939
F_fleet_2_YR_1940_s_1	0.0031	0.0001	_	0	8	F	_	_	Estimated	A	F_COM_RR_1940
F_fleet_2_YR_1941_s_1	0.0007	0.0000	_	0	8	F	_	_	Estimated	A	F_COM_RR_1941
F_fleet_2_YR_1942_s_1	0.0007	0.0000	_	0	8	F	_	_	Estimated	A	F_COM_RR_1942
F_fleet_2_YR_1943_s_1	0.0007	0.0000	_	0	8	F	_	_	Estimated	A	F_COM_RR_1943
F_fleet_2_YR_1944_s_1	0.0007	0.0000	_	0	8	F	_	_	Estimated	A	F_COM_RR_1944
F_fleet_2_YR_1945_s_1	0.0001	0.0000	_	0	8	F	_	_	Estimated	A	F_COM_RR_1945
F_fleet_2_YR_1946_s_1	0.0006	0.0000	_	0	8	F	_	_	Estimated	A	F_COM_RR_1946
F_fleet_2_YR_1947_s_1	0.0006	0.0000	_	0	8	F	_	_	Estimated	A	F_COM_RR_1947
F_fleet_2_YR_1948_s_1	0.0007	0.0000	_	0	8	F	_	_	Estimated	A	F_COM_RR_1948
F_fleet_2_YR_1949_s_1	0.0029	0.0001	_	0	8	F	_	_	Estimated	A	F_COM_RR_1949
F_fleet_2_YR_1950_s_1	0.0020	0.0001	_	0	8	F	_	_	Estimated	A	F_COM_RR_1950

F_fleet_2_YR_1951_s_1	0.0053	0.0002	_	0	8	F	_	_	Estimated	A	F_COM_RR_1951
F_fleet_2_YR_1952_s_1	0.0039	0.0001	_	0	8	F	_	_	Estimated	A	F_COM_RR_1952
F_fleet_2_YR_1953_s_1	0.0026	0.0001	_	0	8	F	_	_	Estimated	A	F_COM_RR_1953
F_fleet_2_YR_1954_s_1	0.0026	0.0001	_	0	8	F	_	_	Estimated	A	F_COM_RR_1954
F_fleet_2_YR_1955_s_1	0.0015	0.0001	_	0	8	F	_	_	Estimated	A	F_COM_RR_1955
F_fleet_2_YR_1956_s_1	0.0028	0.0001	_	0	8	F	_	_	Estimated	A	F_COM_RR_1956
F_fleet_2_YR_1957_s_1	0.0037	0.0001	_	0	8	F	_	_	Estimated	A	F_COM_RR_1957
F_fleet_2_YR_1958_s_1	0.0042	0.0002	_	0	8	F	_	_	Estimated	A	F_COM_RR_1958
F_fleet_2_YR_1959_s_1	0.0055	0.0002	_	0	8	F	_	_	Estimated	A	F_COM_RR_1959
F_fleet_2_YR_1960_s_1	0.0070	0.0003	_	0	8	F	_	_	Estimated	A	F_COM_RR_1960
F_fleet_2_YR_1961_s_1	0.0055	0.0003	_	0	8	F	_	_	Estimated	A	F_COM_RR_1961
F_fleet_2_YR_1962_s_1	0.0035	0.0002	_	0	8	F	_	_	Estimated	A	F_COM_RR_1962
F_fleet_2_YR_1963_s_1	0.0022	0.0001	_	0	8	F	_	_	Estimated	A	F_COM_RR_1963
F_fleet_2_YR_1964_s_1	0.0050	0.0003	_	0	8	F	_	_	Estimated	A	F_COM_RR_1964
F_fleet_2_YR_1965_s_1	0.0087	0.0005	_	0	8	F	_	_	Estimated	A	F_COM_RR_1965
F_fleet_2_YR_1966_s_1	0.0106	0.0006	_	0	8	F	_	_	Estimated	A	F_COM_RR_1966
F_fleet_2_YR_1967_s_1	0.0093	0.0005	_	0	8	F	_	_	Estimated	A	F_COM_RR_1967
F_fleet_2_YR_1968_s_1	0.0087	0.0005	_	0	8	F	_	_	Estimated	A	F_COM_RR_1968
F_fleet_2_YR_1969_s_1	0.0079	0.0005	_	0	8	F	_	_	Estimated	A	F_COM_RR_1969
F_fleet_2_YR_1970_s_1	0.0103	0.0007	_	0	8	F	_	_	Estimated	A	F_COM_RR_1970
F_fleet_2_YR_1971_s_1	0.0111	0.0007	_	0	8	F	_	_	Estimated	A	F_COM_RR_1971
F_fleet_2_YR_1972_s_1	0.0187	0.0012	_	0	8	F	_	_	Estimated	A	F_COM_RR_1972
F_fleet_2_YR_1973_s_1	0.0058	0.0004	_	0	8	F	_	_	Estimated	A	F_COM_RR_1973
F_fleet_2_YR_1974_s_1	0.0320	0.0022	_	0	8	F	_	_	Estimated	A	F_COM_RR_1974
F_fleet_2_YR_1975_s_1	0.0377	0.0027	_	0	8	F	_	_	Estimated	A	F_COM_RR_1975
F_fleet_2_YR_1976_s_1	0.0409	0.0030	_	0	8	F	_	_	Estimated	A	F_COM_RR_1976
F_fleet_2_YR_1977_s_1	0.0319	0.0023	_	0	8	F	_	_	Estimated	A	F_COM_RR_1977
F_fleet_2_YR_1978_s_1	0.0283	0.0020	_	0	8	F	_	_	Estimated	A	F_COM_RR_1978

F_fleet_2_YR_1979_s_1	0.0033	0.0002	_	0	8	F	_	_	Estimated	A	F_COM_RR_1979
F_fleet_2_YR_1980_s_1	0.0047	0.0003	_	0	8	F	_	_	Estimated	A	F_COM_RR_1980
F_fleet_2_YR_1981_s_1	0.0097	0.0006	_	0	8	F	_	_	Estimated	A	F_COM_RR_1981
F_fleet_2_YR_1982_s_1	0.0098	0.0007	_	0	8	F	_	_	Estimated	A	F_COM_RR_1982
F_fleet_2_YR_1983_s_1	0.0089	0.0007	_	0	8	F	_	_	Estimated	A	F_COM_RR_1983
F_fleet_2_YR_1984_s_1	0.0032	0.0002	_	0	8	F	_	_	Estimated	A	F_COM_RR_1984
F_fleet_2_YR_1985_s_1	0.0038	0.0003	_	0	8	F	_	_	Estimated	A	F_COM_RR_1985
F_fleet_2_YR_1986_s_1	0.0020	0.0001	_	0	8	F	_	_	Estimated	A	F_COM_RR_1986
F_fleet_2_YR_1987_s_1	0.0161	0.0010	_	0	8	F	_	_	Estimated	A	F_COM_RR_1987
F_fleet_2_YR_1988_s_1	0.0019	0.0001	_	0	8	F	_	_	Estimated	A	F_COM_RR_1988
F_fleet_2_YR_1989_s_1	0.0045	0.0003	_	0	8	F	_	_	Estimated	A	F_COM_RR_1989
F_fleet_2_YR_1990_s_1	0.0014	0.0001	_	0	8	F	_	_	Estimated	A	F_COM_RR_1990
F_fleet_2_YR_1991_s_1	0.0121	0.0008	_	0	8	F	_	_	Estimated	A	F_COM_RR_1991
F_fleet_2_YR_1992_s_1	0.0027	0.0002	_	0	8	F	_	_	Estimated	A	F_COM_RR_1992
F_fleet_2_YR_1993_s_1	0.0024	0.0002	_	0	8	F	_	_	Estimated	A	F_COM_RR_1993
F_fleet_2_YR_1994_s_1	0.0021	0.0002	_	0	8	F	_	_	Estimated	A	F_COM_RR_1994
F_fleet_2_YR_1995_s_1	0.0022	0.0002	_	0	8	F	_	_	Estimated	A	F_COM_RR_1995
F_fleet_2_YR_1996_s_1	0.0030	0.0002	_	0	8	F	_	_	Estimated	A	F_COM_RR_1996
F_fleet_2_YR_1997_s_1	0.0041	0.0003	_	0	8	F	_	_	Estimated	A	F_COM_RR_1997
F_fleet_2_YR_1998_s_1	0.0049	0.0004	_	0	8	F	_	_	Estimated	A	F_COM_RR_1998
F_fleet_2_YR_1999_s_1	0.0052	0.0004	_	0	8	F	_	_	Estimated	A	F_COM_RR_1999
F_fleet_2_YR_2000_s_1	0.0033	0.0002	_	0	8	F	_	_	Estimated	A	F_COM_RR_2000
F_fleet_2_YR_2001_s_1	0.0061	0.0004	_	0	8	F	_	_	Estimated	A	F_COM_RR_2001
F_fleet_2_YR_2002_s_1	0.0029	0.0002	_	0	8	F	_	_	Estimated	A	F_COM_RR_2002
F_fleet_2_YR_2003_s_1	0.0031	0.0002	_	0	8	F	_	_	Estimated	A	F_COM_RR_2003
F_fleet_2_YR_2004_s_1	0.0028	0.0002	_	0	8	F	_	_	Estimated	A	F_COM_RR_2004
F_fleet_2_YR_2005_s_1	0.0020	0.0002	_	0	8	F	_	_	Estimated	A	F_COM_RR_2005
F_fleet_2_YR_2006_s_1	0.0031	0.0002	_	0	8	F	_	_	Estimated	A	F_COM_RR_2006

F_fleet_2_YR_2007_s_1	0.0013	0.0001	_	0	8	F	_	_	Estimated	A	F_COM_RR_2007
F_fleet_2_YR_2008_s_1	0.0037	0.0003	_	0	8	F	_	_	Estimated	A	F_COM_RR_2008
F_fleet_2_YR_2009_s_1	0.0031	0.0003	_	0	8	F	_	_	Estimated	A	F_COM_RR_2009
F_fleet_2_YR_2010_s_1	0.0056	0.0005	_	0	8	F	_	_	Estimated	A	F_COM_RR_2010
F_fleet_2_YR_2011_s_1	0.0044	0.0004	_	0	8	F	_	_	Estimated	A	F_COM_RR_2011
F_fleet_3_YR_1955_s_1	0.0184	0.0012	_	0	8	F	_	_	Estimated	A	F_REC_1955
F_fleet_3_YR_1956_s_1	0.0210	0.0007	_	0	8	F	_	_	Estimated	A	F_REC_1956
F_fleet_3_YR_1957_s_1	0.0240	0.0008	_	0	8	F	_	_	Estimated	A	F_REC_1957
F_fleet_3_YR_1958_s_1	0.0274	0.0009	_	0	8	F	_	_	Estimated	A	F_REC_1958
F_fleet_3_YR_1959_s_1	0.0314	0.0011	_	0	8	F	_	_	Estimated	A	F_REC_1959
F_fleet_3_YR_1960_s_1	0.0357	0.0014	_	0	8	F	_	_	Estimated	A	F_REC_1960
F_fleet_3_YR_1961_s_1	0.0373	0.0015	_	0	8	F	_	_	Estimated	A	F_REC_1961
F_fleet_3_YR_1962_s_1	0.0389	0.0015	_	0	8	F	_	_	Estimated	A	F_REC_1962
F_fleet_3_YR_1963_s_1	0.0417	0.0017	_	0	8	F	_	_	Estimated	A	F_REC_1963
F_fleet_3_YR_1964_s_1	0.0443	0.0019	_	0	8	F	_	_	Estimated	A	F_REC_1964
F_fleet_3_YR_1965_s_1	0.0463	0.0021	_	0	8	F	_	_	Estimated	A	F_REC_1965
F_fleet_3_YR_1966_s_1	0.0485	0.0022	_	0	8	F	_	_	Estimated	A	F_REC_1966
F_fleet_3_YR_1967_s_1	0.0506	0.0022	_	0	8	F	_	_	Estimated	A	F_REC_1967
F_fleet_3_YR_1968_s_1	0.0536	0.0024	_	0	8	F	_	_	Estimated	A	F_REC_1968
F_fleet_3_YR_1969_s_1	0.0580	0.0027	_	0	8	F	_	_	Estimated	A	F_REC_1969
F_fleet_3_YR_1970_s_1	0.0621	0.0030	_	0	8	F	_	_	Estimated	A	F_REC_1970
F_fleet_3_YR_1971_s_1	0.0684	0.0033	_	0	8	F	_	_	Estimated	A	F_REC_1971
F_fleet_3_YR_1972_s_1	0.0754	0.0037	_	0	8	F	_	_	Estimated	A	F_REC_1972
F_fleet_3_YR_1973_s_1	0.0837	0.0042	_	0	8	F	_	_	Estimated	A	F_REC_1973
F_fleet_3_YR_1974_s_1	0.0938	0.0049	_	0	8	F	_	_	Estimated	A	F_REC_1974
F_fleet_3_YR_1975_s_1	0.1020	0.0055	_	0	8	F	_	_	Estimated	A	F_REC_1975
F_fleet_3_YR_1976_s_1	0.1037	0.0056	_	0	8	F	_	_	Estimated	A	F_REC_1976
F_fleet_3_YR_1977_s_1	0.1048	0.0056	_	0	8	F	_	_	Estimated	A	F_REC_1977

F_fleet_3_YR_1978_s_1	0.1049	0.0055	_	0	8	F	_	_	Estimated	A	F_REC_1978
F_fleet_3_YR_1979_s_1	0.1068	0.0056	_	0	8	F	_	_	Estimated	A	F_REC_1979
F_fleet_3_YR_1980_s_1	0.1072	0.0055	_	0	8	F	_	_	Estimated	A	F_REC_1980
F_fleet_3_YR_1981_s_1	0.1010	0.0053	_	0	8	F	_	_	Estimated	A	F_REC_1981
F_fleet_3_YR_1982_s_1	0.1801	0.0105	_	0	8	F	_	_	Estimated	A	F_REC_1982
F_fleet_3_YR_1983_s_1	0.1342	0.0079	_	0	8	F	_	_	Estimated	A	F_REC_1983
F_fleet_3_YR_1984_s_1	0.0529	0.0031	_	0	8	F	_	_	Estimated	A	F_REC_1984
F_fleet_3_YR_1985_s_1	0.0632	0.0033	_	0	8	F	_	_	Estimated	A	F_REC_1985
F_fleet_3_YR_1986_s_1	0.3433	0.0179	_	0	8	F	_	_	Estimated	A	F_REC_1986
F_fleet_3_YR_1987_s_1	0.1127	0.0060	_	0	8	F	_	_	Estimated	A	F_REC_1987
F_fleet_3_YR_1988_s_1	0.1038	0.0055	_	0	8	F	_	_	Estimated	A	F_REC_1988
F_fleet_3_YR_1989_s_1	0.0799	0.0044	_	0	8	F	_	_	Estimated	A	F_REC_1989
F_fleet_3_YR_1990_s_1	0.0974	0.0053	_	0	8	F	_	_	Estimated	A	F_REC_1990
F_fleet_3_YR_1991_s_1	0.0957	0.0052	_	0	8	F	_	_	Estimated	A	F_REC_1991
F_fleet_3_YR_1992_s_1	0.1287	0.0073	_	0	8	F	_	_	Estimated	A	F_REC_1992
F_fleet_3_YR_1993_s_1	0.1478	0.0093	_	0	8	F	_	_	Estimated	A	F_REC_1993
F_fleet_3_YR_1994_s_1	0.1631	0.0111	_	0	8	F	_	_	Estimated	A	F_REC_1994
F_fleet_3_YR_1995_s_1	0.1422	0.0102	_	0	8	F	_	_	Estimated	A	F_REC_1995
F_fleet_3_YR_1996_s_1	0.1604	0.0113	_	0	8	F	_	_	Estimated	A	F_REC_1996
F_fleet_3_YR_1997_s_1	0.1447	0.0098	_	0	8	F	_	_	Estimated	A	F_REC_1997
F_fleet_3_YR_1998_s_1	0.1257	0.0080	_	0	8	F	_	_	Estimated	A	F_REC_1998
F_fleet_3_YR_1999_s_1	0.1488	0.0090	_	0	8	F	_	_	Estimated	A	F_REC_1999
F_fleet_3_YR_2000_s_1	0.1552	0.0090	_	0	8	F	_	_	Estimated	A	F_REC_2000
F_fleet_3_YR_2001_s_1	0.2214	0.0130	_	0	8	F	_	_	Estimated	A	F_REC_2001
F_fleet_3_YR_2002_s_1	0.1755	0.0108	_	0	8	F	_	_	Estimated	A	F_REC_2002
F_fleet_3_YR_2003_s_1	0.1302	0.0085	_	0	8	F	_	_	Estimated	A	F_REC_2003
F_fleet_3_YR_2004_s_1	0.1673	0.0119	_	0	8	F	_	_	Estimated	A	F_REC_2004
F_fleet_3_YR_2005_s_1	0.0835	0.0061	_	0	8	F	_	_	Estimated	A	F_REC_2005

F_fleet_3_YR_2006_s_1	0.1127	0.0084	_	0	8	F	_	_	Estimated	A	F_REC_2006
F_fleet_3_YR_2007_s_1	0.0843	0.0064	_	0	8	F	_	_	Estimated	A	F_REC_2007
F_fleet_3_YR_2008_s_1	0.1115	0.0089	_	0	8	F	_	_	Estimated	A	F_REC_2008
F_fleet_3_YR_2009_s_1	0.0853	0.0072	_	0	8	F	_	_	Estimated	A	F_REC_2009
F_fleet_3_YR_2010_s_1	0.0890	0.0080	_	0	8	F	_	_	Estimated	A	F_REC_2010
F_fleet_3_YR_2011_s_1	0.0773	0.0075	_	0	8	F	_	_	Estimated	A	F_REC_2011
F_fleet_4_YR_1945_s_1	0.0001	0.0000	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1945
F_fleet_4_YR_1946_s_1	0.0007	0.0001	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1946
F_fleet_4_YR_1947_s_1	0.0034	0.0005	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1947
F_fleet_4_YR_1948_s_1	0.0089	0.0012	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1948
F_fleet_4_YR_1949_s_1	0.0144	0.0019	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1949
F_fleet_4_YR_1950_s_1	0.0257	0.0034	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1950
F_fleet_4_YR_1951_s_1	0.0326	0.0043	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1951
F_fleet_4_YR_1952_s_1	0.0385	0.0051	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1952
F_fleet_4_YR_1953_s_1	0.0398	0.0053	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1953
F_fleet_4_YR_1954_s_1	0.0518	0.0069	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1954
F_fleet_4_YR_1955_s_1	0.0512	0.0068	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1955
F_fleet_4_YR_1956_s_1	0.0657	0.0088	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1956
F_fleet_4_YR_1957_s_1	0.0767	0.0102	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1957
F_fleet_4_YR_1958_s_1	0.0993	0.0132	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1958
F_fleet_4_YR_1959_s_1	0.1067	0.0142	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1959
F_fleet_4_YR_1960_s_1	0.1066	0.0142	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1960
F_fleet_4_YR_1961_s_1	0.0658	0.0088	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1961
F_fleet_4_YR_1962_s_1	0.1132	0.0150	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1962
F_fleet_4_YR_1963_s_1	0.1279	0.0170	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1963
F_fleet_4_YR_1964_s_1	0.1502	0.0199	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1964
F_fleet_4_YR_1965_s_1	0.0974	0.0129	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1965
F_fleet_4_YR_1966_s_1	0.0822	0.0109	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1966

F_fleet_4_YR_1967_s_1	0.0982	0.0130	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1967
F_fleet_4_YR_1968_s_1	0.1144	0.0151	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1968
F_fleet_4_YR_1969_s_1	0.1244	0.0163	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1969
F_fleet_4_YR_1970_s_1	0.0877	0.0115	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1970
F_fleet_4_YR_1971_s_1	0.0986	0.0129	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1971
F_fleet_4_YR_1972_s_1	0.1329	0.0169	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1972
F_fleet_4_YR_1973_s_1	0.1342	0.0170	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1973
F_fleet_4_YR_1974_s_1	0.1363	0.0172	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1974
F_fleet_4_YR_1975_s_1	0.1052	0.0133	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1975
F_fleet_4_YR_1976_s_1	0.1388	0.0171	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1976
F_fleet_4_YR_1977_s_1	0.1610	0.0193	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1977
F_fleet_4_YR_1978_s_1	0.1954	0.0221	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1978
F_fleet_4_YR_1979_s_1	0.1884	0.0204	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1979
F_fleet_4_YR_1980_s_1	0.1643	0.0191	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1980
F_fleet_4_YR_1981_s_1	0.2493	0.0341	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1981
F_fleet_4_YR_1982_s_1	0.2276	0.0301	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1982
F_fleet_4_YR_1983_s_1	0.2489	0.0325	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1983
F_fleet_4_YR_1984_s_1	0.2374	0.0296	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1984
F_fleet_4_YR_1985_s_1	0.2509	0.0308	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1985
F_fleet_4_YR_1986_s_1	0.2680	0.0341	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1986
F_fleet_4_YR_1987_s_1	0.3030	0.0384	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1987
F_fleet_4_YR_1988_s_1	0.2255	0.0288	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1988
F_fleet_4_YR_1989_s_1	0.2793	0.0356	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1989
F_fleet_4_YR_1990_s_1	0.3040	0.0410	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1990
F_fleet_4_YR_1991_s_1	0.2954	0.0396	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1991
F_fleet_4_YR_1992_s_1	0.2917	0.0429	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1992
F_fleet_4_YR_1993_s_1	0.2445	0.0337	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1993
F_fleet_4_YR_1994_s_1	0.2616	0.0356	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1994

F_fleet_4_YR_1995_s_1	0.2167	0.0292	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1995
F_fleet_4_YR_1996_s_1	0.2358	0.0319	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1996
F_fleet_4_YR_1997_s_1	0.2361	0.0315	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1997
F_fleet_4_YR_1998_s_1	0.2509	0.0328	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1998
F_fleet_4_YR_1999_s_1	0.2662	0.0351	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_1999
F_fleet_4_YR_2000_s_1	0.2339	0.0307	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_2000
F_fleet_4_YR_2001_s_1	0.2259	0.0297	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_2001
F_fleet_4_YR_2002_s_1	0.2013	0.0269	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_2002
F_fleet_4_YR_2003_s_1	0.1615	0.0215	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_2003
F_fleet_4_YR_2004_s_1	0.1239	0.0166	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_2004
F_fleet_4_YR_2005_s_1	0.0728	0.0097	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_2005
F_fleet_4_YR_2006_s_1	0.0979	0.0131	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_2006
F_fleet_4_YR_2007_s_1	0.0948	0.0126	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_2007
F_fleet_4_YR_2008_s_1	0.0810	0.0107	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_2008
F_fleet_4_YR_2009_s_1	0.0939	0.0124	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_2009
F_fleet_4_YR_2010_s_1	0.0664	0.0088	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_2010
F_fleet_4_YR_2011_s_1	0.0620	0.0082	_	0	8	F	_	_	Estimated	A	F_SHRIMP BYCATCH_2011
Q_base_4_Shrimp_Bycatch_4	1.9460	0.0460	1	-10	20	No_prior	_	_	Estimated	A	Q Shrimp Bycatch fishery
SizeSel_1P_1_Com_GN_1	45.0000	559.0140	45	20	70	No_prior	_	_	Estimated	A	COM_GN size select peak
SizeSel_1P_2_Com_GN_1	-0.0002	447.2100	-1.5	-20	20	No_prior	_	_	Estimated	A	COM_GN size select top
SizeSel_1P_3_Com_GN_1	-2.5000	391.3090	5	-20	15	No_prior	_	_	Estimated	A	COM_GN size select ascending width
SizeSel_1P_4_Com_GN_1	6.5000	190.0620	4	-2	15	No_prior	_	_	Estimated	A	COM_GN size select descending width
SizeSel_1P_5_Com_GN_1	-999.0000	_	-999	-1000	15	No_prior	_	_	Fixed	NA	COM_GN select initial
SizeSel_1P_6_Com_GN_1	-999.0000	_	-999	-1000	15	No_prior	_	_	Fixed	NA	COM_GN select final
SizeSel_2P_1_Com_RR_2	55.0000	_	55	10	70	No_prior	_	_	Fixed	NA	COM_RR size select peak
SizeSel_2P_2_Com_RR_2	10.0000	_	10	-20	15	No_prior	_	_	Fixed	NA	COM_RR size select top
SizeSel_2P_3_Com_RR_2	5.0616	0.0509	6.1	-20	12	No_prior	_	_	Estimated	A	COM_RR size select ascending width

SizeSel_2P_4_Com_RR_2	-4.0000	_	-4	-5	15	No_prior	_	_	Fixed	NA	COM_RR size select descending width
SizeSel_2P_5_Com_RR_2	-999.0000	_	-999	-1000	15	No_prior	_	_	Fixed	NA	COM_RR select initial
SizeSel_2P_6_Com_RR_2	15.0000	_	15	-15	15	No_prior	_	_	Fixed	NA	COM_RR select final
Retain_2P_1_Com_RR_2	30.0000	_	30	7	99	No_prior	_	_	Fixed	NA	COM_RR retention inflection Period 1
Retain_2P_2_Com_RR_2	4.5000	_	4.5	-1	20	No_prior	_	_	Fixed	NA	COM_RR retention inflection Period 2
Retain_2P_3_Com_RR_2	0.9900	_	0.99	0.1	1	No_prior	_	_	Fixed	NA	COM_RR retention slope Period 1
Retain_2P_4_Com_RR_2	0.0000	_	0	-1	2	No_prior	_	_	Fixed	NA	COM_RR retention slope Period 2
DiscMort_2P_1_Com_RR_2	-4.0000	_	-4	-10	30	No_prior	_	_	Fixed	NA	COM_RR discard mortality Period 1 inflection
DiscMort_2P_2_Com_RR_2	1.0000	_	1	-1	2	No_prior	_	_	Fixed	NA	COM_RR discard mortality Period 2 inflection
DiscMort_2P_3_Com_RR_2	0.1000	_	0.1	-1	2	No_prior	_	_	Fixed	NA	COM_RR discard mortality Period 1 slope
DiscMort_2P_4_Com_RR_2	0.0000	_	0	-1	2	No_prior	_	_	Fixed	NA	COM_RR discard mortality Period 2 slope
SizeSel_3P_1_REC_3	38.4093	1.0406	40	7	99	No_prior	_	_	Estimated	A	REC size select peak
SizeSel_3P_2_REC_3	10.0000	_	10	-20	15	No_prior	_	_	Fixed	NA	REC size select top
SizeSel_3P_3_REC_3	5.0377	0.1724	6.6	-10	12	No_prior	_	_	Estimated	A	REC size select ascending width
SizeSel_3P_4_REC_3	-4.0000	_	-4	-5	15	No_prior	_	_	Fixed	NA	REC size select descending width
SizeSel_3P_5_REC_3	-999.0000	_	-999	-1000	15	No_prior	_	_	Fixed	NA	REC select initial
SizeSel_3P_6_REC_3	15.0000	_	15	-15	15	No_prior	_	_	Fixed	NA	REC select final
Retain_3P_1_REC_3	30.0000	_	30	7	99	No_prior	_	_	Fixed	NA	REC retention inflection Period 1
Retain_3P_2_REC_3	4.5000	_	4.5	-1	15	No_prior	_	_	Fixed	NA	Rec retention inflection Period 2
Retain_3P_3_REC_3	0.9900	_	0.99	0.1	1	No_prior	_	_	Fixed	NA	REC retention slope Period 1
Retain_3P_4_REC_3	0.0000	_	0	0	2	No_prior	_	_	Fixed	NA	REC retention slope Period 2
DiscMort_3P_1_REC_3	-4.0000	_	-4	-10	30	No_prior	_	_	Fixed	NA	REC discard mortality Period 1 inflection
DiscMort_3P_2_REC_3	1.0000	_	1	0	2	No_prior	_	_	Fixed	NA	REC discard mortality Period 2 inflection
DiscMort_3P_3_REC_3	0.2000	_	0.2	0	2	No_prior	_	_	Fixed	NA	REC discard mortality Period 1 slope
DiscMort_3P_4_REC_3	0.0000	_	0	-1	2	No_prior	_	_	Fixed	NA	REC discard mortality Period 2 slope
SizeSel_4P_1_Shrimp_Bycatch_4	19.3447	0.8075	20	10	70	No_prior	_	_	Estimated	A	SHRIMP BYCATCHJ size select peak

SizeSel_4P_2_Shrimp_Bycatch_4	-11.3590	57.5102	-12	-15	3	No_prior	_	_	Estimated	A	SHRIMP BYCATCH size select top
SizeSel_4P_3_Shrimp_Bycatch_4	4.1776	0.2128	3.9	-20	12	No_prior	_	_	Estimated	A	SHRIMP BYCATCH size select ascending width
SizeSel_4P_4_Shrimp_Bycatch_4	7.1720	0.1617	5	-2	12	No_prior	_	_	Estimated	A	SHRIMP BYCATCH size select descending width
SizeSel_4P_5_Shrimp_Bycatch_4	-999.0000	_	-999	-999	15	No_prior	_	_	Fixed	NA	SHRIMP BYCACH select initial
SizeSel_4P_6_Shrimp_Bycatch_4	-999.0000	_	-999	-999	15	No_prior	_	_	Fixed	NA	SHRIMP BYCATCH select final
SizeSel_5P_1_MRFSS_5	1.0000	_	1	1	49	No_prior	_	_	Mirror REC	NA	MRFFS SURVEY size select min length bin
SizeSel_5P_2_MRFSS_5	49.0000	_	49	1	49	No_prior	_	_	Mirror REC	NA	MRFFS SURVEY size select max length bin
SizeSel_8P_1_COM_FWC_VERT_LINE_8	1.0000	_	1	1	49	No_prior	_	_	Mirror COM_RR	NA	FWC SURVEY size select min length bin
SizeSel_8P_2_COM_FWC_VERT_LINE_8	49.0000	_	49	1	49	No_prior	_	_	Mirror COM_RR	NA	FWC SURVEY size select max length bin
SizeSel_9P_1_SEAMAP_Survey_9	1.0000	_	1	1	49	No_prior	_	_	Mirror Shrimp Bycatch	NA	SEAMAP SURVEY size select min length bin
SizeSel_9P_2_SEAMAP_Survey_9	49.0000	_	49	1	49	No_prior	_	_	Mirror Shrimp Bycatch	NA	SEAMAP SURVEY size select max length bin
AgeSel_1P_1_Com_GN_1	0.0000	_	0	0	12	No_prior	_	_	Fixed	NA	COM_GN age select min age
AgeSel_1P_2_Com_GN_1	12.0000	_	12	0	12	No_prior	_	_	Fixed	NA	COM_GN age select max age
SizeSel_1P_1_Com_GN_1_BLK1repl_1886	47.8903	1.0154	45	20	70	No_prior	_	_	Estimated	A	COM_GN TIME BLOCK 1 PEAK
SizeSel_1P_1_Com_GN_1_BLK1repl_2006	39.3328	0.7705	45	20	70	No_prior	_	_	Estimated	A	COM_GN TIME BLOCK 2 peak
SizeSel_1P_2_Com_GN_1_BLK1repl_1886	3.1249	436.4340	-1.5	-20	20	No_prior	_	_	Estimated	A	COM_GN TIME BLOCK 1 top
SizeSel_1P_2_Com_GN_1_BLK1repl_2006	-10.6749	111.5510	-1.5	-20	20	No_prior	_	_	Estimated	A	COM_GN TIME BLOCK 2 top
SizeSel_1P_3_Com_GN_1_BLK1repl_1886	4.2679	0.1489	5	-20	15	No_prior	_	_	Estimated	A	COM_GN TIME BLOCK 1 ascending width
SizeSel_1P_3_Com_GN_1_BLK1repl_2006	3.7890	0.1680	5	-20	15	No_prior	_	_	Estimated	A	COM_GN TIME BLOCK W ascending width
SizeSel_1P_4_Com_GN_1_BLK1repl_1886	12.7205	88.2746	4	-2	15	No_prior	_	_	Estimated	A	COM_GN TIME BLOCK 1 descending width
SizeSel_1P_4_Com_GN_1_BLK1repl_2006	5.9846	0.2407	4	-2	15	No_prior	_	_	Estimated	A	COM_GN TIME BLOCK 2 descending width
Retain_2P_1_Com_RR_2_BLK2repl_1886	16.6124	23.1932	26	7	99	No_prior	_	_	Estimated	A	COM_RR TIME BLOCK 1 Retention inflection
Retain_2P_1_Com_RR_2_BLK2repl_1993	32.0127	3.9123	30.5	7	55	No_prior	_	_	Estimated	A	COM_RR TIME BLOCK 2 Retention inflection
Retain_2P_2_Com_RR_2_BLK2repl_1886	0.0500	_	0.05	0.005	30	No_prior	_	_	Fixed	NA	COM_RR TIME BLOCK 1 Retention slope

Retain_2P_2_Com_RR_2_BLK2repl_1993	11.6318	2.7992	0.05	0.005	30	No_prior	_	_	Estimated	A	COM_RR TIME BLOCK 2 Retention slope
Retain_3P_1_REC_3_BLK2repl_1886	31.0875	0.3253	26	7	75	No_prior	_	_	Estimated	A	REC TIME BLOCK 1 Retention inflection
Retain_3P_1_REC_3_BLK2repl_1993	38.2588	0.3561	30.5	7	55	No_prior	_	_	Estimated	A	REC TIME BLOCK 2 Retention inflection
Retain_3P_2_REC_3_BLK2repl_1886	1.7882	0.1629	2.05	0.005	30	No_prior	_	_	Estimated	A	REC TIME BLOCK 1 Retention slope
Retain_3P_2_REC_3_BLK2repl_1993	4.2409	0.2907	2.05	0.005	30	No_prior	_	_	Estimated	A	REC TIME BLOCK 2 Retention slope

Table 3.2. Description of initial model runs and alternative runs (sensitivity, data exclusion, reweighting, and retrospective) conducted for the Gulf of Mexico Spanish mackerel SS evaluation.

Run	Name	Key	Description
1	Run 1 Configuration	Initial Model, Estimated Steepness, M = DW point estimate ($0.3y^{-1}$)	Estimated growth, M=0.38 input into Lorenzen scaled to age 4, estimate steepness, estimate virgin stock (R0), estimate recruitment deviations (1985-2010), input discards as discards (thousands of fish 1 super period (shrimp bycatch fishery), fractions directed fishery (1 super period commercial line gears (COM_RR), 3 super periods (recreational (REC)), 2 time varying selectivity/retention blocks commercial line gear (COM_RR) and recreational all modes (REC): pre 1993, 1993-2011, 2 time varying selectivity blocks commercial gillnet fleet (COM_GN) pre 2006, 2006-2011.
2	Run 1 Configuration, Steepness=0.9	Sensitivity on estimation of Steepness	Run 1 Configuration, M = $0.38y^{-1}$, except Beverton and Holt steepness parameter fixed at 0. 9.
3	Run 1 Configuration, Steepness=0.8	Sensitivity on estimation of Steepness	Run 1 Configuration, M = $0.38y^{-1}$, except Beverton and Holt steepness parameter fixed at 0.8.
4	Run 1 Configuration, Steepness=0.7	Sensitivity on estimation of Steepness	Run 1 Configuration, M = $0.38y^{-1}$, except Beverton and Holt steepness parameter fixed at 0.7.
5	Run 3 Configuration, M HI	Sensitivity on M	Run 3 Model Configuration (Steepness = 0.8), M SENS HI (M = $0.49y^{-1}$) sensitivity with M value input into Lorenzen function
6	Run 3 Configuration, M LO	Sensitivity on M	Run 3 Model Configuration (Steepness = 0.8), M SENS LO 2 (M = $0.27y^{-1}$) sensitivity with M value input into Lorenzen function.
7	Run 3 Configuration, M REF Age 3	Sensitivity on M	Run 3 Model Configuration (Steepness = 0.8), M ($0.38y^{-1}$), Reference (REF) Age 3 with reference scaling age in Lorenzen function.
8	Run 3 Configuration, Discard Mortality	Sensitivity on Discard Mortality	Run 3 Model Configuration (Steepness parameter = 0.8), M = $0.38y^{-1}$, discard release mortality varied from 10% to 20% for COM_RR and from 20% 40% for REC)
9	Run 3 Configuration, NO MRFSS	Sensitivity on data exclusion	Run 3 Model Configuration (Steepness parameter = 0.8), M = $0.38y^{-1}$, exclusion of MRFSS index.
10	Run 3 Configuration, NO FWC	Sensitivity on data exclusion	Run 3 Model Configuration (Steepness parameter = 0.8), M = $0.38y^{-1}$, exclusion of FWC Trip Ticket index.
11	Run 3 Configuration, NO SEAMAP Survey	Sensitivity on data exclusion	Run 3 Model Configuration (Steepness parameter = 0.8), M = $0.38y^{-1}$, exclusion of SEAMAP Survey Index.
12	Run 1 Configuration, SS Reweighting	Sensitivity on data component weighting	Initial Model M ($0.38y^{-1}$), with SS reweighting of abundance indices, age composition, and length composition components. Steepness parameter estimated in this run.
13	Run 3 Configuration, RETRO_2010	Retrospective Analysis	Run 3 Model Configuration (Steepness = 0.8, M =$0.38y^{-1}$), RETROSPECTIVE 2010, 2011 data excluded.
14	Run 3 Configuration, RETRO_2009	Retrospective Analysis	Run 3 Model Configuration (Steepness = 0.8, M =$0.38y^{-1}$), 2010-2011 data excluded.
15	Run 3 Configuration, RETRO_2008	Retrospective Analysis	Run 3 Model Configuration (Steepness = 0.8, M =$0.38y^{-1}$), 2009-2011 data excluded.
16	Run 3 Configuration, RETRO_2007	Retrospective Analysis	Run 3 Model Configuration (Steepness = 0.8, M =$0.38y^{-1}$), 2008-2011 data excluded.
17	Run 3 Configuration, RETRO_2006	Retrospective Analysis	Run 3 Model Configuration (Steepness = 0.8, M =$0.38y^{-1}$), 2007-2011 data excluded.

Table 3.3. Mean and standard deviation of parameter estimates from 1,000 bootstrap samples for Gulf of Mexico Spanish mackerel for 1,000 bootstrap runs for Run 3 (Model is Run 1 configuration except steepness fixed at 0.8). Run 3 assumed M = 0.38 value was input into Lorenzen function.

Parameter	Average	Standard error	Status
L_at_Amax_Fem_GP_1	59.9556	0.8473	Estimated
L_at_Amin_Fem_GP_1	19.3014	0.4963	Estimated
VonBert_K_Fem_GP_1	0.3004	0.0132	Estimated
CV_old_Fem_GP_1	9.7682	0.3243	Estimated
CV_young_Fem_GP_1	6.9883	0.2520	Estimated
Wtlen_1_Fem	0.0000	-	Fixed
Wtlen_2_Fem	2.8617	-	Fixed
AgeSel_1P_2_Com_GN_1	12.0000	-	Fixed
Eggs/kg_inter_Fem	1.0000	-	Fixed
Eggs/kg_slope_wt_Fem	0.0000	-	Fixed
SR_autocorr	0.0000	-	Fixed
SR_BH_steep	0.8000	-	Fixed
SR_envlink	0.1000	-	Fixed
SR_LN(R0)	10.7914	0.0204	Estimated
SR_R1_offset	0.0000	-	Fixed
SR_sigmaR	0.7000	-	Fixed
Main_RecrDev_1985	0.3274	0.0888	Estimated
Main_RecrDev_1986	-0.1076	0.0793	Estimated
Main_RecrDev_1987	-0.3025	0.0715	Estimated
Main_RecrDev_1988	-0.1257	0.0621	Estimated
Main_RecrDev_1989	0.3444	0.0564	Estimated
Main_RecrDev_1990	0.3130	0.0603	Estimated
Main_RecrDev_1991	0.4148	0.0548	Estimated
Main_RecrDev_1992	-0.5065	0.0825	Estimated
Main_RecrDev_1993	-0.1727	0.0740	Estimated
Main_RecrDev_1994	-0.7947	0.0982	Estimated
Main_RecrDev_1995	0.0062	0.0788	Estimated
Main_RecrDev_1996	0.0680	0.0800	Estimated
Main_RecrDev_1997	-0.1781	0.0808	Estimated
Main_RecrDev_1998	0.4302	0.0641	Estimated
Main_RecrDev_1999	-0.0543	0.0749	Estimated
Main_RecrDev_2000	0.1123	0.0639	Estimated
Main_RecrDev_2001	0.0629	0.0621	Estimated
Main_RecrDev_2002	-0.0579	0.0639	Estimated
Main_RecrDev_2003	0.1803	0.0607	Estimated

Main_RecrDev_2004	0.1062	0.0643	Estimated
Main_RecrDev_2005	0.0338	0.0628	Estimated
Main_RecrDev_2006	-0.2962	0.0705	Estimated
Main_RecrDev_2007	0.2547	0.0652	Estimated
Main_RecrDev_2008	0.0009	0.0812	Estimated
Main_RecrDev_2009	-0.2599	0.1039	Estimated
Main_RecrDev_2010	0.4654	0.1114	Estimated
Main_RecrDev_2011	-0.2646	0.2308	Estimated
InitF_1Com_GN_1	0.0000	-	Fixed
InitF_2Com_RR_2	0.0000	-	Fixed
InitF_3REC_3	0.0000	-	Fixed
InitF_4Shrimp_Bycatch_4	0.0000	-	Fixed
Mat_slope_Fem	-0.0650	-	Fixed
Mat50%_Fem	31.0000	-	Fixed
Q_base_4_Shrimp_Bycatch_4	2.0299	0.0493	Estimated
RecrDist_Area_1	0.0000	-	Fixed
RecrDist_GP_1	0.0000	-	Fixed
RecrDist_Seas_1	0.0000	-	Fixed
F_fleet_1_YR_1886_s_1	0.0008	0.0001	Estimated
F_fleet_1_YR_1887_s_1	0.0017	0.0001	Estimated
F_fleet_1_YR_1888_s_1	0.0033	0.0002	Estimated
F_fleet_1_YR_1889_s_1	0.0064	0.0003	Estimated
F_fleet_1_YR_1890_s_1	0.0074	0.0004	Estimated
F_fleet_1_YR_1891_s_1	0.0078	0.0004	Estimated
F_fleet_1_YR_1892_s_1	0.0078	0.0004	Estimated
F_fleet_1_YR_1893_s_1	0.0079	0.0004	Estimated
F_fleet_1_YR_1894_s_1	0.0079	0.0004	Estimated
F_fleet_1_YR_1895_s_1	0.0079	0.0004	Estimated
F_fleet_1_YR_1896_s_1	0.0079	0.0004	Estimated
F_fleet_1_YR_1897_s_1	0.0082	0.0004	Estimated
F_fleet_1_YR_1898_s_1	0.0106	0.0005	Estimated
F_fleet_1_YR_1899_s_1	0.0106	0.0005	Estimated
F_fleet_1_YR_1900_s_1	0.0107	0.0005	Estimated
F_fleet_1_YR_1901_s_1	0.0107	0.0005	Estimated
F_fleet_1_YR_1902_s_1	0.0174	0.0008	Estimated
F_fleet_1_YR_1903_s_1	0.0169	0.0008	Estimated
F_fleet_1_YR_1904_s_1	0.0170	0.0008	Estimated
F_fleet_1_YR_1905_s_1	0.0171	0.0008	Estimated
F_fleet_1_YR_1906_s_1	0.0171	0.0008	Estimated
F_fleet_1_YR_1907_s_1	0.0172	0.0008	Estimated
F_fleet_1_YR_1908_s_1	0.0167	0.0008	Estimated

F_fleet_1_YR_1909_s_1	0.0175	0.0008	Estimated
F_fleet_1_YR_1910_s_1	0.0204	0.0010	Estimated
F_fleet_1_YR_1911_s_1	0.0233	0.0011	Estimated
F_fleet_1_YR_1912_s_1	0.0263	0.0012	Estimated
F_fleet_1_YR_1913_s_1	0.0293	0.0014	Estimated
F_fleet_1_YR_1914_s_1	0.0324	0.0015	Estimated
F_fleet_1_YR_1915_s_1	0.0356	0.0017	Estimated
F_fleet_1_YR_1916_s_1	0.0388	0.0018	Estimated
F_fleet_1_YR_1917_s_1	0.0409	0.0019	Estimated
F_fleet_1_YR_1918_s_1	0.0418	0.0020	Estimated
F_fleet_1_YR_1919_s_1	0.0428	0.0020	Estimated
F_fleet_1_YR_1920_s_1	0.0445	0.0021	Estimated
F_fleet_1_YR_1921_s_1	0.0462	0.0022	Estimated
F_fleet_1_YR_1922_s_1	0.0466	0.0022	Estimated
F_fleet_1_YR_1923_s_1	0.0470	0.0022	Estimated
F_fleet_1_YR_1924_s_1	0.0501	0.0024	Estimated
F_fleet_1_YR_1925_s_1	0.0536	0.0026	Estimated
F_fleet_1_YR_1926_s_1	0.0572	0.0027	Estimated
F_fleet_1_YR_1927_s_1	0.0595	0.0028	Estimated
F_fleet_1_YR_1928_s_1	0.0412	0.0020	Estimated
F_fleet_1_YR_1929_s_1	0.0444	0.0021	Estimated
F_fleet_1_YR_1930_s_1	0.0520	0.0025	Estimated
F_fleet_1_YR_1931_s_1	0.0293	0.0014	Estimated
F_fleet_1_YR_1932_s_1	0.0358	0.0017	Estimated
F_fleet_1_YR_1933_s_1	0.0390	0.0018	Estimated
F_fleet_1_YR_1934_s_1	0.0429	0.0020	Estimated
F_fleet_1_YR_1935_s_1	0.0532	0.0025	Estimated
F_fleet_1_YR_1936_s_1	0.0648	0.0031	Estimated
F_fleet_1_YR_1937_s_1	0.0495	0.0024	Estimated
F_fleet_1_YR_1938_s_1	0.0511	0.0024	Estimated
F_fleet_1_YR_1939_s_1	0.0535	0.0026	Estimated
F_fleet_1_YR_1940_s_1	0.0460	0.0022	Estimated
F_fleet_1_YR_1941_s_1	0.0010	0.0000	Estimated
F_fleet_1_YR_1942_s_1	0.0010	0.0000	Estimated
F_fleet_1_YR_1943_s_1	0.0010	0.0000	Estimated
F_fleet_1_YR_1944_s_1	0.0010	0.0000	Estimated
F_fleet_1_YR_1945_s_1	0.0010	0.0000	Estimated
F_fleet_1_YR_1946_s_1	0.0009	0.0000	Estimated
F_fleet_1_YR_1947_s_1	0.0009	0.0000	Estimated
F_fleet_1_YR_1948_s_1	0.0099	0.0005	Estimated
F_fleet_1_YR_1949_s_1	0.0434	0.0021	Estimated

F_fleet_1_YR_1950_s_1	0.0299	0.0014	Estimated
F_fleet_1_YR_1951_s_1	0.0783	0.0038	Estimated
F_fleet_1_YR_1952_s_1	0.0571	0.0028	Estimated
F_fleet_1_YR_1953_s_1	0.0388	0.0019	Estimated
F_fleet_1_YR_1954_s_1	0.0384	0.0019	Estimated
F_fleet_1_YR_1955_s_1	0.0221	0.0011	Estimated
F_fleet_1_YR_1956_s_1	0.0410	0.0020	Estimated
F_fleet_1_YR_1957_s_1	0.0538	0.0027	Estimated
F_fleet_1_YR_1958_s_1	0.0606	0.0031	Estimated
F_fleet_1_YR_1959_s_1	0.0789	0.0041	Estimated
F_fleet_1_YR_1960_s_1	0.0995	0.0054	Estimated
F_fleet_1_YR_1961_s_1	0.0771	0.0043	Estimated
F_fleet_1_YR_1962_s_1	0.1448	0.0081	Estimated
F_fleet_1_YR_1963_s_1	0.1229	0.0070	Estimated
F_fleet_1_YR_1964_s_1	0.0912	0.0053	Estimated
F_fleet_1_YR_1965_s_1	0.1162	0.0070	Estimated
F_fleet_1_YR_1966_s_1	0.1752	0.0107	Estimated
F_fleet_1_YR_1967_s_1	0.1519	0.0093	Estimated
F_fleet_1_YR_1968_s_1	0.1917	0.0118	Estimated
F_fleet_1_YR_1969_s_1	0.2364	0.0149	Estimated
F_fleet_1_YR_1970_s_1	0.2465	0.0161	Estimated
F_fleet_1_YR_1971_s_1	0.2344	0.0155	Estimated
F_fleet_1_YR_1972_s_1	0.1974	0.0131	Estimated
F_fleet_1_YR_1973_s_1	0.2023	0.0137	Estimated
F_fleet_1_YR_1974_s_1	0.2668	0.0188	Estimated
F_fleet_1_YR_1975_s_1	0.1772	0.0128	Estimated
F_fleet_1_YR_1976_s_1	0.2613	0.0191	Estimated
F_fleet_1_YR_1977_s_1	0.0755	0.0055	Estimated
F_fleet_1_YR_1978_s_1	0.0410	0.0029	Estimated
F_fleet_1_YR_1979_s_1	0.0752	0.0052	Estimated
F_fleet_1_YR_1980_s_1	0.0672	0.0047	Estimated
F_fleet_1_YR_1981_s_1	0.1323	0.0092	Estimated
F_fleet_1_YR_1982_s_1	0.1358	0.0098	Estimated
F_fleet_1_YR_1983_s_1	0.0948	0.0070	Estimated
F_fleet_1_YR_1984_s_1	0.1586	0.0116	Estimated
F_fleet_1_YR_1985_s_1	0.0901	0.0062	Estimated
F_fleet_1_YR_1986_s_1	0.1296	0.0085	Estimated
F_fleet_1_YR_1987_s_1	0.1415	0.0093	Estimated
F_fleet_1_YR_1988_s_1	0.1317	0.0085	Estimated
F_fleet_1_YR_1989_s_1	0.1862	0.0122	Estimated
F_fleet_1_YR_1990_s_1	0.1543	0.0103	Estimated

F_fleet_1_YR_1991_s_1	0.1842	0.0123	Estimated
F_fleet_1_YR_1992_s_1	0.1955	0.0133	Estimated
F_fleet_1_YR_1993_s_1	0.1381	0.0097	Estimated
F_fleet_1_YR_1994_s_1	0.1619	0.0120	Estimated
F_fleet_1_YR_1995_s_1	0.0981	0.0078	Estimated
F_fleet_1_YR_1996_s_1	0.0256	0.0020	Estimated
F_fleet_1_YR_1997_s_1	0.0312	0.0024	Estimated
F_fleet_1_YR_1998_s_1	0.0235	0.0017	Estimated
F_fleet_1_YR_1999_s_1	0.0425	0.0030	Estimated
F_fleet_1_YR_2000_s_1	0.0420	0.0029	Estimated
F_fleet_1_YR_2001_s_1	0.0521	0.0037	Estimated
F_fleet_1_YR_2002_s_1	0.0423	0.0031	Estimated
F_fleet_1_YR_2003_s_1	0.0615	0.0046	Estimated
F_fleet_1_YR_2004_s_1	0.0426	0.0032	Estimated
F_fleet_1_YR_2005_s_1	0.0529	0.0041	Estimated
F_fleet_1_YR_2006_s_1	0.0398	0.0031	Estimated
F_fleet_1_YR_2007_s_1	0.0266	0.0021	Estimated
F_fleet_1_YR_2008_s_1	0.0316	0.0026	Estimated
F_fleet_1_YR_2009_s_1	0.0458	0.0040	Estimated
F_fleet_1_YR_2010_s_1	0.0289	0.0027	Estimated
F_fleet_1_YR_2011_s_1	0.0282	0.0029	Estimated
F_fleet_2_YR_1886_s_1	0.0001	0.0000	Estimated
F_fleet_2_YR_1887_s_1	0.0001	0.0000	Estimated
F_fleet_2_YR_1888_s_1	0.0002	0.0000	Estimated
F_fleet_2_YR_1889_s_1	0.0004	0.0000	Estimated
F_fleet_2_YR_1890_s_1	0.0005	0.0000	Estimated
F_fleet_2_YR_1891_s_1	0.0001	0.0000	Estimated
F_fleet_2_YR_1892_s_1	0.0001	0.0000	Estimated
F_fleet_2_YR_1893_s_1	0.0001	0.0000	Estimated
F_fleet_2_YR_1894_s_1	0.0001	0.0000	Estimated
F_fleet_2_YR_1895_s_1	0.0001	0.0000	Estimated
F_fleet_2_YR_1896_s_1	0.0001	0.0000	Estimated
F_fleet_2_YR_1897_s_1	0.0005	0.0000	Estimated
F_fleet_2_YR_1898_s_1	0.0007	0.0000	Estimated
F_fleet_2_YR_1899_s_1	0.0007	0.0000	Estimated
F_fleet_2_YR_1900_s_1	0.0007	0.0000	Estimated
F_fleet_2_YR_1901_s_1	0.0007	0.0000	Estimated
F_fleet_2_YR_1902_s_1	0.0012	0.0000	Estimated
F_fleet_2_YR_1903_s_1	0.0011	0.0000	Estimated
F_fleet_2_YR_1904_s_1	0.0011	0.0000	Estimated
F_fleet_2_YR_1905_s_1	0.0011	0.0000	Estimated

F_fleet_2_YR_1906_s_1	0.0011	0.0000	Estimated
F_fleet_2_YR_1907_s_1	0.0011	0.0000	Estimated
F_fleet_2_YR_1908_s_1	0.0011	0.0000	Estimated
F_fleet_2_YR_1909_s_1	0.0013	0.0000	Estimated
F_fleet_2_YR_1910_s_1	0.0015	0.0001	Estimated
F_fleet_2_YR_1911_s_1	0.0016	0.0001	Estimated
F_fleet_2_YR_1912_s_1	0.0018	0.0001	Estimated
F_fleet_2_YR_1913_s_1	0.0020	0.0001	Estimated
F_fleet_2_YR_1914_s_1	0.0021	0.0001	Estimated
F_fleet_2_YR_1915_s_1	0.0023	0.0001	Estimated
F_fleet_2_YR_1916_s_1	0.0025	0.0001	Estimated
F_fleet_2_YR_1917_s_1	0.0027	0.0001	Estimated
F_fleet_2_YR_1918_s_1	0.0028	0.0001	Estimated
F_fleet_2_YR_1919_s_1	0.0029	0.0001	Estimated
F_fleet_2_YR_1920_s_1	0.0029	0.0001	Estimated
F_fleet_2_YR_1921_s_1	0.0031	0.0001	Estimated
F_fleet_2_YR_1922_s_1	0.0031	0.0001	Estimated
F_fleet_2_YR_1923_s_1	0.0032	0.0001	Estimated
F_fleet_2_YR_1924_s_1	0.0033	0.0001	Estimated
F_fleet_2_YR_1925_s_1	0.0035	0.0001	Estimated
F_fleet_2_YR_1926_s_1	0.0037	0.0001	Estimated
F_fleet_2_YR_1927_s_1	0.0040	0.0001	Estimated
F_fleet_2_YR_1928_s_1	0.0028	0.0001	Estimated
F_fleet_2_YR_1929_s_1	0.0030	0.0001	Estimated
F_fleet_2_YR_1930_s_1	0.0035	0.0001	Estimated
F_fleet_2_YR_1931_s_1	0.0020	0.0001	Estimated
F_fleet_2_YR_1932_s_1	0.0024	0.0001	Estimated
F_fleet_2_YR_1933_s_1	0.0026	0.0001	Estimated
F_fleet_2_YR_1934_s_1	0.0029	0.0001	Estimated
F_fleet_2_YR_1935_s_1	0.0035	0.0001	Estimated
F_fleet_2_YR_1936_s_1	0.0044	0.0002	Estimated
F_fleet_2_YR_1937_s_1	0.0034	0.0001	Estimated
F_fleet_2_YR_1938_s_1	0.0035	0.0001	Estimated
F_fleet_2_YR_1939_s_1	0.0036	0.0001	Estimated
F_fleet_2_YR_1940_s_1	0.0031	0.0001	Estimated
F_fleet_2_YR_1941_s_1	0.0007	0.0000	Estimated
F_fleet_2_YR_1942_s_1	0.0007	0.0000	Estimated
F_fleet_2_YR_1943_s_1	0.0007	0.0000	Estimated
F_fleet_2_YR_1944_s_1	0.0007	0.0000	Estimated
F_fleet_2_YR_1945_s_1	0.0001	0.0000	Estimated
F_fleet_2_YR_1946_s_1	0.0006	0.0000	Estimated

F_fleet_2_YR_1947_s_1	0.0006	0.0000	Estimated
F_fleet_2_YR_1948_s_1	0.0007	0.0000	Estimated
F_fleet_2_YR_1949_s_1	0.0029	0.0001	Estimated
F_fleet_2_YR_1950_s_1	0.0020	0.0001	Estimated
F_fleet_2_YR_1951_s_1	0.0053	0.0002	Estimated
F_fleet_2_YR_1952_s_1	0.0038	0.0001	Estimated
F_fleet_2_YR_1953_s_1	0.0026	0.0001	Estimated
F_fleet_2_YR_1954_s_1	0.0026	0.0001	Estimated
F_fleet_2_YR_1955_s_1	0.0015	0.0001	Estimated
F_fleet_2_YR_1956_s_1	0.0028	0.0001	Estimated
F_fleet_2_YR_1957_s_1	0.0037	0.0001	Estimated
F_fleet_2_YR_1958_s_1	0.0041	0.0002	Estimated
F_fleet_2_YR_1959_s_1	0.0054	0.0002	Estimated
F_fleet_2_YR_1960_s_1	0.0068	0.0003	Estimated
F_fleet_2_YR_1961_s_1	0.0053	0.0003	Estimated
F_fleet_2_YR_1962_s_1	0.0034	0.0002	Estimated
F_fleet_2_YR_1963_s_1	0.0021	0.0001	Estimated
F_fleet_2_YR_1964_s_1	0.0048	0.0003	Estimated
F_fleet_2_YR_1965_s_1	0.0083	0.0005	Estimated
F_fleet_2_YR_1966_s_1	0.0101	0.0006	Estimated
F_fleet_2_YR_1967_s_1	0.0088	0.0005	Estimated
F_fleet_2_YR_1968_s_1	0.0083	0.0005	Estimated
F_fleet_2_YR_1969_s_1	0.0075	0.0005	Estimated
F_fleet_2_YR_1970_s_1	0.0097	0.0006	Estimated
F_fleet_2_YR_1971_s_1	0.0104	0.0007	Estimated
F_fleet_2_YR_1972_s_1	0.0175	0.0012	Estimated
F_fleet_2_YR_1973_s_1	0.0054	0.0004	Estimated
F_fleet_2_YR_1974_s_1	0.0296	0.0021	Estimated
F_fleet_2_YR_1975_s_1	0.0348	0.0026	Estimated
F_fleet_2_YR_1976_s_1	0.0376	0.0028	Estimated
F_fleet_2_YR_1977_s_1	0.0292	0.0022	Estimated
F_fleet_2_YR_1978_s_1	0.0261	0.0019	Estimated
F_fleet_2_YR_1979_s_1	0.0030	0.0002	Estimated
F_fleet_2_YR_1980_s_1	0.0043	0.0003	Estimated
F_fleet_2_YR_1981_s_1	0.0089	0.0006	Estimated
F_fleet_2_YR_1982_s_1	0.0089	0.0007	Estimated
F_fleet_2_YR_1983_s_1	0.0080	0.0006	Estimated
F_fleet_2_YR_1984_s_1	0.0028	0.0002	Estimated
F_fleet_2_YR_1985_s_1	0.0034	0.0002	Estimated
F_fleet_2_YR_1986_s_1	0.0018	0.0001	Estimated
F_fleet_2_YR_1987_s_1	0.0147	0.0010	Estimated

F_fleet_2_YR_1988_s_1	0.0018	0.0001	Estimated
F_fleet_2_YR_1989_s_1	0.0042	0.0003	Estimated
F_fleet_2_YR_1990_s_1	0.0013	0.0001	Estimated
F_fleet_2_YR_1991_s_1	0.0112	0.0008	Estimated
F_fleet_2_YR_1992_s_1	0.0025	0.0002	Estimated
F_fleet_2_YR_1993_s_1	0.0023	0.0002	Estimated
F_fleet_2_YR_1994_s_1	0.0019	0.0001	Estimated
F_fleet_2_YR_1995_s_1	0.0020	0.0002	Estimated
F_fleet_2_YR_1996_s_1	0.0027	0.0002	Estimated
F_fleet_2_YR_1997_s_1	0.0037	0.0003	Estimated
F_fleet_2_YR_1998_s_1	0.0044	0.0003	Estimated
F_fleet_2_YR_1999_s_1	0.0046	0.0003	Estimated
F_fleet_2_YR_2000_s_1	0.0030	0.0002	Estimated
F_fleet_2_YR_2001_s_1	0.0055	0.0004	Estimated
F_fleet_2_YR_2002_s_1	0.0026	0.0002	Estimated
F_fleet_2_YR_2003_s_1	0.0028	0.0002	Estimated
F_fleet_2_YR_2004_s_1	0.0025	0.0002	Estimated
F_fleet_2_YR_2005_s_1	0.0018	0.0001	Estimated
F_fleet_2_YR_2006_s_1	0.0029	0.0002	Estimated
F_fleet_2_YR_2007_s_1	0.0012	0.0001	Estimated
F_fleet_2_YR_2008_s_1	0.0034	0.0003	Estimated
F_fleet_2_YR_2009_s_1	0.0029	0.0002	Estimated
F_fleet_2_YR_2010_s_1	0.0052	0.0005	Estimated
F_fleet_2_YR_2011_s_1	0.0040	0.0004	Estimated
F_fleet_4_YR_1945_s_1	0.0001	0.0000	Estimated
F_fleet_4_YR_1946_s_1	0.0006	0.0001	Estimated
F_fleet_4_YR_1947_s_1	0.0032	0.0004	Estimated
F_fleet_4_YR_1948_s_1	0.0082	0.0011	Estimated
F_fleet_4_YR_1949_s_1	0.0133	0.0018	Estimated
F_fleet_4_YR_1950_s_1	0.0238	0.0031	Estimated
F_fleet_4_YR_1951_s_1	0.0301	0.0040	Estimated
F_fleet_4_YR_1952_s_1	0.0357	0.0047	Estimated
F_fleet_4_YR_1953_s_1	0.0369	0.0049	Estimated
F_fleet_4_YR_1954_s_1	0.0482	0.0064	Estimated
F_fleet_4_YR_1955_s_1	0.0476	0.0063	Estimated
F_fleet_4_YR_1956_s_1	0.0607	0.0080	Estimated
F_fleet_4_YR_1957_s_1	0.0710	0.0094	Estimated
F_fleet_4_YR_1958_s_1	0.0912	0.0120	Estimated
F_fleet_4_YR_1959_s_1	0.0995	0.0131	Estimated
F_fleet_4_YR_1960_s_1	0.0992	0.0131	Estimated
F_fleet_4_YR_1961_s_1	0.0614	0.0081	Estimated

F_fleet_4_YR_1962_s_1	0.1051	0.0139	Estimated
F_fleet_4_YR_1963_s_1	0.1192	0.0157	Estimated
F_fleet_4_YR_1964_s_1	0.1394	0.0184	Estimated
F_fleet_4_YR_1965_s_1	0.0908	0.0120	Estimated
F_fleet_4_YR_1966_s_1	0.0764	0.0101	Estimated
F_fleet_4_YR_1967_s_1	0.0905	0.0119	Estimated
F_fleet_4_YR_1968_s_1	0.1066	0.0141	Estimated
F_fleet_4_YR_1969_s_1	0.1148	0.0151	Estimated
F_fleet_4_YR_1970_s_1	0.0815	0.0107	Estimated
F_fleet_4_YR_1971_s_1	0.0915	0.0121	Estimated
F_fleet_4_YR_1972_s_1	0.1232	0.0160	Estimated
F_fleet_4_YR_1973_s_1	0.1249	0.0163	Estimated
F_fleet_4_YR_1974_s_1	0.1259	0.0164	Estimated
F_fleet_4_YR_1975_s_1	0.0975	0.0127	Estimated
F_fleet_4_YR_1976_s_1	0.1281	0.0166	Estimated
F_fleet_4_YR_1977_s_1	0.1487	0.0192	Estimated
F_fleet_4_YR_1978_s_1	0.1805	0.0229	Estimated
F_fleet_4_YR_1979_s_1	0.1745	0.0219	Estimated
F_fleet_4_YR_1980_s_1	0.1526	0.0194	Estimated
F_fleet_4_YR_1981_s_1	0.2299	0.0289	Estimated
F_fleet_4_YR_1982_s_1	0.2116	0.0266	Estimated
F_fleet_4_YR_1983_s_1	0.2303	0.0286	Estimated
F_fleet_4_YR_1984_s_1	0.2222	0.0273	Estimated
F_fleet_4_YR_1985_s_1	0.2330	0.0286	Estimated
F_fleet_4_YR_1986_s_1	0.2497	0.0313	Estimated
F_fleet_4_YR_1987_s_1	0.2842	0.0359	Estimated
F_fleet_4_YR_1988_s_1	0.2094	0.0269	Estimated
F_fleet_4_YR_1989_s_1	0.2598	0.0328	Estimated
F_fleet_4_YR_1990_s_1	0.2831	0.0353	Estimated
F_fleet_4_YR_1991_s_1	0.2736	0.0339	Estimated
F_fleet_4_YR_1992_s_1	0.2706	0.0337	Estimated
F_fleet_4_YR_1993_s_1	0.2269	0.0288	Estimated
F_fleet_4_YR_1994_s_1	0.2449	0.0312	Estimated
F_fleet_4_YR_1995_s_1	0.2030	0.0261	Estimated
F_fleet_4_YR_1996_s_1	0.2187	0.0279	Estimated
F_fleet_4_YR_1997_s_1	0.2201	0.0281	Estimated
F_fleet_4_YR_1998_s_1	0.2332	0.0295	Estimated
F_fleet_4_YR_1999_s_1	0.2478	0.0312	Estimated
F_fleet_4_YR_2000_s_1	0.2176	0.0276	Estimated
F_fleet_4_YR_2001_s_1	0.2078	0.0264	Estimated
F_fleet_4_YR_2002_s_1	0.1863	0.0238	Estimated

F_fleet_4_YR_2003_s_1	0.1498	0.0193	Estimated
F_fleet_4_YR_2004_s_1	0.1152	0.0150	Estimated
F_fleet_4_YR_2005_s_1	0.0672	0.0088	Estimated
F_fleet_4_YR_2006_s_1	0.0906	0.0118	Estimated
F_fleet_4_YR_2007_s_1	0.0880	0.0115	Estimated
F_fleet_4_YR_2008_s_1	0.0750	0.0098	Estimated
F_fleet_4_YR_2009_s_1	0.0872	0.0114	Estimated
F_fleet_4_YR_2010_s_1	0.0614	0.0080	Estimated
F_fleet_4_YR_2011_s_1	0.0572	0.0075	Estimated
Retain_2P_1_Com_RR_2	30.0000	-	Fixed
Retain_2P_1_Com_RR_2_BLK2repl_1886	20.1669	15.2547	
Retain_2P_1_Com_RR_2_BLK2repl_1993	30.3991	7.0037	
Retain_2P_2_Com_RR_2	4.5000	-	Fixed
Retain_2P_2_Com_RR_2_BLK2repl_1886	0.0500		Fixed
Retain_2P_2_Com_RR_2_BLK2repl_1993	12.5286	5.0116	
Retain_2P_3_Com_RR_2	0.9900	-	Fixed
Retain_2P_4_Com_RR_2	0.0000	-	Fixed
Retain_3P_1_REC_3	30.0000	-	Fixed
Retain_3P_1_REC_3_BLK2repl_1886	30.9248	0.3293	
Retain_3P_1_REC_3_BLK2repl_1993	38.2921	0.3227	
Retain_3P_2_REC_3	4.5000	-	Fixed
Retain_3P_2_REC_3_BLK2repl_1886	1.8394	0.2195	
Retain_3P_2_REC_3_BLK2repl_1993	4.3462	0.2510	
Retain_3P_3_REC_3	0.9900	-	Fixed
Retain_3P_4_REC_3	0.0000	-	Fixed
SizeSel_1P_1_Com_GN_1	45.0000	550.5697	
SizeSel_1P_1_Com_GN_1_BLK1repl_1886	47.9997	0.7073	
SizeSel_1P_1_Com_GN_1_BLK1repl_2006	39.4711	0.8399	
SizeSel_1P_2_Com_GN_1	-0.0069	440.4270	
SizeSel_1P_2_Com_GN_1_BLK1repl_1886	-1.4708	86.8076	
SizeSel_1P_2_Com_GN_1_BLK1repl_2006	-8.9516	70.9321	
SizeSel_1P_3_Com_GN_1	-2.4992	385.3976	
SizeSel_1P_3_Com_GN_1_BLK1repl_1886	4.2890	0.1084	
SizeSel_1P_3_Com_GN_1_BLK1repl_2006	3.8209	0.1793	
SizeSel_1P_4_Com_GN_1	6.5003	187.0025	
SizeSel_1P_4_Com_GN_1_BLK1repl_1886	5.5912	83.5751	
SizeSel_1P_4_Com_GN_1_BLK1repl_2006	5.9615	0.3410	
SizeSel_1P_5_Com_GN_1	-999.0000	-	Fixed
SizeSel_1P_6_Com_GN_1	-999.0000	-	Fixed
SizeSel_2P_1_Com_RR_2	55.0000	-	Fixed
SizeSel_2P_2_Com_RR_2	10.0000	-	Fixed

SizeSel_2P_3_Com_RR_2	5.0826	0.0677	
SizeSel_2P_4_Com_RR_2	-4.0000	-	Fixed
SizeSel_2P_5_Com_RR_2	-999.0000	-	Fixed
SizeSel_2P_6_Com_RR_2	15.0000	-	Fixed
SizeSel_3P_1_REC_3	39.5705	1.5942	
SizeSel_3P_2_REC_3	10.0000	-	Fixed
SizeSel_3P_3_REC_3	5.2031	0.2301	
SizeSel_3P_4_REC_3	-4.0000	-	Fixed
SizeSel_3P_5_REC_3	-999.0000	-	Fixed
SizeSel_3P_6_REC_3	15.0000	-	Fixed
SizeSel_4P_1_Shrimp_Bycatch_4	19.2485	1.1964	
SizeSel_4P_2_Shrimp_Bycatch_4	-8.5231	45.4199	
SizeSel_4P_3_Shrimp_Bycatch_4	4.3293	0.3113	
SizeSel_4P_4_Shrimp_Bycatch_4	7.1210	0.2288	
SizeSel_4P_5_Shrimp_Bycatch_4	-999.0000	-	Fixed
SizeSel_4P_6_Shrimp_Bycatch_4	-999.0000	-	Fixed

Table 3.4. Summary results for Gulf of Mexico Spanish mackerel for model convergence level, total likelihood, , unfished spawning biomass (R0), SSB@30%SPR (SSB_SPRTtgt), predicted spawning stock biomass in 2011 (SSB_2011, whole weight, mtons), predicted spawning potential ratio 2011 (SPR_2011), F_SPRTtgt (equals F30%SPR), Fcurrent), SSB_REF and F_REF from the SS jitter analysis for Run 3 Model Configuration (estimate steepness and M=0.38 y^{-1}). Fcurrent = geometric mean of F in 2009 through 2011. SSB_REF = SSB_2011 / SSB_MSST. MSST = (1.0-M) * SSB@30%SPR. F_REF= Fcurrent /F_SPRTtgt .

Run_ ID	Converge nce	Likeli hood	R0	Virgin_Bio mass	SSB_SPR Ttgt	SSB_20 11	SPR_2 011	F_SPRT tgt	F_CURR ENT	SSB_R EF	F_R EF
1	0.0193208	4252	10.7781	41800	10589	19419	0.60	0.35	0.14	2.96	0.39
2	0.025521	4252	10.7781	41800	10589	19419	0.60	0.35	0.14	2.96	0.39
8	0.00735732	4252	10.7781	41800	10589	19419	0.60	0.35	0.14	2.96	0.39
12	0.0084232	4252	10.7781	41800	10589	19419	0.60	0.35	0.14	2.96	0.39
16	0.00112108	4252	10.7781	41800	10589	19419	0.60	0.35	0.14	2.96	0.39
20	0.00448941	4252	10.7781	41800	10589	19419	0.60	0.35	0.14	2.96	0.39
22	0.0247162	4252	10.7781	41800	10589	19419	0.60	0.35	0.14	2.96	0.39
23	0.00283252	4252	10.7781	41800	10589	19419	0.60	0.35	0.14	2.96	0.39
27	0.017825	4252	10.7781	41800	10589	19419	0.60	0.35	0.14	2.96	0.39
35	0.0100494	4252	10.7781	41800	10589	19419	0.60	0.35	0.14	2.96	0.39
38	0.0249437	4252	10.7781	41800	10589	19419	0.60	0.35	0.14	2.96	0.39
41	0.0156508	4252	10.7781	41800	10589	19419	0.60	0.35	0.14	2.96	0.39
42	0.00126917	4252	10.7781	41800	10589	19419	0.60	0.35	0.14	2.96	0.39
48	0.00347047	4252	10.7781	41800	10589	19419	0.60	0.35	0.14	2.96	0.39
51	0.0149252	4252	10.7781	41800	10589	19419	0.60	0.35	0.14	2.96	0.39
52	0.0010587	4252	10.7781	41800	10589	19419	0.60	0.35	0.14	2.96	0.39
54	0.00264981	4252	10.7781	41800	10589	19419	0.60	0.35	0.14	2.96	0.39
56	0.00882105	4252	10.7781	41800	10589	19419	0.60	0.35	0.14	2.96	0.39
57	0.0010074	4252	10.7781	41800	10589	19419	0.60	0.35	0.14	2.96	0.39
58	0.00492613	4252	10.7781	41800	10589	19419	0.60	0.35	0.14	2.96	0.39
59	0.0106461	4252	10.7781	41800	10589	19419	0.60	0.35	0.14	2.96	0.39
60	0.000502046	4252	10.7781	41800	10589	19419	0.60	0.35	0.14	2.96	0.39

61	0.00165795	4252	10.7781	41800	10589	19419	0.60	0.35	0.14	2.96	0.39
63	0.00610258	4252	10.7781	41800	10589	19419	0.60	0.35	0.14	2.96	0.39
65	0.00315178	4252	10.7781	41800	10589	19419	0.60	0.35	0.14	2.96	0.39
68	0.00433998	4252	10.7781	41800	10589	19419	0.60	0.35	0.14	2.96	0.39
72	0.0134151	4252	10.7781	41800	10589	19419	0.60	0.35	0.14	2.96	0.39
73	0.00704818	4252	10.7781	41800	10589	19419	0.60	0.35	0.14	2.96	0.39
74	0.0360098	4252	10.7781	41800	10589	19419	0.60	0.35	0.14	2.96	0.39
77	0.0122285	4252	10.7781	41800	10589	19419	0.60	0.35	0.14	2.96	0.39
79	0.00619656	4252	10.7781	41800	10589	19419	0.60	0.35	0.14	2.96	0.39
80	0.00160841	4252	10.7781	41800	10589	19419	0.60	0.35	0.14	2.96	0.39
82	0.00619887	4252	10.7781	41800	10589	19419	0.60	0.35	0.14	2.96	0.39
89	0.0358414	4252	10.7781	41800	10589	19419	0.60	0.35	0.14	2.96	0.39
90	0.00117738	4252	10.7781	41800	10589	19419	0.60	0.35	0.14	2.96	0.39
92	0.00281103	4252	10.7781	41800	10589	19419	0.60	0.35	0.14	2.96	0.39
93	0.0161329	4252	10.7781	41800	10589	19419	0.60	0.35	0.14	2.96	0.39
94	0.0257107	4252	10.7781	41800	10589	19419	0.60	0.35	0.14	2.96	0.39
95	0.00104386	4252	10.7781	41800	10589	19419	0.60	0.35	0.14	2.96	0.39
96	0.0179732	4252	10.7781	41800	10589	19419	0.60	0.35	0.14	2.96	0.39
98	0.00051994	4252	10.7781	41800	10589	19419	0.60	0.35	0.14	2.96	0.39
99	0.00405368	4252	10.7781	41800	10589	19419	0.60	0.35	0.14	2.96	0.39
5	0.0195468	4252	10.7781	41801	10590	19419	0.60	0.35	0.14	2.96	0.39
10	0.00707724	4252	10.7781	41801	10590	19419	0.60	0.35	0.14	2.96	0.39
15	0.00716685	4252	10.7781	41801	10590	19419	0.60	0.35	0.14	2.96	0.39
18	0.00188561	4252	10.7781	41801	10590	19419	0.60	0.35	0.14	2.96	0.39
25	0.0228218	4252	10.7781	41801	10590	19419	0.60	0.35	0.14	2.96	0.39
33	0.00405331	4252	10.7781	41801	10590	19419	0.60	0.35	0.14	2.96	0.39
44	0.0060942	4252	10.7781	41801	10590	19419	0.60	0.35	0.14	2.96	0.39
49	0.00953289	4252	10.7781	41801	10590	19419	0.60	0.35	0.14	2.96	0.39

50	0.00408325	4252	10.7781	41801	10590	19419	0.60	0.35	0.14	2.96	0.39
62	0.0207567	4252	10.7781	41801	10590	19419	0.60	0.35	0.14	2.96	0.39
66	0.010683	4252	10.7781	41801	10590	19419	0.60	0.35	0.14	2.96	0.39
69	0.00229862	4252	10.7781	41801	10590	19419	0.60	0.35	0.14	2.96	0.39
91	0.0951241	4252	10.7781	41800	10589	19419	0.60	0.35	0.14	2.96	0.39
97	0.000652747	4252	10.7781	41801	10590	19419	0.60	0.35	0.14	2.96	0.39
100	0.000870326	4252	10.7781	41801	10590	19419	0.60	0.35	0.14	2.96	0.39
7	0.0269314	4252	10.7781	41802	10590	19420	0.60	0.35	0.14	2.96	0.39
26	0.00584864	4252	10.7781	41802	10590	19420	0.60	0.35	0.14	2.96	0.39
37	0.0557999	4252	10.7781	41802	10590	19420	0.60	0.35	0.14	2.96	0.39
40	0.0060555	4252	10.7781	41802	10590	19420	0.60	0.35	0.14	2.96	0.39
64	0.0168041	4252	10.7781	41802	10590	19420	0.60	0.35	0.14	2.96	0.39
86	0.0211252	4252	10.7781	41802	10590	19420	0.60	0.35	0.14	2.96	0.39
88	0.0114211	4252	10.7781	41802	10590	19420	0.60	0.35	0.14	2.96	0.39
11	0.00118265	4252	10.7781	41804	10590	19423	0.60	0.35	0.14	2.96	0.39
29	0.00707389	4252	10.7781	41804	10590	19423	0.60	0.35	0.14	2.96	0.39
30	0.00572288	4252	10.7781	41804	10590	19423	0.60	0.35	0.14	2.96	0.39
43	0.0178268	4252	10.7781	41804	10590	19423	0.60	0.35	0.14	2.96	0.39
53	0.000777517	4252	10.7781	41804	10590	19423	0.60	0.35	0.14	2.96	0.39
84	0.00211714	4252	10.7781	41804	10590	19423	0.60	0.35	0.14	2.96	0.39
55	765.026	4252	10.7783	41818	10594	19430	0.60	0.35	0.14	2.96	0.39
19	0.00164353	4252	10.7782	41811	10592	19428	0.60	0.35	0.14	2.96	0.39
28	0.00129209	4252	10.7782	41811	10592	19428	0.60	0.35	0.14	2.96	0.39
31	0.0248992	4252	10.7782	41811	10592	19428	0.60	0.35	0.14	2.96	0.39
32	0.00833836	4252	10.7782	41811	10592	19428	0.60	0.35	0.14	2.96	0.39
34	0.00661328	4252	10.7782	41811	10592	19428	0.60	0.35	0.14	2.96	0.39
45	0.0225048	4252	10.7782	41811	10592	19428	0.60	0.35	0.14	2.96	0.39
81	0.0162646	4252	10.7782	41811	10592	19428	0.60	0.35	0.14	2.96	0.39

9	0.00740524	4253	10.7783	41824	10596	19438	0.60	0.35	0.14	2.96	0.39
67	0.0125651	4253	10.7783	41824	10596	19438	0.60	0.35	0.14	2.96	0.39
70	0.0225829	4253	10.7783	41824	10596	19438	0.60	0.35	0.14	2.96	0.39
76	0.00176639	4253	10.7783	41824	10596	19438	0.60	0.35	0.14	2.96	0.39
46	0.0345288	4257	10.7751	41515	10517	19237	0.60	0.35	0.14	2.95	0.39
13	0.0789689	4258	10.7739	41368	10480	19224	0.60	0.35	0.14	2.96	0.39
24	0.044589	4258	10.774	41371	10481	19227	0.60	0.35	0.14	2.96	0.39
3	0.0139188	4262	10.7684	40812	10339	18998	0.60	0.36	0.14	2.96	0.39
4	0.029232	4262	10.7684	40812	10339	18998	0.60	0.36	0.14	2.96	0.39
6	0.0203405	4262	10.7684	40812	10339	18998	0.60	0.36	0.14	2.96	0.39
39	0.0105513	4262	10.7684	40812	10339	18998	0.60	0.36	0.14	2.96	0.39
47	0.0103614	4262	10.7684	40812	10339	18998	0.60	0.36	0.14	2.96	0.39
83	0.057487	4262	10.7684	40812	10339	18998	0.60	0.36	0.14	2.96	0.39
21	331.538	4262	10.7684	40812	10339	18997	0.60	0.36	0.14	2.96	0.39
14	0.0092814	4263	10.7684	40813	10339	18999	0.60	0.36	0.14	2.96	0.39
87	0.0735974	4263	10.7684	40814	10339	18999	0.60	0.36	0.14	2.96	0.39
75	0.00707711	4278	10.8439	44374	11242	21600	0.61	0.36	0.14	3.10	0.39
17	0.0299497	4713	10.8116	44214	11201	21831	0.64	0.37	0.11	3.14	0.30
71	0.0216508	14808	9.96449	17963	4551	3540	0.31	0.51	0.35	1.25	0.69
85	0.256915	16537	10.787	40793	10334	22788	0.67	0.37	0.10	3.56	0.28
36	0.103999	18592	10.8868	37471	9493	28724	0.77	0.43	0.08	4.88	0.18
78	2533350	20531	17.7961	30666000	7792330	70036900	1.00	0.54	0.00	14.50	0.00

Table 3.5. Predicted total biomass (whole weight mtons), spawning biomass (whole weight mtons), age-0 recruits (thousand fish), and fishing mortality for Gulf of Mexico Spanish mackerel from SS Model 3 Run.

Year	Total Biomass	Spawning Biomass	Recruits	Fishing Mortality
Virgin	55,126	40,812	47,495	0.0000
1886	55,126	40,812	47,495	0.0007
1887	55,098	40,790	47,494	0.0013
1888	55,047	40,748	47,491	0.0026
1889	54,953	40,670	47,485	0.0050
1890	54,776	40,524	47,474	0.0058
1891	54,602	40,379	47,464	0.0058
1892	54,465	40,264	47,455	0.0058
1893	54,358	40,173	47,448	0.0058
1894	54,274	40,102	47,443	0.0058
1895	54,210	40,047	47,439	0.0058
1896	54,160	40,005	47,436	0.0058
1897	54,122	39,972	47,433	0.0063
1898	54,072	39,930	47,430	0.0082
1899	53,953	39,832	47,422	0.0083
1900	53,859	39,753	47,416	0.0083
1901	53,784	39,690	47,412	0.0083
1902	53,726	39,641	47,408	0.0135
1903	53,467	39,428	47,391	0.0131
1904	53,278	39,270	47,379	0.0131
1905	53,128	39,144	47,369	0.0132
1906	53,011	39,044	47,361	0.0132
1907	52,920	38,967	47,355	0.0132
1908	52,850	38,907	47,351	0.0129
1909	52,812	38,874	47,348	0.0136
1910	52,754	38,825	47,344	0.0158
1911	52,620	38,716	47,335	0.0180
1912	52,426	38,556	47,322	0.0202
1913	52,184	38,355	47,306	0.0225
1914	51,903	38,122	47,287	0.0248
1915	51,592	37,864	47,265	0.0272
1916	51,258	37,586	47,242	0.0296
1917	50,906	37,293	47,217	0.0312

1918	50,575	37,016	47,193	0.0318
1919	50,296	36,782	47,172	0.0326
1920	50,053	36,577	47,154	0.0338
1921	49,824	36,386	47,137	0.0352
1922	49,599	36,197	47,120	0.0354
1923	49,418	36,045	47,106	0.0358
1924	49,267	35,919	47,094	0.0380
1925	49,071	35,756	47,079	0.0405
1926	48,825	35,553	47,060	0.0432
1927	48,538	35,316	47,038	0.0450
1928	48,253	35,079	47,015	0.0313
1929	48,537	35,302	47,037	0.0337
1930	48,681	35,419	47,048	0.0394
1931	48,582	35,341	47,040	0.0224
1932	49,130	35,785	47,082	0.0273
1933	49,386	35,998	47,102	0.0297
1934	49,491	36,091	47,110	0.0327
1935	49,458	36,068	47,108	0.0403
1936	49,139	35,812	47,085	0.0490
1937	48,563	35,342	47,040	0.0375
1938	48,541	35,316	47,038	0.0388
1939	48,488	35,268	47,033	0.0405
1940	48,387	35,184	47,025	0.0349
1941	48,514	35,284	47,035	0.0012
1942	49,863	36,375	47,136	0.0012
1943	50,966	37,285	47,216	0.0012
1944	51,849	38,024	47,279	0.0011
1945	52,547	38,614	47,327	0.0008
1946	53,106	39,088	47,365	0.0015
1947	53,506	39,432	47,392	0.0030
1948	53,719	39,629	47,407	0.0127
1949	53,408	39,411	47,390	0.0413
1950	51,890	38,211	47,294	0.0374
1951	50,709	37,291	47,217	0.0770
1952	48,136	35,234	47,030	0.0650
1953	46,551	33,957	46,904	0.0524
1954	45,758	33,310	46,836	0.0590
1955	44,810	32,568	46,756	0.0629
1956	43,867	31,827	46,672	0.0872

1957	42,182	30,512	46,514	0.1054
1958	40,191	28,948	46,309	0.1262
1959	37,864	27,141	46,046	0.1470
1960	35,458	25,245	45,733	0.1655
1961	33,233	23,459	45,397	0.1294
1962	32,879	23,051	45,313	0.1997
1963	30,725	21,380	44,942	0.1980
1964	29,126	20,161	44,638	0.1969
1965	27,837	19,208	44,376	0.1849
1966	27,469	18,827	44,265	0.2140
1967	26,871	18,265	44,093	0.2116
1968	26,505	17,963	43,997	0.2472
1969	25,473	17,190	43,739	0.2823
1970	24,044	16,111	43,342	0.2708
1971	23,515	15,635	43,153	0.2761
1972	23,091	15,293	43,010	0.2862
1973	22,422	14,842	42,813	0.2911
1974	21,793	14,397	42,609	0.3458
1975	20,510	13,429	42,127	0.2881
1976	20,686	13,512	42,170	0.3563
1977	19,709	12,801	41,781	0.2692
1978	20,069	13,132	41,967	0.2693
1979	20,028	13,194	42,001	0.2736
1980	19,865	13,104	41,951	0.2543
1981	20,130	13,278	42,046	0.3406
1982	18,702	12,299	41,485	0.3871
1983	17,113	11,122	40,704	0.3516
1984	16,498	10,680	40,376	0.3203
1985	16,708	10,706	56,448	0.3162
1986	18,325	11,660	35,246	0.5064
1987	14,975	9,623	27,792	0.3882
1988	13,175	8,612	32,320	0.3323
1989	13,127	8,404	52,435	0.4101
1990	14,457	8,889	51,677	0.4211
1991	15,698	9,578	58,146	0.4356
1992	16,816	10,422	23,534	0.4091
1993	14,456	9,389	31,107	0.3563
1994	13,330	8,806	15,973	0.3673
1995	11,004	7,347	34,627	0.3263

1996	11,502	7,370	36,610	0.3159
1997	12,573	7,970	29,319	0.2984
1998	13,131	8,315	55,205	0.3247
1999	15,531	9,675	36,051	0.3309
2000	15,777	10,048	41,648	0.3137
2001	16,348	10,488	39,707	0.3494
2002	16,139	10,392	35,722	0.2961
2003	16,343	10,567	45,872	0.2595
2004	18,023	11,572	42,824	0.2401
2005	19,664	12,712	40,021	0.1516
2006	22,041	14,563	28,879	0.1776
2007	22,099	14,917	51,485	0.1525
2008	24,265	16,247	40,295	0.1611
2009	25,251	17,093	31,216	0.1572
2010	25,053	17,111	66,096	0.1401
2011	28,367	18,998	31,500	0.1197

Table 3.6. Fleet-specific estimates of fishing mortality rate in terms of exploitable biomass for Gulf of Mexico Spanish mackerel from SS for the Run 3 model (steepness =0.8, M=0.38).

		Fleet Continuous Fishing Mortality			
Year	**Annual Exploitation Rate**	**Com_GN**	**Com_RR**	**REC**	**Shrimp_Bycatch**
1886	0.0007	0.0008	0.0001		
1887	0.0013	0.0016	0.0001		
1888	0.0026	0.0032	0.0002		
1889	0.0050	0.0062	0.0004		
1890	0.0058	0.0072	0.0005		
1891	0.0058	0.0076	0.0001		
1892	0.0058	0.0076	0.0001		
1893	0.0058	0.0076	0.0001		
1894	0.0058	0.0076	0.0001		
1895	0.0058	0.0076	0.0001		
1896	0.0058	0.0076	0.0001		
1897	0.0063	0.0079	0.0005		
1898	0.0082	0.0103	0.0007		
1899	0.0083	0.0103	0.0007		
1900	0.0083	0.0103	0.0007		
1901	0.0083	0.0104	0.0007		
1902	0.0135	0.0169	0.0012		
1903	0.0131	0.0164	0.0011		
1904	0.0131	0.0165	0.0011		
1905	0.0132	0.0166	0.0011		
1906	0.0132	0.0166	0.0011		
1907	0.0132	0.0166	0.0011		
1908	0.0129	0.0161	0.0011		
1909	0.0136	0.0170	0.0013		
1910	0.0158	0.0198	0.0015		
1911	0.0180	0.0226	0.0016		
1912	0.0202	0.0255	0.0018		
1913	0.0225	0.0285	0.0020		
1914	0.0248	0.0315	0.0021		
1915	0.0272	0.0346	0.0023		
1916	0.0296	0.0377	0.0025		
1917	0.0312	0.0397	0.0027		
1918	0.0318	0.0406	0.0028		
1919	0.0326	0.0416	0.0029		

1920	0.0338	0.0433	0.0029		
1921	0.0352	0.0450	0.0031		
1922	0.0354	0.0453	0.0031		
1923	0.0358	0.0458	0.0032		
1924	0.0380	0.0488	0.0033		
1925	0.0405	0.0522	0.0035		
1926	0.0432	0.0557	0.0037		
1927	0.0450	0.0580	0.0041		
1928	0.0313	0.0402	0.0028		
1929	0.0337	0.0432	0.0030		
1930	0.0394	0.0507	0.0035		
1931	0.0224	0.0286	0.0020		
1932	0.0273	0.0349	0.0024		
1933	0.0297	0.0380	0.0026		
1934	0.0327	0.0418	0.0029		
1935	0.0403	0.0518	0.0035		
1936	0.0490	0.0632	0.0044		
1937	0.0375	0.0482	0.0034		
1938	0.0388	0.0498	0.0035		
1939	0.0405	0.0521	0.0036		
1940	0.0349	0.0448	0.0031		
1941	0.0012	0.0010	0.0007		
1942	0.0012	0.0010	0.0007		
1943	0.0012	0.0010	0.0007		
1944	0.0011	0.0009	0.0007		
1945	0.0008	0.0010	0.0001		0.0001
1946	0.0015	0.0009	0.0006		0.0007
1947	0.0030	0.0009	0.0006		0.0034
1948	0.0127	0.0096	0.0007		0.0089
1949	0.0413	0.0421	0.0029		0.0144
1950	0.0374	0.0290	0.0020		0.0257
1951	0.0770	0.0762	0.0053		0.0326
1952	0.0650	0.0556	0.0039		0.0385
1953	0.0524	0.0379	0.0026		0.0398
1954	0.0590	0.0375	0.0026		0.0518
1955	0.0629	0.0217	0.0015	0.0184	0.0512
1956	0.0872	0.0402	0.0028	0.0210	0.0657
1957	0.1054	0.0530	0.0037	0.0240	0.0767
1958	0.1262	0.0598	0.0042	0.0274	0.0993
1959	0.1470	0.0783	0.0055	0.0314	0.1067
1960	0.1655	0.0991	0.0070	0.0357	0.1066

1961	0.1294	0.0771	0.0055	0.0373	0.0658
1962	0.1997	0.1454	0.0035	0.0389	0.1132
1963	0.1980	0.1239	0.0022	0.0417	0.1279
1964	0.1969	0.0925	0.0050	0.0443	0.1502
1965	0.1849	0.1180	0.0087	0.0463	0.0974
1966	0.2140	0.1787	0.0106	0.0485	0.0822
1967	0.2116	0.1556	0.0093	0.0506	0.0982
1968	0.2472	0.1970	0.0087	0.0536	0.1144
1969	0.2823	0.2441	0.0079	0.0580	0.1244
1970	0.2708	0.2558	0.0103	0.0621	0.0877
1971	0.2761	0.2442	0.0111	0.0684	0.0986
1972	0.2862	0.2063	0.0187	0.0754	0.1329
1973	0.2911	0.2120	0.0058	0.0837	0.1342
1974	0.3458	0.2812	0.0320	0.0938	0.1363
1975	0.2881	0.1875	0.0377	0.1020	0.1052
1976	0.3563	0.2777	0.0409	0.1037	0.1388
1977	0.2692	0.0803	0.0319	0.1048	0.1610
1978	0.2693	0.0435	0.0283	0.1049	0.1954
1979	0.2736	0.0798	0.0033	0.1068	0.1884
1980	0.2543	0.0713	0.0047	0.1072	0.1643
1981	0.3406	0.1406	0.0097	0.1010	0.2493
1982	0.3871	0.1455	0.0098	0.1801	0.2276
1983	0.3516	0.1023	0.0089	0.1342	0.2489
1984	0.3203	0.1713	0.0032	0.0529	0.2374
1985	0.3162	0.0971	0.0038	0.0632	0.2509
1986	0.5064	0.1389	0.0020	0.3433	0.2680
1987	0.3882	0.1502	0.0161	0.1127	0.3030
1988	0.3323	0.1389	0.0019	0.1038	0.2255
1989	0.4101	0.1968	0.0045	0.0799	0.2793
1990	0.4211	0.1636	0.0014	0.0974	0.3040
1991	0.4356	0.1944	0.0121	0.0957	0.2954
1992	0.4091	0.2054	0.0027	0.1287	0.2917
1993	0.3563	0.1441	0.0024	0.1478	0.2445
1994	0.3673	0.1692	0.0021	0.1631	0.2616
1995	0.3263	0.1031	0.0022	0.1422	0.2167
1996	0.3159	0.0272	0.0030	0.1604	0.2358
1997	0.2984	0.0336	0.0041	0.1447	0.2361
1998	0.3247	0.0255	0.0049	0.1257	0.2509
1999	0.3309	0.0462	0.0052	0.1488	0.2662
2000	0.3137	0.0455	0.0033	0.1552	0.2339
2001	0.3494	0.0564	0.0061	0.2214	0.2259

2002	0.2961	0.0459	0.0029	0.1755	0.2013
2003	0.2595	0.0667	0.0031	0.1302	0.1615
2004	0.2401	0.0460	0.0028	0.1673	0.1239
2005	0.1516	0.0565	0.0020	0.0835	0.0728
2006	0.1776	0.0432	0.0031	0.1127	0.0979
2007	0.1525	0.0290	0.0013	0.0843	0.0948
2008	0.1611	0.0345	0.0037	0.1115	0.0810
2009	0.1572	0.0499	0.0031	0.0853	0.0939
2010	0.1401	0.0316	0.0056	0.0890	0.0664
2011	0.1197	0.0309	0.0044	0.0773	0.0620

Table 3.7. Summary of SS results from sensitivity and retrospective analysis runs for Gulf of Mexico Spanish mackerel. Results include steepness; virgin recruitment (thousand fish, R0), virgin total biomass (B0), total biomass 2011(Bcurrent), virgin spawning biomass (SSB_UNFISHED= SSB_BO), 2011 spawning biomass (SSB-2011), spawning potential ratio (SPR_2011). For the retrospective runs values for '2011" were the terminal year in the run (i.e., 2006 retrospective terminal year = 2006). Weight units are whole weight mtons.

Run ID	Name	Steepness	R0	B0	B_2011	SSB_UNFISHED	SSB_2011	SSB_2011 / SB_BO	SPR-2011
1	Run 1 Configuration	0.52	83,068	96,695	17,280	71,934	11,195	0.16	0.51
2	Run 1 Configuration, Steepness=0.9	0.9	47,495	55,126	28,367	40,812	18,998	0.47	0.60
3	Run 1 Configuration, Steepness=0.8	0.8	43,839	51,390	29,262	38,217	19,645	0.51	0.60
4	Run 1 Configuration, Steepness=0.7	0.7	54,514	63,852	27,248	47,517	18,235	0.38	0.59
5	Run 3 Configuration, M HI	0.8	77,242	49,253	35,562	34,525	23,551	0.68	0.73
6	Run 3 Configuration, M LO	0.8	37,402	91,707	19,441	72,171	13,150	0.18	0.41
7	Run 3 Configuration, M REF Age 3	0.8	43,717	61,932	27,007	46,822	18,140	0.39	0.56
8	Run 3 Configuration, Discard Mortality	0.8	48,662	56,940	28,376	42,356	18,995	0.45	0.59
9	Run 3 Configuration, NO MRFSS	0.8	48,173	56,449	29,647	41,987	19,886	0.47	0.61
10	Run 3 Configuration, NO FWC	0.8	50,436	59,021	38,246	43,942	25,700	0.58	0.64
11	Run 3 Configuration, NO SEAMAP Survey	0.8	48,554	56,858	30,514	42,297	20,364	0.48	0.61
12	Run 1 Configuration, SS Reweighting	0.53	82,017	93,538	16,752	68,906	11,050	0.16	0.53
13	Run 3 Configuration, RETROSPECITVE_2010	0.8	48,513	57,538	27,244	42,956	18,383	0.43	0.59
14	Run 3 Configuration, RETROSPECTIVE_2009	0.8	48,269	58,062	25,842	43,508	17,503	0.40	0.52
15	Run 3 Configuration, RETROSPECTIVE_2008	0.8	48,233	58,712	26,716	44,140	18,121	0.41	0.53
16	Run 3 Configuration, RETROSPECTIVE_2007	0.8	48,407	59,510	24,697	44,849	16,832	0.38	0.56
17	Run 3 Configuration, RETROSPECTIVE_2006	0.8	46,866	57,711	29,878	43,366	19,528	0.45	0.54

Table 3.8. Reference points and benchmarks from sensitivity runs for Gulf of Mexico Spanish mackerel from SS. Benchmarks are reported for SPR 30%. *Current* refers to geometric mean of 2009-2011 values. MSST is (1-M)*SSBref with M = 0.38, or M=0.27, or M=0.49 representing the M value from the Hoenig maximum age mortality estimator for fully recruited ages from the SEDAR DW corresponding to the Base Model M or the M_LO or M-HI scenario. Ref refers to reference metric, either F30% SPR or SSB 30% SPR. Fratio is Fcurrent / Fref. SSBratio is SSBcurrent / MSST. Spawning biomass units are weight in mtons, and yield units are mtons whole weight.

Run ID	Name	Fcurrent	SSBcurrent	Yref	Fref	SSBref	MFMT	MSST	F/MFMT	SSB/MSST
1	Run 1 Configuration	0.19	11,195	3,563	0.37	6,626	0.37	4,108	0.51	2.73
2	Run 1 Configuration, Steepness=0.9	0.14	18,998	3,090	0.39	10,701	0.35	6,634	0.39	2.86
3	Run 1 Configuration, Steepness=0.8	0.14	19,645	3,053	0.39	10,339	0.36	6,410	0.38	3.06
4	Run 1 Configuration, Steepness=0.7	0.14	18,235	3,056	0.41	10,264	0.35	6,363	0.41	2.87
5	Run 3 Configuration, M HI	0.10	23,551	3,682	0.20	8,746	0.50	4,461	0.20	5.28
6	Run 3 Configuration, M LO	0.20	13,150	4,040	0.83	18,283	0.24	13,347	0.83	0.99
7	Run 3 Configuration, M REF Age 3	0.15	18,140	3,138	0.47	11,862	0.32	7,354	0.47	2.47
8	Run 3 Configuration, Discard Mortality	0.14	18,995	3,029	0.41	10,730	0.35	6,653	0.41	2.86
9	Run 3 Configuration, NO MRFSS	0.14	19,886	3,054	0.39	10,637	0.35	6,595	0.39	3.02
10	Run 3 Configuration, NO FWC	0.12	25,700	2,821	0.34	11,132	0.34	6,902	0.34	3.72
11	Run 3 Configuration, NO SEAMAP Survey	0.13	20,364	3,053	0.38	10,715	0.35	6,643	0.38	3.07
12	Run 1 Configuration, SS Reweighting	0.19	11,050	3,743	0.37	7,011	0.37	4,347	0.50	2.54
13	Run 3 Configuration, RETROSPECITVE_2010	0.15	18,383	3,163	0.43	10,882	0.35	6,747	0.43	2.72
14	Run 3 Configuration, RETROSPECTIVE_2009	0.16	17,503	2,991	0.46	11,022	0.34	6,834	0.46	2.56
15	Run 3 Configuration, RETROSPECTIVE_2008	0.15	18,121	2,968	0.44	11,182	0.35	6,933	0.44	2.61
16	Run 3 Configuration, RETROSPECTIVE_2007	0.15	16,832	3,072	0.46	11,362	0.33	7,044	0.46	2.39
17	Run 3 Configuration, RETROSPECTIVE_2006	0.16	19,528	3,040	0.48	10,986	0.34	6,811	0.48	2.87

Table 3.9. Required SFA and MSRA evaluations using SPR 30% reference point for Gulf of Mexico Spanish mackerel SS Base Model Run 1 for 4 states of nature of steepness at 3 levels of natural mortality (M). Spawning biomass and yield units are mtons, whole weight.. FCURRENT AND SSBCURRENT calculated as geometric mean of 2009-2011 F and SSB.

Criteria	Definition	Steepness = 0.8	Steepness = 0.9
	Mortality Rate Criteria		
FMSY or Proxy, Proxy=F30%SPR	$F_{SPR30\%}$	0.36	0.35
MFMT	$F_{SPR30\%}$	0.36	0.35
FOY	75% of $F_{SPR30\%}$	0.27	0.26
FCURRENT	$F_{2009-F2011}$	0.13	0.14
FCURRENT/MFMT	$F_{2009-F2011}$	0.50	0.52
BASE M=0.38			
	Biomass Criteria		
SSB_MSY OR PROXY mtons	Equilibrium SSB @ $F_{SPR30\%}$	10,339	10,701
MSST	(1-M)*$SSB_{SPR30\%}$	6,410	6,634
SSB CURRENT (mtons)	$SSB_{\_2011}$	18,998	19,645
SSB CURRENT/ MSST	$SSB_{\_2011}$	2.96	2.96
EQUILIBRIUM MSY (mtons)	Equilibrium Yield @ $F_{SPR30\%}$	3,149	3,084
EQUILIBRIUM OY (mtons)	Equilibrium Yield @ F_{OY}	2,362	2,313
F30% SPR OFL	**Annual Yield @ FMFMT (mtons)**	**Steepness = 0.8**	**Steepness = 0.9**
	OFL 2013	6037	6016
	OFL 2014	5470	5383
	OFL 2015	5125	4983
	OFL 2016	4914	4741
	OFL 2017	4778	4594
	OFL 2018	4690	4506
	OFL 2019	4631	4451
	OFL 2020	4591	4416
	OFL 2021	4564	4395
	OFL 2022	4546	4382
Annual OY (ACT)	**Annual Yield@ FOY (mtons) = 75%FMSY**		
	OFL 2013	4642	4623
	OFL 2014	4392	4319
	OFL 2015	4239	4118
	OFL 2016	4143	3990
	OFL 2017	4080	3908
	OFL 2018	4038	3857
	OFL 2019	4009	3823
	OFL 2020	3989	3802
	OFL 2021	3976	3788
	OFL 2022	3966	3779
Annual Yield	**Annual Yield@Fcurrent (mtons)**		
	OFL 2013	2448	2438
	OFL 2014	2473	2431
	OFL 2015	2502	2429
	OFL 2016	2529	2430
	OFL 2017	2550	2431
	OFL 2018	2566	2433
	OFL 2019	2577	2434
	OFL 2020	2585	2435
	OFL 2021	2592	2436
	OFL 2022	2596	2436

3.7 Figures

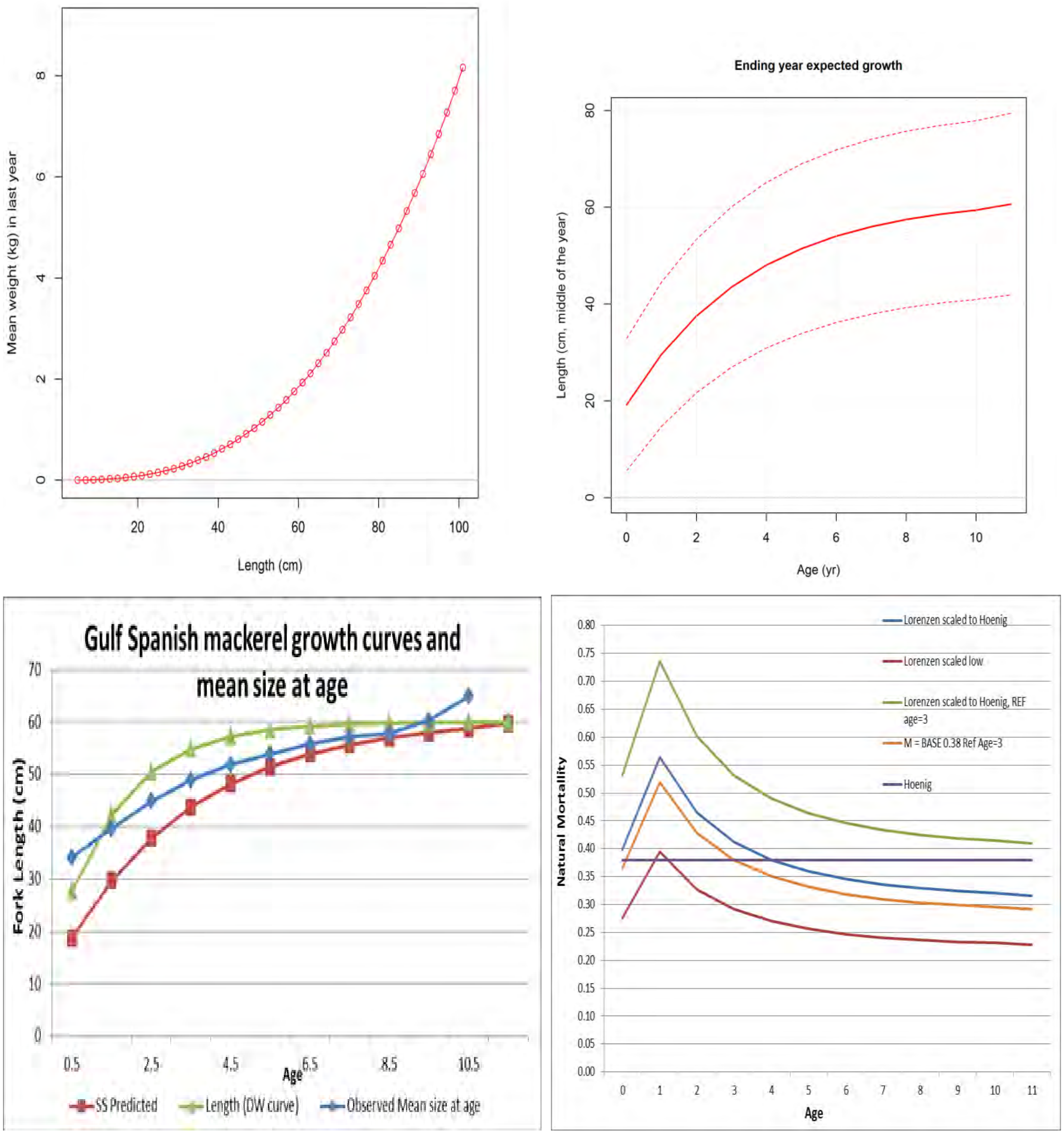


Figure 3.1. Life history characterization for Gulf of Mexico Spanish mackerel. Top Panel Left: Weight length relationship calculated using SEDAR 28 DW inputs. Top Panel Right: Estimated Von Bertalanffy SS growth curves and confidence intervals for Gulf of Mexico Spanish mackerel. Bottom Panel Left: SS estimated growth curve, growth curve estimated from SEDAR DW, and mean size at age from otolith age observations. Bottom Panel Right: Natural mortality at age used in stock assessment and input into Stock Synthesis model. The Lorenzen function scaled to Hoenig point estimate is SEDAR 28 DW Base M function ($M=0.38y^{-1}$) used in the SS stock assessment of Gulf Spanish mackerel (purple line).

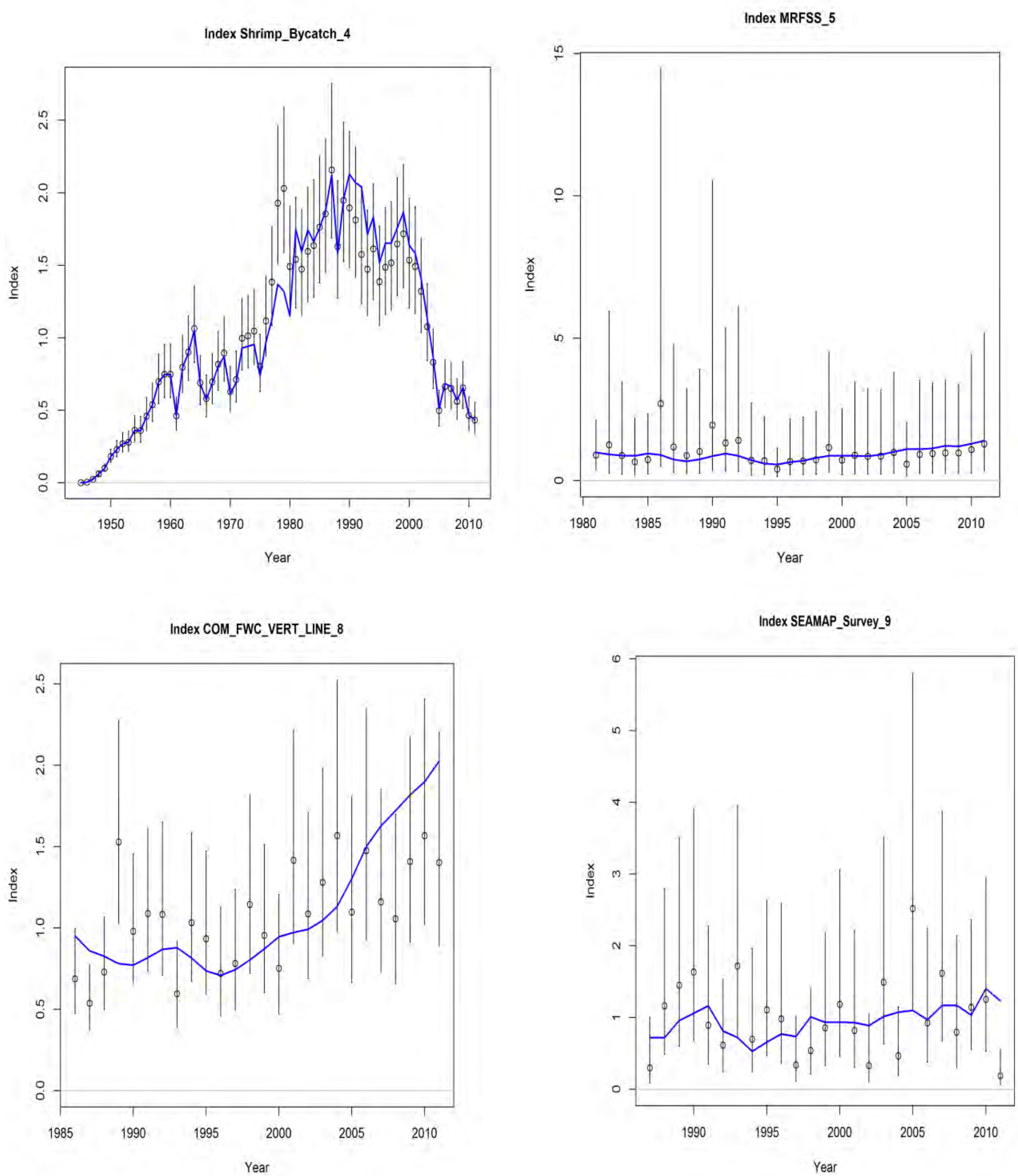
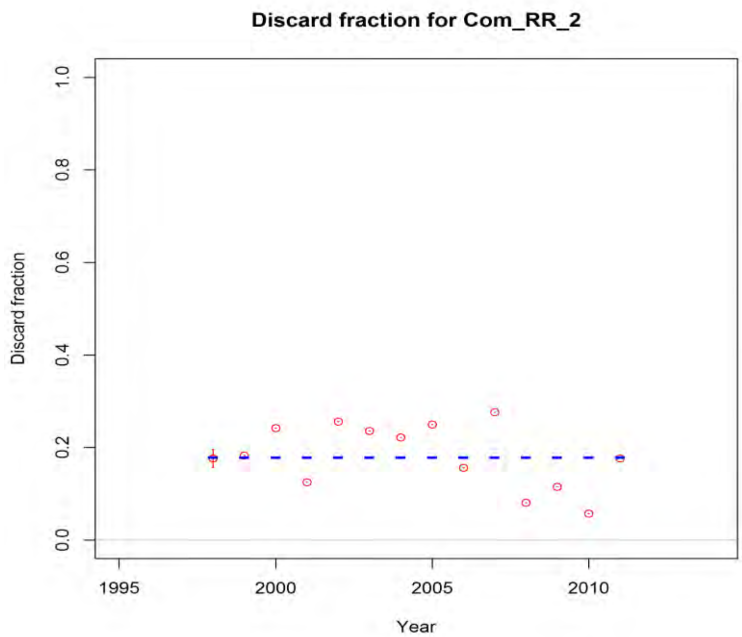


Figure 3.2. Observed and predicted index of CPUE for Gulf of Mexico Spanish mackerel from SS Model 3. Indices include the shrimp fishery effort series (Shrimp_Bycatch_4), the recreational (MRFSS), the commercial line gear (COM_FWC_ VERT_Line), and the SEAMAP trawl survey (SEAMAP_Survey). Error bars represent the observed log-scale standard errors.

A. COM_RR



B. REC

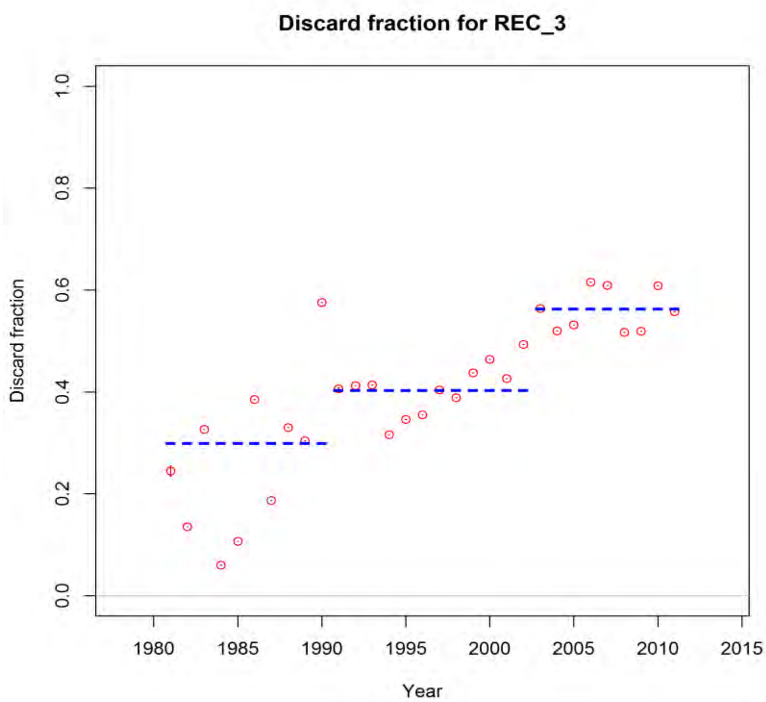


Figure 3.3a and b. SS input super period discard fraction for commercial line gear (COM_RR) and the recreational all modes (REC) fleets plotted against observed discard fraction. Super period definitions were: one period 1998-2011 for the commercial line gear fleet (COM_RR) and three (3) super periods for the recreational all modes (REC) fleet: 1892-1989, 1990-2002, and 2003-2011.

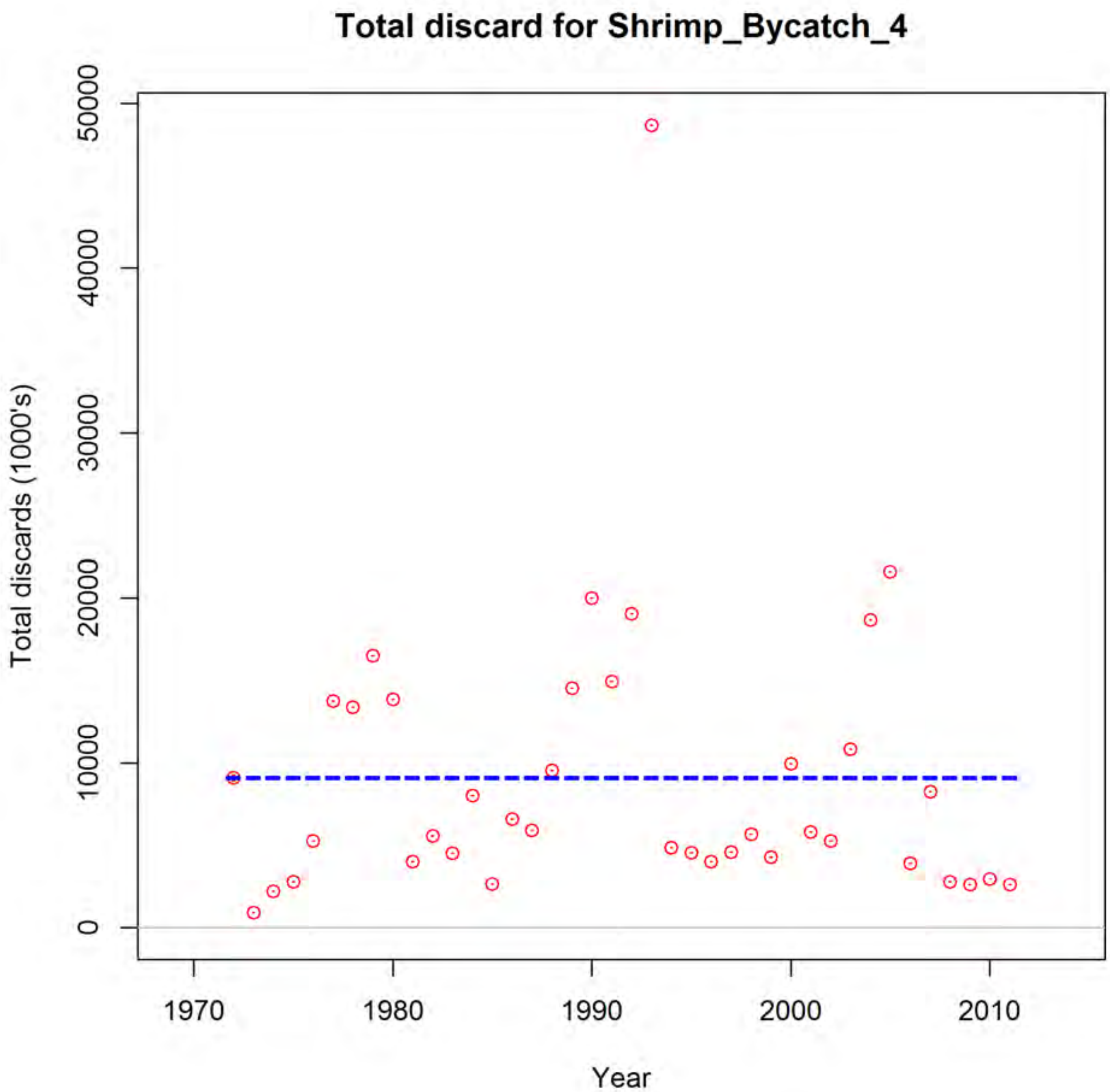


Figure 3.3c. SS input super period discards (thousands of fish) for the shrimp fishery bycatch against observed discards. One single super period (1972-2011) was specified for the shrimp bycatch fleet.

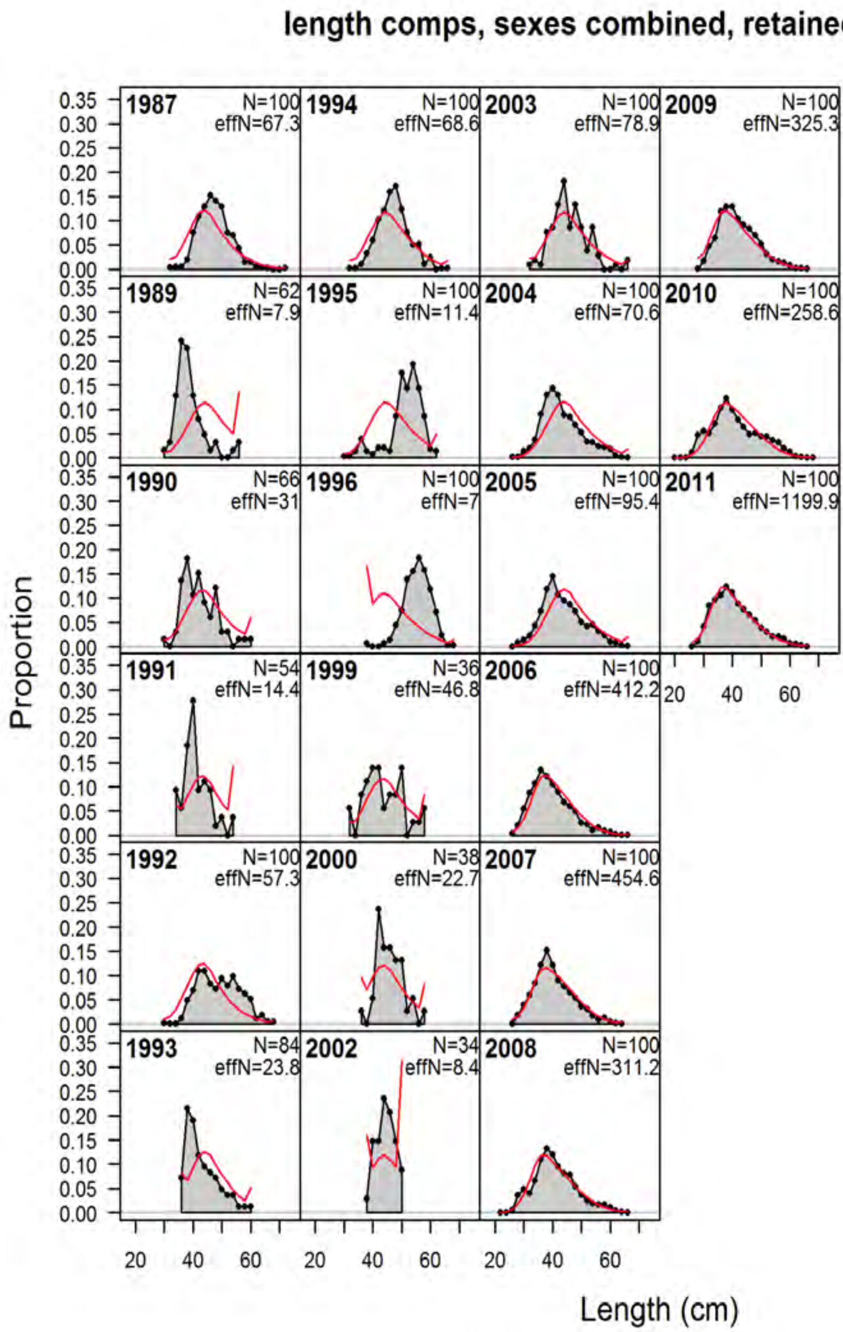


Figure 3.4. Observed and predicted (lines) length compositions for Gulf of Mexico Spanish mackerel commercial gillnet fishery from SS Base Run. Observed (N) sample sizes and effective sample sizes (effN) estimated by SS are also reported. Observed sample sizes were capped at a maximum of 100 fish.

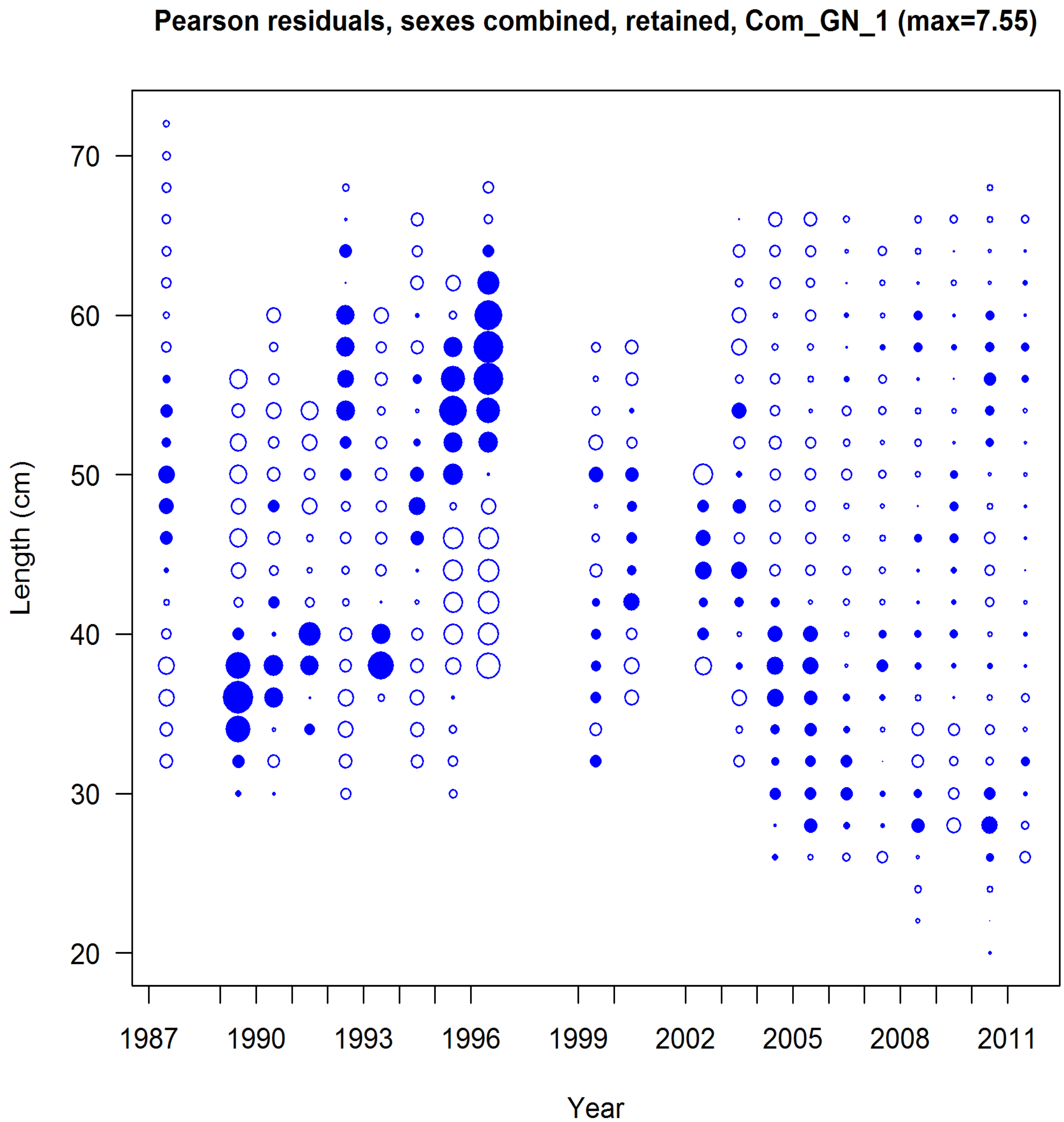


Figure 3.5. Pearson residuals of length composition fits for Gulf of Mexico Spanish mackerel in the commercial gillnet gear fishery from SS Base Run. Solid circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

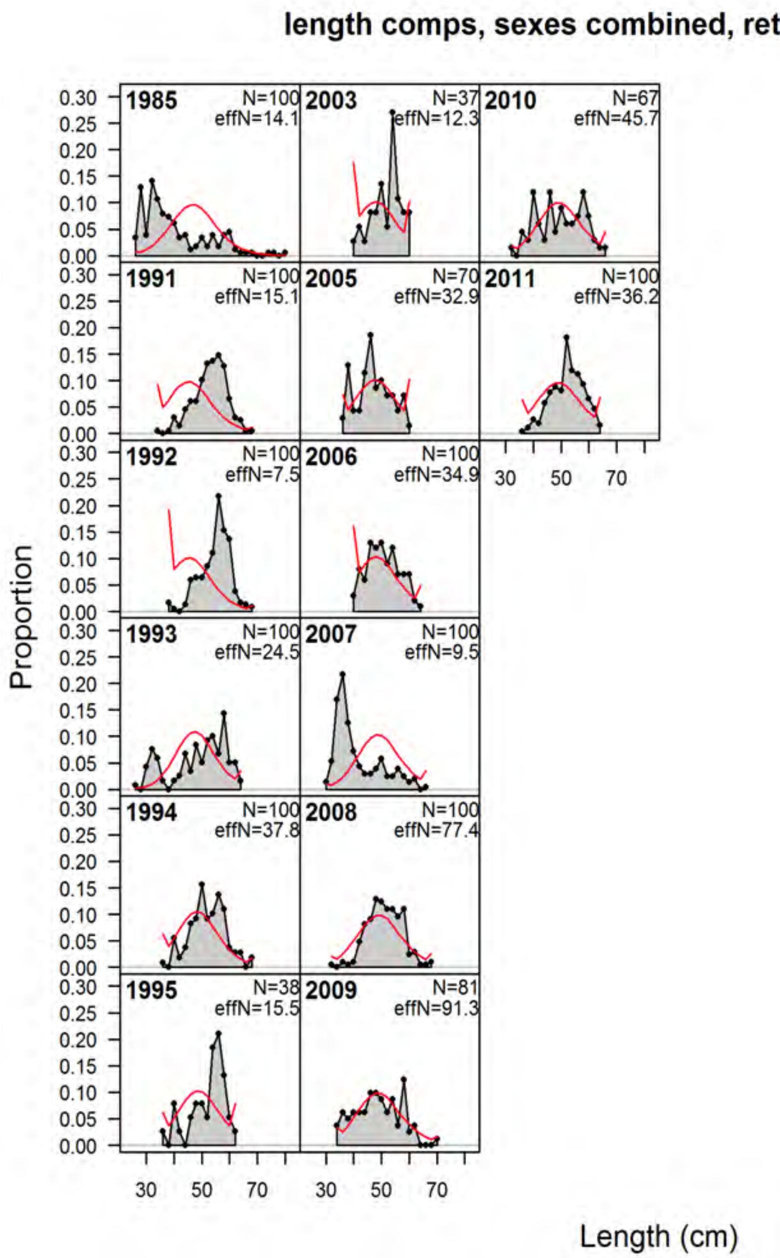


Figure 3.6. Observed and predicted (lines) length compositions for Gulf of Mexico Spanish mackerel commercial lie gear fishery (COM_RR) from SS Base Run. Observed (N) sample sizes and effective sample sizes (effN) estimated by SS are also reported. Observed sample sizes were capped at a maximum of 100 fish.

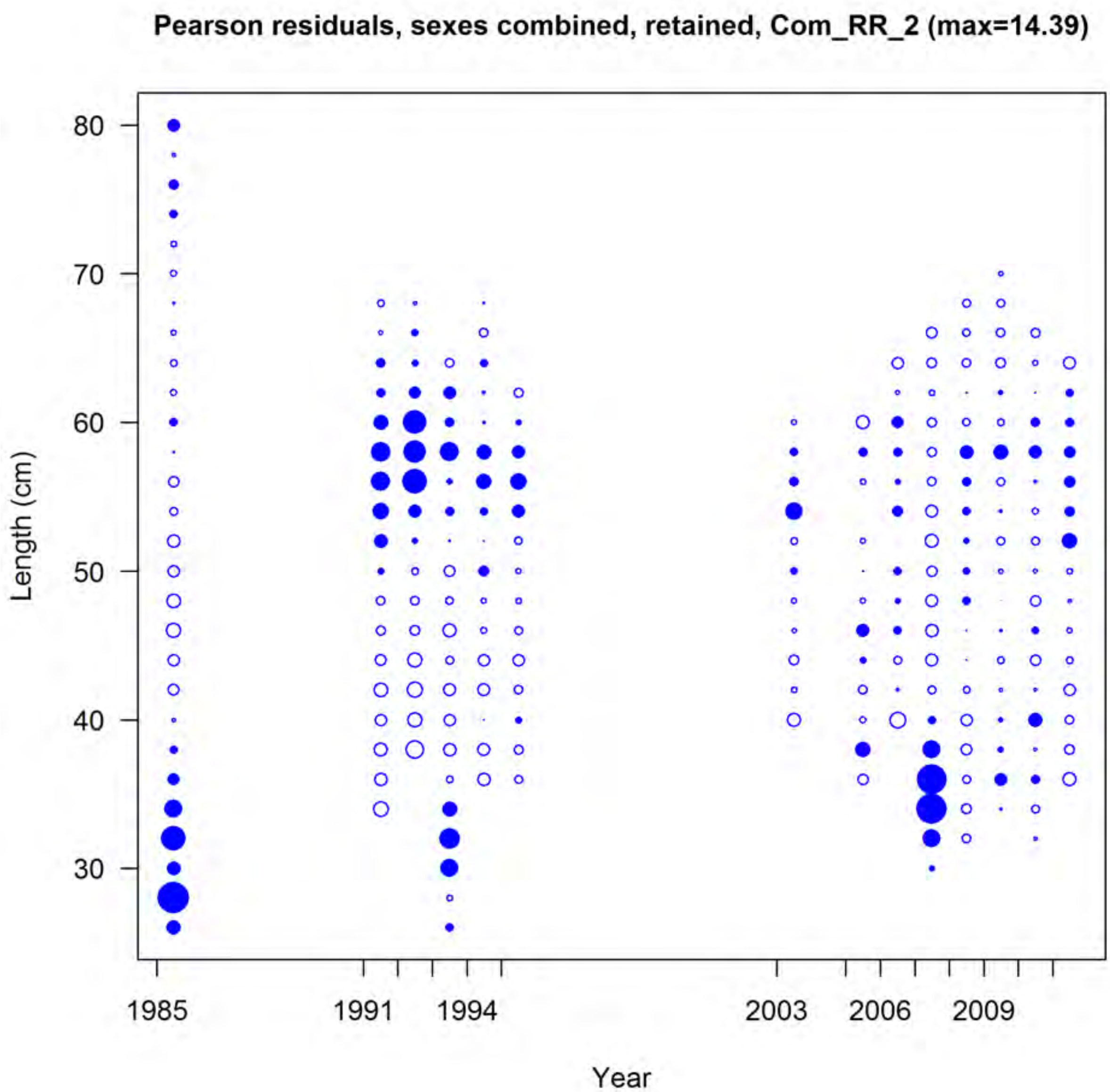


Figure 3.7. Pearson residual distributions of length composition fits for Gulf of Mexico Spanish mackerel in the commercial line gear fishery (COM_RR) from SS Base Run. Solid circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

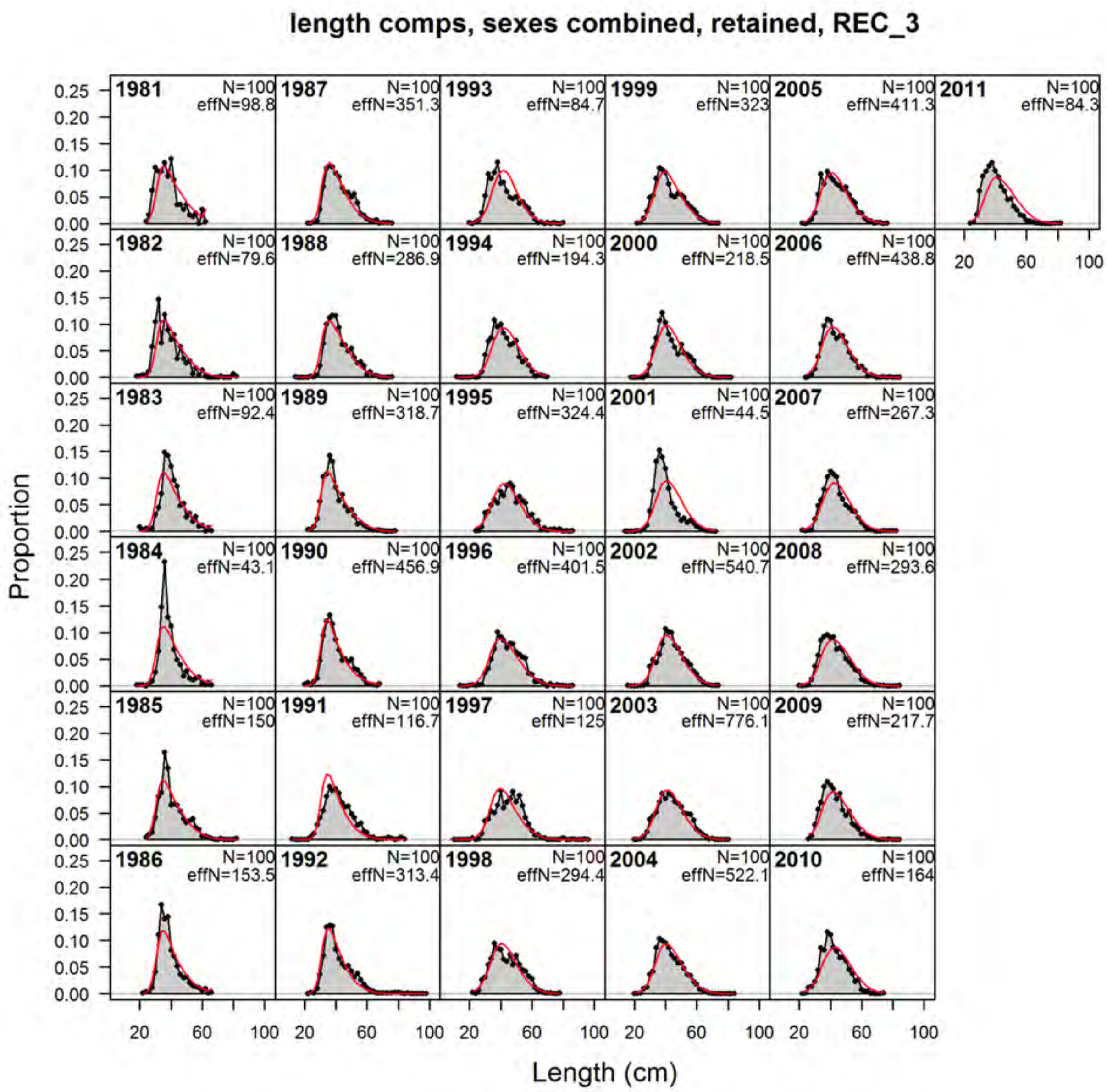


Figure 3. 8. Observed and predicted (lines) length compositions for Gulf of Mexico Spanish mackerel recreational all modes fishery from SS Base Run. Observed (N) sample sizes and effective sample sizes (effN) estimated by SS are also reported. Observed sample sizes were capped at a maximum of 100 fish.

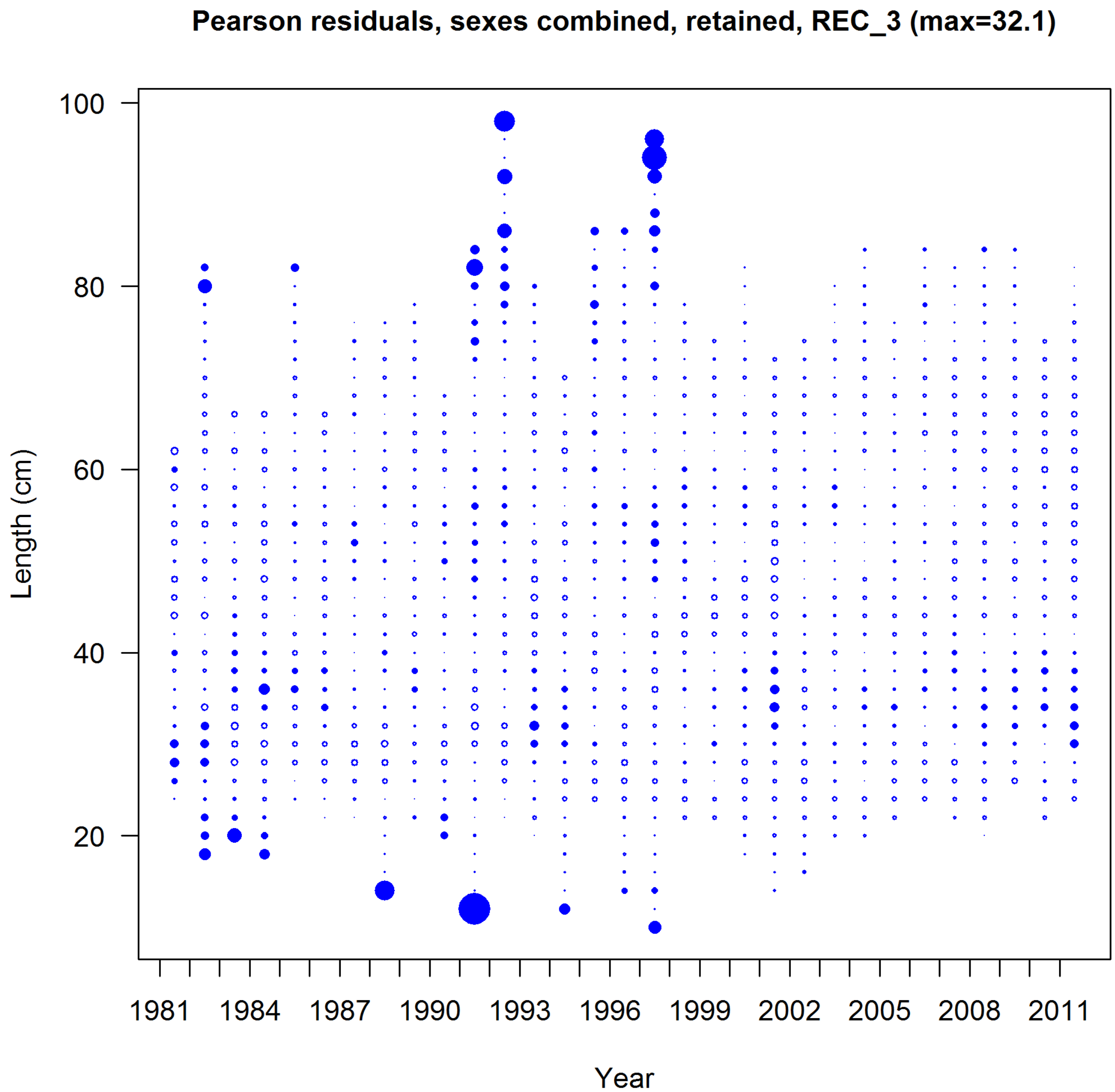


Figure 3.9. Pearson residual of length composition fits for Gulf of Mexico Spanish mackerel in the recreational all modes fishery from SS Base Run. Solid circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

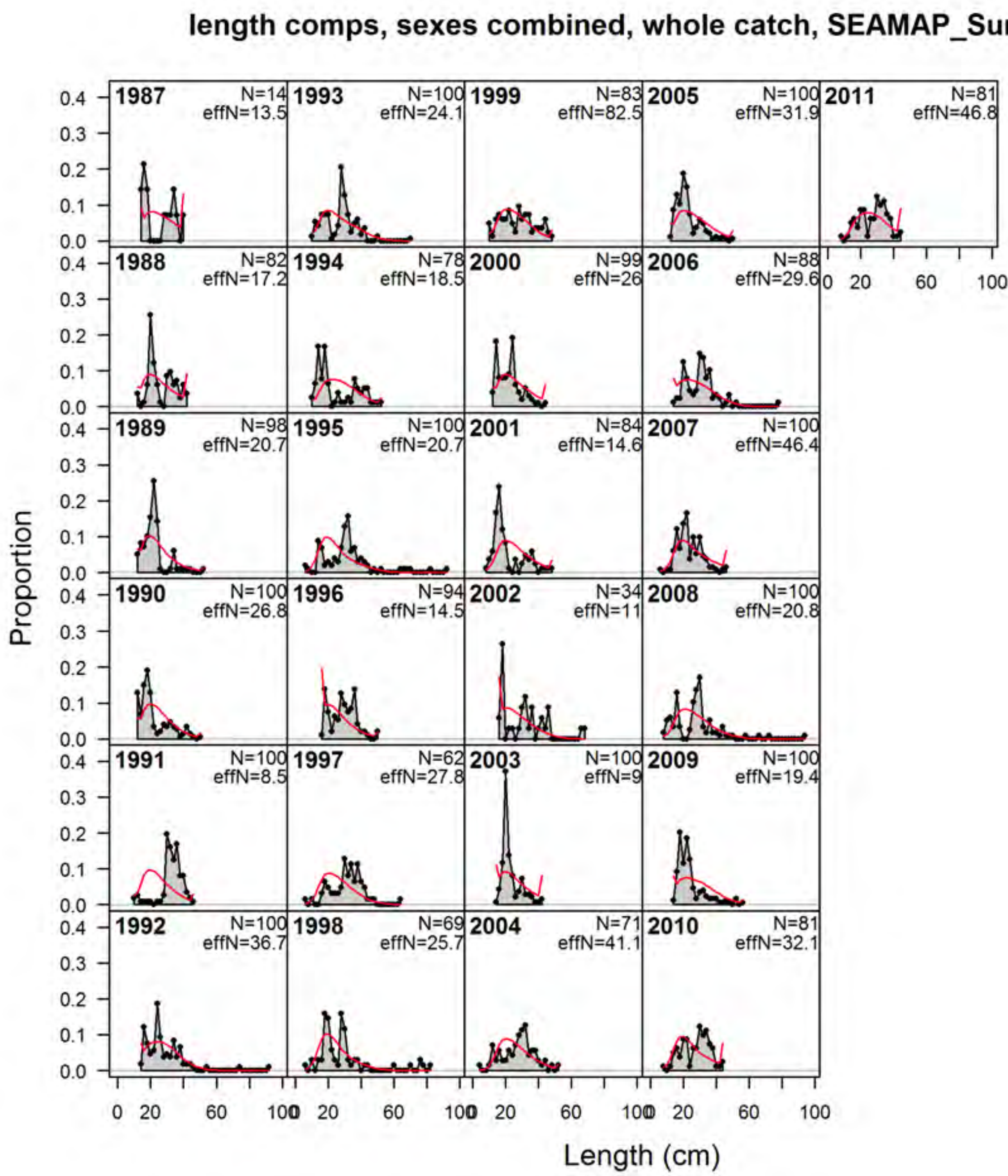


Figure 3.10. Observed and predicted (lines) length compositions for Gulf of Mexico Spanish mackerel from the SEAMAP trawl survey SS Base Run. Observed (N) sample sizes and effective sample sizes (effN) estimated by SS are also reported. Observed sample sizes were capped at a maximum of 100 fish.

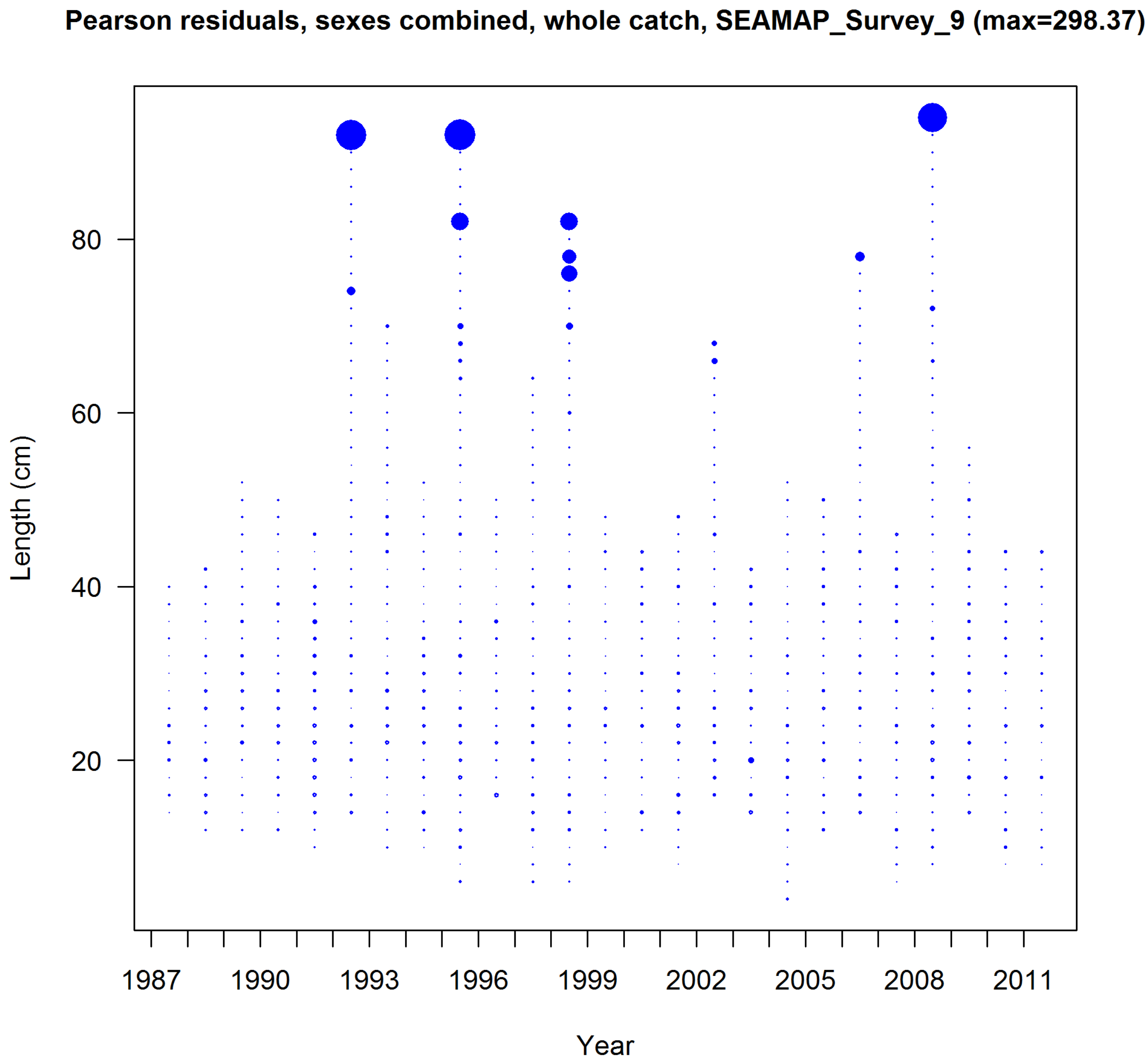


Figure 3.11. Pearson residuals of length composition fits for Gulf of Mexico Spanish mackerel in the SEAMAP trawl survey from SS Base Run. Solid circles are positive residuals (i.e., observed greater than predicted) and open circles are negative residuals (i.e., predicted greater than observed).

\

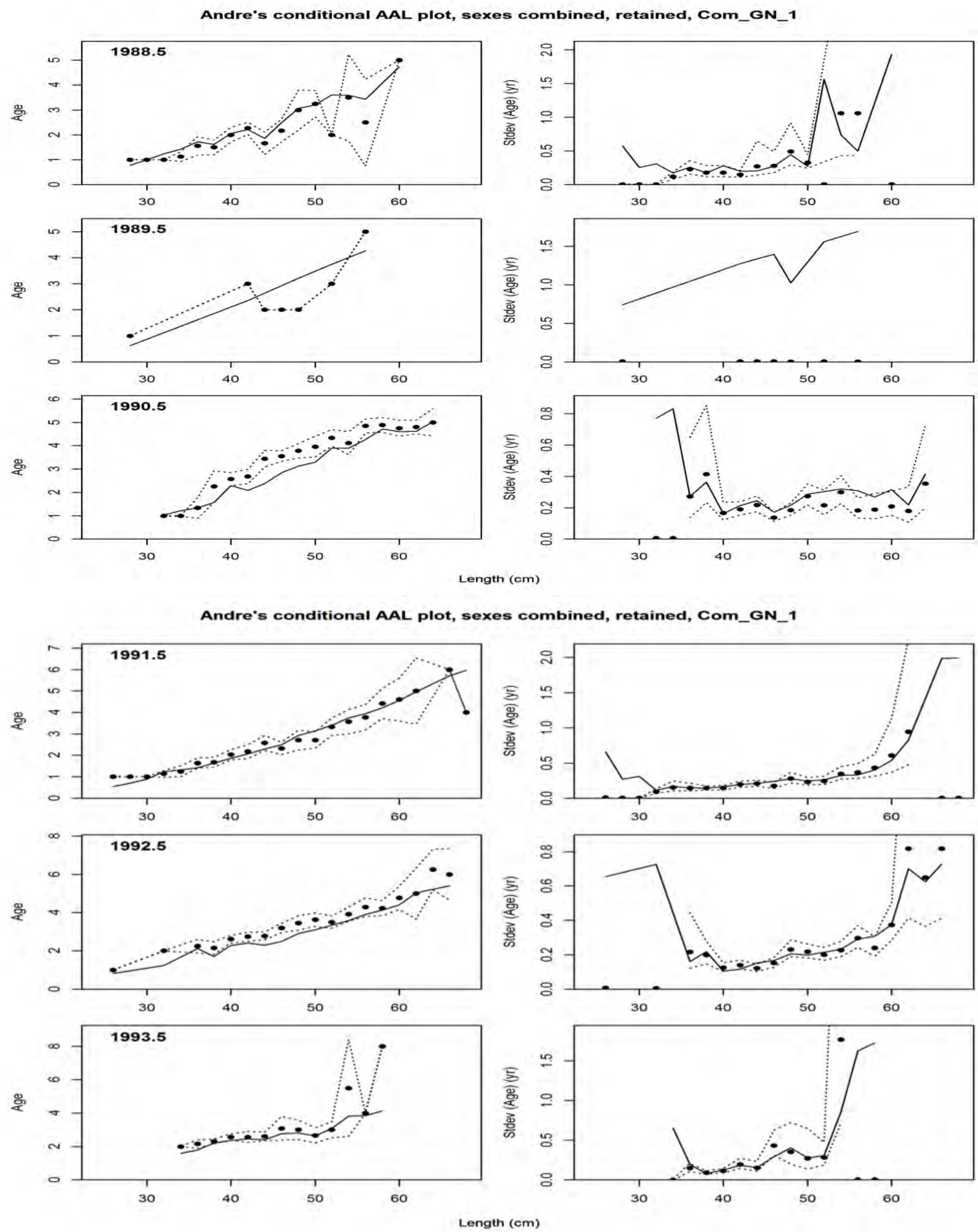
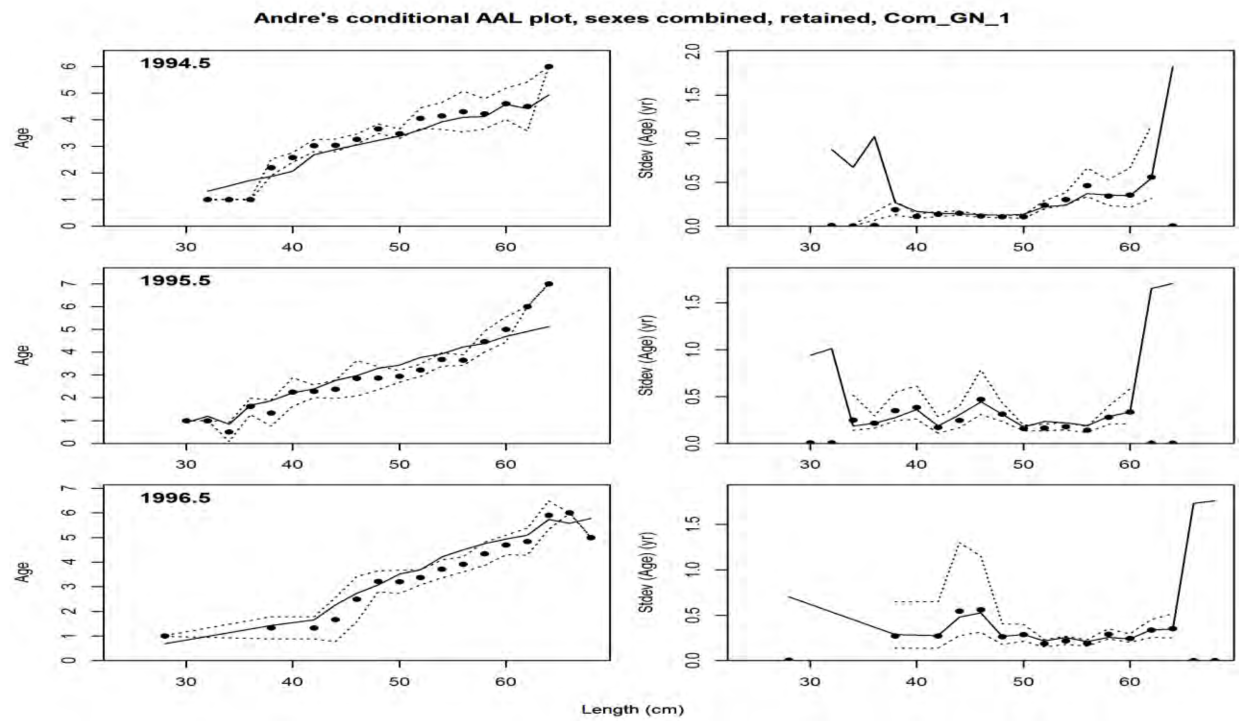


Figure 3.12. Conditional age composition fits for Gulf of Mexico Spanish mackerel from SS Run Base1 1988 – 1993 for the COM_GN fleet. Left panel is estimated age at length at 2cm fork length bin. Right panel is estimated standard deviation of age at 2 cm fork length bin.



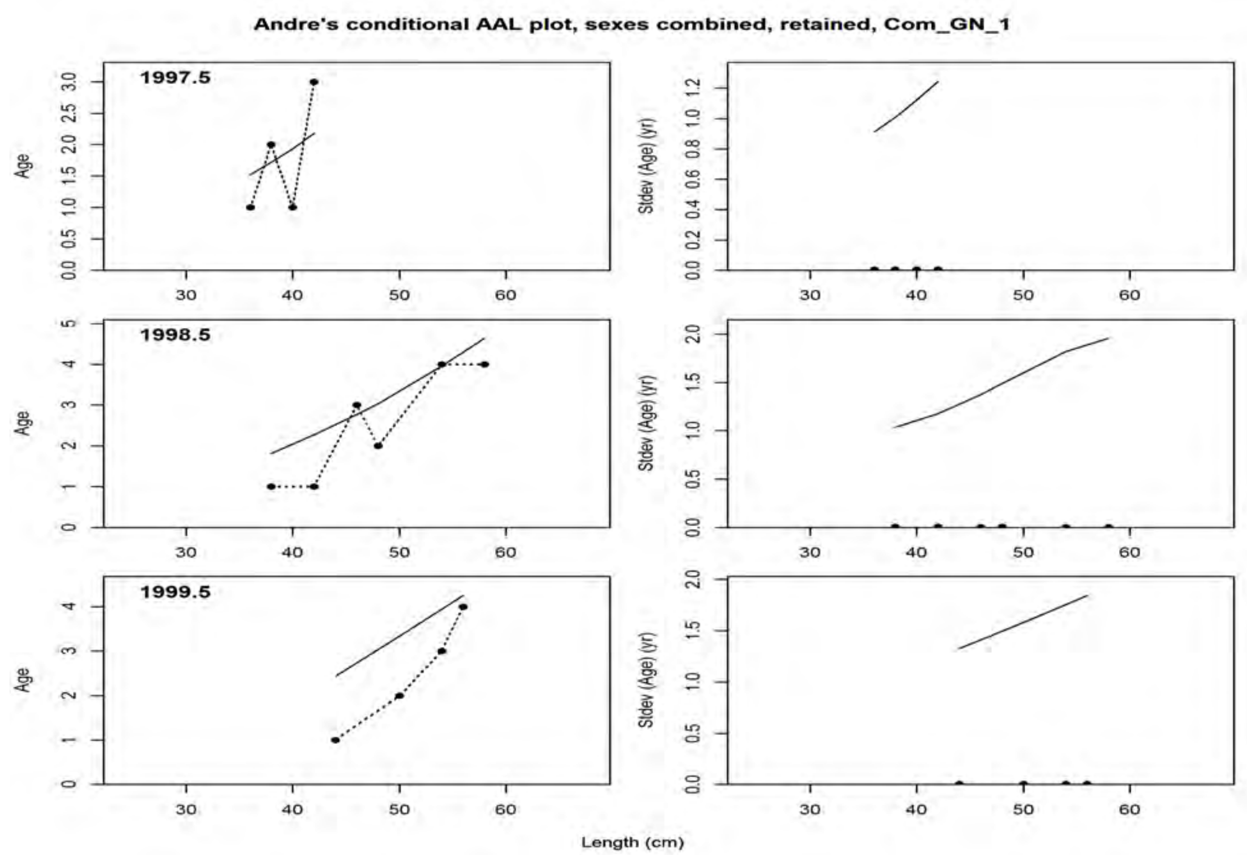


Figure 3.13. Conditional age composition fits for Gulf of Mexico Spanish mackerel from SS Run Base1 1994-1995 for the COM_GN fleet. . Left panel is estimated age at length at 2cm fork length bin. Right panel is estimated standard deviation of age at 2 cm fork length bin.

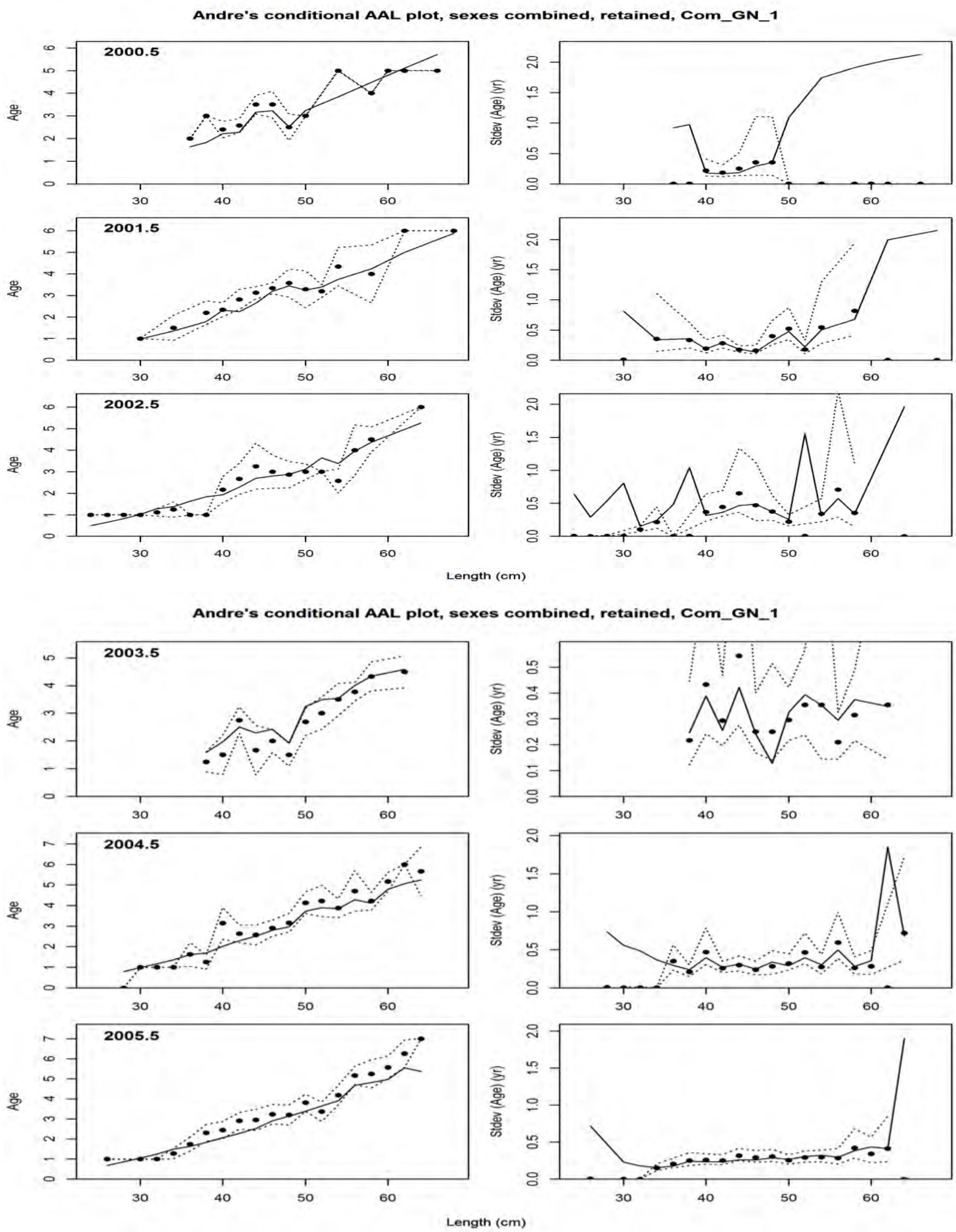


Figure 3.14. Conditional age composition fits for Gulf of Mexico Spanish mackerel from SS Run Base1 2000-2005 for the COM_GN fleet. Left panel is estimated age at length at 2cm fork length bin. Right panel is estimated standard deviation of age at 2 cm fork length bin.

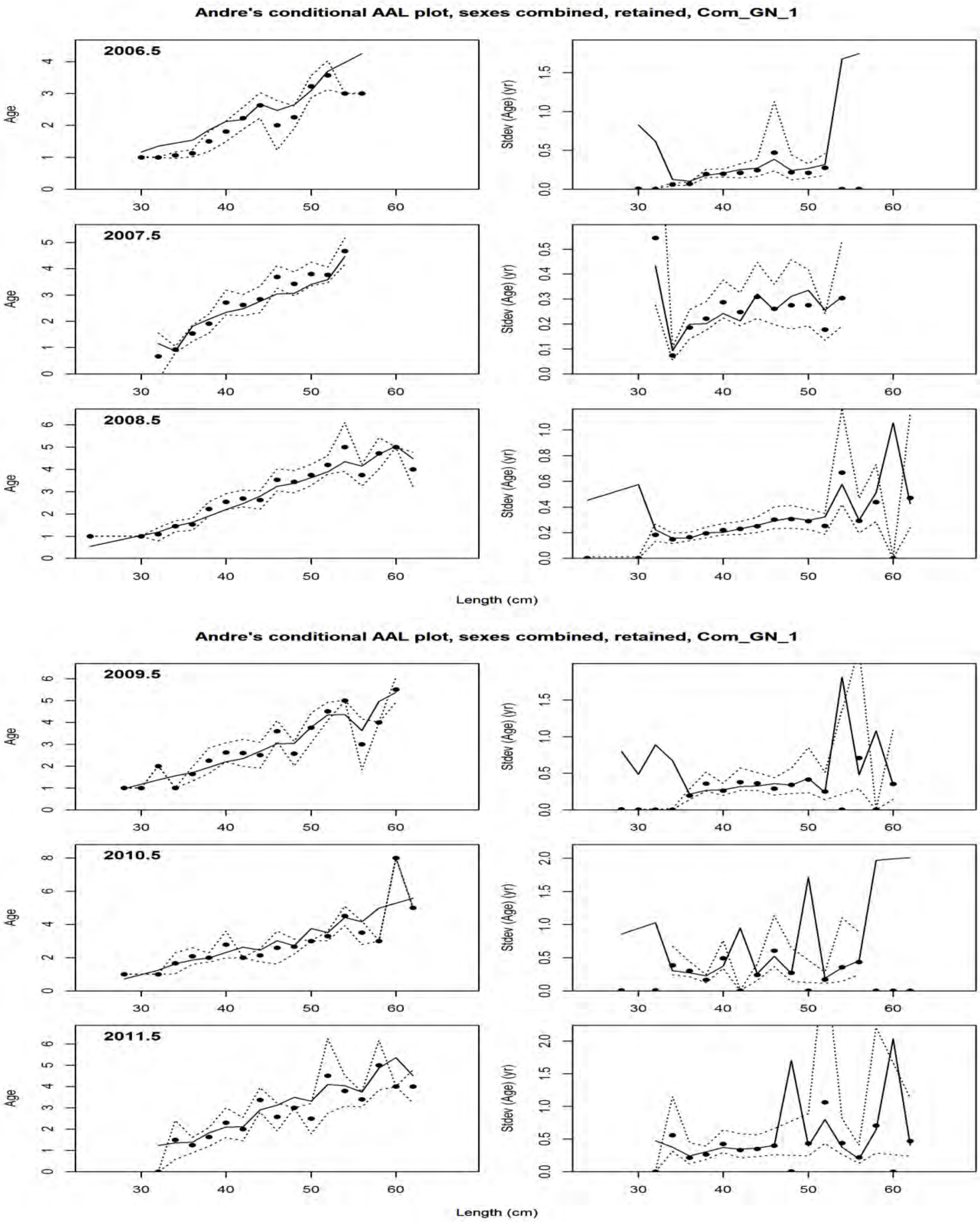
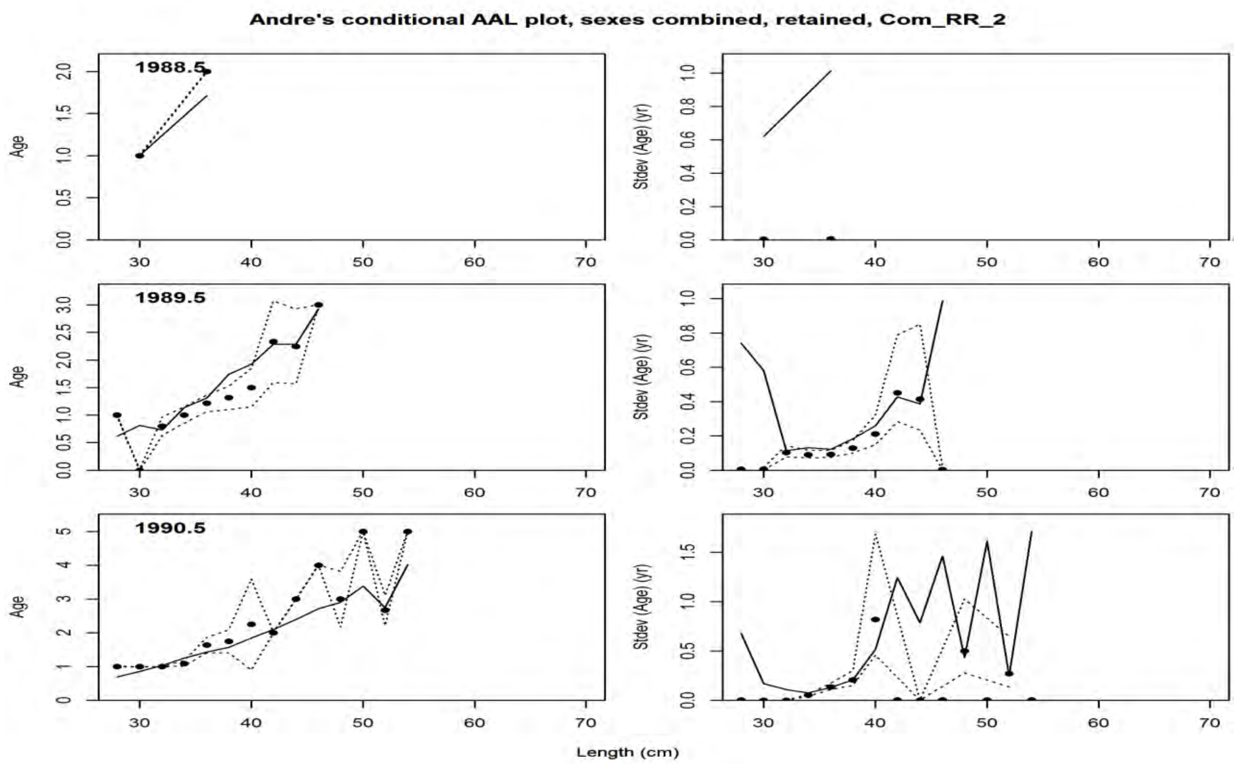


Figure 3.15. Conditional age composition fits for Gulf of Mexico Spanish mackerel from SS Run Base1 2006-2011 for the COM_GN fleet. Left panel is estimated age at length at 2cm fork length bin. Right panel is estimated standard deviation of age at 2 cm fork length bin.



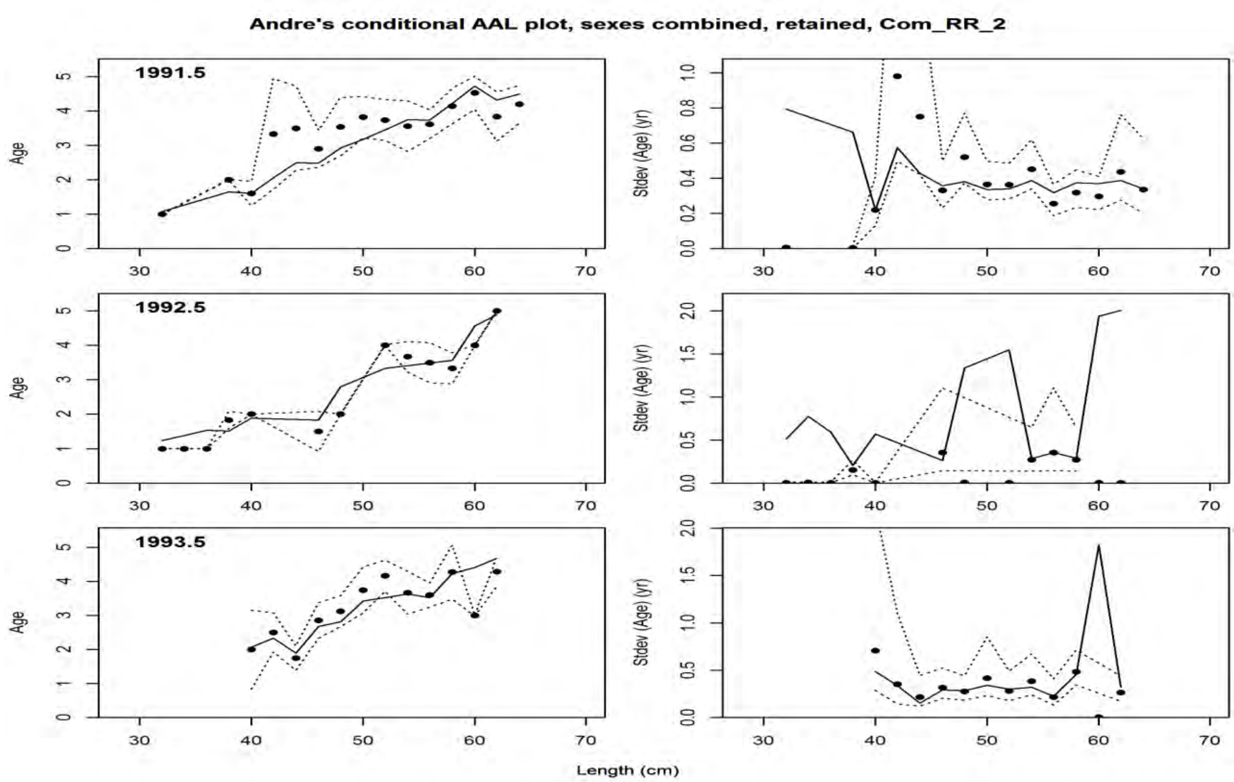
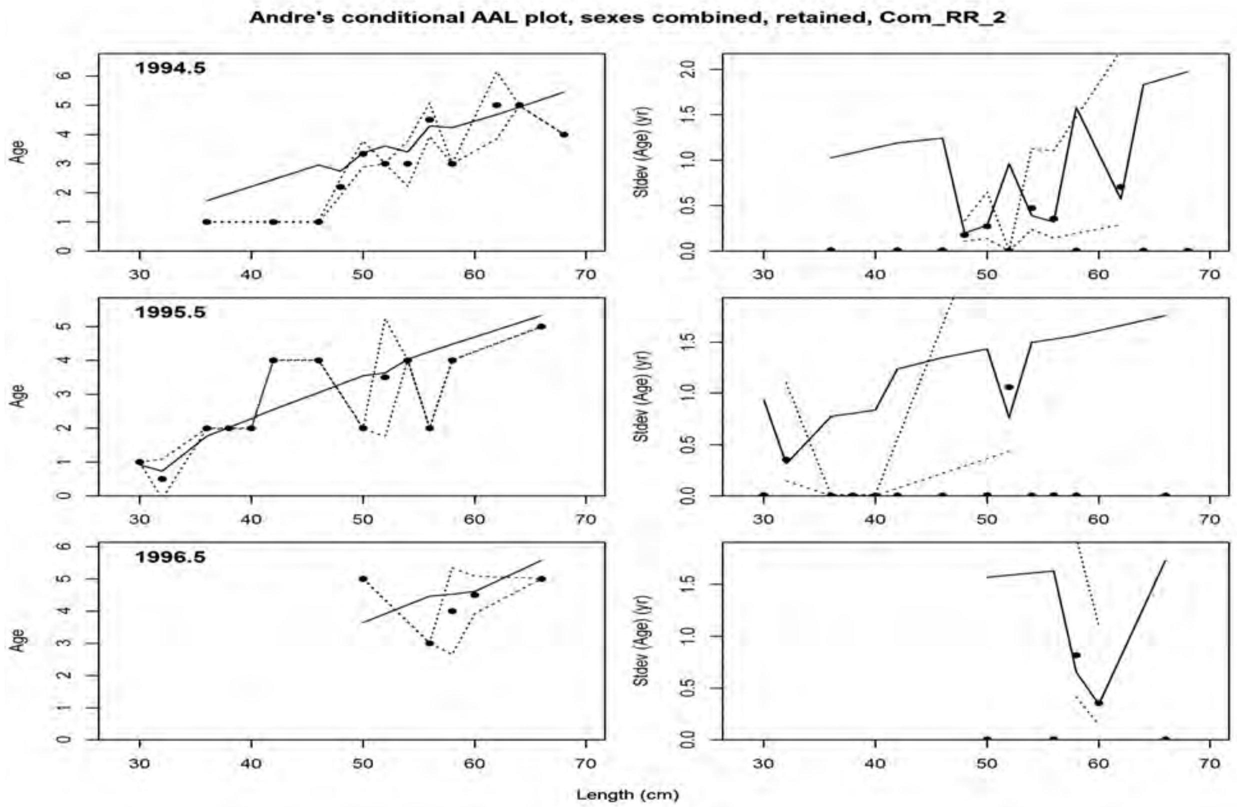


Figure 3.16. Conditional age composition fits for Gulf of Mexico Spanish mackerel from SS Run Base1 1988--1993 for the COM_RR fleet. Left panel is estimated age at length at 2cm fork length bin. Right panel is estimated standard deviation of age at 2 cm fork length bin.



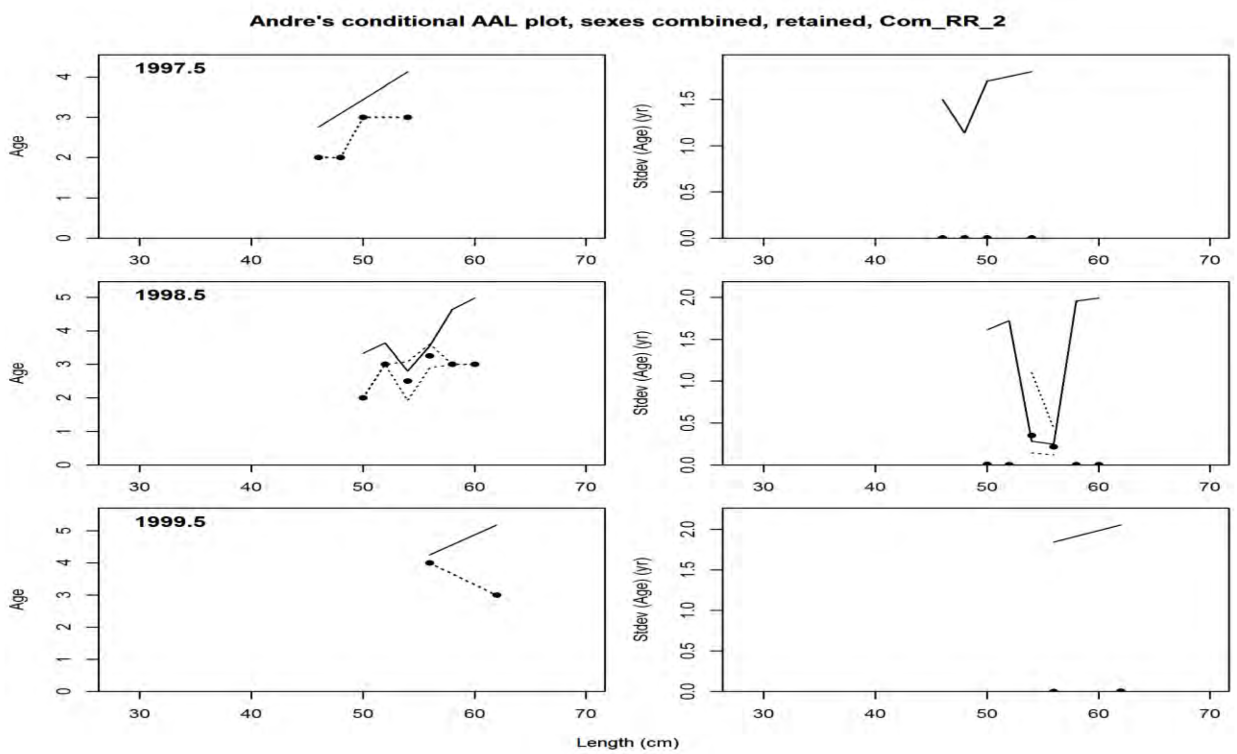


Figure 3.17. Conditional age composition fits for Gulf of Mexico Spanish mackerel from SS Run Base1 1994--1999 for the COM_RR fleet. Left panel is estimated age at length at 2cm fork length bin. Right panel is estimated standard deviation of age at 2 cm fork length bin.

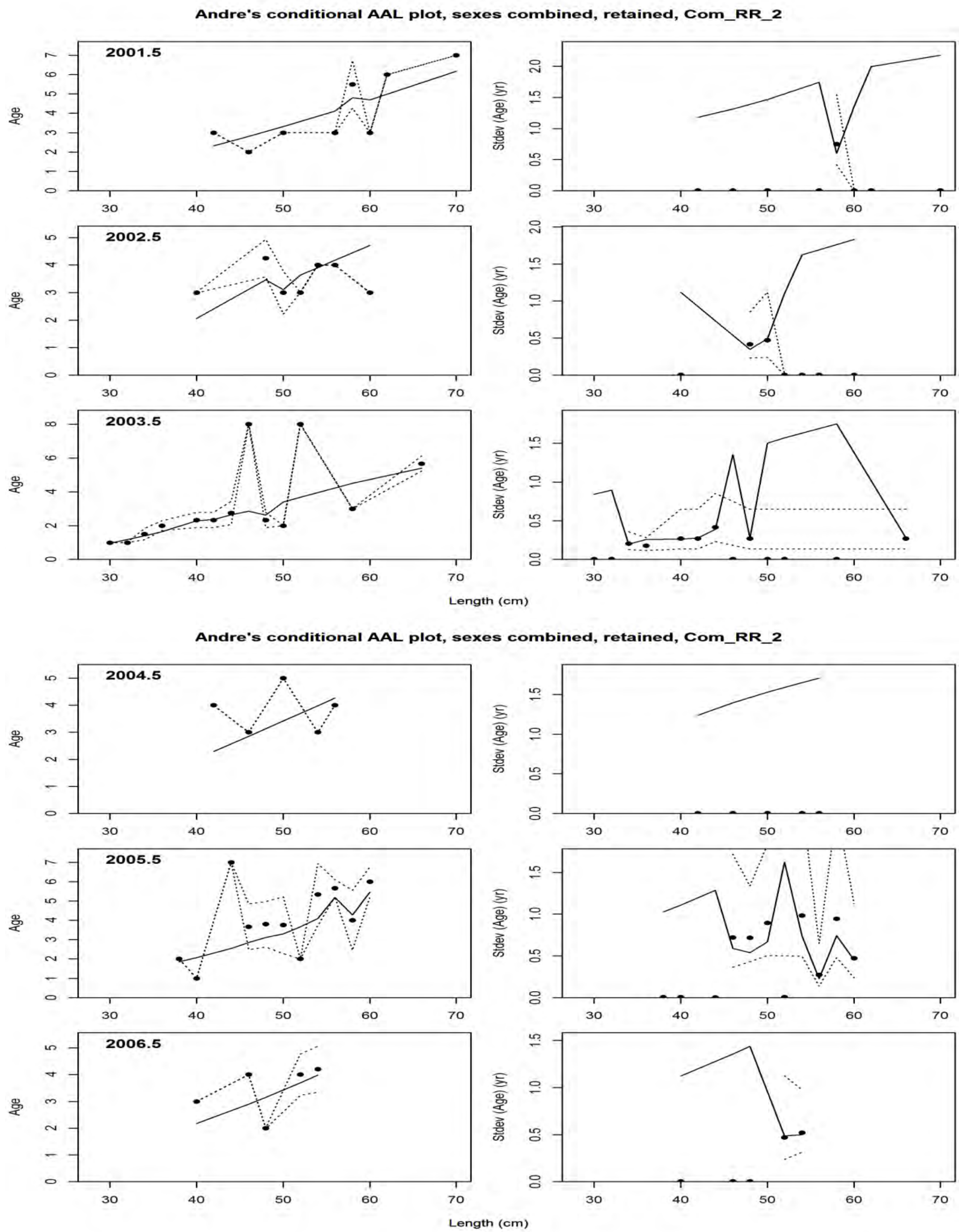
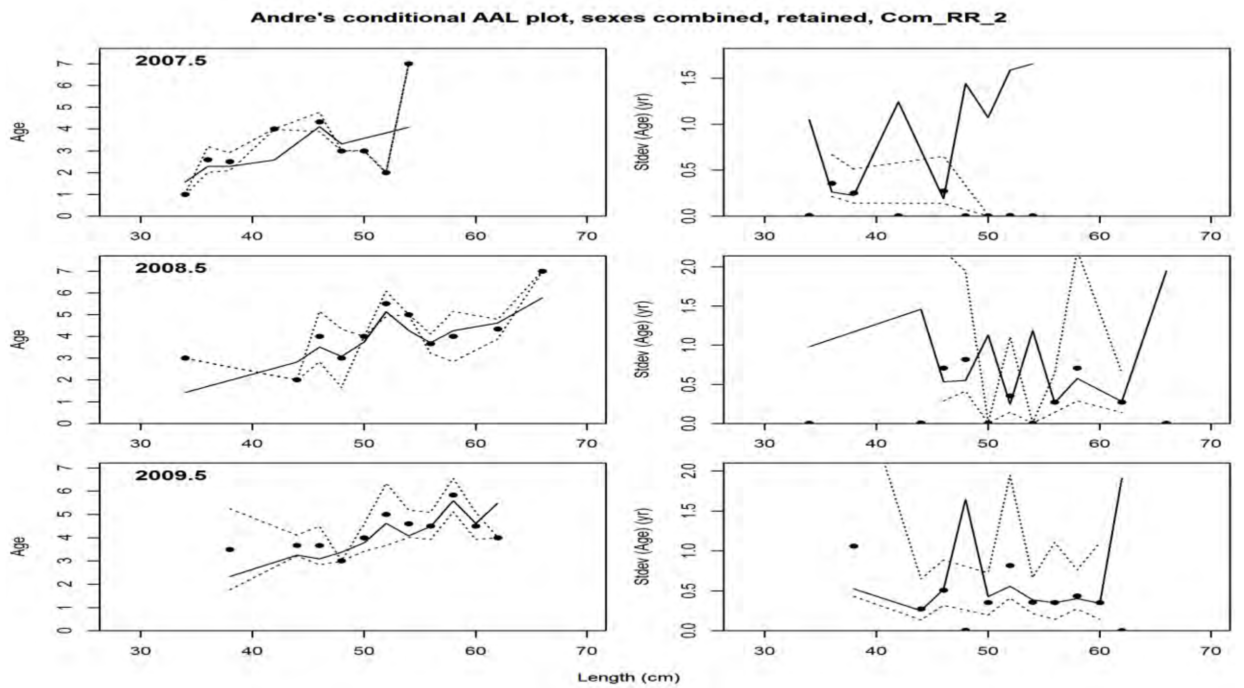


Figure 3.18. Conditional age composition fits for Gulf of Mexico Spanish mackerel from SS Run Base1 2001-2006 for the COM_RR fleet. Left panel is estimated age at length at 2cm fork length bin. Right panel is estimated standard deviation of age at 2 cm fork length bin.



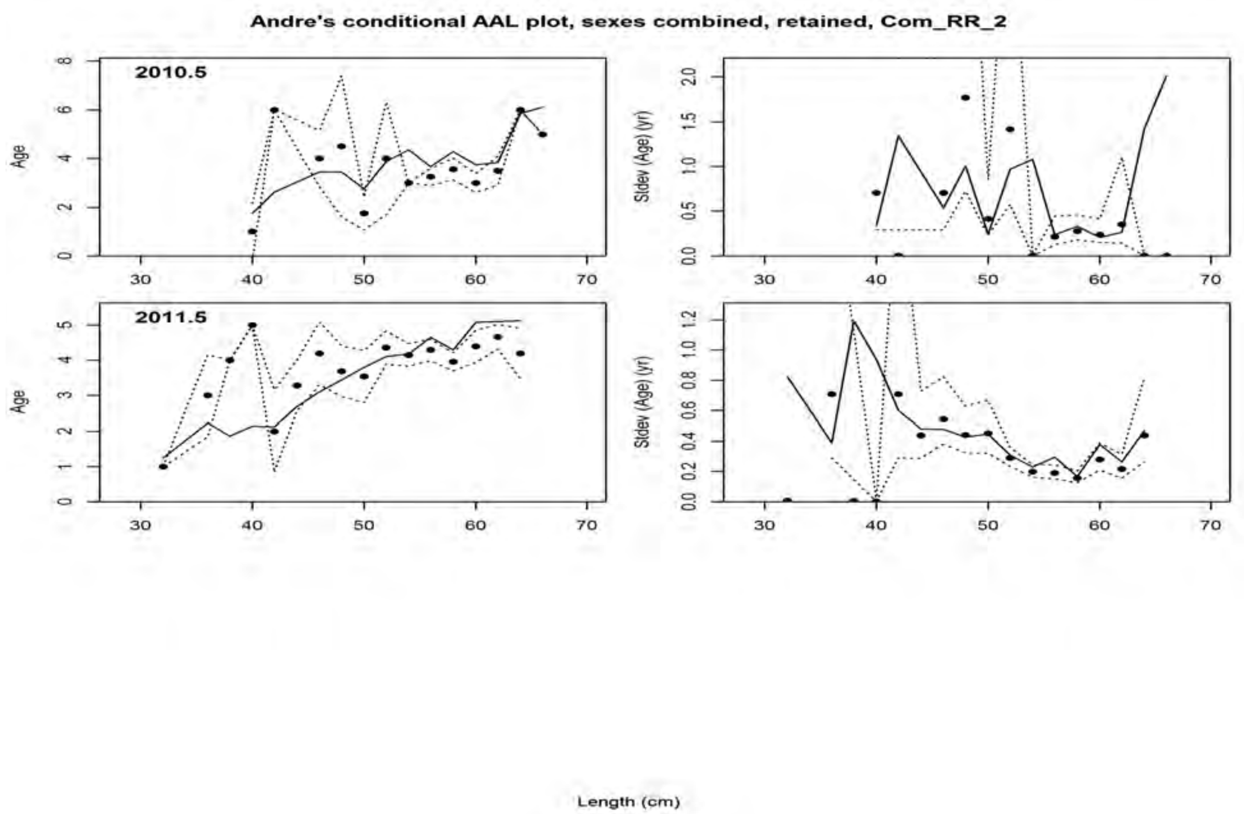
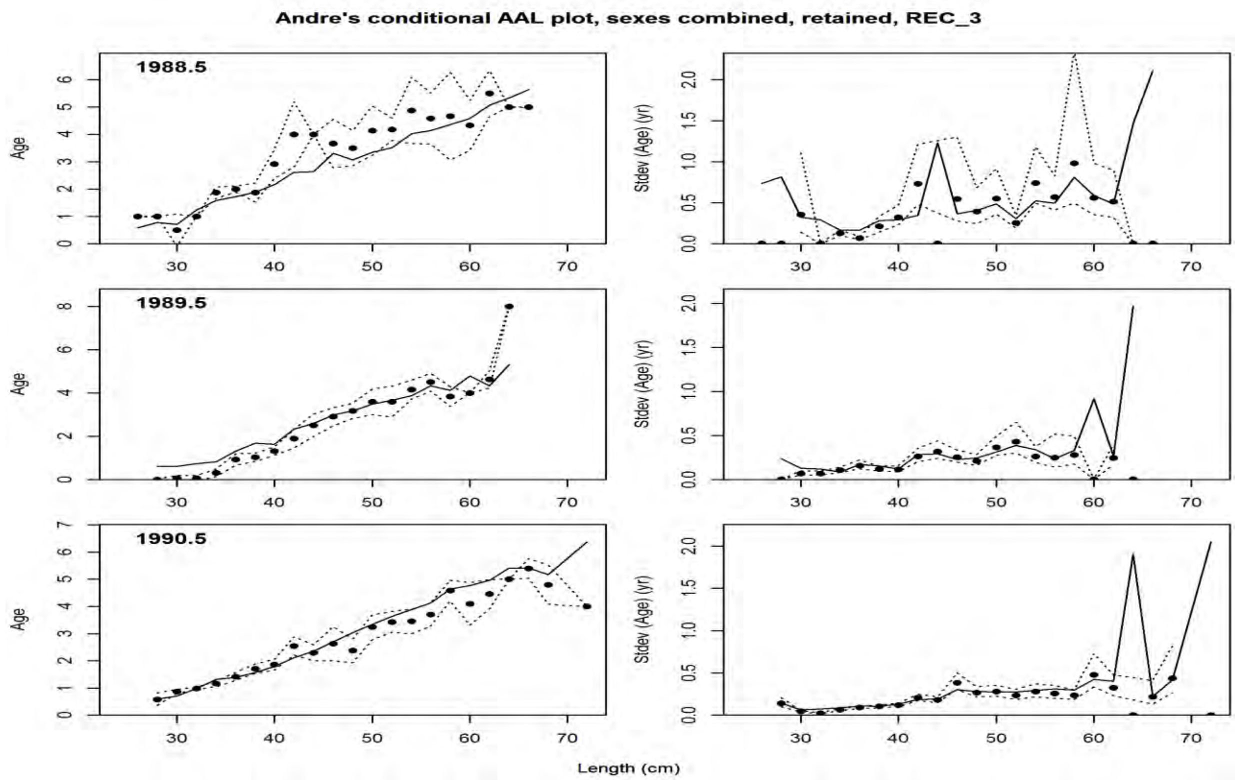


Figure 3.19. Conditional age composition fits for Gulf of Mexico Spanish mackerel from SS Run Base1 2007-2011 for the COM_RR fleet. Left panel is estimated age at length at 2cm fork length bin. Right panel is estimated standard deviation of age at 2 cm fork length bin.



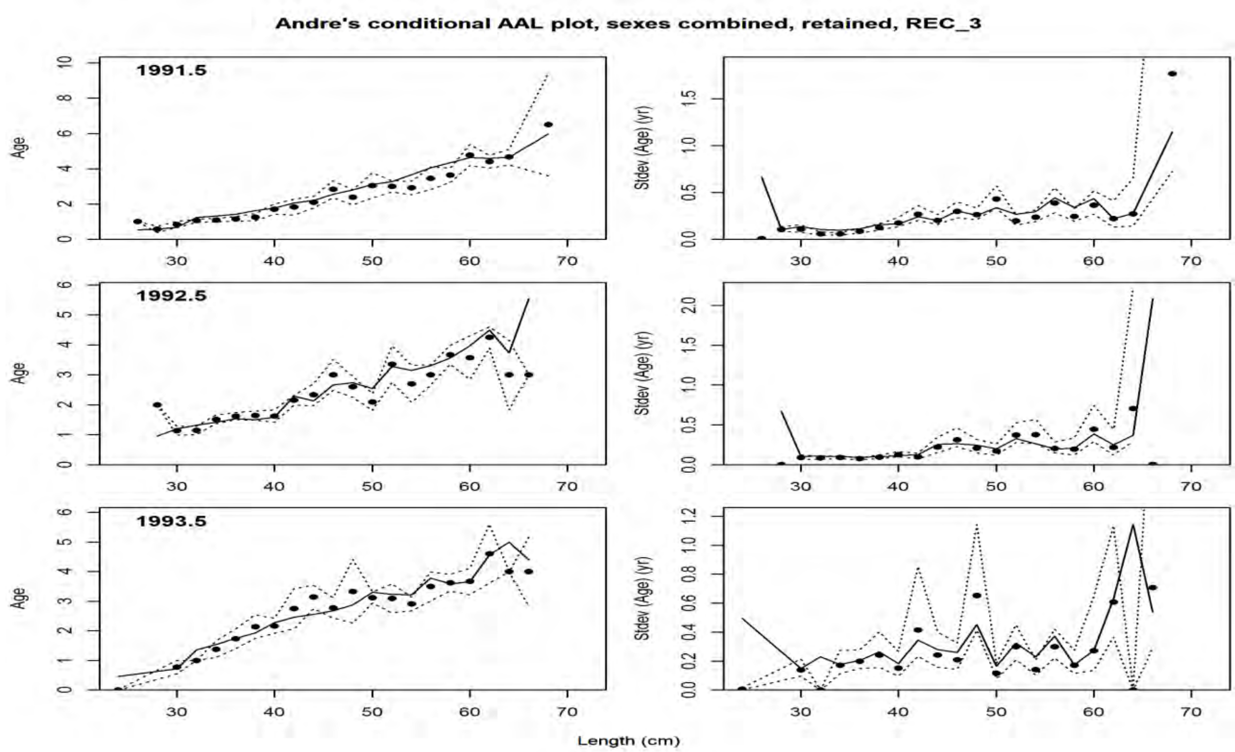
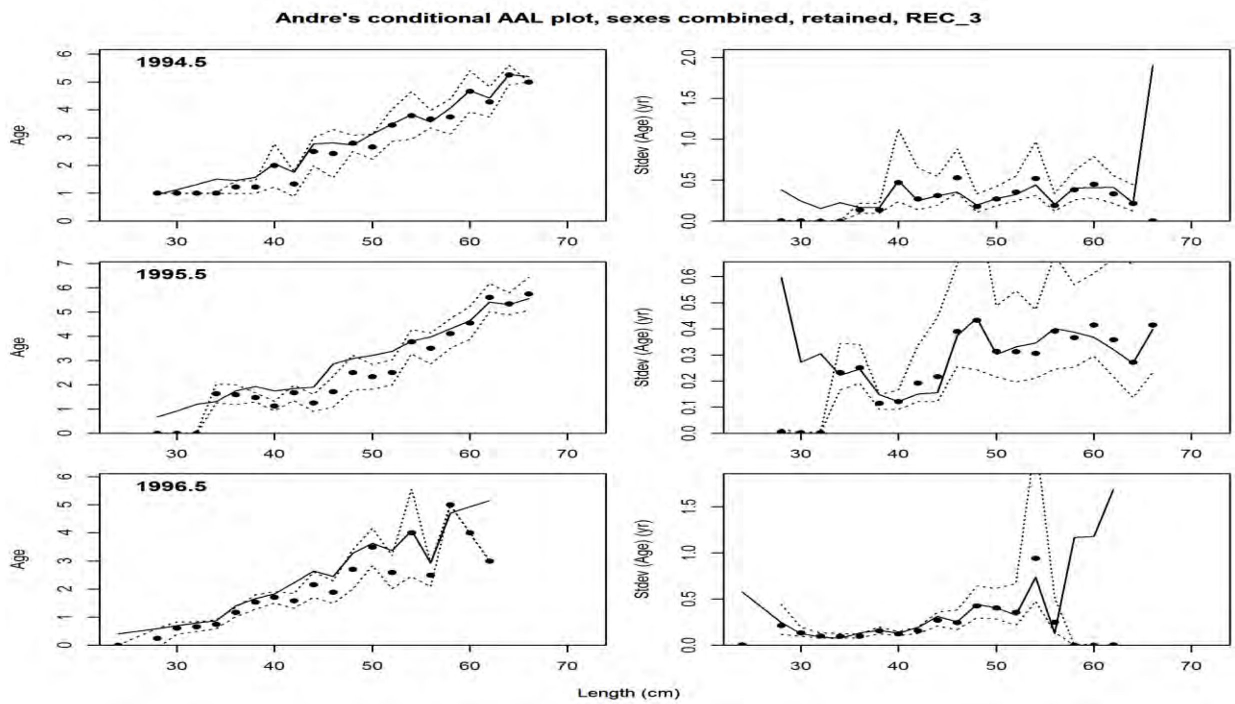


Figure 3.20. Conditional age composition fits for Gulf of Mexico Spanish mackerel from SS Run Base1 1988-1993 for the REC all modes . Left panel is estimated age at length at 2cm fork length bin. Right panel is estimated standard deviation of age at 2 cm fork length bin.



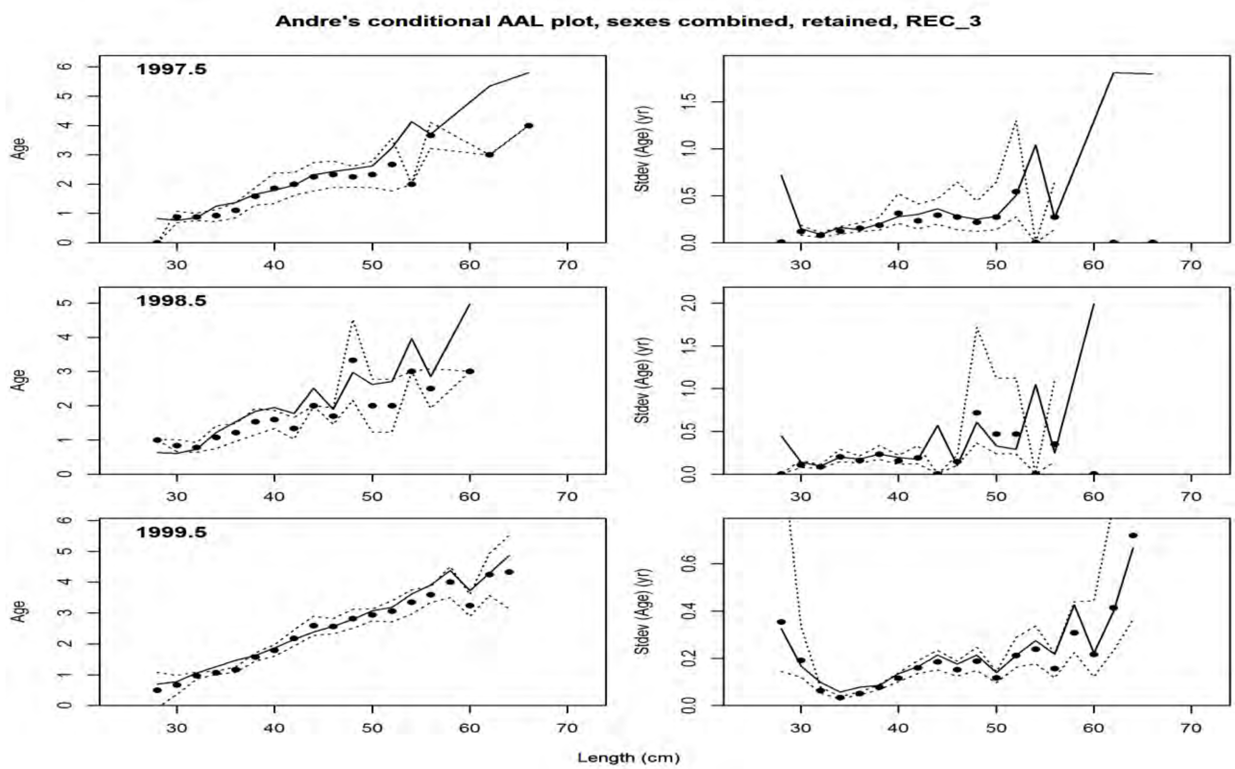


Figure 3.21. Conditional age composition fits for Gulf of Mexico Spanish mackerel from SS Run Base 1994-19991 for the REC all modes fleet. Left panel is estimated age at length at 2cm fork length bin. Right panel is estimated standard deviation of age at 2 cm fork length bin.

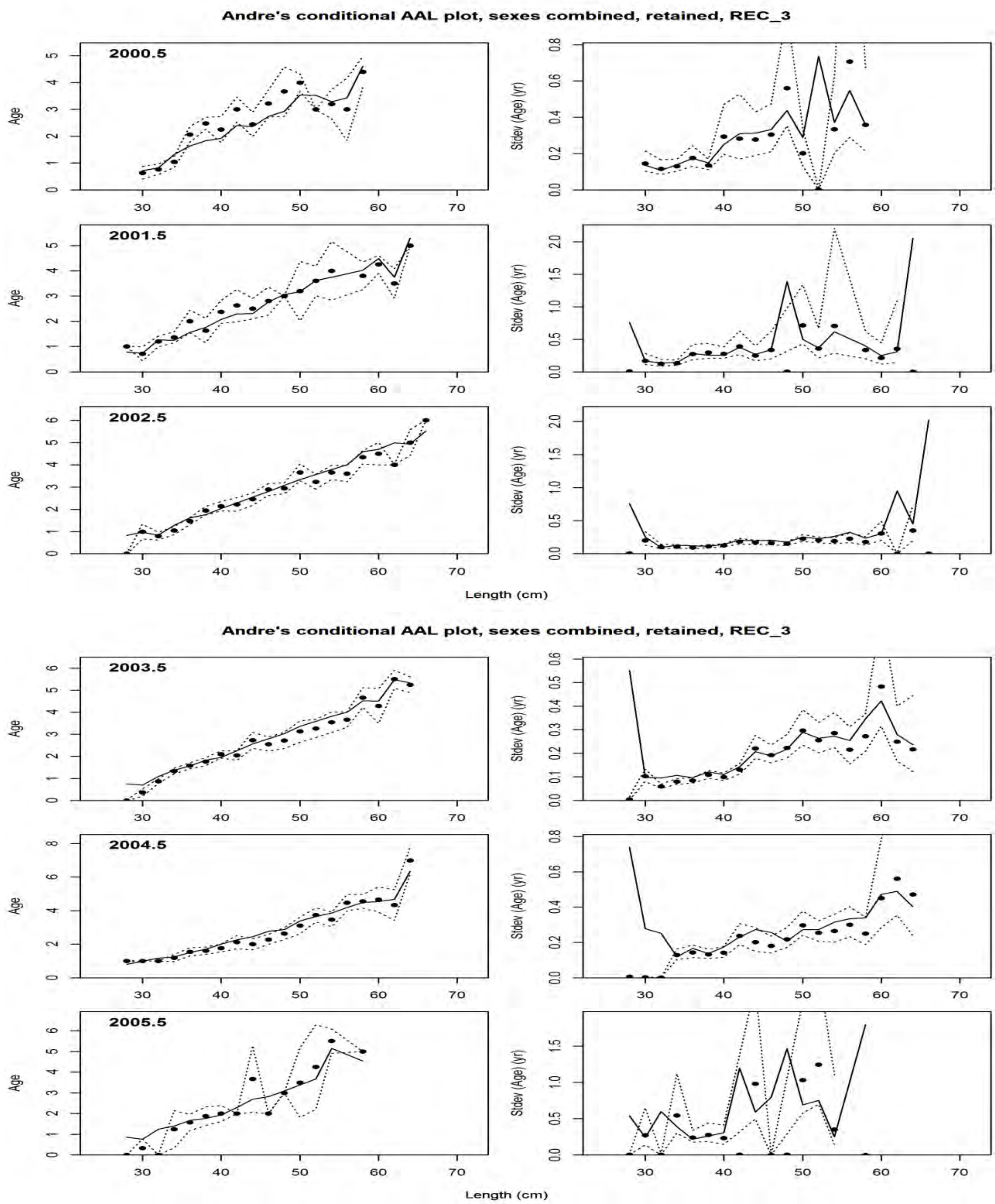


Figure 3.22. Conditional age composition fits for Gulf of Mexico Spanish mackerel from SS Run Base1 2000-2005 for the REC all modes fleet. Left panel is estimated age at length at 2cm fork length bin. Right panel is estimated standard deviation of age at 2 cm fork length bin.

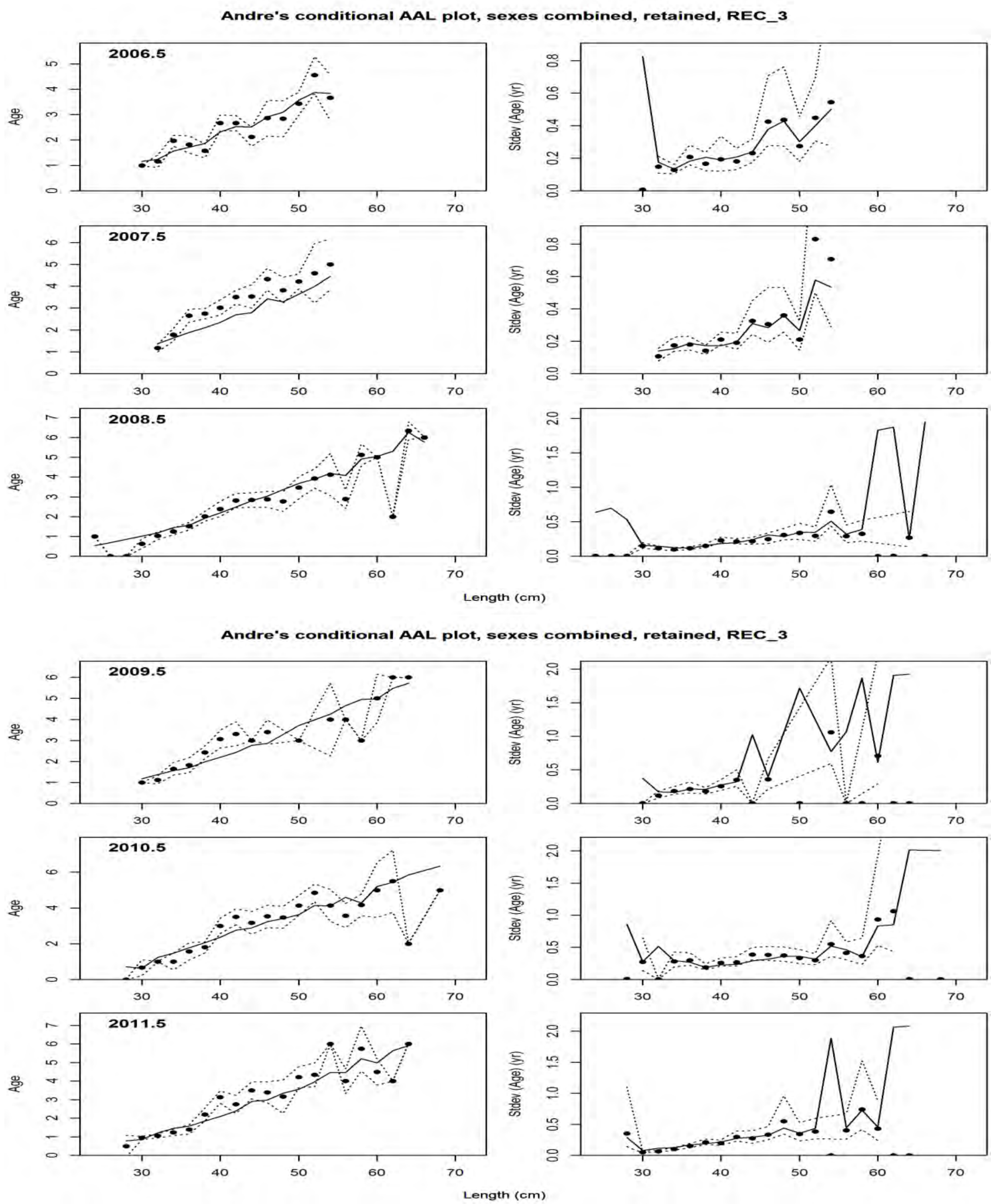


Figure 3.23. Conditional age composition fits for Gulf of Mexico Spanish mackerel from SS Run Base1 2007-2011. for the REC all modes fleet. Left panel is estimated age at length at 2cm fork length bin. Right panel is estimated standard deviation of age at 2 cm fork length bin.

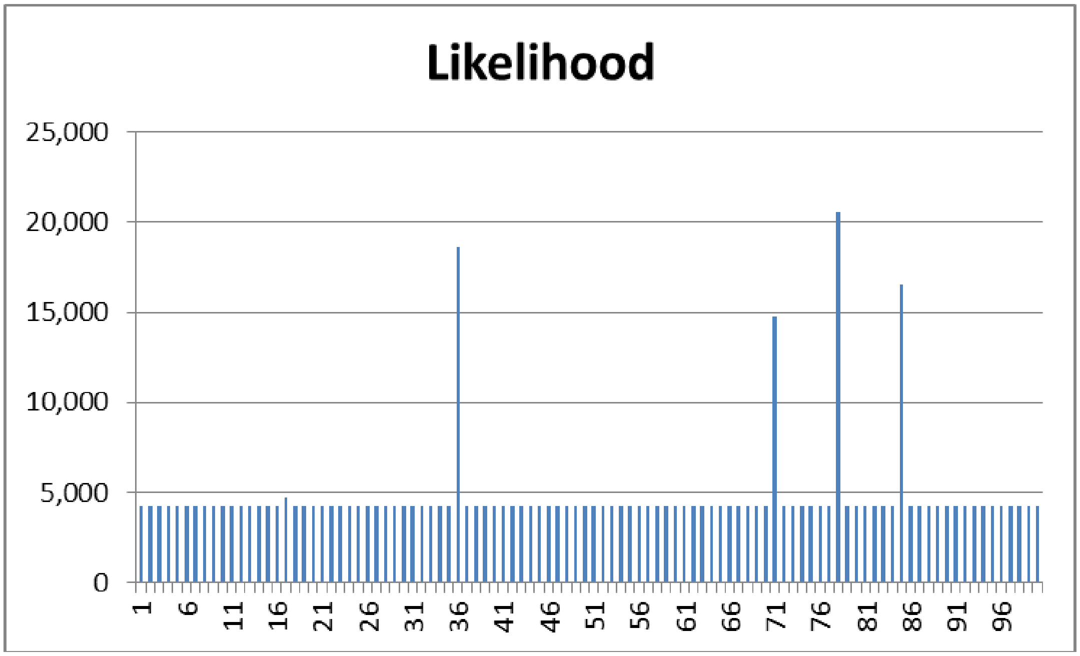


Figure 3.24. Summary results for model likelihood estimate for 100 jitter runs from the SS stock assessment model Run 3 (steepness = 0.8, M=0.38) for Gulf of Mexico Spanish mackerel.

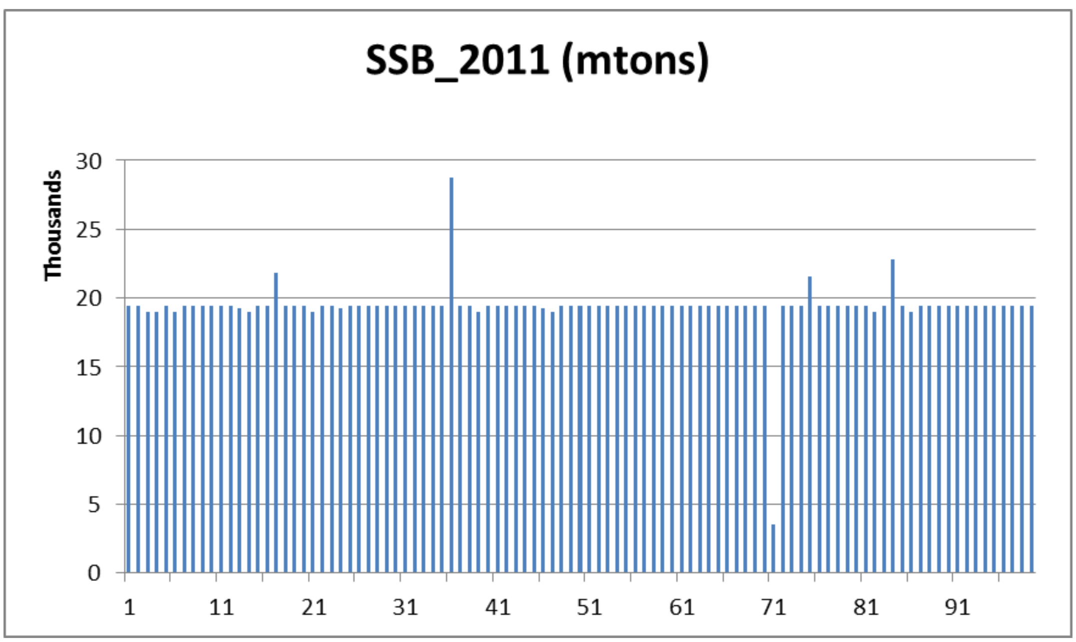
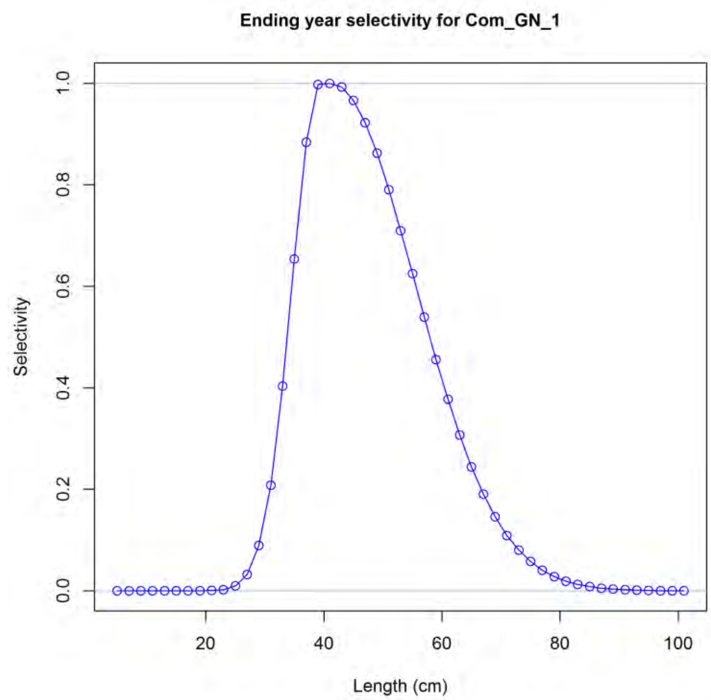


Figure 3.25. Summary results for predicted spawning stock biomass in 2011 (SSB) and spawning potential ratio in 2011 for 100 jitter runs from the SS stock assessment model Run 3 (steepness = 0.8, M=0.38) for Gulf of Mexico Spanish mackerel.

Figure 3.26. Summary results for model estimates of SPR_2011, F_CURRENT, F_REF, AND SSB_REF for 100 jitter runs from the SS stock assessment model Run 3 (steepness = 0.8, M=0.38) for Gulf of Mexico Spanish mackerel. F_CURRENT = geometric mean of F_2009-F_2011. SSB_REF = SSB_2011/MSST. MSST = 1.0 – M) * SSB_SPR30%SPR. F_REF = FCURRENT/F_30%SPR.



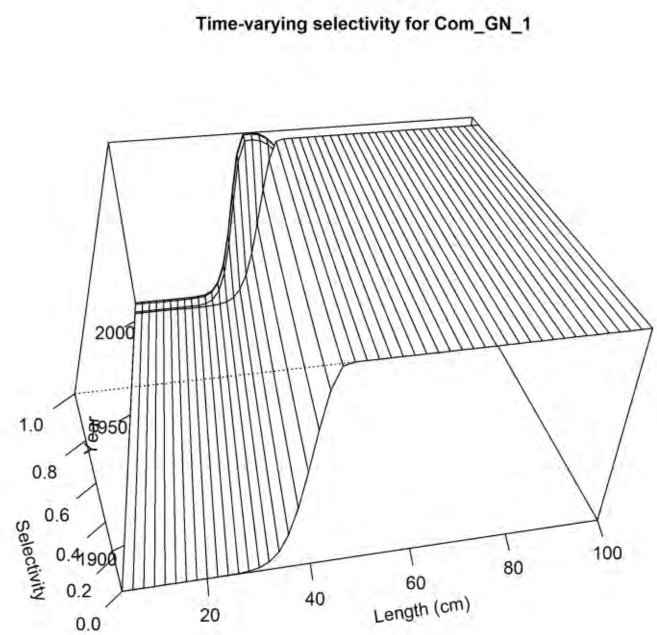
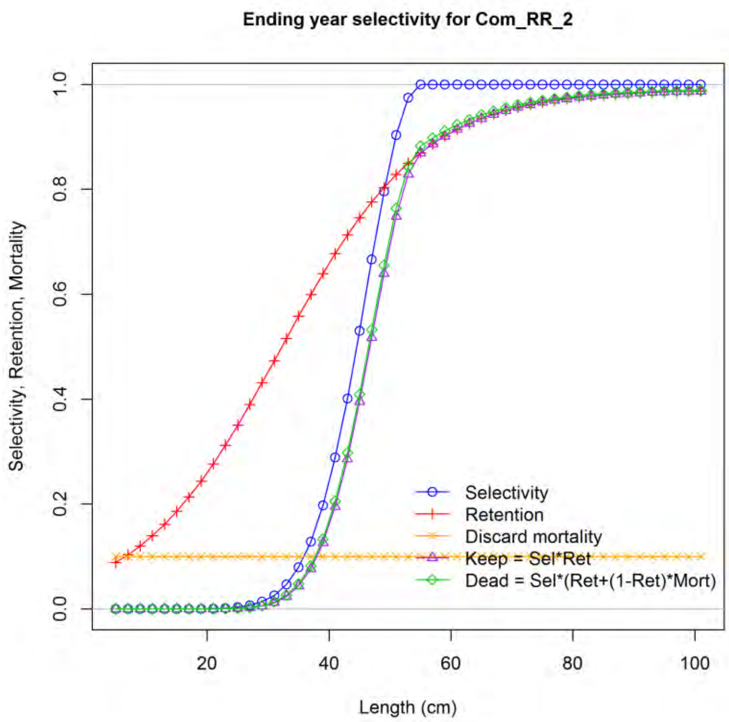


Figure 3.27. Predicted size selectivity for Gulf of Mexico Spanish mackerel from SS for the COM_GN fishery. Model configuration = Run 3, M=0.38 y^{-1} and Steepness = 0.8.

.



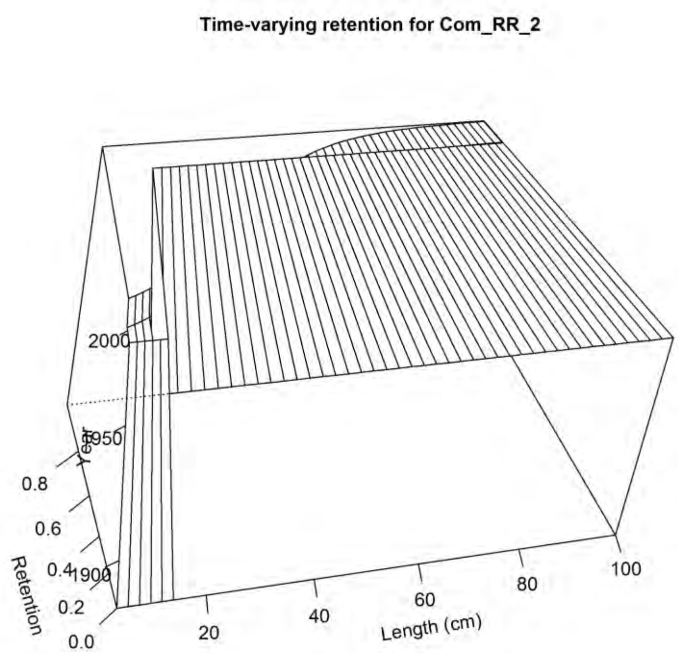


Figure 3.28. Predicted size selectivity for Gulf of Mexico Spanish mackerel from SS for the COM_RR fishery. Model configuration = Run 3, M=0.38 y^{-1} and Steepness = 0.8.
.

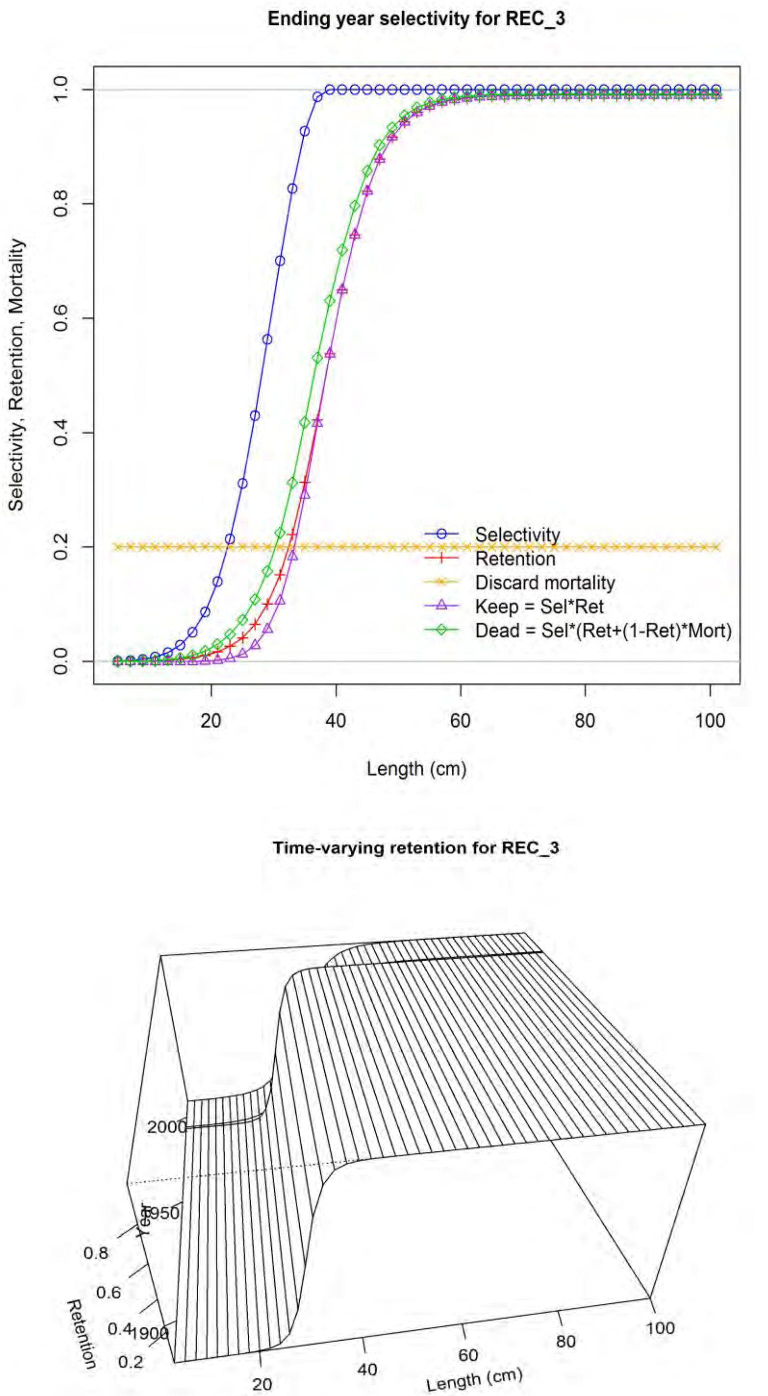


Figure 3.29. Predicted size selectivity for Gulf of Mexico Spanish mackerel from SS the REC (recreational all modes/. Model configuration = Run 3, M=0.38 y^{-1} and Steepness = 0.8.

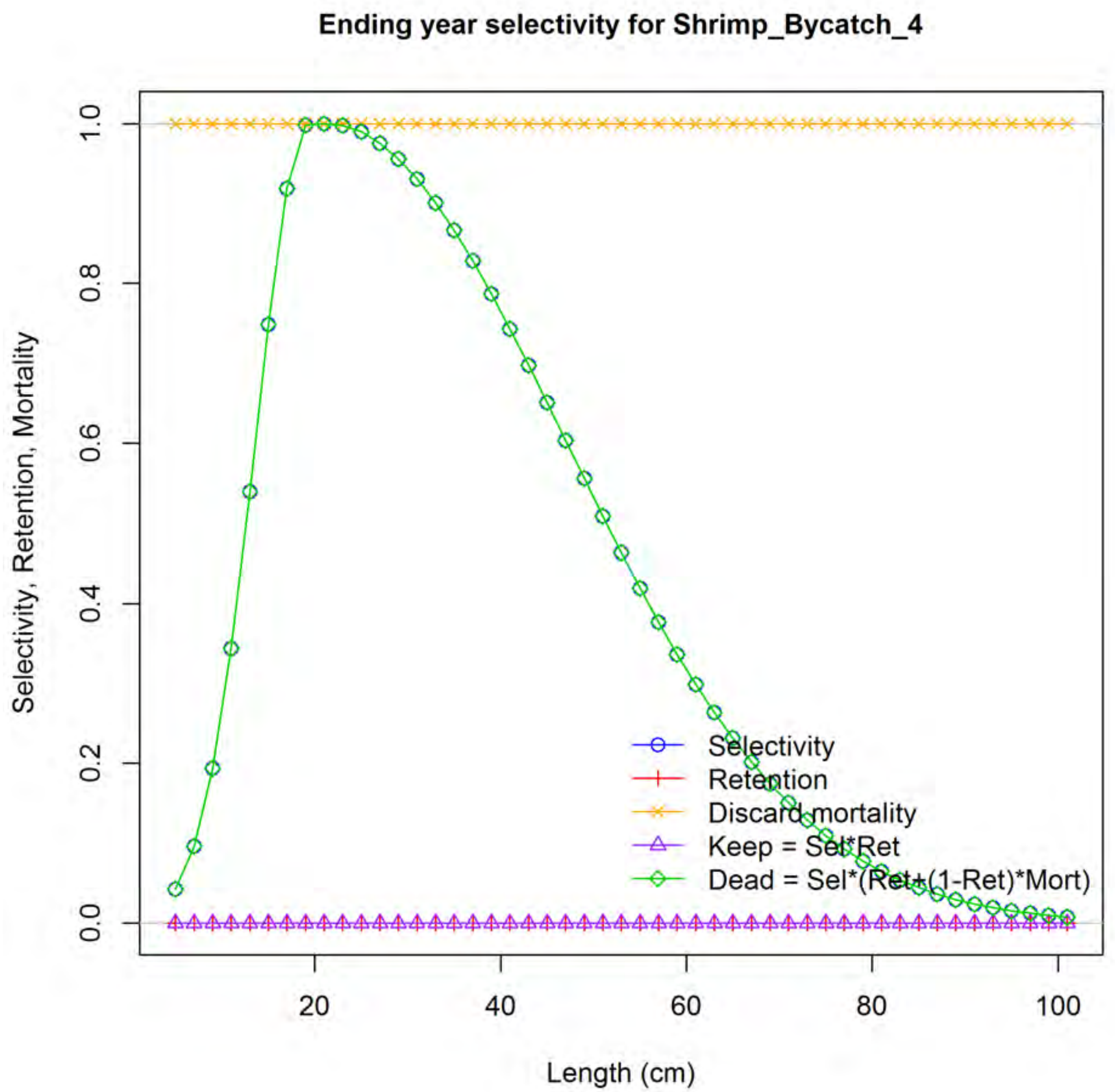


Figure 3.30. Predicted size selectivity for Gulf of Mexico Spanish mackerel from SS for the SEAMAP SURVEY. Model configuration = Run 3, M=0.38 y^{-1} and Steepness = 0.8.

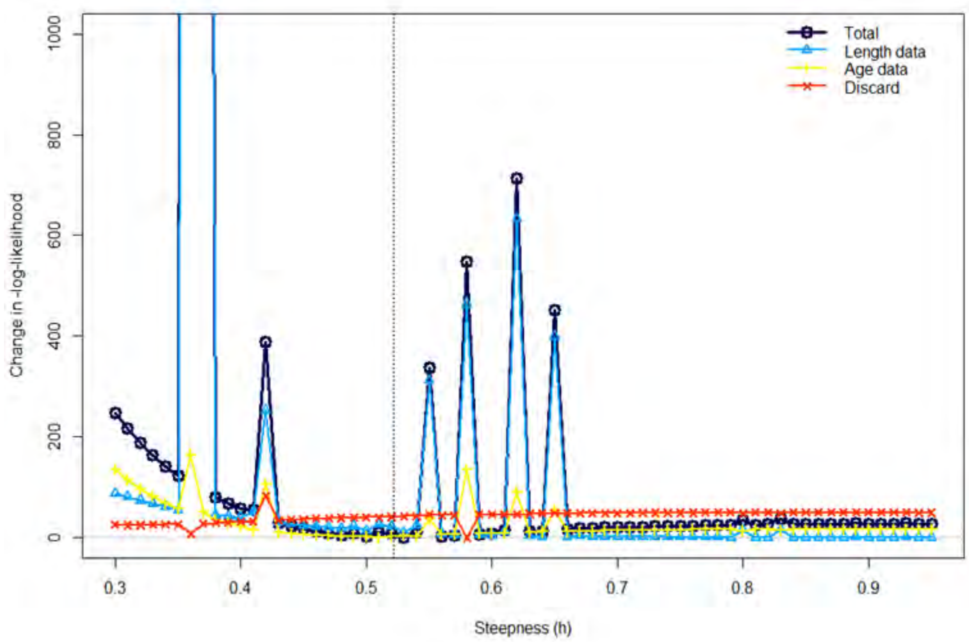


Figure 3.31. Profile of Steepness for Gulf of Mexico Spanish mackerel for Run 1 Model configuration. Model estimated steepness value= 0.5219, SD=0.0151.

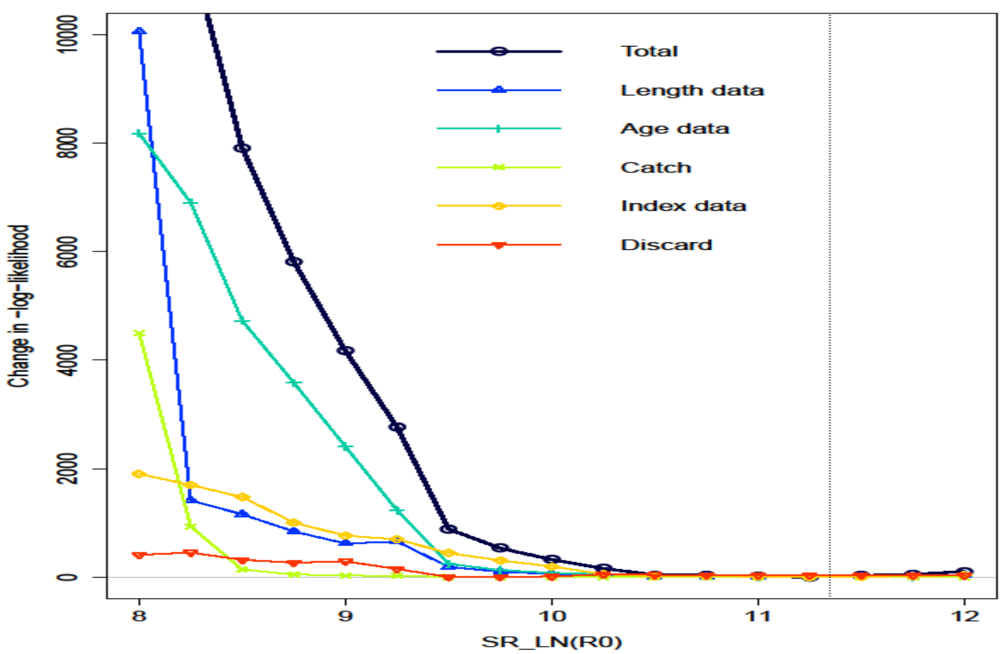


Figure 3.32. Profile of Virgin biomass (R0) for Gulf of Mexico Spanish mackerel for Run 1 Model configuration. Model estimated ln (R0) value=11.3274, SD = 0.052332. Blue line is change in length data likelihood, red line = change in discard data likelihood, aqua color line = change in age likelihood.

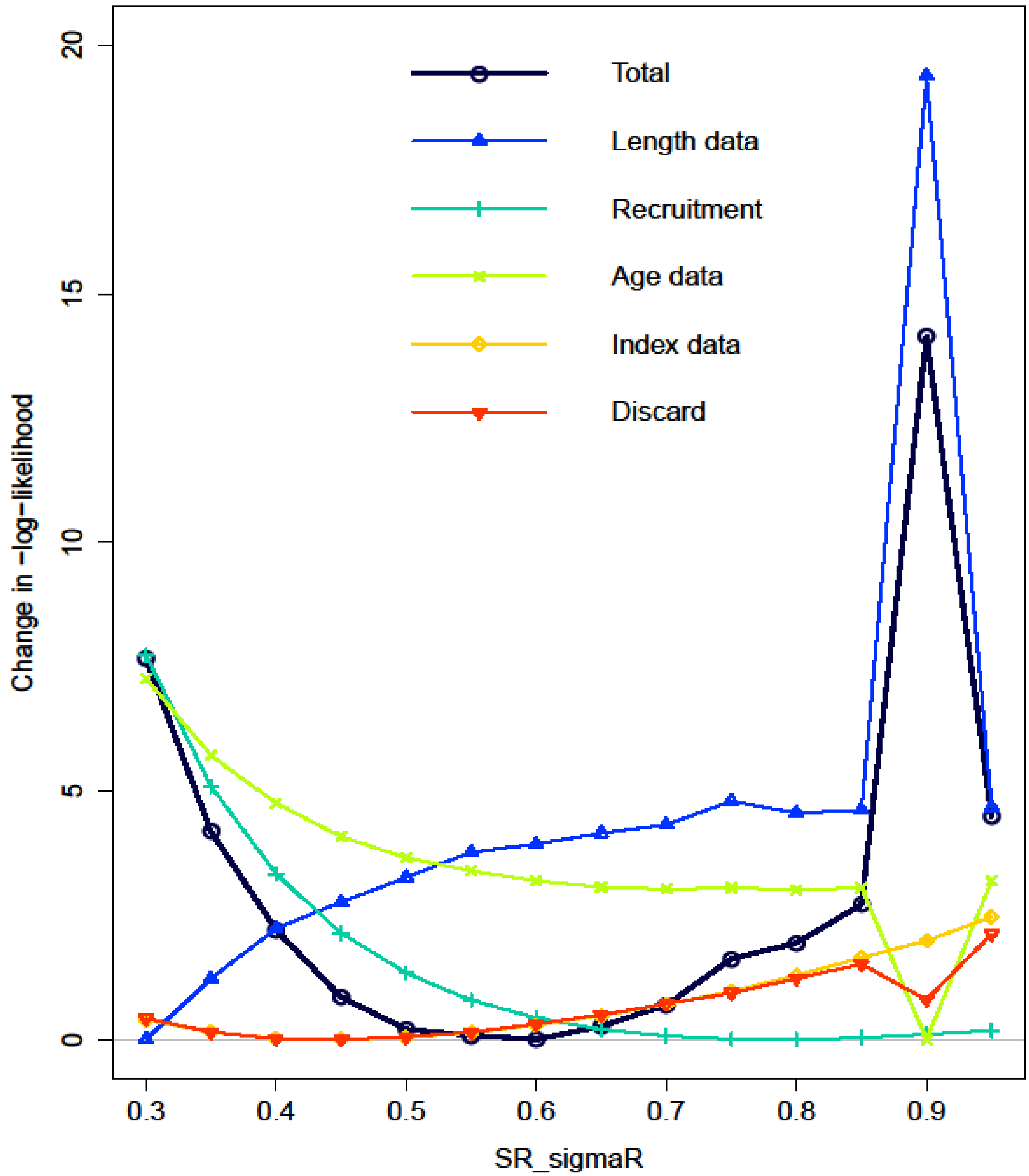


Figure 3.33. Profile of SigmaR of Gulf of Mexico Spanish mackerel for the Run 1 Model configuration. Model estimated sigmaR value=0.565754, SD=0.097579.

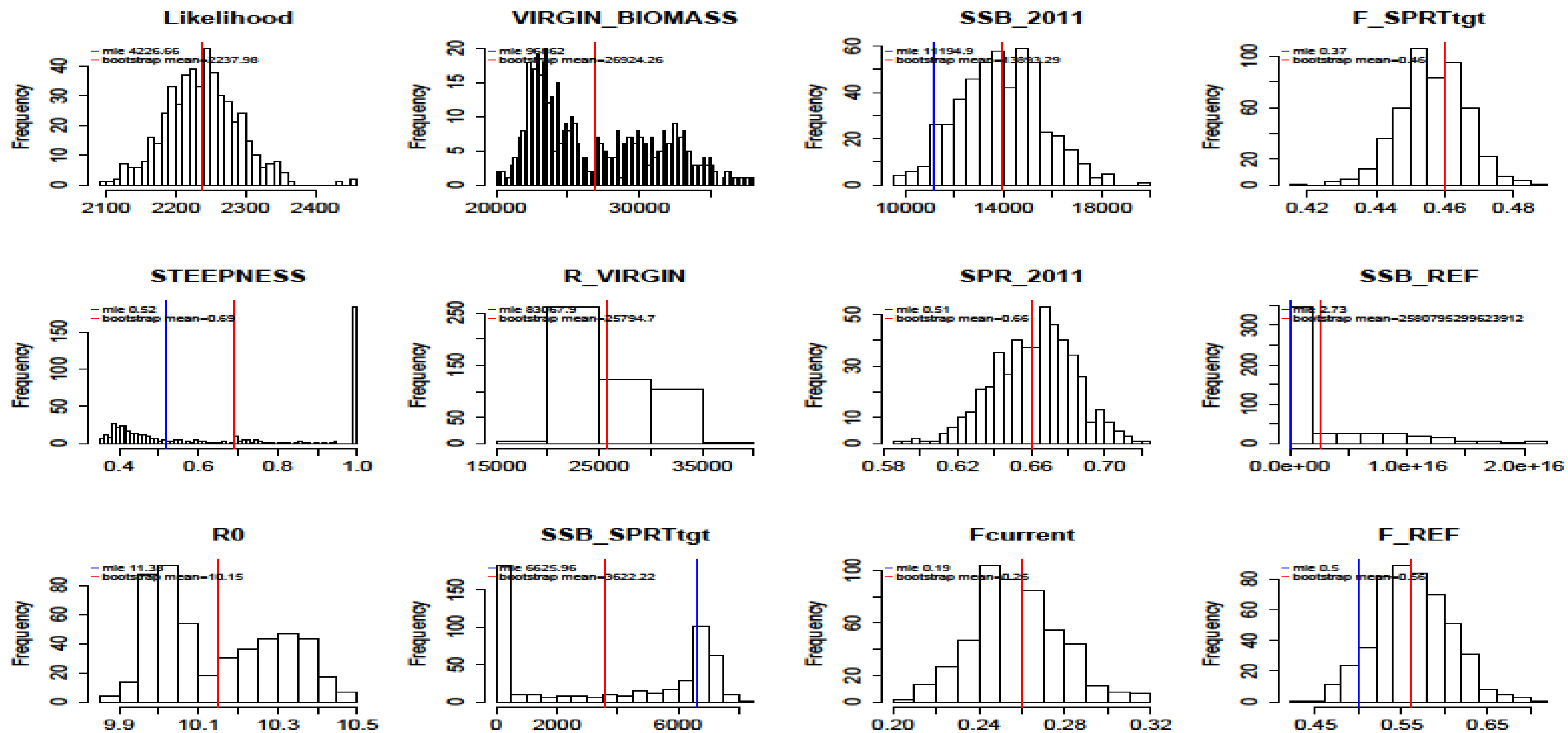


Figure 3.34. Distribution of key parameters estimated via SS from 500 bootstrap samples for the Run 1 model (steepness estimated and M =0.38y^{-1} input in Lorenzen function). Red lines represent mean estimates from the bootstrap samples; blue lines represent the point estimate of the parameters from the Run 1 model. SSB REF = SSB_2011/SSB_SPRTtgt and F_REF = Fcurrent / F_SPRTtgt. Fcurrent = geometric mean for 2009-2011.

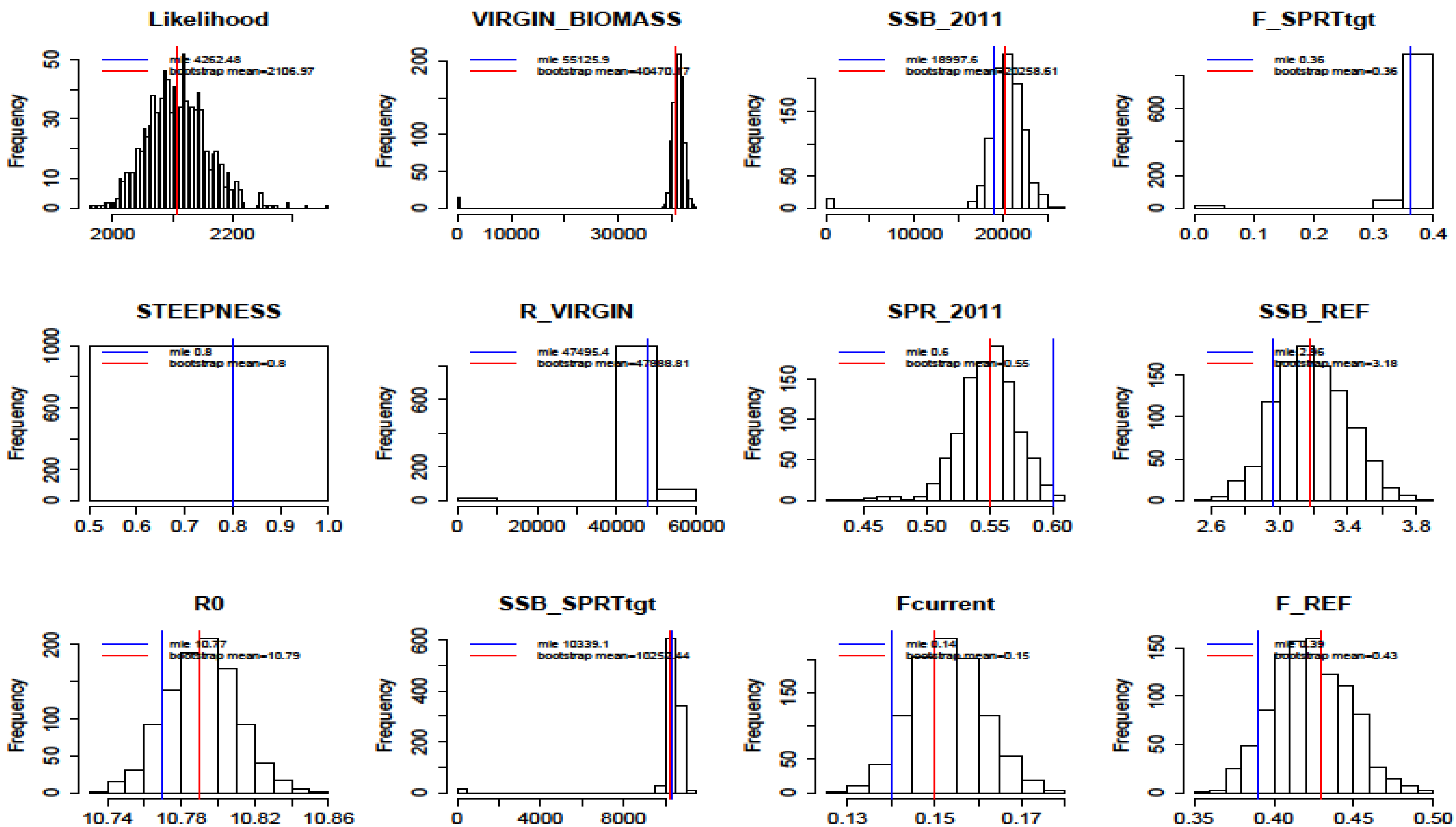


Figure 3.35. Distribution of key parameters estimated via SS from 1,000 bootstrap samples for the Run 1 model (steepness fixed at 0.8 and M =0.38y^{-1} input in Lorenzen function). Red lines represent mean estimates from the bootstrap samples; blue lines represent the point estimate of the parameters from the Run 3 model. SSB REF = SSB_2011/SSB_SPRTtgt and F_REF = Fcurrent / F_SPRTtgt. Fcurrent = geometric mean for 2009-2011.

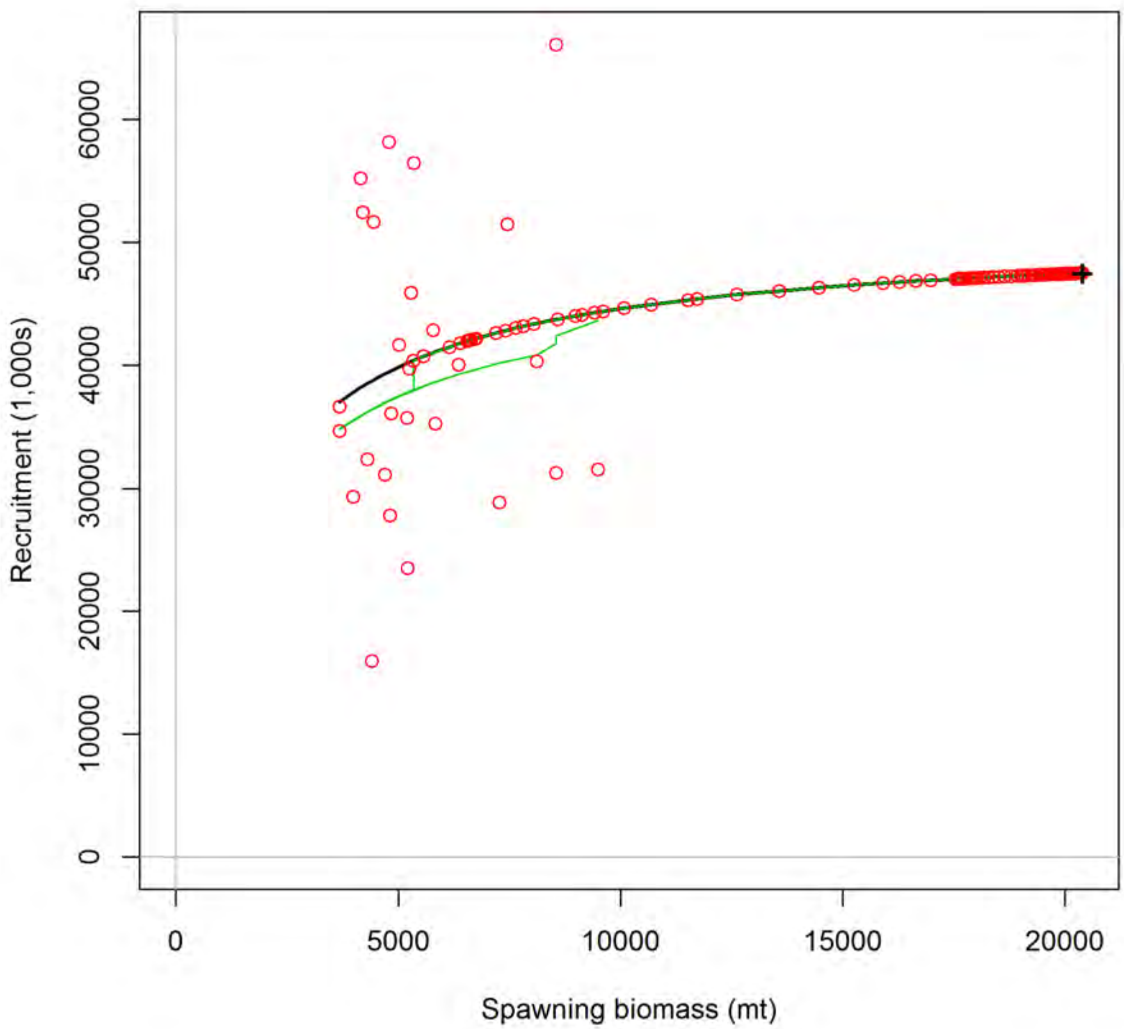


Figure 3.36. Predicted stock-recruitment relationship for Gulf of Mexico Spanish mackerel from SS Run 3 Model configuration (M=0.38 y^{-1} and Steepness = 0.8). Plotted are predicted annual recruitments from SS (circles), expected recruitment from the stock recruit relationship (line), and bias adjusted recruitment from the stock-recruit relationship (line with X). Labels included on first, last, and years with (log) deviations > 0.5.

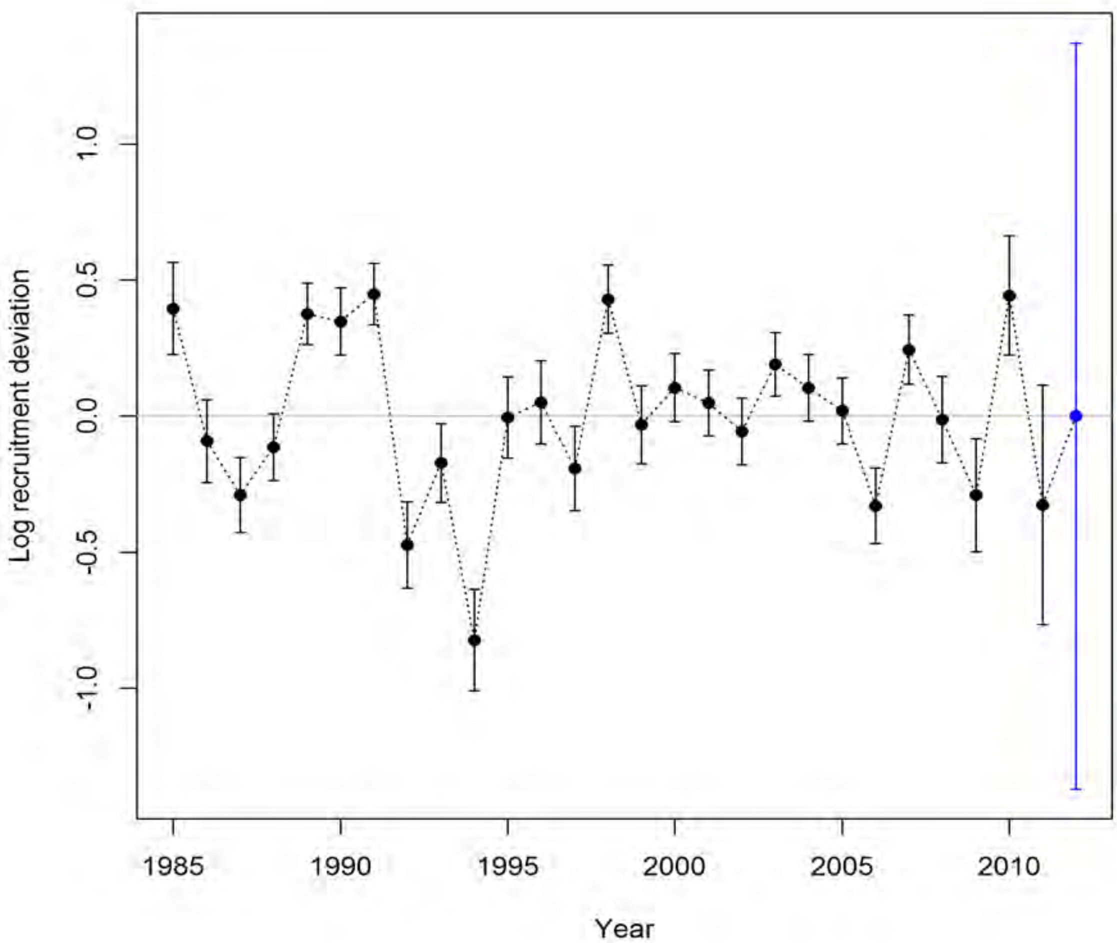


Figure 3.37. Asymptotic standard errors for recruitment deviations (1985-2010) for Gulf of Mexico Spanish mackerel from the SS Run 3 model (assuming steepness =0.8 and M=0.38y^{-1}) .

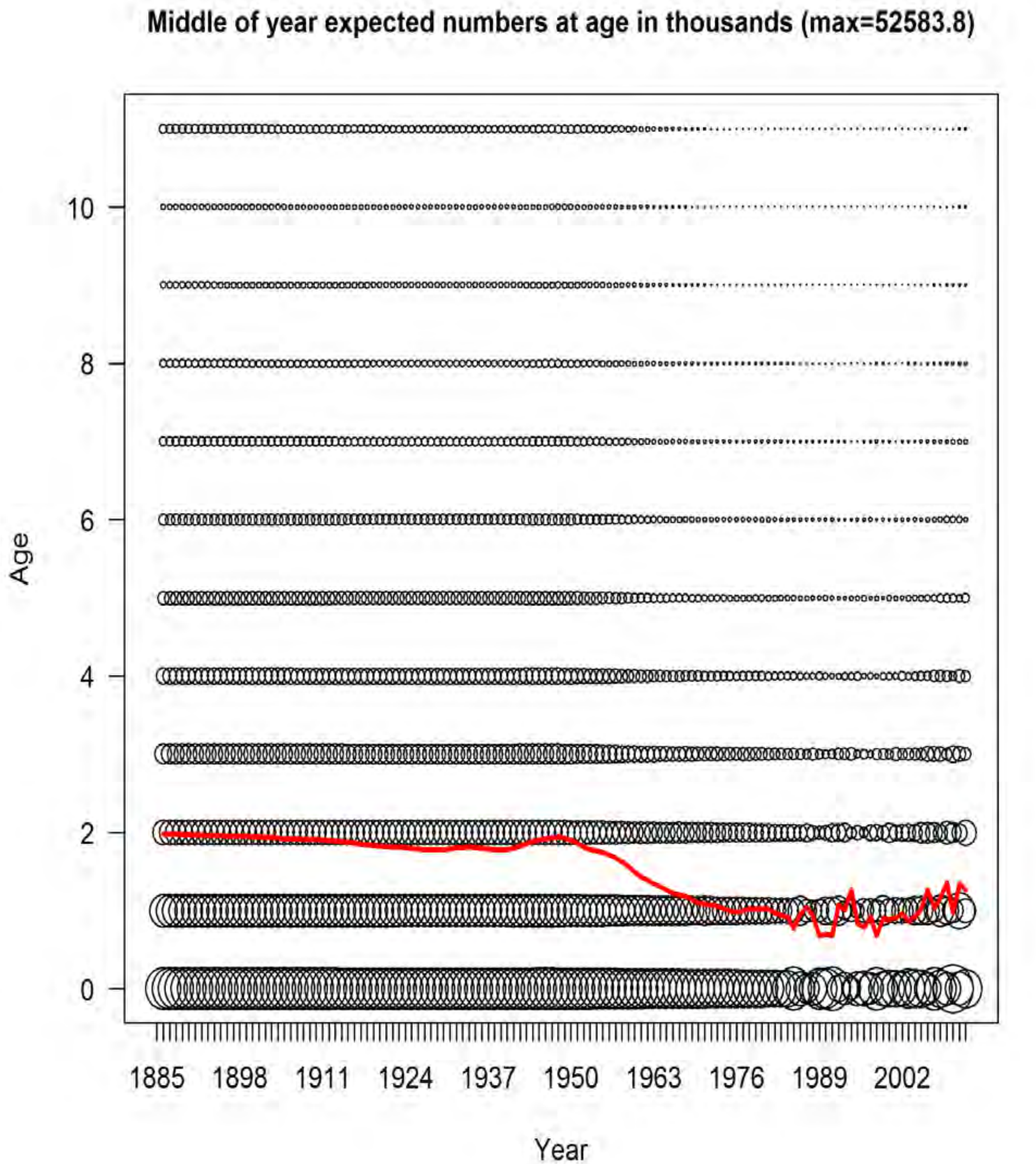


Figure 3.38. Predicted abundance at age (circles) and mean age (line) for Gulf of Mexico Spanish mackerel. Units are abundance in thousands of fish. Model configuration = Run 3, M=0.38 y^{-1} and Steepness = 0.8.

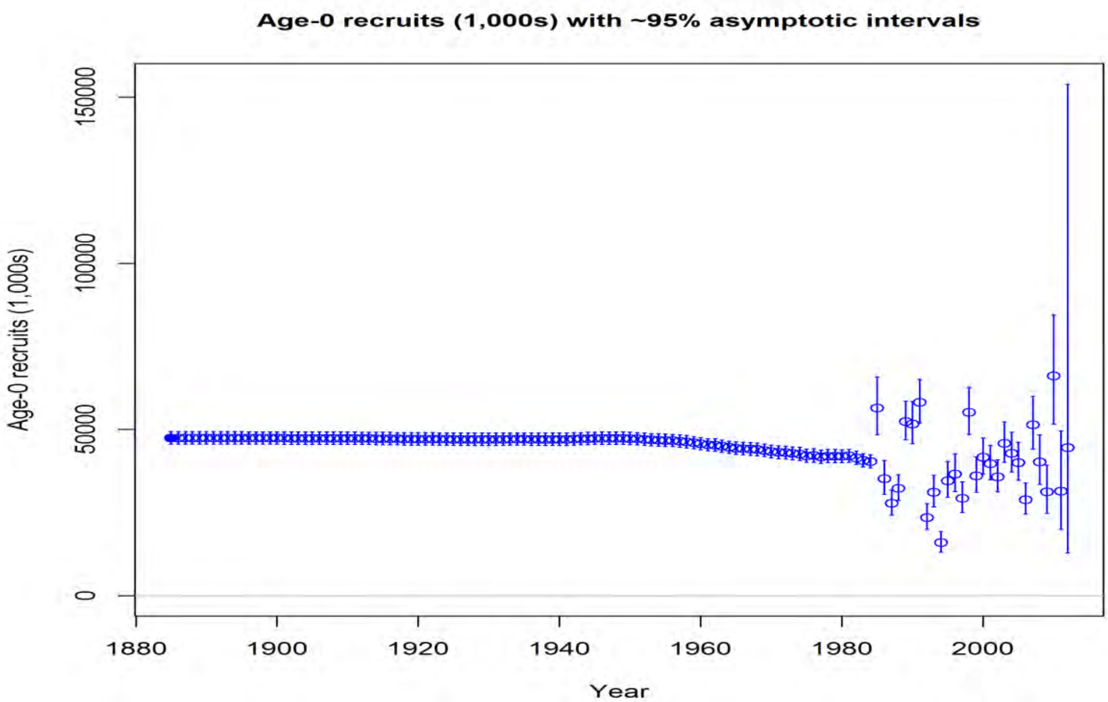


Figure 3.39. Predicted age-0 recruits in thousand fish and log recruitment deviations for Gulf of Mexico Spanish mackerel from SS. Model configuration = Run 3, M=0.38 y^{-1} and Steepness=0.8.

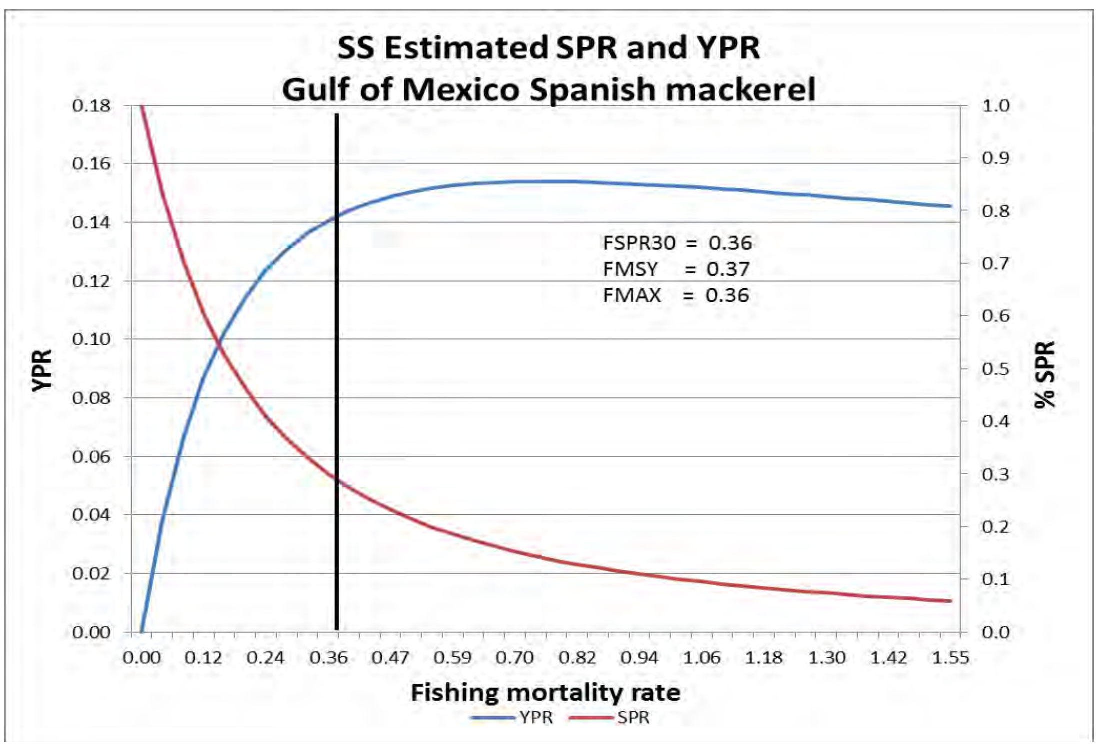
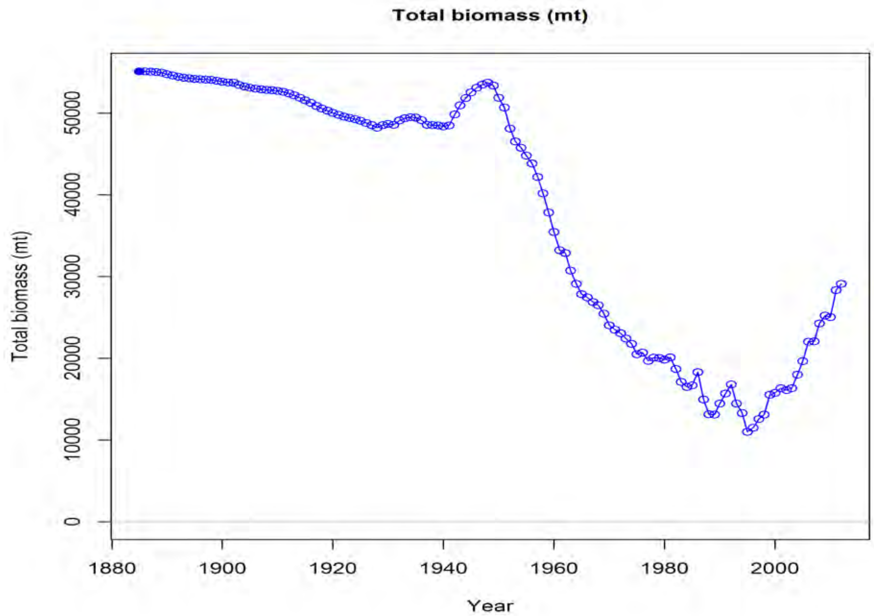


Figure 3.40. SS estimated yield per recruit and spawner per recruit.for Gulf Spanish mackerel.



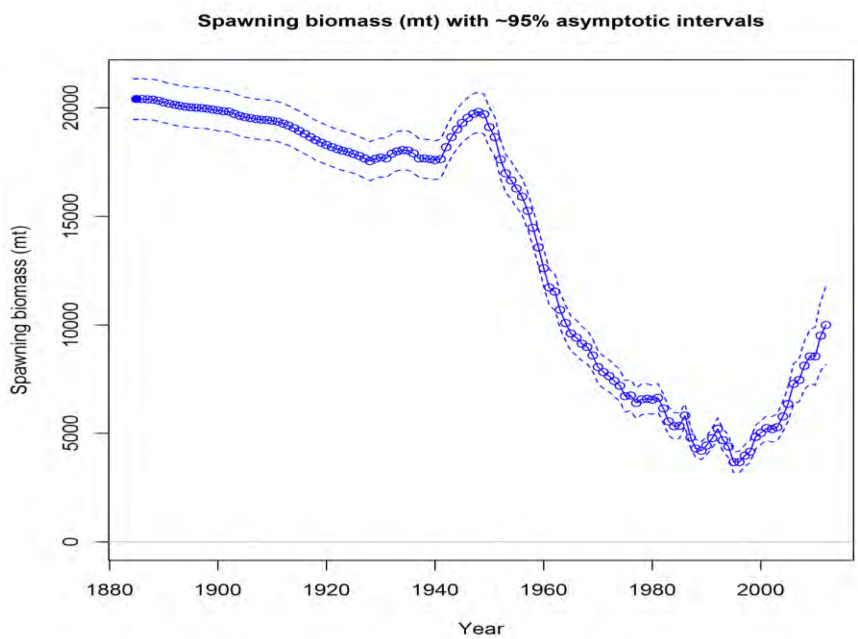


Figure 3. 41. Top Panel: SS predicted total biomass for Gulf of Mexico Spanish mackrel. Bottom Panel: SS predicted spawning biomass for Gulf of Mexico Spanish mackerel from SS. Units are mtons whole weight. Model configuration = Run 3, M=0.38 y^{-1} and Steepness = 0.8.

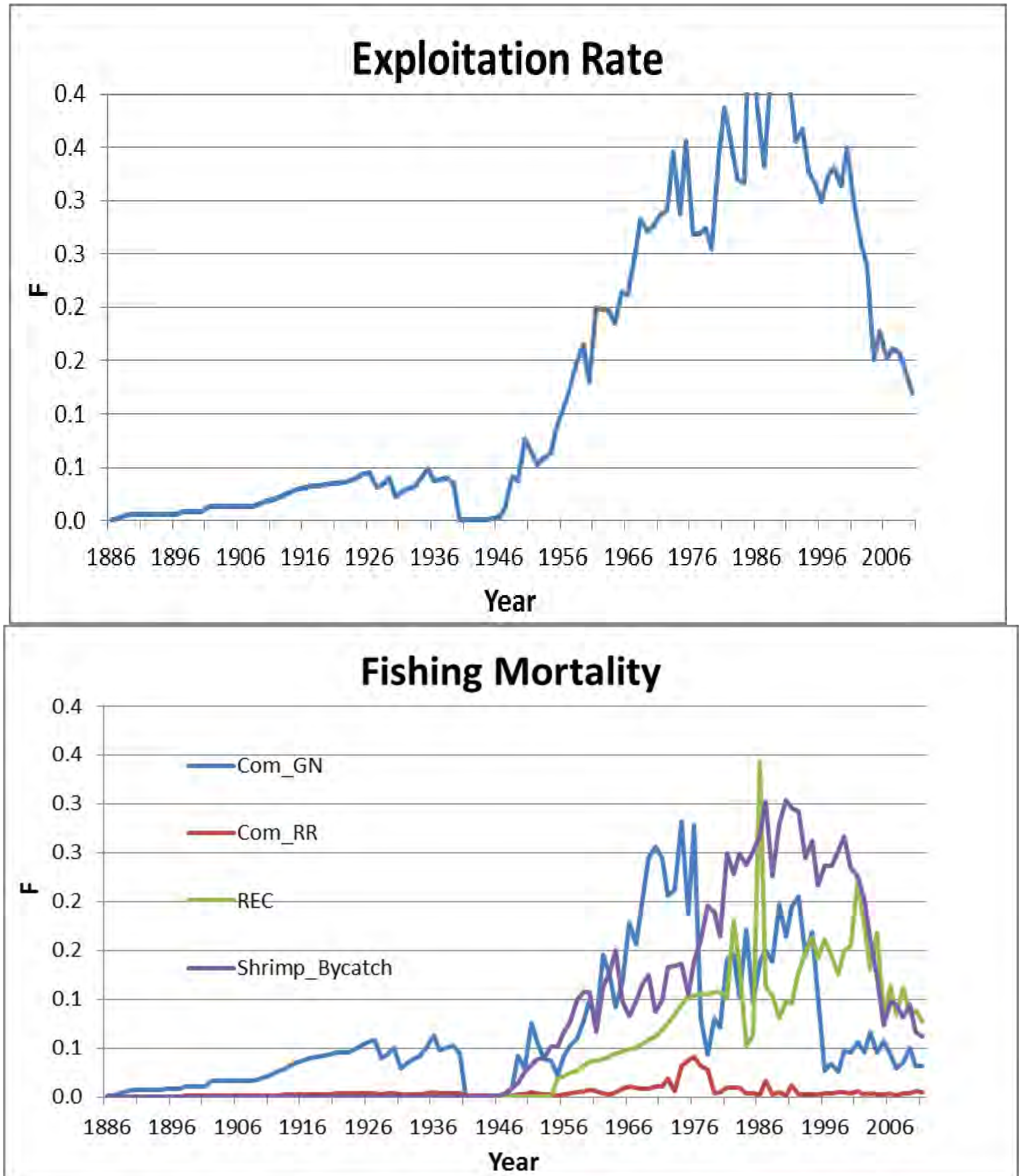


Figure 3.42. Predicted fishing mortality for Gulf of Mexico Spanish mackerel from SS. Model configuration = Run 3, M=0.38 y^{-1} and Steepness = 0.8. Top panel is annual exploitation rate and bottom panel is fleet specific continuous fishing mortality. M=0.38 y^{-1} and Steepness = 0.8).

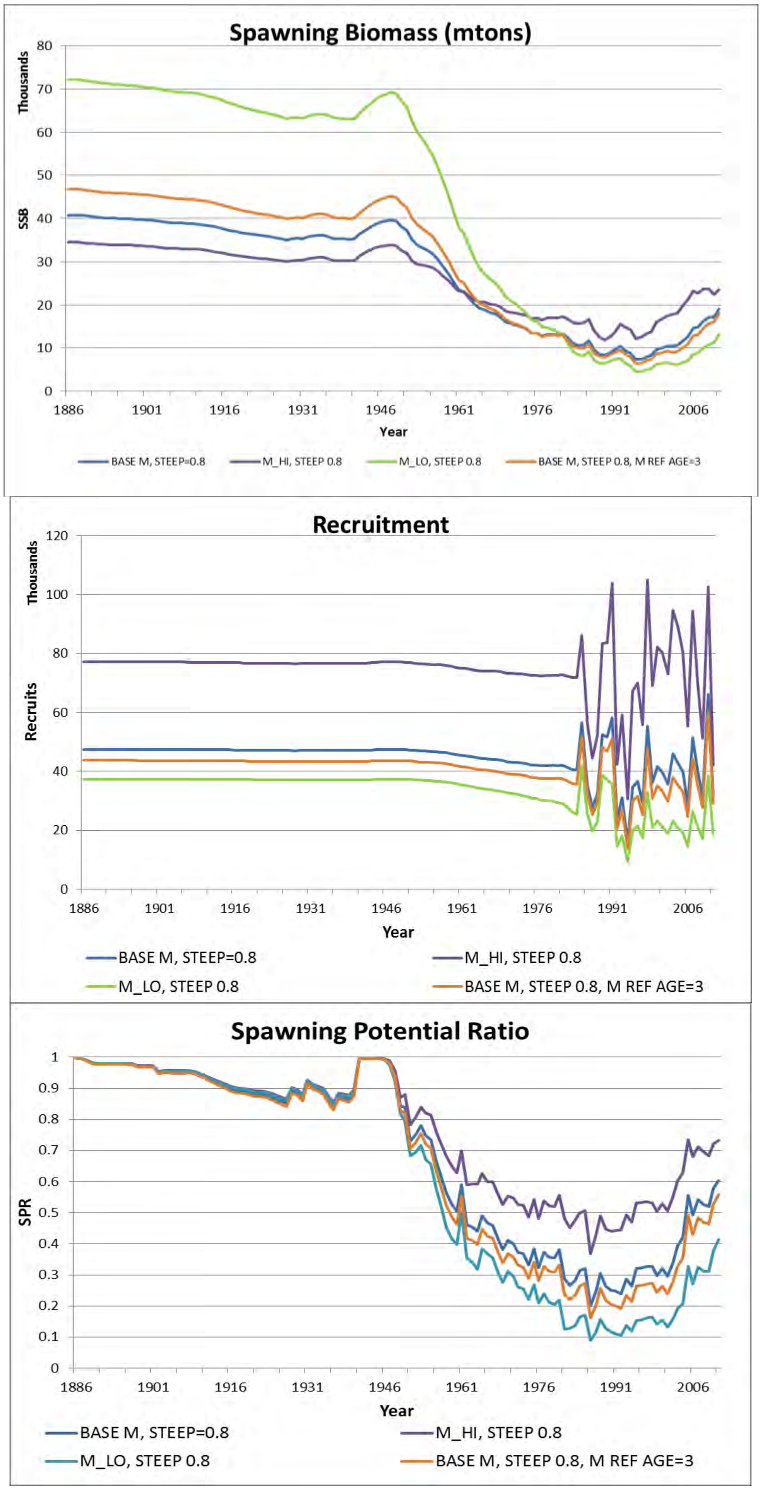


Figure 3.43. Sensitivity analyses for the Run 3 model configuration at three levels of natural mortality ranges (M = 0.38 and M_HI = 0.49 and M_LO = 0.27). Top Panel = spawning biomass (SSB), Middle Panel = Recruitment, Bottom Panel = spawning potential ratio (SPR). All Runs assuming steepness = 0.8.

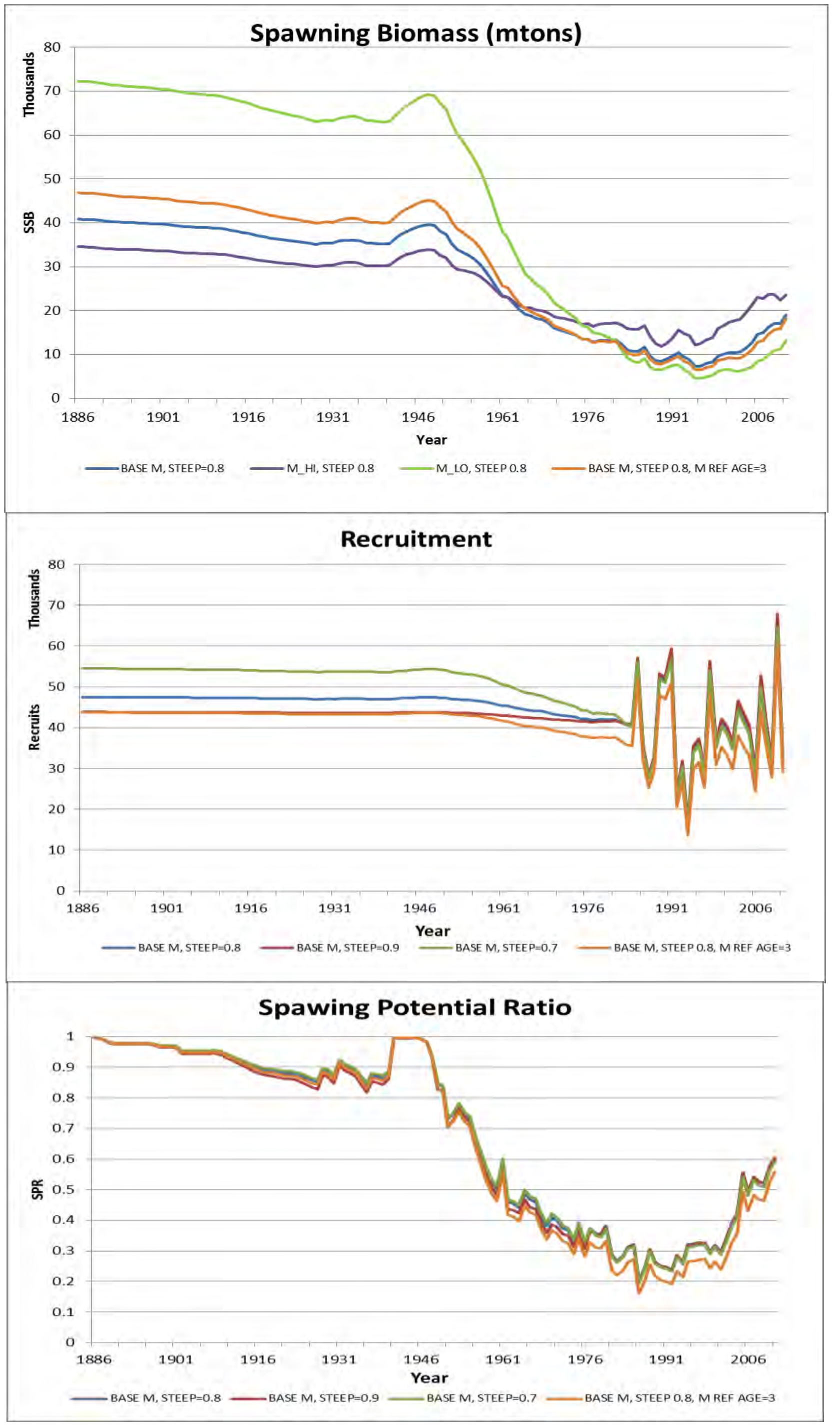


Figure 3.44. Sensitivity analysis for Gulf of Mexico Spanish mackerel with varying assumptions on the Beverton – Holt steepness parameter. Top Panel = spawning biomass (SSB), Middle Panel = Recruitment, Bottom Panel = spawning potential ratio (SPR). For the alternative steepness scenarios (0.7, 0.8, 0.9) the level of M assumed = 0.38 input into Lorenzen function. Metric shown are predicted spawning biomass (SSB), recruitment and spawning potential ratio (SPR).

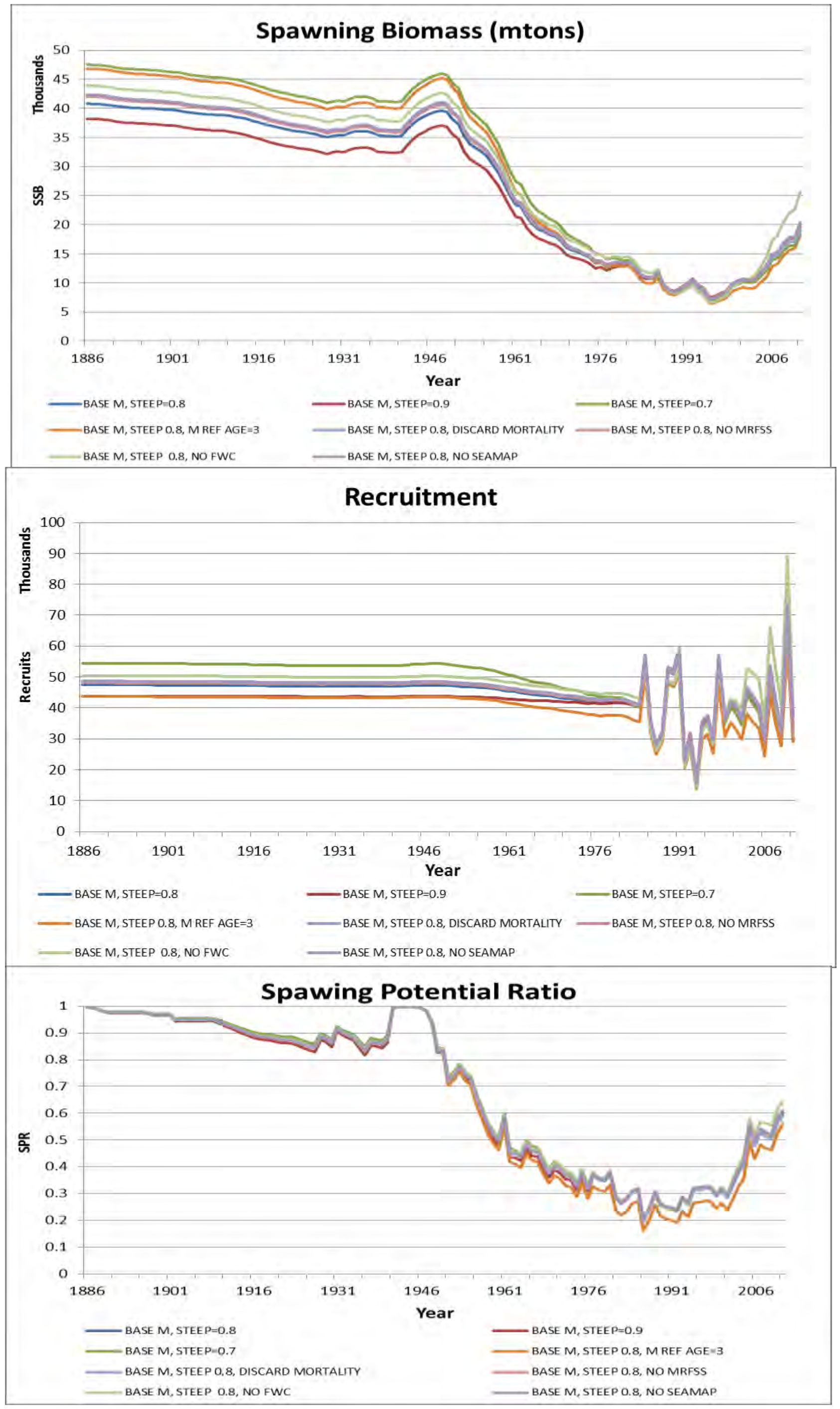


Figure 3.45. Sensitivity analysis for Gulf of Mexico Spanish mackerel with varying assumptions on the data inclusion and assumptions of release mortality. Top Panel = spawning biomass (SSB), Middle Panel = Recruitment, Bottom Panel = spawning potential ratio (SPR). For the alternative steepness scenarios (0.7, 0.8, 0.9) the level of M assumed = 0.38 input into Lorenzen function. Metric shown are predicted spawning biomass (SSB), recruitment and spawning potential ratio (SPR).

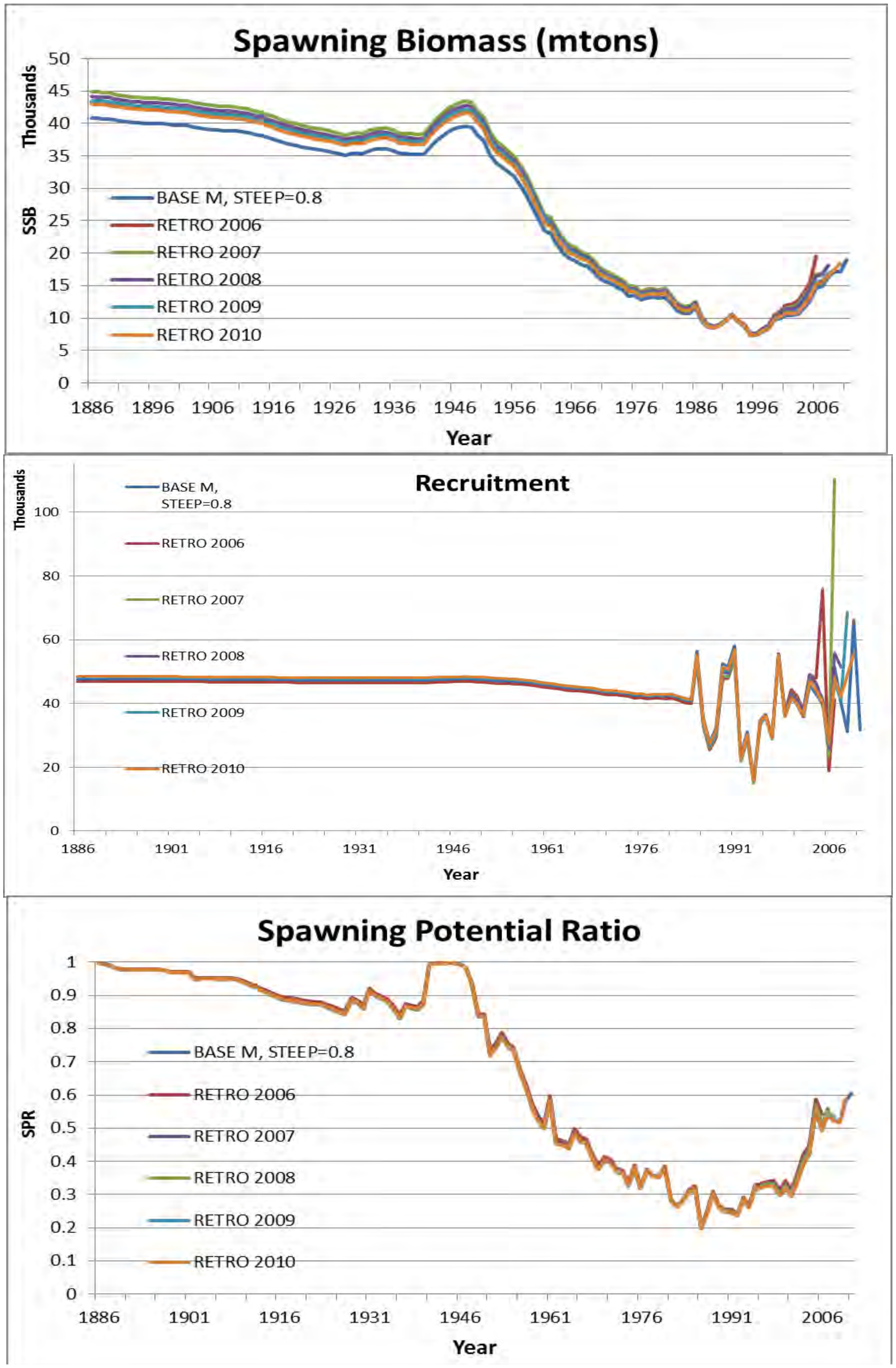


Figure 3.46. Retrospective analysis for Gulf of Mexico Spanish mackerel with last five years of data sequentially dropped from SS for Run 3model. Metrics shown are predicted spawning biomass, recruitment and spawning potential ratio. All retrospective runs assumed that M =0.38y $^{-1}$ was input into the Lorenzen function and steepness = 0.8.

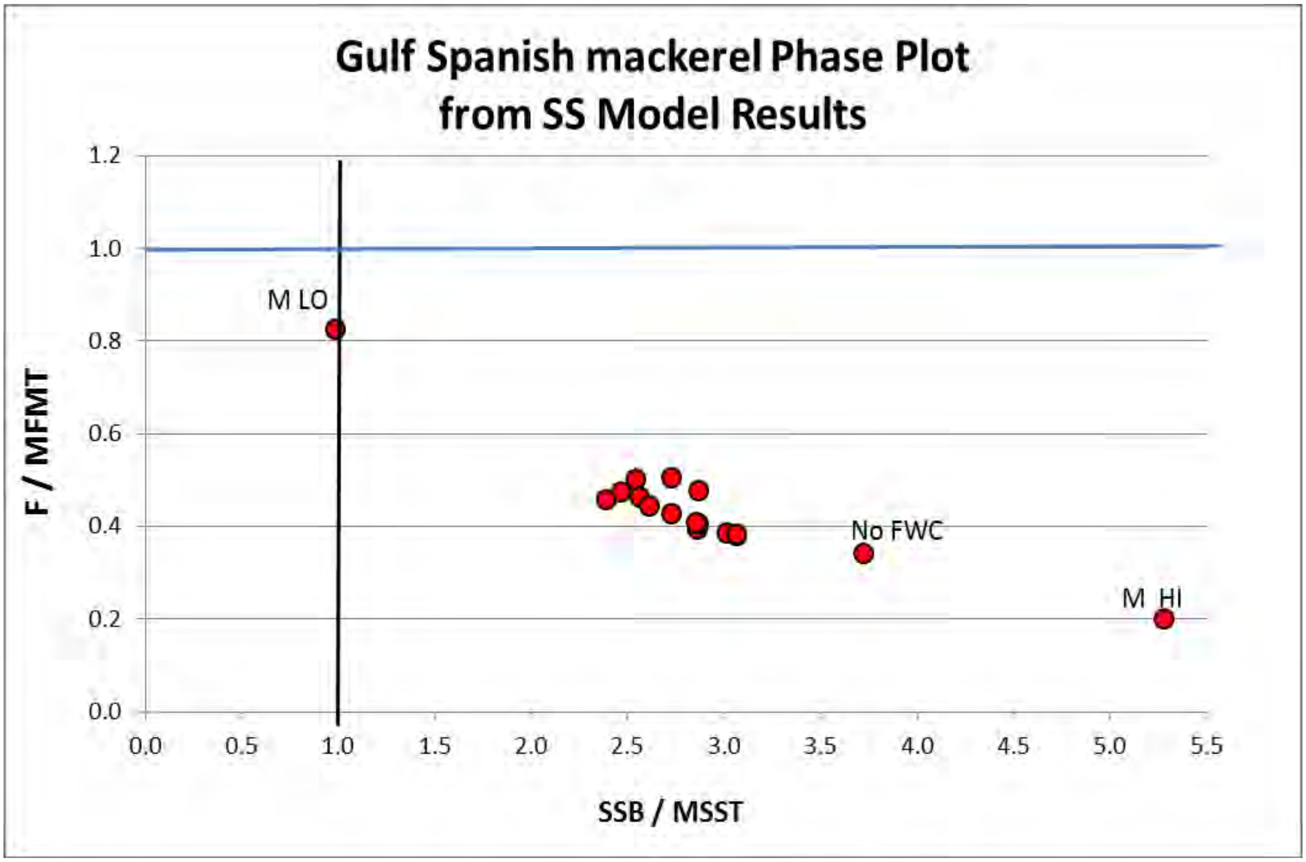


Figure 3.47. Phase plot of Stock Synthesis (SS) estimates of SSB/MSST and F/MFMT Benchmarks for Gulf of Mexico Spanish mackerel SEDAR 28 stock assessment res for varying assumptions for natural mortality at age (input into Lorenzen function), Beverton – Holt parameter, data inclusion, discard release mortality, and retrospective analysis. SSBRatio = SSB_2011 / MSST. MSST=(1-M) * SSB_MSY where SSB_MSY = SSB@F30%SPR. MFMT = F@30%SPR.

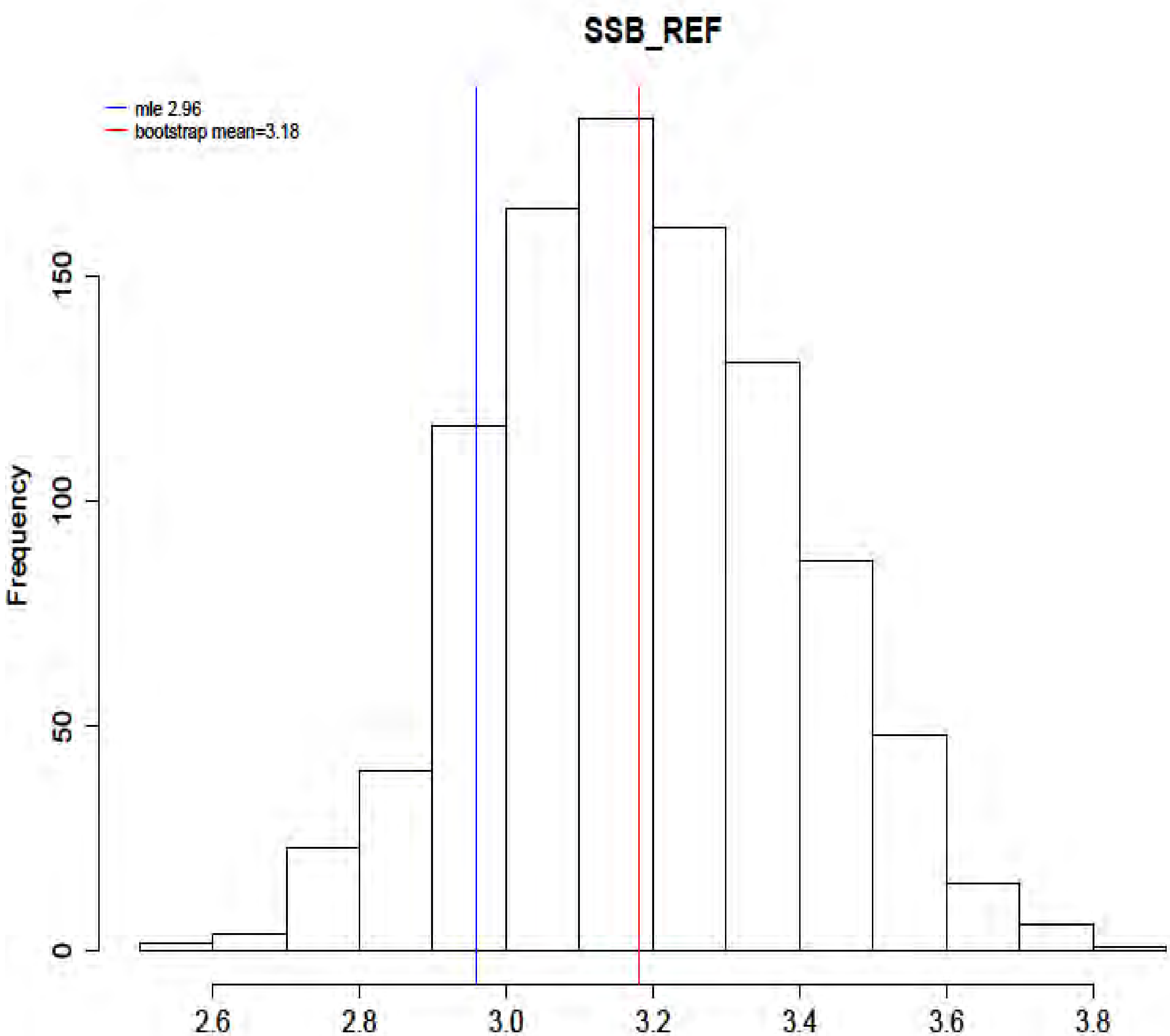


Figure 3.48. SS estimates of Fcurrent / FSPR30% from 1,000 bootstrap samples of the Run 3 model (steepness =0.8, M = $0.38y^{-1}$) for Gulf of Mexico Spanish mackerel. SSBR_REF = SSB_2011 / MSST. MSST = (1-M) * SSB_MSY where SSB_MSY = SSB@F30%SPR. Red lines represent mean estimates from the bootstrap samples; blue lines represent the point estimate of the parameters from the Run 1 model.

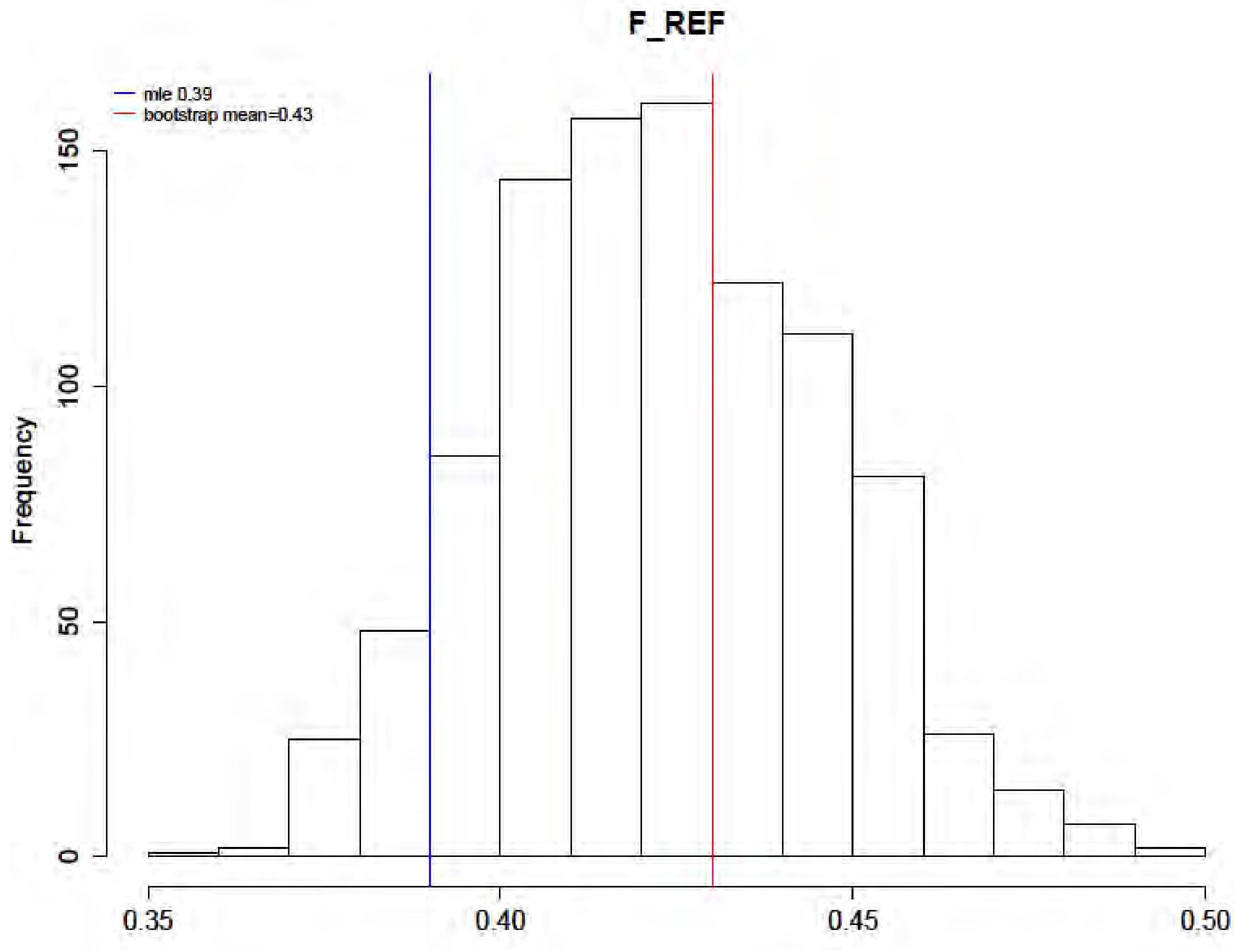


Figure 3.49. SS estimates of F_REF from 1,000 bootstrap samples of the Run 3 model (steepness =0.8, M = $0.38y^{-1}$) for Gulf of Mexico Spanish mackerel. F_REF = Fcurrent / MFMT AND MFMT = F@30%SPR. MFMT = F@30%SPR. Fcurrent = geometric mean of F_2009 – F-2011. Red lines represent mean estimates from the bootstrap samples; blue lines represent the point estimate of the parameters from the Run 1 model.

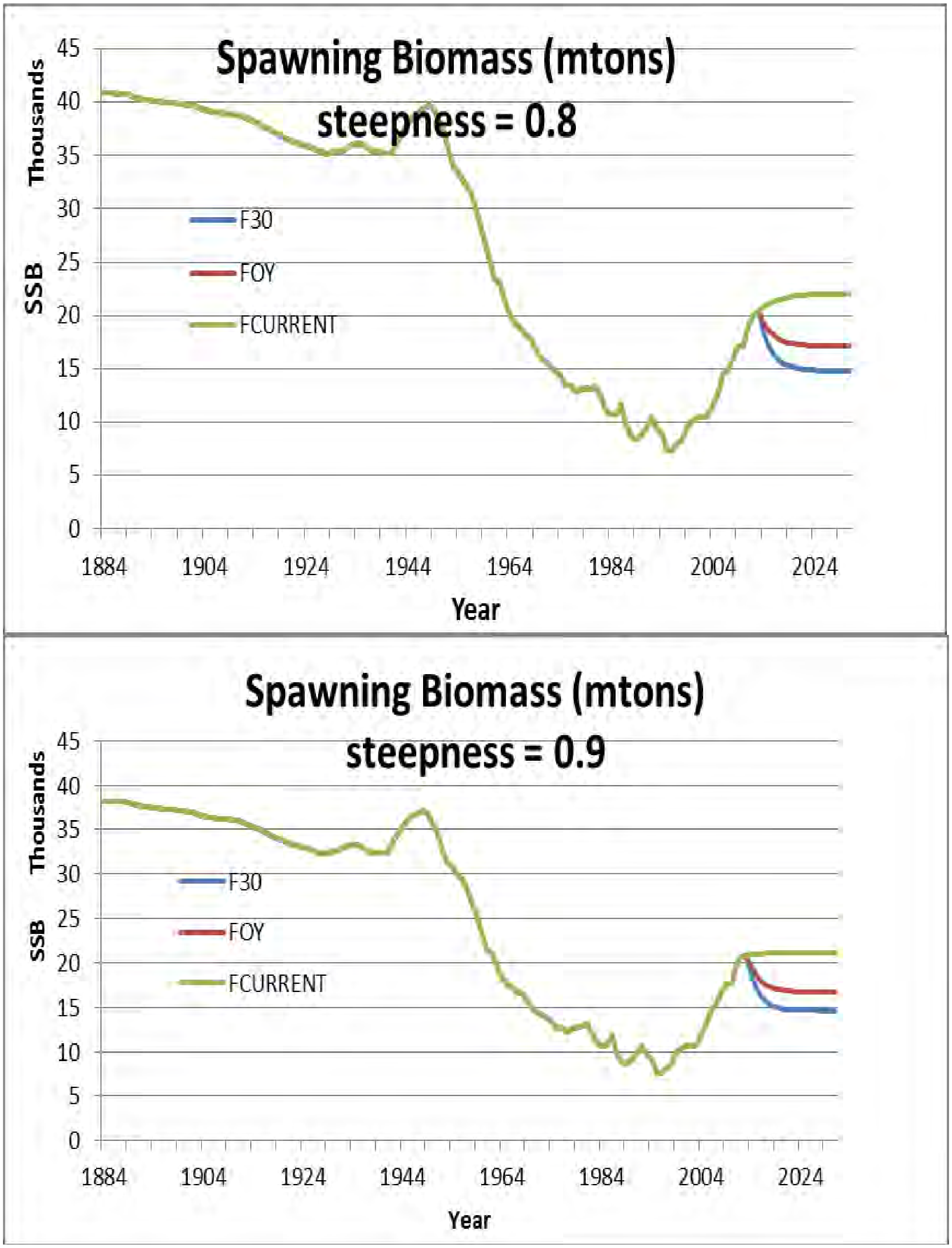


Figure 3.50. SS predicted spawning biomass (SSB) for the Run 3 model configuration (Top Panel) and Run 2 model (Bottom Panel) under three fishing mortality scenarios: $F_{CURRENT}$, F_{SPR30}, and F_{OY}. Both models assumed $M=0.38y^{-1}$ in the input Lorenzen function.

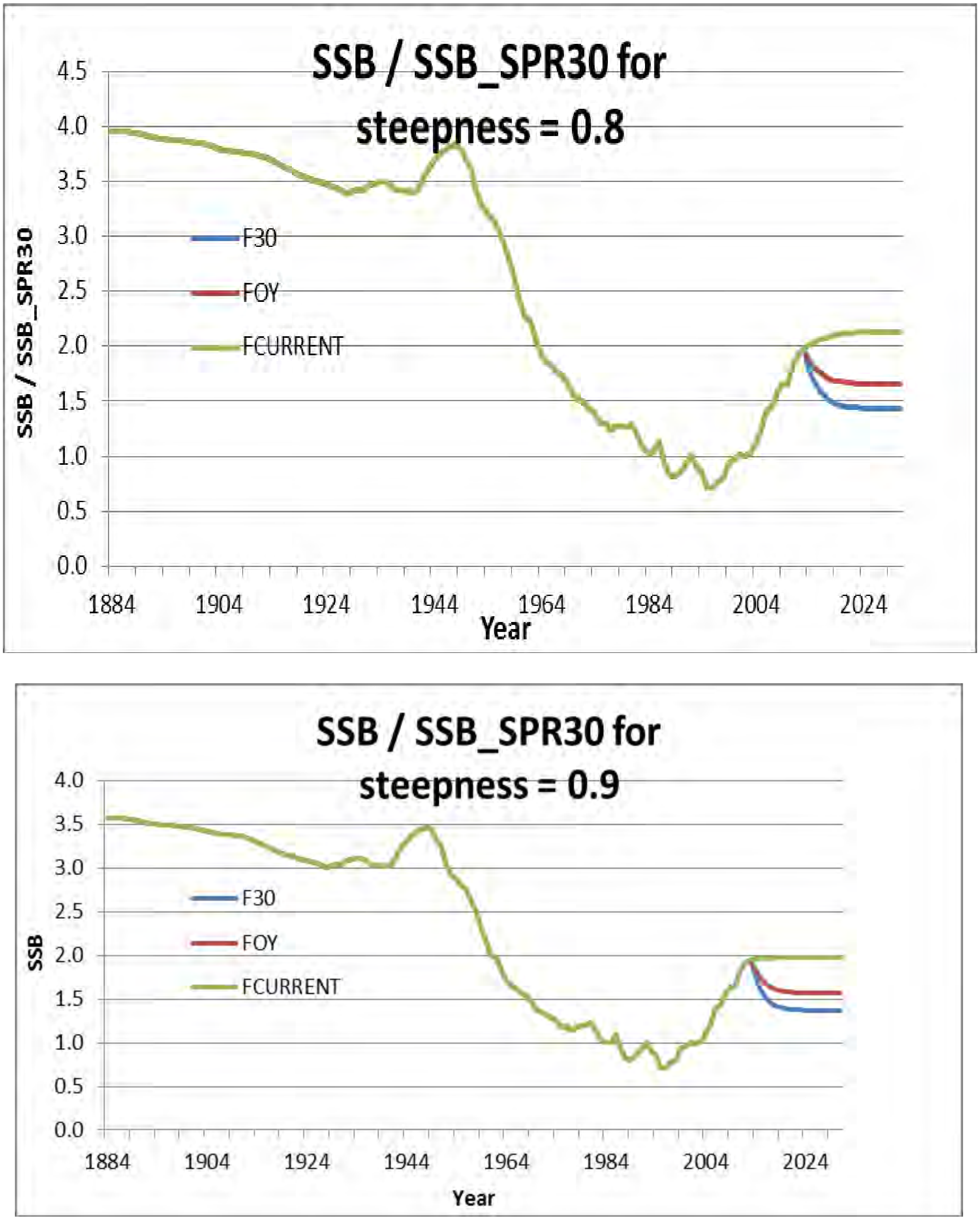
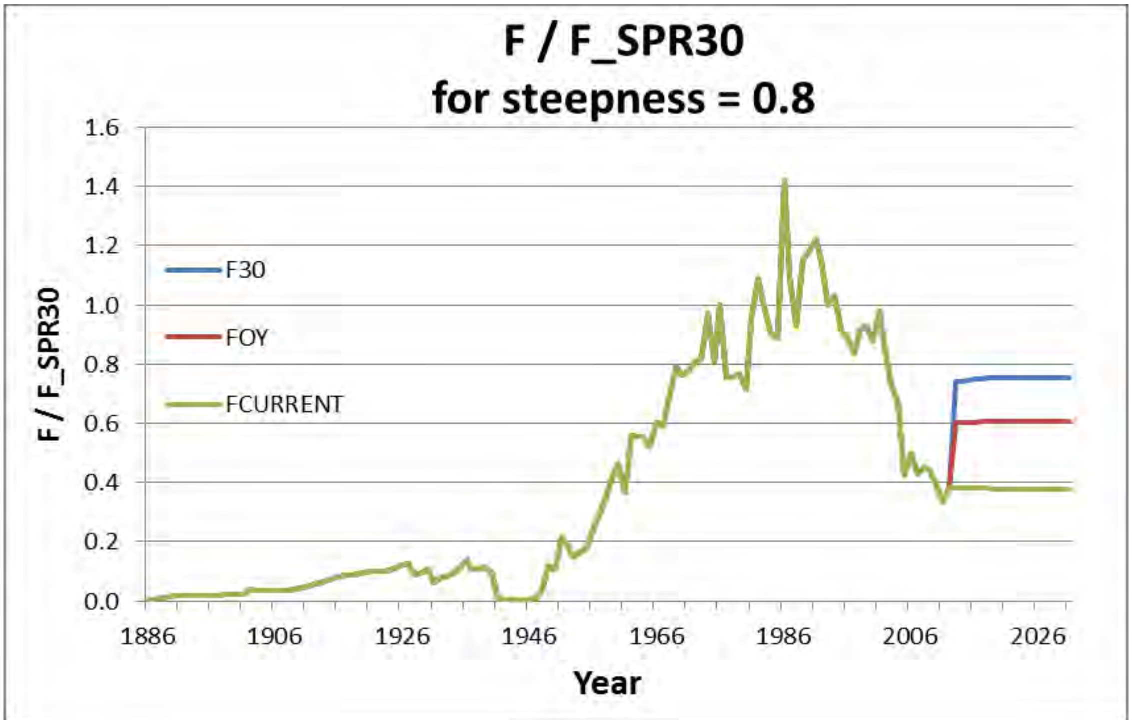


Figure 3.51. Predicted spawning biomass (SSB) relative to F30%SPR for the Run 3 model configuration (Top Panel) and Run 2 model (Bottom Panel) under three fishing mortality scenarios: $F_{CURRENT}$, F_{SPR30}, and F_{OY}. Both models assumed M=0.38y^{-1} in the input Lorenzen function.



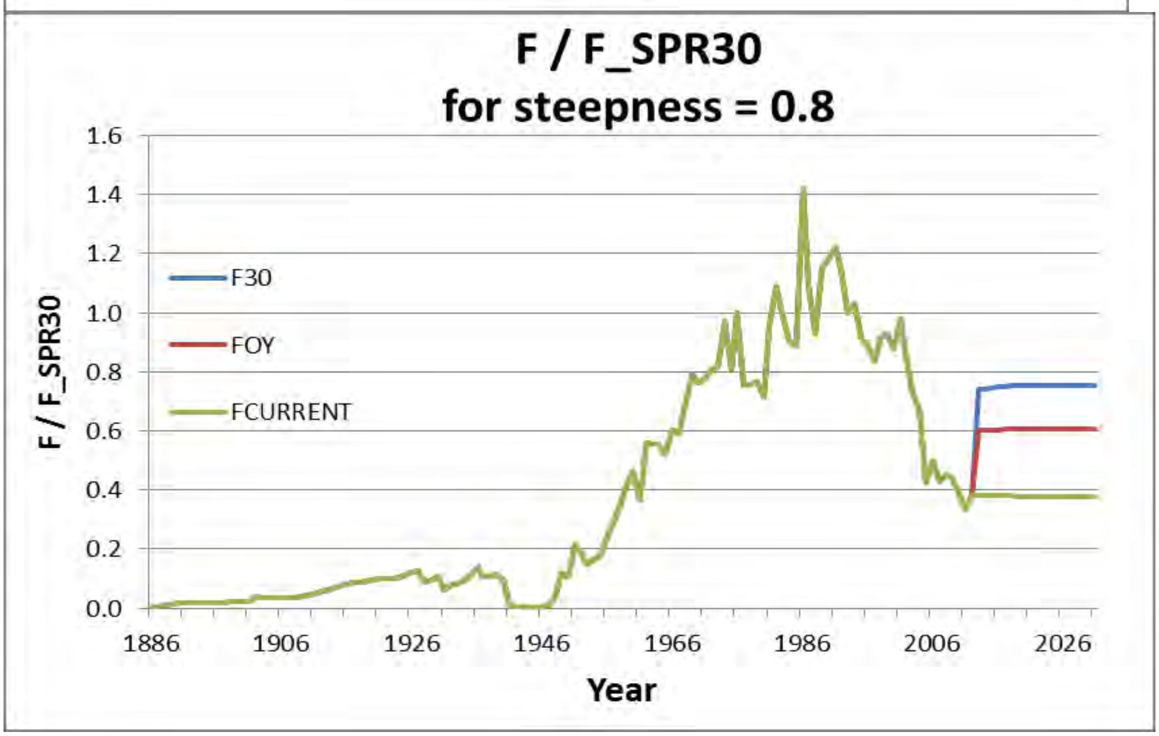


Figure 3.52. Projected fishing mortality rate relative to $F_{SPR30\%}$ for the Run 3 model configuration (Top Panel) and Run 2 model (Bottom Panel) under three fishing mortality scenarios: $F_{CURRENT}$, F_{SPR30}, and F_{OY}. Both models assumed $M=0.38y^{-1}$ in the input Lorenzen function.

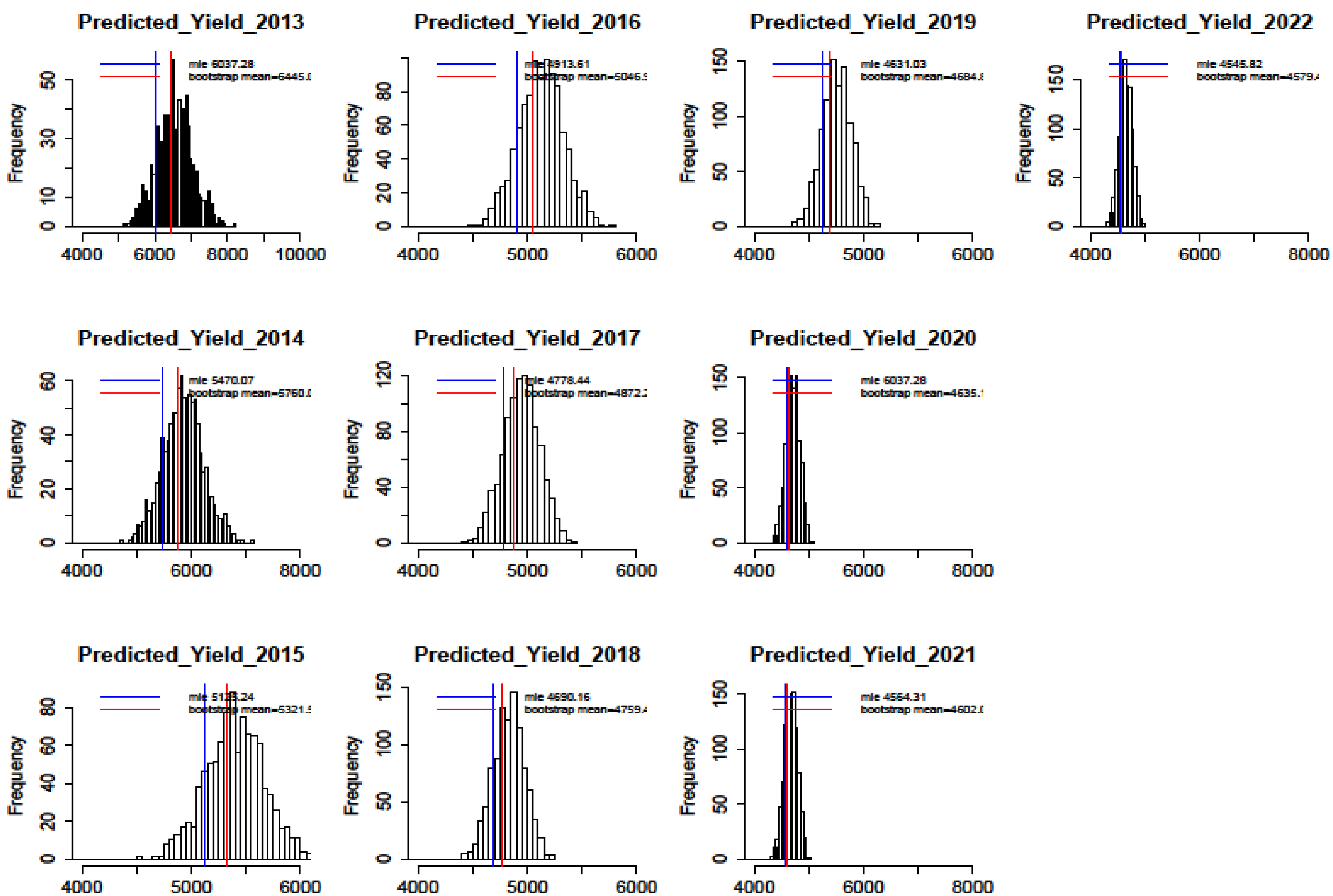


Figure 3.53. Summary for predicted retained yield (mtons, whole weight) for gulf of Mexico Spanish mackerel, from 1,000 bootstrap samples for the Run 3 mode (assuming steepness = 0.8 and M = $0.38y^{-1}$) . Red lines represent mean estimates from the bootstrap samples, blue lines represent the point estimate of the parameters from the Run 1 model.

3.8 Appendices

Appendix A. Length composition data for Gulf of Mexico Spanish mackerel. Fleet 1=COM_GN, Fleet 2=COM_RR, fleet 3=REC (recreational all modes), fleet 9 = SEAMAP SURVEY. Bin size=2 cm fork length widths.

year	fleet	nsamp	Bin4	Bin6	Bin8	Bin10	Bin12	Bin14	Bin16	Bin18	Bin20	Bin22	Bin24	Bin26	Bin28	Bin30	Bin32	Bin34	Bin36	Bin38	Bin40	Bin42	Bin46	Bin48	Bin50
1986	1	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	2	3	2
1987	1	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	3	11	42	60	72	85	79
1989	1	62	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	8	15	14	8	5	3	1	2
1990	1	66	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	9	12	7	10	6	4	8
1991	1	54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	3	10	15	5	6	5	1
1992	1	100	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	5	22	31	49	49	37	32
1993	1	84	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	18	16	10	8	7	6
1994	1	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	5	16	30	51	60	79	85
1995	1	100	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	4	11	4	2	6	6	4	24
1996	1	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	4	13
1997	1	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1999	1	36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	3	4	5	5	2	3	3
2000	1	38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	9	6	6	5
2001	1	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	5	5	2	3
2002	1	34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	5	8	7	5
2003	1	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1	8	9	14	19	9	14
2004	1	100	0	0	0	0	0	0	0	0	0	0	0	6	6	35	50	95	231	330	366	332	225	215	172
2005	1	100	0	0	0	0	0	0	0	0	0	0	0	1	20	32	52	100	171	276	338	251	221	203	169
2006	1	100	0	0	0	0	0	0	0	0	0	0	0	9	47	130	207	251	316	286	248	210	162	142	114
2007	1	100	0	0	0	0	0	0	0	0	0	0	0	2	59	123	192	268	387	481	389	288	245	207	174
2008	1	100	0	0	0	0	0	0	0	0	0	1	1	20	121	164	134	223	371	442	401	320	274	263	182
2009	1	100	0	0	0	0	0	0	0	0	0	0	0	0	2	48	130	173	325	348	348	282	248	227	188
2010	1	100	0	0	0	0	0	0	0	0	1	2	3	34	136	160	149	207	301	358	291	229	185	143	150

2011	1	100	0	0	0	0	0	0	0	0	0	0	0	1	40	147	298	345	378	445	396	316	274	236	193
1983	2	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1984	2	23	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0	2	1	2
1985	2	100	0	0	0	0	0	0	0	0	0	0	0	6	23	7	25	19	14	13	11	6	7	2	3
1986	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
1991	2	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	6	3	9	12	12
1992	2	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	1	0	3	14	15
1993	2	100	0	0	0	0	0	0	0	0	0	0	0	1	0	5	9	7	2	0	2	3	8	4	10
1994	2	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	6	2	4	9	10
1995	2	38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	3	1	0	2	3
1996	2	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	3	0	0
1997	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1998	2	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1999	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2001	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2002	2	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	7
2003	2	37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1	3	3
2004	2	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	2
2005	2	70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	9	3	3	8	13	6
2006	2	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	8	6	13	12
2007	2	100	0	0	0	0	0	0	0	0	0	0	0	0	0	3	11	35	45	26	15	9	6	6	8
2008	2	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	1	2	10	17	19	27
2009	2	81	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	5	4	5	5	5	8	8
2010	2	67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	3	2	8	4	2	8	3
2011	2	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	7	5	15	20	23
1981	3	100	0	0	0	0	0	0	0	0	0	0	1	5	19	32	30	30	35	27	37	25	11	11	8
1982	3	100	0	0	0	0	0	0	0	1	1	2	2	5	26	47	66	29	53	40	32	36	16	26	16
1983	3	100	0	0	0	0	0	0	0	0	5	2	3	3	3	20	29	46	96	92	79	62	55	31	34

1984	3	100	0	0	0	0	0	0	0	1	1	1	0	2	5	14	36	82	129	71	62	38	27	22	10
1985	3	100	0	0	0	0	0	0	0	0	0	0	2	4	6	18	35	38	71	58	28	29	28	23	17
1986	3	100	0	0	0	0	0	0	0	0	0	1	3	3	13	45	122	183	154	159	90	78	56	39	33
1987	3	100	0	0	0	0	0	0	0	0	0	1	1	5	8	39	104	156	165	160	144	133	101	90	88
1988	3	100	0	0	0	0	0	1	0	0	0	0	2	1	4	18	53	82	92	97	96	77	51	50	41
1989	3	100	0	0	0	0	0	0	0	0	0	3	3	9	24	57	104	109	145	133	84	58	70	48	39
1990	3	100	0	0	0	0	0	0	0	0	3	6	2	9	15	52	104	134	146	128	96	74	53	56	49
1991	3	100	0	0	0	0	2	0	0	0	0	1	7	15	36	52	70	103	126	117	121	111	87	78	80
1992	3	100	0	0	0	0	0	0	0	0	0	1	4	3	18	67	132	234	240	238	156	123	106	94	97
1993	3	100	0	0	0	0	0	0	0	0	1	0	2	5	16	42	75	68	77	93	61	62	48	39	38
1994	3	100	0	0	0	0	1	0	0	0	0	1	0	1	11	44	70	76	111	97	103	86	76	63	66
1995	3	100	0	0	0	0	0	0	0	0	0	0	1	1	8	33	35	46	56	50	70	62	81	84	79
1996	3	100	0	0	0	0	0	1	0	0	1	2	1	2	3	27	36	55	76	111	101	94	79	87	86
1997	3	100	0	0	0	1	0	1	0	1	1	4	1	2	15	45	50	68	64	82	117	76	90	97	114
1998	3	100	0	0	0	0	0	0	0	0	0	3	0	10	38	46	82	98	142	128	124	97	91	110	81
1999	3	100	0	0	0	0	0	0	0	0	0	2	5	30	68	143	155	246	304	295	280	218	155	146	167
2000	3	100	0	0	0	0	0	0	0	1	1	0	0	2	14	74	176	232	336	381	324	255	219	177	136
2001	3	100	0	0	0	0	0	1	0	0	0	3	3	16	38	132	265	460	533	488	411	282	185	155	113
2002	3	100	0	0	0	0	0	0	2	0	0	0	1	1	11	83	110	99	133	177	241	227	225	173	158
2003	3	100	0	0	0	0	0	0	0	0	1	1	2	13	29	74	86	100	138	168	151	169	165	140	132
2004	3	100	0	0	0	0	0	0	0	0	1	1	2	23	30	87	101	208	250	241	231	209	176	158	139
2005	3	100	0	0	0	0	0	0	0	0	0	1	0	3	11	29	80	135	109	143	128	119	109	103	93
2006	3	100	0	0	0	0	0	0	0	0	0	0	1	3	10	31	74	120	185	209	205	160	140	149	149
2007	3	100	0	0	0	0	0	0	0	0	0	3	1	4	4	42	88	107	145	189	207	198	188	128	111
2008	3	100	0	0	0	0	0	0	0	0	2	0	1	3	22	70	108	162	176	182	172	173	129	135	128
2009	3	100	0	0	0	0	0	0	0	0	0	0	0	3	14	50	99	122	175	191	181	168	133	151	98
2010	3	100	0	0	0	0	0	0	0	0	0	1	2	23	27	47	90	176	167	238	226	179	163	138	140
2011	3	100	0	0	0	0	0	0	0	0	0	0	3	9	46	171	249	275	305	322	279	247	194	172	125

1987	9	14	0	0	0	0	0	2	3	2	0	0	0	0	1	1	1	2	1	0	1	0	0	0	0
1988	9	82	0	0	0	0	3	0	1	5	21	10	5	1	0	7	8	5	6	2	5	3	0	0	0
1989	9	98	0	0	0	0	5	8	7	10	15	25	14	1	0	0	1	6	1	1	1	1	1	0	0
1990	9	100	0	0	0	0	19	10	22	28	19	5	2	3	6	5	7	5	4	1	2	5	2	1	0
1991	9	100	0	0	0	2	3	1	1	1	1	0	1	1	3	22	18	14	19	9	9	4	2	1	0
1992	9	100	0	0	0	0	0	2	13	8	5	6	20	10	4	5	4	9	4	7	2	2	2	1	0
1993	9	100	0	0	0	2	9	7	12	12	12	1	3	7	34	21	12	4	8	10	3	6	0	0	0
1994	9	78	0	0	0	2	5	13	6	13	5	0	1	3	1	1	2	1	6	4	3	4	4	1	1
1995	9	100	0	2	1	0	0	9	7	2	3	2	4	3	7	13	16	6	7	3	4	3	2	0	1
1996	9	94	0	0	0	0	0	0	1	13	7	2	6	5	12	9	7	8	13	4	2	2	1	0	0
1997	9	62	0	1	0	1	0	0	2	4	3	2	2	2	3	8	5	7	4	7	4	3	1	1	1
1998	9	69	0	1	0	2	0	2	2	11	10	4	2	1	11	8	2	1	2	2	0	1	1	0	0
1999	9	83	0	0	0	4	1	5	6	5	5	7	4	2	8	5	6	6	2	3	3	3	5	2	1
2000	9	99	0	0	0	0	4	18	8	8	8	9	19	6	4	2	5	3	2	1	1	0	1	0	0
2001	9	84	0	0	1	3	5	14	20	10	7	1	0	3	0	2	4	3	5	2	0	1	1	1	1
2002	9	34	0	0	0	0	0	0	2	9	0	1	1	0	1	3	4	1	3	0	1	2	1	3	0
2003	9	100	0	0	0	0	0	1	6	16	51	19	11	3	5	10	4	4	3	1	1	2	0	0	0
2004	9	71	1	0	0	1	5	2	4	2	2	4	3	5	7	8	9	3	4	4	2	1	2	0	1
2005	9	100	0	0	0	0	2	16	24	19	35	28	14	4	7	11	9	5	4	1	2	1	2	1	0
2006	9	88	0	0	0	0	0	1	2	2	11	7	4	3	4	13	12	7	9	2	3	2	0	1	3
2007	9	100	0	1	0	1	1	8	16	9	18	22	5	13	7	13	6	5	2	2	1	0	1	2	0
2008	9	100	0	0	2	6	7	4	15	4	0	0	3	12	16	20	4	2	6	2	2	1	4	1	1
2009	9	100	0	0	0	0	0	2	16	35	20	32	22	8	3	6	7	4	3	3	3	1	1	2	1
2010	9	81	0	0	1	0	1	4	5	3	7	7	1	5	5	10	8	9	6	5	1	1	2	0	0
2011	9	81	0	0	1	0	1	4	5	3	7	7	1	5	5	10	8	9	6	5	1	1	2	0	0

Appendix A. Continued.

year	fleet	nsamp	Bin52	Bin54	Bin56	Bin58	Bin60	Bin62	Bin64	Bin66	Bin68	BIN70	Bin72	Bin74	Bin76	Bin78	Bin80	Bin82	Bin84	Bin86	Bin88	Bin90	Bin92	Bin94	Bin96	Bin98	Bin100
1986	1	17	1	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1987	1	100	72	42	39	24	8	8	3	2	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
1989	1	62	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1990	1	66	2	2	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1991	1	54	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1992	1	100	42	35	44	32	28	23	5	8	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1993	1	84	4	3	3	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1994	1	100	61	38	25	26	5	12	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1995	1	100	49	40	54	40	24	5	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1996	1	100	22	41	46	54	47	35	21	7	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1997	1	12	3	4	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1999	1	36	5	0	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2000	1	38	5	1	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2001	1	23	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2002	1	34	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2003	1	100	9	4	9	3	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2004	1	100	136	86	83	60	59	47	13	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2005	1	100	120	98	107	74	54	22	19	5	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2006	1	100	60	54	26	39	22	16	7	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2007	1	100	115	98	55	30	42	16	8	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2008	1	100	126	84	63	58	57	39	12	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2009	1	100	142	84	55	43	36	21	7	6	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2010	1	100	128	128	106	93	56	37	11	6	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2011	1	100	138	107	72	76	59	23	20	8	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1983	2	7	0	1	1	2	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1984	2	23	2	4	1	0	2	2	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1985	2	100	6	3	7	3	7	8	2	1	1	1	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0

1986	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1991	2	100	20	26	27	29	25	13	6	5	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1992	2	100	15	20	26	51	36	32	9	4	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1993	2	100	6	11	12	8	17	6	6	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1994	2	100	17	10	11	15	12	4	3	3	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1995	2	38	3	2	7	8	5	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1996	2	22	2	1	2	4	2	2	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
1997	2	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1998	2	16	1	1	3	4	2	0	1	0	0	0	0	1	1	0	0	2	0	0	0	0	0	0	0	0
1999	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2001	2	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2002	2	21	2	3	4	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2003	2	37	5	2	10	4	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2004	2	15	1	2	2	0	0	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2005	2	70	7	5	5	3	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2006	2	100	13	9	12	7	7	7	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2007	2	100	12	5	5	8	5	3	4	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2008	2	100	26	23	23	20	23	5	6	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2009	2	81	7	5	7	3	10	2	3	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
2010	2	67	6	4	4	5	8	5	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2011	2	100	21	47	31	29	24	17	12	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1981	3	100	11	5	4	6	0	8	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1982	3	100	12	14	3	8	2	6	1	0	0	0	0	1	0	0	0	3	1	0	0	0	0	0	0	0
1983	3	100	17	22	12	18	6	7	0	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1984	3	100	15	8	6	8	9	2	1	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1985	3	100	14	15	17	10	8	3	3	2	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
1986	3	100	35	23	16	15	12	7	10	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1987	3	100	75	84	58	28	22	14	9	8	10	1	2	3	3	1	0	0	0	0	0	0	0	0	0	0
1988	3	100	45	31	22	24	18	4	9	3	3	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0

1989	3	100	41	30	14	17	11	8	4	2	2	2	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
1990	3	100	55	36	32	23	14	5	3	2	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1991	3	100	61	53	34	40	20	18	6	6	1	2	2	3	6	3	0	2	6	2	0	0	0	0	0	0	0
1992	3	100	79	58	70	48	32	22	12	8	2	2	2	2	2	2	4	4	2	1	3	0	0	1	0	0	1
1993	3	100	40	30	33	27	23	14	6	1	2	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0
1994	3	100	71	39	30	34	24	12	3	4	5	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1995	3	100	51	61	54	50	27	30	15	18	2	6	2	3	4	2	4	0	1	0	1	0	0	0	0	0	0
1996	3	100	69	65	59	57	26	23	9	10	9	3	0	4	0	2	1	1	0	0	1	0	0	0	0	0	0
1997	3	100	90	105	81	52	37	21	11	12	5	5	0	1	1	1	0	4	0	1	2	1	0	1	2	1	0
1998	3	100	108	81	66	63	50	41	17	10	7	2	2	2	0	0	2	0	0	0	0	0	0	0	0	0	0
1999	3	100	156	142	109	92	78	59	31	21	9	3	2	2	1	0	0	0	0	0	0	0	0	0	0	0	0
2000	3	100	194	144	137	121	97	52	35	18	9	11	1	1	2	0	1	0	1	0	0	0	0	0	0	0	0
2001	3	100	73	87	57	71	54	34	21	15	4	5	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
2002	3	100	138	111	102	88	61	50	30	15	7	3	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0
2003	3	100	121	98	94	92	71	38	28	18	10	3	4	1	0	1	1	1	0	0	0	0	0	0	0	0	0
2004	3	100	140	115	87	82	56	42	20	16	8	3	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
2005	3	100	100	78	64	56	31	28	15	9	7	1	3	2	0	1	0	0	0	0	0	0	0	0	0	0	0
2006	3	100	126	91	70	62	36	39	27	5	9	4	1	1	2	0	3	0	0	1	0	0	0	0	0	0	0
2007	3	100	91	81	69	67	47	30	19	6	6	1	0	0	2	1	1	1	1	0	0	0	0	0	0	0	0
2008	3	100	96	85	71	58	52	23	16	14	7	1	3	1	2	0	0	0	0	2	0	0	0	0	0	0	0
2009	3	100	80	94	52	45	35	18	20	11	4	4	1	1	0	1	2	0	0	1	0	0	0	0	0	0	0
2010	3	100	125	93	76	47	55	15	8	8	1	1	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0
2011	3	100	132	92	72	45	38	17	14	7	2	1	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0
1987	9	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1988	9	82	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1989	9	98	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1990	9	100	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1991	9	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1992	9	100	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0

1993	9	100	2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1994	9	78	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1995	9	100	0	1	0	0	0	0	0	1	1	1	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0
1996	9	94	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1997	9	62	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1998	9	69	0	0	0	0	0	1	0	0	0	0	1	0	0	2	1	0	1	0	0	0	0	0	0	0	0
1999	9	83	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2000	9	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2001	9	84	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2002	9	34	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2003	9	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2004	9	71	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2005	9	100	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2006	9	88	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
2007	9	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2008	9	100	1	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0
2009	9	100	0	3	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2010	9	81	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2011	9	81	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix B. Age composition data for Gulf of Mexico Spanish mackerel. Fleet 1=COM_GN, Fleet 2=COM_RR, fleet 3=REC (recreational all modes), fleet 9 = SEAMAP SURVEY. Bin size=2 cm fork length widths. L_binLow and L_Bin_High denote bin id of length composition to which age sample refers.

									AGE											
Year	season	Fleet	Gender	Partition	Age_err_df	L_binLow	L_Bin_High	Nsamp	0	1	2	3	4	5	6	7	8	9	10	11
1988	1	1	0	2	2	13	13	2	0	2	0	0	0	0	0	0	0	0	0	0
1988	1	1	0	2	2	14	14	12	0	12	0	0	0	0	0	0	0	0	0	0
1988	1	1	0	2	2	15	15	9	0	9	0	0	0	0	0	0	0	0	0	0
1988	1	1	0	2	2	16	16	8	0	7	1	0	0	0	0	0	0	0	0	0
1988	1	1	0	2	2	17	17	9	0	5	3	1	0	0	0	0	0	0	0	0
1988	1	1	0	2	2	18	18	8	0	4	4	0	0	0	0	0	0	0	0	0
1988	1	1	0	2	2	19	19	8	0	1	6	1	0	0	0	0	0	0	0	0
1988	1	1	0	2	2	20	20	15	0	1	9	5	0	0	0	0	0	0	0	0
1988	1	1	0	2	2	21	21	3	0	1	2	0	0	0	0	0	0	0	0	0
1988	1	1	0	2	2	22	22	6	0	1	3	2	0	0	0	0	0	0	0	0
1988	1	1	0	2	2	23	23	5	0	0	2	2	0	1	0	0	0	0	0	0
1988	1	1	0	2	2	24	24	16	0	1	5	3	3	4	0	0	0	0	0	0
1988	1	1	0	2	2	25	25	1	0	0	1	0	0	0	0	0	0	0	0	0
1988	1	1	0	2	2	26	26	2	0	0	1	0	0	1	0	0	0	0	0	0
1988	1	1	0	2	2	27	27	2	0	1	0	0	1	0	0	0	0	0	0	0
1988	1	1	0	2	2	29	29	1	0	0	0	0	0	1	0	0	0	0	0	0
1989	1	1	0	2	2	13	13	1	0	1	0	0	0	0	0	0	0	0	0	0
1989	1	1	0	2	2	20	20	1	0	0	0	1	0	0	0	0	0	0	0	0
1989	1	1	0	2	2	21	21	1	0	0	1	0	0	0	0	0	0	0	0	0
1989	1	1	0	2	2	22	22	1	0	0	1	0	0	0	0	0	0	0	0	0
1989	1	1	0	2	2	23	23	2	0	0	2	0	0	0	0	0	0	0	0	0
1989	1	1	0	2	2	25	25	1	0	0	0	1	0	0	0	0	0	0	0	0
1989	1	1	0	2	2	27	27	1	0	0	0	0	0	1	0	0	0	0	0	0
1990	1	1	0	2	2	15	15	1	0	1	0	0	0	0	0	0	0	0	0	0
1990	1	1	0	2	2	16	16	1	0	1	0	0	0	0	0	0	0	0	0	0

1990	1	1	0	2	2	17	17	3	0	2	1	0	0	0	0	0	0	0	0	0
1990	1	1	0	2	2	18	18	4	0	1	1	2	0	0	0	0	0	0	0	0
1990	1	1	0	2	2	19	19	14	0	0	7	6	1	0	0	0	0	0	0	0
1990	1	1	0	2	2	20	20	28	0	3	10	9	5	1	0	0	0	0	0	0
1990	1	1	0	2	2	21	21	27	0	1	5	7	10	3	1	0	0	0	0	0
1990	1	1	0	2	2	22	22	38	0	0	4	14	15	5	0	0	0	0	0	0
1990	1	1	0	2	2	23	23	33	0	0	4	10	9	9	1	0	0	0	0	0
1990	1	1	0	2	2	24	24	24	0	1	3	5	4	9	2	0	0	0	0	0
1990	1	1	0	2	2	25	25	12	0	0	0	1	7	3	1	0	0	0	0	0
1990	1	1	0	2	2	26	26	17	0	0	2	3	6	3	3	0	0	0	0	0
1990	1	1	0	2	2	27	27	13	0	0	0	1	1	10	1	0	0	0	0	0
1990	1	1	0	2	2	28	28	9	0	0	0	0	2	6	1	0	0	0	0	0
1990	1	1	0	2	2	29	29	12	0	0	0	1	2	8	1	0	0	0	0	0
1990	1	1	0	2	2	30	30	5	0	0	0	0	1	4	0	0	0	0	0	0
1990	1	1	0	2	2	31	31	4	0	0	0	0	1	2	1	0	0	0	0	0
1991	1	1	0	2	2	12	12	1	0	1	0	0	0	0	0	0	0	0	0	0
1991	1	1	0	2	2	13	13	7	0	7	0	0	0	0	0	0	0	0	0	0
1991	1	1	0	2	2	14	14	6	0	6	0	0	0	0	0	0	0	0	0	0
1991	1	1	0	2	2	15	15	14	0	12	2	0	0	0	0	0	0	0	0	0
1991	1	1	0	2	2	16	16	8	0	6	2	0	0	0	0	0	0	0	0	0
1991	1	1	0	2	2	17	17	11	0	4	7	0	0	0	0	0	0	0	0	0
1991	1	1	0	2	2	18	18	34	1	15	13	4	1	0	0	0	0	0	0	0
1991	1	1	0	2	2	19	19	33	0	8	18	6	0	1	0	0	0	0	0	0
1991	1	1	0	2	2	20	20	29	0	8	11	9	0	0	1	0	0	0	0	0
1991	1	1	0	2	2	21	21	31	0	3	15	8	4	0	0	1	0	0	0	0
1991	1	1	0	2	2	22	22	22	0	2	13	6	0	1	0	0	0	0	0	0
1991	1	1	0	2	2	23	23	21	0	0	14	3	2	1	0	1	0	0	0	0
1991	1	1	0	2	2	24	24	28	0	0	17	8	0	0	3	0	0	0	0	0
1991	1	1	0	2	2	25	25	27	0	0	9	8	4	4	2	0	0	0	0	0
1991	1	1	0	2	2	26	26	23	0	0	9	5	2	2	4	1	0	0	0	0
1991	1	1	0	2	2	27	27	18	0	0	4	7	1	1	5	0	0	0	0	0

1991	1	1	0	2	2	28	28	12	0	0	1	4	1	1	5	0	0	0	0	0
1991	1	1	0	2	2	29	29	5	0	0	0	2	0	1	2	0	0	0	0	0
1991	1	1	0	2	2	30	30	3	0	0	0	1	0	1	0	1	0	0	0	0
1991	1	1	0	2	2	32	32	1	0	0	0	0	0	0	1	0	0	0	0	0
1991	1	1	0	2	2	33	33	1	0	0	0	0	1	0	0	0	0	0	0	0
1992	1	1	0	2	2	12	12	1	0	1	0	0	0	0	0	0	0	0	0	0
1992	1	1	0	2	2	15	15	1	0	0	1	0	0	0	0	0	0	0	0	0
1992	1	1	0	2	2	17	17	4	0	0	3	1	0	0	0	0	0	0	0	0
1992	1	1	0	2	2	18	18	14	0	2	9	2	1	0	0	0	0	0	0	0
1992	1	1	0	2	2	19	19	34	0	0	17	14	2	1	0	0	0	0	0	0
1992	1	1	0	2	2	20	20	42	0	0	21	13	7	0	1	0	0	0	0	0
1992	1	1	0	2	2	21	21	51	0	1	19	24	5	1	1	0	0	0	0	0
1992	1	1	0	2	2	22	22	41	0	2	6	19	10	4	0	0	0	0	0	0
1992	1	1	0	2	2	23	23	33	0	0	6	16	6	3	0	1	1	0	0	0
1992	1	1	0	2	2	24	24	40	0	0	9	14	5	9	1	2	0	0	0	0
1992	1	1	0	2	2	25	25	40	0	0	7	19	6	5	1	2	0	0	0	0
1992	1	1	0	2	2	26	26	39	0	0	5	12	13	3	2	4	0	0	0	0
1992	1	1	0	2	2	27	27	31	0	0	4	6	11	4	0	5	1	0	0	0
1992	1	1	0	2	2	28	28	26	0	0	1	5	13	4	0	3	0	0	0	0
1992	1	1	0	2	2	29	29	18	0	0	1	2	8	1	1	5	0	0	0	0
1992	1	1	0	2	2	30	30	3	0	0	0	0	2	0	0	1	0	0	0	0
1992	1	1	0	2	2	31	31	4	0	0	0	0	1	0	0	3	0	0	0	0
1992	1	1	0	2	2	32	32	3	0	0	0	0	1	0	0	2	0	0	0	0
1993	1	1	0	2	2	16	16	2	0	0	2	0	0	0	0	0	0	0	0	0
1993	1	1	0	2	2	17	17	13	0	1	9	3	0	0	0	0	0	0	0	0
1993	1	1	0	2	2	18	18	26	0	0	18	8	0	0	0	0	0	0	0	0
1993	1	1	0	2	2	19	19	25	0	0	12	12	1	0	0	0	0	0	0	0
1993	1	1	0	2	2	20	20	14	0	0	8	4	2	0	0	0	0	0	0	0
1993	1	1	0	2	2	21	21	10	0	0	4	6	0	0	0	0	0	0	0	0
1993	1	1	0	2	2	22	22	12	0	0	6	3	1	1	0	1	0	0	0	0
1993	1	1	0	2	2	23	23	4	0	0	1	2	1	0	0	0	0	0	0	0

1993	1	1	0	2	2	24	24	3	0	0	1	2	0	0	0	0	0	0	0	0
1993	1	1	0	2	2	25	25	7	0	0	2	3	2	0	0	0	0	0	0	0
1993	1	1	0	2	2	26	26	2	0	0	0	1	0	0	0	0	1	0	0	0
1993	1	1	0	2	2	27	27	1	0	0	0	0	1	0	0	0	0	0	0	0
1993	1	1	0	2	2	28	28	1	0	0	0	0	0	0	0	0	1	0	0	0
1994	1	1	0	2	2	15	15	1	0	1	0	0	0	0	0	0	0	0	0	0
1994	1	1	0	2	2	16	16	2	0	2	0	0	0	0	0	0	0	0	0	0
1994	1	1	0	2	2	17	17	1	0	1	0	0	0	0	0	0	0	0	0	0
1994	1	1	0	2	2	18	18	10	0	1	6	3	0	0	0	0	0	0	0	0
1994	1	1	0	2	2	19	19	26	0	1	9	16	0	0	0	0	0	0	0	0
1994	1	1	0	2	2	20	20	32	0	0	8	16	7	1	0	0	0	0	0	0
1994	1	1	0	2	2	21	21	52	0	0	16	24	9	2	0	0	1	0	0	0
1994	1	1	0	2	2	22	22	67	0	0	11	33	20	2	0	0	1	0	0	0
1994	1	1	0	2	2	23	23	77	0	0	5	32	28	10	0	2	0	0	0	0
1994	1	1	0	2	2	24	24	63	0	0	7	26	24	5	1	0	0	0	0	0
1994	1	1	0	2	2	25	25	35	0	0	1	13	14	2	2	2	0	1	0	0
1994	1	1	0	2	2	26	26	27	0	0	0	11	10	3	1	0	0	2	0	0
1994	1	1	0	2	2	27	27	13	0	0	0	5	5	0	2	0	0	1	0	0
1994	1	1	0	2	2	28	28	9	0	0	0	3	2	3	1	0	0	0	0	0
1994	1	1	0	2	2	29	29	5	0	0	0	0	3	1	1	0	0	0	0	0
1994	1	1	0	2	2	30	30	4	0	0	0	1	1	1	1	0	0	0	0	0
1994	1	1	0	2	2	31	31	1	0	0	0	0	0	0	1	0	0	0	0	0
1995	1	1	0	2	2	14	14	1	0	1	0	0	0	0	0	0	0	0	0	0
1995	1	1	0	2	2	15	15	1	0	1	0	0	0	0	0	0	0	0	0	0
1995	1	1	0	2	2	16	16	4	2	2	0	0	0	0	0	0	0	0	0	0
1995	1	1	0	2	2	17	17	16	3	1	11	1	0	0	0	0	0	0	0	0
1995	1	1	0	2	2	18	18	9	3	1	4	1	0	0	0	0	0	0	0	0
1995	1	1	0	2	2	19	19	8	1	0	4	2	1	0	0	0	0	0	0	0
1995	1	1	0	2	2	20	20	7	0	0	5	2	0	0	0	0	0	0	0	0
1995	1	1	0	2	2	21	21	8	0	0	6	1	1	0	0	0	0	0	0	0
1995	1	1	0	2	2	22	22	7	0	1	2	2	1	1	0	0	0	0	0	0

1995	1	1	0	2	2	23	23	15	0	0	8	4	1	1	1	0	0	0	0	0
1995	1	1	0	2	2	24	24	39	0	0	17	10	9	3	0	0	0	0	0	0
1995	1	1	0	2	2	25	25	32	0	0	5	18	8	0	0	1	0	0	0	0
1995	1	1	0	2	2	26	26	31	0	0	3	11	12	3	2	0	0	0	0	0
1995	1	1	0	2	2	27	27	29	0	0	0	14	12	2	1	0	0	0	0	0
1995	1	1	0	2	2	28	28	13	0	0	0	2	6	2	3	0	0	0	0	0
1995	1	1	0	2	2	29	29	6	0	0	0	0	2	2	2	0	0	0	0	0
1995	1	1	0	2	2	30	30	1	0	0	0	0	0	0	1	0	0	0	0	0
1995	1	1	0	2	2	31	31	1	0	0	0	0	0	0	0	1	0	0	0	0
1996	1	1	0	2	2	13	13	1	0	1	0	0	0	0	0	0	0	0	0	0
1996	1	1	0	2	2	18	18	3	0	2	1	0	0	0	0	0	0	0	0	0
1996	1	1	0	2	2	20	20	3	0	2	1	0	0	0	0	0	0	0	0	0
1996	1	1	0	2	2	21	21	3	0	2	0	1	0	0	0	0	0	0	0	0
1996	1	1	0	2	2	22	22	4	0	1	1	1	1	0	0	0	0	0	0	0
1996	1	1	0	2	2	23	23	9	0	0	2	3	4	0	0	0	0	0	0	0
1996	1	1	0	2	2	24	24	15	0	0	5	5	2	3	0	0	0	0	0	0
1996	1	1	0	2	2	25	25	29	0	1	3	14	6	5	0	0	0	0	0	0
1996	1	1	0	2	2	26	26	36	0	0	4	14	11	5	1	0	0	1	0	0
1996	1	1	0	2	2	27	27	45	0	0	0	23	12	6	1	1	2	0	0	0
1996	1	1	0	2	2	28	28	38	0	0	0	14	14	4	2	1	1	1	0	1
1996	1	1	0	2	2	29	29	40	0	0	0	10	9	14	2	1	3	1	0	0
1996	1	1	0	2	2	30	30	18	0	0	0	2	8	3	3	0	2	0	0	0
1996	1	1	0	2	2	31	31	11	0	0	0	0	0	5	4	1	0	1	0	0
1996	1	1	0	2	2	32	32	1	0	0	0	0	0	0	1	0	0	0	0	0
1996	1	1	0	2	2	33	33	1	0	0	0	0	0	1	0	0	0	0	0	0
1997	1	1	0	2	2	17	17	1	0	1	0	0	0	0	0	0	0	0	0	0
1997	1	1	0	2	2	18	18	1	0	0	1	0	0	0	0	0	0	0	0	0
1997	1	1	0	2	2	19	19	1	0	1	0	0	0	0	0	0	0	0	0	0
1997	1	1	0	2	2	20	20	1	0	0	0	1	0	0	0	0	0	0	0	0
1998	1	1	0	2	2	18	18	1	0	1	0	0	0	0	0	0	0	0	0	0
1998	1	1	0	2	2	20	20	1	0	1	0	0	0	0	0	0	0	0	0	0

1998	1	1	0	2	2	22	22	1	0	0	0	1	0	0	0	0	0	0	0	0
1998	1	1	0	2	2	23	23	1	0	0	1	0	0	0	0	0	0	0	0	0
1998	1	1	0	2	2	26	26	1	0	0	0	0	1	0	0	0	0	0	0	0
1998	1	1	0	2	2	28	28	1	0	0	0	0	1	0	0	0	0	0	0	0
1999	1	1	0	2	2	21	21	1	0	1	0	0	0	0	0	0	0	0	0	0
1999	1	1	0	2	2	24	24	1	0	0	1	0	0	0	0	0	0	0	0	0
1999	1	1	0	2	2	26	26	1	0	0	0	1	0	0	0	0	0	0	0	0
1999	1	1	0	2	2	27	27	1	0	0	0	0	1	0	0	0	0	0	0	0
2000	1	1	0	2	2	17	17	1	0	0	1	0	0	0	0	0	0	0	0	0
2000	1	1	0	2	2	18	18	1	0	0	0	1	0	0	0	0	0	0	0	0
2000	1	1	0	2	2	19	19	5	0	0	3	2	0	0	0	0	0	0	0	0
2000	1	1	0	2	2	20	20	7	0	0	3	4	0	0	0	0	0	0	0	0
2000	1	1	0	2	2	21	21	4	0	0	0	2	2	0	0	0	0	0	0	0
2000	1	1	0	2	2	22	22	2	0	0	0	1	1	0	0	0	0	0	0	0
2000	1	1	0	2	2	23	23	2	0	0	1	1	0	0	0	0	0	0	0	0
2000	1	1	0	2	2	24	24	2	0	0	0	2	0	0	0	0	0	0	0	0
2000	1	1	0	2	2	26	26	1	0	0	0	0	0	1	0	0	0	0	0	0
2000	1	1	0	2	2	28	28	1	0	0	0	0	1	0	0	0	0	0	0	0
2000	1	1	0	2	2	29	29	1	0	0	0	0	0	1	0	0	0	0	0	0
2000	1	1	0	2	2	30	30	1	0	0	0	0	0	1	0	0	0	0	0	0
2000	1	1	0	2	2	32	32	1	0	0	0	0	0	1	0	0	0	0	0	0
2001	1	1	0	2	2	14	14	1	0	1	0	0	0	0	0	0	0	0	0	0
2001	1	1	0	2	2	16	16	2	0	1	1	0	0	0	0	0	0	0	0	0
2001	1	1	0	2	2	18	18	5	0	1	2	2	0	0	0	0	0	0	0	0
2001	1	1	0	2	2	19	19	6	0	0	4	2	0	0	0	0	0	0	0	0
2001	1	1	0	2	2	20	20	11	0	1	3	4	3	0	0	0	0	0	0	0
2001	1	1	0	2	2	21	21	16	0	0	3	8	5	0	0	0	0	0	0	0
2001	1	1	0	2	2	22	22	9	0	0	0	6	3	0	0	0	0	0	0	0
2001	1	1	0	2	2	23	23	7	0	0	0	5	1	0	1	0	0	0	0	0
2001	1	1	0	2	2	24	24	7	0	1	0	4	1	0	1	0	0	0	0	0
2001	1	1	0	2	2	25	25	5	0	0	0	4	1	0	0	0	0	0	0	0

2001	1	1	0	2	2	26	26	3	0	0	0	1	0	2	0	0	0	0	0	0
2001	1	1	0	2	2	28	28	3	0	0	0	2	0	0	1	0	0	0	0	0
2001	1	1	0	2	2	30	30	1	0	0	0	0	0	0	1	0	0	0	0	0
2001	1	1	0	2	2	33	33	1	0	0	0	0	0	0	1	0	0	0	0	0
2002	1	1	0	2	2	11	11	1	0	1	0	0	0	0	0	0	0	0	0	0
2002	1	1	0	2	2	12	12	6	0	6	0	0	0	0	0	0	0	0	0	0
2002	1	1	0	2	2	13	13	2	0	2	0	0	0	0	0	0	0	0	0	0
2002	1	1	0	2	2	14	14	1	0	1	0	0	0	0	0	0	0	0	0	0
2002	1	1	0	2	2	15	15	9	0	8	1	0	0	0	0	0	0	0	0	0
2002	1	1	0	2	2	16	16	4	0	3	1	0	0	0	0	0	0	0	0	0
2002	1	1	0	2	2	17	17	4	0	4	0	0	0	0	0	0	0	0	0	0
2002	1	1	0	2	2	18	18	1	0	1	0	0	0	0	0	0	0	0	0	0
2002	1	1	0	2	2	19	19	6	0	2	1	3	0	0	0	0	0	0	0	0
2002	1	1	0	2	2	20	20	9	0	2	3	1	2	1	0	0	0	0	0	0
2002	1	1	0	2	2	21	21	4	0	0	2	0	1	1	0	0	0	0	0	0
2002	1	1	0	2	2	22	22	3	0	0	1	1	1	0	0	0	0	0	0	0
2002	1	1	0	2	2	23	23	7	0	1	1	3	2	0	0	0	0	0	0	0
2002	1	1	0	2	2	24	24	11	0	0	3	5	3	0	0	0	0	0	0	0
2002	1	1	0	2	2	25	25	1	0	0	0	1	0	0	0	0	0	0	0	0
2002	1	1	0	2	2	26	26	7	0	1	2	3	1	0	0	0	0	0	0	0
2002	1	1	0	2	2	27	27	2	0	0	0	1	0	1	0	0	0	0	0	0
2002	1	1	0	2	2	28	28	2	0	0	0	0	1	1	0	0	0	0	0	0
2002	1	1	0	2	2	31	31	1	0	0	0	0	0	0	1	0	0	0	0	0
2003	1	1	0	2	2	18	18	4	0	3	1	0	0	0	0	0	0	0	0	0
2003	1	1	0	2	2	19	19	4	0	3	0	1	0	0	0	0	0	0	0	0
2003	1	1	0	2	2	20	20	8	0	0	4	2	2	0	0	0	0	0	0	0
2003	1	1	0	2	2	21	21	3	0	2	0	1	0	0	0	0	0	0	0	0
2003	1	1	0	2	2	22	22	8	0	2	4	2	0	0	0	0	0	0	0	0
2003	1	1	0	2	2	23	23	4	0	2	2	0	0	0	0	0	0	0	0	0
2003	1	1	0	2	2	24	24	13	0	1	6	3	2	1	0	0	0	0	0	0
2003	1	1	0	2	2	25	25	8	0	0	3	3	1	1	0	0	0	0	0	0

2003	1	1	0	2	2	26	26	2	0	0	0	1	1	0	0	0	0	0	0	0
2003	1	1	0	2	2	27	27	9	0	0	0	3	5	1	0	0	0	0	0	0
2003	1	1	0	2	2	28	28	9	0	0	0	2	3	3	1	0	0	0	0	0
2003	1	1	0	2	2	30	30	2	0	0	0	0	1	1	0	0	0	0	0	0
2004	1	1	0	2	2	13	13	1	1	0	0	0	0	0	0	0	0	0	0	0
2004	1	1	0	2	2	14	14	2	0	2	0	0	0	0	0	0	0	0	0	0
2004	1	1	0	2	2	15	15	3	0	3	0	0	0	0	0	0	0	0	0	0
2004	1	1	0	2	2	16	16	6	0	6	0	0	0	0	0	0	0	0	0	0
2004	1	1	0	2	2	17	17	8	0	5	2	0	1	0	0	0	0	0	0	0
2004	1	1	0	2	2	18	18	12	1	8	2	1	0	0	0	0	0	0	0	0
2004	1	1	0	2	2	19	19	7	0	1	1	2	2	1	0	0	0	0	0	0
2004	1	1	0	2	2	20	20	19	0	1	10	6	0	1	1	0	0	0	0	0
2004	1	1	0	2	2	21	21	14	0	2	6	3	2	1	0	0	0	0	0	0
2004	1	1	0	2	2	22	22	11	0	0	4	4	3	0	0	0	0	0	0	0
2004	1	1	0	2	2	23	23	6	0	0	1	3	2	0	0	0	0	0	0	0
2004	1	1	0	2	2	24	24	14	0	0	0	5	5	2	1	1	0	0	0	0
2004	1	1	0	2	2	25	25	9	0	0	0	4	2	1	1	1	0	0	0	0
2004	1	1	0	2	2	26	26	8	0	0	0	3	3	2	0	0	0	0	0	0
2004	1	1	0	2	2	27	27	7	0	0	0	3	0	1	2	1	0	0	0	0
2004	1	1	0	2	2	28	28	9	0	0	0	2	3	4	0	0	0	0	0	0
2004	1	1	0	2	2	29	29	6	0	0	0	0	1	3	2	0	0	0	0	0
2004	1	1	0	2	2	30	30	1	0	0	0	0	0	0	1	0	0	0	0	0
2004	1	1	0	2	2	31	31	3	0	0	0	0	1	0	1	1	0	0	0	0
2005	1	1	0	2	2	12	12	1	0	1	0	0	0	0	0	0	0	0	0	0
2005	1	1	0	2	2	14	14	12	0	12	0	0	0	0	0	0	0	0	0	0
2005	1	1	0	2	2	15	15	22	0	22	0	0	0	0	0	0	0	0	0	0
2005	1	1	0	2	2	16	16	18	0	15	1	2	0	0	0	0	0	0	0	0
2005	1	1	0	2	2	17	17	16	0	8	4	4	0	0	0	0	0	0	0	0
2005	1	1	0	2	2	18	18	13	0	3	4	5	1	0	0	0	0	0	0	0
2005	1	1	0	2	2	19	19	20	0	4	7	7	1	0	1	0	0	0	0	0
2005	1	1	0	2	2	20	20	21	0	1	9	5	3	3	0	0	0	0	0	0

2005	1	1	0	2	2	21	21	21	0	4	5	5	3	3	1	0	0	0	0	0
2005	1	1	0	2	2	22	22	21	0	0	8	6	3	3	0	1	0	0	0	0
2005	1	1	0	2	2	23	23	20	0	0	7	8	2	1	1	1	0	0	0	0
2005	1	1	0	2	2	24	24	26	0	0	5	6	7	6	1	1	0	0	0	0
2005	1	1	0	2	2	25	25	22	0	0	6	10	1	3	1	1	0	0	0	0
2005	1	1	0	2	2	26	26	21	0	0	2	6	4	5	3	1	0	0	0	0
2005	1	1	0	2	2	27	27	12	0	0	0	0	3	6	1	2	0	0	0	0
2005	1	1	0	2	2	28	28	8	0	0	0	0	3	2	1	2	0	0	0	0
2005	1	1	0	2	2	29	29	7	0	0	0	0	1	2	3	1	0	0	0	0
2005	1	1	0	2	2	30	30	4	0	0	0	0	0	1	1	2	0	0	0	0
2005	1	1	0	2	2	31	31	1	0	0	0	0	0	0	0	1	0	0	0	0
2006	1	1	0	2	2	14	14	1	0	1	0	0	0	0	0	0	0	0	0	0
2006	1	1	0	2	2	15	15	2	0	2	0	0	0	0	0	0	0	0	0	0
2006	1	1	0	2	2	16	16	16	0	15	1	0	0	0	0	0	0	0	0	0
2006	1	1	0	2	2	17	17	24	0	21	3	0	0	0	0	0	0	0	0	0
2006	1	1	0	2	2	18	18	20	1	12	3	4	0	0	0	0	0	0	0	0
2006	1	1	0	2	2	19	19	21	0	10	6	4	1	0	0	0	0	0	0	0
2006	1	1	0	2	2	20	20	9	0	1	5	3	0	0	0	0	0	0	0	0
2006	1	1	0	2	2	21	21	8	0	0	4	3	1	0	0	0	0	0	0	0
2006	1	1	0	2	2	22	22	3	0	1	1	1	0	0	0	0	0	0	0	0
2006	1	1	0	2	2	23	23	4	0	0	3	1	0	0	0	0	0	0	0	0
2006	1	1	0	2	2	24	24	9	0	0	1	5	3	0	0	0	0	0	0	0
2006	1	1	0	2	2	25	25	7	0	0	0	4	2	1	0	0	0	0	0	0
2006	1	1	0	2	2	26	26	1	0	0	0	1	0	0	0	0	0	0	0	0
2006	1	1	0	2	2	27	27	1	0	0	0	1	0	0	0	0	0	0	0	0
2007	1	1	0	2	2	15	15	3	2	0	1	0	0	0	0	0	0	0	0	0
2007	1	1	0	2	2	16	16	13	1	12	0	0	0	0	0	0	0	0	0	0
2007	1	1	0	2	2	17	17	15	0	9	4	2	0	0	0	0	0	0	0	0
2007	1	1	0	2	2	18	18	22	0	10	7	2	3	0	0	0	0	0	0	0
2007	1	1	0	2	2	19	19	21	0	3	7	8	1	0	2	0	0	0	0	0
2007	1	1	0	2	2	20	20	21	0	5	4	6	6	0	0	0	0	0	0	0

2007	1	1	0	2	2	21	21	12	0	1	4	4	2	1	0	0	0	0	0	0
2007	1	1	0	2	2	22	22	16	0	0	2	6	3	5	0	0	0	0	0	0
2007	1	1	0	2	2	23	23	7	0	0	1	2	4	0	0	0	0	0	0	0
2007	1	1	0	2	2	24	24	10	0	0	1	2	5	2	0	0	0	0	0	0
2007	1	1	0	2	2	25	25	17	0	0	1	4	10	2	0	0	0	0	0	0
2007	1	1	0	2	2	26	26	6	0	0	0	0	3	2	1	0	0	0	0	0
2008	1	1	0	2	2	11	11	2	0	2	0	0	0	0	0	0	0	0	0	0
2008	1	1	0	2	2	14	14	2	0	2	0	0	0	0	0	0	0	0	0	0
2008	1	1	0	2	2	15	15	12	1	10	0	1	0	0	0	0	0	0	0	0
2008	1	1	0	2	2	16	16	20	0	13	5	2	0	0	0	0	0	0	0	0
2008	1	1	0	2	2	17	17	38	3	22	5	6	2	0	0	0	0	0	0	0
2008	1	1	0	2	2	18	18	32	1	8	11	8	3	1	0	0	0	0	0	0
2008	1	1	0	2	2	19	19	37	0	11	9	6	9	1	1	0	0	0	0	0
2008	1	1	0	2	2	20	20	29	0	5	9	9	2	4	0	0	0	0	0	0
2008	1	1	0	2	2	21	21	27	0	6	8	6	5	1	1	0	0	0	0	0
2008	1	1	0	2	2	22	22	19	0	0	4	7	5	1	1	1	0	0	0	0
2008	1	1	0	2	2	23	23	18	0	2	2	4	7	2	1	0	0	0	0	0
2008	1	1	0	2	2	24	24	20	0	1	2	6	5	4	2	0	0	0	0	0
2008	1	1	0	2	2	25	25	15	0	0	1	2	6	5	1	0	0	0	0	0
2008	1	1	0	2	2	26	26	6	0	0	0	1	2	1	1	0	1	0	0	0
2008	1	1	0	2	2	27	27	8	0	0	0	4	2	2	0	0	0	0	0	0
2008	1	1	0	2	2	28	28	7	0	0	0	1	2	3	0	1	0	0	0	0
2008	1	1	0	2	2	29	29	3	0	0	0	0	0	3	0	0	0	0	0	0
2008	1	1	0	2	2	30	30	3	0	0	0	1	1	1	0	0	0	0	0	0
2009	1	1	0	2	2	13	13	1	0	1	0	0	0	0	0	0	0	0	0	0
2009	1	1	0	2	2	14	14	3	0	3	0	0	0	0	0	0	0	0	0	0
2009	1	1	0	2	2	15	15	1	0	0	1	0	0	0	0	0	0	0	0	0
2009	1	1	0	2	2	16	16	2	0	2	0	0	0	0	0	0	0	0	0	0
2009	1	1	0	2	2	17	17	11	0	5	5	1	0	0	0	0	0	0	0	0
2009	1	1	0	2	2	18	18	12	0	5	2	2	3	0	0	0	0	0	0	0
2009	1	1	0	2	2	19	19	16	0	2	6	5	2	1	0	0	0	0	0	0

2009	1	1	0	2	2	20	20	10	0	3	1	3	3	0	0	0	0	0	0	0
2009	1	1	0	2	2	21	21	14	0	5	2	3	3	1	0	0	0	0	0	0
2009	1	1	0	2	2	22	22	10	0	0	2	1	6	1	0	0	0	0	0	0
2009	1	1	0	2	2	23	23	7	0	0	5	0	2	0	0	0	0	0	0	0
2009	1	1	0	2	2	24	24	4	0	0	0	2	1	1	0	0	0	0	0	0
2009	1	1	0	2	2	25	25	4	0	0	0	0	2	2	0	0	0	0	0	0
2009	1	1	0	2	2	26	26	1	0	0	0	0	0	1	0	0	0	0	0	0
2009	1	1	0	2	2	27	27	2	0	0	1	0	1	0	0	0	0	0	0	0
2009	1	1	0	2	2	28	28	3	0	0	0	0	3	0	0	0	0	0	0	0
2009	1	1	0	2	2	29	29	2	0	0	0	0	0	1	1	0	0	0	0	0
2010	1	1	0	2	2	13	13	1	0	1	0	0	0	0	0	0	0	0	0	0
2010	1	1	0	2	2	15	15	1	0	1	0	0	0	0	0	0	0	0	0	0
2010	1	1	0	2	2	16	16	6	0	4	0	2	0	0	0	0	0	0	0	0
2010	1	1	0	2	2	17	17	11	0	3	6	0	2	0	0	0	0	0	0	0
2010	1	1	0	2	2	18	18	12	0	2	8	2	0	0	0	0	0	0	0	0
2010	1	1	0	2	2	19	19	9	1	0	4	0	3	1	0	0	0	0	0	0
2010	1	1	0	2	2	20	20	2	0	0	2	0	0	0	0	0	0	0	0	0
2010	1	1	0	2	2	21	21	7	0	1	4	2	0	0	0	0	0	0	0	0
2010	1	1	0	2	2	22	22	5	0	1	2	1	0	1	0	0	0	0	0	0
2010	1	1	0	2	2	23	23	3	0	0	1	2	0	0	0	0	0	0	0	0
2010	1	1	0	2	2	24	24	1	0	0	0	1	0	0	0	0	0	0	0	0
2010	1	1	0	2	2	25	25	7	0	0	0	5	2	0	0	0	0	0	0	0
2010	1	1	0	2	2	26	26	2	0	0	0	0	1	1	0	0	0	0	0	0
2010	1	1	0	2	2	27	27	4	0	0	0	3	0	1	0	0	0	0	0	0
2010	1	1	0	2	2	28	28	1	0	0	0	1	0	0	0	0	0	0	0	0
2010	1	1	0	2	2	29	29	1	0	0	0	0	0	0	0	0	1	0	0	0
2010	1	1	0	2	2	30	30	1	0	0	0	0	0	1	0	0	0	0	0	0
2011	1	1	0	2	2	15	15	3	3	0	0	0	0	0	0	0	0	0	0	0
2011	1	1	0	2	2	16	16	4	1	1	1	1	0	0	0	0	0	0	0	0
2011	1	1	0	2	2	17	17	4	0	3	1	0	0	0	0	0	0	0	0	0
2011	1	1	0	2	2	18	18	11	0	6	4	0	1	0	0	0	0	0	0	0

2011	1	1	0	2	2	19	19	10	0	4	2	2	1	1	0	0	0	0	0	0
2011	1	1	0	2	2	20	20	6	0	2	2	2	0	0	0	0	0	0	0	0
2011	1	1	0	2	2	21	21	8	0	0	2	2	3	1	0	0	0	0	0	0
2011	1	1	0	2	2	22	22	7	0	0	5	1	0	1	0	0	0	0	0	0
2011	1	1	0	2	2	23	23	1	0	0	0	1	0	0	0	0	0	0	0	0
2011	1	1	0	2	2	24	24	4	0	0	3	0	1	0	0	0	0	0	0	0
2011	1	1	0	2	2	25	25	2	0	0	0	1	0	0	1	0	0	0	0	0
2011	1	1	0	2	2	26	26	5	0	0	0	3	0	2	0	0	0	0	0	0
2011	1	1	0	2	2	27	27	5	0	0	0	3	2	0	0	0	0	0	0	0
2011	1	1	0	2	2	28	28	2	0	0	0	0	1	0	1	0	0	0	0	0
2011	1	1	0	2	2	29	29	1	0	0	0	0	1	0	0	0	0	0	0	0
2011	1	1	0	2	2	30	30	3	0	0	0	1	1	1	0	0	0	0	0	0
1988	1	2	0	2	2	14	14	2	0	2	0	0	0	0	0	0	0	0	0	0
1988	1	2	0	2	2	17	17	1	0	0	1	0	0	0	0	0	0	0	0	0
1989	1	2	0	2	2	13	13	1	0	1	0	0	0	0	0	0	0	0	0	0
1989	1	2	0	2	2	14	14	2	2	0	0	0	0	0	0	0	0	0	0	0
1989	1	2	0	2	2	15	15	15	3	12	0	0	0	0	0	0	0	0	0	0
1989	1	2	0	2	2	16	16	27	3	21	3	0	0	0	0	0	0	0	0	0
1989	1	2	0	2	2	17	17	28	1	20	7	0	0	0	0	0	0	0	0	0
1989	1	2	0	2	2	18	18	19	0	14	4	1	0	0	0	0	0	0	0	0
1989	1	2	0	2	2	19	19	10	0	6	3	1	0	0	0	0	0	0	0	0
1989	1	2	0	2	2	20	20	6	0	2	1	2	1	0	0	0	0	0	0	0
1989	1	2	0	2	2	21	21	4	0	1	1	2	0	0	0	0	0	0	0	0
1989	1	2	0	2	2	22	22	2	0	0	0	2	0	0	0	0	0	0	0	0
1990	1	2	0	2	2	13	13	1	0	1	0	0	0	0	0	0	0	0	0	0
1990	1	2	0	2	2	14	14	18	0	18	0	0	0	0	0	0	0	0	0	0
1990	1	2	0	2	2	15	15	49	0	49	0	0	0	0	0	0	0	0	0	0
1990	1	2	0	2	2	16	16	31	0	28	3	0	0	0	0	0	0	0	0	0
1990	1	2	0	2	2	17	17	25	0	12	10	3	0	0	0	0	0	0	0	0
1990	1	2	0	2	2	18	18	12	0	5	5	2	0	0	0	0	0	0	0	0
1990	1	2	0	2	2	19	19	4	0	2	1	0	0	1	0	0	0	0	0	0

1990	1	2	0	2	2	20	20	1	0	0	1	0	0	0	0	0	0	0	0	0
1990	1	2	0	2	2	21	21	3	0	0	0	3	0	0	0	0	0	0	0	0
1990	1	2	0	2	2	22	22	1	0	0	0	0	1	0	0	0	0	0	0	0
1990	1	2	0	2	2	23	23	4	0	0	2	0	2	0	0	0	0	0	0	0
1990	1	2	0	2	2	24	24	1	0	0	0	0	0	1	0	0	0	0	0	0
1990	1	2	0	2	2	25	25	3	0	0	1	2	0	0	0	0	0	0	0	0
1990	1	2	0	2	2	26	26	1	0	0	0	0	0	1	0	0	0	0	0	0
1991	1	2	0	2	2	15	15	1	0	1	0	0	0	0	0	0	0	0	0	0
1991	1	2	0	2	2	18	18	2	0	0	2	0	0	0	0	0	0	0	0	0
1991	1	2	0	2	2	19	19	5	0	2	3	0	0	0	0	0	0	0	0	0
1991	1	2	0	2	2	20	20	3	0	1	0	0	1	1	0	0	0	0	0	0
1991	1	2	0	2	2	21	21	4	0	0	2	0	0	2	0	0	0	0	0	0
1991	1	2	0	2	2	22	22	10	0	1	2	5	1	1	0	0	0	0	0	0
1991	1	2	0	2	2	23	23	11	0	0	5	1	2	1	1	1	0	0	0	0
1991	1	2	0	2	2	24	24	17	0	0	5	1	7	1	2	1	0	0	0	0
1991	1	2	0	2	2	25	25	19	0	0	5	5	4	2	1	2	0	0	0	0
1991	1	2	0	2	2	26	26	16	0	0	6	5	1	0	2	2	0	0	0	0
1991	1	2	0	2	2	27	27	13	0	0	1	6	3	3	0	0	0	0	0	0
1991	1	2	0	2	2	28	28	14	0	0	2	2	3	6	1	0	0	0	0	0
1991	1	2	0	2	2	29	29	15	0	0	0	4	2	7	1	1	0	0	0	0
1991	1	2	0	2	2	30	30	6	0	0	1	1	2	2	0	0	0	0	0	0
1991	1	2	0	2	2	31	31	5	0	0	0	1	2	2	0	0	0	0	0	0
1992	1	2	0	2	2	15	15	2	0	2	0	0	0	0	0	0	0	0	0	0
1992	1	2	0	2	2	16	16	1	0	1	0	0	0	0	0	0	0	0	0	0
1992	1	2	0	2	2	17	17	2	0	2	0	0	0	0	0	0	0	0	0	0
1992	1	2	0	2	2	18	18	6	0	1	5	0	0	0	0	0	0	0	0	0
1992	1	2	0	2	2	19	19	3	0	0	3	0	0	0	0	0	0	0	0	0
1992	1	2	0	2	2	22	22	2	0	1	1	0	0	0	0	0	0	0	0	0
1992	1	2	0	2	2	23	23	1	0	0	1	0	0	0	0	0	0	0	0	0
1992	1	2	0	2	2	25	25	1	0	0	0	0	1	0	0	0	0	0	0	0
1992	1	2	0	2	2	26	26	3	0	0	0	1	2	0	0	0	0	0	0	0

1992	1	2	0	2	2	27	27	2	0	0	0	1	1	0	0	0	0	0	0	0
1992	1	2	0	2	2	28	28	3	0	0	0	2	1	0	0	0	0	0	0	0
1992	1	2	0	2	2	29	29	1	0	0	0	0	1	0	0	0	0	0	0	0
1992	1	2	0	2	2	30	30	1	0	0	0	0	0	1	0	0	0	0	0	0
1993	1	2	0	2	2	19	19	2	0	1	0	1	0	0	0	0	0	0	0	0
1993	1	2	0	2	2	20	20	2	0	0	1	1	0	0	0	0	0	0	0	0
1993	1	2	0	2	2	21	21	4	0	1	3	0	0	0	0	0	0	0	0	0
1993	1	2	0	2	2	22	22	7	0	0	3	2	2	0	0	0	0	0	0	0
1993	1	2	0	2	2	23	23	8	0	0	2	3	3	0	0	0	0	0	0	0
1993	1	2	0	2	2	24	24	4	0	0	0	2	1	1	0	0	0	0	0	0
1993	1	2	0	2	2	25	25	6	0	0	0	1	3	2	0	0	0	0	0	0
1993	1	2	0	2	2	26	26	6	0	0	0	4	0	2	0	0	0	0	0	0
1993	1	2	0	2	2	27	27	5	0	0	0	2	3	0	0	0	0	0	0	0
1993	1	2	0	2	2	28	28	11	0	0	0	3	6	1	0	0	0	1	0	0
1993	1	2	0	2	2	29	29	1	0	0	0	1	0	0	0	0	0	0	0	0
1993	1	2	0	2	2	30	30	7	0	0	0	0	6	0	1	0	0	0	0	0
1994	1	2	0	2	2	17	17	1	0	1	0	0	0	0	0	0	0	0	0	0
1994	1	2	0	2	2	20	20	1	0	1	0	0	0	0	0	0	0	0	0	0
1994	1	2	0	2	2	22	22	1	0	1	0	0	0	0	0	0	0	0	0	0
1994	1	2	0	2	2	23	23	5	0	0	4	1	0	0	0	0	0	0	0	0
1994	1	2	0	2	2	24	24	3	0	0	0	2	1	0	0	0	0	0	0	0
1994	1	2	0	2	2	25	25	2	0	0	0	2	0	0	0	0	0	0	0	0
1994	1	2	0	2	2	26	26	3	0	0	1	1	1	0	0	0	0	0	0	0
1994	1	2	0	2	2	27	27	2	0	0	0	0	1	1	0	0	0	0	0	0
1994	1	2	0	2	2	28	28	1	0	0	0	1	0	0	0	0	0	0	0	0
1994	1	2	0	2	2	30	30	2	0	0	0	0	1	0	1	0	0	0	0	0
1994	1	2	0	2	2	31	31	1	0	0	0	0	0	1	0	0	0	0	0	0
1994	1	2	0	2	2	33	33	1	0	0	0	0	1	0	0	0	0	0	0	0
1995	1	2	0	2	2	14	14	1	0	1	0	0	0	0	0	0	0	0	0	0
1995	1	2	0	2	2	15	15	2	1	1	0	0	0	0	0	0	0	0	0	0
1995	1	2	0	2	2	17	17	2	0	0	2	0	0	0	0	0	0	0	0	0

1995	1	2	0	2	2	18	18	2	0	0	2	0	0	0	0	0	0	0	0	0
1995	1	2	0	2	2	19	19	2	0	0	2	0	0	0	0	0	0	0	0	0
1995	1	2	0	2	2	20	20	1	0	0	0	0	1	0	0	0	0	0	0	0
1995	1	2	0	2	2	22	22	1	0	0	0	0	1	0	0	0	0	0	0	0
1995	1	2	0	2	2	24	24	1	0	0	1	0	0	0	0	0	0	0	0	0
1995	1	2	0	2	2	25	25	2	0	0	1	0	0	1	0	0	0	0	0	0
1995	1	2	0	2	2	26	26	1	0	0	0	0	1	0	0	0	0	0	0	0
1995	1	2	0	2	2	27	27	1	0	0	1	0	0	0	0	0	0	0	0	0
1995	1	2	0	2	2	28	28	1	0	0	0	0	1	0	0	0	0	0	0	0
1995	1	2	0	2	2	32	32	1	0	0	0	0	0	1	0	0	0	0	0	0
1996	1	2	0	2	2	24	24	1	0	0	0	0	0	1	0	0	0	0	0	0
1996	1	2	0	2	2	27	27	1	0	0	0	1	0	0	0	0	0	0	0	0
1996	1	2	0	2	2	28	28	3	0	0	0	2	0	0	1	0	0	0	0	0
1996	1	2	0	2	2	29	29	2	0	0	0	0	1	1	0	0	0	0	0	0
1996	1	2	0	2	2	32	32	1	0	0	0	0	0	1	0	0	0	0	0	0
1997	1	2	0	2	2	22	22	1	0	0	1	0	0	0	0	0	0	0	0	0
1997	1	2	0	2	2	23	23	2	0	0	2	0	0	0	0	0	0	0	0	0
1997	1	2	0	2	2	24	24	1	0	0	0	1	0	0	0	0	0	0	0	0
1997	1	2	0	2	2	26	26	1	0	0	0	1	0	0	0	0	0	0	0	0
1998	1	2	0	2	2	24	24	1	0	0	1	0	0	0	0	0	0	0	0	0
1998	1	2	0	2	2	25	25	1	0	0	0	1	0	0	0	0	0	0	0	0
1998	1	2	0	2	2	26	26	2	0	0	1	1	0	0	0	0	0	0	0	0
1998	1	2	0	2	2	27	27	4	0	0	0	3	1	0	0	0	0	0	0	0
1998	1	2	0	2	2	28	28	1	0	0	0	1	0	0	0	0	0	0	0	0
1998	1	2	0	2	2	29	29	1	0	0	0	1	0	0	0	0	0	0	0	0
1999	1	2	0	2	2	27	27	1	0	0	0	0	1	0	0	0	0	0	0	0
1999	1	2	0	2	2	30	30	1	0	0	0	1	0	0	0	0	0	0	0	0
2001	1	2	0	2	2	20	20	1	0	0	0	1	0	0	0	0	0	0	0	0
2001	1	2	0	2	2	22	22	1	0	0	1	0	0	0	0	0	0	0	0	0
2001	1	2	0	2	2	24	24	1	0	0	0	1	0	0	0	0	0	0	0	0
2001	1	2	0	2	2	27	27	1	0	0	0	1	0	0	0	0	0	0	0	0

2001	1	2	0	2	2	28	28	4	0	0	0	0	1	2	0	0	1	0	0	0
2001	1	2	0	2	2	29	29	2	0	0	0	2	0	0	0	0	0	0	0	0
2001	1	2	0	2	2	30	30	1	0	0	0	0	0	0	1	0	0	0	0	0
2001	1	2	0	2	2	34	34	1	0	0	0	0	0	0	0	1	0	0	0	0
2002	1	2	0	2	2	19	19	1	0	0	0	1	0	0	0	0	0	0	0	0
2002	1	2	0	2	2	23	23	4	0	0	0	1	1	2	0	0	0	0	0	0
2002	1	2	0	2	2	24	24	3	0	0	1	1	1	0	0	0	0	0	0	0
2002	1	2	0	2	2	25	25	2	0	0	0	2	0	0	0	0	0	0	0	0
2002	1	2	0	2	2	26	26	1	0	0	0	0	1	0	0	0	0	0	0	0
2002	1	2	0	2	2	27	27	1	0	0	0	0	1	0	0	0	0	0	0	0
2002	1	2	0	2	2	29	29	1	0	0	0	1	0	0	0	0	0	0	0	0
2003	1	2	0	2	2	14	14	1	0	1	0	0	0	0	0	0	0	0	0	0
2003	1	2	0	2	2	15	15	1	0	1	0	0	0	0	0	0	0	0	0	0
2003	1	2	0	2	2	16	16	6	0	3	3	0	0	0	0	0	0	0	0	0
2003	1	2	0	2	2	17	17	8	0	1	6	1	0	0	0	0	0	0	0	0
2003	1	2	0	2	2	19	19	3	0	0	2	1	0	0	0	0	0	0	0	0
2003	1	2	0	2	2	20	20	3	0	0	2	1	0	0	0	0	0	0	0	0
2003	1	2	0	2	2	21	21	4	0	0	2	1	1	0	0	0	0	0	0	0
2003	1	2	0	2	2	22	22	1	0	0	0	0	0	0	0	0	1	0	0	0
2003	1	2	0	2	2	23	23	3	0	0	2	1	0	0	0	0	0	0	0	0
2003	1	2	0	2	2	24	24	1	0	0	1	0	0	0	0	0	0	0	0	0
2003	1	2	0	2	2	25	25	1	0	0	0	0	0	0	0	0	1	0	0	0
2003	1	2	0	2	2	28	28	1	0	0	0	1	0	0	0	0	0	0	0	0
2003	1	2	0	2	2	32	32	3	0	0	0	0	0	1	2	0	0	0	0	0
2004	1	2	0	2	2	20	20	1	0	0	0	0	1	0	0	0	0	0	0	0
2004	1	2	0	2	2	22	22	1	0	0	0	1	0	0	0	0	0	0	0	0
2004	1	2	0	2	2	24	24	1	0	0	0	0	0	1	0	0	0	0	0	0
2004	1	2	0	2	2	26	26	1	0	0	0	1	0	0	0	0	0	0	0	0
2004	1	2	0	2	2	27	27	1	0	0	0	0	1	0	0	0	0	0	0	0
2005	1	2	0	2	2	18	18	1	0	0	1	0	0	0	0	0	0	0	0	0
2005	1	2	0	2	2	19	19	1	0	1	0	0	0	0	0	0	0	0	0	0

2005	1	2	0	2	2	21	21	1	0	0	0	0	0	0	0	1	0	0	0	0
2005	1	2	0	2	2	22	22	3	0	0	1	0	1	1	0	0	0	0	0	0
2005	1	2	0	2	2	23	23	5	0	0	2	0	1	1	1	0	0	0	0	0
2005	1	2	0	2	2	24	24	4	0	1	0	0	2	0	1	0	0	0	0	0
2005	1	2	0	2	2	25	25	1	0	0	1	0	0	0	0	0	0	0	0	0
2005	1	2	0	2	2	26	26	3	0	0	0	1	0	0	1	1	0	0	0	0
2005	1	2	0	2	2	27	27	3	0	0	0	0	0	1	2	0	0	0	0	0
2005	1	2	0	2	2	28	28	3	0	0	1	0	1	0	1	0	0	0	0	0
2005	1	2	0	2	2	29	29	3	0	0	0	0	0	1	1	1	0	0	0	0
2006	1	2	0	2	2	19	19	1	0	0	0	1	0	0	0	0	0	0	0	0
2006	1	2	0	2	2	22	22	1	0	0	0	0	1	0	0	0	0	0	0	0
2006	1	2	0	2	2	23	23	1	0	0	1	0	0	0	0	0	0	0	0	0
2006	1	2	0	2	2	25	25	3	0	0	0	1	1	1	0	0	0	0	0	0
2006	1	2	0	2	2	26	26	5	0	0	0	2	1	1	1	0	0	0	0	0
2007	1	2	0	2	2	16	16	1	0	1	0	0	0	0	0	0	0	0	0	0
2007	1	2	0	2	2	17	17	5	0	0	3	1	1	0	0	0	0	0	0	0
2007	1	2	0	2	2	18	18	4	0	0	2	2	0	0	0	0	0	0	0	0
2007	1	2	0	2	2	20	20	1	0	0	0	0	1	0	0	0	0	0	0	0
2007	1	2	0	2	2	22	22	3	0	0	0	0	2	1	0	0	0	0	0	0
2007	1	2	0	2	2	23	23	1	0	0	0	1	0	0	0	0	0	0	0	0
2007	1	2	0	2	2	24	24	2	0	0	0	2	0	0	0	0	0	0	0	0
2007	1	2	0	2	2	25	25	1	0	0	1	0	0	0	0	0	0	0	0	0
2007	1	2	0	2	2	26	26	1	0	0	0	0	0	0	0	1	0	0	0	0
2008	1	2	0	2	2	16	16	1	0	0	0	1	0	0	0	0	0	0	0	0
2008	1	2	0	2	2	21	21	1	0	0	1	0	0	0	0	0	0	0	0	0
2008	1	2	0	2	2	22	22	2	0	0	0	1	0	1	0	0	0	0	0	0
2008	1	2	0	2	2	23	23	3	0	1	0	0	2	0	0	0	0	0	0	0
2008	1	2	0	2	2	24	24	2	0	0	0	0	2	0	0	0	0	0	0	0
2008	1	2	0	2	2	25	25	2	0	0	0	0	0	1	1	0	0	0	0	0
2008	1	2	0	2	2	26	26	2	0	0	0	0	0	2	0	0	0	0	0	0
2008	1	2	0	2	2	27	27	3	0	0	0	1	2	0	0	0	0	0	0	0

2008	1	2	0	2	2	28	28	2	0	0	0	1	0	1	0	0	0	0	0	0
2008	1	2	0	2	2	30	30	3	0	0	0	0	2	1	0	0	0	0	0	0
2008	1	2	0	2	2	32	32	1	0	0	0	0	0	0	0	1	0	0	0	0
2009	1	2	0	2	2	18	18	2	0	0	1	0	0	1	0	0	0	0	0	0
2009	1	2	0	2	2	21	21	3	0	0	0	1	2	0	0	0	0	0	0	0
2009	1	2	0	2	2	22	22	6	0	0	1	2	2	0	1	0	0	0	0	0
2009	1	2	0	2	2	23	23	1	0	0	0	1	0	0	0	0	0	0	0	0
2009	1	2	0	2	2	24	24	4	0	0	0	1	2	1	0	0	0	0	0	0
2009	1	2	0	2	2	25	25	3	0	0	0	0	2	0	0	1	0	0	0	0
2009	1	2	0	2	2	26	26	5	0	0	0	1	0	4	0	0	0	0	0	0
2009	1	2	0	2	2	27	27	2	0	0	0	0	1	1	0	0	0	0	0	0
2009	1	2	0	2	2	28	28	6	0	0	0	0	0	3	2	0	1	0	0	0
2009	1	2	0	2	2	29	29	2	0	0	0	0	1	1	0	0	0	0	0	0
2009	1	2	0	2	2	30	30	1	0	0	0	0	1	0	0	0	0	0	0	0
2010	1	2	0	2	2	19	19	2	1	0	1	0	0	0	0	0	0	0	0	0
2010	1	2	0	2	2	20	20	1	0	0	0	0	0	0	1	0	0	0	0	0
2010	1	2	0	2	2	22	22	2	0	0	0	1	0	1	0	0	0	0	0	0
2010	1	2	0	2	2	23	23	2	0	0	1	0	0	0	0	1	0	0	0	0
2010	1	2	0	2	2	24	24	4	0	2	1	1	0	0	0	0	0	0	0	0
2010	1	2	0	2	2	25	25	2	0	0	1	0	0	0	1	0	0	0	0	0
2010	1	2	0	2	2	26	26	3	0	0	0	3	0	0	0	0	0	0	0	0
2010	1	2	0	2	2	27	27	4	0	0	0	3	1	0	0	0	0	0	0	0
2010	1	2	0	2	2	28	28	7	0	0	0	4	2	1	0	0	0	0	0	0
2010	1	2	0	2	2	29	29	6	0	0	1	4	1	0	0	0	0	0	0	0
2010	1	2	0	2	2	30	30	2	0	0	0	1	1	0	0	0	0	0	0	0
2010	1	2	0	2	2	31	31	2	0	0	0	0	0	0	2	0	0	0	0	0
2010	1	2	0	2	2	32	32	1	0	0	0	0	0	1	0	0	0	0	0	0
2011	1	2	0	2	2	15	15	1	0	1	0	0	0	0	0	0	0	0	0	0
2011	1	2	0	2	2	17	17	2	0	0	1	0	1	0	0	0	0	0	0	0
2011	1	2	0	2	2	18	18	1	0	0	0	0	1	0	0	0	0	0	0	0
2011	1	2	0	2	2	19	19	2	0	0	0	0	0	2	0	0	0	0	0	0

2011	1	2	0	2	2	20	20	2	0	1	0	1	0	0	0	0	0	0	0	0
2011	1	2	0	2	2	21	21	7	0	1	0	3	2	1	0	0	0	0	0	0
2011	1	2	0	2	2	22	22	10	0	1	1	1	2	3	1	1	0	0	0	0
2011	1	2	0	2	2	23	23	13	0	1	2	3	4	1	1	1	0	0	0	0
2011	1	2	0	2	2	24	24	11	0	0	3	4	1	2	0	1	0	0	0	0
2011	1	2	0	2	2	25	25	30	0	1	3	5	6	8	5	1	1	0	0	0
2011	1	2	0	2	2	26	26	32	0	0	2	7	12	6	5	0	0	0	0	0
2011	1	2	0	2	2	27	27	24	0	0	0	3	15	3	2	1	0	0	0	0
2011	1	2	0	2	2	28	28	23	0	0	0	7	10	6	0	0	0	0	0	0
2011	1	2	0	2	2	29	29	15	0	0	0	1	11	1	0	2	0	0	0	0
2011	1	2	0	2	2	30	30	12	0	0	0	0	6	4	2	0	0	0	0	0
2011	1	2	0	2	2	31	31	5	0	0	0	1	3	0	1	0	0	0	0	0
1988	1	3	0	2	2	12	12	1	0	1	0	0	0	0	0	0	0	0	0	0
1988	1	3	0	2	2	13	13	1	0	1	0	0	0	0	0	0	0	0	0	0
1988	1	3	0	2	2	14	14	2	1	1	0	0	0	0	0	0	0	0	0	0
1988	1	3	0	2	2	15	15	10	0	10	0	0	0	0	0	0	0	0	0	0
1988	1	3	0	2	2	16	16	23	0	5	17	0	1	0	0	0	0	0	0	0
1988	1	3	0	2	2	17	17	21	0	1	19	1	0	0	0	0	0	0	0	0
1988	1	3	0	2	2	18	18	8	0	2	5	1	0	0	0	0	0	0	0	0
1988	1	3	0	2	2	19	19	12	0	2	1	6	2	1	0	0	0	0	0	0
1988	1	3	0	2	2	20	20	7	0	0	3	0	1	1	1	1	0	0	0	0
1988	1	3	0	2	2	21	21	1	0	0	0	0	1	0	0	0	0	0	0	0
1988	1	3	0	2	2	22	22	3	0	0	0	2	0	1	0	0	0	0	0	0
1988	1	3	0	2	2	23	23	6	0	0	1	2	2	1	0	0	0	0	0	0
1988	1	3	0	2	2	24	24	7	0	0	1	1	3	1	0	1	0	0	0	0
1988	1	3	0	2	2	25	25	16	0	0	1	2	8	3	2	0	0	0	0	0
1988	1	3	0	2	2	26	26	8	0	0	0	1	5	0	1	0	0	0	1	0
1988	1	3	0	2	2	27	27	12	0	0	1	2	5	1	2	0	0	0	1	0
1988	1	3	0	2	2	28	28	3	0	0	0	1	1	0	0	1	0	0	0	0
1988	1	3	0	2	2	29	29	6	0	0	0	2	2	1	0	1	0	0	0	0
1988	1	3	0	2	2	30	30	6	0	0	0	0	2	1	1	2	0	0	0	0

1988	1	3	0	2	2	31	31	2	0	0	0	0	0	2	0	0	0	0	0	0
1988	1	3	0	2	2	32	32	1	0	0	0	0	0	1	0	0	0	0	0	0
1989	1	3	0	2	2	13	13	10	10	0	0	0	0	0	0	0	0	0	0	0
1989	1	3	0	2	2	14	14	14	13	1	0	0	0	0	0	0	0	0	0	0
1989	1	3	0	2	2	15	15	14	13	1	0	0	0	0	0	0	0	0	0	0
1989	1	3	0	2	2	16	16	19	13	6	0	0	0	0	0	0	0	0	0	0
1989	1	3	0	2	2	17	17	14	3	9	2	0	0	0	0	0	0	0	0	0
1989	1	3	0	2	2	18	18	32	6	20	5	1	0	0	0	0	0	0	0	0
1989	1	3	0	2	2	19	19	16	0	11	5	0	0	0	0	0	0	0	0	0
1989	1	3	0	2	2	20	20	17	1	5	8	2	0	1	0	0	0	0	0	0
1989	1	3	0	2	2	21	21	16	0	4	6	1	4	1	0	0	0	0	0	0
1989	1	3	0	2	2	22	22	20	0	0	11	3	3	3	0	0	0	0	0	0
1989	1	3	0	2	2	23	23	18	0	0	5	6	6	1	0	0	0	0	0	0
1989	1	3	0	2	2	24	24	17	0	0	6	2	5	2	1	1	0	0	0	0
1989	1	3	0	2	2	25	25	10	0	0	2	4	2	0	2	0	0	0	0	0
1989	1	3	0	2	2	26	26	13	0	0	1	1	7	3	1	0	0	0	0	0
1989	1	3	0	2	2	27	27	4	0	0	0	0	2	2	0	0	0	0	0	0
1989	1	3	0	2	2	28	28	6	0	0	0	2	3	1	0	0	0	0	0	0
1989	1	3	0	2	2	29	29	4	0	0	0	0	4	0	0	0	0	0	0	0
1989	1	3	0	2	2	30	30	8	0	0	0	1	1	6	0	0	0	0	0	0
1989	1	3	0	2	2	31	31	1	0	0	0	0	0	0	0	0	1	0	0	0
1990	1	3	0	2	2	13	13	12	5	7	0	0	0	0	0	0	0	0	0	0
1990	1	3	0	2	2	14	14	49	6	43	0	0	0	0	0	0	0	0	0	0
1990	1	3	0	2	2	15	15	73	2	70	1	0	0	0	0	0	0	0	0	0
1990	1	3	0	2	2	16	16	43	0	37	5	1	0	0	0	0	0	0	0	0
1990	1	3	0	2	2	17	17	59	1	37	17	3	1	0	0	0	0	0	0	0
1990	1	3	0	2	2	18	18	46	0	20	19	7	0	0	0	0	0	0	0	0
1990	1	3	0	2	2	19	19	56	1	21	22	9	3	0	0	0	0	0	0	0
1990	1	3	0	2	2	20	20	42	0	9	14	11	6	1	0	0	1	0	0	0
1990	1	3	0	2	2	21	21	41	0	11	16	8	3	3	0	0	0	0	0	0
1990	1	3	0	2	2	22	22	22	0	6	9	1	3	1	1	0	1	0	0	0

1990	1	3	0	2	2	23	23	29	0	7	13	5	2	1	0	0	1	0	0	0
1990	1	3	0	2	2	24	24	29	0	3	7	8	6	2	2	1	0	0	0	0
1990	1	3	0	2	2	25	25	23	0	0	5	9	4	4	1	0	0	0	0	0
1990	1	3	0	2	2	26	26	20	0	0	7	2	7	3	1	0	0	0	0	0
1990	1	3	0	2	2	27	27	17	0	0	1	8	5	1	2	0	0	0	0	0
1990	1	3	0	2	2	28	28	24	0	0	0	4	8	8	3	0	1	0	0	0
1990	1	3	0	2	2	29	29	10	0	0	0	5	3	0	0	2	0	0	0	0
1990	1	3	0	2	2	30	30	11	0	0	0	2	4	4	0	1	0	0	0	0
1990	1	3	0	2	2	31	31	1	0	0	0	0	0	1	0	0	0	0	0	0
1990	1	3	0	2	2	32	32	5	0	0	0	0	0	3	2	0	0	0	0	0
1990	1	3	0	2	2	33	33	5	0	0	0	1	0	3	1	0	0	0	0	0
1990	1	3	0	2	2	35	35	1	0	0	0	0	1	0	0	0	0	0	0	0
1991	1	3	0	2	2	12	12	1	0	1	0	0	0	0	0	0	0	0	0	0
1991	1	3	0	2	2	13	13	23	10	13	0	0	0	0	0	0	0	0	0	0
1991	1	3	0	2	2	14	14	12	2	10	0	0	0	0	0	0	0	0	0	0
1991	1	3	0	2	2	15	15	17	0	16	1	0	0	0	0	0	0	0	0	0
1991	1	3	0	2	2	16	16	24	0	22	2	0	0	0	0	0	0	0	0	0
1991	1	3	0	2	2	17	17	19	0	16	3	0	0	0	0	0	0	0	0	0
1991	1	3	0	2	2	18	18	19	0	15	3	1	0	0	0	0	0	0	0	0
1991	1	3	0	2	2	19	19	20	0	10	6	4	0	0	0	0	0	0	0	0
1991	1	3	0	2	2	20	20	17	0	8	7	0	1	1	0	0	0	0	0	0
1991	1	3	0	2	2	21	21	22	0	6	11	2	3	0	0	0	0	0	0	0
1991	1	3	0	2	2	22	22	18	0	1	7	7	2	0	0	1	0	0	0	0
1991	1	3	0	2	2	23	23	26	0	6	13	2	2	2	1	0	0	0	0	0
1991	1	3	0	2	2	24	24	19	0	3	8	2	2	1	1	2	0	0	0	0
1991	1	3	0	2	2	25	25	19	0	0	6	8	4	1	0	0	0	0	0	0
1991	1	3	0	2	2	26	26	23	0	0	11	7	2	2	1	0	0	0	0	0
1991	1	3	0	2	2	27	27	13	0	0	4	3	4	1	0	1	0	0	0	0
1991	1	3	0	2	2	28	28	22	0	0	3	8	7	3	0	1	0	0	0	0
1991	1	3	0	2	2	29	29	13	0	0	1	1	3	4	3	1	0	0	0	0
1991	1	3	0	2	2	30	30	5	0	0	0	0	3	2	0	0	0	0	0	0

1991	1	3	0	2	2	31	31	3	0	0	0	0	1	2	0	0	0	0	0	0
1991	1	3	0	2	2	33	33	2	0	0	0	0	1	0	0	0	0	1	0	0
1992	1	3	0	2	2	13	13	1	0	0	1	0	0	0	0	0	0	0	0	0
1992	1	3	0	2	2	14	14	15	0	13	2	0	0	0	0	0	0	0	0	0
1992	1	3	0	2	2	15	15	28	0	25	2	1	0	0	0	0	0	0	0	0
1992	1	3	0	2	2	16	16	41	0	22	17	2	0	0	0	0	0	0	0	0
1992	1	3	0	2	2	17	17	56	0	23	31	2	0	0	0	0	0	0	0	0
1992	1	3	0	2	2	18	18	25	0	9	16	0	0	0	0	0	0	0	0	0
1992	1	3	0	2	2	19	19	21	1	6	14	0	0	0	0	0	0	0	0	0
1992	1	3	0	2	2	20	20	13	0	0	11	2	0	0	0	0	0	0	0	0
1992	1	3	0	2	2	21	21	9	0	1	4	4	0	0	0	0	0	0	0	0
1992	1	3	0	2	2	22	22	11	0	0	4	5	0	2	0	0	0	0	0	0
1992	1	3	0	2	2	23	23	10	0	0	5	4	1	0	0	0	0	0	0	0
1992	1	3	0	2	2	24	24	10	0	1	7	2	0	0	0	0	0	0	0	0
1992	1	3	0	2	2	25	25	14	0	0	5	4	2	1	2	0	0	0	0	0
1992	1	3	0	2	2	26	26	10	0	2	3	1	4	0	0	0	0	0	0	0
1992	1	3	0	2	2	27	27	14	0	0	4	6	4	0	0	0	0	0	0	0
1992	1	3	0	2	2	28	28	6	0	0	0	2	4	0	0	0	0	0	0	0
1992	1	3	0	2	2	29	29	7	0	0	2	1	2	2	0	0	0	0	0	0
1992	1	3	0	2	2	30	30	4	0	0	0	0	3	1	0	0	0	0	0	0
1992	1	3	0	2	2	31	31	2	0	0	1	0	1	0	0	0	0	0	0	0
1992	1	3	0	2	2	32	32	1	0	0	0	1	0	0	0	0	0	0	0	0
1993	1	3	0	2	2	11	11	2	2	0	0	0	0	0	0	0	0	0	0	0
1993	1	3	0	2	2	14	14	9	2	7	0	0	0	0	0	0	0	0	0	0
1993	1	3	0	2	2	15	15	16	0	16	0	0	0	0	0	0	0	0	0	0
1993	1	3	0	2	2	16	16	8	0	5	3	0	0	0	0	0	0	0	0	0
1993	1	3	0	2	2	17	17	15	2	1	11	1	0	0	0	0	0	0	0	0
1993	1	3	0	2	2	18	18	7	0	1	4	2	0	0	0	0	0	0	0	0
1993	1	3	0	2	2	19	19	6	0	0	5	1	0	0	0	0	0	0	0	0
1993	1	3	0	2	2	20	20	4	0	0	2	1	1	0	0	0	0	0	0	0
1993	1	3	0	2	2	21	21	7	0	0	1	4	2	0	0	0	0	0	0	0

1993	1	3	0	2	2	22	22	9	0	0	3	5	1	0	0	0	0	0	0	0
1993	1	3	0	2	2	23	23	6	0	1	1	1	2	0	1	0	0	0	0	0
1993	1	3	0	2	2	24	24	8	0	0	0	7	1	0	0	0	0	0	0	0
1993	1	3	0	2	2	25	25	10	0	0	3	4	2	1	0	0	0	0	0	0
1993	1	3	0	2	2	26	26	12	0	0	2	9	1	0	0	0	0	0	0	0
1993	1	3	0	2	2	27	27	14	0	0	1	8	4	0	0	1	0	0	0	0
1993	1	3	0	2	2	28	28	8	0	0	0	3	5	0	0	0	0	0	0	0
1993	1	3	0	2	2	29	29	3	0	0	0	1	2	0	0	0	0	0	0	0
1993	1	3	0	2	2	30	30	5	0	0	0	1	2	1	0	1	0	0	0	0
1993	1	3	0	2	2	31	31	3	0	0	0	0	3	0	0	0	0	0	0	0
1993	1	3	0	2	2	32	32	2	0	0	0	1	0	1	0	0	0	0	0	0
1994	1	3	0	2	2	13	13	4	0	4	0	0	0	0	0	0	0	0	0	0
1994	1	3	0	2	2	14	14	11	0	11	0	0	0	0	0	0	0	0	0	0
1994	1	3	0	2	2	15	15	33	0	33	0	0	0	0	0	0	0	0	0	0
1994	1	3	0	2	2	16	16	18	0	18	0	0	0	0	0	0	0	0	0	0
1994	1	3	0	2	2	17	17	9	0	7	2	0	0	0	0	0	0	0	0	0
1994	1	3	0	2	2	18	18	9	0	7	2	0	0	0	0	0	0	0	0	0
1994	1	3	0	2	2	19	19	3	0	1	1	1	0	0	0	0	0	0	0	0
1994	1	3	0	2	2	20	20	3	0	2	1	0	0	0	0	0	0	0	0	0
1994	1	3	0	2	2	21	21	6	0	0	4	1	1	0	0	0	0	0	0	0
1994	1	3	0	2	2	22	22	7	0	3	1	0	3	0	0	0	0	0	0	0
1994	1	3	0	2	2	23	23	5	0	0	1	4	0	0	0	0	0	0	0	0
1994	1	3	0	2	2	24	24	9	0	1	2	5	1	0	0	0	0	0	0	0
1994	1	3	0	2	2	25	25	9	0	0	2	3	2	2	0	0	0	0	0	0
1994	1	3	0	2	2	26	26	5	0	0	0	3	1	0	1	0	0	0	0	0
1994	1	3	0	2	2	27	27	6	0	0	0	2	4	0	0	0	0	0	0	0
1994	1	3	0	2	2	28	28	8	0	0	1	2	4	0	1	0	0	0	0	0
1994	1	3	0	2	2	29	29	6	0	0	0	0	4	1	0	1	0	0	0	0
1994	1	3	0	2	2	30	30	7	0	0	0	1	4	1	1	0	0	0	0	0
1994	1	3	0	2	2	31	31	4	0	0	0	0	0	3	1	0	0	0	0	0
1994	1	3	0	2	2	32	32	1	0	0	0	0	0	1	0	0	0	0	0	0

1995	1	3	0	2	2	13	13	2	2	0	0	0	0	0	0	0	0	0	0	0
1995	1	3	0	2	2	14	14	12	12	0	0	0	0	0	0	0	0	0	0	0
1995	1	3	0	2	2	15	15	11	11	0	0	0	0	0	0	0	0	0	0	0
1995	1	3	0	2	2	16	16	11	2	0	9	0	0	0	0	0	0	0	0	0
1995	1	3	0	2	2	17	17	17	3	4	8	1	1	0	0	0	0	0	0	0
1995	1	3	0	2	2	18	18	25	0	14	10	1	0	0	0	0	0	0	0	0
1995	1	3	0	2	2	19	19	16	1	12	3	0	0	0	0	0	0	0	0	0
1995	1	3	0	2	2	20	20	6	0	2	4	0	0	0	0	0	0	0	0	0
1995	1	3	0	2	2	21	21	4	0	3	1	0	0	0	0	0	0	0	0	0
1995	1	3	0	2	2	22	22	7	0	4	2	0	1	0	0	0	0	0	0	0
1995	1	3	0	2	2	23	23	4	0	0	3	0	1	0	0	0	0	0	0	0
1995	1	3	0	2	2	24	24	9	0	2	3	3	1	0	0	0	0	0	0	0
1995	1	3	0	2	2	25	25	6	0	0	4	1	1	0	0	0	0	0	0	0
1995	1	3	0	2	2	26	26	9	0	0	1	2	4	2	0	0	0	0	0	0
1995	1	3	0	2	2	27	27	6	0	0	1	2	2	1	0	0	0	0	0	0
1995	1	3	0	2	2	28	28	9	0	0	1	1	4	2	1	0	0	0	0	0
1995	1	3	0	2	2	29	29	11	0	0	0	4	1	3	2	1	0	0	0	0
1995	1	3	0	2	2	30	30	5	0	0	0	0	0	3	1	1	0	0	0	0
1995	1	3	0	2	2	31	31	3	0	0	0	0	0	2	1	0	0	0	0	0
1995	1	3	0	2	2	32	32	4	0	0	0	0	0	2	1	1	0	0	0	0
1996	1	3	0	2	2	11	11	1	1	0	0	0	0	0	0	0	0	0	0	0
1996	1	3	0	2	2	13	13	4	3	1	0	0	0	0	0	0	0	0	0	0
1996	1	3	0	2	2	14	14	13	5	8	0	0	0	0	0	0	0	0	0	0
1996	1	3	0	2	2	15	15	21	7	14	0	0	0	0	0	0	0	0	0	0
1996	1	3	0	2	2	16	16	20	5	15	0	0	0	0	0	0	0	0	0	0
1996	1	3	0	2	2	17	17	40	4	26	9	1	0	0	0	0	0	0	0	0
1996	1	3	0	2	2	18	18	26	0	17	4	5	0	0	0	0	0	0	0	0
1996	1	3	0	2	2	19	19	48	1	24	11	12	0	0	0	0	0	0	0	0
1996	1	3	0	2	2	20	20	31	0	20	5	5	1	0	0	0	0	0	0	0
1996	1	3	0	2	2	21	21	19	0	6	7	5	0	0	1	0	0	0	0	0
1996	1	3	0	2	2	22	22	9	0	3	4	2	0	0	0	0	0	0	0	0

1996	1	3	0	2	2	23	23	10	0	2	2	5	0	0	1	0	0	0	0	0
1996	1	3	0	2	2	24	24	10	0	0	2	5	0	2	1	0	0	0	0	0
1996	1	3	0	2	2	25	25	5	0	0	3	1	1	0	0	0	0	0	0	0
1996	1	3	0	2	2	26	26	3	0	0	1	0	1	0	1	0	0	0	0	0
1996	1	3	0	2	2	27	27	4	0	0	2	2	0	0	0	0	0	0	0	0
1996	1	3	0	2	2	28	28	2	0	0	0	0	0	2	0	0	0	0	0	0
1996	1	3	0	2	2	29	29	2	0	0	0	0	2	0	0	0	0	0	0	0
1996	1	3	0	2	2	30	30	1	0	0	0	1	0	0	0	0	0	0	0	0
1997	1	3	0	2	2	13	13	1	1	0	0	0	0	0	0	0	0	0	0	0
1997	1	3	0	2	2	14	14	8	1	7	0	0	0	0	0	0	0	0	0	0
1997	1	3	0	2	2	15	15	17	2	15	0	0	0	0	0	0	0	0	0	0
1997	1	3	0	2	2	16	16	14	2	11	1	0	0	0	0	0	0	0	0	0
1997	1	3	0	2	2	17	17	18	3	10	5	0	0	0	0	0	0	0	0	0
1997	1	3	0	2	2	18	18	12	0	6	5	1	0	0	0	0	0	0	0	0
1997	1	3	0	2	2	19	19	7	0	3	2	2	0	0	0	0	0	0	0	0
1997	1	3	0	2	2	20	20	6	0	1	4	1	0	0	0	0	0	0	0	0
1997	1	3	0	2	2	21	21	8	0	1	5	1	1	0	0	0	0	0	0	0
1997	1	3	0	2	2	22	22	3	0	0	2	1	0	0	0	0	0	0	0	0
1997	1	3	0	2	2	23	23	4	0	0	3	1	0	0	0	0	0	0	0	0
1997	1	3	0	2	2	24	24	3	0	0	2	1	0	0	0	0	0	0	0	0
1997	1	3	0	2	2	25	25	3	0	0	2	0	1	0	0	0	0	0	0	0
1997	1	3	0	2	2	26	26	3	0	0	3	0	0	0	0	0	0	0	0	0
1997	1	3	0	2	2	27	27	3	0	0	0	1	2	0	0	0	0	0	0	0
1997	1	3	0	2	2	30	30	1	0	0	0	1	0	0	0	0	0	0	0	0
1997	1	3	0	2	2	32	32	1	0	0	0	0	1	0	0	0	0	0	0	0
1998	1	3	0	2	2	13	13	3	0	3	0	0	0	0	0	0	0	0	0	0
1998	1	3	0	2	2	14	14	12	2	10	0	0	0	0	0	0	0	0	0	0
1998	1	3	0	2	2	15	15	23	5	18	0	0	0	0	0	0	0	0	0	0
1998	1	3	0	2	2	16	16	13	3	6	4	0	0	0	0	0	0	0	0	0
1998	1	3	0	2	2	17	17	23	4	11	7	1	0	0	0	0	0	0	0	0
1998	1	3	0	2	2	18	18	13	0	8	4	0	1	0	0	0	0	0	0	0

1998	1	3	0	2	2	19	19	15	0	7	7	1	0	0	0	0	0	0	0	0
1998	1	3	0	2	2	20	20	6	0	4	2	0	0	0	0	0	0	0	0	0
1998	1	3	0	2	2	21	21	5	0	0	5	0	0	0	0	0	0	0	0	0
1998	1	3	0	2	2	22	22	10	0	3	7	0	0	0	0	0	0	0	0	0
1998	1	3	0	2	2	23	23	3	0	0	1	1	0	1	0	0	0	0	0	0
1998	1	3	0	2	2	24	24	3	0	1	1	1	0	0	0	0	0	0	0	0
1998	1	3	0	2	2	25	25	3	0	1	1	1	0	0	0	0	0	0	0	0
1998	1	3	0	2	2	26	26	3	0	0	0	3	0	0	0	0	0	0	0	0
1998	1	3	0	2	2	27	27	2	0	0	1	1	0	0	0	0	0	0	0	0
1998	1	3	0	2	2	29	29	1	0	0	0	1	0	0	0	0	0	0	0	0
1999	1	3	0	2	2	13	13	2	1	1	0	0	0	0	0	0	0	0	0	0
1999	1	3	0	2	2	14	14	6	2	4	0	0	0	0	0	0	0	0	0	0
1999	1	3	0	2	2	15	15	35	3	30	2	0	0	0	0	0	0	0	0	0
1999	1	3	0	2	2	16	16	58	0	54	4	0	0	0	0	0	0	0	0	0
1999	1	3	0	2	2	17	17	83	0	72	8	3	0	0	0	0	0	0	0	0
1999	1	3	0	2	2	18	18	80	0	44	26	10	0	0	0	0	0	0	0	0
1999	1	3	0	2	2	19	19	52	0	24	16	11	1	0	0	0	0	0	0	0
1999	1	3	0	2	2	20	20	49	0	16	15	14	2	1	1	0	0	0	0	0
1999	1	3	0	2	2	21	21	29	0	4	9	13	1	2	0	0	0	0	0	0
1999	1	3	0	2	2	22	22	35	0	4	13	12	6	0	0	0	0	0	0	0
1999	1	3	0	2	2	23	23	22	0	2	5	10	5	0	0	0	0	0	0	0
1999	1	3	0	2	2	24	24	34	0	0	9	18	7	0	0	0	0	0	0	0
1999	1	3	0	2	2	25	25	17	0	2	0	10	5	0	0	0	0	0	0	0
1999	1	3	0	2	2	26	26	14	0	0	2	7	3	2	0	0	0	0	0	0
1999	1	3	0	2	2	27	27	15	0	0	0	7	7	1	0	0	0	0	0	0
1999	1	3	0	2	2	28	28	13	0	0	1	2	8	1	0	1	0	0	0	0
1999	1	3	0	2	2	29	29	4	0	0	0	3	1	0	0	0	0	0	0	0
1999	1	3	0	2	2	30	30	4	0	0	0	1	1	2	0	0	0	0	0	0
1999	1	3	0	2	2	31	31	3	0	0	0	1	1	0	1	0	0	0	0	0
2000	1	3	0	2	2	14	14	11	4	7	0	0	0	0	0	0	0	0	0	0
2000	1	3	0	2	2	15	15	13	3	10	0	0	0	0	0	0	0	0	0	0

2000	1	3	0	2	2	16	16	23	4	14	5	0	0	0	0	0	0	0	0	0
2000	1	3	0	2	2	17	17	15	0	3	8	4	0	0	0	0	0	0	0	0
2000	1	3	0	2	2	18	18	31	0	2	15	11	3	0	0	0	0	0	0	0
2000	1	3	0	2	2	19	19	8	0	2	2	4	0	0	0	0	0	0	0	0
2000	1	3	0	2	2	20	20	5	0	0	1	3	1	0	0	0	0	0	0	0
2000	1	3	0	2	2	21	21	9	0	1	4	3	1	0	0	0	0	0	0	0
2000	1	3	0	2	2	22	22	9	0	0	2	4	2	1	0	0	0	0	0	0
2000	1	3	0	2	2	23	23	6	0	0	2	1	0	3	0	0	0	0	0	0
2000	1	3	0	2	2	24	24	7	0	0	0	1	5	1	0	0	0	0	0	0
2000	1	3	0	2	2	25	25	5	0	0	0	5	0	0	0	0	0	0	0	0
2000	1	3	0	2	2	26	26	5	0	0	1	2	2	0	0	0	0	0	0	0
2000	1	3	0	2	2	27	27	2	0	0	1	0	1	0	0	0	0	0	0	0
2000	1	3	0	2	2	28	28	5	0	0	0	0	4	0	1	0	0	0	0	0
2001	1	3	0	2	2	13	13	1	0	1	0	0	0	0	0	0	0	0	0	0
2001	1	3	0	2	2	14	14	7	2	5	0	0	0	0	0	0	0	0	0	0
2001	1	3	0	2	2	15	15	10	0	8	2	0	0	0	0	0	0	0	0	0
2001	1	3	0	2	2	16	16	19	1	10	8	0	0	0	0	0	0	0	0	0
2001	1	3	0	2	2	17	17	9	1	0	6	2	0	0	0	0	0	0	0	0
2001	1	3	0	2	2	18	18	11	1	5	2	3	0	0	0	0	0	0	0	0
2001	1	3	0	2	2	19	19	16	0	4	5	5	1	1	0	0	0	0	0	0
2001	1	3	0	2	2	20	20	8	0	1	3	3	0	1	0	0	0	0	0	0
2001	1	3	0	2	2	21	21	8	0	1	2	5	0	0	0	0	0	0	0	0
2001	1	3	0	2	2	22	22	5	0	0	2	2	1	0	0	0	0	0	0	0
2001	1	3	0	2	2	23	23	1	0	0	0	1	0	0	0	0	0	0	0	0
2001	1	3	0	2	2	24	24	5	0	1	1	1	0	2	0	0	0	0	0	0
2001	1	3	0	2	2	25	25	5	0	0	0	3	1	1	0	0	0	0	0	0
2001	1	3	0	2	2	26	26	2	0	0	0	1	0	1	0	0	0	0	0	0
2001	1	3	0	2	2	28	28	5	0	0	0	2	2	1	0	0	0	0	0	0
2001	1	3	0	2	2	29	29	4	0	0	0	0	3	1	0	0	0	0	0	0
2001	1	3	0	2	2	30	30	2	0	0	0	1	1	0	0	0	0	0	0	0
2001	1	3	0	2	2	31	31	1	0	0	0	0	0	1	0	0	0	0	0	0

2002	1	3	0	2	2	13	13	1	1	0	0	0	0	0	0	0	0	0	0	0
2002	1	3	0	2	2	14	14	7	1	5	1	0	0	0	0	0	0	0	0	0
2002	1	3	0	2	2	15	15	15	3	12	0	0	0	0	0	0	0	0	0	0
2002	1	3	0	2	2	16	16	24	3	17	4	0	0	0	0	0	0	0	0	0
2002	1	3	0	2	2	17	17	34	0	19	14	1	0	0	0	0	0	0	0	0
2002	1	3	0	2	2	18	18	46	0	15	19	12	0	0	0	0	0	0	0	0
2002	1	3	0	2	2	19	19	44	0	10	21	10	3	0	0	0	0	0	0	0
2002	1	3	0	2	2	20	20	28	0	6	14	5	2	1	0	0	0	0	0	0
2002	1	3	0	2	2	21	21	37	0	3	22	7	3	1	1	0	0	0	0	0
2002	1	3	0	2	2	22	22	36	0	1	13	13	8	0	1	0	0	0	0	0
2002	1	3	0	2	2	23	23	35	0	0	13	13	7	2	0	0	0	0	0	0
2002	1	3	0	2	2	24	24	29	0	1	3	9	12	1	2	1	0	0	0	0
2002	1	3	0	2	2	25	25	30	0	0	9	11	5	4	1	0	0	0	0	0
2002	1	3	0	2	2	26	26	23	0	0	2	8	10	2	1	0	0	0	0	0
2002	1	3	0	2	2	27	27	15	0	0	1	6	7	0	1	0	0	0	0	0
2002	1	3	0	2	2	28	28	12	0	0	0	0	9	2	1	0	0	0	0	0
2002	1	3	0	2	2	29	29	8	0	0	0	0	6	0	2	0	0	0	0	0
2002	1	3	0	2	2	30	30	4	0	0	0	0	4	0	0	0	0	0	0	0
2002	1	3	0	2	2	31	31	4	0	0	0	0	1	2	1	0	0	0	0	0
2002	1	3	0	2	2	32	32	1	0	0	0	0	0	0	1	0	0	0	0	0
2003	1	3	0	2	2	13	13	2	2	0	0	0	0	0	0	0	0	0	0	0
2003	1	3	0	2	2	14	14	22	14	8	0	0	0	0	0	0	0	0	0	0
2003	1	3	0	2	2	15	15	54	9	43	2	0	0	0	0	0	0	0	0	0
2003	1	3	0	2	2	16	16	61	2	40	16	3	0	0	0	0	0	0	0	0
2003	1	3	0	2	2	17	17	75	5	28	36	6	0	0	0	0	0	0	0	0
2003	1	3	0	2	2	18	18	62	4	19	28	10	1	0	0	0	0	0	0	0
2003	1	3	0	2	2	19	19	54	1	9	28	16	0	0	0	0	0	0	0	0
2003	1	3	0	2	2	20	20	47	1	12	21	10	3	0	0	0	0	0	0	0
2003	1	3	0	2	2	21	21	30	0	4	11	8	3	4	0	0	0	0	0	0
2003	1	3	0	2	2	22	22	38	0	7	15	7	6	3	0	0	0	0	0	0
2003	1	3	0	2	2	23	23	29	0	4	11	6	5	3	0	0	0	0	0	0

2003	1	3	0	2	2	24	24	23	0	1	9	5	5	1	1	1	0	0	0	0
2003	1	3	0	2	2	25	25	23	0	0	8	7	3	4	1	0	0	0	0	0
2003	1	3	0	2	2	26	26	22	0	0	6	7	2	5	2	0	0	0	0	0
2003	1	3	0	2	2	27	27	12	0	0	0	6	4	2	0	0	0	0	0	0
2003	1	3	0	2	2	28	28	18	0	0	0	3	4	9	1	0	1	0	0	0
2003	1	3	0	2	2	29	29	7	0	0	0	3	1	1	2	0	0	0	0	0
2003	1	3	0	2	2	30	30	8	0	0	0	0	0	5	2	1	0	0	0	0
2003	1	3	0	2	2	31	31	4	0	0	0	0	0	3	1	0	0	0	0	0
2004	1	3	0	2	2	13	13	1	0	1	0	0	0	0	0	0	0	0	0	0
2004	1	3	0	2	2	14	14	8	0	8	0	0	0	0	0	0	0	0	0	0
2004	1	3	0	2	2	15	15	11	0	11	0	0	0	0	0	0	0	0	0	0
2004	1	3	0	2	2	16	16	27	4	14	9	0	0	0	0	0	0	0	0	0
2004	1	3	0	2	2	17	17	24	2	8	13	1	0	0	0	0	0	0	0	0
2004	1	3	0	2	2	18	18	36	2	15	14	5	0	0	0	0	0	0	0	0
2004	1	3	0	2	2	19	19	31	0	13	13	4	1	0	0	0	0	0	0	0
2004	1	3	0	2	2	20	20	24	1	7	8	5	2	1	0	0	0	0	0	0
2004	1	3	0	2	2	21	21	14	0	3	9	1	1	0	0	0	0	0	0	0
2004	1	3	0	2	2	22	22	21	0	2	13	5	0	1	0	0	0	0	0	0
2004	1	3	0	2	2	23	23	22	0	4	5	8	5	0	0	0	0	0	0	0
2004	1	3	0	2	2	24	24	27	0	5	6	4	7	4	0	1	0	0	0	0
2004	1	3	0	2	2	25	25	28	0	2	1	9	11	1	3	1	0	0	0	0
2004	1	3	0	2	2	26	26	17	0	0	2	9	4	0	2	0	0	0	0	0
2004	1	3	0	2	2	27	27	19	0	0	1	3	8	1	5	1	0	0	0	0
2004	1	3	0	2	2	28	28	16	0	0	0	1	9	3	2	1	0	0	0	0
2004	1	3	0	2	2	29	29	6	0	0	0	1	2	1	2	0	0	0	0	0
2004	1	3	0	2	2	30	30	6	0	0	1	0	3	0	2	0	0	0	0	0
2004	1	3	0	2	2	31	31	3	0	0	0	0	0	0	1	1	1	0	0	0
2005	1	3	0	2	2	13	13	2	2	0	0	0	0	0	0	0	0	0	0	0
2005	1	3	0	2	2	14	14	3	2	1	0	0	0	0	0	0	0	0	0	0
2005	1	3	0	2	2	15	15	2	2	0	0	0	0	0	0	0	0	0	0	0
2005	1	3	0	2	2	16	16	4	1	2	0	1	0	0	0	0	0	0	0	0

2005	1	3	0	2	2	17	17	14	0	9	3	1	1	0	0	0	0	0	0	0
2005	1	3	0	2	2	18	18	8	0	3	3	2	0	0	0	0	0	0	0	0
2005	1	3	0	2	2	19	19	6	0	1	4	1	0	0	0	0	0	0	0	0
2005	1	3	0	2	2	20	20	1	0	0	1	0	0	0	0	0	0	0	0	0
2005	1	3	0	2	2	21	21	3	0	0	1	1	0	0	1	0	0	0	0	0
2005	1	3	0	2	2	22	22	3	0	0	3	0	0	0	0	0	0	0	0	0
2005	1	3	0	2	2	23	23	1	0	0	0	1	0	0	0	0	0	0	0	0
2005	1	3	0	2	2	24	24	4	0	0	2	1	0	0	0	1	0	0	0	0
2005	1	3	0	2	2	25	25	4	0	0	2	0	0	1	0	0	1	0	0	0
2005	1	3	0	2	2	26	26	2	0	0	0	0	0	1	1	0	0	0	0	0
2005	1	3	0	2	2	28	28	1	0	0	0	0	0	1	0	0	0	0	0	0
2006	1	3	0	2	2	14	14	1	0	1	0	0	0	0	0	0	0	0	0	0
2006	1	3	0	2	2	15	15	13	1	9	3	0	0	0	0	0	0	0	0	0
2006	1	3	0	2	2	16	16	28	0	7	15	6	0	0	0	0	0	0	0	0
2006	1	3	0	2	2	17	17	17	0	8	4	5	0	0	0	0	0	0	0	0
2006	1	3	0	2	2	18	18	14	0	7	6	1	0	0	0	0	0	0	0	0
2006	1	3	0	2	2	19	19	6	0	0	2	4	0	0	0	0	0	0	0	0
2006	1	3	0	2	2	20	20	12	0	0	5	6	1	0	0	0	0	0	0	0
2006	1	3	0	2	2	21	21	16	0	4	8	2	2	0	0	0	0	0	0	0
2006	1	3	0	2	2	22	22	7	0	0	4	1	1	1	0	0	0	0	0	0
2006	1	3	0	2	2	23	23	6	0	0	3	2	0	1	0	0	0	0	0	0
2006	1	3	0	2	2	24	24	7	0	0	0	5	1	1	0	0	0	0	0	0
2006	1	3	0	2	2	25	25	9	0	0	0	3	1	3	1	1	0	0	0	0
2006	1	3	0	2	2	26	26	3	0	0	0	2	0	1	0	0	0	0	0	0
2007	1	3	0	2	2	15	15	12	0	10	2	0	0	0	0	0	0	0	0	0
2007	1	3	0	2	2	16	16	23	0	11	6	6	0	0	0	0	0	0	0	0
2007	1	3	0	2	2	17	17	26	0	3	7	13	2	1	0	0	0	0	0	0
2007	1	3	0	2	2	18	18	35	0	1	14	14	5	1	0	0	0	0	0	0
2007	1	3	0	2	2	19	19	41	0	7	7	13	7	6	1	0	0	0	0	0
2007	1	3	0	2	2	20	20	22	0	0	3	8	8	3	0	0	0	0	0	0
2007	1	3	0	2	2	21	21	15	0	1	2	4	5	2	1	0	0	0	0	0

2007	1	3	0	2	2	22	22	6	0	0	0	1	2	3	0	0	0	0	0	0
2007	1	3	0	2	2	23	23	11	0	0	2	2	4	2	1	0	0	0	0	0
2007	1	3	0	2	2	24	24	9	0	0	0	1	5	3	0	0	0	0	0	0
2007	1	3	0	2	2	25	25	5	0	0	0	2	1	1	0	0	1	0	0	0
2007	1	3	0	2	2	26	26	2	0	0	0	0	1	0	1	0	0	0	0	0
2008	1	3	0	2	2	11	11	1	0	1	0	0	0	0	0	0	0	0	0	0
2008	1	3	0	2	2	12	12	1	1	0	0	0	0	0	0	0	0	0	0	0
2008	1	3	0	2	2	13	13	2	2	0	0	0	0	0	0	0	0	0	0	0
2008	1	3	0	2	2	14	14	22	10	11	0	1	0	0	0	0	0	0	0	0
2008	1	3	0	2	2	15	15	28	3	23	0	2	0	0	0	0	0	0	0	0
2008	1	3	0	2	2	16	16	31	0	25	4	2	0	0	0	0	0	0	0	0
2008	1	3	0	2	2	17	17	52	3	28	12	9	0	0	0	0	0	0	0	0
2008	1	3	0	2	2	18	18	50	0	21	14	9	5	1	0	0	0	0	0	0
2008	1	3	0	2	2	19	19	46	2	17	7	10	2	7	1	0	0	0	0	0
2008	1	3	0	2	2	20	20	43	1	8	10	9	10	4	1	0	0	0	0	0
2008	1	3	0	2	2	21	21	31	0	5	7	10	7	1	1	0	0	0	0	0
2008	1	3	0	2	2	22	22	16	0	1	5	6	3	1	0	0	0	0	0	0
2008	1	3	0	2	2	23	23	22	0	6	4	4	6	1	1	0	0	0	0	0
2008	1	3	0	2	2	24	24	13	0	0	3	5	2	2	1	0	0	0	0	0
2008	1	3	0	2	2	25	25	13	0	0	1	4	4	3	1	0	0	0	0	0
2008	1	3	0	2	2	26	26	8	0	1	1	0	3	1	1	1	0	0	0	0
2008	1	3	0	2	2	27	27	9	0	0	3	5	0	1	0	0	0	0	0	0
2008	1	3	0	2	2	28	28	8	0	0	0	0	2	4	1	1	0	0	0	0
2008	1	3	0	2	2	29	29	1	0	0	0	0	0	1	0	0	0	0	0	0
2008	1	3	0	2	2	30	30	1	0	0	1	0	0	0	0	0	0	0	0	0
2008	1	3	0	2	2	31	31	3	0	0	0	0	0	0	2	1	0	0	0	0
2008	1	3	0	2	2	32	32	1	0	0	0	0	0	0	1	0	0	0	0	0
2009	1	3	0	2	2	14	14	5	0	5	0	0	0	0	0	0	0	0	0	0
2009	1	3	0	2	2	15	15	8	0	7	1	0	0	0	0	0	0	0	0	0
2009	1	3	0	2	2	16	16	17	0	9	5	3	0	0	0	0	0	0	0	0
2009	1	3	0	2	2	17	17	11	0	4	5	2	0	0	0	0	0	0	0	0

2009	1	3	0	2	2	18	18	23	0	2	12	7	1	1	0	0	0	0	0	0
2009	1	3	0	2	2	19	19	16	0	1	3	8	2	2	0	0	0	0	0	0
2009	1	3	0	2	2	20	20	13	0	2	0	6	2	3	0	0	0	0	0	0
2009	1	3	0	2	2	21	21	2	0	0	0	2	0	0	0	0	0	0	0	0
2009	1	3	0	2	2	22	22	5	0	0	1	1	3	0	0	0	0	0	0	0
2009	1	3	0	2	2	24	24	1	0	0	0	1	0	0	0	0	0	0	0	0
2009	1	3	0	2	2	26	26	4	0	0	2	0	0	1	0	1	0	0	0	0
2009	1	3	0	2	2	27	27	3	0	0	0	0	3	0	0	0	0	0	0	0
2009	1	3	0	2	2	28	28	1	0	0	0	1	0	0	0	0	0	0	0	0
2009	1	3	0	2	2	29	29	2	0	0	0	0	1	0	1	0	0	0	0	0
2009	1	3	0	2	2	30	30	1	0	0	0	0	0	0	1	0	0	0	0	0
2009	1	3	0	2	2	31	31	1	0	0	0	0	0	0	1	0	0	0	0	0
2010	1	3	0	2	2	13	13	1	1	0	0	0	0	0	0	0	0	0	0	0
2010	1	3	0	2	2	14	14	3	1	2	0	0	0	0	0	0	0	0	0	0
2010	1	3	0	2	2	15	15	4	0	4	0	0	0	0	0	0	0	0	0	0
2010	1	3	0	2	2	16	16	10	3	5	1	1	0	0	0	0	0	0	0	0
2010	1	3	0	2	2	17	17	14	3	3	6	1	1	0	0	0	0	0	0	0
2010	1	3	0	2	2	18	18	25	0	12	8	3	2	0	0	0	0	0	0	0
2010	1	3	0	2	2	19	19	26	0	3	7	9	2	4	1	0	0	0	0	0
2010	1	3	0	2	2	20	20	20	0	0	4	8	4	2	2	0	0	0	0	0
2010	1	3	0	2	2	21	21	23	0	2	10	4	3	0	2	1	1	0	0	0
2010	1	3	0	2	2	22	22	19	0	0	6	6	3	2	0	1	1	0	0	0
2010	1	3	0	2	2	23	23	17	0	2	1	8	2	2	1	1	0	0	0	0
2010	1	3	0	2	2	24	24	14	0	0	1	5	1	5	2	0	0	0	0	0
2010	1	3	0	2	2	25	25	19	0	0	0	4	4	4	5	2	0	0	0	0
2010	1	3	0	2	2	26	26	7	0	0	1	2	1	1	2	0	0	0	0	0
2010	1	3	0	2	2	27	27	14	0	0	3	6	2	2	0	0	1	0	0	0
2010	1	3	0	2	2	28	28	6	0	0	0	2	1	3	0	0	0	0	0	0
2010	1	3	0	2	2	29	29	4	0	0	0	1	1	1	0	0	1	0	0	0
2010	1	3	0	2	2	30	30	2	0	0	0	0	1	0	0	1	0	0	0	0
2010	1	3	0	2	2	31	31	1	0	0	1	0	0	0	0	0	0	0	0	0

2010	1	3	0	2	2	33	33	1	0	0	0	0	0	1	0	0	0	0	0	0
2011	1	3	0	2	2	13	13	2	1	1	0	0	0	0	0	0	0	0	0	0
2011	1	3	0	2	2	14	14	19	1	18	0	0	0	0	0	0	0	0	0	0
2011	1	3	0	2	2	15	15	36	1	33	1	1	0	0	0	0	0	0	0	0
2011	1	3	0	2	2	16	16	41	0	35	3	2	1	0	0	0	0	0	0	0
2011	1	3	0	2	2	17	17	30	1	21	4	3	1	0	0	0	0	0	0	0
2011	1	3	0	2	2	18	18	33	0	13	7	8	3	2	0	0	0	0	0	0
2011	1	3	0	2	2	19	19	29	0	2	6	10	8	3	0	0	0	0	0	0
2011	1	3	0	2	2	20	20	20	0	6	2	4	7	1	0	0	0	0	0	0
2011	1	3	0	2	2	21	21	12	0	0	2	4	4	2	0	0	0	0	0	0
2011	1	3	0	2	2	22	22	15	0	2	2	2	6	3	0	0	0	0	0	0
2011	1	3	0	2	2	23	23	6	0	0	3	1	0	2	0	0	0	0	0	0
2011	1	3	0	2	2	24	24	9	0	0	1	1	2	5	0	0	0	0	0	0
2011	1	3	0	2	2	25	25	9	0	0	1	1	2	4	1	0	0	0	0	0
2011	1	3	0	2	2	26	26	1	0	0	0	0	0	0	1	0	0	0	0	0
2011	1	3	0	2	2	27	27	7	0	0	0	3	2	1	1	0	0	0	0	0
2011	1	3	0	2	2	28	28	4	0	0	0	0	1	1	1	0	1	0	0	0
2011	1	3	0	2	2	29	29	4	0	0	0	0	3	0	1	0	0	0	0	0
2011	1	3	0	2	2	30	30	1	0	0	0	0	1	0	0	0	0	0	0	0
2011	1	3	0	2	2	31	31	1	0	0	0	0	0	0	1	0	0	0	0	0

Appendix C. Starter File used in SS "Starter.SS"

```
## Stock Synthesis Version 3.24h
#
Span_dat.SS
span_ctl_RDM.SS
0 # 0=use init values in control file; 1=use ss3.par
1 # run display detail (0,1,2)
1 # detailed age-structured reports in REPORT.SSO (0,1)
1 # write detailed checkup.sso file (0,1)
1 # write parm values to ParmTrace.sso
2 # report level in CUMREPORT.SSO (0,1,2)
0 # Include prior_like for non-estimated parameters (0,1)
1 # Use Soft Boundaries to aid convergence
1 # Number of bootstrap datafiles to produce
7 # Turn off estimation for parameters entering after this phase
1000 # MCMC burn interval
100  # MCMC thin interval
0  # jitter initial parm value by this fraction
-1 # min yr for sdreport outputs (-1 for styr)
-2 # max yr for sdreport outputs (-1 for endyr; -2 for endyr+Nforecastyrs
0 # N individual STD years
0.0001 # final convergence criteria
0 # retrospective year relative to end year
1 # min age for calc of summary biomass
2 # Depletion basis:  denom is: 0=skip; 1=rel X*B0; 2=rel X*Bmsy; 3=rel X*B_styr
1.00 # Fraction (X) for Depletion denominator
4 # (1-SPR)_reporting:  0=skip; 1=rel(1-SPR); 2=rel(1-SPR_MSY); 3=rel(1-SPR_Btarget); 4=notrel
1 # F_std reporting: 0=skip; 1=exploit(Bio); 2=exploit(Num); 3=sum(frates)
2 # F_report_basis: 0=raw; 1=rel Fspr; 2=rel Fmsy ; 3=rel Fbtgt
999
```

Appendix D. Input Forecast File used in SS "Forecast.SS"

```
#V3.24h
#C generic forecast file
# for all year entries except rebuilder; enter either: actual year, -999 for styr, 0 for endyr, neg number for rel.endyr

1 # Benchmarks: 0=skip; 1=calc F_spr,F_btgt,F_msy
2 # MSY: 1= set to F(SPR); 2=calc F(MSY); 3=set to F(Btgt); 4=set to F(endyr)
0.3 # SPR target (e.g. 0.40)
0.3 # Biomass target (e.g. 0.40)
#_Bmark_years: beg_bio, end_bio, beg_selex, end_selex, beg_relF, end_relF (enter actual year, or values of 0 or -integer to be rel.
endyr)
0 0 -5 0 0 0 #this was njc setup as of October 10- tilefish below
#0 0 0 0 -2 0  #one from tilefish
# 2001 2001 2001 2001 2001 2001 # after processing
1 #Bmark_relF_Basis: 1 = use year range; 2 = set relF same as forecast below
#
2 # Forecast: 0=none; 1=F(SPR); 2=F(MSY) 3=F(Btgt); 4=Ave F (uses first-last relF yrs); 5=input annual F scalar
10 # N forecast years
0.2 # F scalar (only used for Do_Forecast==5)
#_Fcast_years: beg_selex, end_selex, beg_relF, end_relF (enter actual year, or values of 0 or -integer to be rel.endyr)
-5 0 -2 0  #this also changed back
# 2001 2001 1991 2001 # after processing
2     # Control rule method (1=catch=f(SSB) west coast; 2=F=f(SSB) )
0.01  # Control rule Biomass level for constant F (as frac of Bzero, e.g. 0.40)
0.005 # Control rule Biomass level for no F (as frac of Bzero, e.g. 0.10)
1.0   # Control rule target as fraction of Flimit (e.g. 0.75)#njc had it set to 0.75 for the Foy projection
3 #_N forecast loops (1-3) (fixed at 3 for now)
3 #_First forecast loop with stochastic recruitment
0 #_Forecast loop control #3 (reserved for future bells&whistles)
0 #_Forecast loop control #4 (reserved for future bells&whistles)
0 #_Forecast loop control #5 (reserved for future bells&whistles)
2012 #FirstYear for caps and allocations (should be after years with fixed inputs)
0 # stddev of log(realized catch/target catch) in forecast (set value>0.0 to cause active impl_error)
0 # Do West Coast gfish rebuilder output (0/1)
2012 # Rebuilder: first year catch could have been set to zero (Ydecl)(-1 to set to 1999)
2013 # Rebuilder: year for current age structure (Yinit) (-1 to set to endyear+1)
1 # fleet relative F: 1=use first-last alloc year; 2=read seas(row) x fleet(col) below
# Note that fleet allocation is used directly as average F if Do_Forecast=4
2 # basis for fcast catch tuning and for fcast catch caps and allocation (2=deadbio; 3=retainbio; 5=deadnum;6=retainnum)
#       Conditional input if relative F choice = 2
# Fleet relative F: rows are seasons, columns are fleets
#_Fleet: FISHERY1
# 1
# max totalcatch by fleet (-1 to have no max)
-1  -1 -1 -1
# max totalcatch by area (-1 to have no max)
-1
# fleet assignment to allocation group (enter group ID# for each fleet, 0 for not included in an alloc group)
0 0 0 0
```

```
#_Conditional on >1 allocation group
# allocation fraction for each of: 0 allocation groups
# no allocation groups
0 # Number of forecast catch levels to input (else calc catch from forecast F)
#Nancie total directed retained catch in 2011 was 1479.834969 mtons
2 # basis for input Fcast catch: 2=dead catch; 3=retained catch; 99=input Hrate(F) (units are from fleetunits; note new codes in
SSV3.20)
# Input fixed catch values
#Year Seas Fleet Catch(or_F)
#
999 # verify end of input
```

Appendix E. Control File used in SS "span_dat.SS"

```
#
#Gulf of Mexico Spanish Mackerel Full model control file
#_data_and_control_files: span.dat    //      span.ctl

#SS -V3.24h October 17 2012; Stock Synthiesis_by_Richard_Method
1 #_N_Growth_Patterns
1 #_N_Morphs_Within_GrowthPattern
#_Cond 1 #_Morph_between/within_stdev_ratio (no read if N_morphs=1)
#_Cond  1 #vector_Morphdist_(-1_in_first_val_gives_normal_approx)
#
#_Cond 0  #  N recruitment designs goes here if N_GP*nseas*area>1
#_Cond 0  #  placeholder for recruitment interaction request
#_Cond 1 1 1  # example recruitment design element for GP=1, seas=1, area=1
#
#_Cond 0 # N_movement_definitions goes here if N_areas > 1
#_Cond 1.0 # first age that moves (real age at begin of season, not integer) also cond on do_migration>0
#_Cond 1 1 1 2 4 10 # example move definition for seas=1, morph=1, source=1 dest=2, age1=4, age2=10
#
2 #_Nblock_Patterns
2 2 #_Cond 0 #_blocks_per_pattern
1886 2005 2006 2011 # begin and end years of block pattern 2 blocks 1 and 2, for gillnet fishery
1886   1992   1993   2011 # begin and end years of blocks - 1993 size limit, USING ONLY TIME BLOCK FOR COM AND REC SEL
#
0.5 #_fracfemale
3 #_natM_type:_0=1Parm; 1=N_breakpoints;_2=Lorenzen;_3=agespecific;_4=agespec_withseasinterpolate
0.40   0.56   0.47   0.41   0.38   0.36   0.35   0.34   0.33   0.32   0.32   0.32 # age specific Lorenzen M, estimated assuming
M=0.38, ref age = 4
#4 #_no additional input for selected M option; read 1P per morph
1 # GrowthModel: 1=vonBert with L1&L2; 2=Richards with L1&L2; 3=not implemented; 4=not implemented
0.5 #_Growth_Age_for_L1
999 #_Growth_Age_for_L2 (999 to use as Linf)
0 #_SD_add_to_LAA (set to 0.1 for SS2 V1.x compatibility)
2 #_CV_Growth_Pattern:  0 CV=f(LAA); 1 CV=F(A); 2 SD=F(LAA); 3 SD=F(A)
1 #_maturity_option:  1=length logistic; 2=age logistic; 3=read age-maturity matrix by growth_pattern; 4=read age-fecundity; 5=read
fec and wt from wtatage.ss
#_placeholder for empirical age-maturity by growth pattern
1 #_First_Mature_Age
1 #_fecundity option:(1)eggs=Wt*(a+b*Wt);(2)eggs=a*L^b;(3)eggs=a*Wt^b
0 #_hermaphroditism option:  0=none; 1=age-specific fxn
1 #_parameter_offset_approach (1=none, 2= M, G, CV_G as offset from female-GP1, 3=like SS2 V1.x)
2 #_env/block/dev_adjust_method (1=standard; 2=logistic transform keeps in base parm bounds; 3=standard w/ no bound check)
#
#_growth_parms
#_LO          HI        INIT        PRIOR  PR_type   SD      PHASE env-var use_dev dev_minyr dev_maxyr dev_stddev  Block Block_Fxn
#0.1          0.7        0.3          0.3     -1      99       -3       0       0       0         0         0          0       0
       # NatM_p_1_Fem_GP_1
```

```
2            30         10           10      -1      5          3       0       0       0         0          0.5        0       0
       # L_at_Amin_Fem_GP_1
40           90         56           56      -1      5          6       0       0       0         0          0.5        0       0
       # L_at_Amax_Fem_GP_1
0.1          1.2        0.61       0.61      -1      0.2        6       0       0       0         0          0.5        0       0
       # VonBert_K_Fem_GP_1

0.001        20         10          10       -1      99         7       0       0       0         0          0.5        0       0
       # CV_young_Fem_GP_1
0.001        45         10          10       -1      99         7       0       0       0         0          0.5        0       0
       # CV_old_Fem_GP_1


0.1           1       1.50E-05     1.50E-05  -1     0.8       -2       0       0       0         0          0.5         0       0
       # Wtlen_1_Fem  # WAS 1.1519E-05 FROM LITERATURE
2             4        2.8617       2.8617   -1     0.8       -2       0       0       0         0          0.5         0       0
       # Wtlen_2_Fem  # WAS 2.856 FROM LITERATURE
#      making  all     fish    mature
25          100         31            31     -1     0.8       -3       0       0       0         0          0           0       0 #
Mat50%_Fem
-1            0        -0.065       -0.065   -1     0.8       -3       0       0       0         0          0           0       0 #
Mat_slope_Fem
-3            3          1             1     -1     0.8       -3       0       0       0         0          0           0       0 #
Eg/kg_inter_Fem
-3            3          0             0     -1     0.8       -3       0       0       0         0          0           0       0 #
Eg/kg_slope_wt_Fem
 0            0          0             0     -1     0         -4       0       0       0         0          0           0       0 #
RecrDist_GP_1
 0            0          0             0     -1     0         -4       0       0       0         0          0           0       0 #
RecrDist_Area_1
 0            0          0             0     -1     0         -4       0       0       0         0          0           0       0 #
RecrDist_Seas_1
 0            0          0             0     -1     0         -4       0       0       0         0          0           0       0 #
CohortGrowDev
#
#_Cond 0  #custom_MG-env_setup (0/1)
#_Cond -2 2 0 0 -1 99 -2 #_placeholder when no MG-environ parameters
#
#_Cond 0  #custom_MG-block_setup (0/1)
#_Cond -2 2 0 0 -1 99 -2 #_placeholder when no MG-block parameters
#_Cond No MG parm trends
#
#_seasonal_effects_on_biology_parms
 0 0 0 0 0 0 0 0 0 0 #_femwtlen1,femwtlen2,mat1,mat2,fec1,fec2,Malewtlen1,malewtlen2,L1,K
#_Cond -2 2 0 0 -1 99 -2 #_placeholder when no seasonal MG parameters
#
#_Cond -4 #_MGparm_Dev_Phase

#_Spawner-Recruitment
3 #_SR_function
#_LO    HI      INIT    PRIOR   PR_type   SD     PHASE
```

```
1       20      10      10     -1       99       4      # SR_R0  #_RDM  start with larger value
#==================================================================================
#0.2     0.99    0.27    0.60    -1       99      -2      # SR_steep FOR PROFILING
#0.2     0.99    0.27    0.60    -1       99      -2      # SR_steep uniform/none
#0.2     0.99    0.8     0.80     0       0.80    -2      # SR_steep normal
#0.2     1       0.21445 0.60     2       2.5     -2      # SR_steep Full beta
#0.2     1       0.21445 0.60    -1       2.5     -2      # SR_steep symetrical beta
0.2      1       0.7     0.7     -1       2.5      4      # SR_steep
#=====================================================================================
0        2       0.7     0.7     -1       0.8     -4       # SR_sigmaR
-5       5       0.1     0       -1       1       -3       # SR_envlink
-5       5       0       0       -1       1       -4       # SR_R1_offset
0        0       0       0       -1       0       -4       # SR_autocorr
0 #_SR_env_link
0 #_SR_env_target_0=none;1=devs;_2=R0;_3=steepness
1 #do_recdev:  0=none; 1=devvector; 2=simple deviations
1985 # first year of main recr_devs; early devs can preceed this era
2011 # last year of main recr_devs; forecast devs start in following year
3 #_recdev phase

#0# (0/1) to read 13 advanced options
1 # (0/1) to read 13 advanced options
0 #_recdev_early_start (0=none; neg value makes relative to recdev_start)
-4 #_recdev_early_phase
0 #_forecast_recruitment phase (incl. late recr) (0 value resets to maxphase+1)
1 #_lambda for Fcast_recr_like occurring before endyr+1
1984 #_last_early_yr_nobias_adj_in_MPD
1985 #_first_yr_fullbias_adj_in_MPD
2008 #_last_yr_fullbias_adj_in_MPD
2012 #_first_recent_yr_nobias_adj_in_MPD
0.25 #_max_bias_adj_in_MPD (-1 to override ramp and set biasadj=1.0 for all estimated recdevs)
0 #_period of cycles in recruitment (N parms read below)
-5 #min rec_dev
5 #max rec_dev
0 #_read_recdevs
#_end of advanced SR options

#
#
#Fishing Mortality info
0.3 # F ballpark for tuning early phases
-2001 # F ballpark year (neg value to disable)
2 # F_Method:  1=Pope; 2=instan. F; 3=hybrid (hybrid is recommended)
2.9 # max F or harvest rate, depends on F_Method
# no additional F input needed for Fmethod 1
##################################################
# if Fmethod=2; read overall start F value; overall phase; N detailed inputs to read
0.05  # RDM recommended to change to 0.05 from .1- this section is on page 75 in manual (njc)
1
4
1 1886  1  0.005  0.05   1
```

```
2 1886  1  0.005  0.05   1
3 1955  1  0.005  0.05   1
4 1945  1  0.005  0.05   1
#####################################################
# if Fmethod=3; read N iterations for tuning for Fmethod 3
# 4  # N iterations for tuning F in hybrid method (recommend 3 to 7)

#_initial_F_parms
#_LO HI  INIT    PRIOR  PR_type SD  PHASE
 0    1   0.0      0.0    -1      99   -1 # InitF_1FISHERY1 COM_GN
 0    1   0.0      0.0    -1      99   -1 # InitF_1FISHERY2 COM_RR
 0    1   0.0      0.0    -1      99   -1 # InitF_1FISHERY3 REC
 0    1   0.0      0.0    -1      99   -1 # InitF_1FISHERY4 SHRIMP BYCATCH

#_Q_setup
 # A=do power, B=env-var, C=extra SD, D=devtype(<0=mirror, 0/1=none, 2=constant, 3=rand, 4=randwalk);
 #_A  B  C  D  E  F
 0 0 0 0  # 1 FISHERY1 COM_GN
 0 0 0 0  # 2 FISHERY2 COM_RR
 0 0 0 0  # 3 FISHERY3 REC
 0 0 0 2  # 4 FISHERY4 SHRIMP EFFORT

 0 0 0 0  # 1 SURVEY1  MRFSS
 0 0 0 0  # 2 SURVEY2  Headboat
 0 0 0 0  # 3 SURVEY3  Gillnet
 0 0 0 0  # 4 SURVEY4  FWC Vertical Line
 0 0 0 0  # 5 SURVEY5  SEAMAP Trawl

#
#_Cond 0 #_If q has random component, then 0=read one parm for each fleet with random q; 1=read a parm for each year of index
#_Q_parms(if_any)
# LO HI  INIT PRIOR  PR_type SD   PHASE
#-50 50 -13    0     -1       1    1   # Q_base_2_SURVEY5 SHRIMP EFFORT span
-10  20   1    0     -1       1    1   # Q_base_2_FISHERY1 cobia  #_RDM expanded range just in case

#_size_selex_types
#_Pattern Discard Male Special
  24 0 0 0 # 1 FISHERY1   COM_GN - double norm    ## discard code is 0 for GN since it is whole catch all are dead so only have
selectivy set
  24 2 0 0 # 2 FISHERY2   COM_RR - double normal  ## discard code is 2 for COM_RR = retained catch so read 4 retention and 4 discard
below
  24 2 0 0 # 3 FISHERY3   MRFSS  - logistic       ## discard code is 2 for REC = retained catch so read 4 retention and 4 discard
below
#  1 2 0 0 # 2 FISHERY2   COM_RR - logistic       ## discard code is 2 for COM_RR = retained catch so read 4 reention and 4 discard
below
#  1 2 0 0 # 3 FISHERY3   MRFSS  - logistic       ## discard code is 2 for REC = retained catch so read 4 retention and 4 discard
below
  24 3 0 0 # 4 FISHERY5   Shrimp Effort - double norm  #_RDM  change to option #1 because all are dead, change 2 by rdm, email to
Isely August 7 2012, change discard option to 3 per rdm

 5 0 0 3 # 1 SURVEY1 - MRFSS SURVEY mirror REC
```

```
 5 0 0 3 # 2 SURVEY2 - HB Survey mirror REC
 5 0 0 1 # 3 SURVEY3 - Gillnet Survey mirror COM_GN
 5 0 0 2 # 4 SURVEY4 - FWC Fish Ticket Vert Line mirror COM_RR
 5 0 0 4 # 5 SURVEY5 - SEAMAP Survey mirror Shrimp Bycatch
#
#_age_selex_types
#_Pattern ___ Male Special
 11 0 0 0 # 1 FISHERY1  COM_GN - double norm
 15 0 0 1 # 2 FISHERY2  COM_RR - logistic
 15 0 0 1 # 3 FISHERY3  MRFSS - logistic
 15 0 0 1 # 4 FISHERY4  Shrimp Effort - db norm

 15 0 0 1 # 1 SURVEY1  - MRFSS Survey
 15 0 0 1 # 2 SURVEY2  - HB  Survey
 15 0 0 1 # 3 SURVEY3  - Gillnet
 15 0 0 1 # 4 SURVEY4  - Vert Line
 15 0 0 1 # 5 SURVEY5  - SEAMAP

#_LENGTH SELEX PARMS
#####################################################################################################################################
#COM_GN / double normal
#LO    HI    INIT     PRIOR  PR_type    SD  PHASE env-var  use_dev dev_minyr dev_maxyr dev_stddev  Block_Pattern Block_Type
 20    70     45       45     -1        99     3      0       0       0         0        0.5           1        2  # PEAK  value
-20    20    -1.5     -1.5    -1        99     4      0       0       0         0        0.5           1        2  # TOP logistic
-20    15.0   5         5     -1        99     3      0       0       0         0        0.5           1        2  # WIDTH exp
-2     15     4         4     -1        99     2      0       0       0         0        0.5           1        2  # WIDTH exp
-1000   15       -999       -15        -1       99              -3         0         0       0        0             0.5
0             0       #       INIT    logistic

-1000   15       -999    -15    -1       99              -4         0         0      0        0             0.5              0
0      #      FINAL   logistic

#####################################################################################################################################
#COM_RR  / using double normal specified as logistic
#LO    HI    INIT     PRIOR  PR_type    SD  PHASE env-var  use_dev dev_minyr dev_maxyr dev_stddev  Block_Pattern Block_Type
10     70     55       55      -1       99     -3      0       0       0         0        0.5           0        0  # PEAK  value
RDM:  reduce max from 99 to reasonable value
-20    15     10      10       -1       99     -4      0       0       0         0        0.5           0        0  # TOP logistic
-20    12     6.1      2       -1       99      4      0       0       0         0        0.5           0        0  # WIDTH exp
-5     15.0  -4       -4       -1       99     -3      0       0       0         0        0.5           0        0  # WIDTH exp
-1000                  15      -999          -15         -1       99          -6       0       0      0        0             0.5
0             0       #       INIT    logistic

-15                   15             15                     15         -1       99          -6                 0           0      0
        0           0.5              0           0       #      FINAL   logistic

#
#COM_RR Retained Size
7      99    30       30      -1       99      -3       0       0       0        0         0.5           2        2  # P1 - inflection
-1     20    4.5    0.99      -1       99      -4       0       0       0        0         0.5           2        2  # P2 - slope
##njc changed to 0.99 fixed value to set knife edge
```

```
0.1    1   0.99   0.99    -1      99     -3      0      0      0       0        0.5         0        0  # P3 - asymptote -
use this to set non-selective mortality #_RDM allow estimate to get better fit to mean
-1     2   0      0       -1      99     -4      0      0      0       0        0.5         0        0  # P4 - male offset
to inflection (arithmetic, not multiplicative)
#
#COM_RR Release Mortality
-10    30    -4      -4    -1     99    -2      0      0      0       0        0.5          0        0  # P1 - inflection
-1     2      1       1    -1     99    -4      0      0      0       0        0.5          0        0  # P2 - slope
-1     2     0.1     0.1   -1     99    -2      0      0      0       0        0.5          0        0  # P3 - asymptote -
use this to set non-selective mortality
-1     2      0       0    -1     99    -4      0      0      0       0        0.5          0        0  # P4 - male offset
to inflection (arithmetic, not multiplicative)
#
##################################################################################################################################
#MRFSS / DOUBLE NORMAL SPECIFIED AS logistic
#LO    HI    INIT      PRIOR  PR_type   SD  PHASE env-var  use_dev dev_minyr dev_maxyr dev_stddev  Block_Pattern Block_Type
7      99     40        40      -1       99     3      0      0      0        0       0.5          0        0  # PEAK  value
-20    15     10        10      -1       99    -4      0      0      0        0       0.5          0        0  # TOP logistic
-10    12     6.6       2       -1       99     3      0      0      0        0       0.5          0        0  # WIDTH exp
-5     15     -4       -4       -1       99    -3      0      0      0        0       0.5          0        0  # WIDTH exp
-1000   15      -999      -15           -1      99    -6     0       0      0      0            0.5          0        0
#      INIT   logistic
-15      15      15        15           -1      99     -6     0       0      0      0            0.5            0        0
#      FINAL  logistic
#MRFSS Retained Size
7      99      30       30      -1        99    -3      0      0      0       0        0.5          2        2   # P1 -
inflection
-1     15      4.5      1       -1        99    -4      0      0      0       0        0.5          2        2   # P2 - slope
0.1    1     0.99      .99      -1        99    -3      0      0      0       0        0.5          0        0   # P3 - asymptote
- use this to set non-selective mortality #_RDM allow estimate to get better fit to mean
0      2       0        0       -1        99    -4      0      0      0       0        0.5          0        0   # P4 - male
offset to inflection (arithmetic, not multiplicative)
#
#MRFSS Released Mortality
-10   30     -4        -4       -1      99     -2      0      0      0       0        0.5          0        0    # P1 -
inflection
0     2       1         1       -1      99     -4      0      0      0       0        0.5          0        0    # P2 - slope
0     2     0.2       0.2       -1      99     -2      0      0      0       0        0.5          0        0    # P3 -
asymptote - use this to set non-selective mortality
-1    2       0         0       -1      99     -4      0      0      0       0        0.5          0        0    # P4 - male
offset to inflection (arithmetic, not multiplicative)
##################################################################################################################################
###
#Shrimp Bycatch / double normal
#LO    HI    INIT     PRIOR  PR_type SD  PHASE env-var  use_dev dev_minyr dev_maxyr dev_stddev  Block_Pattern Block_Type
 10    70     20       20       -1     99     3      0      0      0        0       0.5           0          0   # PEAK  value
-15     3    -12      -12       -1     99     4      0      0      0        0       0.5           0          0   # TOP logistic
-20    12    3.9      3.9       -1     99     3      0      0      0        0       0.5           0          0   # WIDTH exp
-2     12     5        5        -1     99     3      0      0      0        0       0.5           0          0   # WIDTH expS
-999   15   -999     -15        -1     99    -5      0      0      0        0       0.5           0          0   # WIDTH exp
```

```
-999   15   -999    -15        -1     99    -4      0       0       0         0        0.5              0          0   # FINAL
logistic
#Shrimp Retained
#1    30      4        4       -1      99    -2      0       0       0         0        0.5              0          0  # P1 -
inflection
#0    2       1        1       -1      99    -4      0       0       0         0        0.5              0          0  # P2 - slope
#0    1       0.0001   0.0001  -1      99    -2      0       0       0         0        0.5              0          0  # P3 - asymptote
- use this to set non-selective mortality
#0    2       0        0       -1      99    -4      0       0       0         0        0.5              0          0  # P4 - male
offset to inflection (arithmetic, not multiplicative)
#
#############################################################################################################################
# Size Selex MIRRORS For the Surveys
#_LO   HI  INIT PRIOR PR_type  SD   PHASE env-var use_dev dev_minyr dev_maxyr dev_stddev Block Block_Fxn
 1     49    1    1    -1     99     -2   0 0 0 0 0 0 0 # SizeSel_1P_1_FISHERY3 MRFSS Survey mirror fishery 3 REC
 1     49    49   49   -1     99     -2   0 0 0 0 0 0 0 # SizeSel_1P_2_FISHERY3 MRFSS Survey mirror fishery 3 REC
 1     49    1    1    -1     99     -2   0 0 0 0 0 0 0 # SizeSel_1P_1_FISHERY3 Hboat Survery mirror fishery 3 REC
 1     49    49   49   -1     99     -2   0 0 0 0 0 0 0 # SizeSel_1P_2_FISHERY3 Hboat Survey mirror fishery 3 REC
 1     49    1    1    -1     99     -2   0 0 0 0 0 0 0 # SizeSel_1P_1_FISHERY1 Gillnet index, mirror fishery 1
 1     49    49   49   -1     99     -2   0 0 0 0 0 0 0 # SizeSel_1P_2_FISHERY1 Gillnet index, mirror fishery 1
 1     49    1    1    -1     99     -2   0 0 0 0 0 0 0 # SizeSel_1P_1_FISHERY2 Vertical Line, mirror fishery 2
 1     49    49   49   -1     99     -2   0 0 0 0 0 0 0 # SizeSel_1P_2_FISHERY2 Vertical Line, mirror fishery 2
 1     49    1    1    -1     99     -2   0 0 0 0 0 0 0 # SizeSel_1P_1_FISHERY4 SEAMAP index, mirror fishery 4
 1     49    49   49   -1     99     -2   0 0 0 0 0 0 0 # SizeSel_1P_2_FISHERY4 SEAMAP index, mirror fishery 4
#################################################################################################################################
####
# AGE Selex
 0     12     0     0    -1     99     -1   0 0 0 0 0 0 0 # AgeSel_1P_1_FISHERY1
 0     12    12    12    -1     99     -1   0 0 0 0 0 0 0 # AgeSel_1P_2_FISHERY1
#_Cond 0 #_custom_sel-env_setup (0/1)
#_Cond -2 2 0 0 -1 99 -2 #_placeholder when no enviro fxns
1 #_Cond 0 #_custom_sel-blk_setup (0/1)
#COM_GN FLEET 1 SELECTIVITY/ double normal
#LO    HI    INIT     PRIOR  PR_type    SD  PHASE
20     70     45       45     -1        99     3    # P1  PEAK  value PRE 2006
20     70     45       45     -1        99     3    # P1  PEAK  value  2006+
-20    20    -1.5     -1.5    -1        99     4    # P2  TOP logistic PRE 2006
-20    20    -1.5     -1.5    -1        99     4    # P2  TOP logistic 2006+
-20    15.0   5         5     -1        99     3    # P3  WIDTH exp  PRE 2006
-20    15.0   5         5     -1        99     3    # P3  WIDTH exp  2006+
-2     15     4         4     -1        99     4    # P4  WIDTH exp  PRE 2006
-2     15     4         4     -1        99     4    # P4  WIDTH exp  2006+
#Commercial RR Retention - Pre and Post 1993 Size limit
7              99      26       26       -1 99    3        #      P1     -      inflection pre size limit
7              55   30.5       30.5     -1  99    3        #      P1     -      inflection post size limit
0.005   30      0.05  0.05       -1   99      -6       #     P2     -      slope_block1 pre size limit   #njc changed  min and init
value to 0.05 from 5.5
0.005   30   0.05       0.05      -1   99    6   #     P2     -      slope_block2 post size limit   #njc changed  min and init value to
0.05 from 5.5, then to 0.1
#Recreational Retention - Pre and Post 1993 Size limit
7               75   26          26    -1   99       3      #     P1     -      inflection pre size limit
```

```
7               55    30.5   30.5    -1    99       3      #     P1      -      inflection post size limit
0.005  30  2.05   0.05   -1   99       6    #      P2      -      slope_block1 pre size limit    #njc changed  min and init value to
0.05 from 2.05
0.005  30      2.05    0.05   -1    99       6      #     P2      -      slope_block2 post size limit   #njc changed  min and init
value to 0.05 from 2.05
#_Cond -2 2 0 0 -1 99 -2 #_placeholder when no block usage
#_Cond No selex parm trends
#_Cond -4 # placeholder for selparm_Dev_Phase
1      #_Cond 0 #_env/block/dev_adjust_method (1=standard; 2=logistic trans to keep in base parm bounds; 3=standard w/ no bound check)
#
# Tag loss and Tag reporting parameters go next
0  # TG_custom:  0=no read; 1=read if tags exist
#_Cond -6 6 1 1 2 0.01 -4 0 0 0 0 0 0 0  #_placeholder if no parameters
#
1 #_Variance_adjustments_to_input_values
0      0      0      0 0 0 0 0 0 #_add_to_survey_CV
0      0      0      0      0      0      0      0      0      #_add_to_discard_stddev
0      0      0      0      0      0      0      0      0      #_add_to_bodywt_CV
1 1 1 1 1 1 1  1      1      #_mult_by_lencomp_N
1      1      1      1      1      1      1      1      1      #_mult_by_agecomp_N
1      1      1      1      1      1      1      1      1      #_mult_by_size-at-age
#
1 #_maxlambdaphase
1 #_sd_offset
#
0 # number of changes to make to default Lambdas (default value is 1.0)
# Like_comp codes:  1=surv; 2=disc; 3=mnwt; 4=length; 5=age; 6=SizeFreq; 7=sizeage; 8=catch;
# 9=init_equ_catch; 10=recrdev; 11=parm_prior; 12=parm_dev; 13=CrashPen; 14=Morphcomp; 15=Tag-comp; 16=Tag-negbin
#_comp  fleet phase val   sizefreq_method
#age comps
# 5       1     1   1   1    # COM_GN
# 5       2     1   1   1    # COM_RR
# 5       3     1   1   1    # REC
# 5       4     1 0.001  1
# Lengths
# 4       1     1   1   1    # COM_GN
# 4       2     1   1   1    # COM_RR
# 4       3     1   1   1    # REC
# 4       4     1   1   1    # SHRIMP BYCATCH
# discards
# 2       2    1    1   1    # COM_RR
# 2       3    1    1   1    # REC
# 2       4    1    1   1    # Shrimp Bycatch
#catch
# 8       1     1   1   1   #FISHERY COM_GN
# 8       2     1   1   1   #FISHERY COM_RR
# Surveys
# 1       5     1   1   1   #SURVEY1 MRFSS
# 1       6     1   1   1   #SURVEY2 Headboat
# 1       7     1   1   1   #SURVEY3 Com GN
# 1       8     1   1   1   #SURVEY4 Com RR
```

```
# 1       9     1   1   1   #SURVEY5 Shrimp Bycatch

0 # (0/1) read specs for more stddev reporting
 # 0 1 -1 5 1 5 1 -1 5 # placeholder for selex type, len/age, year, N selex bins, Growth pattern, N growth ages, NatAge_area(-1 for all), NatAge_yr, N Natages
 # placeholder for vector of selex bins to be reported
 # placeholder for vector of growth ages to be reported
 # placeholder for vector of NatAges ages to be reported
999
```

Appendix F. Input data file used in SS "span_ctl.SS"

```
#C  Spanish mackerel 2011
#C  bootstrap file: 1
1886 #_styr
2011 #_endyr
1    #_nseas
12   #_months/season
1    #_spawn_seas
4    #_N_Fishing_fleet
5    #_Nsurveys
1    #_N_areas
Com_GN_1%Com_RR_2%REC_3%Shrimp_Bycatch_4%MRFSS_5%Headboat_6%Gillnet_7%COM_FWC_VERT_LINE_8%SEAMAP_Survey_9

 0.5 #_surveytiming_in_season
 0.5 #_surveytiming_in_season
 0.5 #_surveytiming_in_season
 0.5 #_surveytiming_in_season
 0.5 #_surveytiming_in_season
 0.5 #_surveytiming_in_season
 0.5 #_surveytiming_in_season
 0.5 #_surveytiming_in_season
 0.5 #_surveytiming_in_season

1 1 1 1 1 1 1 1 1    #_area_assignments_for_each_fishery_and_survey
1 1 2 2              #_units of catch:  1=bio; 2=num

0.01 0.01 0.01 -1.    #_se of log(catch) only used for init_eq_catch and for Fmethod 2 and 3
1      #_Ngenders
11     # Accumulator age per the manual not the number of ages (Nages)
0 0 0 0   #_init_equil_catch_for_each_fishery
126       # Number of Catch Observations
# COM_GN           COM_RR                REC        SHRIMP       YEAR      TYPE
34.0 2.0 0 0  1886  1
68.43016708   4.142723315           0            0        1887  1
133.4387113   8.078424994           0            0        1888  1
255.75756     15.48361782           0            0        1889  1
296.3881022   17.94322936           0            0        1890  1
310.3605292   1.884331784           0            0        1891  1
310.3605292   1.884331784           0            0        1892  1
310.3605292   1.884331784           0            0        1893  1
310.3605292   1.884331784           0            0        1894  1
310.3605292   1.884331784           0            0        1895  1
310.3605292   1.884331784           0            0        1896  1
321.1938757   19.44512857           0            0        1897  1
416.771671    25.46937989           0            0        1898  1
416.771671    25.46937989           0            0        1899  1
416.771671    25.46937989           0            0        1900  1
416.771671    25.46937989           0            0        1901  1
677.4588215   41.01324713           0            0        1902  1
```

655.5522883	39.3331373	0	0	1903	1
655.5522883	39.3331373	0	0	1904	1
655.5522883	39.3331373	0	0	1905	1
655.5522883	39.3331373	0	0	1906	1
655.5522883	39.3331373	0	0	1907	1
635.5450549	38.47566471	0	0	1908	1
667.6138941	44.50759294	0	0	1909	1
775.6532078	49.8634205	0	0	1910	1
883.6816654	55.23010409	0	0	1911	1
991.7028478	60.60406292	0	0	1912	1
1099.718917	65.98313502	0	0	1913	1
1207.731255	71.36593782	0	0	1914	1
1315.740789	76.751546	0	0	1915	1
1423.748159	82.13931686	0	0	1916	1
1485.872836	88.05172367	0	0	1917	1
1506.318634	91.1916619	0	0	1918	1
1535.148767	93.20546088	0	0	1919	1
1585.315785	92.93230469	0	0	1920	1
1638.880721	98.33284324	0	0	1921	1
1643.159783	98.58958696	0	0	1922	1
1653.015944	100.0729394	0	0	1923	1
1751.16886	103.9756511	0	0	1924	1
1863.460154	109.6153032	0	0	1925	1
1975.754083	115.2523215	0	0	1926	1
2040.875956	123.5497203	0	0	1927	1
1413.068858	85.54363835	0	0	1928	1
1528.988512	92.561101	0	0	1929	1
1794.326473	108.6240679	0	0	1930	1
1018.029223	61.62904973	0	0	1931	1
1255.005154	75.9748529	0	0	1932	1
1373.57888	82.41473285	0	0	1933	1
1512.095016	91.53861734	0	0	1934	1
1867.743971	109.8672924	0	0	1935	1
2251.966558	136.3287958	0	0	1936	1
1704.256198	103.1716367	0	0	1937	1
1759.588442	106.5213786	0	0	1938	1
1834.941259	111.0831073	0	0	1939	1
1580.208302	95.66211907	0	0	1940	1
36.24630533	22.26558755	0	0	1941	1
36.24630533	22.26558755	0	0	1942	1
36.24630533	22.26558755	0	0	1943	1
36.24630533	22.26558755	0	0	1944	1
39.64706553	2.400306428	0	0	1945	1
36.24630533	22.26558755	0	0.1	1946	1
36.24630533	22.26558755	0	0.1	1947	1
383.7653132	23.23252777	0	0.1	1948	1
1657.808971	100.3600147	0	0.1	1949	1
1109.040718	67.13859114	0	0.1	1950	1
2784.599066	168.5732772	0	0.1	1951	1
1931.915336	116.9534348	0	0.1	1952	1
1276.310359	77.26476291	0	0.1	1953	1

1234.568037	74.73762103	0	0.1	1954	1
696.0213894	42.13562209	774.329	0.1	1955	1
1248.424966	75.57670272	858.972	0.1	1956	1
1560.510025	94.46938237	943.615	0.1	1957	1
1654.943512	100.1864837	1028.258	0.1	1958	1
2006.333205	121.4585833	1112.901	0.1	1959	1
2338.519559	141.5687079	1197.544	0.1	1960	1
1717.001379	103.9431567	1219.048	0.1	1961	1
3071.528135	63.12179139	1240.552	0.1	1962	1
2434.217912	36.52614134	1262.056	0.1	1963	1
1715.428671	78.89068647	1283.56	0.1	1964	1
2095.274878	129.7645834	1305.064	0.1	1965	1
3053.483264	151.6530827	1356.661	0.1	1966	1
2582.367971	128.2748432	1408.258	0.1	1967	1
3163.535515	116.4869825	1459.856	0.1	1968	1
3684.911877	98.94791266	1511.453	0.1	1969	1
3630.865374	120.1098237	1563.051	0.1	1970	1
3349.08911	124.4308569	1705.132	0.1	1971	1
2758.32349	204.4647598	1847.214	0.1	1972	1
2748.202882	61.41121132	1989.295	0.1	1973	1
3431.542543	318.2987038	2131.377	0.1	1974	1
2191.628777	358.0836524	2273.458	0.1	1975	1
3153.448217	376.7693205	2277.451	0.1	1976	1
904.9597517	290.8682143	2281.444	0.1	1977	1
505.3129052	268.0632764	2285.437	0.1	1978	1
931.1046676	31.38059107	2289.429	0.1	1979	1
831.7146714	44.53312872	2293.422	0.1	1980	1
1592.006749	90.35395561	2102.038	0.1	1981	1
1485.691109	81.6978089	3442.701	0.1	1982	1
960.017746	67.79082484	2430.193	0.1	1983	1
1566.665447	23.45874273	946.926	0.1	1984	1
904.115191	28.76168912	1177.354	0.1	1985	1
1225.099756	14.1535594	6397.814	0.1	1986	1
1190.630774	101.8198311	1794.555	0.1	1987	1
1038.640009	11.63168543	1459.955	0.1	1988	1
1388.061847	26.07807348	1135.6	0.1	1989	1
1161.126947	8.139340948	1597.435	0.1	1990	1
1488.327025	72.75712239	1738.578	0.1	1991	1
1682.054362	17.26254596	2393.032	0.1	1992	1
1167.933074	13.02606697	1488.351	0.1	1993	1
1249.588808	10.32238076	1427.593	0.1	1994	1
674.7322704	9.763892329	1073.448	0.1	1995	1
171.6726706	12.9178368	1260.391	0.1	1996	1
226.4684311	18.45872382	1261.861	0.1	1997	1
185.5482764	23.86442747	1180.977	0.1	1998	1
368.412134	27.16273403	1590.312	0.1	1999	1
394.2524232	18.93815317	1730.988	0.1	2000	1
500.4443274	36.1083695	2481.769	0.1	2001	1
412.7072599	17.42137548	1976.072	0.1	2002	1
627.9811197	19.77637795	1518.347	0.1	2003	1
469.4024284	18.92331502	2150.34	0.1	2004	1

```
662.4834388   15.69706811   1216.407          0.1      2005  1
614.0356686   28.29383044   1789.544          0.1      2006  1
413.7935981   13.25205018   1352.93           0.1      2007  1
521.225866    38.7007447    1905.216          0.1      2008  1
789.0971604   34.61240289   1518.817          0.1      2009  1
501.3432236   65.5186339    1601.134          0.1      2010  1
546.1829242    54.05135563      1547.069          0.1      2011  1
#
# Abundance Indices
188     # Number of Survey Observations
# Fleet Units (0=num, 1=bio, 2=F)                    error dist(-1=normal, 0=lognorm, >0=df_T)
 1  1 0   # COM_GN
 2  1 0   # COM_RR
 3  0 0   # REC
 4  2 0   # Shrimp Effort
 5  0 0   # MRFSS
 6  0 0   # Hboat
 7  1 0   # COM_GN LOGBOOK
 8  1 0   # COM_FWC_VERT_LINE
 9  0 0   # SEAMAP SURVEY

#Year   Season  FLEET   EFFORT  SD      Label
# represents shrimp effort of choice
#       year                  season                 fleet               scaled effort                                 label
        1945                  1                      4                     0.001         0.125         # Shrimp Effort
        1946                  1                      4                     0.004669018    0.125                     #    Shrimp
Effort
        1947                  1                      4                     0.023811993      0.125                   #    Shrimp
Effort
        1948                  1                      4                     0.062564845    0.125                     #    Shrimp
Effort
        1949                  1                      4                     0.101084245    0.125                     #    Shrimp
Effort
        1950                  1                      4                     0.180224105    0.125                     #    Shrimp
Effort
        1951                  1                      4                     0.228548444      0.125                   #    Shrimp
Effort
        1952                  1                      4                     0.269869256      0.125                   #    Shrimp
Effort
        1953                  1                      4                     0.278506939    0.125                     #    Shrimp
Effort
        1954                  1                      4                     0.362549268    0.125                     #    Shrimp
Effort
        1955                  1                      4                     0.358814053    0.125                     #    Shrimp
Effort
        1956                  1                      4                     0.460598652      0.125                   #    Shrimp
Effort
        1957                  1                      4                     0.537637453      0.125                   #    Shrimp
Effort
        1958                  1                      4                     0.696150623    0.125                     #    Shrimp
Effort
```

1959	1	4	0.748677078	0.125	#	Shrimp Effort
1960	1	4	0.748248745	0.125	#	Shrimp Effort
1961	1	4	0.461965464	0.125	#	Shrimp Effort
1962	1	4	0.796688961	0.125	#	Shrimp Effort
1963	1	4	0.901471045	0.125	#	Shrimp Effort
1964	1	4	1.062382853	0.125	#	Shrimp Effort
1965	1	4	0.688010649	0.125	#	Shrimp Effort
1966	1	4	0.580599779	0.125	#	Shrimp Effort
1967	1	4	0.696735062	0.125	#	Shrimp Effort
1968	1	4	0.816884814	0.125	#	Shrimp Effort
1969	1	4	0.894284436	0.125	#	Shrimp Effort
1970	1	4	0.628212137	0.125	#	Shrimp Effort
1971	1	4	0.711675645	0.125	#	Shrimp Effort
1972	1	4	0.995050076	0.125	#	Shrimp Effort
1973	1	4	1.012571097	0.125	#	Shrimp Effort
1974	1	4	1.0450401	0.125	#	Shrimp Effort
1975	1	4	0.802247483	0.125	#	Shrimp Effort
1976	1	4	1.115133225	0.125	#	Shrimp Effort
1977	1	4	1.384552149	0.125	#	Shrimp Effort
1978	1	4	1.92755231	0.125	#	Shrimp Effort
1979	1	4	2.029138408	0.125	#	Shrimp Effort
1980	1	4	1.491874379	0.125	#	Shrimp Effort
1981	1	4	1.540411951	0.125	#	Shrimp Effort
1982	1	4	1.473560859	0.125	#	Shrimp Effort
1983	1	4	1.595318307	0.125	#	Shrimp Effort

1984	1	4	1.636084144	0.125	#	Shrimp Effort
1985	1	4	1.762284299	0.125	#	Shrimp Effort
1986	1	4	1.855517978	0.125	#	Shrimp Effort
1987	1	4	2.156347484	0.125	#	Shrimp Effort
1988	1	4	1.629358168	0.125	#	Shrimp Effort
1989	1	4	1.94696849	0.125	#	Shrimp Effort
1990	1	4	1.895500031	0.125	#	Shrimp Effort
1991	1	4	1.812570503	0.125	#	Shrimp Effort
1992	1	4	1.574425171	0.125	#	Shrimp Effort
1993	1	4	1.473319277	0.125	#	Shrimp Effort
1994	1	4	1.612885045	0.125	#	Shrimp Effort
1995	1	4	1.38522427	0.125	#	Shrimp Effort
1996	1	4	1.485346076	0.125	#	Shrimp Effort
1997	1	4	1.517712625	0.125	#	Shrimp Effort
1998	1	4	1.648277699	0.125	#	Shrimp Effort
1999	1	4	1.717437717	0.125	#	Shrimp Effort
2000	1	4	1.535732761	0.125	#	Shrimp Effort
2001	1	4	1.491186635	0.125	#	Shrimp Effort
2002	1	4	1.32140767	0.125	#	Shrimp Effort
2003	1	4	1.076364509	0.125	#	Shrimp Effort
2004	1	4	0.829801142	0.125	#	Shrimp Effort
2005	1	4	0.499034062	0.125	#	Shrimp Effort
2006	1	4	0.663099426	0.125	#	Shrimp Effort
2007	1	4	0.649566399	0.125	#	Shrimp Effort
2008	1	4	0.560997109	0.125	#	Shrimp Effort

```
      2009                  1                      4                      0.653462462      0.125                                  #     Shrimp
Effort
      2010                  1                      4                      0.463170413    0.125                                    #     Shrimp
Effort
      2011                  1                      4                      0.43360253       0.125                                  #     Shrimp
Effort
1981         1        5           0.8981     0.4377  # MRFSS   #se calculated as sqrt(loge(1+CV(index)**2))
1982         1        5           1.2552     0.7935  # MRFSS
1983         1        5           0.8820     0.6986  # MRFSS
1984         1        5           0.6564     0.6170  # MRFSS
1985         1        5           0.7353     0.5893  # MRFSS
1986         1        5           2.6980     0.8561  # MRFSS
1987         1        5           1.1851     0.7114  # MRFSS
1988         1        5           0.8780     0.6646  # MRFSS
1989         1        5           1.0244     0.6841  # MRFSS
1990         1        5           1.9452     0.8619  # MRFSS
1991         1        5           1.3235     0.7116  # MRFSS
1992         1        5     1.4129     0.7470  # MRFSS
1993         1        5           0.7096     0.6855  # MRFSS
1994         1        5           0.6942     0.5974  # MRFSS
1995         1        5           0.4094     0.5214  # MRFSS
1996         1        5           0.6716     0.5985  # MRFSS
1997         1        5           0.6881     0.6000  # MRFSS
1998         1        5           0.7264     0.6124  # MRFSS
1999         1        5           1.1596     0.6931  # MRFSS
2000         1        5           0.7170     0.6426  # MRFSS
2001         1        5           0.8873     0.6959  # MRFSS
2002         1        5           0.8451     0.6840  # MRFSS
2003         1        5           0.8580     0.6690  # MRFSS
2004         1        5           0.9920     0.6841  # MRFSS
2005         1        5           0.5725     0.6475  # MRFSS
2006         1        5           0.9179     0.6852  # MRFSS
2007         1        5           0.9469     0.6546  # MRFSS
2008         1        5           0.9681     0.6606  # MRFSS
2009         1        5     0.9646     0.6375  # MRFSS
2010         1        5     1.0875     0.7155  # MRFSS
2011         1        5           1.2902     0.7083  # MRFSS
-1986  1       6       0.73  0.25     # Headboat
-1987  1       6       1.91   0.25           # Headboat
-1988  1       6       0.63   0.25           # Headboat
-1989  1       6       0.96  0.25       # Headboat
-1990  1       6       1.04   0.25      # Headboat
-1991  1       6       2.44  0.25       # Headboat
-1992  1       6       1.41   0.25           # Headboat
-1993  1       6       0.96   0.25      # Headboat
-1994  1       6       1.33   0.25           # Headboat
-1995  1       6       0.91   0.25           # Headboat
-1996  1       6       0.85   0.25           # Headboat
-1997  1       6       0.67   0.25           # Headboat
-1998  1       6       0.34   0.25           # Headboat
-1999  1       6       0.66   0.25           # Headboat
```

```
-2000   1       6       0.96    0.25            # Headboat
-2001   1       6       0.35    0.25            # Headboat
-2002   1       6       0.74    0.25            # Headboat
-2003   1       6       0.42  0.25              # Headboat
-2004   1       6       0.3     0.25            # Headboat
-2005   1       6       0.37    0.25            # Headboat
-2006   1       6       1.02    0.25    # Headboat
-2007   1       6       1.04  0.25        # Headboat
-2008   1       6       1.62    0.25            # Headboat
-2009   1       6       1.5     0.25            # Headboat
-2010   1       6       0.99    0.25            # Headboat
-2011   1       6       1.82    0.25            # Headboat
-1998   1       7       0.56137 1.402862166             # Gillnet
-1999   1       7       0.36191 0.754696424             # Gillnet
-2000   1       7       0.25462 0.607726803             # Gillnet
-2001   1       7       0.80905 0.482417492             # Gillnet
-2002   1       7       0.0705  0.636722669             # Gillnet
-2003   1       7       2.19239 1.045292238             # Gillnet
-2004   1       7       2.06259 1.29086811              # Gillnet
-2005   1       7       2.37125 0.96597585              # Gillnet
-2006   1       7       0.19907 0.715991358             # Gillnet
-2007   1       7       0.70306 0.652266994             # Gillnet
-2008   1       7       0.56617 0.828449353             # Gillnet
-2009   1       7       0.57952 1.293673735             # Gillnet
-2010   1       7       2.2685  0.868775614             # Gillnet
1986    1       8       0.687   0.1901                    # COM_FWC_VERT_LINE
1987    1       8       0.537   0.1854                    # COM_FWC_VERT_LINE
1988    1       8       0.729   0.1943                    # COM_FWC_VERT_LINE
1989    1       8       1.529   0.2029                    # COM_FWC_VERT_LINE
1990    1       8       0.979   0.2027                    # COM_FWC_VERT_LINE
1991    1       8       1.089   0.2005                    # COM_FWC_VERT_LINE
1992    1       8       1.083   0.2158                    # COM_FWC_VERT_LINE
1993    1       8       0.595   0.2220                    # COM_FWC_VERT_LINE
1994    1       8       1.032   0.2187                    # COM_FWC_VERT_LINE
1995    1       8       0.933   0.2325                    # COM_FWC_VERT_LINE
1996    1       8       0.721   0.2284                    # COM_FWC_VERT_LINE
1997    1       8       0.782   0.2340                    # COM_FWC_VERT_LINE
1998    1       8       1.145   0.2360                    # COM_FWC_VERT_LINE
1999    1       8       0.955   0.2350                          # COM_FWC_VERT_LINE
2000    1       8       0.752   0.2411                    # COM_FWC_VERT_LINE
2001    1       8       1.416   0.2290                          # COM_FWC_VERT_LINE
2002    1       8       1.087   0.2317                          # COM_FWC_VERT_LINE
2003    1       8       1.281   0.2227                          # COM_FWC_VERT_LINE
2004    1       8       1.568   0.2428                          # COM_FWC_VERT_LINE
2005    1       8       1.097   0.2556                          # COM_FWC_VERT_LINE
2006    1       8       1.475   0.2365                          # COM_FWC_VERT_LINE
2007    1       8       1.161    0.2384           # COM_FWC_VERT_LINE
2008    1       8       1.056   0.2425                          # COM_FWC_VERT_LINE
2009    1       8       1.408    0.2213           # COM_FWC_VERT_LINE
2010    1       8       1.567   0.2192                          # COM_FWC_VERT_LINE
2011    1       8       1.401    0.2311           # COM_FWC_VERT_LINE
```

```
1987  1  9  0.29632  0.6224     # SEAMAP Trawl
1988  1  9  1.16452  0.4463     # SEAMAP Trawl
1989  1  9  1.45153  0.4503     # SEAMAP Trawl
1990  1  9  1.63143  0.4452     # SEAMAP Trawl
1991  1  9  0.89001  0.4792     # SEAMAP Trawl
1992  1  9  0.61261  0.4670     # SEAMAP Trawl
1993  1  9  1.71736  0.4257     # SEAMAP Trawl
1994  1  9  0.69900  0.5265     # SEAMAP Trawl
1995  1  9  1.10658  0.4422     # SEAMAP Trawl
1996  1  9  0.97891  0.4968     # SEAMAP Trawl
1997  1  9  0.33724  0.5634     # SEAMAP Trawl
1998  1  9  0.54031  0.4832     # SEAMAP Trawl
1999  1  9  0.85572  0.4801     # SEAMAP Trawl
2000  1  9  1.18156  0.4850     # SEAMAP Trawl
2001  1  9  0.82051  0.5069     # SEAMAP Trawl
2002  1  9  0.32739  0.5947     # SEAMAP Trawl
2003  1  9  1.49226  0.4371     # SEAMAP Trawl
2004  1  9  0.46692  0.4575     # SEAMAP Trawl
2005  1  9  2.51801  0.4260     # SEAMAP Trawl
2006  1  9  0.92219  0.4536     # SEAMAP Trawl
2007  1  9  1.61528  0.4463     # SEAMAP Trawl
2008  1  9  0.79497  0.5053     # SEAMAP Trawl
2009  1  9  1.14124  0.3707     # SEAMAP Trawl
2010  1  9  1.25012  0.4371     # SEAMAP Trawl
2011  1  9  0.18800  0.5505     # SEAMAP Trawl
#
3      #_N_fleets     with    discard_obs
#      Fleet   Units   Error (1=biomass or numbers according to selection made for retained catch, 2= fraction (biomass or numbers) of total catch discarded, 3= numbers of fish discarded, even if retained catch has units of biomass)
# Discard Error Structure (>=1 degrees of freedem for students T, 0=normal and value interperted as CV of observation, -1 normal and value interperted as SE of observation)
2      2      -1
3      2      -1
4      3      -2
85     #      number  of      discard observations
# year  season  fleet   discard      error
1998     -1      2    0.17665   0.01   #COM_RR   value for 1998 was  0.20281, ave for 1998-2007 is   0.21503 AND ERROR WAS 0.35
1999      1     -2    0.18306   0.025   #COM_RR
2000      1     -2    0.24251   0.025   #COM_RR
2001      1     -2    0.12481   0.025   #COM_RR
2002      1     -2    0.25631   0.025   #COM_RR
2003      1     -2    0.23598   0.025   #COM_RR
2004      1     -2    0.22211   0.025   #COM_RR
2005      1     -2    0.24985   0.025   #COM_RR
2006      1     -2    0.15636   0.025   #COM_RR
2007      1     -2    0.27638   0.025   #COM_RR
2008      1     -2    0.08071   0.025   #COM_RR value for 2008 was 0.08290, ave for 2008-2011 is and error was 0.35
2009      1     -2    0.11538   0.025   #COM_RR
2010      1     -2    0.05754   0.025   #COM_RR
2011     -1     -2    0.17665   0.025   #COM_RR     value for 2011 was 0.06702
1981     -1      3    0.24473   0.005   #REC 1981 VALUE WAS 0.0358 AND AVE discard value for 1981-90 was  0.24473 AND ERROR WAS 0.001
```

```
1982      1     -3    0.1353    0.0001   #REC
1983      1     -3    0.3266    0.01   #REC
1984      1     -3    0.0600    0.01   #REC
1985      1     -3    0.1070    0.01   #REC
1986      1     -3    0.3853    0.01   #REC
1987      1     -3    0.1873    0.01   #REC
1988      1     -3    0.3298    0.01   #REC
1989      1     -3    0.3041    0.01   #REC
1990     -1     -3    0.5760    0.01   #REC
1991     -1      3    0.4062    0.001   #REC 1991 VALUE WAS 0.4158 AVE DISCARD value for 1991-2002 was 0.4062  AND ERROR WAS 0.001
1992      1     -3    0.4127    0.025  #REC
1993      1     -3    0.4138    0.025  #REC
1994      1     -3    0.3161    0.025  #REC
1995      1     -3    0.3463    0.025  #REC
1996      1     -3    0.3551    0.025  #REC
1997      1     -3    0.4043    0.025  #REC
1998      1     -3    0.3884    0.025  #REC
1999      1     -3    0.4376    0.025  #REC
2000      1     -3    0.4644    0.025  #REC
2001      1     -3    0.4265    0.025  #REC
2002     -1     -3    0.4932    0.025  #REC
2003     -1      3    0.5635    0.001   #REC 2003 VALUES WAS 0.59332003 AVE discard value FOR 2003-2011 was 0.5635  AND ERRO WAS 0.01
2004      1     -3    0.5196    0.025  #REC
2005      1     -3    0.5315    0.025  #REC
2006      1     -3    0.6156    0.025  #REC
2007      1     -3    0.6093    0.025  #REC
2008      1     -3    0.5174    0.025  #REC
2009      1     -3    0.5191    0.025  #REC
2010      1     -3    0.6083    0.025  #REC
2011     -1     -3    0.5575    0.025  #REC
1972     -1      4     9096     0.01  #SHRIMP BYCATCH  #_RDM  cahnge error to smaller value to force better fit
1973           1         -4          915.5    0.65  #SHRIMP BYCATCH
1974           1         -4      2230        0.65  #SHRIMP BYCATCH
1975       1      -4      2774         0.65  #SHRIMP BYCATCH
1976       1      -4      5264         0.65  #SHRIMP BYCATCH
1977       1      -4     13750         0.65  #SHRIMP BYCATCH
1978                1              -4       13400          0.65  #SHRIMP BYCATCH
1979                1         -4    16510    0.65  #SHRIMP BYCATCH
1980                1         -4     13870        0.65  #SHRIMP BYCATCH
1981                1         -4      4028         0.65  #SHRIMP BYCATCH
1982                1         -4      5582         0.65  #SHRIMP BYCATCH
1983                1         -4      4506         0.65  #SHRIMP BYCATCH
1984                1         -4      8033         0.65  #SHRIMP BYCATCH
1985                1         -4      2654         0.65  #SHRIMP BYCATCH
1986                1         -4      6586         0.65  #SHRIMP BYCATCH
1987                1         -4      5911         0.65  #SHRIMP BYCATCH
1988                1         -4         9566      0.65  #SHRIMP BYCATCH
1989                1         -4     14530         0.65  #SHRIMP BYCATCH
1990                1         -4    20020    0.65  #SHRIMP BYCATCH
1991                1         -4     14960         0.65  #SHRIMP BYCATCH
1992                1         -4     19070         0.65  #SHRIMP BYCATCH
```

```
1993                1         -4     48680          0.65  #SHRIMP BYCATCH
1994                1         -4      4856          0.65  #SHRIMP BYCATCH
1995                1         -4      4555          0.65  #SHRIMP BYCATCH
1996                1         -4      4026          0.65  #SHRIMP BYCATCH
1997                1         -4      4586          0.65  #SHRIMP BYCATCH
1998                1         -4      5672          0.65  #SHRIMP BYCATCH
1999                1         -4      4289          0.65  #SHRIMP BYCATCH
2000                1         -4      9968          0.65  #SHRIMP BYCATCH
2001                1         -4      5797        0.65  #SHRIMP BYCATCH
2002                1         -4      5258        0.65  #SHRIMP BYCATCH
2003                1         -4    10850    0.65  #SHRIMP BYCATCH
2004                1         -4    18680    0.65  #SHRIMP BYCATCH
2005                1         -4     21590          0.65  #SHRIMP BYCATCH
2006                1         -4      3903          0.65  #SHRIMP BYCATCH
2007                1         -4      8264          0.65  #SHRIMP BYCATCH
2008                1         -4      2797          0.65  #SHRIMP BYCATCH
2009                1    -4    2621          0.65  #SHRIMP BYCATCH
2010                1         -4      2945          0.65  #SHRIMP BYCATCH
2011          -1       -4      2632          0.65  #SHRIMP BYCATCH
#
#
0  #_N_meanbodywt_obs
30 #degrees of freedom (must be here)

2 # length bin method: 1=use databins; 2=generate from binwidth,min,max below; 3=read vector
2 # binwidth for population size comp
4   # minimum size in the population (lower edge of first bin and size at age 0.00)
100 # maximum size in the population (lower edge of last bin)

0 #_comp_tail_compression note, set to 0 for tail compress and set to - value for no tail compressing
1e-007 #_add_to_comp


0       #_combine       males   into    females at      or      below   this    bin     number
49 #_N_LengthBins
4       6       8       10      12      14      16      18      20      22      24      26      28      30      32      34      36      38
        40      42      44      46      48      50      52      54      56      58      60      62      64      66      68      70      72
        74      76      78      80      82      84      86      88      90      92      94      96      98      100
104     #_N_Length_obs
#
#_year  season  fleet   gender  part    nsamp   Bin4    Bin6    Bin8    Bin10   Bin12   Bin14   Bin16   Bin18   Bin20   Bin22   Bin24   Bin26
        Bin28   Bin30   Bin32   Bin34   Bin36   Bin38   Bin40   Bin42   Bin46   Bin48   Bin50   Bin52   Bin54   Bin56   Bin58   Bin60   Bin62
        Bin64   Bin66   Bin68   BIN70   Bin72   Bin74   Bin76   Bin78   Bin80   Bin82   Bin84   Bin86   Bin88   Bin90   Bin92   Bin94   Bin96
        Bin98   Bin100


-1986   1       1       0       2       17      0       0       0       0       0       0       0       0       0       0       0       0
        0       0       0       0       0       0       0       6       2       3       2       1       2       0       1       0       0
        0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0
        0       0       0
```

1987	1	1	0	2	100	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	2	3	3	11	42	60	72	85	79	72	42	39	24	8	8
	3	2	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
1989	1	1	0	2	62	0	0	0	0	0	0	0	0	0	0	0	0
	0	1	2	8	15	14	8	5	3	1	2	0	0	1	2	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
1990	1	1	0	2	66	0	0	0	0	0	0	0	0	0	0	0	0
	0	1	0	2	9	12	7	10	6	4	8	2	2	0	1	1	1
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
1991	1	1	0	2	54	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	5	3	10	15	5	6	5	1	2	0	2	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
1992	1	1	0	2	100	0	0	0	0	0	0	0	0	0	0	0	0
	0	1	0	0	5	22	31	49	49	37	32	42	35	44	32	28	23
	5	8	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
1993	1	1	0	2	84	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	6	18	16	10	8	7	6	4	3	3	1	1	1
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
1994	1	1	0	2	100	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	1	1	5	16	30	51	60	79	85	61	38	25	26	5	12
	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
1995	1	1	0	2	100	0	0	0	0	0	0	0	0	0	0	0	0
	0	1	1	4	11	4	2	6	6	4	24	49	40	54	40	24	5
	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
1996	1	1	0	2	100	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	2	0	0	2	4	13	22	41	46	54	47	35
	21	7	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
-1997	1	1	0	2	12	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	1	3	4	3	1	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
1999	1	1	0	2	36	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	2	0	3	4	5	5	2	3	3	5	0	1	1	2	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
2000	1	1	0	2	38	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	1	0	2	9	6	6	5	5	1	2	0	1	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
-2001	1	1	0	2	23	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	2	1	5	5	2	3	3	2	0	0	0	0

	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
2002	1	1	0	2	34	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	1	5	5	8	7	5	3	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
2003	1	1	0	2	100	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	1	2	1	8	9	14	19	9	14	9	4	9	3	0	0
	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
2004	1	1	0	2	100	0	0	0	0	0	0	0	0	0	0	0	6
	6	35	50	95	231	330	366	332	225	215	172	136	86	83	60	59	47
	13	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
2005	1	1	0	2	100	0	0	0	0	0	0	0	0	0	0	0	1
	20	32	52	100	171	276	338	251	221	203	169	120	98	107	74	54	22
	19	5	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
2006	1	1	0	2	100	0	0	0	0	0	0	0	0	0	0	0	9
	47	130	207	251	316	286	248	210	162	142	114	60	54	26	39	22	16
	7	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
2007	1	1	0	2	100	0	0	0	0	0	0	0	0	0	0	0	2
	59	123	192	268	387	481	389	288	245	207	174	115	98	55	30	42	16
	8	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
2008	1	1	0	2	100	0	0	0	0	0	0	0	0	0	1	1	20
	121	164	134	223	371	442	401	320	274	263	182	126	84	63	58	57	39
	12	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
2009	1	1	0	2	100	0	0	0	0	0	0	0	0	0	0	0	0
	2	48	130	173	325	348	348	282	248	227	188	142	84	55	43	36	21
	7	6	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
2010	1	1	0	2	100	0	0	0	0	0	0	0	0	1	2	3	34
	136	160	149	207	301	358	291	229	185	143	150	128	128	106	93	56	37
	11	6	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
2011	1	1	0	2	100	0	0	0	0	0	0	0	0	0	0	0	1
	40	147	298	345	378	445	396	316	274	236	193	138	107	72	76	59	23
	20	8	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
-1983	1	2	0	2	7	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	1	2
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
-1984	1	2	0	2	23	0	0	0	0	0	0	0	0	0	0	0	0
	0	1	1	1	0	1	0	0	2	1	2	2	4	1	0	2	2
	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														

1985	1	2	0	2	100	0	0	0	0	0	0	0	0	0	0	0	6
	23	7	25	19	14	13	11	6	7	2	3	6	3	7	3	7	8
	2	1	1	1	0	0	1	1	0	1	0	0	0	0	0	0	0
	0	0	0														
-1986	1	2	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
1991	1	2	0	2	100	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	1	0	1	6	3	9	12	12	20	26	27	29	25	13
	6	5	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
1992	1	2	0	2	100	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	4	1	0	3	14	15	15	20	26	51	36	32
	9	4	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
1993	1	2	0	2	100	0	0	0	0	0	0	0	0	0	0	0	1
	0	5	9	7	2	0	2	3	8	4	10	6	11	12	8	17	6
	6	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
1994	1	2	0	2	100	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	1	0	6	2	4	9	10	17	10	11	15	12	4
	3	3	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
1995	1	2	0	2	38	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	1	0	3	1	0	2	3	3	2	7	8	5	2
	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
-1996	1	2	0	2	22	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	2	2	3	0	0	2	1	2	4	2	2
	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
-1997	1	2	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
-1998	1	2	0	2	16	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	1	1	3	4	2	0
	1	0	0	0	0	1	1	0	0	2	0	0	0	0	0	0	0
	0	0	0														
-1999	1	2	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
-2001	1	2	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
-2002	1	2	0	2	21	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	1	0	1	0	7	2	3	4	1	1	0

	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
2003	1	2	0	2	37	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	1	2	1	3	3	5	2	10	4	3	3
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
-2004	1	2	0	2	15	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	1	1	1	1	0	0	2	1	2	2	0	0	1
	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
2005	1	2	0	2	70	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	2	9	3	3	8	13	6	7	5	5	3	5	1
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
2006	1	2	0	2	100	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	3	8	6	13	12	13	9	12	7	7	7
	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
2007	1	2	0	2	100	0	0	0	0	0	0	0	0	0	0	0	0
	0	3	11	35	45	26	15	9	6	6	8	12	5	5	8	5	3
	4	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
2008	1	2	0	2	100	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	1	0	2	1	2	10	17	19	27	26	23	23	20	23	5
	6	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
2009	1	2	0	2	81	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	3	5	4	5	5	5	8	8	7	5	7	3	10	2
	3	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
2010	1	2	0	2	67	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	1	0	3	2	8	4	2	8	3	6	4	4	5	8	5
	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
2011	1	2	0	2	100	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	1	3	7	5	15	20	23	21	47	31	29	24	17
	12	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
1981	1	3	0	2	100	0	0	0	0	0	0	0	0	0	0	1	5
	19	32	30	30	35	27	37	25	11	11	8	11	5	4	6	0	8
	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
1982	1	3	0	2	100	0	0	0	0	0	0	0	1	1	2	2	5
	26	47	66	29	53	40	32	36	16	26	16	12	14	3	8	2	6
	1	0	0	0	0	1	0	0	0	3	1	0	0	0	0	0	0
	0	0	0														
1983	1	3	0	2	100	0	0	0	0	0	0	0	0	5	2	3	3
	3	20	29	46	96	92	79	62	55	31	34	17	22	12	18	6	7
	0	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														

1984	1	3	0	2	100	0	0	0	0	0	0	0	1	1	1	0	2
	5	14	36	82	129	71	62	38	27	22	10	15	8	6	8	9	2
	1	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
1985	1	3	0	2	100	0	0	0	0	0	0	0	0	0	0	2	4
	6	18	35	38	71	58	28	29	28	23	17	14	15	17	10	8	3
	3	2	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0
	0	0	0														
1986	1	3	0	2	100	0	0	0	0	0	0	0	0	0	1	3	3
	13	45	122	183	154	159	90	78	56	39	33	35	23	16	15	12	7
	10	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
1987	1	3	0	2	100	0	0	0	0	0	0	0	0	0	1	1	5
	8	39	104	156	165	160	144	133	101	90	88	75	84	58	28	22	14
	9	8	10	1	2	3	3	1	0	0	0	0	0	0	0	0	0
	0	0	0														
1988	1	3	0	2	100	0	0	0	0	0	1	0	0	0	0	2	1
	4	18	53	82	92	97	96	77	51	50	41	45	31	22	24	18	4
	9	3	3	1	0	0	0	1	0	0	0	0	0	0	0	0	0
	0	0	0														
1989	1	3	0	2	100	0	0	0	0	0	0	0	0	0	3	3	9
	24	57	104	109	145	133	84	58	70	48	39	41	30	14	17	11	8
	4	2	2	2	1	0	0	0	1	0	0	0	0	0	0	0	0
	0	0	0														
1990	1	3	0	2	100	0	0	0	0	0	0	0	0	3	6	2	9
	15	52	104	134	146	128	96	74	53	56	49	55	36	32	23	14	5
	3	2	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
1991	1	3	0	2	100	0	0	0	0	2	0	0	0	0	1	7	15
	36	52	70	103	126	117	121	111	87	78	80	61	53	34	40	20	18
	6	6	1	2	2	3	6	3	0	2	6	2	0	0	0	0	0
	0	0	0														
1992	1	3	0	2	100	0	0	0	0	0	0	0	0	0	1	4	3
	18	67	132	234	240	238	156	123	106	94	97	79	58	70	48	32	22
	12	8	2	2	2	2	2	2	4	4	2	1	3	0	0	1	0
	0	1	0														
1993	1	3	0	2	100	0	0	0	0	0	0	0	0	1	0	2	5
	16	42	75	68	77	93	61	62	48	39	38	40	30	33	27	23	14
	6	1	2	0	1	0	1	0	0	1	0	0	0	0	0	0	0
	0	0	0														
1994	1	3	0	2	100	0	0	0	0	1	0	0	0	0	1	0	1
	11	44	70	76	111	97	103	86	76	63	66	71	39	30	34	24	12
	3	4	5	2	1	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
1995	1	3	0	2	100	0	0	0	0	0	0	0	0	0	0	1	1
	8	33	35	46	56	50	70	62	81	84	79	51	61	54	50	27	30
	15	18	2	6	2	3	4	2	4	0	1	0	1	0	0	0	0
	0	0	0														
1996	1	3	0	2	100	0	0	0	0	0	1	0	0	1	2	1	2
	3	27	36	55	76	111	101	94	79	87	86	69	65	59	57	26	23

	9	10	9	3	0	4	0	2	1	1	0	0	1	0	0	0	0
	0	0	0														
1997	1	3	0	2	100	0	0	0	1	0	1	0	1	1	4	1	2
	15	45	50	68	64	82	117	76	90	97	114	90	105	81	52	37	21
	11	12	5	5	0	1	1	1	0	4	0	1	2	1	0	1	2
	1	0	0														
1998	1	3	0	2	100	0	0	0	0	0	0	0	0	0	3	0	10
	38	46	82	98	142	128	124	97	91	110	81	108	81	66	63	50	41
	17	10	7	2	2	2	0	0	2	0	0	0	0	0	0	0	0
	0	0	0														
1999	1	3	0	2	100	0	0	0	0	0	0	0	0	0	2	5	30
	68	143	155	246	304	295	280	218	155	146	167	156	142	109	92	78	59
	31	21	9	3	2	2	1	0	0	0	0	0	0	0	0	0	0
	0	0	0														
2000	1	3	0	2	100	0	0	0	0	0	0	0	1	1	0	0	2
	14	74	176	232	336	381	324	255	219	177	136	194	144	137	121	97	52
	35	18	9	11	1	1	2	0	1	0	1	0	0	0	0	0	0
	0	0	0														
2001	1	3	0	2	100	0	0	0	0	0	1	0	0	0	3	3	16
	38	132	265	460	533	488	411	282	185	155	113	73	87	57	71	54	34
	21	15	4	5	0	1	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
2002	1	3	0	2	100	0	0	0	0	0	0	2	0	0	0	1	1
	11	83	110	99	133	177	241	227	225	173	158	138	111	102	88	61	50
	30	15	7	3	2	1	1	0	0	0	0	0	0	0	0	0	0
	0	0	0														
2003	1	3	0	2	100	0	0	0	0	0	0	0	0	1	1	2	13
	29	74	86	100	138	168	151	169	165	140	132	121	98	94	92	71	38
	28	18	10	3	4	1	0	1	1	1	0	0	0	0	0	0	0
	0	0	0														
2004	1	3	0	2	100	0	0	0	0	0	0	0	0	1	1	2	23
	30	87	101	208	250	241	231	209	176	158	139	140	115	87	82	56	42
	20	16	8	3	0	0	1	0	0	0	0	1	0	0	0	0	0
	0	0	0														
2005	1	3	0	2	100	0	0	0	0	0	0	0	0	0	1	0	3
	11	29	80	135	109	143	128	119	109	103	93	100	78	64	56	31	28
	15	9	7	1	3	2	0	1	0	0	0	0	0	0	0	0	0
	0	0	0														
2006	1	3	0	2	100	0	0	0	0	0	0	0	0	0	0	1	3
	10	31	74	120	185	209	205	160	140	149	149	126	91	70	62	36	39
	27	5	9	4	1	1	2	0	3	0	0	1	0	0	0	0	0
	0	0	0														
2007	1	3	0	2	100	0	0	0	0	0	0	0	0	0	3	1	4
	4	42	88	107	145	189	207	198	188	128	111	91	81	69	67	47	30
	19	6	6	1	0	0	2	1	1	1	1	0	0	0	0	0	0
	0	0	0														
2008	1	3	0	2	100	0	0	0	0	0	0	0	0	2	0	1	3
	22	70	108	162	176	182	172	173	129	135	128	96	85	71	58	52	23
	16	14	7	1	3	1	2	0	0	0	0	2	0	0	0	0	0
	0	0	0														

2009	1	3	0	2	100	0	0	0	0	0	0	0	0	0	0	0	3
	14	50	99	122	175	191	181	168	133	151	98	80	94	52	45	35	18
	20	11	4	4	1	1	0	1	2	0	0	1	0	0	0	0	0
	0	0	0														
2010	1	3	0	2	100	0	0	0	0	0	0	0	0	0	1	2	23
	27	47	90	176	167	238	226	179	163	138	140	125	93	76	47	55	15
	8	8	1	1	1	1	2	0	0	0	0	0	0	0	0	0	0
	0	0	0														
2011	1	3	0	2	100	0	0	0	0	0	0	0	0	0	0	3	9
	46	171	249	275	305	322	279	247	194	172	125	132	92	72	45	38	17
	14	7	2	1	0	0	0	0	1	1	1	0	0	0	0	0	0
	0	0	0														
1987	1	9	0	0	14	0	0	0	0	0	2	3	2	0	0	0	0
	1	1	1	2	1	0	1	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
1988	1 9	0	0	82	0	0	0	0	3	0	1	5	21	10	5	1	0
	7	8	5	6	2	5	3	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0															
1989	1	9	0	0	98	0	0	0	0	5	8	7	10	15	25	14	1
	0	0	1	6	1	1	1	1	1	0	0	0	1	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
1990	1	9	0	0	100	0	0	0	0	19	10	22	28	19	5	2	3
	6	5	7	5	4	1	2	5	2	1	0	1	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
1991	1	9	0	0	100	0	0	0	2	3	1	1	1	1	0	1	1
	3	22	18	14	19	9	9	4	2	1	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
1992	1	9	0	0	100	0	0	0	0	0	2	13	8	5	6	20	10
	4	5	4	9	4	7	2	2	2	1	0	0	0	1	0	0	0
	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0
	0	0	0														
1993	1	9	0	0	100	0	0	0	2	9	7	12	12	12	1	3	7
	34	21	12	4	8	10	3	6	0	0	0	2	0	0	0	0	0
	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
1994	1	9	0	0	78	0	0	0	2	5	13	6	13	5	0	1	3
	1	1	2	1	6	4	3	4	4	1	1	1	1	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
1995	1	9	0	0	100	0	2	1	0	0	9	7	2	3	2	4	3
	7	13	16	6	7	3	4	3	2	0	1	0	1	0	0	0	0
	0	1	1	1	1	0	0	0	0	0	1	0	0	0	0	1	0
	0	0	0														
1996	1	9	0	0	94	0	0	0	0	0	0	1	13	7	2	6	5
	12	9	7	8	13	4	2	2	1	0	0	2	0	0	0	0	0

	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
1997	1	9	0	0	62	0	1	0	1	0	0	2	4	3	2	2	2
	3	8	5	7	4	7	4	3	1	1	1	0	0	0	0	0	0
	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
1998	1	9	0	0	69	0	1	0	2	0	2	2	11	10	4	2	1
	11	8	2	1	2	2	0	1	1	0	0	0	0	0	0	0	1
	0	0	0	0	1	0	0	2	1	0	1	0	0	0	0	0	0
	0	0	0														
1999	1	9	0	0	83	0	0	0	4	1	5	6	5	5	7	4	2
	8	5	6	6	2	3	3	3	5	2	1	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
2000	1	9	0	0	99	0	0	0	0	4	18	8	8	8	9	19	6
	4	2	5	3	2	1	1	0	1	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
2001	1	9	0	0	84	0	0	1	3	5	14	20	10	7	1	0	3
	0	2	4	3	5	2	0	1	1	1	1	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
2002	1	9	0	0	34	0	0	0	0	0	0	2	9	0	1	1	0
	1	3	4	1	3	0	1	2	1	3	0	0	0	0	0	0	0
	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
2003	1	9	0	0	100	0	0	0	0	0	1	6	16	51	19	11	3
	5	10	4	4	3	1	1	2	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
2004	1	9	0	0	71	1	0	0	1	5	2	4	2	2	4	3	5
	7	8	9	3	4	4	2	1	2	0	1	0	1	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
2005	1	9	0	0	100	0	0	0	0	2	16	24	19	35	28	14	4
	7	11	9	5	4	1	2	1	2	1	0	1	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
2006	1	9	0	0	88	0	0	0	0	0	1	2	2	11	7	4	3
	4	13	12	7	9	2	3	2	0	1	3	0	1	0	0	0	0
	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
	0	0	0														
2007	1	9	0	0	100	0	1	0	1	1	8	16	9	18	22	5	13
	7	13	6	5	2	2	1	0	1	2	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0														
2008	1	9	0	0	100	0	0	2	6	7	4	15	4	0	0	3	12
	16	20	4	2	6	2	2	1	4	1	1	1	0	0	0	1	0
	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1
	0	0	0														

```
2009    1       9       0       0       100     0       0       0       0       0       2       16      35      20      32      22      8
        3       6       7       4       3       3       3       1       1       2       1       0       3       0       1       0       0
        0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0
        0       0       0
2010    1       9       0       0       81      0       0       1       0       1       4       5       3       7       7       1       5
        5       10      8       9       6       5       1       1       2       0       0       0       0       0       0       0       0
        0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0
        0       0       0
2011    1       9       0       0       81      0       0       1       0       1       4       5       3       7       7       1       5
        5       10      8       9       6       5       1       1       2       0       0       0       0       0       0       0       0
        0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0
        0       0       0
#
12 #_N_age_bins
0 1 2 3 4 5 6 7 8 9 10 11
2 #_N_ageerror_definitions

 0.5 1.5 2.5 3.5 4.5 5.5 6.5 7.5 8.5 9.5 10.5 11.5
 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001
 0.5  1.5  2.5  3.5  4.5  5.5  6.5  7.5  8.5  9.5  10.5 11.5
 0.01 0.01  0.06  0.08   0.11  0.11  0.37  0.37   0.37   0.37  0.37   0.37  # values from C. Palmer (Panama City lab) August 8 2012

#0.01 0.27 0.96  1.37  1.65  1.88  2.06  2.21   2.35  2.46  2.57   2.66
# 2.0  2.5  2.75 3.0  3.25 3.5  3.75 3.85 3.95 3.5  3.65 3.75
#
1031    #_N_Agecomp_obs

2               #_Lbin_method: 1=poplenbins_index;   2=datalenbins_index;  3=lengths

1               #_combine       males   into    females at      or      below   this    bin     number

#_Year  season  Fleet   Gender  Partition       Age_err_df      L_binL  L_Bin_H Nsamp   0       1       2       3       4       5       6
        7       8       9       10      11
1988    1       1       0       2       2       13      13      2       0       2       0       0       0       0       0       0       0
        0       0       0
1988    1       1       0       2       2       14      14      12      0       12      0       0       0       0       0       0       0
        0       0       0
1988    1       1       0       2       2       15      15      9       0       9       0       0       0       0       0       0       0
        0       0       0
1988    1       1       0       2       2       16      16      8       0       7       1       0       0       0       0       0       0
        0       0       0
1988    1       1       0       2       2       17      17      9       0       5       3       1       0       0       0       0       0
        0       0       0
1988    1       1       0       2       2       18      18      8       0       4       4       0       0       0       0       0       0
        0       0       0
1988    1       1       0       2       2       19      19      8       0       1       6       1       0       0       0       0       0
        0       0       0
1988    1       1       0       2       2       20      20      15      0       1       9       5       0       0       0       0       0
        0       0       0
1988    1       1       0       2       2       21      21      3       0       1       2       0       0       0       0       0       0
        0       0       0
```

1988	1	1	0	2	2	22	22	6	0	1	3	2	0	0	0	0	0	0	0	0
1988	1	1	0	2	2	23	23	5	0	0	2	2	0	1	0	0	0	0	0	0
1988	1	1	0	2	2	24	24	16	0	1	5	3	3	4	0	0	0	0	0	0
1988	1	1	0	2	2	25	25	1	0	0	1	0	0	0	0	0	0	0	0	0
1988	1	1	0	2	2	26	26	2	0	0	1	0	0	1	0	0	0	0	0	0
1988	1	1	0	2	2	27	27	2	0	1	0	0	1	0	0	0	0	0	0	0
1988	1	1	0	2	2	29	29	1	0	0	0	0	0	1	0	0	0	0	0	0
1989	1	1	0	2	2	13	13	1	0	1	0	0	0	0	0	0	0	0	0	0
1989	1	1	0	2	2	20	20	1	0	0	0	1	0	0	0	0	0	0	0	0
1989	1	1	0	2	2	21	21	1	0	0	1	0	0	0	0	0	0	0	0	0
1989	1	1	0	2	2	22	22	1	0	0	1	0	0	0	0	0	0	0	0	0
1989	1	1	0	2	2	23	23	2	0	0	2	0	0	0	0	0	0	0	0	0
1989	1	1	0	2	2	25	25	1	0	0	0	1	0	0	0	0	0	0	0	0
1989	1	1	0	2	2	27	27	1	0	0	0	0	0	1	0	0	0	0	0	0
1990	1	1	0	2	2	15	15	1	0	1	0	0	0	0	0	0	0	0	0	0
1990	1	1	0	2	2	16	16	1	0	1	0	0	0	0	0	0	0	0	0	0
1990	1	1	0	2	2	17	17	3	0	2	1	0	0	0	0	0	0	0	0	0
1990	1	1	0	2	2	18	18	4	0	1	1	2	0	0	0	0	0	0	0	0
1990	1	1	0	2	2	19	19	14	0	0	7	6	1	0	0	0	0	0	0	0
1990	1	1	0	2	2	20	20	28	0	3	10	9	5	1	0	0	0	0	0	0
1990	1	1	0	2	2	21	21	27	0	1	5	7	10	3	1	0	0	0	0	0
1990	1	1	0	2	2	22	22	38	0	0	4	14	15	5	0	0	0	0	0	0
1990	1	1	0	2	2	23	23	33	0	0	4	10	9	9	1	0	0	0	0	0
1990	1	1	0	2	2	24	24	24	0	1	3	5	4	9	2	0	0	0	0	0
1990	1	1	0	2	2	25	25	12	0	0	0	1	7	3	1	0	0	0	0	0

1990	1	1	0	2	2	26	26	17	0	0	2	3	6	3	3	0	0	0	0	0
1990	1	1	0	2	2	27	27	13	0	0	0	1	1	10	1	0	0	0	0	0
1990	1	1	0	2	2	28	28	9	0	0	0	0	2	6	1	0	0	0	0	0
1990	1	1	0	2	2	29	29	12	0	0	0	1	2	8	1	0	0	0	0	0
1990	1	1	0	2	2	30	30	5	0	0	0	0	1	4	0	0	0	0	0	0
1990	1	1	0	2	2	31	31	4	0	0	0	0	1	2	1	0	0	0	0	0
1991	1	1	0	2	2	12	12	1	0	1	0	0	0	0	0	0	0	0	0	0
1991	1	1	0	2	2	13	13	7	0	7	0	0	0	0	0	0	0	0	0	0
1991	1	1	0	2	2	14	14	6	0	6	0	0	0	0	0	0	0	0	0	0
1991	1	1	0	2	2	15	15	14	0	12	2	0	0	0	0	0	0	0	0	0
1991	1	1	0	2	2	16	16	8	0	6	2	0	0	0	0	0	0	0	0	0
1991	1	1	0	2	2	17	17	11	0	4	7	0	0	0	0	0	0	0	0	0
1991	1	1	0	2	2	18	18	34	1	15	13	4	1	0	0	0	0	0	0	0
1991	1	1	0	2	2	19	19	33	0	8	18	6	0	1	0	0	0	0	0	0
1991	1	1	0	2	2	20	20	29	0	8	11	9	0	0	1	0	0	0	0	0
1991	1	1	0	2	2	21	21	31	0	3	15	8	4	0	0	1	0	0	0	0
1991	1	1	0	2	2	22	22	22	0	2	13	6	0	1	0	0	0	0	0	0
1991	1	1	0	2	2	23	23	21	0	0	14	3	2	1	0	1	0	0	0	0
1991	1	1	0	2	2	24	24	28	0	0	17	8	0	0	3	0	0	0	0	0
1991	1	1	0	2	2	25	25	27	0	0	9	8	4	4	2	0	0	0	0	0
1991	1	1	0	2	2	26	26	23	0	0	9	5	2	2	4	1	0	0	0	0
1991	1	1	0	2	2	27	27	18	0	0	4	7	1	1	5	0	0	0	0	0
1991	1	1	0	2	2	28	28	12	0	0	1	4	1	1	5	0	0	0	0	0
1991	1	1	0	2	2	29	29	5	0	0	0	2	0	1	2	0	0	0	0	0
1991	1	1	0	2	2	30	30	3	0	0	0	1	0	1	0	1	0	0	0	0

1991	1	1	0	2	2	32	32	1	0	0	0	0	0	0	1	0	0	0	0	0
1991	1	1	0	2	2	33	33	1	0	0	0	0	1	0	0	0	0	0	0	0
1992	1	1	0	2	2	12	12	1	0	1	0	0	0	0	0	0	0	0	0	0
1992	1	1	0	2	2	15	15	1	0	0	1	0	0	0	0	0	0	0	0	0
1992	1	1	0	2	2	17	17	4	0	0	3	1	0	0	0	0	0	0	0	0
1992	1	1	0	2	2	18	18	14	0	2	9	2	1	0	0	0	0	0	0	0
1992	1	1	0	2	2	19	19	34	0	0	17	14	2	1	0	0	0	0	0	0
1992	1	1	0	2	2	20	20	42	0	0	21	13	7	0	1	0	0	0	0	0
1992	1	1	0	2	2	21	21	51	0	1	19	24	5	1	1	0	0	0	0	0
1992	1	1	0	2	2	22	22	41	0	2	6	19	10	4	0	0	0	0	0	0
1992	1	1	0	2	2	23	23	33	0	0	6	16	6	3	0	1	1	0	0	0
1992	1	1	0	2	2	24	24	40	0	0	9	14	5	9	1	2	0	0	0	0
1992	1	1	0	2	2	25	25	40	0	0	7	19	6	5	1	2	0	0	0	0
1992	1	1	0	2	2	26	26	39	0	0	5	12	13	3	2	4	0	0	0	0
1992	1	1	0	2	2	27	27	31	0	0	4	6	11	4	0	5	1	0	0	0
1992	1	1	0	2	2	28	28	26	0	0	1	5	13	4	0	3	0	0	0	0
1992	1	1	0	2	2	29	29	18	0	0	1	2	8	1	1	5	0	0	0	0
1992	1	1	0	2	2	30	30	3	0	0	0	0	2	0	0	1	0	0	0	0
1992	1	1	0	2	2	31	31	4	0	0	0	0	1	0	0	3	0	0	0	0
1992	1	1	0	2	2	32	32	3	0	0	0	0	1	0	0	2	0	0	0	0
1993	1	1	0	2	2	16	16	2	0	0	2	0	0	0	0	0	0	0	0	0
1993	1	1	0	2	2	17	17	13	0	1	9	3	0	0	0	0	0	0	0	0
1993	1	1	0	2	2	18	18	26	0	0	18	8	0	0	0	0	0	0	0	0
1993	1	1	0	2	2	19	19	25	0	0	12	12	1	0	0	0	0	0	0	0
1993	1	1	0	2	2	20	20	14	0	0	8	4	2	0	0	0	0	0	0	0

1993	1	1	0	2	2	21	21	10	0	0	4	6	0	0	0	0	0	0	0	0
1993	1	1	0	2	2	22	22	12	0	0	6	3	1	1	0	1	0	0	0	0
1993	1	1	0	2	2	23	23	4	0	0	1	2	1	0	0	0	0	0	0	0
1993	1	1	0	2	2	24	24	3	0	0	1	2	0	0	0	0	0	0	0	0
1993	1	1	0	2	2	25	25	7	0	0	2	3	2	0	0	0	0	0	0	0
1993	1	1	0	2	2	26	26	2	0	0	0	1	0	0	0	0	1	0	0	0
1993	1	1	0	2	2	27	27	1	0	0	0	0	1	0	0	0	0	0	0	0
1993	1	1	0	2	2	28	28	1	0	0	0	0	0	0	0	0	1	0	0	0
1994	1	1	0	2	2	15	15	1	0	1	0	0	0	0	0	0	0	0	0	0
1994	1	1	0	2	2	16	16	2	0	2	0	0	0	0	0	0	0	0	0	0
1994	1	1	0	2	2	17	17	1	0	1	0	0	0	0	0	0	0	0	0	0
1994	1	1	0	2	2	18	18	10	0	1	6	3	0	0	0	0	0	0	0	0
1994	1	1	0	2	2	19	19	26	0	1	9	16	0	0	0	0	0	0	0	0
1994	1	1	0	2	2	20	20	32	0	0	8	16	7	1	0	0	0	0	0	0
1994	1	1	0	2	2	21	21	52	0	0	16	24	9	2	0	0	1	0	0	0
1994	1	1	0	2	2	22	22	67	0	0	11	33	20	2	0	0	1	0	0	0
1994	1	1	0	2	2	23	23	77	0	0	5	32	28	10	0	2	0	0	0	0
1994	1	1	0	2	2	24	24	63	0	0	7	26	24	5	1	0	0	0	0	0
1994	1	1	0	2	2	25	25	35	0	0	1	13	14	2	2	2	0	1	0	0
1994	1	1	0	2	2	26	26	27	0	0	0	11	10	3	1	0	0	2	0	0
1994	1	1	0	2	2	27	27	13	0	0	0	5	5	0	2	0	0	1	0	0
1994	1	1	0	2	2	28	28	9	0	0	0	3	2	3	1	0	0	0	0	0
1994	1	1	0	2	2	29	29	5	0	0	0	0	3	1	1	0	0	0	0	0
1994	1	1	0	2	2	30	30	4	0	0	0	1	1	1	1	0	0	0	0	0
1994	1	1	0	2	2	31	31	1	0	0	0	0	0	0	1	0	0	0	0	0

1995	1	1	0	2	2	14	14	1	0	1	0	0	0	0	0	0	0	0	0	0
1995	1	1	0	2	2	15	15	1	0	1	0	0	0	0	0	0	0	0	0	0
1995	1	1	0	2	2	16	16	4	2	2	0	0	0	0	0	0	0	0	0	0
1995	1	1	0	2	2	17	17	16	3	1	11	1	0	0	0	0	0	0	0	0
1995	1	1	0	2	2	18	18	9	3	1	4	1	0	0	0	0	0	0	0	0
1995	1	1	0	2	2	19	19	8	1	0	4	2	1	0	0	0	0	0	0	0
1995	1	1	0	2	2	20	20	7	0	0	5	2	0	0	0	0	0	0	0	0
1995	1	1	0	2	2	21	21	8	0	0	6	1	1	0	0	0	0	0	0	0
1995	1	1	0	2	2	22	22	7	0	1	2	2	1	1	0	0	0	0	0	0
1995	1	1	0	2	2	23	23	15	0	0	8	4	1	1	1	0	0	0	0	0
1995	1	1	0	2	2	24	24	39	0	0	17	10	9	3	0	0	0	0	0	0
1995	1	1	0	2	2	25	25	32	0	0	5	18	8	0	0	1	0	0	0	0
1995	1	1	0	2	2	26	26	31	0	0	3	11	12	3	2	0	0	0	0	0
1995	1	1	0	2	2	27	27	29	0	0	0	14	12	2	1	0	0	0	0	0
1995	1	1	0	2	2	28	28	13	0	0	0	2	6	2	3	0	0	0	0	0
1995	1	1	0	2	2	29	29	6	0	0	0	0	2	2	2	0	0	0	0	0
1995	1	1	0	2	2	30	30	1	0	0	0	0	0	0	1	0	0	0	0	0
1995	1	1	0	2	2	31	31	1	0	0	0	0	0	0	0	1	0	0	0	0
1996	1	1	0	2	2	13	13	1	0	1	0	0	0	0	0	0	0	0	0	0
1996	1	1	0	2	2	18	18	3	0	2	1	0	0	0	0	0	0	0	0	0
1996	1	1	0	2	2	20	20	3	0	2	1	0	0	0	0	0	0	0	0	0
1996	1	1	0	2	2	21	21	3	0	2	0	1	0	0	0	0	0	0	0	0
1996	1	1	0	2	2	22	22	4	0	1	1	1	1	0	0	0	0	0	0	0
1996	1	1	0	2	2	23	23	9	0	0	2	3	4	0	0	0	0	0	0	0
1996	1	1	0	2	2	24	24	15	0	0	5	5	2	3	0	0	0	0	0	0

1996	1	1	0	2	2	25	25	29	0	1	3	14	6	5	0	0	0	0	0
1996	1	1	0	2	2	26	26	36	0	0	4	14	11	5	1	0	0	1	0	0
1996	1	1	0	2	2	27	27	45	0	0	0	23	12	6	1	1	2	0	0	0
1996	1	1	0	2	2	28	28	38	0	0	0	14	14	4	2	1	1	1	0	1
1996	1	1	0	2	2	29	29	40	0	0	0	10	9	14	2	1	3	1	0	0
1996	1	1	0	2	2	30	30	18	0	0	0	2	8	3	3	0	2	0	0	0
1996	1	1	0	2	2	31	31	11	0	0	0	0	0	5	4	1	0	1	0	0
1996	1	1	0	2	2	32	32	1	0	0	0	0	0	0	1	0	0	0	0	0
1996	1	1	0	2	2	33	33	1	0	0	0	0	0	1	0	0	0	0	0	0
1997	1	1	0	2	2	17	17	1	0	1	0	0	0	0	0	0	0	0	0	0
1997	1	1	0	2	2	18	18	1	0	0	1	0	0	0	0	0	0	0	0	0
1997	1	1	0	2	2	19	19	1	0	1	0	0	0	0	0	0	0	0	0	0
1997	1	1	0	2	2	20	20	1	0	0	0	1	0	0	0	0	0	0	0	0
1998	1	1	0	2	2	18	18	1	0	1	0	0	0	0	0	0	0	0	0	0
1998	1	1	0	2	2	20	20	1	0	1	0	0	0	0	0	0	0	0	0	0
1998	1	1	0	2	2	22	22	1	0	0	0	1	0	0	0	0	0	0	0	0
1998	1	1	0	2	2	23	23	1	0	0	1	0	0	0	0	0	0	0	0	0
1998	1	1	0	2	2	26	26	1	0	0	0	0	1	0	0	0	0	0	0	0
1998	1	1	0	2	2	28	28	1	0	0	0	0	1	0	0	0	0	0	0	0
1999	1	1	0	2	2	21	21	1	0	1	0	0	0	0	0	0	0	0	0	0
1999	1	1	0	2	2	24	24	1	0	0	1	0	0	0	0	0	0	0	0	0
1999	1	1	0	2	2	26	26	1	0	0	0	1	0	0	0	0	0	0	0	0
1999	1	1	0	2	2	27	27	1	0	0	0	0	1	0	0	0	0	0	0	0
2000	1	1	0	2	2	17	17	1	0	0	1	0	0	0	0	0	0	0	0	0
2000	1	1	0	2	2	18	18	1	0	0	0	1	0	0	0	0	0	0	0	0

2000	1	1	0	2	2	19	19	5	0	0	3	2	0	0	0	0	0	0	0	0
2000	1	1	0	2	2	20	20	7	0	0	3	4	0	0	0	0	0	0	0	0
2000	1	1	0	2	2	21	21	4	0	0	0	2	2	0	0	0	0	0	0	0
2000	1	1	0	2	2	22	22	2	0	0	0	1	1	0	0	0	0	0	0	0
2000	1	1	0	2	2	23	23	2	0	0	1	1	0	0	0	0	0	0	0	0
2000	1	1	0	2	2	24	24	2	0	0	0	2	0	0	0	0	0	0	0	0
2000	1	1	0	2	2	26	26	1	0	0	0	0	0	1	0	0	0	0	0	0
2000	1	1	0	2	2	28	28	1	0	0	0	0	1	0	0	0	0	0	0	0
2000	1	1	0	2	2	29	29	1	0	0	0	0	0	1	0	0	0	0	0	0
2000	1	1	0	2	2	30	30	1	0	0	0	0	0	1	0	0	0	0	0	0
2000	1	1	0	2	2	32	32	1	0	0	0	0	0	1	0	0	0	0	0	0
2001	1	1	0	2	2	14	14	1	0	1	0	0	0	0	0	0	0	0	0	0
2001	1	1	0	2	2	16	16	2	0	1	1	0	0	0	0	0	0	0	0	0
2001	1	1	0	2	2	18	18	5	0	1	2	2	0	0	0	0	0	0	0	0
2001	1	1	0	2	2	19	19	6	0	0	4	2	0	0	0	0	0	0	0	0
2001	1	1	0	2	2	20	20	11	0	1	3	4	3	0	0	0	0	0	0	0
2001	1	1	0	2	2	21	21	16	0	0	3	8	5	0	0	0	0	0	0	0
2001	1	1	0	2	2	22	22	9	0	0	0	6	3	0	0	0	0	0	0	0
2001	1	1	0	2	2	23	23	7	0	0	0	5	1	0	1	0	0	0	0	0
2001	1	1	0	2	2	24	24	7	0	1	0	4	1	0	1	0	0	0	0	0
2001	1	1	0	2	2	25	25	5	0	0	0	4	1	0	0	0	0	0	0	0
2001	1	1	0	2	2	26	26	3	0	0	0	1	0	2	0	0	0	0	0	0
2001	1	1	0	2	2	28	28	3	0	0	0	2	0	0	1	0	0	0	0	0
2001	1	1	0	2	2	30	30	1	0	0	0	0	0	0	1	0	0	0	0	0
2001	1	1	0	2	2	33	33	1	0	0	0	0	0	0	1	0	0	0	0	0

2002	1	1	0	2	2	11	11	1	0	1	0	0	0	0	0	0	0	0	0	0
2002	1	1	0	2	2	12	12	6	0	6	0	0	0	0	0	0	0	0	0	0
2002	1	1	0	2	2	13	13	2	0	2	0	0	0	0	0	0	0	0	0	0
2002	1	1	0	2	2	14	14	1	0	1	0	0	0	0	0	0	0	0	0	0
2002	1	1	0	2	2	15	15	9	0	8	1	0	0	0	0	0	0	0	0	0
2002	1	1	0	2	2	16	16	4	0	3	1	0	0	0	0	0	0	0	0	0
2002	1	1	0	2	2	17	17	4	0	4	0	0	0	0	0	0	0	0	0	0
2002	1	1	0	2	2	18	18	1	0	1	0	0	0	0	0	0	0	0	0	0
2002	1	1	0	2	2	19	19	6	0	2	1	3	0	0	0	0	0	0	0	0
2002	1	1	0	2	2	20	20	9	0	2	3	1	2	1	0	0	0	0	0	0
2002	1	1	0	2	2	21	21	4	0	0	2	0	1	1	0	0	0	0	0	0
2002	1	1	0	2	2	22	22	3	0	0	1	1	1	0	0	0	0	0	0	0
2002	1	1	0	2	2	23	23	7	0	1	1	3	2	0	0	0	0	0	0	0
2002	1	1	0	2	2	24	24	11	0	0	3	5	3	0	0	0	0	0	0	0
2002	1	1	0	2	2	25	25	1	0	0	0	1	0	0	0	0	0	0	0	0
2002	1	1	0	2	2	26	26	7	0	1	2	3	1	0	0	0	0	0	0	0
2002	1	1	0	2	2	27	27	2	0	0	0	1	0	1	0	0	0	0	0	0
2002	1	1	0	2	2	28	28	2	0	0	0	0	1	1	0	0	0	0	0	0
2002	1	1	0	2	2	31	31	1	0	0	0	0	0	0	1	0	0	0	0	0
2003	1	1	0	2	2	18	18	4	0	3	1	0	0	0	0	0	0	0	0	0
2003	1	1	0	2	2	19	19	4	0	3	0	1	0	0	0	0	0	0	0	0
2003	1	1	0	2	2	20	20	8	0	0	4	2	2	0	0	0	0	0	0	0
2003	1	1	0	2	2	21	21	3	0	2	0	1	0	0	0	0	0	0	0	0
2003	1	1	0	2	2	22	22	8	0	2	4	2	0	0	0	0	0	0	0	0
2003	1	1	0	2	2	23	23	4	0	2	2	0	0	0	0	0	0	0	0	0

2003	1	1	0	2	2	24	24	13	0	1	6	3	2	1	0	0	0	0	0
2003	1	1	0	2	2	25	25	8	0	0	3	3	1	1	0	0	0	0	0
2003	1	1	0	2	2	26	26	2	0	0	0	1	1	0	0	0	0	0	0
2003	1	1	0	2	2	27	27	9	0	0	0	3	5	1	0	0	0	0	0
2003	1	1	0	2	2	28	28	9	0	0	0	2	3	3	1	0	0	0	0
2003	1	1	0	2	2	30	30	2	0	0	0	0	1	1	0	0	0	0	0
2004	1	1	0	2	2	13	13	1	1	0	0	0	0	0	0	0	0	0	0
2004	1	1	0	2	2	14	14	2	0	2	0	0	0	0	0	0	0	0	0
2004	1	1	0	2	2	15	15	3	0	3	0	0	0	0	0	0	0	0	0
2004	1	1	0	2	2	16	16	6	0	6	0	0	0	0	0	0	0	0	0
2004	1	1	0	2	2	17	17	8	0	5	2	0	1	0	0	0	0	0	0
2004	1	1	0	2	2	18	18	12	1	8	2	1	0	0	0	0	0	0	0
2004	1	1	0	2	2	19	19	7	0	1	1	2	2	1	0	0	0	0	0
2004	1	1	0	2	2	20	20	19	0	1	10	6	0	1	1	0	0	0	0
2004	1	1	0	2	2	21	21	14	0	2	6	3	2	1	0	0	0	0	0
2004	1	1	0	2	2	22	22	11	0	0	4	4	3	0	0	0	0	0	0
2004	1	1	0	2	2	23	23	6	0	0	1	3	2	0	0	0	0	0	0
2004	1	1	0	2	2	24	24	14	0	0	0	5	5	2	1	1	0	0	0
2004	1	1	0	2	2	25	25	9	0	0	0	4	2	1	1	1	0	0	0
2004	1	1	0	2	2	26	26	8	0	0	0	3	3	2	0	0	0	0	0
2004	1	1	0	2	2	27	27	7	0	0	0	3	0	1	2	1	0	0	0
2004	1	1	0	2	2	28	28	9	0	0	0	2	3	4	0	0	0	0	0
2004	1	1	0	2	2	29	29	6	0	0	0	0	1	3	2	0	0	0	0
2004	1	1	0	2	2	30	30	1	0	0	0	0	0	0	1	0	0	0	0
2004	1	1	0	2	2	31	31	3	0	0	0	0	1	0	1	1	0	0	0

2005	1	1	0	2	2	12	12	1	0	1	0	0	0	0	0	0	0
	0	0	0														
2005	1	1	0	2	2	14	14	12	0	12	0	0	0	0	0	0	0
	0	0	0														
2005	1	1	0	2	2	15	15	22	0	22	0	0	0	0	0	0	0
	0	0	0														
2005	1	1	0	2	2	16	16	18	0	15	1	2	0	0	0	0	0
	0	0	0														
2005	1	1	0	2	2	17	17	16	0	8	4	4	0	0	0	0	0
	0	0	0														
2005	1	1	0	2	2	18	18	13	0	3	4	5	1	0	0	0	0
	0	0	0														
2005	1	1	0	2	2	19	19	20	0	4	7	7	1	0	1	0	0
	0	0	0														
2005	1	1	0	2	2	20	20	21	0	1	9	5	3	3	0	0	0
	0	0	0														
2005	1	1	0	2	2	21	21	21	0	4	5	5	3	3	1	0	0
	0	0	0														
2005	1	1	0	2	2	22	22	21	0	0	8	6	3	3	0	1	0
	0	0	0														
2005	1	1	0	2	2	23	23	20	0	0	7	8	2	1	1	1	0
	0	0	0														
2005	1	1	0	2	2	24	24	26	0	0	5	6	7	6	1	1	0
	0	0	0														
2005	1	1	0	2	2	25	25	22	0	0	6	10	1	3	1	1	0
	0	0	0														
2005	1	1	0	2	2	26	26	21	0	0	2	6	4	5	3	1	0
	0	0	0														
2005	1	1	0	2	2	27	27	12	0	0	0	0	3	6	1	2	0
	0	0	0														
2005	1	1	0	2	2	28	28	8	0	0	0	0	3	2	1	2	0
	0	0	0														
2005	1	1	0	2	2	29	29	7	0	0	0	0	1	2	3	1	0
	0	0	0														
2005	1	1	0	2	2	30	30	4	0	0	0	0	0	1	1	2	0
	0	0	0														
2005	1	1	0	2	2	31	31	1	0	0	0	0	0	0	0	1	0
	0	0	0														
2006	1	1	0	2	2	14	14	1	0	1	0	0	0	0	0	0	0
	0	0	0														
2006	1	1	0	2	2	15	15	2	0	2	0	0	0	0	0	0	0
	0	0	0														
2006	1	1	0	2	2	16	16	16	0	15	1	0	0	0	0	0	0
	0	0	0														
2006	1	1	0	2	2	17	17	24	0	21	3	0	0	0	0	0	0
	0	0	0														
2006	1	1	0	2	2	18	18	20	1	12	3	4	0	0	0	0	0
	0	0	0														
2006	1	1	0	2	2	19	19	21	0	10	6	4	1	0	0	0	0
	0	0	0														

2006	1	1	0	2	2	20	20	9	0	1	5	3	0	0	0	0	0
	0	0	0														
2006	1	1	0	2	2	21	21	8	0	0	4	3	1	0	0	0	0
	0	0	0														
2006	1	1	0	2	2	22	22	3	0	1	1	1	0	0	0	0	0
	0	0	0														
2006	1	1	0	2	2	23	23	4	0	0	3	1	0	0	0	0	0
	0	0	0														
2006	1	1	0	2	2	24	24	9	0	0	1	5	3	0	0	0	0
	0	0	0														
2006	1	1	0	2	2	25	25	7	0	0	0	4	2	1	0	0	0
	0	0	0														
2006	1	1	0	2	2	26	26	1	0	0	0	1	0	0	0	0	0
	0	0	0														
2006	1	1	0	2	2	27	27	1	0	0	0	1	0	0	0	0	0
	0	0	0														
2007	1	1	0	2	2	15	15	3	2	0	1	0	0	0	0	0	0
	0	0	0														
2007	1	1	0	2	2	16	16	13	1	12	0	0	0	0	0	0	0
	0	0	0														
2007	1	1	0	2	2	17	17	15	0	9	4	2	0	0	0	0	0
	0	0	0														
2007	1	1	0	2	2	18	18	22	0	10	7	2	3	0	0	0	0
	0	0	0														
2007	1	1	0	2	2	19	19	21	0	3	7	8	1	0	2	0	0
	0	0	0														
2007	1	1	0	2	2	20	20	21	0	5	4	6	6	0	0	0	0
	0	0	0														
2007	1	1	0	2	2	21	21	12	0	1	4	4	2	1	0	0	0
	0	0	0														
2007	1	1	0	2	2	22	22	16	0	0	2	6	3	5	0	0	0
	0	0	0														
2007	1	1	0	2	2	23	23	7	0	0	1	2	4	0	0	0	0
	0	0	0														
2007	1	1	0	2	2	24	24	10	0	0	1	2	5	2	0	0	0
	0	0	0														
2007	1	1	0	2	2	25	25	17	0	0	1	4	10	2	0	0	0
	0	0	0														
2007	1	1	0	2	2	26	26	6	0	0	0	0	3	2	1	0	0
	0	0	0														
2008	1	1	0	2	2	11	11	2	0	2	0	0	0	0	0	0	0
	0	0	0														
2008	1	1	0	2	2	14	14	2	0	2	0	0	0	0	0	0	0
	0	0	0														
2008	1	1	0	2	2	15	15	12	1	10	0	1	0	0	0	0	0
	0	0	0														
2008	1	1	0	2	2	16	16	20	0	13	5	2	0	0	0	0	0
	0	0	0														
2008	1	1	0	2	2	17	17	38	3	22	5	6	2	0	0	0	0
	0	0	0														

2008	1	1	0	2	2	18	18	32	1	8	11	8	3	1	0	0	0	0	0	0
2008	1	1	0	2	2	19	19	37	0	11	9	6	9	1	1	0	0	0	0	0
2008	1	1	0	2	2	20	20	29	0	5	9	9	2	4	0	0	0	0	0	0
2008	1	1	0	2	2	21	21	27	0	6	8	6	5	1	1	0	0	0	0	0
2008	1	1	0	2	2	22	22	19	0	0	4	7	5	1	1	1	0	0	0	0
2008	1	1	0	2	2	23	23	18	0	2	2	4	7	2	1	0	0	0	0	0
2008	1	1	0	2	2	24	24	20	0	1	2	6	5	4	2	0	0	0	0	0
2008	1	1	0	2	2	25	25	15	0	0	1	2	6	5	1	0	0	0	0	0
2008	1	1	0	2	2	26	26	6	0	0	0	1	2	1	1	0	1	0	0	0
2008	1	1	0	2	2	27	27	8	0	0	0	4	2	2	0	0	0	0	0	0
2008	1	1	0	2	2	28	28	7	0	0	0	1	2	3	0	1	0	0	0	0
2008	1	1	0	2	2	29	29	3	0	0	0	0	0	3	0	0	0	0	0	0
2008	1	1	0	2	2	30	30	3	0	0	0	1	1	1	0	0	0	0	0	0
2009	1	1	0	2	2	13	13	1	0	1	0	0	0	0	0	0	0	0	0	0
2009	1	1	0	2	2	14	14	3	0	3	0	0	0	0	0	0	0	0	0	0
2009	1	1	0	2	2	15	15	1	0	0	1	0	0	0	0	0	0	0	0	0
2009	1	1	0	2	2	16	16	2	0	2	0	0	0	0	0	0	0	0	0	0
2009	1	1	0	2	2	17	17	11	0	5	5	1	0	0	0	0	0	0	0	0
2009	1	1	0	2	2	18	18	12	0	5	2	2	3	0	0	0	0	0	0	0
2009	1	1	0	2	2	19	19	16	0	2	6	5	2	1	0	0	0	0	0	0
2009	1	1	0	2	2	20	20	10	0	3	1	3	3	0	0	0	0	0	0	0
2009	1	1	0	2	2	21	21	14	0	5	2	3	3	1	0	0	0	0	0	0
2009	1	1	0	2	2	22	22	10	0	0	2	1	6	1	0	0	0	0	0	0
2009	1	1	0	2	2	23	23	7	0	0	5	0	2	0	0	0	0	0	0	0
2009	1	1	0	2	2	24	24	4	0	0	0	2	1	1	0	0	0	0	0	0

2009	1	1	0	2	2	25	25	4	0	0	0	0	2	2	0	0	0
	0	0	0														
2009	1	1	0	2	2	26	26	1	0	0	0	0	0	1	0	0	0
	0	0	0														
2009	1	1	0	2	2	27	27	2	0	0	1	0	1	0	0	0	0
	0	0	0														
2009	1	1	0	2	2	28	28	3	0	0	0	0	3	0	0	0	0
	0	0	0														
2009	1	1	0	2	2	29	29	2	0	0	0	0	0	1	1	0	0
	0	0	0														
2010	1	1	0	2	2	13	13	1	0	1	0	0	0	0	0	0	0
	0	0	0														
2010	1	1	0	2	2	15	15	1	0	1	0	0	0	0	0	0	0
	0	0	0														
2010	1	1	0	2	2	16	16	6	0	4	0	2	0	0	0	0	0
	0	0	0														
2010	1	1	0	2	2	17	17	11	0	3	6	0	2	0	0	0	0
	0	0	0														
2010	1	1	0	2	2	18	18	12	0	2	8	2	0	0	0	0	0
	0	0	0														
2010	1	1	0	2	2	19	19	9	1	0	4	0	3	1	0	0	0
	0	0	0														
2010	1	1	0	2	2	20	20	2	0	0	2	0	0	0	0	0	0
	0	0	0														
2010	1	1	0	2	2	21	21	7	0	1	4	2	0	0	0	0	0
	0	0	0														
2010	1	1	0	2	2	22	22	5	0	1	2	1	0	1	0	0	0
	0	0	0														
2010	1	1	0	2	2	23	23	3	0	0	1	2	0	0	0	0	0
	0	0	0														
2010	1	1	0	2	2	24	24	1	0	0	0	1	0	0	0	0	0
	0	0	0														
2010	1	1	0	2	2	25	25	7	0	0	0	5	2	0	0	0	0
	0	0	0														
2010	1	1	0	2	2	26	26	2	0	0	0	0	1	1	0	0	0
	0	0	0														
2010	1	1	0	2	2	27	27	4	0	0	0	3	0	1	0	0	0
	0	0	0														
2010	1	1	0	2	2	28	28	1	0	0	0	1	0	0	0	0	0
	0	0	0														
2010	1	1	0	2	2	29	29	1	0	0	0	0	0	0	0	0	1
	0	0	0														
2010	1	1	0	2	2	30	30	1	0	0	0	0	0	1	0	0	0
	0	0	0														
2011	1	1	0	2	2	15	15	3	3	0	0	0	0	0	0	0	0
	0	0	0														
2011	1	1	0	2	2	16	16	4	1	1	1	1	0	0	0	0	0
	0	0	0														
2011	1	1	0	2	2	17	17	4	0	3	1	0	0	0	0	0	0
	0	0	0														

2011	1	1	0	2	2	18	18	11	0	6	4	0	1	0	0	0	0	0	0	0
2011	1	1	0	2	2	19	19	10	0	4	2	2	1	1	0	0	0	0	0	0
2011	1	1	0	2	2	20	20	6	0	2	2	2	0	0	0	0	0	0	0	0
2011	1	1	0	2	2	21	21	8	0	0	2	2	3	1	0	0	0	0	0	0
2011	1	1	0	2	2	22	22	7	0	0	5	1	0	1	0	0	0	0	0	0
2011	1	1	0	2	2	23	23	1	0	0	0	1	0	0	0	0	0	0	0	0
2011	1	1	0	2	2	24	24	4	0	0	3	0	1	0	0	0	0	0	0	0
2011	1	1	0	2	2	25	25	2	0	0	0	1	0	0	1	0	0	0	0	0
2011	1	1	0	2	2	26	26	5	0	0	0	3	0	2	0	0	0	0	0	0
2011	1	1	0	2	2	27	27	5	0	0	0	3	2	0	0	0	0	0	0	0
2011	1	1	0	2	2	28	28	2	0	0	0	0	1	0	1	0	0	0	0	0
2011	1	1	0	2	2	29	29	1	0	0	0	0	1	0	0	0	0	0	0	0
2011	1	1	0	2	2	30	30	3	0	0	0	1	1	1	0	0	0	0	0	0
1988	1	2	0	2	2	14	14	2	0	2	0	0	0	0	0	0	0	0	0	0
1988	1	2	0	2	2	17	17	1	0	0	1	0	0	0	0	0	0	0	0	0
1989	1	2	0	2	2	13	13	1	0	1	0	0	0	0	0	0	0	0	0	0
1989	1	2	0	2	2	14	14	2	2	0	0	0	0	0	0	0	0	0	0	0
1989	1	2	0	2	2	15	15	15	3	12	0	0	0	0	0	0	0	0	0	0
1989	1	2	0	2	2	16	16	27	3	21	3	0	0	0	0	0	0	0	0	0
1989	1	2	0	2	2	17	17	28	1	20	7	0	0	0	0	0	0	0	0	0
1989	1	2	0	2	2	18	18	19	0	14	4	1	0	0	0	0	0	0	0	0
1989	1	2	0	2	2	19	19	10	0	6	3	1	0	0	0	0	0	0	0	0
1989	1	2	0	2	2	20	20	6	0	2	1	2	1	0	0	0	0	0	0	0
1989	1	2	0	2	2	21	21	4	0	1	1	2	0	0	0	0	0	0	0	0
1989	1	2	0	2	2	22	22	2	0	0	0	2	0	0	0	0	0	0	0	0

1990	1	2	0	2	2	13	13	1	0	1	0	0	0	0	0	0	0	0	0	0
1990	1	2	0	2	2	14	14	18	0	18	0	0	0	0	0	0	0	0	0	0
1990	1	2	0	2	2	15	15	49	0	49	0	0	0	0	0	0	0	0	0	0
1990	1	2	0	2	2	16	16	31	0	28	3	0	0	0	0	0	0	0	0	0
1990	1	2	0	2	2	17	17	25	0	12	10	3	0	0	0	0	0	0	0	0
1990	1	2	0	2	2	18	18	12	0	5	5	2	0	0	0	0	0	0	0	0
1990	1	2	0	2	2	19	19	4	0	2	1	0	0	1	0	0	0	0	0	0
1990	1	2	0	2	2	20	20	1	0	0	1	0	0	0	0	0	0	0	0	0
1990	1	2	0	2	2	21	21	3	0	0	0	3	0	0	0	0	0	0	0	0
1990	1	2	0	2	2	22	22	1	0	0	0	0	1	0	0	0	0	0	0	0
1990	1	2	0	2	2	23	23	4	0	0	2	0	2	0	0	0	0	0	0	0
1990	1	2	0	2	2	24	24	1	0	0	0	0	0	1	0	0	0	0	0	0
1990	1	2	0	2	2	25	25	3	0	0	1	2	0	0	0	0	0	0	0	0
1990	1	2	0	2	2	26	26	1	0	0	0	0	0	1	0	0	0	0	0	0
1991	1	2	0	2	2	15	15	1	0	1	0	0	0	0	0	0	0	0	0	0
1991	1	2	0	2	2	18	18	2	0	0	2	0	0	0	0	0	0	0	0	0
1991	1	2	0	2	2	19	19	5	0	2	3	0	0	0	0	0	0	0	0	0
1991	1	2	0	2	2	20	20	3	0	1	0	0	1	1	0	0	0	0	0	0
1991	1	2	0	2	2	21	21	4	0	0	2	0	0	2	0	0	0	0	0	0
1991	1	2	0	2	2	22	22	10	0	1	2	5	1	1	0	0	0	0	0	0
1991	1	2	0	2	2	23	23	11	0	0	5	1	2	1	1	1	0	0	0	0
1991	1	2	0	2	2	24	24	17	0	0	5	1	7	1	2	1	0	0	0	0
1991	1	2	0	2	2	25	25	19	0	0	5	5	4	2	1	2	0	0	0	0
1991	1	2	0	2	2	26	26	16	0	0	6	5	1	0	2	2	0	0	0	0
1991	1	2	0	2	2	27	27	13	0	0	1	6	3	3	0	0	0	0	0	0

1991	1	2	0	2	2	28	28	14	0	0	2	2	3	6	1	0	0
	0	0	0														
1991	1	2	0	2	2	29	29	15	0	0	0	4	2	7	1	1	0
	0	0	0														
1991	1	2	0	2	2	30	30	6	0	0	1	1	2	2	0	0	0
	0	0	0														
1991	1	2	0	2	2	31	31	5	0	0	0	1	2	2	0	0	0
	0	0	0														
1992	1	2	0	2	2	15	15	2	0	2	0	0	0	0	0	0	0
	0	0	0														
1992	1	2	0	2	2	16	16	1	0	1	0	0	0	0	0	0	0
	0	0	0														
1992	1	2	0	2	2	17	17	2	0	2	0	0	0	0	0	0	0
	0	0	0														
1992	1	2	0	2	2	18	18	6	0	1	5	0	0	0	0	0	0
	0	0	0														
1992	1	2	0	2	2	19	19	3	0	0	3	0	0	0	0	0	0
	0	0	0														
1992	1	2	0	2	2	22	22	2	0	1	1	0	0	0	0	0	0
	0	0	0														
1992	1	2	0	2	2	23	23	1	0	0	1	0	0	0	0	0	0
	0	0	0														
1992	1	2	0	2	2	25	25	1	0	0	0	0	1	0	0	0	0
	0	0	0														
1992	1	2	0	2	2	26	26	3	0	0	0	1	2	0	0	0	0
	0	0	0														
1992	1	2	0	2	2	27	27	2	0	0	0	1	1	0	0	0	0
	0	0	0														
1992	1	2	0	2	2	28	28	3	0	0	0	2	1	0	0	0	0
	0	0	0														
1992	1	2	0	2	2	29	29	1	0	0	0	0	1	0	0	0	0
	0	0	0														
1992	1	2	0	2	2	30	30	1	0	0	0	0	0	1	0	0	0
	0	0	0														
1993	1	2	0	2	2	19	19	2	0	1	0	1	0	0	0	0	0
	0	0	0														
1993	1	2	0	2	2	20	20	2	0	0	1	1	0	0	0	0	0
	0	0	0														
1993	1	2	0	2	2	21	21	4	0	1	3	0	0	0	0	0	0
	0	0	0														
1993	1	2	0	2	2	22	22	7	0	0	3	2	2	0	0	0	0
	0	0	0														
1993	1	2	0	2	2	23	23	8	0	0	2	3	3	0	0	0	0
	0	0	0														
1993	1	2	0	2	2	24	24	4	0	0	0	2	1	1	0	0	0
	0	0	0														
1993	1	2	0	2	2	25	25	6	0	0	0	1	3	2	0	0	0
	0	0	0														
1993	1	2	0	2	2	26	26	6	0	0	0	4	0	2	0	0	0
	0	0	0														

1993	1	2	0	2	2	27	27	5	0	0	0	2	3	0	0	0	0	0	0	0
1993	1	2	0	2	2	28	28	11	0	0	0	3	6	1	0	0	0	1	0	0
1993	1	2	0	2	2	29	29	1	0	0	0	1	0	0	0	0	0	0	0	0
1993	1	2	0	2	2	30	30	7	0	0	0	0	6	0	1	0	0	0	0	0
1994	1	2	0	2	2	17	17	1	0	1	0	0	0	0	0	0	0	0	0	0
1994	1	2	0	2	2	20	20	1	0	1	0	0	0	0	0	0	0	0	0	0
1994	1	2	0	2	2	22	22	1	0	1	0	0	0	0	0	0	0	0	0	0
1994	1	2	0	2	2	23	23	5	0	0	4	1	0	0	0	0	0	0	0	0
1994	1	2	0	2	2	24	24	3	0	0	0	2	1	0	0	0	0	0	0	0
1994	1	2	0	2	2	25	25	2	0	0	0	2	0	0	0	0	0	0	0	0
1994	1	2	0	2	2	26	26	3	0	0	1	1	1	0	0	0	0	0	0	0
1994	1	2	0	2	2	27	27	2	0	0	0	0	1	1	0	0	0	0	0	0
1994	1	2	0	2	2	28	28	1	0	0	0	1	0	0	0	0	0	0	0	0
1994	1	2	0	2	2	30	30	2	0	0	0	0	1	0	1	0	0	0	0	0
1994	1	2	0	2	2	31	31	1	0	0	0	0	0	1	0	0	0	0	0	0
1994	1	2	0	2	2	33	33	1	0	0	0	0	1	0	0	0	0	0	0	0
1995	1	2	0	2	2	14	14	1	0	1	0	0	0	0	0	0	0	0	0	0
1995	1	2	0	2	2	15	15	2	1	1	0	0	0	0	0	0	0	0	0	0
1995	1	2	0	2	2	17	17	2	0	0	2	0	0	0	0	0	0	0	0	0
1995	1	2	0	2	2	18	18	2	0	0	2	0	0	0	0	0	0	0	0	0
1995	1	2	0	2	2	19	19	2	0	0	2	0	0	0	0	0	0	0	0	0
1995	1	2	0	2	2	20	20	1	0	0	0	0	1	0	0	0	0	0	0	0
1995	1	2	0	2	2	22	22	1	0	0	0	0	1	0	0	0	0	0	0	0
1995	1	2	0	2	2	24	24	1	0	0	1	0	0	0	0	0	0	0	0	0
1995	1	2	0	2	2	25	25	2	0	0	1	0	0	1	0	0	0	0	0	0

1995	1	2	0	2	2	26	26	1	0	0	0	0	1	0	0	0	0	0	0	0
1995	1	2	0	2	2	27	27	1	0	0	1	0	0	0	0	0	0	0	0	0
1995	1	2	0	2	2	28	28	1	0	0	0	0	1	0	0	0	0	0	0	0
1995	1	2	0	2	2	32	32	1	0	0	0	0	0	1	0	0	0	0	0	0
1996	1	2	0	2	2	24	24	1	0	0	0	0	0	1	0	0	0	0	0	0
1996	1	2	0	2	2	27	27	1	0	0	0	1	0	0	0	0	0	0	0	0
1996	1	2	0	2	2	28	28	3	0	0	0	2	0	0	1	0	0	0	0	0
1996	1	2	0	2	2	29	29	2	0	0	0	0	1	1	0	0	0	0	0	0
1996	1	2	0	2	2	32	32	1	0	0	0	0	0	1	0	0	0	0	0	0
1997	1	2	0	2	2	22	22	1	0	0	1	0	0	0	0	0	0	0	0	0
1997	1	2	0	2	2	23	23	2	0	0	2	0	0	0	0	0	0	0	0	0
1997	1	2	0	2	2	24	24	1	0	0	0	1	0	0	0	0	0	0	0	0
1997	1	2	0	2	2	26	26	1	0	0	0	1	0	0	0	0	0	0	0	0
1998	1	2	0	2	2	24	24	1	0	0	1	0	0	0	0	0	0	0	0	0
1998	1	2	0	2	2	25	25	1	0	0	0	1	0	0	0	0	0	0	0	0
1998	1	2	0	2	2	26	26	2	0	0	1	1	0	0	0	0	0	0	0	0
1998	1	2	0	2	2	27	27	4	0	0	0	3	1	0	0	0	0	0	0	0
1998	1	2	0	2	2	28	28	1	0	0	0	1	0	0	0	0	0	0	0	0
1998	1	2	0	2	2	29	29	1	0	0	0	1	0	0	0	0	0	0	0	0
1999	1	2	0	2	2	27	27	1	0	0	0	0	1	0	0	0	0	0	0	0
1999	1	2	0	2	2	30	30	1	0	0	0	1	0	0	0	0	0	0	0	0
2001	1	2	0	2	2	20	20	1	0	0	0	1	0	0	0	0	0	0	0	0
2001	1	2	0	2	2	22	22	1	0	0	1	0	0	0	0	0	0	0	0	0
2001	1	2	0	2	2	24	24	1	0	0	0	1	0	0	0	0	0	0	0	0
2001	1	2	0	2	2	27	27	1	0	0	0	1	0	0	0	0	0	0	0	0

2001	1	2	0	2	2	28	28	4	0	0	0	0	1	2	0	0	1	0	0	0
2001	1	2	0	2	2	29	29	2	0	0	0	2	0	0	0	0	0	0	0	0
2001	1	2	0	2	2	30	30	1	0	0	0	0	0	0	1	0	0	0	0	0
2001	1	2	0	2	2	34	34	1	0	0	0	0	0	0	0	1	0	0	0	0
2002	1	2	0	2	2	19	19	1	0	0	0	1	0	0	0	0	0	0	0	0
2002	1	2	0	2	2	23	23	4	0	0	0	1	1	2	0	0	0	0	0	0
2002	1	2	0	2	2	24	24	3	0	0	1	1	1	0	0	0	0	0	0	0
2002	1	2	0	2	2	25	25	2	0	0	0	2	0	0	0	0	0	0	0	0
2002	1	2	0	2	2	26	26	1	0	0	0	0	1	0	0	0	0	0	0	0
2002	1	2	0	2	2	27	27	1	0	0	0	0	1	0	0	0	0	0	0	0
2002	1	2	0	2	2	29	29	1	0	0	0	1	0	0	0	0	0	0	0	0
2003	1	2	0	2	2	14	14	1	0	1	0	0	0	0	0	0	0	0	0	0
2003	1	2	0	2	2	15	15	1	0	1	0	0	0	0	0	0	0	0	0	0
2003	1	2	0	2	2	16	16	6	0	3	3	0	0	0	0	0	0	0	0	0
2003	1	2	0	2	2	17	17	8	0	1	6	1	0	0	0	0	0	0	0	0
2003	1	2	0	2	2	19	19	3	0	0	2	1	0	0	0	0	0	0	0	0
2003	1	2	0	2	2	20	20	3	0	0	2	1	0	0	0	0	0	0	0	0
2003	1	2	0	2	2	21	21	4	0	0	2	1	1	0	0	0	0	0	0	0
2003	1	2	0	2	2	22	22	1	0	0	0	0	0	0	0	0	1	0	0	0
2003	1	2	0	2	2	23	23	3	0	0	2	1	0	0	0	0	0	0	0	0
2003	1	2	0	2	2	24	24	1	0	0	1	0	0	0	0	0	0	0	0	0
2003	1	2	0	2	2	25	25	1	0	0	0	0	0	0	0	0	1	0	0	0
2003	1	2	0	2	2	28	28	1	0	0	0	1	0	0	0	0	0	0	0	0
2003	1	2	0	2	2	32	32	3	0	0	0	0	0	1	2	0	0	0	0	0
2004	1	2	0	2	2	20	20	1	0	0	0	0	1	0	0	0	0	0	0	0

2004	1	2	0	2	2	22	22	1	0	0	0	1	0	0	0	0	0	0	0
2004	1	2	0	2	2	24	24	1	0	0	0	0	0	1	0	0	0	0	0
2004	1	2	0	2	2	26	26	1	0	0	0	1	0	0	0	0	0	0	0
2004	1	2	0	2	2	27	27	1	0	0	0	0	1	0	0	0	0	0	0
2005	1	2	0	2	2	18	18	1	0	0	1	0	0	0	0	0	0	0	0
2005	1	2	0	2	2	19	19	1	0	1	0	0	0	0	0	0	0	0	0
2005	1	2	0	2	2	21	21	1	0	0	0	0	0	0	0	1	0	0	0
2005	1	2	0	2	2	22	22	3	0	0	1	0	1	1	0	0	0	0	0
2005	1	2	0	2	2	23	23	5	0	0	2	0	1	1	1	0	0	0	0
2005	1	2	0	2	2	24	24	4	0	1	0	0	2	0	1	0	0	0	0
2005	1	2	0	2	2	25	25	1	0	0	1	0	0	0	0	0	0	0	0
2005	1	2	0	2	2	26	26	3	0	0	0	1	0	0	1	1	0	0	0
2005	1	2	0	2	2	27	27	3	0	0	0	0	0	1	2	0	0	0	0
2005	1	2	0	2	2	28	28	3	0	0	1	0	1	0	1	0	0	0	0
2005	1	2	0	2	2	29	29	3	0	0	0	0	0	1	1	1	0	0	0
2006	1	2	0	2	2	19	19	1	0	0	0	1	0	0	0	0	0	0	0
2006	1	2	0	2	2	22	22	1	0	0	0	0	1	0	0	0	0	0	0
2006	1	2	0	2	2	23	23	1	0	0	1	0	0	0	0	0	0	0	0
2006	1	2	0	2	2	25	25	3	0	0	0	1	1	1	0	0	0	0	0
2006	1	2	0	2	2	26	26	5	0	0	0	2	1	1	1	0	0	0	0
2007	1	2	0	2	2	16	16	1	0	1	0	0	0	0	0	0	0	0	0
2007	1	2	0	2	2	17	17	5	0	0	3	1	1	0	0	0	0	0	0
2007	1	2	0	2	2	18	18	4	0	0	2	2	0	0	0	0	0	0	0
2007	1	2	0	2	2	20	20	1	0	0	0	0	1	0	0	0	0	0	0
2007	1	2	0	2	2	22	22	3	0	0	0	0	2	1	0	0	0	0	0

2007	1	2	0	2	2	23	23	1	0	0	0	1	0	0	0	0	0	0	0	0
2007	1	2	0	2	2	24	24	2	0	0	0	2	0	0	0	0	0	0	0	0
2007	1	2	0	2	2	25	25	1	0	0	1	0	0	0	0	0	0	0	0	0
2007	1	2	0	2	2	26	26	1	0	0	0	0	0	0	0	1	0	0	0	0
2008	1	2	0	2	2	16	16	1	0	0	0	1	0	0	0	0	0	0	0	0
2008	1	2	0	2	2	21	21	1	0	0	1	0	0	0	0	0	0	0	0	0
2008	1	2	0	2	2	22	22	2	0	0	0	1	0	1	0	0	0	0	0	0
2008	1	2	0	2	2	23	23	3	0	1	0	0	2	0	0	0	0	0	0	0
2008	1	2	0	2	2	24	24	2	0	0	0	0	2	0	0	0	0	0	0	0
2008	1	2	0	2	2	25	25	2	0	0	0	0	0	1	1	0	0	0	0	0
2008	1	2	0	2	2	26	26	2	0	0	0	0	0	2	0	0	0	0	0	0
2008	1	2	0	2	2	27	27	3	0	0	0	1	2	0	0	0	0	0	0	0
2008	1	2	0	2	2	28	28	2	0	0	0	1	0	1	0	0	0	0	0	0
2008	1	2	0	2	2	30	30	3	0	0	0	0	2	1	0	0	0	0	0	0
2008	1	2	0	2	2	32	32	1	0	0	0	0	0	0	0	1	0	0	0	0
2009	1	2	0	2	2	18	18	2	0	0	1	0	0	1	0	0	0	0	0	0
2009	1	2	0	2	2	21	21	3	0	0	0	1	2	0	0	0	0	0	0	0
2009	1	2	0	2	2	22	22	6	0	0	1	2	2	0	1	0	0	0	0	0
2009	1	2	0	2	2	23	23	1	0	0	0	1	0	0	0	0	0	0	0	0
2009	1	2	0	2	2	24	24	4	0	0	0	1	2	1	0	0	0	0	0	0
2009	1	2	0	2	2	25	25	3	0	0	0	0	2	0	0	1	0	0	0	0
2009	1	2	0	2	2	26	26	5	0	0	0	1	0	4	0	0	0	0	0	0
2009	1	2	0	2	2	27	27	2	0	0	0	0	1	1	0	0	0	0	0	0
2009	1	2	0	2	2	28	28	6	0	0	0	0	0	3	2	0	1	0	0	0
2009	1	2	0	2	2	29	29	2	0	0	0	0	1	1	0	0	0	0	0	0

2009	1	2	0	2	2	30	30	1	0	0	0	0	1	0	0	0	0	0	0	0
2010	1	2	0	2	2	19	19	2	1	0	1	0	0	0	0	0	0	0	0	0
2010	1	2	0	2	2	20	20	1	0	0	0	0	0	0	1	0	0	0	0	0
2010	1	2	0	2	2	22	22	2	0	0	0	1	0	1	0	0	0	0	0	0
2010	1	2	0	2	2	23	23	2	0	0	1	0	0	0	0	1	0	0	0	0
2010	1	2	0	2	2	24	24	4	0	2	1	1	0	0	0	0	0	0	0	0
2010	1	2	0	2	2	25	25	2	0	0	1	0	0	0	1	0	0	0	0	0
2010	1	2	0	2	2	26	26	3	0	0	0	3	0	0	0	0	0	0	0	0
2010	1	2	0	2	2	27	27	4	0	0	0	3	1	0	0	0	0	0	0	0
2010	1	2	0	2	2	28	28	7	0	0	0	4	2	1	0	0	0	0	0	0
2010	1	2	0	2	2	29	29	6	0	0	1	4	1	0	0	0	0	0	0	0
2010	1	2	0	2	2	30	30	2	0	0	0	1	1	0	0	0	0	0	0	0
2010	1	2	0	2	2	31	31	2	0	0	0	0	0	0	2	0	0	0	0	0
2010	1	2	0	2	2	32	32	1	0	0	0	0	0	1	0	0	0	0	0	0
2011	1	2	0	2	2	15	15	1	0	1	0	0	0	0	0	0	0	0	0	0
2011	1	2	0	2	2	17	17	2	0	0	1	0	1	0	0	0	0	0	0	0
2011	1	2	0	2	2	18	18	1	0	0	0	0	1	0	0	0	0	0	0	0
2011	1	2	0	2	2	19	19	2	0	0	0	0	0	2	0	0	0	0	0	0
2011	1	2	0	2	2	20	20	2	0	1	0	1	0	0	0	0	0	0	0	0
2011	1	2	0	2	2	21	21	7	0	1	0	3	2	1	0	0	0	0	0	0
2011	1	2	0	2	2	22	22	10	0	1	1	1	2	3	1	1	0	0	0	0
2011	1	2	0	2	2	23	23	13	0	1	2	3	4	1	1	1	0	0	0	0
2011	1	2	0	2	2	24	24	11	0	0	3	4	1	2	0	1	0	0	0	0
2011	1	2	0	2	2	25	25	30	0	1	3	5	6	8	5	1	1	0	0	0
2011	1	2	0	2	2	26	26	32	0	0	2	7	12	6	5	0	0	0	0	0

2011	1	2	0	2	2	27	27	24	0	0	0	3	15	3	2	1	0	0	0
2011	1	2	0	2	2	28	28	23	0	0	0	7	10	6	0	0	0	0	0
2011	1	2	0	2	2	29	29	15	0	0	0	1	11	1	0	2	0	0	0
2011	1	2	0	2	2	30	30	12	0	0	0	0	6	4	2	0	0	0	0
2011	1	2	0	2	2	31	31	5	0	0	0	1	3	0	1	0	0	0	0
1988	1	3	0	2	2	12	12	1	0	1	0	0	0	0	0	0	0	0	0
1988	1	3	0	2	2	13	13	1	0	1	0	0	0	0	0	0	0	0	0
1988	1	3	0	2	2	14	14	2	1	1	0	0	0	0	0	0	0	0	0
1988	1	3	0	2	2	15	15	10	0	10	0	0	0	0	0	0	0	0	0
1988	1	3	0	2	2	16	16	23	0	5	17	0	1	0	0	0	0	0	0
1988	1	3	0	2	2	17	17	21	0	1	19	1	0	0	0	0	0	0	0
1988	1	3	0	2	2	18	18	8	0	2	5	1	0	0	0	0	0	0	0
1988	1	3	0	2	2	19	19	12	0	2	1	6	2	1	0	0	0	0	0
1988	1	3	0	2	2	20	20	7	0	0	3	0	1	1	1	1	0	0	0
1988	1	3	0	2	2	21	21	1	0	0	0	0	1	0	0	0	0	0	0
1988	1	3	0	2	2	22	22	3	0	0	0	2	0	1	0	0	0	0	0
1988	1	3	0	2	2	23	23	6	0	0	1	2	2	1	0	0	0	0	0
1988	1	3	0	2	2	24	24	7	0	0	1	1	3	1	0	1	0	0	0
1988	1	3	0	2	2	25	25	16	0	0	1	2	8	3	2	0	0	0	0
1988	1	3	0	2	2	26	26	8	0	0	0	1	5	0	1	0	0	0	1	0
1988	1	3	0	2	2	27	27	12	0	0	1	2	5	1	2	0	0	0	1	0
1988	1	3	0	2	2	28	28	3	0	0	0	1	1	0	0	1	0	0	0
1988	1	3	0	2	2	29	29	6	0	0	0	2	2	1	0	1	0	0	0
1988	1	3	0	2	2	30	30	6	0	0	0	0	2	1	1	2	0	0	0
1988	1	3	0	2	2	31	31	2	0	0	0	0	0	2	0	0	0	0	0

1988	1	3	0	2	2	32	32	1	0	0	0	0	0	1	0	0	0	0	0
1989	1	3	0	2	2	13	13	10	10	0	0	0	0	0	0	0	0	0	0
1989	1	3	0	2	2	14	14	14	13	1	0	0	0	0	0	0	0	0	0
1989	1	3	0	2	2	15	15	14	13	1	0	0	0	0	0	0	0	0	0
1989	1	3	0	2	2	16	16	19	13	6	0	0	0	0	0	0	0	0	0
1989	1	3	0	2	2	17	17	14	3	9	2	0	0	0	0	0	0	0	0
1989	1	3	0	2	2	18	18	32	6	20	5	1	0	0	0	0	0	0	0
1989	1	3	0	2	2	19	19	16	0	11	5	0	0	0	0	0	0	0	0
1989	1	3	0	2	2	20	20	17	1	5	8	2	0	1	0	0	0	0	0
1989	1	3	0	2	2	21	21	16	0	4	6	1	4	1	0	0	0	0	0
1989	1	3	0	2	2	22	22	20	0	0	11	3	3	3	0	0	0	0	0
1989	1	3	0	2	2	23	23	18	0	0	5	6	6	1	0	0	0	0	0
1989	1	3	0	2	2	24	24	17	0	0	6	2	5	2	1	1	0	0	0
1989	1	3	0	2	2	25	25	10	0	0	2	4	2	0	2	0	0	0	0
1989	1	3	0	2	2	26	26	13	0	0	1	1	7	3	1	0	0	0	0
1989	1	3	0	2	2	27	27	4	0	0	0	0	2	2	0	0	0	0	0
1989	1	3	0	2	2	28	28	6	0	0	0	2	3	1	0	0	0	0	0
1989	1	3	0	2	2	29	29	4	0	0	0	0	4	0	0	0	0	0	0
1989	1	3	0	2	2	30	30	8	0	0	0	1	1	6	0	0	0	0	0
1989	1	3	0	2	2	31	31	1	0	0	0	0	0	0	0	0	1	0	0
1990	1	3	0	2	2	13	13	12	5	7	0	0	0	0	0	0	0	0	0
1990	1	3	0	2	2	14	14	49	6	43	0	0	0	0	0	0	0	0	0
1990	1	3	0	2	2	15	15	73	2	70	1	0	0	0	0	0	0	0	0
1990	1	3	0	2	2	16	16	43	0	37	5	1	0	0	0	0	0	0	0
1990	1	3	0	2	2	17	17	59	1	37	17	3	1	0	0	0	0	0	0

1990	1	3	0	2	2	18	18	46	0	20	19	7	0	0	0	0	0	0	0	0
1990	1	3	0	2	2	19	19	56	1	21	22	9	3	0	0	0	0	0	0	0
1990	1	3	0	2	2	20	20	42	0	9	14	11	6	1	0	0	1	0	0	0
1990	1	3	0	2	2	21	21	41	0	11	16	8	3	3	0	0	0	0	0	0
1990	1	3	0	2	2	22	22	22	0	6	9	1	3	1	1	0	1	0	0	0
1990	1	3	0	2	2	23	23	29	0	7	13	5	2	1	0	0	1	0	0	0
1990	1	3	0	2	2	24	24	29	0	3	7	8	6	2	2	1	0	0	0	0
1990	1	3	0	2	2	25	25	23	0	0	5	9	4	4	1	0	0	0	0	0
1990	1	3	0	2	2	26	26	20	0	0	7	2	7	3	1	0	0	0	0	0
1990	1	3	0	2	2	27	27	17	0	0	1	8	5	1	2	0	0	0	0	0
1990	1	3	0	2	2	28	28	24	0	0	0	4	8	8	3	0	1	0	0	0
1990	1	3	0	2	2	29	29	10	0	0	0	5	3	0	0	2	0	0	0	0
1990	1	3	0	2	2	30	30	11	0	0	0	2	4	4	0	1	0	0	0	0
1990	1	3	0	2	2	31	31	1	0	0	0	0	0	1	0	0	0	0	0	0
1990	1	3	0	2	2	32	32	5	0	0	0	0	0	3	2	0	0	0	0	0
1990	1	3	0	2	2	33	33	5	0	0	0	1	0	3	1	0	0	0	0	0
1990	1	3	0	2	2	35	35	1	0	0	0	0	1	0	0	0	0	0	0	0
1991	1	3	0	2	2	12	12	1	0	1	0	0	0	0	0	0	0	0	0	0
1991	1	3	0	2	2	13	13	23	10	13	0	0	0	0	0	0	0	0	0	0
1991	1	3	0	2	2	14	14	12	2	10	0	0	0	0	0	0	0	0	0	0
1991	1	3	0	2	2	15	15	17	0	16	1	0	0	0	0	0	0	0	0	0
1991	1	3	0	2	2	16	16	24	0	22	2	0	0	0	0	0	0	0	0	0
1991	1	3	0	2	2	17	17	19	0	16	3	0	0	0	0	0	0	0	0	0
1991	1	3	0	2	2	18	18	19	0	15	3	1	0	0	0	0	0	0	0	0
1991	1	3	0	2	2	19	19	20	0	10	6	4	0	0	0	0	0	0	0	0

1991	1	3	0	2	2	20	20	17	0	8	7	0	1	1	0	0	0	0	0	0
1991	1	3	0	2	2	21	21	22	0	6	11	2	3	0	0	0	0	0	0	0
1991	1	3	0	2	2	22	22	18	0	1	7	7	2	0	0	1	0	0	0	0
1991	1	3	0	2	2	23	23	26	0	6	13	2	2	2	1	0	0	0	0	0
1991	1	3	0	2	2	24	24	19	0	3	8	2	2	1	1	2	0	0	0	0
1991	1	3	0	2	2	25	25	19	0	0	6	8	4	1	0	0	0	0	0	0
1991	1	3	0	2	2	26	26	23	0	0	11	7	2	2	1	0	0	0	0	0
1991	1	3	0	2	2	27	27	13	0	0	4	3	4	1	0	1	0	0	0	0
1991	1	3	0	2	2	28	28	22	0	0	3	8	7	3	0	1	0	0	0	0
1991	1	3	0	2	2	29	29	13	0	0	1	1	3	4	3	1	0	0	0	0
1991	1	3	0	2	2	30	30	5	0	0	0	0	3	2	0	0	0	0	0	0
1991	1	3	0	2	2	31	31	3	0	0	0	0	1	2	0	0	0	0	0	0
1991	1	3	0	2	2	33	33	2	0	0	0	0	1	0	0	0	0	1	0	0
1992	1	3	0	2	2	13	13	1	0	0	1	0	0	0	0	0	0	0	0	0
1992	1	3	0	2	2	14	14	15	0	13	2	0	0	0	0	0	0	0	0	0
1992	1	3	0	2	2	15	15	28	0	25	2	1	0	0	0	0	0	0	0	0
1992	1	3	0	2	2	16	16	41	0	22	17	2	0	0	0	0	0	0	0	0
1992	1	3	0	2	2	17	17	56	0	23	31	2	0	0	0	0	0	0	0	0
1992	1	3	0	2	2	18	18	25	0	9	16	0	0	0	0	0	0	0	0	0
1992	1	3	0	2	2	19	19	21	1	6	14	0	0	0	0	0	0	0	0	0
1992	1	3	0	2	2	20	20	13	0	0	11	2	0	0	0	0	0	0	0	0
1992	1	3	0	2	2	21	21	9	0	1	4	4	0	0	0	0	0	0	0	0
1992	1	3	0	2	2	22	22	11	0	0	4	5	0	2	0	0	0	0	0	0
1992	1	3	0	2	2	23	23	10	0	0	5	4	1	0	0	0	0	0	0	0
1992	1	3	0	2	2	24	24	10	0	1	7	2	0	0	0	0	0	0	0	0

1992	1	3	0	2	2	25	25	14	0	0	5	4	2	1	2	0	0	0	0	0
1992	1	3	0	2	2	26	26	10	0	2	3	1	4	0	0	0	0	0	0	0
1992	1	3	0	2	2	27	27	14	0	0	4	6	4	0	0	0	0	0	0	0
1992	1	3	0	2	2	28	28	6	0	0	0	2	4	0	0	0	0	0	0	0
1992	1	3	0	2	2	29	29	7	0	0	2	1	2	2	0	0	0	0	0	0
1992	1	3	0	2	2	30	30	4	0	0	0	0	3	1	0	0	0	0	0	0
1992	1	3	0	2	2	31	31	2	0	0	1	0	1	0	0	0	0	0	0	0
1992	1	3	0	2	2	32	32	1	0	0	0	1	0	0	0	0	0	0	0	0
1993	1	3	0	2	2	11	11	2	2	0	0	0	0	0	0	0	0	0	0	0
1993	1	3	0	2	2	14	14	9	2	7	0	0	0	0	0	0	0	0	0	0
1993	1	3	0	2	2	15	15	16	0	16	0	0	0	0	0	0	0	0	0	0
1993	1	3	0	2	2	16	16	8	0	5	3	0	0	0	0	0	0	0	0	0
1993	1	3	0	2	2	17	17	15	2	1	11	1	0	0	0	0	0	0	0	0
1993	1	3	0	2	2	18	18	7	0	1	4	2	0	0	0	0	0	0	0	0
1993	1	3	0	2	2	19	19	6	0	0	5	1	0	0	0	0	0	0	0	0
1993	1	3	0	2	2	20	20	4	0	0	2	1	1	0	0	0	0	0	0	0
1993	1	3	0	2	2	21	21	7	0	0	1	4	2	0	0	0	0	0	0	0
1993	1	3	0	2	2	22	22	9	0	0	3	5	1	0	0	0	0	0	0	0
1993	1	3	0	2	2	23	23	6	0	1	1	1	2	0	1	0	0	0	0	0
1993	1	3	0	2	2	24	24	8	0	0	0	7	1	0	0	0	0	0	0	0
1993	1	3	0	2	2	25	25	10	0	0	3	4	2	1	0	0	0	0	0	0
1993	1	3	0	2	2	26	26	12	0	0	2	9	1	0	0	0	0	0	0	0
1993	1	3	0	2	2	27	27	14	0	0	1	8	4	0	0	1	0	0	0	0
1993	1	3	0	2	2	28	28	8	0	0	0	3	5	0	0	0	0	0	0	0
1993	1	3	0	2	2	29	29	3	0	0	0	1	2	0	0	0	0	0	0	0

1993	1	3	0	2	2	30	30	5	0	0	0	1	2	1	0	1	0	0	0	0
1993	1	3	0	2	2	31	31	3	0	0	0	0	3	0	0	0	0	0	0	0
1993	1	3	0	2	2	32	32	2	0	0	0	1	0	1	0	0	0	0	0	0
1994	1	3	0	2	2	13	13	4	0	4	0	0	0	0	0	0	0	0	0	0
1994	1	3	0	2	2	14	14	11	0	11	0	0	0	0	0	0	0	0	0	0
1994	1	3	0	2	2	15	15	33	0	33	0	0	0	0	0	0	0	0	0	0
1994	1	3	0	2	2	16	16	18	0	18	0	0	0	0	0	0	0	0	0	0
1994	1	3	0	2	2	17	17	9	0	7	2	0	0	0	0	0	0	0	0	0
1994	1	3	0	2	2	18	18	9	0	7	2	0	0	0	0	0	0	0	0	0
1994	1	3	0	2	2	19	19	3	0	1	1	1	0	0	0	0	0	0	0	0
1994	1	3	0	2	2	20	20	3	0	2	1	0	0	0	0	0	0	0	0	0
1994	1	3	0	2	2	21	21	6	0	0	4	1	1	0	0	0	0	0	0	0
1994	1	3	0	2	2	22	22	7	0	3	1	0	3	0	0	0	0	0	0	0
1994	1	3	0	2	2	23	23	5	0	0	1	4	0	0	0	0	0	0	0	0
1994	1	3	0	2	2	24	24	9	0	1	2	5	1	0	0	0	0	0	0	0
1994	1	3	0	2	2	25	25	9	0	0	2	3	2	2	0	0	0	0	0	0
1994	1	3	0	2	2	26	26	5	0	0	0	3	1	0	1	0	0	0	0	0
1994	1	3	0	2	2	27	27	6	0	0	0	2	4	0	0	0	0	0	0	0
1994	1	3	0	2	2	28	28	8	0	0	1	2	4	0	1	0	0	0	0	0
1994	1	3	0	2	2	29	29	6	0	0	0	0	4	1	0	1	0	0	0	0
1994	1	3	0	2	2	30	30	7	0	0	0	1	4	1	1	0	0	0	0	0
1994	1	3	0	2	2	31	31	4	0	0	0	0	0	3	1	0	0	0	0	0
1994	1	3	0	2	2	32	32	1	0	0	0	0	0	1	0	0	0	0	0	0
1995	1	3	0	2	2	13	13	2	2	0	0	0	0	0	0	0	0	0	0	0
1995	1	3	0	2	2	14	14	12	12	0	0	0	0	0	0	0	0	0	0	0

1995	1	3	0	2	2	15	15	11	11	0	0	0	0	0	0	0	0	0	0
1995	1	3	0	2	2	16	16	11	2	0	9	0	0	0	0	0	0	0	0
1995	1	3	0	2	2	17	17	17	3	4	8	1	1	0	0	0	0	0	0
1995	1	3	0	2	2	18	18	25	0	14	10	1	0	0	0	0	0	0	0
1995	1	3	0	2	2	19	19	16	1	12	3	0	0	0	0	0	0	0	0
1995	1	3	0	2	2	20	20	6	0	2	4	0	0	0	0	0	0	0	0
1995	1	3	0	2	2	21	21	4	0	3	1	0	0	0	0	0	0	0	0
1995	1	3	0	2	2	22	22	7	0	4	2	0	1	0	0	0	0	0	0
1995	1	3	0	2	2	23	23	4	0	0	3	0	1	0	0	0	0	0	0
1995	1	3	0	2	2	24	24	9	0	2	3	3	1	0	0	0	0	0	0
1995	1	3	0	2	2	25	25	6	0	0	4	1	1	0	0	0	0	0	0
1995	1	3	0	2	2	26	26	9	0	0	1	2	4	2	0	0	0	0	0
1995	1	3	0	2	2	27	27	6	0	0	1	2	2	1	0	0	0	0	0
1995	1	3	0	2	2	28	28	9	0	0	1	1	4	2	1	0	0	0	0
1995	1	3	0	2	2	29	29	11	0	0	0	4	1	3	2	1	0	0	0
1995	1	3	0	2	2	30	30	5	0	0	0	0	0	3	1	1	0	0	0
1995	1	3	0	2	2	31	31	3	0	0	0	0	0	2	1	0	0	0	0
1995	1	3	0	2	2	32	32	4	0	0	0	0	0	2	1	1	0	0	0
1996	1	3	0	2	2	11	11	1	1	0	0	0	0	0	0	0	0	0	0
1996	1	3	0	2	2	13	13	4	3	1	0	0	0	0	0	0	0	0	0
1996	1	3	0	2	2	14	14	13	5	8	0	0	0	0	0	0	0	0	0
1996	1	3	0	2	2	15	15	21	7	14	0	0	0	0	0	0	0	0	0
1996	1	3	0	2	2	16	16	20	5	15	0	0	0	0	0	0	0	0	0
1996	1	3	0	2	2	17	17	40	4	26	9	1	0	0	0	0	0	0	0
1996	1	3	0	2	2	18	18	26	0	17	4	5	0	0	0	0	0	0	0

1996	1	3	0	2	2	19	19	48	1	24	11	12	0	0	0	0	0	0	0	0
1996	1	3	0	2	2	20	20	31	0	20	5	5	1	0	0	0	0	0	0	0
1996	1	3	0	2	2	21	21	19	0	6	7	5	0	0	1	0	0	0	0	0
1996	1	3	0	2	2	22	22	9	0	3	4	2	0	0	0	0	0	0	0	0
1996	1	3	0	2	2	23	23	10	0	2	2	5	0	0	1	0	0	0	0	0
1996	1	3	0	2	2	24	24	10	0	0	2	5	0	2	1	0	0	0	0	0
1996	1	3	0	2	2	25	25	5	0	0	3	1	1	0	0	0	0	0	0	0
1996	1	3	0	2	2	26	26	3	0	0	1	0	1	0	1	0	0	0	0	0
1996	1	3	0	2	2	27	27	4	0	0	2	2	0	0	0	0	0	0	0	0
1996	1	3	0	2	2	28	28	2	0	0	0	0	0	2	0	0	0	0	0	0
1996	1	3	0	2	2	29	29	2	0	0	0	0	2	0	0	0	0	0	0	0
1996	1	3	0	2	2	30	30	1	0	0	0	1	0	0	0	0	0	0	0	0
1997	1	3	0	2	2	13	13	1	1	0	0	0	0	0	0	0	0	0	0	0
1997	1	3	0	2	2	14	14	8	1	7	0	0	0	0	0	0	0	0	0	0
1997	1	3	0	2	2	15	15	17	2	15	0	0	0	0	0	0	0	0	0	0
1997	1	3	0	2	2	16	16	14	2	11	1	0	0	0	0	0	0	0	0	0
1997	1	3	0	2	2	17	17	18	3	10	5	0	0	0	0	0	0	0	0	0
1997	1	3	0	2	2	18	18	12	0	6	5	1	0	0	0	0	0	0	0	0
1997	1	3	0	2	2	19	19	7	0	3	2	2	0	0	0	0	0	0	0	0
1997	1	3	0	2	2	20	20	6	0	1	4	1	0	0	0	0	0	0	0	0
1997	1	3	0	2	2	21	21	8	0	1	5	1	1	0	0	0	0	0	0	0
1997	1	3	0	2	2	22	22	3	0	0	2	1	0	0	0	0	0	0	0	0
1997	1	3	0	2	2	23	23	4	0	0	3	1	0	0	0	0	0	0	0	0
1997	1	3	0	2	2	24	24	3	0	0	2	1	0	0	0	0	0	0	0	0
1997	1	3	0	2	2	25	25	3	0	0	2	0	1	0	0	0	0	0	0	0

1997	1	3	0	2	2	26	26	3	0	0	3	0	0	0	0	0	0	0	0
1997	1	3	0	2	2	27	27	3	0	0	0	1	2	0	0	0	0	0	0
1997	1	3	0	2	2	30	30	1	0	0	0	1	0	0	0	0	0	0	0
1997	1	3	0	2	2	32	32	1	0	0	0	0	1	0	0	0	0	0	0
1998	1	3	0	2	2	13	13	3	0	3	0	0	0	0	0	0	0	0	0
1998	1	3	0	2	2	14	14	12	2	10	0	0	0	0	0	0	0	0	0
1998	1	3	0	2	2	15	15	23	5	18	0	0	0	0	0	0	0	0	0
1998	1	3	0	2	2	16	16	13	3	6	4	0	0	0	0	0	0	0	0
1998	1	3	0	2	2	17	17	23	4	11	7	1	0	0	0	0	0	0	0
1998	1	3	0	2	2	18	18	13	0	8	4	0	1	0	0	0	0	0	0
1998	1	3	0	2	2	19	19	15	0	7	7	1	0	0	0	0	0	0	0
1998	1	3	0	2	2	20	20	6	0	4	2	0	0	0	0	0	0	0	0
1998	1	3	0	2	2	21	21	5	0	0	5	0	0	0	0	0	0	0	0
1998	1	3	0	2	2	22	22	10	0	3	7	0	0	0	0	0	0	0	0
1998	1	3	0	2	2	23	23	3	0	0	1	1	0	1	0	0	0	0	0
1998	1	3	0	2	2	24	24	3	0	1	1	1	0	0	0	0	0	0	0
1998	1	3	0	2	2	25	25	3	0	1	1	1	0	0	0	0	0	0	0
1998	1	3	0	2	2	26	26	3	0	0	0	3	0	0	0	0	0	0	0
1998	1	3	0	2	2	27	27	2	0	0	1	1	0	0	0	0	0	0	0
1998	1	3	0	2	2	29	29	1	0	0	0	1	0	0	0	0	0	0	0
1999	1	3	0	2	2	13	13	2	1	1	0	0	0	0	0	0	0	0	0
1999	1	3	0	2	2	14	14	6	2	4	0	0	0	0	0	0	0	0	0
1999	1	3	0	2	2	15	15	35	3	30	2	0	0	0	0	0	0	0	0
1999	1	3	0	2	2	16	16	58	0	54	4	0	0	0	0	0	0	0	0
1999	1	3	0	2	2	17	17	83	0	72	8	3	0	0	0	0	0	0	0

1999	1	3	0	2	2	18	18	80	0	44	26	10	0	0	0	0	0
	0	0	0													
1999	1	3	0	2	2	19	19	52	0	24	16	11	1	0	0	0	0
	0	0	0													
1999	1	3	0	2	2	20	20	49	0	16	15	14	2	1	1	0	0
	0	0	0													
1999	1	3	0	2	2	21	21	29	0	4	9	13	1	2	0	0	0
	0	0	0													
1999	1	3	0	2	2	22	22	35	0	4	13	12	6	0	0	0	0
	0	0	0													
1999	1	3	0	2	2	23	23	22	0	2	5	10	5	0	0	0	0
	0	0	0													
1999	1	3	0	2	2	24	24	34	0	0	9	18	7	0	0	0	0
	0	0	0													
1999	1	3	0	2	2	25	25	17	0	2	0	10	5	0	0	0	0
	0	0	0													
1999	1	3	0	2	2	26	26	14	0	0	2	7	3	2	0	0	0
	0	0	0													
1999	1	3	0	2	2	27	27	15	0	0	0	7	7	1	0	0	0
	0	0	0													
1999	1	3	0	2	2	28	28	13	0	0	1	2	8	1	0	1	0
	0	0	0													
1999	1	3	0	2	2	29	29	4	0	0	0	3	1	0	0	0	0
	0	0	0													
1999	1	3	0	2	2	30	30	4	0	0	0	1	1	2	0	0	0
	0	0	0													
1999	1	3	0	2	2	31	31	3	0	0	0	1	1	0	1	0	0
	0	0	0													
2000	1	3	0	2	2	14	14	11	4	7	0	0	0	0	0	0	0
	0	0	0													
2000	1	3	0	2	2	15	15	13	3	10	0	0	0	0	0	0	0
	0	0	0													
2000	1	3	0	2	2	16	16	23	4	14	5	0	0	0	0	0	0
	0	0	0													
2000	1	3	0	2	2	17	17	15	0	3	8	4	0	0	0	0	0
	0	0	0													
2000	1	3	0	2	2	18	18	31	0	2	15	11	3	0	0	0	0
	0	0	0													
2000	1	3	0	2	2	19	19	8	0	2	2	4	0	0	0	0	0
	0	0	0													
2000	1	3	0	2	2	20	20	5	0	0	1	3	1	0	0	0	0
	0	0	0													
2000	1	3	0	2	2	21	21	9	0	1	4	3	1	0	0	0	0
	0	0	0													
2000	1	3	0	2	2	22	22	9	0	0	2	4	2	1	0	0	0
	0	0	0													
2000	1	3	0	2	2	23	23	6	0	0	2	1	0	3	0	0	0
	0	0	0													
2000	1	3	0	2	2	24	24	7	0	0	0	1	5	1	0	0	0
	0	0	0													

2000	1	3	0	2	2	25	25	5	0	0	0	5	0	0	0	0	0	0	0	0
2000	1	3	0	2	2	26	26	5	0	0	1	2	2	0	0	0	0	0	0	0
2000	1	3	0	2	2	27	27	2	0	0	1	0	1	0	0	0	0	0	0	0
2000	1	3	0	2	2	28	28	5	0	0	0	0	4	0	1	0	0	0	0	0
2001	1	3	0	2	2	13	13	1	0	1	0	0	0	0	0	0	0	0	0	0
2001	1	3	0	2	2	14	14	7	2	5	0	0	0	0	0	0	0	0	0	0
2001	1	3	0	2	2	15	15	10	0	8	2	0	0	0	0	0	0	0	0	0
2001	1	3	0	2	2	16	16	19	1	10	8	0	0	0	0	0	0	0	0	0
2001	1	3	0	2	2	17	17	9	1	0	6	2	0	0	0	0	0	0	0	0
2001	1	3	0	2	2	18	18	11	1	5	2	3	0	0	0	0	0	0	0	0
2001	1	3	0	2	2	19	19	16	0	4	5	5	1	1	0	0	0	0	0	0
2001	1	3	0	2	2	20	20	8	0	1	3	3	0	1	0	0	0	0	0	0
2001	1	3	0	2	2	21	21	8	0	1	2	5	0	0	0	0	0	0	0	0
2001	1	3	0	2	2	22	22	5	0	0	2	2	1	0	0	0	0	0	0	0
2001	1	3	0	2	2	23	23	1	0	0	0	1	0	0	0	0	0	0	0	0
2001	1	3	0	2	2	24	24	5	0	1	1	1	0	2	0	0	0	0	0	0
2001	1	3	0	2	2	25	25	5	0	0	0	3	1	1	0	0	0	0	0	0
2001	1	3	0	2	2	26	26	2	0	0	0	1	0	1	0	0	0	0	0	0
2001	1	3	0	2	2	28	28	5	0	0	0	2	2	1	0	0	0	0	0	0
2001	1	3	0	2	2	29	29	4	0	0	0	0	3	1	0	0	0	0	0	0
2001	1	3	0	2	2	30	30	2	0	0	0	1	1	0	0	0	0	0	0	0
2001	1	3	0	2	2	31	31	1	0	0	0	0	0	1	0	0	0	0	0	0
2002	1	3	0	2	2	13	13	1	1	0	0	0	0	0	0	0	0	0	0	0
2002	1	3	0	2	2	14	14	7	1	5	1	0	0	0	0	0	0	0	0	0
2002	1	3	0	2	2	15	15	15	3	12	0	0	0	0	0	0	0	0	0	0

2002	1	3	0	2	2	16	16	24	3	17	4	0	0	0	0	0	0	0	0
2002	1	3	0	2	2	17	17	34	0	19	14	1	0	0	0	0	0	0	0
2002	1	3	0	2	2	18	18	46	0	15	19	12	0	0	0	0	0	0	0
2002	1	3	0	2	2	19	19	44	0	10	21	10	3	0	0	0	0	0	0
2002	1	3	0	2	2	20	20	28	0	6	14	5	2	1	0	0	0	0	0
2002	1	3	0	2	2	21	21	37	0	3	22	7	3	1	1	0	0	0	0
2002	1	3	0	2	2	22	22	36	0	1	13	13	8	0	1	0	0	0	0
2002	1	3	0	2	2	23	23	35	0	0	13	13	7	2	0	0	0	0	0
2002	1	3	0	2	2	24	24	29	0	1	3	9	12	1	2	1	0	0	0
2002	1	3	0	2	2	25	25	30	0	0	9	11	5	4	1	0	0	0	0
2002	1	3	0	2	2	26	26	23	0	0	2	8	10	2	1	0	0	0	0
2002	1	3	0	2	2	27	27	15	0	0	1	6	7	0	1	0	0	0	0
2002	1	3	0	2	2	28	28	12	0	0	0	0	9	2	1	0	0	0	0
2002	1	3	0	2	2	29	29	8	0	0	0	0	6	0	2	0	0	0	0
2002	1	3	0	2	2	30	30	4	0	0	0	0	4	0	0	0	0	0	0
2002	1	3	0	2	2	31	31	4	0	0	0	0	1	2	1	0	0	0	0
2002	1	3	0	2	2	32	32	1	0	0	0	0	0	0	1	0	0	0	0
2003	1	3	0	2	2	13	13	2	2	0	0	0	0	0	0	0	0	0	0
2003	1	3	0	2	2	14	14	22	14	8	0	0	0	0	0	0	0	0	0
2003	1	3	0	2	2	15	15	54	9	43	2	0	0	0	0	0	0	0	0
2003	1	3	0	2	2	16	16	61	2	40	16	3	0	0	0	0	0	0	0
2003	1	3	0	2	2	17	17	75	5	28	36	6	0	0	0	0	0	0	0
2003	1	3	0	2	2	18	18	62	4	19	28	10	1	0	0	0	0	0	0
2003	1	3	0	2	2	19	19	54	1	9	28	16	0	0	0	0	0	0	0
2003	1	3	0	2	2	20	20	47	1	12	21	10	3	0	0	0	0	0	0

2003	1	3	0	2	2	21	21	30	0	4	11	8	3	4	0	0	0	0	0	0
2003	1	3	0	2	2	22	22	38	0	7	15	7	6	3	0	0	0	0	0	0
2003	1	3	0	2	2	23	23	29	0	4	11	6	5	3	0	0	0	0	0	0
2003	1	3	0	2	2	24	24	23	0	1	9	5	5	1	1	1	0	0	0	0
2003	1	3	0	2	2	25	25	23	0	0	8	7	3	4	1	0	0	0	0	0
2003	1	3	0	2	2	26	26	22	0	0	6	7	2	5	2	0	0	0	0	0
2003	1	3	0	2	2	27	27	12	0	0	0	6	4	2	0	0	0	0	0	0
2003	1	3	0	2	2	28	28	18	0	0	0	3	4	9	1	0	1	0	0	0
2003	1	3	0	2	2	29	29	7	0	0	0	3	1	1	2	0	0	0	0	0
2003	1	3	0	2	2	30	30	8	0	0	0	0	0	5	2	1	0	0	0	0
2003	1	3	0	2	2	31	31	4	0	0	0	0	0	3	1	0	0	0	0	0
2004	1	3	0	2	2	13	13	1	0	1	0	0	0	0	0	0	0	0	0	0
2004	1	3	0	2	2	14	14	8	0	8	0	0	0	0	0	0	0	0	0	0
2004	1	3	0	2	2	15	15	11	0	11	0	0	0	0	0	0	0	0	0	0
2004	1	3	0	2	2	16	16	27	4	14	9	0	0	0	0	0	0	0	0	0
2004	1	3	0	2	2	17	17	24	2	8	13	1	0	0	0	0	0	0	0	0
2004	1	3	0	2	2	18	18	36	2	15	14	5	0	0	0	0	0	0	0	0
2004	1	3	0	2	2	19	19	31	0	13	13	4	1	0	0	0	0	0	0	0
2004	1	3	0	2	2	20	20	24	1	7	8	5	2	1	0	0	0	0	0	0
2004	1	3	0	2	2	21	21	14	0	3	9	1	1	0	0	0	0	0	0	0
2004	1	3	0	2	2	22	22	21	0	2	13	5	0	1	0	0	0	0	0	0
2004	1	3	0	2	2	23	23	22	0	4	5	8	5	0	0	0	0	0	0	0
2004	1	3	0	2	2	24	24	27	0	5	6	4	7	4	0	1	0	0	0	0
2004	1	3	0	2	2	25	25	28	0	2	1	9	11	1	3	1	0	0	0	0
2004	1	3	0	2	2	26	26	17	0	0	2	9	4	0	2	0	0	0	0	0

2004	1	3	0	2	2	27	27	19	0	0	1	3	8	1	5	1	0	0	0	0
2004	1	3	0	2	2	28	28	16	0	0	0	1	9	3	2	1	0	0	0	0
2004	1	3	0	2	2	29	29	6	0	0	0	1	2	1	2	0	0	0	0	0
2004	1	3	0	2	2	30	30	6	0	0	1	0	3	0	2	0	0	0	0	0
2004	1	3	0	2	2	31	31	3	0	0	0	0	0	0	1	1	1	0	0	0
2005	1	3	0	2	2	13	13	2	2	0	0	0	0	0	0	0	0	0	0	0
2005	1	3	0	2	2	14	14	3	2	1	0	0	0	0	0	0	0	0	0	0
2005	1	3	0	2	2	15	15	2	2	0	0	0	0	0	0	0	0	0	0	0
2005	1	3	0	2	2	16	16	4	1	2	0	1	0	0	0	0	0	0	0	0
2005	1	3	0	2	2	17	17	14	0	9	3	1	1	0	0	0	0	0	0	0
2005	1	3	0	2	2	18	18	8	0	3	3	2	0	0	0	0	0	0	0	0
2005	1	3	0	2	2	19	19	6	0	1	4	1	0	0	0	0	0	0	0	0
2005	1	3	0	2	2	20	20	1	0	0	1	0	0	0	0	0	0	0	0	0
2005	1	3	0	2	2	21	21	3	0	0	1	1	0	0	1	0	0	0	0	0
2005	1	3	0	2	2	22	22	3	0	0	3	0	0	0	0	0	0	0	0	0
2005	1	3	0	2	2	23	23	1	0	0	0	1	0	0	0	0	0	0	0	0
2005	1	3	0	2	2	24	24	4	0	0	2	1	0	0	0	1	0	0	0	0
2005	1	3	0	2	2	25	25	4	0	0	2	0	0	1	0	0	1	0	0	0
2005	1	3	0	2	2	26	26	2	0	0	0	0	0	1	1	0	0	0	0	0
2005	1	3	0	2	2	28	28	1	0	0	0	0	0	1	0	0	0	0	0	0
2006	1	3	0	2	2	14	14	1	0	1	0	0	0	0	0	0	0	0	0	0
2006	1	3	0	2	2	15	15	13	1	9	3	0	0	0	0	0	0	0	0	0
2006	1	3	0	2	2	16	16	28	0	7	15	6	0	0	0	0	0	0	0	0
2006	1	3	0	2	2	17	17	17	0	8	4	5	0	0	0	0	0	0	0	0
2006	1	3	0	2	2	18	18	14	0	7	6	1	0	0	0	0	0	0	0	0

2006	1	3	0	2	2	19	19	6	0	0	2	4	0	0	0	0	0	0	0	0
2006	1	3	0	2	2	20	20	12	0	0	5	6	1	0	0	0	0	0	0	0
2006	1	3	0	2	2	21	21	16	0	4	8	2	2	0	0	0	0	0	0	0
2006	1	3	0	2	2	22	22	7	0	0	4	1	1	1	0	0	0	0	0	0
2006	1	3	0	2	2	23	23	6	0	0	3	2	0	1	0	0	0	0	0	0
2006	1	3	0	2	2	24	24	7	0	0	0	5	1	1	0	0	0	0	0	0
2006	1	3	0	2	2	25	25	9	0	0	0	3	1	3	1	1	0	0	0	0
2006	1	3	0	2	2	26	26	3	0	0	0	2	0	1	0	0	0	0	0	0
2007	1	3	0	2	2	15	15	12	0	10	2	0	0	0	0	0	0	0	0	0
2007	1	3	0	2	2	16	16	23	0	11	6	6	0	0	0	0	0	0	0	0
2007	1	3	0	2	2	17	17	26	0	3	7	13	2	1	0	0	0	0	0	0
2007	1	3	0	2	2	18	18	35	0	1	14	14	5	1	0	0	0	0	0	0
2007	1	3	0	2	2	19	19	41	0	7	7	13	7	6	1	0	0	0	0	0
2007	1	3	0	2	2	20	20	22	0	0	3	8	8	3	0	0	0	0	0	0
2007	1	3	0	2	2	21	21	15	0	1	2	4	5	2	1	0	0	0	0	0
2007	1	3	0	2	2	22	22	6	0	0	0	1	2	3	0	0	0	0	0	0
2007	1	3	0	2	2	23	23	11	0	0	2	2	4	2	1	0	0	0	0	0
2007	1	3	0	2	2	24	24	9	0	0	0	1	5	3	0	0	0	0	0	0
2007	1	3	0	2	2	25	25	5	0	0	0	2	1	1	0	0	1	0	0	0
2007	1	3	0	2	2	26	26	2	0	0	0	0	1	0	1	0	0	0	0	0
2008	1	3	0	2	2	11	11	1	0	1	0	0	0	0	0	0	0	0	0	0
2008	1	3	0	2	2	12	12	1	1	0	0	0	0	0	0	0	0	0	0	0
2008	1	3	0	2	2	13	13	2	2	0	0	0	0	0	0	0	0	0	0	0
2008	1	3	0	2	2	14	14	22	10	11	0	1	0	0	0	0	0	0	0	0
2008	1	3	0	2	2	15	15	28	3	23	0	2	0	0	0	0	0	0	0	0

2008	1	3	0	2	2	16	16	31	0	25	4	2	0	0	0	0	0	0	0
0																			
2008	1	3	0	2	2	17	17	52	3	28	12	9	0	0	0	0	0	0	0
0																			
2008	1	3	0	2	2	18	18	50	0	21	14	9	5	1	0	0	0	0	0
0																			
2008	1	3	0	2	2	19	19	46	2	17	7	10	2	7	1	0	0	0	0
0																			
2008	1	3	0	2	2	20	20	43	1	8	10	9	10	4	1	0	0	0	0
0																			
2008	1	3	0	2	2	21	21	31	0	5	7	10	7	1	1	0	0	0	0
0																			
2008	1	3	0	2	2	22	22	16	0	1	5	6	3	1	0	0	0	0	0
0																			
2008	1	3	0	2	2	23	23	22	0	6	4	4	6	1	1	0	0	0	0
0																			
2008	1	3	0	2	2	24	24	13	0	0	3	5	2	2	1	0	0	0	0
0																			
2008	1	3	0	2	2	25	25	13	0	0	1	4	4	3	1	0	0	0	0
0																			
2008	1	3	0	2	2	26	26	8	0	1	1	0	3	1	1	1	0	0	0
0																			
2008	1	3	0	2	2	27	27	9	0	0	3	5	0	1	0	0	0	0	0
0																			
2008	1	3	0	2	2	28	28	8	0	0	0	0	2	4	1	1	0	0	0
0																			
2008	1	3	0	2	2	29	29	1	0	0	0	0	0	1	0	0	0	0	0
0																			
2008	1	3	0	2	2	30	30	1	0	0	1	0	0	0	0	0	0	0	0
0																			
2008	1	3	0	2	2	31	31	3	0	0	0	0	0	0	2	1	0	0	0
0																			
2008	1	3	0	2	2	32	32	1	0	0	0	0	0	0	1	0	0	0	0
0																			
2009	1	3	0	2	2	14	14	5	0	5	0	0	0	0	0	0	0	0	0
0																			
2009	1	3	0	2	2	15	15	8	0	7	1	0	0	0	0	0	0	0	0
0																			
2009	1	3	0	2	2	16	16	17	0	9	5	3	0	0	0	0	0	0	0
0																			
2009	1	3	0	2	2	17	17	11	0	4	5	2	0	0	0	0	0	0	0
0																			
2009	1	3	0	2	2	18	18	23	0	2	12	7	1	1	0	0	0	0	0
0																			
2009	1	3	0	2	2	19	19	16	0	1	3	8	2	2	0	0	0	0	0
0																			
2009	1	3	0	2	2	20	20	13	0	2	0	6	2	3	0	0	0	0	0
0																			
2009	1	3	0	2	2	21	21	2	0	0	0	2	0	0	0	0	0	0	0

2009	1	3	0	2	2	22	22	5	0	0	1	1	3	0	0	0	0	0	0	0
2009	1	3	0	2	2	24	24	1	0	0	0	1	0	0	0	0	0	0	0	0
2009	1	3	0	2	2	26	26	4	0	0	2	0	0	1	0	1	0	0	0	0
2009	1	3	0	2	2	27	27	3	0	0	0	0	3	0	0	0	0	0	0	0
2009	1	3	0	2	2	28	28	1	0	0	0	1	0	0	0	0	0	0	0	0
2009	1	3	0	2	2	29	29	2	0	0	0	0	1	0	1	0	0	0	0	0
2009	1	3	0	2	2	30	30	1	0	0	0	0	0	0	1	0	0	0	0	0
2009	1	3	0	2	2	31	31	1	0	0	0	0	0	0	1	0	0	0	0	0
2010	1	3	0	2	2	13	13	1	1	0	0	0	0	0	0	0	0	0	0	0
2010	1	3	0	2	2	14	14	3	1	2	0	0	0	0	0	0	0	0	0	0
2010	1	3	0	2	2	15	15	4	0	4	0	0	0	0	0	0	0	0	0	0
2010	1	3	0	2	2	16	16	10	3	5	1	1	0	0	0	0	0	0	0	0
2010	1	3	0	2	2	17	17	14	3	3	6	1	1	0	0	0	0	0	0	0
2010	1	3	0	2	2	18	18	25	0	12	8	3	2	0	0	0	0	0	0	0
2010	1	3	0	2	2	19	19	26	0	3	7	9	2	4	1	0	0	0	0	0
2010	1	3	0	2	2	20	20	20	0	0	4	8	4	2	2	0	0	0	0	0
2010	1	3	0	2	2	21	21	23	0	2	10	4	3	0	2	1	1	0	0	0
2010	1	3	0	2	2	22	22	19	0	0	6	6	3	2	0	1	1	0	0	0
2010	1	3	0	2	2	23	23	17	0	2	1	8	2	2	1	1	0	0	0	0
2010	1	3	0	2	2	24	24	14	0	0	1	5	1	5	2	0	0	0	0	0
2010	1	3	0	2	2	25	25	19	0	0	0	4	4	4	5	2	0	0	0	0
2010	1	3	0	2	2	26	26	7	0	0	1	2	1	1	2	0	0	0	0	0
2010	1	3	0	2	2	27	27	14	0	0	3	6	2	2	0	0	1	0	0	0
2010	1	3	0	2	2	28	28	6	0	0	0	2	1	3	0	0	0	0	0	0
2010	1	3	0	2	2	29	29	4	0	0	0	1	1	1	0	0	1	0	0	0

2010	1	3	0	2	2	30	30	2	0	0	0	0	1	0	0	1	0	0	0	0
2010	1	3	0	2	2	31	31	1	0	0	1	0	0	0	0	0	0	0	0	0
2010	1	3	0	2	2	33	33	1	0	0	0	0	0	1	0	0	0	0	0	0
2011	1	3	0	2	2	13	13	2	1	1	0	0	0	0	0	0	0	0	0	0
2011	1	3	0	2	2	14	14	19	1	18	0	0	0	0	0	0	0	0	0	0
2011	1	3	0	2	2	15	15	36	1	33	1	1	0	0	0	0	0	0	0	0
2011	1	3	0	2	2	16	16	41	0	35	3	2	1	0	0	0	0	0	0	0
2011	1	3	0	2	2	17	17	30	1	21	4	3	1	0	0	0	0	0	0	0
2011	1	3	0	2	2	18	18	33	0	13	7	8	3	2	0	0	0	0	0	0
2011	1	3	0	2	2	19	19	29	0	2	6	10	8	3	0	0	0	0	0	0
2011	1	3	0	2	2	20	20	20	0	6	2	4	7	1	0	0	0	0	0	0
2011	1	3	0	2	2	21	21	12	0	0	2	4	4	2	0	0	0	0	0	0
2011	1	3	0	2	2	22	22	15	0	2	2	2	6	3	0	0	0	0	0	0
2011	1	3	0	2	2	23	23	6	0	0	3	1	0	2	0	0	0	0	0	0
2011	1	3	0	2	2	24	24	9	0	0	1	1	2	5	0	0	0	0	0	0
2011	1	3	0	2	2	25	25	9	0	0	1	1	2	4	1	0	0	0	0	0
2011	1	3	0	2	2	26	26	1	0	0	0	0	0	0	1	0	0	0	0	0
2011	1	3	0	2	2	27	27	7	0	0	0	3	2	1	1	0	0	0	0	0
2011	1	3	0	2	2	28	28	4	0	0	0	0	1	1	1	0	1	0	0	0
2011	1	3	0	2	2	29	29	4	0	0	0	0	3	0	1	0	0	0	0	0
2011	1	3	0	2	2	30	30	1	0	0	0	0	1	0	0	0	0	0	0	0
2011	1	3	0	2	2	31	31	1	0	0	0	0	0	0	1	0	0	0	0	0
-2011	1	4	0	1	2	2	2	5	5	0	0	0	0	0	0	0	0	0	0	0
-2011	1	4	0	1	2	3	3	5	5	0	0	0	0	0	0	0	0	0	0	0
-2011	1	4	0	1	2	4	4	5	5	0	0	0	0	0	0	0	0	0	0	0

```
-2011  1   4   0   1   2   5    5    5     5    0    0    0    0    0    0    0    0
       0   0   0
-2011  1   4   0   1   2   6    6    5     5    0    0    0    0    0    0    0    0
       0   0   0
-2011  1   4   0   1   2   7    7    5     5    0    0    0    0    0    0    0    0
       0   0   0
-2011  1   4   0   1   2   8    8    5     5    0    0    0    0    0    0    0    0
       0   0   0
-2011  1   4   0   1   2   9    9    5     5    0    0    0    0    0    0    0    0
       0   0   0
-2011  1   4   0   1   2   10   10   5     5    0    0    0    0    0    0    0    0
       0   0   0
-2011  1   4   0   1   2   11   11   5     5    0    0    0    0    0    0    0    0
       0   0   0
-2011  1   4   0   1   2   12   12   7     3    4    0    0    0    0    0    0    0
       0   0   0
-2011  1   4   0   1   2   13   13   14    3    11   0    0    0    0    0    0    0
       0   0   0
-2011  1   4   0   1   2   14   14   102   45   55   2    0    0    0    0    0    0
       0   0   0
-2011  1   4   0   1   2   15   15   352   89   258  4    1    0    0    0    0    0
       0   0   0
-2011  1   4   0   1   2   16   16   665   77   559  24   5    0    0    0    0    0
       0   0   0
-2011  1   4   0   1   2   17   17   797   54   537  169  35   2    0    0    0    0
       0   0   0
-2011  1   4   0   1   2   18   18   974   42   487  343  87   14   1    0    0    0
       0   0   0
-2011  1   4   0   1   2   19   19   1019  20   409  377  171  35   7    0    0    0
       0   0   0
-2011  1   4   0   1   2   20   20   994   10   272  360  252  59   34   7    0    0
       0   0   0
-2011  1   4   0   1   2   21   21   838   4    163  300  222  105  33   9    1    1
       0   0   0
-2011  1   4   0   1   2   22   22   765   0    104  283  218  108  36   11   3    2
       0   0   0
-2011  1   4   0   1   2   23   23   742   0    58   232  234  144  57   7    6    4
       0   0   0
-2011  1   4   0   1   2   24   24   685   0    43   202  215  142  57   15   9    2
       0   0   0
-2011  1   4   0   1   2   25   25   744   0    27   180  231  172  92   26   16   0
       0   0   0
-2011  1   4   0   1   2   26   26   692   1    7    123  244  164  90   41   17   4
       1   0   0

0 #_N_MeanSize-at-Age_obs
0 #_N_environ_variables
0 # N sizefreq methods to read
0 # N super periods
0 # no tag data
0 # no morphcomp data
```

```
999
ENDDATA
```

SEDAR

Southeast Data, Assessment, and Review

SEDAR 28
Gulf of Mexico Spanish Mackerel

SECTION IV: Research Recommendations
April 2013

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

Section IV: Research Recommendations

Contents

Data Workshop Research Recommendations:
Gulf of Mexico Spanish Mackerel

Life History

None provided.

Commercial Statistics
The WG determined the following recommendations be added to any pending recommendations issued in SEDAR 17 that have not been addressed:

- Need expanded observer coverage for the fisheries for Spanish mackerel.
  - 5-10% allocated by strata within states
  - get maximum information from fish
- Need research methods that capture Spanish mackerel in large enough numbers to create a reasonable index for young (age 0) Spanish mackerel.
- Expand TIP sampling to better cover all statistical strata.
  - Predominantly from Florida and by gillnet
  - Greater emphasis on collecting unbiased samples
- Establish a mechanism for identifying age samples that were collected by length or market categories, so as to better address any potential bias in age compositions.
- Need better information on migration patterns.
- Need to address issue of fish retained for bait (undersized) or used for food by crew (how to capture in landings).
- Compiling commercial data is surprisingly complex. As this is the 28th SEDAR, one might expect that many of the complications would have been resolved by now through better coordination among NMFS, ACCSP, and the states. Increased attention should be given toward the goal of "one-stop shopping" for commercial data.

Recreational Statistics

- Increase proportion of fish with biological data within MRFSS sampling.
- Continue to develop methods to collect a higher degree of information on released fish (length, condition, etc.) in the recreational fishery.
- Require mandatory reporting for all charter boats state and federal.
- Continue development of electronic mandatory reporting for for-hire sector.
- Continued research efforts to incorporate/require logbook reporting from recreational anglers.
- Establish a review panel to evaluate methods for reconstructing historical landings (SWAS, FWS, etc.).
- Quantify historical fishing photos for use in reconstructing recreational historical landings.

- Narrow down the sampling universe. Identify angler preference and effort. Require a reef fish stamp for anglers targeting reef fish, pelagic stamp for migratory species, and deepwater complex stamp for deep-water species. The program would be similar to the federal duck stamp required of hunters. This would allow the managers to identify what anglers were fishing for.
- Continue and expand fishery dependent at-sea-observer surveys to collect discard information, which would provide for a more accurate index of abundance.

Indices

None provided.

Assessment Workshop Research Recommendations:
Gulf of Mexico Spanish Mackerel

Gulf of Mexico Spanish mackerel has a lengthy history of exploitation dating to the early late 1800s. Directed commercial gillnet fisheries have operated on this resource for well over a hundred years and recreational fisheries more than 65 years. However detailed catch statistics on size and individual weight of removals only exists for the recent time period, since the mid to late 1980's. In addition, management measures including size limits (30.5 cm FL beginning 1983) and quotas (beginning in 1987) have resulted in discards for both fisheries.

Gulf of Mexico Spanish mackerel are not a directed target of the commercial line gear fisheries (COM_RR fleet) therefore extensive samples for length and/or age-length key characterizations are not available. Efforts should be made to obtain samples from this fleet in order to better inform future stock assessment evaluations as relates length composition and discard levels. In particular, a review of the sampling protocols for length and age – length collections is needed to better characterize the catch length and age at length compositions. In addition, attention is needed to evaluate optimal spatial sampling factors in relation to overall removals throughout the year and region.

The magnitude of discards from the recreational fleet is high and very variable over the time series for which estimates exist from the MRFSS/MRIP survey (1981 forward). Hind casting was used to develop estimates of recreational removals and discards prior to 1981 however information on uncertainty in the hind casting was not incorporated into the stock assessment. Future assessments should consider uncertainty around hind casted data.

The indices of abundance are generally flat but variable yielding little information with which to characterize abundance. In addition the additional observations of length and conditional age at length are more recent thus providing only limited history of data with which to estimate the spawner- recruit relationship during the early part of the time period. The quantity and quality of length and age composition information directly impacts the ability to estimate recruitment.

There was difficulties with estimating steepness thus the AW felt that providing benchmarks at several levels and making projections using several levels of steepness was needed.

Review Workshop Research Recommendations:
Gulf of Mexico Spanish Mackerel

Reviewer #1:
The Spanish mackerel assessment would benefit from the development of an enhanced biological sampling program. For instance, the development of a research recruitment index would inform the model on the process and possibly preclude the introduction of such strong assumptions.

Increasing sample sizes for the length composition data in both extractions and surveys is recommended if this information is to be used in the assessment. Further, an expanded observer coverage in all Spanish mackerel fisheries would enhance data quality overall. The sensitivity to uncertainties in the catch data do need to be explored in the future. I agree with the Data Workshop recommendation that there is need of research-based data where Spanish mackerel are caught in sufficiently large numbers to provide a reasonable index of young fish (age 0) abundance. There is currently very little signal of recruitment strength to inform the assessment.

Reviewer #2:
A number of research needs, which are listed below in priority order, were identified in the course of the desk review. As expected, these were highly consistent with, and thus overlap, a number of the research needs that had been identified by the Data and Assessment workshops.

1. Review or establish programs to collect data on the length composition and age-at-length compositions of landings and discards from each commercial gear and from each recreational fishing mode, and of bycatch of Spanish mackerel from the shrimp fishery.

2. Ensure that the statistical design and spatial coverage of survey or sampling programs are appropriate and that survey or sampling intensity is sufficient to produce estimates of the required precision for the Gulf of Mexico stock of Spanish mackerel. Set goals for performance and establish and monitor performance criteria to assess the quality and completeness of data collection programs. This research need is of the highest priority as it will provide information required by Stock Synthesis to determine the selectivity and retention curves for Spanish mackerel for the commercial, recreational, and shrimp fisheries, the lack of which is a key source of uncertainty in the model.

3. Undertake research to determine reliable relationships between the proportion of females that are mature and both length and age for the Gulf of Mexico stock of Spanish mackerel. This is also of high priority, as the maturity information that is currently used is imprecise. The calculation of spawning stock biomass, a crucial parameter in the calculation of benchmarks and assessment of stock status, should be based on reliable data.

4. Review programs that are used to collect discard data for Spanish mackerel (and data on the bycatch of Spanish mackerel by the shrimp fishery), and refine these programs to ensure that accurate and complete data estimates of the discards (and bycatch) are

collected. Ensure that the statistical design and spatial coverage of survey or sampling programs are appropriate and that survey or sampling intensity is sufficient to produce estimates of the required precision. Set goals for performance and establish and monitor performance criteria to assess the quality and completeness of data collection programs. While this research will not produce immediate improvement in the quality of the assessment, it is important that action is taken as soon as possible to improve the accuracy and precision of the data relating to the quantities of fish that are discarded from each of the fisheries, such that, in the future, the time series of discards become more reliable.

5. A comprehensive study of the stock structure of Spanish mackerel should be undertaken, with the following objectives:
    a. To determine stock structure and the areas occupied by each stock; and, assuming that the current view that there are two stocks, *i.e.,* a Gulf of Mexico and a South Atlantic stock, is substantiated,
    b. To determine more reliably the boundary between the Gulf of Mexico and South Atlantic stocks or the extent of overlap;
    c. To extend sampling into Mexican waters and thereby determine the southern boundary of the Gulf of Mexico stock;
    d. To ascertain whether, regardless of the time of year, catches of fish may be assigned reliably to either the Gulf of Mexico or South Atlantic stock on the basis of the area in which they are caught.

    As this study will take some time before completion, it has been assigned a lower priority than the previous items. Determination of the southern stock boundary, however, is important to ensure that other removals from the stock are not occurring in Mexican waters, as such removals are not taken into account in the current assessment.

6. Undertake research to determine the discard mortality of Gulf of Mexico Spanish mackerel that are discarded from the catches of each commercial fishing gear or each recreational fishing mode, recognizing that such mortality is likely to differ among different categories into which the discarded fish are classified, *e.g*., “alive”, “mostly alive”, and “mostly dead”.

7. In future stock assessments for the Gulf of Mexico stock of Spanish mackerel, explore whether the use of an age-dependent rather than constant M results in a significant improvement in fit, considering the Lorenzen and alternative functional forms of the relationship with age and the alternative of estimating the value of the age-dependent M at each age (or range of ages).

8. In future stock assessments, explore the sensitivity of the model to the uncertainty of the landings data.
9. As a low research priority, assess whether, in future refinement of the Stock Synthesis model, sexually dimorphic growth should be introduced. Note that the benefit of this

might only be realized if appropriate sex composition data for landings and discards are available for input, and length and age-at-length compositions are sexually disaggregated.

Reviewer #3:

In the short-term, a new assessment is needed. There are data that may provide defensible abundance indices if analyzed properly (e.g., commercial logbook, vertical line data; Florida trip-ticket, hand-line/trolling data). It may also be possible to get something useful from the recreational data with appropriate filtering.

A workshop should be held to train people in the analysis and post-stratification of composition data.

My main recommendations are:

- Top priority should be given to the construction of defensible abundance indices for both cobia and Spanish mackerel from the commercial and recreational data. I suggest the following approach:
    - Discussion with some of the participants in the fisheries to get some understanding of how, when, and where, they target cobia and Spanish mackerel.
    - A full descriptive/exploratory analysis of the data to understand the temporal and spatial variation in the catches and all of the available explanatory variables.
    - Identification of regional and seasonal fisheries for which fishing effort is likely to catch the species of interest (cobia or Spanish mackerel). This is likely to involve the identification of vessels in each year which fish at the times and places of interest and catch the species on some of their trips. It does not require that individual vessels be tracked across years (although that would be ideal).
    - An analysis to determine if fishing regulations have impacted on the ability of the data to track abundance (time series may have to be split to account for different fishing behavior caused by regulation changes)
    - Production of standardized CPUE indices for each identified regional/seasonal fishery
    - Comparison of the trends across the different fisheries
    - Decide which if any of the CPUE indices are defensible as relative abundance indices (the length of the time series is not relevant to this decision).
- If defensible abundance indices can be constructed then assessments can be done as before except:
    - Composition data should be appropriately post-stratified and scaled; sample sizes should be based on the number of trips/landings sampled (not the number of fish measured or aged). This will require an analysis of the variability in length frequencies and proportion-at-age for given length across the various strata.
    - Recruitment deviates should only be estimated for cohorts which are well represented in the composition data (e.g., appear at least three times in the age data).
    - Steepness should be fixed or estimated with an informed prior.

SEDAR

Southeast Data, Assessment, and Review

SEDAR 28

Gulf of Mexico Spanish Mackerel

SECTION V: Review Report

April 2013

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

Table of Contents

1. Review Proceedings

1.1 Introduction

1.1.1 Method of Review

The SEDAR 28 Review for Gulf of Mexico Spanish mackerel (*Scomberomorus maculatus*) and Cobia (*Rachycentron canadum*) was conducted as a Center for Independent Experts (CIE) desk review. Three reviewers were provided with all information generated throughout the Data and Assessment Workshops and webinars, and each reviewer then provided an independent analysis of the stock.

1.1.2 Terms of Reference

1. Evaluate the quality and applicability of data used in the assessment.
2. Evaluate the quality and applicability of methods used to assess the stock.
3. Recommend appropriate estimates of stock abundance, biomass, and exploitation.
4. Evaluate the methods used to estimate population benchmarks and management parameters. Recommend and provide estimated values for appropriate management benchmarks and declarations of stock status for each model run presented for review.
5. Evaluate the quality and applicability of the methods used to project future population status. Recommend appropriate estimates of future stock condition.
6. Evaluate the quality and applicability of methods used to characterize uncertainty in estimated parameters.
   - Provide measures of uncertainty for estimated parameters
   - Ensure that the implications of uncertainty in technical conclusions are clearly stated
   - If there are significant changes to the base model, or to the choice of alternate states of nature, then provide a probability distribution function for the base model, or a combination of models that represent alternate states of nature, presented for review.
     - Determine the yield associated with a probability of exceeding OFL at P* values of 30% to 50% in single percentage increments
     - Provide justification for the weightings used in producing the combinations of models
7. If available, ensure that stock assessment results are accurately presented in the Stock Assessment Report and that stated results are consistent with Review Panel recommendations.
8. Evaluate the quality and applicability of the SEDAR Process as applied to the reviewed assessment and identify the degree to which Terms of Reference were addressed during the assessment process.
9. Make any additional recommendations or prioritizations warranted.

- Clearly denote research and monitoring needs that could improve the reliability of future assessments

10. Prepare a Review Summary Report summarizing the Panel's evaluation of the stock assessment and addressing each Term of Reference. Develop a list of tasks to be completed following the workshop. Complete and submit the Review Summary Report no later than the date set by the Review Panel Chair at the conclusion of the workshop.

The review panel may request additional sensitivity analyses, evaluation of alternative assumptions, and correction of errors identified in the assessments provided by the assessment workshop panel; the review panel may not request a new assessment. Additional details regarding the latitude given the review panel to deviate from assessments provided by the assessment workshop panel are provided in the SEDAR Guidelines and the SEDAR Review Panel Overview and Instructions.

The panel shall ensure that corrected estimates are provided by addenda to the assessment report in the event corrections are made, alternate model configurations are recommended, or additional analyses are prepared as a result of review panel findings regarding the TORs above.

1.1.3 List of Participants

Reviewers

Beatriz Roel	Reviewer	CIE
Patrick Cordue	Reviewer	CIE
Norm Hall	Reviewer	CIE

1.1.4 List of Review Working Papers

Documents Prepared for the Review		
SEDAR28-GRW01	CIE Desk Review: SEDAR 28: Gulf of Mexico Spanish Mackerel and Cobia	Roel
SEDAR28-GRW02	CIE Desk Review: SEDAR 28: Gulf of Mexico Spanish Mackerel and Cobia	Cordue
SEDAR28-GRW03	CIE Desk Review: SEDAR 28: Gulf of Mexico Spanish Mackerel and Cobia	Hall

2. CIE Reviewer Summary Reports

The following CIE reviewer summary reports are the express findings and opinions of the individual author of each report. Reviewers were not influenced by the findings and/or determinations of other reviewers involved in the SEDAR 28 review process for Spanish mackerel.

Independent Peer Review Report on the SEDAR 28 Desk Review of the Gulf of Mexico Spanish Mackerel and Cobia Assessments

Dr. Beatriz A. Roel

Prepared for

Center for Independent Experts (CIE)

The Centre for Fisheries and Aquaculture Science
Lowestoft Laboratory
Pakefield Road
Lowestoft
Suffolk NR33 0HT
UK

Executive Summary

The assessments of Spanish mackerel and cobia in the Gulf of Mexico were reviewed independently for the Center for Independent Experts (CIE) without consultation with other reviewers or those who produced the assessments. The process extended from 9 January to 4 February 2013. The main conclusions are given separately by species.

The Gulf of Mexico Spanish mackerel stock assessment presented to the SEDAR 28 Assessment Workshop provided output and analysis of results from Stock Synthesis (SS), an integrated statistical catch-at-age model. The model was considered appropriate because it can make best use of the data available including a data-poor historical period. However, data limitations (a recruitment index and data that would inform the model on the stock's response to exploitation) have enforced the requirement for strong assumptions to be made on key parameters.

SS was used to estimate the stock status of Spanish mackerel in the Gulf of Mexico in relation to SPR30% reference points for the Base Run and each alternative model examined. The current stock status was estimated in the Base Run as SSB_{2011} / MSST = 2.96, and exploitation status as $F_{2009\text{-}2011}$ / $F_{SPR30\%}$ = 0.5. Sensitivity tests carried out resulted in estimates of key parameters for management that suggest that the stock is above MSST and exploited below MFMT. The results suggest that the Gulf of Mexico Spanish mackerel stock is not overfished under any of the model scenarios examined and that it is not undergoing overfishing under any of the scenarios examined.

The Spanish mackerel assessment would benefit from the development of an enhanced biological sampling programme. For instance, the development of a research recruitment index would inform the model on the process and possibly preclude the introduction of such strong assumptions.

The Gulf of Mexico cobia assessment was based on results from SS. The assessment used data through 2011 and the time period of the assessment is 1926–2011. Model projections were run from 2013 to 2019. The estimated biomass trajectories showed a sharp decline as the fisheries developed, reaching levels below the minimum stock threshold (MSST) in the late 1980s and early 1990s. Since then the stock appears to have fluctuated above and below the target spawning stock biomass.

Benchmark and reference points for fishing mortality and stock biomass were estimated relative to SPR 30% which were presented for the base case and for each of the sensitivity runs. For cobia, SPR30% reference points are considered valid proxies for MSY. For the base model $F_{current\ (2009–2011)}$ / $F_{SPR30\%}$ was 0.63, whereas the current spawning biomass (2011) relative to MSST was 1.73; on that basis the stock is not considered to be overfished nor undergoing overfishing.

The stock was considered neither overfished nor undergoing overfishing in most of the sensitivity scenarios explored. In the case of low natural mortality, the more pessimistic scenario, both the F_{SPR30} and F_{OY} scenarios led to future stock conditions where the stock was no longer overfished nor undergoing overfishing by 2014. However, fishing under current F predicted a stock undergoing overfishing throughout the projection period.

The lack of information on recruits of age 0 in the data increased the uncertainty of the assessment and the evaluation of the stock relative to reference points. The development of a fishery-independent recruitment index is recommended.

Background

SEDAR 28 consisted of a compilation of data, an assessment of the stocks, and an assessment review conducted for Gulf of Mexico Spanish mackerel and cobia. The Center for Independent Experts (CIE) review for SEDAR 28 was scheduled from 9–24 January 2013, with the deadline for submission of the Peer Review Report on 4 February 2013. The CIE peer review is ultimately responsible for ensuring that the best possible assessment has been provided through the SEDAR process. The stocks assessed through SEDAR 28 are within the jurisdiction of the Gulf of Mexico Fisheries Management Council and states in the Gulf of Mexico region.

Three CIE reviewers with the requisite qualifications to complete an impartial and independent peer review in accordance with the statement of work (SoW) tasks and terms of reference (ToRs) specified herein participated in the process. They were selected on the basis of their expertise in stock assessment, statistics, fisheries science and marine biology being deemed sufficient to complete the tasks of the peer review described herein. Each CIE reviewer participated and conducted an independent peer review as a desk review, so travel was not required.

Description of the Individual Reviewer's Role in the Review Activities

I participated in all aspects of the review. In particular, I conducted the necessary pre-review preparations, including reviewing background material and reports provided by the NMFS Project Contact in advance of the peer review. I then conducted an impartial and independent (of anyone else) peer review in accordance with the tasks and ToRs specified herein, focusing on the data analyses, parameter estimation and associated uncertainties and the implications for management advice.

SPANISH MACKEREL

Findings by ToR

1. *Evaluate the quality and applicability of data used in the assessment*

A wide range of commercial, recreational and research data was made available for the stock assessment. The data were explored extensively at the Data Workshop (DW).

<u>Life history</u>: The available life history information was reviewed and the main issues were considered carefully. The information does seem to be adequate to conduct a stock assessment. The DW followed the Life History Group recommendation to model the natural mortality rate (M) as a declining Lorenzen function of size consistent with previous SEDAR recommendations.

Discard mortality depends on the conditions of the catching process, including the type of gear utilised. Gillnets had few discards because of its selectivity patterns, but discard mortality does appear to be very high. The shrimp trawl fishery results in very high discard mortality (virtually 100%). There is in fact limited information available on discard mortality for Spanish mackerel, so the values for the gillnet, shrimp trawl and handline fisheries were agreed on the basis of fisher experience and “common sense” and recommended to the Assessment Workshop (AW). Testing the sensitivity to these assumptions would be appropriate here.

The growth models considered seemed to be appropriate, and the decision to combine sexes given practical considerations (the fishery does not distinguish them) is sensible. The scarcity of small fish in the samples did result in growth parameters being rather unrealistic, but the output was adjusted to more biologically reasonable values.

Based on different data sources, it appears that insufficient gonad samples are being collected for histological analyses.

Commercial fishery statistics: Commercial landings data have been developed by gear for the period 1890–2010 and appear to be adequate to support the assessment, although the landings prior to 1950 are considered to be highly uncertain. Landings were aggregated by gillnet, handline and miscellaneous gears, but for assessment purposes, the category miscellaneous is assigned proportionally into gillnet and handline categories.

Shrimp fishery discards: A median value was assumed over the entire period 1945–2011. Initially, this seemed a somewhat questionable decision given that annual shrimp fishery effort was available and a catchability parameter estimated, allowing annual estimates of Spanish mackerel bycatch to be computed. However, bycatch in the shrimp fishery appeared difficult to determine given the low encounter rate between shrimp trawls and Spanish mackerel, and because of irregular observer coverage. As a consequence, the annual variability in shrimp bycatch appeared to be poorly estimated. The decision to impose a super-period based on an estimated mean bycatch seemed therefore to be appropriate.

Commercial discards: These were computed for the period 1998–2010 based on a gear-specific discard rate and effort data. The method seemed to be appropriate but cannot be applied prior to 1998. Discard estimates are, of course, more uncertain than the landings. A weakness here is that the calculated discards may only represent the minimum number of discards made by the commercial fisheries.

Biological sampling: Sample sizes for developing length compositions were inadequate for a considerable number of years and gear strata. This may jeopardise the use of length compositions to correct for potential biases in age compositions in those years.

Recreational fishery statistics: Landings appear to be adequately recorded or estimated for the period covered. For historical recreational landings, a period is defined as pre-1981, with removals for the years 1955–1981 based on a hindcast. It is difficult to assess the strengths and weaknesses of this data series based on the report of the Data Workshop.

Discards: Sample sizes for Spanish mackerel in the observer data are very small. Some extrapolations were applied and proxies used to calculate the discarded quanta from the different fisheries. There seem to be uncertainties here that need to be reconciled.

Biological sampling: The number of fish sampled is listed, but it is not possible to characterise the sample sizes because the sampling strategy and the targets are not shown. Size data appear to represent the landed catch for the charter and headboat sector adequately. Based on examination of the length composition histograms shown in Fig 4.12.21, sample sizes may have been rather small in recent years.

2. Evaluate the quality and applicability of methods used to assess the stock.

The assessment is carried out using Stock Synthesis (SS), a methodology widely used for stock assessment in the United States and elsewhere, including in Europe, where it is used to assess quite a few ICES stocks (ICES, 2012). Interaction with the model developer has contributed to correct implementation of the methodology, and it focused on the handling of discards, which were estimated according to “super periods”; however, the reasons and advantages of using this approach need to be stated more clearly. There is reference to a small CV associated with discards, but it is not clear how that was estimated.

Discard release mortality was incorporated in the model, but the rate seems to be based on rather few data.

A tool to conduct parametric bootstrap analyses was used to characterise uncertainty. This seems to have been a correct decision, because SS provides asymptotic standard errors only, which constitute a minimum estimate.

The model configuration seems to have been appropriate; it includes removals from three directed fisheries:

1. Commercial gillnet (COM-GN)
2. Commercial vertical line gears (Com_RR)
3. Recreational charter, private, headboat and shore anglers (REC)

Of these, the miscellaneous commercial category was apportioned into 1 and 2.

The model fits three indices of abundance (there is some confusion regarding the labelling of the fishery cpue indices on section 3.1.2 of the Assessment Workshop report):

1. Recreational (MRFSS),
2. Commercial line fishery (FWC Vertical line fishery),
3. SEAMAP fishery independent trawl survey.

The indices seem, however, to be very noisy generally, and varying without a trend.

Natural mortality is based on a declining Lorenzen function, and sensitivity to the various assumptions is explored throughout the stock assessment. This is an appropriate procedure because assumptions on the level of M are anticipated to be very influential.

Several parameters were fixed, namely steepness (h) and recruitment variability, but it is not that obvious that the sensitivity to such assumptions was explored sufficiently in the assessment process.

In terms of shrimp fishery discards, a median value was assumed over the entire period 1945–2011. It is not clear why this is done given that annual shrimp fishery effort was available and a catchability parameter estimated, allowing annual estimates of Spanish mackerel bycatch to have been computed.

Model configuration and equations: The shrimp effort index seems to be fitted well by the SS. The index is said to be used to derive annual estimates of F for the shrimp bycatch fleet. This seems to have been done by estimating the catchability Q parameter. However, F is then used to estimate the mackerel bycatch. Figure 3.3c shows the fit (straight line) to the "observed" discards. That procedure is not explained clearly, and specifying the equations would help understanding.

I believe that presentation of the likelihood function would go a long way towards interpreting the model fit to the data.

The fact that the model resulted in an unrealistic estimate for steepness needs further investigation. A plot of the time-series of total landings may provide some insight on the response of the stock to exploitation. Landings between the 1950s and the late 1990s were large, but abundance indices are only available from the 1980s on and do not seem to capture the response of the stock to the decrease in exploitation during recent years. In light of this, fixing steepness to a more realistic value would seem to be appropriate. The value assumed for steepness is the same as that assumed for South Atlantic Spanish mackerel, which would be expected to have similar dynamics.

There are obviously some poor fits to the length 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. Simpler age-structured production models (Restrepo and Legault 1998; De Oliveira *et al.*, 2007) run from 1981 on would require fewer assumptions, would be less labour-intensive, and may well perform adequately.

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

A number of datasets were examined by the Data Workshop. Those considered appropriate for use in the assessment model were ranked according to their utility as indices of abundance.

1. SEAMAP Groundfish Survey (1987–2011). Recommended for use because it is a long time-series with good geographic coverage.
2. Florida Trip Ticket index (1986–2011) is recommended because it provides good spatial coverage. All indices are based on positive trips only, which is a limitation, and including zero trips would enhance the index's performance as

an indicator of abundance. The handline/trolling index is good because it covers a long period and samples the entire fishery, both inshore and offshore.

3. Recreational MRFSS Index (1981– 2011). This is a Cpue standardised index based on all trips.

The indices proposed are appropriate as indicators of abundance, representing both the commercial and the recreational fisheries as well as providing fishery-independent information. The recreational Headboat Index, based on all trips and standardised by means of a generalized linear model, was not used in the assessment. The reasons behind this decision are not clearly stated in the report.

A shrimp effort index was used to estimate Spanish mackerel mortality in the shrimp fishery.

4. *Evaluate the methods used to estimate population benchmarks and management parameters. Recommend and provide estimated values for appropriate management benchmarks and declarations of stock status for each model run presented for review.*

The methods used to estimate population benchmarks and management parameters are based on MSY criteria and yield per recruit. MSY reference points are also supported by ICES, based on international agreements to achieve MSY for exploited stocks by 2015. MSY reference points are based on assumptions about the stock and recruitment functional form that may not be justified by the data. SPR reference points are well accepted proxies for MSY. For precautionary considerations, short-lived species and pelagic stocks should be kept above 30% virgin SPR (Caddy and Agnew, 2004).

The SS estimates of F_REF and SSB_REF (based on 30% SPR) from 1000 bootstrap samples (Figs 3.48-3.49) show that the probability of the stock being outside precautionary levels is very low. Results for the more pessimistic Run 1 also identify the stock as not overfished and not undergoing overfishing. Tables 3.7 and 3.8 provide the necessary values to assess the state of the stock relative to management benchmarks for all configurations presented for review.

5. *Evaluate the quality and applicability of the methods used to project future population status. Recommend appropriate estimates of future stock condition.*

Deterministic future population status were projected in terms of SSB and SSB and F relative to 30%SPR reference points for two values of steepness (0.8; 0.9) and three levels of exploitation. The projections are not sensitive to the steepness assumed. The results suggest that the stock is projected to remain within safe biological limits given the selected F, and will remain exploited below optimal levels. Note that the top and the bottom panels in Figure 3.52 are the same and that Figure 3.53 was not discussed in the Assessment Workshop report.

Figure 3.53 illustrates future yields for stochastic projections. Yields appear to be stabilising at levels above estimated MSY (Table 3.9).

6. *Evaluate the quality and applicability of methods used to characterize uncertainty in estimated parameters.*
    - *Verify that appropriate measures were provided*
    - *Verify that the implications of uncertainty in technical conclusions are clearly and acceptably stated*
    - *If there are significant changes to the base model, or to the choice of alternate states of nature, then verify that a probability distribution function for the base model, or a combination of models that represent alternate states of nature were provided.*

Asymptotic standard errors were computed for all the parameters estimated. As these tend to underestimate associated uncertainties, the results from a parametric bootstrap procedure (mean and standard error) are presented for key parameters. Mean and standard deviations resulting from bootstrapping were presented. Showing the median as a measure of central tendency and the CVs for comparison between parameters would probably have been a better choice of statistics.

Model estimates are highly sensitive to the value of steepness, which the model estimates poorly. Comparison of the distributions in Figures 3.34 and 3.35 shows that fixing steepness results in more sensible distributions for virgin biomass, SSB ref and R0.

Sensitivity tests were carried out to explore the impact of uncertainties in model parameters such as natural mortality (M) and steepness, data exclusion, data weighting and discard mortality, on parameters that have implications for management. The results from the analyses did not change the perception of the stock relative to reference points because none of the configurations explored suggested that the stock was outside safe biological limits. Interesting to note here is that the alternative exclusion of the abundance indices made little difference to the estimates of key parameters relative to the base run.

7. *If available, ensure that stock assessment results are accurately presented in the Stock Assessment Report and that stated results are consistent with Review Panel recommendations.*

The stock assessment results are clearly stated in the Stock Assessment report. Table 3.9 addressed the MSRA evaluations requirements. Mortality rate and biomass criteria were estimated for steepness values of 0.8 and 0.9. Annual yields (2013–2022) are provided for F_{MFMT}, F_{OY} and $F_{current}$.

In terms of the requirements for projections, these were all met, although only total yields were provided. Projections were made under three scenarios for fishing mortality: $F_{current}$, F_{SPR30} (F_{msy}) and F_{OY}. Projections under $F_{rebuild}$ or F_0 were not necessary.

8. *Evaluate the quality and applicability of the SEDAR Process as applied to the reviewed assessment and identify the degree to which Terms of Reference were addressed during the assessment process.*

The SEDAR process results in a rigorous and in-depth review of the data made available and of the assessment. As this is a desk-based review, it lacks any possibility to include interaction with other reviewers of the same material or with the analysts, in my opinion undermining the quality of the review process. Succinctly, questions arising during the review cannot be addressed to those who conducted the analyses, nor was it possible for reviewers of varying skills to complement each others' skills in coming to an overall evaluation of the appropriateness of the methodology or outputs.

9. *Make any additional recommendations or prioritizations warranted.*

   - *Clearly denote research and monitoring needs that could improve the reliability of future assessments*

Increasing sample sizes for the length composition data in both extractions and surveys is recommended if this information is to be used in the assessment. Further, an expanded observer coverage in all Spanish mackerel fisheries would enhance data quality overall.

The sensitivity to uncertainties in the catch data do need to be explored in future.

I agree with the Data Workshop recommendation that there is need of research-based data where Spanish mackerel are caught in sufficiently large numbers to provide a reasonable index of young fish (age 0) abundance. There is currently very little signal of recruitment strength to inform the assessment.

Errata
Assessment Workshop Report
Figure 3.6 caption 2nd line: mackerel commercial **vertical line** gear fishery.
Figure 3.42 upper panel the y-axis needs to be expanded to include all exploitation rate values.
Figure 3.47 define FWC in the figure caption.
Figure 3.49 MFMP definition repeated.

Gulf of Mexico Cobia

Findings by ToR

1. *Evaluate the quality and applicability of data used in the assessment.*

Life history data used in the assessment included natural mortality, growth, maturity and fecundity. There is some uncertainty regarding life history characteristics for this stock because of a general paucity of data, so some common sense decisions were made by the Data Workshop and the Assessment Workshop, such as assuming 50% maturity at age 2 despite recognizing that maturity is better correlated with size. Despite the differential growth of males and females the decision to conduct the stock assessment on the basis of both sexes combined seemed appropriate.

<u>Landings</u>
In terms of commercial landings, the Data Workshop apportioned commercial landings into handline, longline and miscellaneous. For the assessment, commercial landings data (1927– 2011) were aggregated across gears; handline landings represent ~67% of the total commercial landings since 1981. The reason for aggregation is not clearly stated in the workshop reports but presumably is related to inadequate samples sizes for developing length compositions for sufficient year and gear strata, along with inadequate age composition data for all years. Landings data before 1950 are considered to be very uncertain.

Discard estimates have greater uncertainty than the landings and they are likely to be underestimated. The year-specific age structure of cobia could not always be estimated.

The bycatch of cobia in the shrimp fishery was estimated from observer data and SEAMAP trawl data, then scaled using shrimp effort.

Recreational landings data (1950–2011) were aggregated across modes and regions for the assessment. Landings data were collected from 1981 but were hindcast to 1950. Uncertainties in the historical period were estimated, but it is not clear whether those were taken into account in the assessment.

Discard information from recreational fisheries is limited; in other words the discard information reported by anglers cannot be verified, as some surveys simply do not estimate discard levels. Discarded fish size is unknown for all modes covered by MRFSS.

Biological data

Length composition data were collected in both commercial and recreational fisheries with reasonable sample sizes for the recreational fishery. However, given the minimum size limit in operation and the variable growth patterns of cobia, length frequency data did not provide sufficient information on historical recruitment patterns. Age composition data were collected, but there was too little information to be able to track cohorts through time.

Having reviewed the information presented by the Data Workshop and the Assessment Workshop, it was concluded that, despite certain limitations such as those mentioned above, the data provided for assessment were the best available. Every effort had clearly been made to eliminate potential biases and to make the best possible decisions in cases where data were missing. Those decisions and assumptions are fully documented in the report of the Data Workshop.

2. Evaluate the quality and applicability of methods used to assess the stock.

The stock was assessed by means of Stock Synthesis (SS), Methot 2011. Model configurations of increasing complexity were explored, showing that trends in estimated stock biomass remained similar as model complexity increased. The selected model seems to have been appropriate because it allows the assessors to make best use of the information that was available.

The assessment used data through 2011 and the time period of the assessment is 1926–2011. Model projections were run from 2013 to 2019. The assessment was set up to include three fishing fleets and two indices of abundance. The stock was assumed to be at equilibrium at the start of the modelled period in 1926. Removals of cobia were not substantial until after World War II for any of the fisheries.

A single Beverton & Holt stock–recruitment function was estimated in SS, although the reason for selecting this function was not stated. The model was configured to estimate steepness and equilibrium recruitment; however, steepness is very poorly estimated. Variability in recruitment was constrained by fixing sigma R to 0.6. The reality is that there were few data to inform the Beverton & Holt function parameters, and there is concern that the assumptions on steepness may be driving model results. However, the perception of the stock relative to reference points did not change for the range of steepness explored in the sensitivity tests, rendering the assumption at least credible. Estimated parameter standard deviations were generally small and the convergence test results suggested that the model converged with high probability.

Patterns in the residuals from the fit to length frequency data suggest that the model underestimated the numbers of small and large fish in the early period of the commercial data. This is probably related to small sample sizes in which fish at the extremes of the distribution would have been generally under-represented, resulting in selectivity curves that would have driven model predictions for the entire period. Given the paucity of length data, the assumption of time-invariant selection for all fisheries was appropriate. The model seemed to have underestimated small, undersize fish in the recreational fishery, which was hardly surprising.

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

Estimates of SSB, total biomass and fishing mortality were provided by SS. The model predicted the trends in the two indices of catch per unit effort (CPUE) reasonably well, but the uncertainty associated with point estimates appeared to be large. The SSB trajectories show a sharp decline as the fisheries developed, reaching levels below MSST in the late 1980s and early 1990s. Model-predicted SSB is shown with associated 80% asymptotic intervals rather than 90% or 95% confidence intervals, which might be slightly deceiving. Fishing mortality was estimated to have decreased in the early 1990s, and varying with a slightly declining trend thereafter. Whereas F in the recreational fishery has fluctuated quite widely since the late 1990s, fishing mortality in both the commercial fishery and the shrimp fishery declined during the same period. Results from bootstrap analysis show greater uncertainties around the estimated trajectory of F than reflected by 80% asymptotic intervals.

4. Evaluate the methods used to estimate population benchmarks and management parameters. Recommend and provide estimated values for appropriate management benchmarks and declarations of stock status for each model run presented for review.

The state of the stock is primarily evaluated relative to 30% spawner-per-recruit population benchmarks. Those seem more appropriate in the case of Gulf of Mexico cobia than MSY reference points, which may be driven by assumptions about the stock–recruit relationship.

Stock status and benchmarks relative to SPR 30% were presented for the base case and each of the sensitivity runs. For the base model $F_{current\ (2009–2011)}$ / $F_{SPR30\%}$ was 0.63, whereas the current spawning biomass (2011) relative to MSST was 1.73; on that basis the stock is not considered to be overfished nor undergoing overfishing. Based on results from the bootstrap analysis for the base case, the $F_{current}$ /$F_{SPR30\%}$ ratio was estimated to be <1, with a high probability, and current SSB /MSST was estimated to be >1, also with a high probability.

The stock was considered neither overfished nor undergoing overfishing in most of the sensitivity scenarios explored. The exceptions were the low M scenario where the stock was considered both overfished and undergoing overfishing, and Run 7; for the latter, only the MRFSS index fitted, which suggested that the stock was overfished.

5. Evaluate the quality and applicability of the methods used to project future population status. Recommend appropriate estimates of future stock condition.

Model projections carried out with SS were run from 2013 to 2019. The stock was projected under constant fishing mortalities: $F_{current}$, $F_{30\%SPR}$ and F_{OY}. Recruitment was projected by the fitted stock and recruit function. All scenarios explored show an increase in SSB and yields over the projection period as a result of predicting recruitment at a higher level than the recent average. A more pessimistic scenario of future recruitment, e.g., randomly selecting from the estimated recruitment between 2000 and 2009 (omitting 2010 and2011 as highly uncertain), would have been informative.

Fishing at $F_{current}$, $F_{30\%SPR}$ and F_{OY}, the stock is predicted to be within safe biological limits for the base case. For the most pessimistic scenario, low M, the stock is predicted to undergo overfishing under $F_{current}$ but not under $F_{30\%SPR}$ or $F_{OY.}$

For the base model, under the assumptions made in the projections, fishing the stock at $F_{30\%SPR}$ (F = 0.378) seems to lead to a long-term equilibrium yield below the estimated MSY. Yield per recruit F_{max} is estimated as well above F_{msy}.

6. Evaluate the quality and applicability of methods used to characterize uncertainty in estimated parameters.

- *Verify that appropriate measures were provided*
- *Verify that the implications of uncertainty in technical conclusions are clearly and acceptably stated*
- *If there are significant changes to the base model, or to the choice of alternate states of nature, then verify that a probability distribution function for the base model, or a combination of models that represent alternate states of nature were provided.*

Asymptotic standard errors were computed for all the parameters estimated. As these tend to underestimate associated uncertainties, the results from a parametric bootstrap procedure (mean and standard error) were presented for key parameters. In general, estimates of uncertainty were similar between the two methods. The distributions of F and SSB relative to benchmark parameters from bootstrap samples were shown for the base model, suggesting that there is a high probability that the stock is neither overfished nor undergoing overfishing.

A number of alternative model configurations and states of nature were investigated in sensitivity tests. Iteratively re-weighting the different components did not reveal any conflicting information among alternative data sources. However, this sensitivity run favoured the Headboat index, leading to a conclusion of a slightly more productive stock and experiencing lower fishing mortalities.

The model was only fit assuming a Beverton & Holt stock–recruit relationship but fitting it to an alternative such as a smooth hockey stick would have been informative as a sensitivity test. As a general point, exploring alternative assessment models that do not require strong assumptions on the stock and recruitment functional form would provide clues on the sensitivity of the assessment results to structural assumptions.

Results from the retrospective analysis suggest a stable assessment and show no indication of substantial bias in the assessment. The analysis for age 0 recruits illustrates the uncertainty associated with recruit estimates for the final few years in a given assessment. This is to be expected given the lack of information on recruitment strength for year classes that have not passed through the fishery.

7. If available, ensure that stock assessment results are accurately presented in the Stock Assessment Report and that stated results are consistent with Review Panel recommendations.

Stock assessment results are accurately presented in the Stock Assessment Report and are consistent with the Panel recommendations.

8. Evaluate the quality and applicability of the SEDAR Process as applied to the reviewed assessment and identify the degree to which Terms of Reference were addressed during the assessment process.

This review was conducted as a desk review which, in the opinion of this reviewer, might have been undermined by the lack of direct interactions with other members of the Panel and the analysts. The data analyses and stock assessment presented for review were of high standard and state of the art. Terms of Reference were addressed appropriately during the assessment process.

9. Make any additional recommendations or prioritizations warranted.

- *Clearly denote research and monitoring needs that could improve the reliability of future assessments.*

I support the Research Recommendations presented by the Data Workshop. In particular and given the lack of information on cobia recruitment, the development of a recruitment (age 0) index for this important stock is recommended.

A tagging study to identify spawning areas and aggregations would be valuable if additional conservation measures were to be required.

The development of a fishery-independent index of abundance is recommended.

References

Caddy, J. F. and Agnew, D. J. 2004. An overview of recent global experience with recovery plans for depleted marine resources and suggested guidelines for recovery planning. *Reviews in Fish Biology and Fisheries* **14**: 43–112.

De Oliveira, J. A. A., Boyer, H. J, and Kirchner, C. H. 2007. Developing age-structured production models as a basis for management procedure evaluations for Namibian sardine. *Fisheries Research* **85**: 148–158.

ICES. 2012. Report of the Working Group on the Assessment of Southern Shelf Stocks of Hake, Monk and Megrim. ICES Document CM 2012/ACOM: 11.

Restrepo, V. R. and C. M. Legault 1998. A Stochastic Implementation of an Age-Structured Production Model. Alaska Sea Grant College Program • AK-SG-98-01. *Fishery Stock Assessment Models* pp 435 – 450.

Appendix 1: **Bibliography of materials provided for review**

SEDAR 28 Gulf of Mexico Cobia Data Workshop Report, May 2012

SEDAR 28 Gulf of Mexico Spanish mackerel Data Workshop Report, May 2012

SEDAR 28 Gulf of Mexico Cobia, Assessment Workshop Report, Dec 2012

SEDAR 28 Gulf of Mexico Spanish Mackerel, Assessment Workshop Report, Dec 2012

Working Papers

SEDAR28-AW01 Florida Trip Tickets

SEDAR28-AW02 Spanish mackerel bycatch estimates from US Atlantic coast shrimp trawls

Appendix 2: **Statement of Work**

Statement of Work

External Independent Peer Review by the Center for Independent Experts

SEDAR 28: Gulf of Mexico Cobia and Spanish Mackerel Assessment Desk Review

Scope of Work and CIE Process: The National Marine Fisheries Service's (NMFS) Office of Science and Technology coordinates and manages a contract providing external expertise through the Center for Independent Experts (CIE) to conduct independent peer reviews of NMFS scientific projects. The Statement of Work (SoW) described herein was established by the NMFS Project Contact and Contracting Officer's Representative (COR), and reviewed by CIE for compliance with their policy for providing independent expertise that can provide impartial and independent peer review without conflicts of interest. CIE reviewers are selected by the CIE Steering Committee and CIE Coordination Team to conduct the independent peer review of NMFS science in compliance the predetermined Terms of Reference (ToRs) of the peer review. Each CIE reviewer is contracted to deliver an independent peer review report to be approved by the CIE Steering Committee and the report is to be formatted with content requirements as specified in **Annex 1**. This SoW describes the work tasks and deliverables of the CIE reviewer for conducting an independent peer review of the following NMFS project. Further information on the CIE process can be obtained from www.ciereviews.org.

Project Description SEDAR 28 will be a compilation of data, an assessment of the stocks, and an assessment review conducted for Gulf of Mexico Spanish mackerel and cobia. The CIE peer review is ultimately responsible for ensuring that the best possible assessment has been provided through the SEDAR process. The stocks assessed through SEDAR 28 are within the jurisdiction of the Gulf of Mexico Fisheries Management Councils and states in the Gulf of Mexico region. The Terms of Reference (ToRs) of the peer review are attached in **Annex 2**.

Requirements for CIE Reviewers: Three CIE reviewers shall have the necessary qualifications to complete an impartial and independent peer review in accordance with the statement of work (SoW) tasks and terms of reference (ToRs) specified herein. The CIE reviewers shall have expertise in stock assessment, statistics, fisheries science, and marine biology sufficient to complete the tasks of the peer-review described herein. Each CIE reviewer's duties shall not exceed a maximum of 10 days to complete all work tasks of the peer review described herein.

Location of Peer Review: Each CIE reviewer shall participate and conduct an independent peer review as a desk review, therefore travel will not be required.

Statement of Tasks: Each CIE reviewer shall complete the following tasks in accordance with the SoW and Schedule of Milestones and Deliverables herein.

Prior to the Peer Review: Upon completion of the CIE reviewer selection by the CIE Steering Committee, the CIE shall provide the CIE reviewer contact information to the COR, who forwards this information to the NMFS Project Contact no later the date specified in the Schedule of Milestones and Deliverables. The CIE is responsible for providing the SoW and ToRs to the CIE reviewers. The NMFS Project Contact is responsible for providing the CIE reviewers with the assessment and other pertinent background documents for the peer review. Any changes to the SoW or ToRs must be made through the COR prior to the commencement of the peer review.

Pre-review Background Documents: Two weeks before the peer review, the NMFS Project Contact will send (by electronic mail or make available at an FTP site) to the CIE reviewers the necessary background information and reports for the peer review. In the case where the documents need to be mailed, the NMFS Project Contact will consult with the CIE Lead Coordinator on where to send documents. CIE reviewers are responsible only for the pre-review documents that are delivered to the reviewer in accordance to the SoW scheduled deadlines specified herein. The CIE reviewers shall read all documents in preparation for the peer review.

Desk Review: Each CIE reviewer shall conduct the independent peer review in accordance with the SoW and ToRs, and shall not serve in any other role unless specified herein. Modifications to the SoW and ToRs shall not be made during the peer review, and any SoW or ToRs modifications prior to the peer review shall be approved by the COR and CIE Lead Coordinator. The CIE Lead Coordinator can contact the Project Contact to confirm any peer review arrangements.

Contract Deliverables - Independent CIE Peer Review Reports: Each CIE reviewer shall complete an independent peer review report in accordance with the SoW. Each CIE reviewer shall complete the independent peer review according to required format and content as described in Annex 1. Each CIE reviewer shall complete the independent peer review addressing each ToR as described in Annex 2.

Specific Tasks for CIE Reviewers: The following chronological list of tasks shall be completed by each CIE reviewer in a timely manner as specified in the **Schedule of Milestones and Deliverables**.

1) Conduct necessary pre-review preparations, including the review of background material and reports provided by the NMFS Project Contact in advance of the peer review.
2) Conduct an impartial and independent peer review in accordance with the tasks and ToRs specified herein, and each ToRs must be addressed (**Annex 2**).
3) No later than January 25, 2013, each CIE reviewer shall submit an independent peer review report addressed to the "Center for Independent Experts," and sent to Mr. Manoj Shivlani, CIE Lead Coordinator, via email to

shivlanim@bellsouth.net, and CIE Regional Coordinator, via email to Dr. David Sampson david.sampson@oregonstate.edu. Each CIE report shall be written using the format and content requirements specified in **Annex 1**, and address each ToR in **Annex 2**.

Schedule of Milestones and Deliverables: CIE shall complete the tasks and deliverables described in this SoW in accordance with the following schedule.

21 December 2012	CIE sends reviewer contact information to the COR, who then sends this to the NMFS Project Contact
2 January 2013	NMFS Project Contact sends the CIE Reviewers the assessment report and background documents
9-24 January 2013	Each reviewer conducts an independent peer review as a desk review
25 January 2013	CIE reviewers submit draft CIE independent peer review reports to the CIE Lead Coordinator and CIE Regional Coordinator
8 February 2013	CIE submits CIE independent peer review reports to the COR
15 February 2013	The COR distributes the final CIE reports to the NMFS Project Contact and regional Center Director

Modifications to the Statement of Work: This 'Time and Materials' task order may require an update or modification due to possible changes to the terms of reference or schedule of milestones resulting from the fishery management decision process of the NOAA Leadership, Fishery Management Council, and Council's SSC advisory committee. A request to modify this SoW must be approved by the Contracting Officer at least 15 working days prior to making any permanent changes. The Contracting Officer will notify the COR within 10 working days after receipt of all required information of the decision on changes. The COR can approve changes to the milestone dates, list of pre-review documents, and ToRs within the SoW as long as the role and ability of the CIE reviewers to complete the deliverable in accordance with the SoW is not adversely impacted. The SoW and ToRs shall not be changed once the peer review has begun.

Acceptance of Deliverables: Upon review and acceptance of the CIE independent peer review reports by the CIE Lead Coordinator, Regional Coordinator, and Steering Committee, these reports shall be sent to the COR for final approval as contract deliverables based on compliance with the SoW and ToRs. As specified in the Schedule of Milestones and Deliverables, the CIE shall send via e-mail the contract deliverables (CIE independent peer review reports) to the COR (William Michaels, via William.Michaels@noaa.gov).

Applicable Performance Standards: The contract is successfully completed when the COR provides final approval of the contract deliverables. The acceptance of the contract deliverables shall be based on three performance standards:
(1) The CIE report shall completed with the format and content in accordance with **Annex 1**,
(2) The CIE report shall address each ToR as specified in **Annex 2**,
(3) The CIE reports shall be delivered in a timely manner as specified in the schedule of milestones and deliverables.

Distribution of Approved Deliverables: Upon acceptance by the COR, the CIE Lead Coordinator shall send via e-mail the final CIE reports in *.PDF format to the COR. The COR will distribute the CIE reports to the NMFS Project Contact and Center Director.

Support Personnel:

William Michaels, Program Manager, COR
NMFS Office of Science and Technology
1315 East West Hwy, SSMC3, F/ST4, Silver Spring, MD 20910
William.Michaels@noaa.gov Phone: 301-427-8155

Manoj Shivlani, CIE Lead Coordinator
Northern Taiga Ventures, Inc.
10600 SW 131st Court, Miami, FL 33186
shivlanim@bellsouth.net Phone: 305-383-4229

Roger W. Peretti, Executive Vice President
Northern Taiga Ventures, Inc. (NTVI)
22375 Broderick Drive, Suite 215, Sterling, VA 20166
RPerretti@ntvifederal.com Phone: 571-223-7717

Key Personnel:

NMFS Project Contact:

Ryan Rindone, SEDAR Coordinator
2203 N. Lois Avenue, Suite 1100
Tampa, FL 33607
Ryan.Rindone@gulfcouncil.org Phone: 813-348-1630

Annex 1: Format and Contents of CIE Independent Peer Review Report

1. The CIE independent report shall be prefaced with an Executive Summary providing a concise summary of the findings and recommendations, and specify whether the science reviewed is the best scientific information available.

2. The main body of the reviewer report shall consist of a Background, Description of the Individual Reviewer's Role in the Review Activities, Summary of Findings for each ToR in which the weaknesses and strengths are described, and Conclusions and Recommendations in accordance with the ToRs.

   The CIE independent report shall be a stand-alone document for others to understand the weaknesses and strengths of the science reviewed, regardless of whether or not they read the summary report. The CIE independent report shall be an independent peer review of each ToRs, and shall not simply repeat the contents of the summary report.

3. The reviewer report shall include the following appendices:

   Appendix 1: Bibliography of materials provided for review
   Appendix 2: A copy of the CIE Statement of Work

Annex 2a – Terms of Reference for

SEDAR 28: Gulf of Mexico Cobia Assessment Desk Review

1. Evaluate the quality and applicability of data used in the assessment.
2. Evaluate the quality and applicability of methods used to assess the stock.
3. Recommend appropriate estimates of stock abundance, biomass, and exploitation.
4. Evaluate the methods used to estimate population benchmarks and management parameters. Recommend and provide estimated values for appropriate management benchmarks and declarations of stock status for each model run presented for review.
5. Evaluate the quality and applicability of the methods used to project future population status. Recommend appropriate estimates of future stock condition.
6. Evaluate the quality and applicability of methods used to characterize uncertainty in estimated parameters.
   - Provide measures of uncertainty for estimated parameters
   - Ensure that the implications of uncertainty in technical conclusions are clearly stated
   - If there are significant changes to the base model, or to the choice of alternate states of nature, then provide a probability distribution function for the base model, or a combination of models that represent alternative states of nature, presented for review.
     - Determine the yield associated with a probability of exceeding OFL at P* values of 30% to 50% in single percentage increments
     - Provide justification for the weightings used in producing the combinations of models
7. If available, ensure that stock assessment results are accurately presented in the Stock Assessment Report and that stated results are consistent with Review Panel recommendations.
8. Evaluate the quality and applicability of the SEDAR Process as applied to the reviewed assessment and identify the degree to which Terms of Reference were addressed during the assessment process.
9. Make any additional recommendations or prioritizations warranted.
   - Clearly denote research and monitoring needs that could improve the reliability of future assessments

SEDAR 28:

Gulf of Mexico

Cobia and Spanish Mackerel

Stock Assessment Review

P.L. Cordue

Fisheries Consultant

New Zealand

***For* CIE Independent System for Peer Review**

19 February 2013

Executive summary

A desktop review of Gulf of Mexico cobia and Spanish mackerel stock assessments was conducted by three independent CIE reviewers, in January 2013, as part of SEDAR 28. This document presents my findings and recommendations, with regard to the assessments, based on a detailed review of the assessments as described in the Data and Assessment Workshop reports and supporting documents.

The cobia and Spanish mackerel stocks in the Gulf of Mexico were both assessed using the Stock Synthesis package SS3. This is a well-tested package which enables fully-integrated age-structured stock assessments using landings, discards, length, and age data from multiple fisheries.

Both assessments used very similar data sources: landings and discard data from recreational fisheries (the bulk of the landings) and some commercial fisheries; discard estimates from the shrimp fishery (substantial in some years); length and age data as available for each fishery; and standardized CPUE indices.

A simple and typical model structure was used in both assessments. Population in age-structured equilibrium before the start of the fisheries. Year-round fisheries with constant selectivity patterns (with some time-blocking). Constant age-specific natural mortality over time. A single von Bertalanffy growth curve estimated in the model and a Beverton Holt stock-recruitment relationship. Year class strengths (recruitment deviations) estimated for about 20 cohorts.

The assessments have common problems: the CPUE time series used in the assessment runs are not defensible as relative abundance indices; and the length and age data were not appropriately post-stratified or scaled. Primarily because of the lack of defensible abundance indices it would be unsafe to use the assessments to provide management advice.

My main conclusions are:

- Stock structure and fixed life history parameters were adequately considered.
- Landings history, discards, and discard mortalities were adequately determined and considered.
- Composition data were poorly treated at both the Data and Assessment Workshops. There was an absence of appropriate analysis and discussion with regard to post-stratification of the data to deal with inadequate sample sizes within some strata.
- The Index Working Group made very poor recommendations with regard to the time series to use in the stock assessments as relative abundance indices:
    - For cobia, two recreational CPUE time series were recommended but these both had very low proportions of successful trips and spanned a period when fishing regulations had become more restrictive.
    - For Spanish mackerel: a SEAMAP survey was recommended as a recruitment time series, but it caught very few Spanish mackerel each year; a recreational time series was recommended but it had a very low proportion of successful trips; and a commercial index based on catch-per-trip was recommended but it had not been standardized for trip duration or time fished.
- None of the abundance indices used in the stock assessment runs are defensible.

- The model structure used, the choice of runs, and the methods of projection and describing of uncertainty were adequate but could not overcome the flawed data inputs.
- None of the model runs should be used to determine biomass estimates or recommend stock status.

My main recommendations are:

- Top priority should be given to the construction of defensible abundance indices for both cobia and Spanish mackerel from the commercial and recreational data:
    - Talk to some of the participants in the fisheries to get an understanding of how, when, and where, they target cobia and Spanish mackerel (if at all).
    - Perform a full descriptive/exploratory analysis of the data to understand the temporal and spatial variation in the catches and the potential explanatory variables.
    - Identify regional and seasonal fisheries for which fishing effort is "likely" to catch cobia or Spanish mackerel.
    - Perform an analysis to determine if fishing regulations have impacted on the ability of the data to track abundance (time series may have to be split to account for different fishing behaviour caused by regulation changes)
    - Produce standardized CPUE indices for each identified regional/seasonal fishery and consider which if any can defensibly be used as abundance indices.

- If defensible abundance indices can be constructed then assessments can be done as before except:
    - Composition data should be appropriately post-stratified and scaled; sample sizes should be based on the number of trips/landings sampled (not the number of fish measured or aged).
    - Recruitment deviates should only be estimated for cohorts which are well-represented in the composition data (e.g., appear at least three times in the age data).

Background

The South-East, Data, Assessment, Review (SEDAR) process was initiated in 2002 to improve the reliability of fishery stock assessments in the South Atlantic, Gulf of Mexico, and US Caribbean. This review is part of SEDAR 28 and covers the Gulf of Mexico Spanish mackerel and cobia stock assessments.

I am one of three CIE reviewers who performed a desktop review during January 2013. The three reviews are meant to be independent and I have had no contact or discussion with the other two reviewers. This report presents my findings and recommendations in accordance with the Terms of Reference (ToRs) for the review (Appendix 2, annex 2).

Review Activities

The main documents provided for the review were made available in a timely manner through an ftp site. Also, a link was provided to the SEDAR website which contained many workshop, background, and reference documents (Appendix 1).

I noted, that in the original ToRs, it was assumed that a normal review was being conducted and that the reviewers would jointly write a Summary Report. I contacted CIE and they supplied me with amended ToRs which were specific to a desktop review (Appendix 2, annex 2).

The main documents for the review were the Data Workshop and Assessment Workshop reports (Appendix 1). I read these four reports in detail, a number of times, over the period of the review and consulted specific workshop or reference documents as needed. I also searched the Web to obtain information on current and past federal and state recreational fishing regulations for cobia (in particular).

Summary of findings

Cobia and Spanish mackerel were both assessed using the Stock Synthesis package SS3. This is a well-tested package that allows data from a range of sources to be fitted to obtain estimates of population parameters and management quantities. Estimates of uncertainty were obtained by performing sensitivity runs and bootstrapping the main runs.

The two assessments use very similar methods and data sources (estimated catch histories for commercial and recreational fisheries, abundance indices, and length and age data). For this reason they share a number of strengths and weaknesses.

Before considering the specific ToRs for each assessment I will discuss some problems which are common to both assessments.

Obtaining abundance indices from recreational CPUE data

For both assessments standardized CPUE indices were calculated for the headboat survey and for the MRFSS data (although the headboat time series was not used in the mackerel assessment). In each case a delta-lognormal model was used (binomial for success/failure and lognormal for positive catches). This approach was applied to the whole of each dataset with limited or no filtering of records to remove irrelevant effort. As a consequence, the proportions of successful trips (those that caught the species of interest) were very low (mackerel: MRFSS 5%, headboat <5%; cobia: MRFSS <1%, headboat 7%).

These success rates are so low that one would think that it was very unlikely that the CPUE indices could be tracking abundance. The Index Working Groups (IWG) had attempted to filter the data to obtain relevant effort using Stephens and MacCall (2004) and a number of ad hoc approaches. However, they were unable to find a satisfactory subset of the data to use and defaulted to the full data set. (The failure of Stephens and MacCall (2004) is interesting and bears further investigation at a later date – why did the method fail so completely?)

I have no faith in any of these CPUE time series as indices of *relative abundance* because the very low success rates show that most of the effort is irrelevant to cobia and Spanish mackerel. This means that the basic assumption of catch being proportional to effort is violated. The standardization of the indices does not help. To get a defensible abundance index from these data requires that relevant effort is identified – e.g., so that a doubling of effort (in a given "stratum") will result in a doubling of catch – or a doubling of biomass for a given amount of effort will double the catch.

In order to subset these data and identify relevant effort it is necessary to obtain an understanding of the different recreational fisheries that are operating on cobia and Spanish mackerel. This will not be an easy process. It will probably require that additional information on the operation of the fisheries be obtained by interviewing the participants (e.g. headboat skippers). Cobia and Spanish mackerel are probably targeted by recreational fishers in some places at some times during the year (e.g., cobia during a known migration wave). It may be possible to identify vessels which fish in certain areas at certain times and to use their data (positive catches and success/failure in the given areas and times) to obtain defensible abundance indices. Alternatively, it may be that additional information needs to be routinely collected from recreational fishers before any reliable abundance indices can be produced from the recreational fisheries for these species.

Using the positive catches is a possibility, which was explored by the IWG. The concern is that such indices will be hyperstable. However, with sufficient descriptive analysis it may be possible to justify the use of just the positive trips (e.g., showing that there is no shrinkage in the area and the season from which successful trips occur over time).

Changes in recreational fishing regulations
Changes in fishing regulations have to be considered when recreational CPUE data are being analysed for abundance indices.

For cobia, the Data Workshop report contains no information on changes in regulations or the variation in regulations between state and federal waters. This is a serious omission because the federal daily bag limit of 2 per person did not come into effect until August 1990 and in Florida state waters the limit was reduced to 1 per person (with no more than 6 per vessel) on 22 March 2001. The only abundance indices used in the cobia assessment are the headboat and MRFSS time series which both span the period of regulation changes (headboat: 1986-2010; MRFSS: 1981-2010). The implementation of a minimum legal size for cobia in 1984 is mentioned in the Data Workshop report and the potential change in selectivity is modelled in the assessment. In the Assessment Workshop report the imposition of the federal bag limit in 1990 is noted, but only in the discussion of the fit to discard rates. The Florida state regulation is not mentioned in the Assessment Workshop report.

For Spanish mackerel there were numerous changes in bag limits over the period covered by the MRFSS CPUE indices. The fact that there were changes is noted in the reports but no analysis or discussion of the potential effect on catch rates is given. The changes were generally increases in the daily bag limit, so it may be that they are not particularly important in terms of affecting catch rates. However, there should have been an analysis of the data to see if there were effects such as a limiting of catch before the bag limits were increased.

Modelling of year interactions as random effects

The standard approach taken by the Index Working Group when standardizing the commercial and recreational CPUE data was to fit two-way interactions involving year as a random effect. The software will let this be done, but it is inappropriate because year interactions are probably not random (in the sense of random effects, where the values can be considered as random samples from a particular distribution). For example, consider a year-area interaction. If there are very different trends in different areas then this is a sign that there are groups of fish associated with each area which have different abundance trajectories – not a random effect at all (the changes in abundance are correlated within each area and perhaps across areas). Also, it is a sign of a fundamental problem with the CPUE analysis. A valid abundance index can only be obtained in this case if the number of records in each area is a good approximation to the relative abundance across areas (so that the different trends are appropriately weighted). Fitting the year-area interactions as a random effect does not change the mean effects (Venables and Dichmont, 2004) and merely hides the potential problem. This is not to say that mixed models should not be used – there are factors which can be appropriately modelled as random effects (e.g., individual vessel effects).

Scaling of length and age (composition) data

It is important to try to make of the most of whatever composition data are available. These are the data that provide information on growth, selectivity, and year class strength. If they are not properly stratified and scaled then legitimate signals in the data will be obscured.

There should be little debate about how length and age data are scaled. If there was an appropriate sampling design, then this includes the stratification and how to scale the data. For length samples, normally, there is a two-stage scaling procedure: sample scaled to catch or landing; and then the combined samples within a stratum are scaled to the stratum catch (and then combined across strata without any further weighting). For age data, sampled at random, the same scaling procedure applies. For age data, collected to construct an age-length key, the length frequency is first constructed (by appropriate scaling) and then the age-length key(s) is applied to produce the age frequency.

The recommendation of the Data Working Group, for both cobia and mackerel, to scale the age data "using the length frequency" is very worrying. I first heard of this method when reviewing SEDAR 17 and on investigation I found that it was invalid. Simple examples were enough to show that the method did not achieve its stated intent (Cordue 2008). That the same method is still being recommended is very disappointing. They cite a paper which apparently uses the method when estimating growth curves (Chih 2009). It may have some utility in the situation the author considered but the method should not be used to produce age frequencies.

When composition data are sampled in an ad hoc basis (or there are inadequate sample sizes in the original stratification) 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). It is also important to exclude data in years when the coverage is inadequate – it should not just be “thrown in” in the hope that the model can account for non-representative samples (because it cannot).

Using age data as conditional age-at-length

This appears to have become the norm for assessments using SS3. It has advantages and disadvantages. It stops the worry 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, when they were collected, and how they were collected.

One problem is the timing of the sampling. It is important to consider how fast the fish grow and at what size they are recruited to each fishery. If fish are growing rapidly during the year in which they were sampled then there is the problem that the age proportions at given length change during the year (e.g., sample for age at 20 cms: on 1 February the proportions at age are 70% 1 year old and 30% 2 year old; but on 1 November the expected proportions are 100% 1 year old).

Another issue is that age-proportions at given length can also vary spatially. For example, a recreational fishery in one area may be catching spawning fish, while in another area the same “fishery” (in the model at least) is capturing non-spawning fish. The age-proportions at length will be very different between the two areas. A similar effect could occur because of spatial variation in growth. Yet another issue is the variation in growth between cohorts. At a given time of year, the age-proportions at a given length could be dramatically different for fast and slow growing cohorts. If there is only patchy conditional age-at-length data in the model then fast growing cohorts could be estimated as strong cohorts and slow-growing cohorts as weak cohorts.

Because of all of these issues it is by no means certain that it is best to incorporate age data into SS3 as conditional age-at-length and to estimate growth in the model. Certainly, it is always important to analyse the age data with regard to these potential issues and to make sure that the data are appropriately stratified and scaled.

None of the issues relating to the problems of using conditional age-at-length data appear to have been considered in the cobia and Spanish mackerel assessments. The paucity of data is not an excuse for ignoring these issues – it does, in some ways, make it more important that they are considered.

Data weighting

There are various methods for obtaining relative weights (CVs and effective sample sizes) for the different data sets fitted in a stock assessment model. In both assessments, fairly arbitrary weights are used in the base models and iterative re-weighting methods (Francis 2011, SS3 re-weighting) are only considered in sensitivity runs. This is the wrong way round. The base runs should be using a formal weighting scheme and alternative schemes investigated in sensitivity runs. As it happens, it appears that the results are not particularly sensitive to the relative weights.

Effective sample sizes for composition data

This is partly covered under the data weighting heading (the method of Francis will give much lower sample sizes for composition data than SS3 re-weighting). However, in the cobia and mackerel assessments, the effective sample sizes that are used are based on the number of fish measured or aged (with a cap for sample size on length frequencies). This is not good practice. Best practice is to bootstrap the data to determine an effective sample size for each year based on how many fish were sampled in each trip and hence the within and between trip variability (and to use these sample sizes as initial values in iterative reweighting). Alternatively, if a rule-of-thumb is used, then the initial sample sizes should be based on the number of trips sampled rather than the total number of fish measured/aged. For example, if 100 fish were measured from 1 trip, the effective sample size should be closer to 1 than to 100 (e.g., Pennington et al. 2002). For age data the scaling down shouldn't be as extreme as for length data. For example, 100 fish aged from 10 trips could be worth 3-5 fish per trip, but almost certainly not 10 per trip.

That covers the joint problems.

Each of the ToRs are specifically considered below.

Cobia

1. *Evaluate the quality and applicability of data used in the assessment.*

Life history
The Life History Working Group covered the definition of stock boundaries and the estimation of fixed biological parameters. They considered appropriate data and made sensible recommendations with the exception of recommending 60% females at birth. They based this on the skewed sex ratios observed in the fisheries. However, the sex ratio in the population is hopelessly confounded with the fishing selectivities. It will make little difference, but the fishery dependent data considered do not give a reasonable basis to move from a 50-50 sex ratio at birth.

Catch history
The catch history was estimated for the commercial fishery starting in 1926 for three gear types (hand-line, long-line, and other). Recreational landings (which are much larger than the commercial landings) were calculated by mode and region (to some extent). Modes included charter-boat, headboat, private/rental boat, and shore based. Landings for Texas were calculated separately from the Gulf. Discard data for commercial and recreational fisheries were also compiled. The bycatch from the shrimp fishery, which was very substantial in some years, was also estimated (SEDAR28-DW6).

It is usually a difficult and tedious job to reconstruct full catch histories for stock assessment purposes and I think that a good job was done in this case. However, it would have been useful to provide the assessment team with an envelope of potential landings and discards so that they could have easily performed sensitivity runs with "low" and "high" levels of landings and discards.

Composition data
Available length and age data from the recreational and commercial fisheries were compiled by the Data Workshop (DW).

There was very little commercial length data and almost no commercial age data. The DW report says that the length data were "weighted by the landings in numbers by strata (state, year, gear)". This is not appropriate as many of the strata contained no samples. In order to get sensible length frequencies for the assessment there needed to have been an attempt to identify period of years which could be combined to provide adequate samples across a sensible post-stratification (e.g., combining some states). To determine an appropriate post-stratification requires an analysis of the variability of length frequencies across the various strata (e.g., it may be that some gear types could be combined). With so few samples the best that can probably be done is to construct a combined-year length frequency for each fishery.

The recreational sample sizes are also very low with many strata having zero or close to zero fish measured. Again it raises the issue of having to conduct a detailed analysis of the length data to determine how strata should be combined before scaling and production of annual or combined-year length frequencies. This is not discussed in the DW report at all so I must assume that no such analysis was done and that strata with low sample sizes (including zero) were just mechanically scaled.

Abundance indices

The Index Working Group (IWG) considered five potential abundance time series and recommended two of them for use in the assessment.

The SEAMAP data were not recommended because of the very low occurrence of cobia in the catch. A time series was developed from a delta-lognormal model. There is no mention in the DW report or the document they cite for details (SEDAR28-DW03) of why the indices were not constructed in the normal way for a trawl survey. Certainly, the original design was a random stratified trawl survey – so it makes no sense to use a delta-lognormal model which only measures density when abundance/biomass could have been measured. However, given the index was not used, my point is academic.

The Texas Parks and Wildlife Survey (TPWS) was analyzed using a delta-lognormal model where the data were restricted to an area that had relatively high cobia catches (SEDAR28-DW10). However, even for this area the proportion of positive trips was only 3.1% and the IWG did not recommend its use. The very low success rate does mean it is very unlikely to be tracking abundance.

A commercial vertical line index was constructed using the usual delta-lognormal model and no descriptive analysis at all (SEDAR28-DW16). The IWG did not recommend the time series because of the restrictive trip limit of two fish per person per day. The proportion of successful trips was also very low (2-4% each year). Certainly the derived indices could not be recommended. However, this dataset deserves more analysis. There may be a subset of trips which could provide some useful qualitative information on abundance from the proportion of positive trips.

The headboat and MRFSS datasets were analyzed to produce recreational CPUE indices (SEDAR28-DW28). Different filtering methods were considered and implemented but none were successful in identifying a subset of relevant cobia effort. Indices were calculated from just positive trips and also, using the delta-lognormal model, from all trips. Eventually the decision was made to base the index on all trips: "The working group also noted that there was little difference in the indices that were estimated for the entire dataset and the indices estimated for the subset of only positive trips. Therefore, it was reluctantly decided at the data workshop, that fishing effort for cobia and Spanish mackerel would be based on all trips".

I assume that the IWG felt that they had to recommend at least one time series for use as a relative abundance index in the stock assessment. However, the low level of successful trips for the headboat (7%) and MRFSS (<1%) datasets should have led to the same conclusion as for the TPWS. Additionally, there is the issue of the change in regulations in the period spanned by the time series and the different regulations in Florida state waters. These data may be able to provide useful abundance indices. However, an analysis based on an understanding of the various fisheries which occur over the region, will be needed to deliver defensible indices.

The two time series recommended by the IWG are not defensible in my opinion.

2. *Evaluate the quality and applicability of methods used to assess the stock.*

The stock assessment modeling was adequate but the assessment overall cannot recover from the poor data inputs. In the Data Workshop, there was inadequate attention to detail in regard to the composition data, and the recommended CPUE indices were not defensible as relative abundance indices.

Stock Synthesis 3
The Data Working Group recommended that the assessment be updated using ASPIC because of the paucity of composition data. This was a poor recommendation because the important fisheries for the stock have very different size/age based selectivities. It is not clear how the bycatch in the shrimp fishery could have been modeled satisfactorily in ASPIC or how a minimum legal size would have been implemented.

Perhaps an assessment could have been done in ASPIC, but then an equivalent assessment could also be done in SS3 – which can be run as an “age-based production model”. The advantage of using SS3 is that there are numerous options for exploring the effect of fitting the available composition data and estimating or not estimating selectivity patterns and year class strengths.

Model structure
A simple and typical model structure was used. Population in age-structured equilibrium before the start of the fisheries. Year-round fisheries with constant selectivity patterns (with some time-blocking). Constant age-specific natural mortality over time. A single von Bertalanffy growth curve estimated in the model and a Beverton Holt stock-recruitment relationship. Year class strengths (recruitment deviations) were estimated from 1982-2010 (which is probably far too many given the paucity of composition data).

The shrimp fishery was modeled as a bycatch fishery with the catch driven by an effort time series and fitted to the median estimate of cobia bycatch from 1972-2011 using the “super-year” feature of SS3. Modeling the shrimp fishery in this way is a good approach.

Only a single commercial and a single recreational fishery were modeled despite the Data Working group providing landings histories for a number of fisheries. I assume the lumping of these data was because of the paucity of composition data but no explanation was provided in the Assessment Report. I have not considered whether it was justified or not – it would depend on whether the fisheries had similar selectivity patterns and whether their landings histories varied in a similar way over time.

Treatment of the data
The catch/landings histories were combined into single commercial and recreational fisheries which may or may not have been justified. The raw composition data, assembled by the Data Working group, seems to have been used in the assessment without any stratification or scaling (e.g., see Table 2.11 in the Assessment report – the number of fish measured is given in each year and then the number of fish in each 3cm bin is given; it looks like raw un-scaled data).

To get the most out of the limited composition data requires that it is very carefully post-stratified and scaled. The data are just there to help with estimation of growth, selectivities, and year class strength so it is unlikely to be fatal if they are not properly prepared; rather there is just a loss of information. Of course, if they are over-weighted relative to the abundance indices, then properly prepared or not they can severely distort an assessment.

The likelihood profile on virgin recruitment in the Assessment report (Figure 3.32) suggests that the age and length data are dominating the abundance indices in terms of a biomass signal (although it is a bit hard to tell – a "zoom in" would have been useful). The sample sizes, based on the number of fish measured or aged are too large. However, the abundance time series appear to be consistent with the biomass signal from the composition data so re-weighting of the data is unlikely to change the result.

Model runs
The base model used all of the available data and estimated steepness as well as numerous recruitment deviations. Given the paucity of composition data (and the fact it was not prepared properly) it is unlikely that there is good information on year class strength. The model will have no trouble coming up with estimates and will even provide good precision for those estimates because of the relatively high effective sample sizes assumed – but, in reality, the model is over-parameterized (and year class strengths are not well estimated).

Estimating steepness in these models is almost always the wrong thing to do. To get a good estimate requires excellent information on year class strengths over a wide range of relative spawning biomass. A glance at the available data tells us that steepness should not be estimated in this model.

A good range of sensitivity runs were performed, including low and high natural mortality and using one or other of the abundance time series. The only runs missing were those exploring the effects of different catch histories and discard rates. Certainly, the early catch history is very uncertain as are the discards from the shrimp fishery.

3. *Recommend appropriate estimates of stock abundance, biomass, and exploitation.*

I cannot recommend any of the model runs for this assessment. The abundance indices are not defensible. The composition data were not properly prepared (and are over-weighted). The model was over-parameterized.

4. *Evaluate the methods used to estimate population benchmarks and management parameters. Recommend and provide estimated values for appropriate management benchmarks and declarations of stock status for each model run presented for review.*

The methods used to estimate the SPR-based benchmarks are standard and done within SS3 which has been thoroughly tested. However, I cannot recommend any of the model runs and therefore do not provide any declarations of stock status.

5. *Evaluate the quality and applicability of the methods used to project future population status. Recommend appropriate estimates of future stock condition.*

   The base run and the low and high natural mortality runs were projected forward under three levels of fishing mortality ($F_{CURRENT}$, $FSPR_{30}$, and F_{OY}) using 1000 bootstrap replicates. The method is appropriate but I cannot recommend any of the runs.

6. *Evaluate the quality and applicability of methods used to characterize uncertainty in estimated parameters.*

   Uncertainty in the assessment was characterized by sensitivity runs and a parametric bootstrap on the base run. A good range of sensitivities were performed. The use of the bootstrap would not be my preferred choice but it is an acceptable approach. Calculation of Bayesian posteriors is generally preferable (even with uninformed priors). Also, uncertainty is badly under-estimated because of all the structural assumptions in the model (which is always the case) and the relatively large sample sizes used for the composition data (which does not have to be the case).

   - *Provide measures of uncertainty for estimated parameters*

     Confidence intervals from the bootstrap are provided in the Assessment report.

   - *Ensure that the implications of uncertainty in technical conclusions are clearly stated*

     The Assessment Report does not conclude that the assessment is highly uncertain and should be treated with extreme caution. This is my conclusion, mainly because of the lack of defensible abundance indices, but also because of the poor treatment of the composition data and the over-parameterization in the model.

   - *If there are significant changes to the base model, or to the choice of alternate states of nature, then provide a probability distribution function for the base model, or a combination of models that represent alternative states of nature, presented for review.*
     - *Determine the yield associated with a probability of exceeding OFL at P* values of 30% to 50% in single percentage increments*
     - *Provide justification for the weightings used in producing the combinations of models*

     Not applicable for this desktop review.

7. *If available, ensure that stock assessment results are accurately presented in the Stock Assessment Report and that stated results are consistent with Review Panel recommendations.*

   Not applicable for this desktop review.

8. *Evaluate the quality and applicability of the SEDAR Process as applied to the reviewed assessment and identify the degree to which Terms of Reference were addressed during the assessment process.*

   In general, the SEDAR process is a useful process for developing good quality stock assessments. However, the Data and Assessment Workshops in this case have not delivered good assessments.

   Problems with the cobia assessment should have been identified at the Data Workshop – someone should have had the courage to say “we don’t have a defensible abundance index” and they should have been listened to. The changes in fishing regulations and the variation between state and federal rules should have been noted by somebody.

   The ToRs of the Data Workshop were each addressed. Of course, some were done better than others as I have already noted. The preparation of the composition data was very poor. The recommendation to scale the age data using the length frequencies was unfortunate.

   ToR 5 for the Data Workshop requires them to recommend the assessment method. I don’t think this is the role of a data workshop. They should get all the data together, in a form that provides options for the stock assessment (e.g., finer scale than that which might eventually be used in the stock assessment) but they shouldn’t be telling the scientists who have to do the stock assessment modeling how to do it. Of course, ideally the person who has to do the modeling should be closely involved in all aspects of the Data Workshop.

   The ToRs of the Assessment Workshop were each addressed. They used SS3 instead of ASPIC, which was a good choice. They didn’t adequately document their reasons for some choices, such as using only a single commercial fishery and a single recreational fishery. They also appear to have used completely un-stratified and un-scaled composition data – certainly there is no explanation of how the data were scaled.

   The review process normally involves a meeting where questions can be asked and answered and additional analyses used to explore issues. A desktop review, where the reviewers are not able to ask questions or discuss issues with the assessment scientists and each other, is not as good. Desktop reviewers only comment on the issues that they notice. In a meeting, issues that are noticed by each reviewer (and other meeting participants) come to the attention of all reviewers.

9. *Make any additional recommendations or prioritizations warranted.*
   - *Clearly denote research and monitoring needs that could improve the reliability of future assessments*

   In the short-term, a new assessment is needed. There are no defensible abundance indices and it will hard to produce any quickly. Therefore, an assessment which looks at worst case scenarios should be considered. If the stock is in reasonable shape even at biomass levels that would only just allow the estimated catch to have been taken, then there is no rush to produce a full assessment.

   Of course, a reliable assessment generally requires a defensible abundance time series. The development of such a series should be the top priority. Pursuit of such an index should also provide some answers on what other data need to be collected to provide defensible indices for cobia.

A workshop should be held to train people in the analysis and post-stratification of composition data.

Spanish Mackerel

10. *Evaluate the quality and applicability of data used in the assessment.*

Life history
The Life History Working Group covered the definition of stock boundaries and the estimation of fixed biological parameters. They considered appropriate data and made sensible recommendations with the exception of a strange recommendation on sex ratio: "Over all ages and gears, weighted percent females 66%". This was derived from their analysis of sex ratio data from fisheries. The Assessment Workshop took this as a recommendation for 50-50 at birth in 1886 (apparently): "Sex ratio at the start time of the population analysis (1886) was assumed to be 1:1 as recommended by the SEDAR 28 DW". It is strangely worded as 50-50 at birth in 1886 means 50-50 every year at birth.

Catch history
The catch history was estimated for the commercial fishery starting in 1880 for three gear types (gill nets, hand-line, and other). Recreational landings (which are much larger than the commercial landings) were calculated by mode and region (to some extent): MRFSS/MRIP estimates of landings from charter, private angler; Texas Parks and Wildlife (charter, private and headboat); and the for-hire headboat fishery. Discard data for commercial and recreational fisheries were also compiled. The bycatch from the shrimp fishery, which was very substantial in some years, was also estimated (SEDAR28-DW6).

It is usually a difficult and tedious job to reconstruct full catch histories for stock assessment purposes and I think that a good job was done in this case (no doubt building on the work done in previous assessments). However, it would have been useful to provide the assessment team with an envelope of potential landings and discards so that they could have easily performed sensitivity runs with "low" and "high" levels of landings and discards.

Composition data
Available length and age data from the recreational and commercial fisheries were compiled by the Data Workshop.

There were few commercial length and age data. The DW report says that the length data "were weighted by the trip landings in numbers and the landings in numbers by strata (state, year, gear).". This is not appropriate when many of the strata contained no samples. In order to get sensible length frequencies for the assessment there needed to have been an attempt to identify period of years which could be combined to provide adequate samples across a sensible post-stratification (e.g., combining some states). To determine an appropriate post-stratification requires an analysis of the variability of length frequencies across the various strata.

The recreational sample sizes are much higher but there are still a number of strata having zero or close to zero fish measured. Again it raises the issue of having to conduct a detailed analysis of the length data to determine how strata should be combined before scaling and production of annual or combined-year length frequencies. This is not discussed in the DW report at all so I must assume that no such analysis was done and that strata with low sample sizes (including zero) were just mechanically scaled. This is not a big issue for the MRFSS data, but for the headboat survey the sampling is very patchy and the data need to be carefully post-stratified.

Abundance indices

The Index Working Group (IWG) considered nine potential abundance time series and recommended three of them for use in the assessment.

The SEAMAP data were analyzed to produce an abundance time series for 0-1 year old Spanish mackerel (SEDAR28-DW03). The IWG recommended the time series for use because " it is a fisheries independent survey across a long time series (1987-2010), with very good spatial converge (TX/Mexico border to Mobile Bay)". Their statement is true but does not provide sufficient justification to include this time series in a stock assessment. In total, the two surveys each year caught between 32 and 487 fish. Typically, about 50-200 fish are caught each year. The proportion of positive stations was about 4% in summer and 8% in fall (SEDAR28-DW03). Basically, the survey doesn't catch much Spanish mackerel and the variability in the index is probably unrelated to the abundance of Spanish mackerel.

The three recreational surveys (Texas sport-boat angler survey, headboat, and MRFSS) all have very few successful trips. The IWG rejected the Texas and headboat surveys on this basis but recommended the use of the MRFSS time series although they didn't give any reasons other than: "This index was particularly favored because it presents a long time series." With less than 5% positive trips it is not reasonable to accept the unfiltered delta-lognormal time series as an abundance index.

Of the commercial data sets considered the IWG preferred the Florida State ticket data to the commercial logbook data for vertical lines and gillnets. I agree that the "run-around" gillnet method is likely to produce hyper-stable indices. Also, if Florida covers most of the fishery and has a longer time series then it is probably to be preferred to the shorter time series from the vertical line index (though, perhaps not in this case – see below).

The Florida trip-ticket data were used to construct cast net, hand-line/trolling, and gillnet indices split into time periods when trip limits were (assumed to be) not too restrictive. The IWG identified various problems with the "interpretation of data from trips using gill nets (e.g., deployment methods, mesh sizes, configuration of panels, and changes in state/federal waters restrictions) and cast nets (e.g., configuration, depth, bottom types)". I agree with their recommendation not to use these time series in stock assessment.

The IWG did recommend the Florida trip-ticket hand-line/trolling index (which shows an increasing trend over time) for use in stock assessment. This is a standardized index of catch-per-trip for trips that caught some Spanish mackerel (SEDAR28-AW01). The standardization approach is unusual as 8 of 11 explanatory variables are dummy variables which indicate whether a species-group was caught on the trip or not (this is slightly problematic as these are random variables and, strictly speaking, should not be used as explanatory variables). The remaining variables are year, month, and Florida sub-region. The documentation for this analysis does not mention using any measure of trip duration or "actual time fished" (which is a field on the Trip Ticket). They also do not make use of "number of crew" another field on the trip ticket (available since 2000). The response variable is given as "catch per trip" and not as “catch per trip per hour”. Perhaps this is just a documentation error? It is very hard to tell because there is no descriptive analysis to give a context to the standardization analysis. There is some discussion of outliers in the response variable: “those with landings greater than 1,223 pounds were excluded”. This tends to support “catch per trip”, but also it seems odd to exclude data on this basis – again the length of trip and the size of the vessel/number of crew, are important because longer trips and bigger vessels may catch more fish.

If “actual time fished” was not used in the standardization, and/or it is not properly reported on the form, then it is wrong to use this time series in stock assessment. The increasing trend could simply be the result of longer trips over time. It could also be the result of a change in the fleet with vessels that used to make short trips and/or not catch many fish, dropping out of the fishery over time. In a proper standardization these effects would be accounted for. It is also important when doing a standardization to first fully understand the data by doing a descriptive/exploratory analysis – it is very bad practice, as appears to have been done here, to simply “throw the data into the machine and turn the handle”. Not using “actual time fished” in the analysis is very hard to understand.

Unfortunately, I have found fatal faults with each of the three abundance times series used in the Spanish mackerel stock assessment.

11. *Evaluate the quality and applicability of methods used to assess the stock.*

The stock assessment modeling was adequate but the assessment overall cannot recover from the poor data inputs. In the Data Workshop, there was inadequate attention to detail in regard to the composition data, and the recommended CPUE indices were not defensible as relative abundance indices.

Stock Synthesis 3
The use of this package was appropriate given the available data.

Model structure
A simple and typical model structure was used. Population in age-structured equilibrium before the start of the fisheries. Year-round fisheries with constant selectivity patterns (with some time-blocking). Constant age-specific natural mortality over time. A single von Bertalanffy growth curve estimated in the model and a Beverton Holt stock-recruitment relationship. Year class strengths (recruitment deviations) were estimated from 1985-2010.

The shrimp fishery was modeled as a bycatch fishery with the catch driven by an effort time series and fitted to the median estimate of Spanish mackerel bycatch from 1972-2011 using the “super-year” feature of SS3. Modeling the shrimp fishery in this way is a good approach.

Two commercial fisheries were modeled but only a single recreational fishery was used despite the Data Working group providing landings histories for a number of fisheries. No explanation for this was provided in the Assessment Report. I have not considered whether it was justified or not – it would depend on whether the fisheries had similar selectivity patterns and whether their landings histories varied in a similar way over time.

Treatment of the data
The catch/landings histories were combined into two commercial fisheries and a single recreational fishery which may or may not have been justified. The raw length data, assembled by the Data Working group, seems to have been used in the assessment without

state in the stratification: “Length data were stratified by calendar year, fishery/survey (commercial gillnet fleet (COM_GN), commercial line gears (COM_RR), and recreational all fisheries combined (headboat, private angler, charter, shore = REC)”. There should have been scaling from sample to trip and stratification needed to include state (unless there was an analysis showing that length frequencies were similar across states).

To get the most out of the limited composition data requires that it is very carefully post-stratified and scaled. The data are just there to help with estimation of growth, selectivities, and year class strength so it is unlikely to be fatal if they are not properly prepared; rather there is just a loss of information. Of course, if they are over-weighted relative to the abundance indices, then properly prepared or not they can severely distort an assessment.

The likelihood profile on virgin recruitment in the Assessment report (Figure 3.32) suggests that the age and length data are dominating the abundance indices in terms of a biomass signal (though it is a bit hard to tell – a “zoom in” would have been useful). The sample sizes, based on the number of fish measured or aged are too large. However, the abundance time series appear to be consistent with the biomass signal from the composition data so re-weighting of the data is unlikely to change the result.

Model runs

The base model (Run 3) used all of the available data and sensibly fixed steepness (0.8). Estimating steepness in these models is almost always the wrong thing to do. To get a good estimate requires excellent information on year class strengths over a wide range of relative spawning biomass.

A good range of sensitivity runs were performed, including low and high natural mortality and alternative values of steepness. The only runs missing were those exploring the effects of different catch histories and discard rates. Certainly, the early catch history is very uncertain as are the discards from the shrimp fishery.

12. *Recommend appropriate estimates of stock abundance, biomass, and exploitation.*

I cannot recommend any of the model runs for this assessment. The abundance indices are not defensible. The composition data were not properly prepared (and are over-weighted).

13. *Evaluate the methods used to estimate population benchmarks and management parameters. Recommend and provide estimated values for appropriate management benchmarks and declarations of stock status for each model run presented for review.*

The methods used to estimate the SPR-based benchmarks are standard and done within SS3 which has been thoroughly tested. However, I cannot recommend any of the model runs and therefore do not provide any declarations of stock status.

14. *Evaluate the quality and applicability of the methods used to project future population status. Recommend appropriate estimates of future stock condition.*

The base run and a sensitivity run on steepness were projected forward deterministically under three levels of fishing mortality (FCURRENT, FSPR30, and F_{OY}). Stochastic projections using 1000 bootstrap replicates were also done for the base model. The method is adequate but I cannot recommend any of the runs.

15. *Evaluate the quality and applicability of methods used to characterize uncertainty in estimated parameters.*

Uncertainty in the assessment was characterized by sensitivity runs and a parametric bootstrap on the base run. A good range of sensitivities were performed. The use of the bootstrap would not be my preferred choice but it is an acceptable approach. Calculation of Bayesian posteriors is generally preferable (even with uninformed priors). Also, uncertainty is badly under-estimated because of all the structural assumptions in the model (which is always the case) and the relatively large assumed sample sizes for the composition data (which does not have to be the case).

- *Provide measures of uncertainty for estimated parameters*

  Confidence intervals from the bootstrap are provided in the Assessment report.

- *Ensure that the implications of uncertainty in technical conclusions are clearly stated*

  The Assessment Report does not conclude that the assessment is highly uncertain and should be treated with extreme caution. This is my conclusion, mainly because of the lack of defensible abundance indices, but also because of the poor treatment of the composition data.

- *If there are significant changes to the base model, or to the choice of alternate states of nature, then provide a probability distribution function for the base model, or a combination of models that represent alternative states of nature, presented for review.*
  - *Determine the yield associated with a probability of exceeding OFL at P* values of 30% to 50% in single percentage increments*
  - *Provide justification for the weightings used in producing the combinations of models*

  Not applicable for this desktop review.

16. *If available, ensure that stock assessment results are accurately presented in the Stock Assessment Report and that stated results are consistent with Review Panel recommendations.*

Not applicable for this desktop review.

17. *Evaluate the quality and applicability of the SEDAR Process as applied to the reviewed assessment and identify the degree to which Terms of Reference were addressed during the assessment process.*

In general, the SEDAR process is a useful process for developing good quality stock assessments.

The ToRs of the Data Workshop were each addressed. Of course, some were done better than others as I have already noted. The preparation of the composition data was poor. The recommendation to scale the age data using the length frequencies was very poor.

ToR 5 for the Data Workshop requires them to recommend the assessment method. I don’t think this is the role of a data workshop. They should get all the data together, in a form that provides options for the stock assessment (e.g., finer scale than that which might eventually be used in the stock assessment) but they shouldn't be telling the scientists who have to do the stock assessment modeling how to do it. Of course, ideally the person who has to do the modeling should be closely involved in all aspects of the Data Workshop.

The ToRs of the Assessment Workshop were each addressed. They didn't adequately document their reasons for some choices, such as using only a single recreational fishery. The stratification of the length data was very poor (state should have been included or a full justification given for ignoring it).

The review process normally involves a meeting where questions can be asked and answered and additional analyses used to explore issues. A desktop review, where the reviewers are not able to ask questions or discuss issues with the assessment scientists and each other, is not as good. Desktop reviewers only comment on the issues that they notice. In a meeting, issues that are noticed by each reviewer (and other meeting participants) come to the attention of all reviewers.

18. *Make any additional recommendations or prioritizations warranted.*
    - *Clearly denote research and monitoring needs that could improve the reliability of future assessments*

In the short-term, a new assessment is needed. There are data that may provide defensible abundance indices if analyzed properly (e.g., commercial logbook, vertical line data; Florida trip-ticket, hand-line/trolling data). It may also be possible to get something useful from the recreational data with appropriate filtering.

A workshop should be held to train people in the analysis and post-stratification of composition data.

Conclusions and Recommendations

The reviewed cobia and Spanish mackerel assessments are not suitable to be used to provide management advice because of the flawed data inputs used in the models.

My main conclusions are:

- Stock structure and fixed life history parameters were adequately considered.
- Landings history, discards, and discard mortalities were adequately determined and considered.
- Composition data were poorly treated at both the Data and Assessment Workshops. There was an absence of appropriate analysis and discussion with regard to post-stratification of the data to deal with inadequate sample sizes within some strata.
- The Index Working Group made very poor recommendations with regard to time series to use in the stock assessments as relative abundance indices:
    - For cobia, two recreational CPUE time series were recommended but these both had very low proportions of successful trips and spanned a period when fishing regulations had become more restrictive.
    - For Spanish mackerel: a SEAMAP survey was recommended as a recruitment time series, but it caught very few Spanish mackerel each year; a recreational time series was recommended but it had a very low proportion of successful trips; and a commercial index based on catch-per-trip was recommended but it had not been standardized for trip duration or time fished.
- None of the abundance indices used in the stock assessment runs were defensible.
- The model structure used, the choice of runs, and the methods of projection and capturing of uncertainty were adequate but could not overcome the flawed data inputs.
- None of the model runs should be used to determine biomass estimates or recommend stock status.

My main recommendations are:

- Top priority should be given to the construction of defensible abundance indices for both cobia and Spanish mackerel from the commercial and recreational data. I suggest the following approach:
    - Discussion with some of the participants in the fisheries to get some understanding of how, when, and where, they target cobia and Spanish mackerel.
    - A full descriptive/exploratory analysis of the data to understand the temporal and spatial variation in the catches and all of the available explanatory variables.
    - Identification of regional and seasonal fisheries for which fishing effort is likely to catch the species of interest (cobia or Spanish mackerel). This is likely to involve the identification of vessels in each year which fish at the times and places of interest and catch the species on some of their trips. It does not require that individual vessels be tracked across years (although that would be ideal).
    - An analysis to determine if fishing regulations have impacted on the ability of the data to track abundance (time series may have to be split to account for different fishing behaviour caused by regulation changes)
    - Production of standardized CPUE indices for each identified regional/seasonal fishery
    - Comparison of the trends across the different fisheries

        - Decide which if any of the CPUE indices are defensible as relative abundance indices (the length of the time series is not relevant to this decision).

- If defensible abundance indices can be constructed then assessments can be done as before except:
    - Composition data should be appropriately post-stratified and scaled; sample sizes should be based on the number of trips/landings sampled (not the number of fish measured or aged). This will require an analysis of the variability in length frequencies and proportion-at-age for given length across the various strata.
    - Recruitment deviates should only be estimated for cohorts which are well-represented in the composition data (e.g., appear at least three times in the age data).
    - Steepness should be fixed or estimated with an informed prior.

References

Chih, C. 2009. The effects of otolith sampling methods on the precision of growth curves. *North American Journal of Fisheries Management 29*: 1519-1528.

Cordue, P.L. 2008: Report on SEDAR 17, Stock Assessment Review, South Atlantic Vermilion Snapper and Spanish Mackerel, October 20 - 24, 2008, Savannah, Georgia. *For* CIE Independent System for Peer Review. 36 p.

Francis, R.I.C.C. 2011. Data weighting in statistical fisheries stock assessment models. *Can. J. Fish. Aquat. Sci. 68*: 1124–1138.

Pennington, M.; Burmeister, L.; Hjellvik V. 2002. Assessing the precision of frequency distributions estimated from trawl-survey samples. *Fish. Bull. 100*: 74–80.

Stephens, A.; MacCall, A. 2004. A multispecies approach to sub-setting logbook data for the purposes of estimating CPUE. *Fisheries Research 70*: 299–310.

Venables, W.N.; Dichmont, C.M. 2004. GLMs, GAMs and GLMMs: an overview of theory for applications in fisheries research. *Fisheries Research 70*: 319–337.

Appendix 1: Bibliography of supplied material

The following data and assessment workshop reports were supplied for the desktop review.

SEDAR 28: Gulf of Mexico cobia, SECTION II: Data Workshop Report, May 2012. 239 p.
SEDAR 28: Gulf of Mexico Spanish mackerel, SECTION II: Data Workshop Report, May 2012. 268 p.
SEDAR 28: Gulf of Mexico cobia, SECTION III: Assessment Process Report, December 2012. 208 p.
SEDAR 28: Gulf of Mexico Spanish mackerel, SECTION III: Assessment Workshop Report, December 2012. 274 p.

The numerous workshop, background, and reference documents listed below were made available through the SEDAR website and were consulted as needed.

Document	**Title**	**Authors**
SEDAR28-DW01	Cobia preliminary data analyses – US Atlantic and GOM genetic population structure	Darden 2012
SEDAR28-DW02	South Carolina experimental stocking of cobia *Rachycentron canadum*	Denson 2012
SEDAR28-DW03	Spanish Mackerel and Cobia Abundance Indices from SEAMAP Groundfish Surveys in the Northern Gulf of Mexico	Pollack and Ingram, 2012
SEDAR28-DW04	Calculated discards of Spanish mackerel and cobia from commercial fishing vessels in the Gulf of Mexico and US South Atlantic	K. McCarthy
SEDAR28-DW05	Evaluation of cobia movement and distribution using tagging data from the Gulf of Mexico and South Atlantic coast of the United States	M. Perkinson and M. Denson 2012
SEDAR28-DW06	Methods for Estimating Shrimp Bycatch of Gulf of Mexico Spanish Mackerel and Cobia	B. Linton 2012
SEDAR28-DW07	Size Frequency Distribution of Spanish Mackerel from Dockside	N.Cummings, J. Isely

	Sampling of Recreational and Commercial Landings in the Gulf of Mexico 1981-2011	
SEDAR28-DW08	Size Frequency Distribution of Cobia from Dockside Sampling of Recreational and Commercial Landings in the Gulf of Mexico 1986-2011	J. Isely and N. Cummings
SEDAR28-DW09	Texas Parks and Wildlife Catch Per unit of Effort Abundance Information for Spanish mackerel	N. Cummings, J. Isely
SEDAR28-DW10	Texas Parks and Wildlife Catch Per unit of Effort Abundance Information for cobia	J. Isely, N. Cummings
SEDAR28-DW11	Size Frequency Distribution of Cobia and Spanish Mackerel from the Galveston, Texas, Reef Fish Observer Program 2006-2011	J Isely and N Cummings
SEDAR28-DW12	Estimated conversion factors for calibrating MRFSS charterboat landings and effort estimates for the South Atlantic and Gulf of Mexico in 1981-1985 with For Hire Survey estimates with application to Spanish mackerel and cobia landings	V. Matter, N Cummings, J Isely, K Brennen, and K Fitzpatrick
SEDAR28-DW13	Constituent based tagging of cobia in the Atlantic and Gulf of Mexico waters	E. Orbesen

SEDAR28-DW14	Recreational Survey Data for Spanish Mackerel and Cobia in the Atlantic and the Gulf of Mexico from the MRFSS and TPWD Surveys	V. Matter
SEDAR28-DW15	Commercial Vertical Line and Gillnet Vessel Standardized Catch Rates of Spanish Mackerel in the US Gulf of Mexico, 1998-2010	N. Baertlein, K. McCarthy
SEDAR28-DW16	Commercial Vertical Line Vessel Standardized Catch Rates of Cobia in the US Gulf of Mexico, 1993-2010	K. McCarthy
SEDAR28-DW17	Standardized Catch Rates of Spanish Mackerel from Commercial Handline, Trolling and Gillnet Fishing Vessels in the US South Atlantic, 1998-2010	K. McCarthy
SEDAR28-DW18	Standardized catch rates of cobia from commercial handline and trolling fishing vessels in the US South Atlantic, 1993-2010	K. McCarthy
SEDAR28-DW19	MRFSS Index for Atlantic Spanish mackerel and cobia	Drew et al.
SEDAR28-DW20	Preliminary standardized catch rates of Southeast US Atlantic cobia (*Rachycentron canadum*) from headboat data.	NMFS Beaufort
SEDAR28-DW21	Spanish mackerel preliminary data summary: SEAMAP-SA Coastal Survey	Boylan and Webster
SEDAR28-DW22	Recreational indices for cobia and Spanish mackerel in the Gulf of Mexico	Bryan and Saul
SEDAR28-DW23	A review of Gulf of Mexico and Atlantic Spanish mackerel (*Scomberomorus*	Palmer, DeVries, and Fioramonti

	maculatus) age data, 1987-2011, from the Panama City Laboratory, Southeast Fisheries Science Center, NOAA Fisheries Service	
SEDAR28-DW24	SCDNR Charterboat Logbook Program Data, 1993 - 2010	Errigo, Hiltz, and Byrd
SEDAR28-DW25	South Carolina Department of Natural Resources State Finfish Survey (SFS)	Hiltz and Byrd
SEDAR28-DW26	Cobia bycatch on the VIMS elasmobranch longline survey:1989-2011	Parsons et al.
SEDAR28-RW01	The Beaufort Assessment Model (BAM) with application to cobia: mathematical description, implementation details, and computer code	Craig
SEDAR28-RW02	Development and diagnostics of the Beaufort assessment model applied to Cobia	Craig
SEDAR28-RW03	The Beaufort Assessment Model (BAM) with application to Spanish mackerel: mathematical description, implementation details, and computer code	Andrews
SEDAR28-RW04	Development and diagnostics of the Beaufort assessment model applied to Spanish mackerel	Andrews
SEDAR28-RD01	List of documents and working papers for SEDAR 17 (South Atlantic Spanish mackerel) – all documents available on the SEDAR website	SEDAR 17
SEDAR28-RD02	2003 Report of the mackerel Stock Assessment Panel	GMFMC and SAFMC, 2003
SEDAR28-RD03	Assessment of cobia, Rachycentron canadum, in the waters of the U.S. Gulf of Mexico	Williams, 2001

SEDAR28-RD04	Biological-statistical census of the species entering fisheries in the Cape Canaveral area	Anderson and Gehringer, 1965
SEDAR28-RD05	A survey of offshore fishing in Florida	Moe 1963
SEDAR28-RD06	Age, growth, maturity, and spawning of Spanish mackerel, Scomberomorus maculates (Mitchill), from the Atlantic Coast of the southeastern United States	Schmidt et al. 1993
SEDAR28-RD07	Omnibus amendment to the Interstate Fishery Management Plans for Spanish mackerel, spot, and spotted seatrout	ASMFC 2011
SEDAR28-RD08	Life history of Cobia, Rachycentron canadum (Osteichthyes: Rachycentridae), in North Carolina waters	Smith 1995
SEDAR28-RD09	Population genetics of cobia Rachycentron canadum: Management implications along the Southeastern US coast	Darden et al, 2012
SEDAR28-RD10	Inshore spawning of cobia (Rachycentron canadum) in South Carolina	Lefebvre and Denson, 2012
SEDAR28-RD11	A review of age, growth, and reproduction of cobia Rachycentron canadum, from US water of the Gulf of Mexico and Atlantic ocean	Franks and Brown-Peterson, 2002
SEDAR28-RD12	An assessment of cobia in Southeast US waters	Thompson 1995
SEDAR28-RD13	Reproductive biology of cobia, Rachycentron canadum, from coastal waters of the southern United States	Brown-Peterson et al. 2001
SEDAR28-RD14	Larval development, distribution, and ecology of cobia Rachycentron canadum (Family: Rachycentridae) in the northern Gulf of Mexico	Ditty and Shaw 1992

SEDAR28-RD15	Age and growth of cobia, Rachycentron canadum, from the northeastern Gulf of Mexico	Franks et al 1999
SEDAR28-RD16	Age and growth of Spanish mackerel, Scomberomorus maculates, in the Chesapeake Bay region	Gaichas, 1997
SEDAR28-RD17	Status of the South Carolina fisheries for cobia	Hammond, 2001
SEDAR28-RD18	Age, growth and fecundity of the cobia, Rachycentron canadum, from Chesapeake Bay and adjacent Mid-Atlantic waters	Richards 1967
SEDAR28-RD19	Cobia (Rachycentron canadum) tagging within Cheasapeake Bay and updating of growth equations	Richards 1977
SEDAR28-RD20	Synopsis of biological data on the cobia Rachycentron canadum (Pisces: Rachycentridae)	Shaffer and Nakamura 1989
SEDAR28-RD21	South Carolina marine game fish tagging program 1978-2009	Wiggers, 2010
SEDAR28-RD22	Cobia (Rachycentron canadum), amberjack (Seriola dumerili), and dolphin (Coryphaena hipurus) migration and life history study off the southwest coast of Florida	MARFIN 1992
SEDAR28-RD23	Sport fish tag and release in Mississippi coastal water and the adjacent Gulf of Mexico	Hendon and Franks 2010
SEDAR28-RD24	VMRC Cobia otolith preparation protocol	VMRC
SEDAR28-RD25	VMRC Cobia otolith ageing protocol	VMRC
SEDAR28-RD26	Age, growth, and reproductive biology of greater amberjack and cobia from Louisiana waters	Thompson et al. 1991

SEDAR28-RD27	Gonadal maturation in the cobia, Rachycentron canadum, from the northcentral Gulf of Mexico	Lotz et al. 1996
SEDAR28-RD28	Cobia (Rachycentron canadum) stock assessment study in the Gulf of Mexico and in the South Atlantic	Burns et al. 1998
SEDAR28-RD29	Total mortality estimates for Spanish mackerel captured in the Gulf of Mexico commercial and recreational fisheries 1983 to 2011	Bryan 2012

SEDAR28-AW01	Florida Trip Tickets	S. Brown
SEDAR28-AW02	SEDAR 28 Spanish mackerel bycatch estimates	NMFS Beaufort

Appendix 2: Statement of Work for Patrick Cordue

Amended Statement of Work

External Independent Peer Review by the Center for Independent Experts

SEDAR 28: Gulf of Mexico Cobia and Spanish Mackerel Assessment Desk Review

Scope of Work and CIE Process: The National Marine Fisheries Service's (NMFS) Office of Science and Technology coordinates and manages a contract providing external expertise through the Center for Independent Experts (CIE) to conduct independent peer reviews of NMFS scientific projects. The Statement of Work (SoW) described herein was established by the NMFS Project Contact and Contracting Officer's Representative (COR), and reviewed by CIE for compliance with their policy for providing independent expertise that can provide impartial and independent peer review without conflicts of interest. CIE reviewers are selected by the CIE Steering Committee and CIE Coordination Team to conduct the independent peer review of NMFS science in compliance the predetermined Terms of Reference (ToRs) of the peer review. Each CIE reviewer is contracted to deliver an independent peer review report to be approved by the CIE Steering Committee and the report is to be formatted with content requirements as specified in **Annex 1**. This SoW describes the work tasks and deliverables of the CIE reviewer for conducting an independent peer review of the following NMFS project. Further information on the CIE process can be obtained from www.ciereviews.org.

Project Description SEDAR 28 will be a compilation of data, an assessment of the stocks, and an assessment review conducted for Gulf of Mexico Spanish mackerel and cobia. The CIE peer review is ultimately responsible for ensuring that the best possible assessment has been provided through the SEDAR process. The stocks assessed through SEDAR 28 are within the jurisdiction of the Gulf of Mexico Fisheries Management Councils and states in the Gulf of Mexico region. The Terms of Reference (ToRs) of the peer review are attached in **Annex 2**.

Requirements for CIE Reviewers: Three CIE reviewers shall have the necessary qualifications to complete an impartial and independent peer review in accordance with the statement of work (SoW) tasks and terms of reference (ToRs) specified herein. The CIE reviewers shall have expertise in stock assessment, statistics, fisheries science, and marine biology sufficient to complete the tasks of the peer-review described herein. Each CIE reviewer's duties shall not exceed a maximum of 10 days to complete all work tasks of the peer review described herein.

Location of Peer Review: Each CIE reviewer shall participate and conduct an independent peer review as a desk review, therefore travel will not be required.

Statement of Tasks: Each CIE reviewer shall complete the following tasks in accordance with the SoW and Schedule of Milestones and Deliverables herein.

Prior to the Peer Review: Upon completion of the CIE reviewer selection by the CIE Steering Committee, the CIE shall provide the CIE reviewer contact information to the COR, who forwards this information to the NMFS Project Contact no later the date specified in the Schedule of Milestones and Deliverables. The CIE is responsible for providing the SoW and ToRs to the CIE reviewers. The NMFS Project Contact is responsible for providing the CIE reviewers with the assessment and other pertinent background documents for the peer review. Any changes to the SoW or ToRs must be made through the COR prior to the commencement of the peer review.

Pre-review Background Documents: Two weeks before the peer review, the NMFS Project Contact will send (by electronic mail or make available at an FTP site) to the CIE reviewers the necessary background information and reports for the peer review. In the case where the documents need to be mailed, the NMFS Project Contact will consult with the CIE Lead Coordinator on where to send documents. CIE reviewers are responsible only for the pre-review documents that are delivered to the reviewer in accordance to the SoW scheduled deadlines specified herein. The CIE reviewers shall read all documents in preparation for the peer review.

Desk Review: Each CIE reviewer shall conduct the independent peer review in accordance with the SoW and ToRs, and shall not serve in any other role unless specified herein. Modifications to the SoW and ToRs shall not be made during the peer review, and any SoW or ToRs modifications prior to the peer review shall be approved by the COR and CIE Lead Coordinator. The CIE Lead Coordinator can contact the Project Contact to confirm any peer review arrangements.

Contract Deliverables - Independent CIE Peer Review Reports: Each CIE reviewer shall complete an independent peer review report in accordance with the SoW. Each CIE reviewer shall complete the independent peer review according to required format and content as described in Annex 1. Each CIE reviewer shall complete the independent peer review addressing each ToR as described in Annex 2.

Specific Tasks for CIE Reviewers: The following chronological list of tasks shall be completed by each CIE reviewer in a timely manner as specified in the **Schedule of Milestones and Deliverables**.

1) Conduct necessary pre-review preparations, including the review of background material and reports provided by the NMFS Project Contact in advance of the peer review.
2) Conduct an impartial and independent peer review in accordance with the tasks and ToRs specified herein, and each ToRs must be addressed (**Annex 2**).
3) No later than January 25, 2013, each CIE reviewer shall submit an independent peer review report addressed to the "Center for Independent Experts," and sent to Mr. Manoj Shivlani, CIE Lead Coordinator, via email to shivlanim@bellsouth.net, and CIE Regional Coordinator, via email to Dr. David Sampson david.sampson@oregonstate.edu. Each CIE report shall be written using the format and content requirements specified in **Annex 1**, and address each ToR in **Annex 2**.

Schedule of Milestones and Deliverables: CIE shall complete the tasks and deliverables described in this SoW in accordance with the following schedule.

21 December 2012	CIE sends reviewer contact information to the COR, who then sends this to the NMFS Project Contact
2 January 2013	NMFS Project Contact sends the CIE Reviewers the assessment report and background documents
9-24 January 2013	Each reviewer conducts an independent peer review as a desk review
25 January 2013	CIE reviewers submit draft CIE independent peer review reports to the CIE Lead Coordinator and CIE Regional Coordinator
8 February 2013	CIE submits CIE independent peer review reports to the COR
15 February 2013	The COR distributes the final CIE reports to the NMFS Project Contact and regional Center Director

Modifications to the Statement of Work: This 'Time and Materials' task order may require an update or modification due to possible changes to the terms of reference or schedule of milestones resulting from the fishery management decision process of the NOAA Leadership, Fishery Management Council, and Council's SSC advisory committee. A request to modify this SoW must be approved by the Contracting Officer at least 15 working days prior to making any permanent changes. The Contracting Officer will notify the COR within 10 working days after receipt of all required information of the decision on changes. The COR can approve changes to the milestone dates, list of pre-review documents, and ToRs within the SoW as long as the role and ability of the CIE reviewers to complete the deliverable in accordance with the SoW is not adversely impacted. The SoW and ToRs shall not be changed once the peer review has begun.

Acceptance of Deliverables: Upon review and acceptance of the CIE independent peer review reports by the CIE Lead Coordinator, Regional Coordinator, and Steering Committee, these reports shall be sent to the COR for final approval as contract deliverables based on compliance with the SoW and ToRs. As specified in the Schedule of Milestones and Deliverables, the CIE shall send via e-mail the contract deliverables (CIE independent peer review reports) to the COR (William Michaels, via William.Michaels@noaa.gov).

Applicable Performance Standards: The contract is successfully completed when the COR provides final approval of the contract deliverables. The acceptance of the contract deliverables shall be based on three performance standards:
(1) The CIE report shall completed with the format and content in accordance with **Annex 1**,
(2) The CIE report shall address each ToR as specified in **Annex 2**,
(3) The CIE reports shall be delivered in a timely manner as specified in the schedule of milestones and deliverables.

Distribution of Approved Deliverables: Upon acceptance by the COR, the CIE Lead Coordinator shall send via e-mail the final CIE reports in *.PDF format to the COR. The COR will distribute the CIE reports to the NMFS Project Contact and Center Director.

Support Personnel:

William Michaels, Program Manager, COR
NMFS Office of Science and Technology
1315 East West Hwy, SSMC3, F/ST4, Silver Spring, MD 20910
William.Michaels@noaa.gov Phone: 301-427-8155

Manoj Shivlani, CIE Lead Coordinator
Northern Taiga Ventures, Inc.
10600 SW 131st Court, Miami, FL 33186
shivlanim@bellsouth.net Phone: 305-383-4229

Roger W. Peretti, Executive Vice President
Northern Taiga Ventures, Inc. (NTVI)
22375 Broderick Drive, Suite 215, Sterling, VA 20166
RPerretti@ntvifederal.com Phone: 571-223-7717

Key Personnel:

NMFS Project Contact:

Ryan Rindone, SEDAR Coordinator
2203 N. Lois Avenue, Suite 1100
Tampa, FL 33607
Ryan.Rindone@gulfcouncil.org Phone: 813-348-1630

Annex 1: Format and Contents of CIE Independent Peer Review Report

1. The CIE independent report shall be prefaced with an Executive Summary providing a concise summary of the findings and recommendations, and specify whether the science reviewed is the best scientific information available.

2. The main body of the reviewer report shall consist of a Background, Description of the Individual Reviewer's Role in the Review Activities, Summary of Findings for each ToR in which the weaknesses and strengths are described, and Conclusions and Recommendations in accordance with the ToRs.

   The CIE independent report shall be a stand-alone document for others to understand the weaknesses and strengths of the science reviewed, regardless of whether or not they read the summary report. The CIE independent report shall be an independent peer review of each ToRs, and shall not simply repeat the contents of the summary report.

3. The reviewer report shall include the following appendices:

   Appendix 1: Bibliography of materials provided for review
   Appendix 2: A copy of the CIE Statement of Work

Annex 2a – Terms of Reference for

SEDAR 28: Gulf of Mexico Cobia Assessment Desk Review

1. Evaluate the quality and applicability of data used in the assessment.
2. Evaluate the quality and applicability of methods used to assess the stock.
3. Recommend appropriate estimates of stock abundance, biomass, and exploitation.
4. Evaluate the methods used to estimate population benchmarks and management parameters. Recommend and provide estimated values for appropriate management benchmarks and declarations of stock status for each model run presented for review.
5. Evaluate the quality and applicability of the methods used to project future population status. Recommend appropriate estimates of future stock condition.
6. Evaluate the quality and applicability of methods used to characterize uncertainty in estimated parameters.
    - Provide measures of uncertainty for estimated parameters
    - Ensure that the implications of uncertainty in technical conclusions are clearly stated
    - If there are significant changes to the base model, or to the choice of alternate states of nature, then provide a probability distribution function for the base model, or a combination of models that represent alternative states of nature, presented for review.
        - Determine the yield associated with a probability of exceeding OFL at P* values of 30% to 50% in single percentage increments
        - Provide justification for the weightings used in producing the combinations of models
7. If available, ensure that stock assessment results are accurately presented in the Stock Assessment Report and that stated results are consistent with Review Panel recommendations.
8. Evaluate the quality and applicability of the SEDAR Process as applied to the reviewed assessment and identify the degree to which Terms of Reference were addressed during the assessment process.
9. Make any additional recommendations or prioritizations warranted.
    - Clearly denote research and monitoring needs that could improve the reliability of future assessments

Table 1. Required MSRA Evaluations for cobia assessment:

Criteria	Definition* (2001)	Current Value* (2001)
Mortality Rate Criteria		
F_{MSY}	F_{MSY}	0.34
MFMT	F_{MSY}	0.34
F_{OY}	75% of F_{MSY}	0.26
$F_{CURRENT}$	F_{2000}	0.30
$F_{CURRENT}$/ F_{MSY}	Percentage of $F_{Current}/F_{MSY}$ > MFMT	0.40
Base M		0.30
Biomass Criteria		
SSB_{MSY}	Equilibrium SSB_{MSY} @ F_{MSY}	3.02 mp
MSST	(1-M)*SSB_{MSY}: M=0.30	2.11 mp
$SSB_{CURRENT}$	SSB_{2000}	
$SSB_{CURRENT}$/ SSB_{MSY}	Percentage of $SSB_{Current}/SSB_{MSY}$ < MSST	0.30
Equilibrium MSY	Equilibrium Yield @ F_{MSY}	1.50 mp
Equilibrium OY	Equilibrium Yield @ F_{OY}	1.45 mp
OFL	Annual Yield @ MFMT	
	2013	
	2014	
	2015	
	2016	
	2017	
	2018	
Annual OY**	Annual Yield @ F_{OY}	
	2013	
	2014	
	2015	
	2016	
	2017	
	2018	

*Definitions and values are subject to change as per guidance from this assessment.

**Based upon current definitions of OY, where OY = 75% of F_{MSY}

Table 2. Projection Scenario Details for cobia assessment

2.1 Initial Assumptions:

OPTION	Value
2012 base TAC	TBD
2012 Recruits	TBD by Panel
2012 Selectivity	TBD by Panel
Projection Period	6 yrs (2013-2018)
1^{st} year of change F, Yield	2013

2.2 Scenarios to Evaluate (preliminary, to be modified as appropriate)

1. Landings fixed at 2013 target
2. F_{OY}= 65%, 75%, 85% F_{MSY} (project when OY will be achieved)
3. F_{MSY}
4. $F_{REBUILD}$ (if necessary)
5. F=0 (if necessary)

2.3 Output values

1. Landings
2. Discards (including dead discards)
3. Exploitation
4. F/F_{MSY}
5. B/B_{MSY}

10. Evaluate the quality and applicability of data used in the assessment.
11. Evaluate the quality and applicability of methods used to assess the stock.
12. Recommend appropriate estimates of stock abundance, biomass, and exploitation.
13. Evaluate the methods used to estimate population benchmarks and management parameters. Recommend and provide estimated values for appropriate management benchmarks and declarations of stock status for each model run presented for review.
14. Evaluate the quality and applicability of the methods used to project future population status. Recommend appropriate estimates of future stock condition.
15. Evaluate the quality and applicability of methods used to characterize uncertainty in estimated parameters.
    - Provide measures of uncertainty for estimated parameters
    - Ensure that the implications of uncertainty in technical conclusions are clearly stated
    - If there are significant changes to the base model, or to the choice of alternate states of nature, then provide a probability distribution function for the base model, or a combination of models that represent alternate states of nature, presented for review.
        - Determine the yield associated with a probability of exceeding OFL at P* values of 30% to 50% in single percentage increments
        - Provide justification for the weightings used in producing the combinations of models
16. If available, ensure that stock assessment results are accurately presented in the Stock Assessment Report and that stated results are consistent with Review Panel recommendations.
17. Evaluate the quality and applicability of the SEDAR Process as applied to the reviewed assessment and identify the degree to which Terms of Reference were addressed during the assessment process.
18. Make any additional recommendations or prioritizations warranted.
    - Clearly denote research and monitoring needs that could improve the reliability of future assessments

Table 1. Required MSRA Evaluations for Spanish mackerel assessment:

Note: te = trillion eggs

Criteria	Definition* (as of 2002/2003)	Current Value* (2002/03)
Mortality Rate Criteria		
F_{MSY}	$F_{30\%SPR}$	
MFMT	$F_{30\%SPR}$	
F_{OY}	75% of $F_{30\%SPR}$	0.40
$F_{CURRENT}$	$F_{2002/03}$	
$F_{CURRENT}$/MFMT		0.53
Base M		0.30
Biomass Criteria		
SSB_{MSY}	Equilibrium SSB_{MSY} @ $F_{30\%SPR}$	19.10 te
MSST	(1-M)*SSB_{MSY}: M=0.30	13.40 te
$SSB_{CURRENT}$	SSB_{2003}	17.96 te
$SSB_{CURRENT}$/ MSST		1.34
Equilibrium MSY	Equilibrium Yield @ $F_{30\%SPR}$	8.7 mp
Equilibrium OY	Equil. Yield @ 75% of $F_{30\%SPR}$	8.3 mp
OFL	Annual Yield @ MFMT	
	2013	
	2014	
	2015	
	2016	
	2017	
	2018	
Annual OY**	Annual Yield @ F_{OY}	
	2013	
	2014	
	2015	
	2016	
	2017	
	2018	

*Definitions and values are subject to change as per guidance from this assessment.

**Based upon current definitions of OY, where OY = 75% of F_{MSY}

Table 2. Projection Scenario Details for Spanish mackerel assessment

2.1 Initial Assumptions:

OPTION	Value
2012 base TAC	TBD
2012 Recruits	TBD by Panel
2012 Selectivity	TBD by Panel
Projection Period	6 yrs (2013-2018)
1st year of change F, Yield	2013

2.2 Scenarios to Evaluate (preliminary, to be modified as appropriate)

1. Landings fixed at 2013 target
2. F_{OY}= 65%, 75%, 85% F_{MSY} (project when OY will be achieved)
3. F_{MSY}
4. $F_{REBUILD}$ (if necessary)
5. F=0 (if necessary)

2.3 Output values

1. Landings
2. Discards (including dead discards)
3. Exploitation
4. F/F_{MSY}
5. B/B_{MSY}

-

Report on the SEDAR 28 Desk Review of the Stock Assessments for Gulf of Mexico Cobia and Spanish Mackerel

N. G. Hall

Unit 2
2 Wexford Street
Subiaco
Western Australia 6008
Australia
Phone: +61 8 9401 6891
Email: nghall@iinet.net.au

February 2013

Contents

1. Executive Summary

Between 9 and 24 January 2013, a Center for Independent Experts (CIE) desk review of the SEDAR 28 Gulf of Mexico cobia (*Rachycentron canadum*) and Spanish mackerel (*Scomberomorus maculates*) stock assessments was undertaken. The key findings of that review are summarised below.

Prior to the development of assessment models by the Assessment Workshops, the Data Workshops had collated the biological data for the Gulf of Mexico stocks of cobia and Spanish mackerel and constructed time series of reliable data for the landings made by the commercial and recreational fisheries. Despite some deficiencies of the data collection programs, the Workshops had developed time series of discards from these fisheries and of the bycatch of the two species from the shrimp fishery. Although imprecise, these time series, together with the time series of landings data, had been considered appropriate for use in the assessments. Length composition data sufficient to characterize the landings data, and, in the case of the Spanish mackerel stock, one of the survey indices, had been collated, together with those age-at-length data that were available. The Data Workshop for cobia had also recommended two fishery-dependent survey indices, while that for Spanish mackerel had recommended one fishery-independent index of abundance and two fishery-dependent indices. Each of the survey indices had been standardized using an appropriate statistical approach.

Although both maturity at age and the various time series of discard data for both species were imprecise, and there was a lack of length and age-at-length composition data for those fish that had been discarded from the commercial and recreational fisheries, the data that the Data Workshops had collated for the Gulf of Mexico stocks of both cobia and Spanish mackerel represented the best data that were available and were considered adequate for use in stock assessment. It should be noted, however, that the imprecision of the input data and limited age composition data are reflected in uncertainty in the results of each assessment. In the case of cobia, the lack of a fishery-independent index of abundance is also likely to have influenced the results that were obtained from the assessment.

Assessments for both cobia and Spanish mackerel had been undertaken by the Assessment Workshops using Stock Synthesis 3, a versatile and well-tested program that has been employed in numerous stock assessments both in the U.S. and elsewhere. The methods employed by this program are of high quality and the software provides tools that facilitate exploration of uncertainty, calculation of benchmarks, projection of yields with specified fishing rates to assess future stock status, and, through bootstrapping, either within Stock Synthesis (in the case of cobia) or using auxiliary software (in the case of Spanish mackerel), generation of probability distributions of parameters, benchmarks, and other variables. The ease with which alternative values of parameters can be set up within Stock Synthesis had facilitated (1) the exploration by the Assessment Workshops of the sensitivity of the results produced by the cobia and Spanish mackerel models to a number of alternative assumptions regarding values of natural mortality, steepness, and discard mortality, (2) the conducting of retrospective analyses, and (3) investigation of alternative data weighting options.

For both cobia and Spanish mackerel, estimates of the steepness of the stock-recruitment relationship had been found to be imprecise. The key uncertainty reflected in the choice by the Assessment Workshop for Gulf of Mexico cobia of a set of models to represent alternative states of nature was the value of steepness. For Spanish mackerel, the Assessment Workshop chose to explore the effects of a range of values for the base level of natural mortality M when proposing alternative states of nature. Sensitivity analysis had also indicated that the results of the assessment for cobia were sensitive to this parameter.

The base model for the Gulf of Mexico stock of cobia assumed a base level of natural mortality of 0.38 y^{-1}, which, when fitted, resulted in an estimated steepness of 0.925. Based on the sensitivity analyses and explorations of uncertainty that had been carried out by the Assessment Workshop, this model and two alternative models were accepted as suitable for use as alternative states of nature when assessing the condition of the cobia stock. The alternative models assumed base levels of natural mortality of 0.26 and 0.5 y^{-1}, and, when fitted, resulted in steepness estimates of 0.96 and 0.92, respectively. On fitting the base model for the Gulf of Mexico stock of cobia, it was estimated that $SSB_{2011}/MSST=1.73$ and that $F_{current}/$ MFMT = 0.63, where the benchmarks MSST and MFMT had been calculated as MFMT = $F_{30\%SPR}$ and MSST = $(1 – M)$ $SSB_{30\%SPR}$. Based on this result and the examination of the results of the various sensitivity runs for Gulf of Mexico cobia, it is highly likely that the stock of cobia is not overfished and is not experiencing overfishing.

Exploration of parameter estimates, sensitivity runs, likelihood profiles, and results from bootstrapping led the Assessment Workshop for the Gulf of Mexico stock of Spanish mackerel to accept an alternative to the initial model as the new base model for this species. While this new model had an identical structure to that of the original base model, the value of steepness was fixed at 0.8, rather than estimated. An alternative model with similar structure to that of the new base model, but with steepness fixed at 0.9, was chosen by the Assessment Workshop to represent an alternative state of nature. Estimates obtained from the fitted base model indicated that $SSB_{2011}/MSST=3.06$ and that $F_{current}/$ MFMT = 0.38, where the benchmarks MSST and MFMT had been calculated as MFMT = $F_{30\%SPR}$ and MSST = $(1 – M)$ $SSB_{30\%SPR}$. Based on this result and examination of the results of the various sensitivity runs, it is highly likely that the Gulf of Mexico stock of Spanish mackerel is not overfished and is not experiencing overfishing.

The assessments produced by the Assessment Workshops for the Gulf of Mexico stocks of cobia and Spanish mackerel are based on the best data that are available, and the models that have been developed in Stock Synthesis are appropriate given the input data that are available for each stock. The results of these assessments provide the best scientific advice regarding the status of these two stocks that is currently available. While the limitations of the data and the uncertainty reflected in the sensitivity analyses and in the values calculated by the assessment models should be recognized when considering future management options, the explorations described in the Assessment Workshop Reports suggest that the conclusions regarding current stock status and levels of fishing mortality are likely to be robust despite the uncertainty associated with the assessments. Future stock assessments would benefit from improvement in the programs used (1) to collect discard data from the commercial and recreational fisheries and bycatch data from the shrimp fishery, and (2) to collect length and age-at-length data from landings and discards from both the commercial and recreational fisheries and from the bycatch of cobia and Spanish mackerel by the shrimp fishery.

The individuals involved in collating the input data and in developing the stock assessments are commended for their efforts.

2. Background

2.1. Overview

Between 9 and 24 January, 2013, a Center for Independent Experts (CIE) desk review was undertaken of the SEDAR 28 Gulf of Mexico cobia and Spanish mackerel stock assessments.

The Statement of Work provided to Dr Norm Hall by the CIE is attached as Appendix 2. This CIE report, which is prepared in accordance with the Statement of Work, describes his evaluation of the assessments and the review process.

Prior to the Review, stock assessment documents and other background documentation were made available to CIE Reviewers. A list of these documents is presented in Appendix 1. Note that, in the text of this review report, the "Gulf of Mexico – Cobia – Assessment Process Report" is referred to as the "Workshop Assessment Report" for the Gulf of Mexico stock of cobia.

2.2. Terms of Reference

The terms of reference for the desk review of the stock assessments of the Gulf of Mexico stocks of cobia and Spanish mackerel are presented in the Statement of Work (Appendix 2).

3. Description of Reviewer's role in review activities

Prior to undertaking the desk review, the Reviewer familiarised himself with the background documentation and the assessment reports for the two species that were the subject of the review (Appendix 1). Subsequently, he examined the Data Workshop and Assessment Workshop Reports for each species in greater detail, focussing on the preparation of this document, *i.e.*, the CIE report describing his evaluation of the two stock assessments and the SEDAR process.

4. Summary of findings relevant to the SEDAR 28 stock assessments for Gulf of Mexico cobia and Spanish mackerel

Because of the similarity of the models and many aspects of the data for the Gulf of Mexico stocks of cobia and Spanish mackerel, common issues in both assessments were often identified. There is thus some duplication of the text used when discussing those issues under the Terms of Reference for the separate stocks.

*4.1 Gulf of Mexico Cobia (*Rachycentron canadum*).*

ToR 1. Evaluate the quality and applicability of data used in the assessment.

Conclusions

The data that the Data Workshop has compiled for the Gulf of Mexico stock of cobia are the best that are available. Although limited, and imprecise in some aspects, the data are of a quality that allows a broad assessment of the likely condition of the stock.

Strengths

- The collation of life history data for the Gulf of Mexico stock of cobia.
- The collation of commercial landings data to produce time series of landings by handline, longline, and other gears from 1927, and, particularly, more precise data from 1950.
- The collation of a time series of estimates of bycatch of cobia by the shrimp fishery from 1972, using a Bayesian model to estimate catch per unit of effort.
- The collation of recreational fisheries data from different sources to produce sound time series of landings by fishing mode from 1955, and, particularly, more precise data from 1981.
- The collation of data to produce time series of discards from the commercial gears and recreational fishing modes.
- The collation of length composition data to characterize the landings by the commercial and recreational fisheries.
- The collation of two fishery-dependent indices of abundance, and the use of appropriate statistical analyses to standardize those indices of abundance.

Weaknesses

- Lack of definition of the southern boundary of the Gulf of Mexico stock of cobia.
- Paucity of data on the relationship of the proportion mature with age.
- The unreliable nature of the discard data due to low reporting, low intercept rates, and inadequate data collection programs.
- Inadequate sampling of length and age composition data from commercial landings and from bycatch of cobia from the shrimp fishery.

- Lack of length and age composition sampling from commercial and recreational discards.

Specific comments

Stock structure

The decision that, during the spawning season, mature individuals of cobia in the Gulf of Mexico are genetically distinct from those on the Atlantic coast north of Florida appears sound given the genetic and tagging data that are available. While the number of cobia in the sample collected in waters off Texas for the genetic study appears adequate, samples from the north of the Gulf of Mexico and from waters off the west coast of Florida are small. Further research to collect additional data from within the Gulf and to confirm the preliminary genetic findings would be valuable.

Despite the overall conclusion that the Gulf of Mexico stock is distinct from the South Atlantic stock of cobia, the genetic and tagging data indicate that there is some gene flow and a small amount of movement between the stock in the Gulf and those stocks in the stock complex off the South Atlantic coast, the latter complex being considered as the South Atlantic “stock” of cobia. There is also an inconsistency between the findings reported in SEDAR28-DW01 and those reported in SEDAR28-RD09, which needs to be reconciled. The former report advises that the collections from offshore in the Gulf of Mexico were genetically distinct from those offshore in the South Atlantic region, while the latter reports that “Based on our U.S. collections of *R. canadum* encountered along the SA and GOM coasts, tests of both genotypic distributions and pairwise hierarchical RST statistics suggest the offshore groups are genetically homogenous, even between the SA and GOM” and that “information gathered from the offshore collections … shows high levels of movement between the SA and GOM”.

From the Data Workshop Report, it appears that the majority of tag recoveries have been made in locations that are consistent with the location of release of the tagged fish and the results of genetic studies of fish collected during the spawning season. Although not stated in this Report, the temporal distribution of recaptures of tagged fish presumably reflects the temporal distribution of catches in both spawning and non-spawning periods. The tag recovery data thus suggest that, despite the migrations that cobia undertake, regardless of the time of year and with the exception of fish caught in the waters off Brevard County, catches of fish may be assigned reliably to one or other of the two stocks on the basis of the area in which they are caught. Genetic studies should be undertaken to confirm this hypothesis, however.

As concluded in the Data Workshop Report, the genetic and tagging data indicate that Gulf of Mexico and South Atlantic stocks of cobia overlap in the waters to the east of Florida, and there is thus no distinct boundary that separates the stocks. For assessment and management, and for allocation of catches to one or other of the two stocks, the boundary between Florida and Georgia was selected (for convenience and because it was consistent with genetic, tagging and life history data) as the line separating the two stocks. Consideration should be given to whether catches within the area of overlap are of sufficient magnitude that assessment results could be sensitive to this decision, *i.e.*, whether an assessment based on an alternative line of separation at, say, the southern edge of the zone of overlap of the two stocks would be likely to yield results that differ greatly from those reported for the current assessment.

Unfortunately, maps of the distribution of the species and stocks of cobia, which were requested in the terms of reference for the Data Workshop, were not prepared. FishBase (Froese and Pauly, 2012) advises, however, that cobia has a worldwide distribution, which extends south of U.S. waters into waters off South America. The genetic study provides no information to suggest that the Gulf of Mexico stock does not extend into waters off Mexico, where it may also experience the effects of fishing. Further genetic research to determine the southern extent of the Gulf of Mexico stock of cobia appears necessary.

Biological data

The Life History Working Group's recommendation to base its estimate of the average value of the instantaneous rate of natural mortality *M* for fully-selected fish (ages 3-11) on the value determined from the Hoenig (1983) equation for fish using a maximum age of 11 years, *i.e.*, 0.38 y^{-1}, is endorsed. The range of estimates of *M* ultimately used to explore the sensitivity of the assessment model to imprecision in the estimate of natural mortality, *i.e.*, 0.26 to 0.5 y^{-1}, was broader than that initially proposed by the Life History Working Group (LHWG), *i.e.*, 0.26 to 0.42 y^{-1}. While the LHWG also recommended that a range of values of *M* based on a CV of 0.54 (MacCall, 2011), or other CVs, should also be explored, such exploration does not appear to have been undertaken by the Assessment Workshop. The basis for the use of 0.5 y^{-1} as a high value of *M* is not explained in the Assessment Workshop Report, but it is noted that the difference between this high value and the base level of 0.38 y^{-1} is equal to the difference between that latter value and the low value of 0.26 y^{-1}. Research is needed to determine methods by which an appropriate range of feasible values of *M* for a species might be selected for use in stock assessment as alternate plausible states of nature.

For Gulf of Mexico cobia, estimates of *M* from the Lorenzen equation were scaled such that the average value of *M* over the fully-selected ages 3 to 11 years was equal to the estimate from Hoenig's (1983) equation for fish, *i.e.*, 0.38 y^{-1}. It is unclear, however, whether the same approach as used for Run 1 was applied in sensitivity runs 2 and 3 when, as advised in the Assessment Workshop Report, the Lorenzen-based age dependent mortalities were scaled to achieve the same cumulative survivals over all ages as that expected for constant mortalities equal to the low and high values of *M*, respectively. It is likely that the cumulative survival was calculated over only ages 3-11, rather than all ages, to ensure consistency with the approach used in Run 1 when average *M* was set to 0.38 y^{-1}.

Use of the Lorenzen (1996) equation to derive age-dependent estimates of natural mortality *M* is not endorsed. In his report to the CIE on the stock assessments conducted for yellowtail flounder and Atlantic herring at Woods Hole in 2012, Francis (2012) advised that prediction of *M*, and, through body weight, its variation with age for an individual species, using Lorenzen's (1996) equation was likely to be highly imprecise, as was evident in the wide scatter about the regression line in Lorenzen's Figure 1. Francis observed that, for about one-third of Lorenzen's data points, predicted and observed *M*s appeared to differ by a factor of more than 2. Furthermore, in the case of both herring and yellowtail, the values of *M* estimated by Lorenzen's (1996) equation differed markedly from the values estimated using Hoenig's (1983) equation and had to be scaled substantially for use in the yellowtail flounder and Atlantic herring assessments. If it is assumed that the length measure used for Gulf of Mexico cobia in the growth equation, the parameters of which are presented in Table 2.7.1 of the Data Workshop Report, is fork length rather than total length (not advised in the text or table but inferred from Fig. 2.7.2), the value of *M* at age 3 is estimated by the Lorenzen (1996) equation to be 0.21 y^{-1}. This suggests that the estimates for the Gulf of Mexico stock of cobia calculated using Lorenzen's (1996) method were scaled up by a factor of at least 1.8 to produce the estimates of age-dependent natural mortality used in the assessment. Francis (2012) raised the valid point that, if the estimates produced for a species by Lorenzen's (1996) equation provide such unreliable estimates that the mean *M* differs from the estimate calculated using Hoenig's (1983) equation by a factor that differs markedly from 1, can it be considered sufficiently reliable to estimate how *M* varies with age within these species?

There has been no test to assess whether the introduction of the additional complexity associated with age-dependent natural mortality was justified by the resultant improvement in fit that was obtained for the Gulf of Mexico cobia model. It is recommended that a model employing a constant value of *M* is fitted to the cobia data. If this model fits just as well as the model that employs an age-dependent *M*, then the simpler model should be used. If the age-dependent model produces a significantly better fit, it would probably be better to estimate age-dependent *M* within the assessment model rather than assuming that it is of the form predicted by the Lorenzen (1996) equation.

The Data Workshop's decision, that cobia are hardy and unlikely to suffer barotrauma-associated post-release mortality, is subjective. Further research on discard mortality would be useful.

The Data Workshop correctly identified that, because of bias introduced into biological samples by the 33 inch minimum legal size, an allowance would need to be made when fitting von Bertalanffy growth curves to length-at-age data. By fitting the growth curves in Stock Synthesis, the influence of the selection curves on the observed length-at-age data is automatically taken into account and uncertainty associated with fitting the growth curves is carried through to the estimates of parameters and benchmarks that are produced by Stock Synthesis.

Because of the paucity of the youngest ages of fish in samples, the advice relating to maturity at age, which was reported in the Data Workshop Report, was subjective. Research based on fishery-independent samples is needed to provide more reliable estimates of the parameters of the maturity-length relationship and the proportion mature at age.

Although the Data Workshop noted that cobia exhibit sexually dimorphic growth, the Stock Synthesis model used in the assessment employed only the growth curve for the pooled sexes. In future refinement of the assessment model, consideration should be given to including sexually dimorphic growth, noting that the benefit of this might only be realised if appropriate sex composition data for landings and discards become available for input, and length and age-at-length compositions are sexually disaggregated.

Commercial landings

The decision by the Data Workshop to extend the historical time series of commercial landings of Gulf of Mexico cobia as far as possible into the past is endorsed, as catches from that earlier time period are likely to have influenced current stock status. It was noted that the Data Workshop reported that "Landings prior to 1950 are considered highly uncertain" and that the precision of landings improved following the introduction of the trip ticket system in each state. The tables that are presented provide no estimates of the precision likely to be associated with the annual landings data, nor is any information provided as to whether the commercial landings for cobia, which were reported by the Data Workshop, were likely to be biased, and, if so, the magnitude and direction of such bias.

Without an alternative time series, such as fishing effort, to provide information on fishing mortality, Stock Synthesis assumes that the catches are known sufficiently well to estimate the fishing mortalities required to take those catches (Methot and Wetzel, 2012), and thus estimated catches match the values that were input. In the current assessment, there has been no evaluation of the implications of the greater imprecision of the commercial landings data prior to 1950. Such evaluation may have required a sensitivity run with an alternative time series of commercial landings encompassing the imprecision of the landings data.

The Data Workshop has reported that, because few trips with cobia discards were observed by the Reeffish Observer Program and the NMFS logbook does not provide coverage of the entire fishery, discards of cobia by the commercial fishery have greater uncertainty than commercial landings and are likely to underestimate the true quantities of discarded fish. No estimate is provided of the likely magnitude of such underestimation.

The Working group advised that discards reported as "kept, not sold" should be added to the landings, and not included in the discards. This recommendation does not appear to have been accepted by the Assessment Workshop as Table 3.6 of the Data Workshop Report includes these fish within the discards, and the same values are carried over and used in the assessment (Table 2.5 and Appendix A, Assessment Workshop Report). The value for 2011 in Table 2.5 differs from that reported in Appendix A in the Assessment Workshop Report.

The estimates of the annual bycatch of cobia in the Gulf of Mexico by the shrimp fishery, which are reported in Table 2.7 of the Assessment Workshop Report, differ from the values in Table 3.10 of the Data Workshop Report. The latter values match those reported in SEDAR-DW06. There is no explanation in the Assessment Workshop Report to explain this inconsistency. Although the Assessment Workshop Report refers to a data workshop report for SEDAR 22 for details of the methods employed to obtain these bycatch estimates, frequent other references to SEDAR 22 in the Assessment Workshop Report suggest that the references to SEDAR 22 are erroneous and that the correct citation should have been the Data Workshop Report for SEDAR 28. This last report provides no explanation for the inconsistency between the values presented in the two reports.

The Assessment Workshop Report presents a table (Table 2.8) of annual standardized estimates of effort for 1945-2011 by the shrimp fishery. These effort values are inconsistent with the effort (days fished) for 1981-2010, which are reported in Table 3 of SEDAR-DW06. While this could possibly have been explained by the fact that the values in Table 2.8 of the Assessment Workshop Report have been standardized, there is no explanation as to how the data for these estimates were collected, nor the method employed to standardize the values. As a further complication, the Assessment Workshop Report advises that the values of effort for the shrimp fishery were input as an index of fishing mortality for the shrimp fishery and. while it would therefore have been expected that the effort values used in the Stock Synthesis model would have been those values reported in Table 2.8 of the Assessment Workshop Report, this is not the case. While there is a broad degree of similarity, the values that are actually input into Stock Synthesis 3, as shown in the data file listed in Appendix A of the Assessment Workshop Report, differ considerably from those presented in Table 2.8. No explanation for this inconsistency is to be found in the cobia Assessment Workshop Report, however the time series of values of effort used in the Stock Synthesis data file for cobia appears to match the time series of scaled effort for the shrimp fishery presented in Table 2.8 of the Assessment Workshop Report for Spanish mackerel. Although this inconsistency thus appears to have a possible explanation, it is important that the results of the stock synthesis runs, estimates of benchmarks, and determinations of current stock status, which have been reported for cobia in the cobia Assessment Workshop Report, are based on the input data for Stock Synthesis that were described in the appendices of that assessment report. Inconsistencies between the data inputs for cobia that have been described and the Stock Synthesis data files for that species need to be reconciled.

The Data Workshop noted that the CVs of the estimates of bycatch of cobia by the shrimp fishery ranged from 66 to 208%, with only 4 of the 39 years having CVs less than 100%. An issue that may have been resolved after the Data Workshop was that a number of the estimates of bycatch calculated by the Bayesian model became stuck on bounds, although the Data Workshop Report does not identify which of the 39 years encountered such problems. As a consequence of these issues, bycatch estimates for the shrimp fishery were recognised by the Assessment Workshop as being very imprecise. For this reason, shrimp fishery effort was used as a proxy for the trends present in the point estimates of bycatch by the shrimp fishery. The median of the 1972 to 2011 estimates of bycatch was used, however, to provide an estimate of the magnitude of the bycatch. An estimate of the catchability coefficient relating shrimp effort to fishing mortality was then calculated within Stock Synthesis using 1972 to 2011 as a super period. A similar super period approach was employed in Stock Synthesis to accommodate the small sample sizes of the length composition data from the SEAMAP program, which were considered to be representative of the length compositions of cobia caught by the shrimp fishery. Use of such a super period to deal with the imprecision of the bycatch estimates of cobia from the shrimp fishery is an appropriate modelling approach. It would have been preferable, however, to have used a reliable time series of precise estimates of discards of the bycatch of cobia from the shrimp fishery in the Stock Synthesis model if such a time series had been available, rather than having to “work around” the problem. Consideration therefore should be given to establishing a well-designed program to monitor the bycatch of cobia by the shrimp fishery such that reliable estimates can be collected in the future.

Very few samples of landed fish were available from catches taken by commercial miscellaneous gears, and thus reliable characterization of the length composition of these landings is not possible, The Data Workshop advised that sample sizes for developing length compositions of commercial landings were inadequate for a considerable number of gears and years. It is reasonable to conclude that length composition data collected from the commercial landings are imprecise. Low sample sizes may also affect the extent to which the resultant length compositions are representative of total annual landings. After filtering, too few measurements of discarded cobia were available from the Reeffish Observer Program to characterize the length composition of discarded fish. The Data Workshop Report advised that age compositions of commercial catches were inadequate for all years and that no aging error matrix could be generated for these ageing data because 86% of the age readings were from a period 15-20 years earlier and thus reader comparisons were not possible. Well-designed monitoring programmes to collect length and age composition data from the landings and discards by each of the principal gear types used by commercial fishers should be established.

Recreational landings

When combining the time series of data collected by different approaches for the same fishing mode, calibration factors were calculated using the data collected during a period of overlap. No comment is made in the Data Workshop Report, but it should be recognised that imprecision of the calculated calibration factor adds to the imprecision of the data that are adjusted and should be carried through into the resulting time series.

While CVs of the estimates of the recreational landings for a fishing mode are calculated and reported in summaries for a number of the data collection programs, estimates of the uncertainty of the values in the resulting time series of the total recreational landings are not provided (Table 2.4, Assessment Workshop Report), and thus are not considered in the assessment.

The collection of age data from the landings of the recreational fishery appears opportunistic, judging from the description provided in the Data Workshop Report. A well-designed program to collect length and age composition data for Gulf of Mexico cobia from the landings and discards of the recreational fishery should be established.

Survey indices

The decisions made by the Data Workshop when selecting indices of abundance appear sound. Despite the fact that both were derived from fishery-dependent data, the time series of headboat and MRFSS catch-per-unit-of-effort (cpue) data were endorsed by the Data Workshop as acceptable indices of abundance for Gulf of Mexico cobia. The time series of data for these indices were standardized using the delta lognormal model.

Adjustment by Assessment Workshop

Although the Data Workshop produced time series of commercial landings by gear type, the Assessment Workshop pooled these data to create a single time series, which was input to Stock Synthesis. Similarly, the Assessment Workshop combined the recreational landings, which had been tabulated by mode, into a single time series of recreational landings. Such pooling obviously suited the incremental approach that was used when developing the assessment model, *i.e.*, first developing a simple production model, then an age-structured production model, and finally a length-structured catch-at-age model. By pooling the data into the two time series, the number of parameters to be estimated was reduced but, as a common selection curve is applied to each time series of combined data within Stock Synthesis, it is assumed that annual length and age-at-length data for the pooled data were representative of those combined data.

ToR 2. Evaluate the quality and applicability of methods used to assess the stock.

Conclusions

Stock Synthesis 3, the software within which the model for the Gulf of Mexico stock of cobia was developed, has gained international recognition for its quality and the applicability of the methods it uses to assess the condition of fish stocks. The model for cobia was of an appropriate structure given the data that were available. Values predicted by the model, including those of benchmarks, were imprecise, however, due to the nature of the input data. Further imprecision of model outputs due to alternative values of key parameters, such as natural mortality and steepness of the stock-recruitment relationship, was explored. Recognising the types of data that were available for input and the uncertainty of model outputs that arose as a consequence of the nature of those input data, the Stock Synthesis model for cobia is of a quality consistent with that which would be considered "best practice", and is able to provide a valuable assessment of the likely condition of the stock in 2011, and, when projected, the likely trajectory of yields and stock condition over the next five to six years.

Strengths

- The decision to use Stock Synthesis 3 as the modelling framework.
- The structure of the model for cobia, which was developed within the Stock Synthesis framework, was appropriate given the data that were available.
- The enhancement of Stock Synthesis to allow modelling of a fishery for which the only source of mortality is that associated with discarding of bycatch.
- The assessment of the uncertainty of parameter estimates was thorough.
- Selectivity runs explored key uncertainties and demonstrated appropriateness of conclusions regarding the current condition of the stock.
- Benchmarks were appropriately calculated.
- Projections were undertaken using two states of nature.

Weaknesses

- Subjective decision to set effective sample size to actual sample size capped at a maximum of 100 rather than to use iterative reweighting, such as proposed by Francis (2011).
- Lack of exploration of sensitivity to the assumption of logistic selectivity for the recreational and commercial fisheries.
- Lack of length and age composition data to provide information on the length compositions of discards and the shape of the retention curves
- Failure of model to match the trends in discards from the commercial and recreational fisheries
- Imprecision in the estimate of steepness of the stock-recruitment relationship.
- Lack of exploration of uncertainty associated with time series of commercial and recreational landings.
- Errors in Stock Synthesis files in the Appendices.

Both the decision by the Assessment Workshop to employ Stock Synthesis 3 as the modelling framework and the structure of the model for the Gulf of Mexico stock of cobia that was developed within this framework are appropriate. Stock Synthesis has been extensively tested, and has the flexibility to be applied to fisheries with data qualities ranging from poor to rich. The software has been equipped with tools to explore uncertainty, to estimate benchmarks, and to undertake projections using alternative harvest policies. Because of its versatility, Stock Synthesis is well suited to explorations of the sensitivities of model outputs to a broad range of alternative model structures or use of alternative sets of data inputs. The enhancement of Stock Synthesis to allow modelling of a fishery for which the only source of mortality is that associated with discarding of bycatch is a particular strength of the assessment that was developed for the Gulf of Mexico stock of cobia. While some deficiencies were identified in the fit of the base model, the overall fit was regarded as adequate.

The Stock Synthesis model for the Gulf of Mexico stock of cobia included three fishing fleets, *i.e*., commercial, recreational and discards of bycatch from the shrimp trawl fishery, and two fishery-dependent abundance indices, *i.e*., cpue data from the MRFSS survey and from the headboat survey. Time series of discards from the commercial, recreational, and shrimp fisheries were input, together with length composition data of cobia from the commercial and recreational fisheries, and, combining the data into a super period, from the bycatch from the shrimp fishery. Age composition data were input for the recreational fishery and considered within the model as age compositions that were conditional on length.

The model employed 3-cm bins for the length composition of cobia, and the lower bounds of the length intervals within these bins ranged from 6 to 165 cm. It was pleasing to note that the Assessment Workshop had reported exploration of the effect of bin size on estimation of selectivity parameters, at least to a limited extent, and concluded that use of a bin width of 3 cm was preferable to use of one that was 5 cm. Methot (2011) notes that, on occasion, wide bin widths can cause problems when the slope of a selectivity or retention curve becomes so steep that all change occurs within a single length class.

Although the Assessment Workshop reported that, as its value is typically unable to be estimated within the assessment model, the standard deviation of recruitment was fixed at 0.6, no justification for the choice of this particular value is provided in the Assessment Workshop Report. It might be useful to note that the use of this value has been proposed in a number of studies (*e.g*., Smith and Punt 1998; Maunder and Deriso, 2003), which typically advise that the value 0.6 is supported by the results of the meta-analyses undertaken by Beddington and Cooke (1983), and later by Mertz and Myers (1996).

When developing the base model for cobia, a subjective decision was made to employ an effective sample size for the length composition data of cobia, which was set equal to annual sample size but capped at a maximum of 100 when the number of fish in the annual sample exceeded this number. Rather than using this subjective approach, the iterative re-weighting approach that was explored in sensitivity run 10, *i.e*., the method proposed by Francis (2011), is recommended.

The decisions by the Assessment Panel to use asymptotic, logistic, size-based selectivity curves for the recreational and commercial fisheries and a double-normal selectivity curve to represent the selectivity of cobia by the shrimp fishery, and to keep these selectivity curves constant over time, are endorsed. It would have been expected, however, that sensitivity to this choice of selectivity patterns would have been explored. As was appropriate, to accommodate the introduction in 1984 of a minimum size limit of 33 inches, separate retention curves were assumed for the time blocks 1927-1984 and 1985-2011. Because of the lack of data prior to 1993, however, it was necessary to assume the shape and parameters of the retention curve for the earlier time block. This represents a source of uncertainty, and it would therefore be appropriate to consider whether assessment results are likely to be sensitive to the assumptions made regarding the form and values of parameters of this retention curve.

The base model was fitted to the data for Gulf of Mexico stock of cobia and reported as Run 1. All estimated parameters were assumed to have uniform, non-informative priors, with wide bounds. The results of the jitter test, with 48 of 50 trials converging to within 2 likelihood units of the minimum, suggested that the model was not particularly sensitive to the initial values of the parameters that were estimated.

While model predictions were broadly consistent with the commercial and recreational discards, the trends of the predictions did not match those of the observed data, suggesting some structural deficiency of the model or, if the model structure was correct, inadequacy of the discard data or overriding influence of other data. In the case of discards by the commercial fishery, the possibility that the discard data were inadequate cannot be discounted as the Data Workshop had identified that these estimates were likely to be both imprecise, as few trips with cobia discards had been recorded in the Reeffish Observer Program, and erroneously low, as the NMFS logbooks do not provide coverage of the entire fishery. In the case of the recreational fishery, however, it is likely that the failure to fit the trend in recreational discards was due to the competing influence of other datasets on model predictions.

It would be useful to advise in the captions of Figures 3.7 and 3.8 of the Assessment Workshop Report that these are plots of the MRFSS and headboat cpue data, respectively. As noted in the Report, the fits to these indices and to the effort data for the shrimp fishery are quite good, although runs of positive and negative deviations were present in the headboat cpue data. Some structure also appeared present in the Pearson residual plots for the commercial (Fig. 3.11) and recreational (Fig. 3.13) length composition data.

In the base model represented by Run 1, estimates of both the log of unexploited equilibrium recruitment (1,033,130 fish) and the steepness of the stock recruitment curve, *i.e*., 0.925, were calculated by Stock Synthesis when the model was fitted to the input data. The Assessment Workshop provided a well-considered evaluation of the reliability of the estimate of steepness, noting that a large proportion of bootstrap estimates of steepness approached the upper bound of 1, and that, although probably greater than 0.8, the distribution of estimates between 0.85 and 1 was relatively uniform. The likelihood profile for steepness was relatively flat between 0.8 and 1, but suggested a minimum between 0.85 and 0.95. Tension was exhibited in the values of steepness that were most consistent with recruitment data (favouring a value of ~1), length and discard data (favouring a value of ~0.8), and age composition (favouring a value of ~0.65), with little information relating to steepness evident in the abundance indices. The fact that the input data were more consistent with lower values of steepness, while the assumption regarding recruitment deviations appeared to be providing the support for higher values of steepness, is interesting as it raises the question of whether, in the case of Gulf of Mexico cobia, the influence of recruitment deviations on the resultant parameter estimates was excessive. The assessment Workshop Report advised that steepness may not be well estimated by the Stock Synthesis model, a conclusion that appears sound. The recent study by Lee *et al.* (2012), which demonstrated the difficulty that is typically encountered when attempting to estimate steepness, concluded that "steepness is reliably estimable inside the stock assessment model only when the model is correctly specified for relatively low productive stocks with good contrast in spawning biomass". This conclusion is relevant to the cobia assessment, for which the results of fitting the base model to cobia, a species that, on the basis of its natural mortality, would be considered of medium productivity, indicated that biomass had been relatively stable over the last 30 years, the period covered by the abundance indices and much of the more reliable input data.

The question of how to respond when the steepness of the stock-recruitment relationship is imprecise or cannot be estimated reliably should be considered. Francis (2012) has suggested that, in such circumstances, he considers it better to fix steepness at a value, such as 0.75, *i.e.*, the default value recommended in Francis (1993), and which is frequently used in Australia and New Zealand, or the average of published values for the same or similar species. Francis (2012) advises that the uncertainty associated with this parameter should then be explored using sensitivity runs with lower and higher values of steepness.

There would have been value in assessing whether the value of steepness estimated from the base model, *i.e.*, 0.925, is consistent with published values for cobia or similar species. The fact that this value of steepness for the base model, and the values of steepness estimated when fitting the models using the low and high values of the base level of natural mortality, which were subsequently used as alternative states of nature, ranged from 0.92 to 0.96 (Table 3.7, Assessment Workshop Report) was initially of concern to the Reviewer, as such values of steepness reflect a robust stock that is able to maintain recruitment despite considerable decline in stock size. It was noted subsequently, however, that the Assessment Workshop had explored sensitivity runs with lower steepness, *i.e.*, 0.7 and 0.8, and that these runs had produced very similar conclusions regarding the condition of the stock with respect to benchmark levels as were determined using the base model (Table 3.8, Stock Assessment Report). Accordingly, after considering the results of the other sensitivity runs, it is concluded that, despite imprecision in the estimate of steepness, the base model accepted by the Assessment Workshop, *i.e.*, the model associated with Run 1, is appropriate for determination of the current condition of the Gulf of Mexico stock of cobia and for use in projecting the fishery over a short time period to assess the likely outcomes of fishing with specified levels of fishing mortality.

There are errors in the stock synthesis files listed in the appendices. For example, there are actually 91 length observations in the data file, not 85, where this inconsistency would cause Stock Synthesis to abort when it attempted to read the data. Also, the number of length bins is specified as 54 in the data file, but the specification of the selectivity for MRFSS data attempts to use 57, which would cause Stock Synthesis to abort when it attempted to run following data input. The listings should be those associated with the base model, but appear to be those of a model that was still under development.

ToR 3. Recommend appropriate estimates of stock abundance, biomass, and exploitation.

Conclusions

Estimates of stock abundance, biomass, and exploitation are produced when the Stock Synthesis model is fitted. The values of total biomass and annual exploitation in 2011, which were estimated when the base model for the Gulf of Mexico stock of cobia was fitted, were 3,030 mt and 0.29, respectively.

Strengths

Stock Synthesis 3 is able to calculate time series of abundance, total biomass, and annual exploitation.

Stock abundance:

The report file that is produced by Stock Synthesis, report.sso, contains a time series section, in which the time series of abundance, recruitment and catch for each of the areas are reported. Output quantities include summary biomass and summary numbers for each gender and growth pattern. The Assessment Workshop Report for the Gulf of Mexico cobia stock has not reported these abundance estimates, but they will be available in the output file for Run 1.

Biomass:

Stock Synthesis produces an estimate of total annual biomass (Table 3.4, Fig. 3.33). The estimate (for Run 1) of total biomass for 2011 was 3,030 mt.

Exploitation:

Although not reported in the text of the Assessment Workshop Report, the code within the Starter.SS file presented in Appendix C of this report specifies that, for the Gulf of Mexico stock of cobia, Stock synthesis is to set the value of fishing mortality, *F*, to the value of annual exploitation, calculated as the ratio of the weight of the total catch (including discards) to the total biomass. The estimate (for Run 1) of the annual exploitation rate for 2011 was 0.29 (Table 3.6, Assessment Workshop Report).

ToR 4. Evaluate the methods used to estimate population benchmarks and management parameters. Recommend and provide estimated values for appropriate management benchmarks and declarations of stock status for each model run presented for review.

Conclusion

Stock Synthesis calculates a range of population benchmarks and management parameters. Benchmarks calculated for cobia were MFMT = $F_{30\%\mathrm{SPR}}$ and MSST = (1 – *M*) $\mathrm{SSB}_{30\%\mathrm{SPR}}$. The estimates of F_{current} and $\mathrm{SSB}_{\mathrm{current}}$, which were calculated for 2011 using the base model for cobia, were 0.24 and 2,213 mt, respectively. The ratios $F_{\mathrm{current}}/\mathrm{MFMT}$ and $\mathrm{SSB}_{\mathrm{current}}/\mathrm{MSST}$, which were calculated using the base model, were 0.63 and 1.73, respectively. These results, which were consistent with those produced by all but one (the model with natural mortality set to 0.26 y^{-1}) of the models used in the various sensitivity runs, imply that, in 2011, the Gulf of Mexico stock of cobia was not experiencing overfishing and was not overfished.

Strengths

Stock Synthesis possesses well-tested procedures to calculate and output a range of population benchmarks and management parameters.

Summary

Stock Synthesis provides estimates of population benchmarks and management parameters. In particular, it is able to produce estimates for indicator variables and reference points based on maximum sustainable yield (MSY), spawning potential ratio (SPR), and spawning stock biomass (SSB), and taking the stock-recruitment relationship into account. SPR is calculated as the equilibrium spawning biomass per recruit that would result from a given year's pattern and the levels of *F*'s and selectivities for that year. For MSY-based reference points, Stock Synthesis searches for a fishing mortality that would maximise the equilibrium yield. For SPR-based reference points, the computer program searches for an *F* that would produce the specified level of SPR. For spawning biomass-based reference points, the software searches for an *F* that would produce the specified level of spawning biomass relative to the unfished value.

The management benchmarks, *i.e.*, the Maximum Fishing Mortality Threshold (MFMT) and Minimum Stock Size Threshold (MSST), which were proposed for the Gulf of Mexico stock of cobia by the Assessment Workshop, are appropriate for use in determining the status of that stock. These benchmarks, which were based on the level of fishing mortality and equilibrium spawning stock biomass associated with a spawning potential ratio of 30%, are

$$\mathrm{MFMT} = F_{30\%\mathrm{SPR}} \quad \text{and} \quad \mathrm{MSST} = (1 - M)\,\mathrm{SSB}_{30\%\mathrm{SPR}},$$

where it was concluded that overfishing was occurring if F_{current} > MFMT, *i.e.*, $F_{\text{current}}/\text{MFMT} > 1$, and the stock was considered to be overfished if $\text{SSB}_{\text{current}}$ < MSST, *i.e.*, $\text{SSB}_{\text{current}}/\text{MSST} < 1$.These benchmarks are approximations for

$$\text{MFMT} = F_{\text{MSY}} \quad \text{and} \quad \text{MSST} = (1 - M)\ \text{SSB}_{\text{MSY}},$$

where F_{MSY} is the fishing mortality that produces the maximum sustainable yield MSY, M is the point estimate of natural mortality for fully recruited ages, and SSB_{MSY} is the equilibrium spawning stock biomass that produces MSY. The benchmarks for the Gulf of Mexico stock of cobia use proxies, where these proxies were based on a spawning potential ratio SPR of 30%. Thus, the proxy that was used for F_{MSY} was the fishing mortality, $F_{30\%\text{SPR}}$, which produces a spawning stock biomass per recruit that is 30% of the spawning stock biomass per recruit produced when the stock is not fished, *i.e.* an SPR of 30%. The proxy that was used for SSB_{MSY} was the corresponding value of equilibrium spawning stock biomass, *i.e.* the spawning stock biomass $\text{SSB}_{30\%\text{SPR}}$ that is produced with a fishing mortality of $F_{30\%\text{SPR}}$.

Although Stock Synthesis is able to estimate MSY-based rather than SPR-based reference points, the Assessment Panel chose to use the proxies $F_{30\%\text{SPR}}$ and $\text{SSB}_{30\%\text{SPR}}$ rather than F_{MSY} and SSB_{MSY}. The latter two reference points are likely to be more appropriate if assessing "the capacity of a fishery to produce the maximum sustainable yield on a continuing basis" (Magnuson-Stevens Fishery Conservation and Management Act, May 2007).

F_{current} was calculated as the geometric mean of the estimates of the three most recent annual fishing mortalities, *i.e.*, the fishing mortalities for 2009-2011, where annual fishing mortality was estimated by its proxy, exploitation rate, calculated as the ratio of the total catch (including discards) to estimated total biomass. $\text{SSB}_{\text{current}}$ was the estimate of spawning stock biomass for 2011.

Table 3.8 of the Assessment Workshop Report, a subset of which is reproduced below, contains the values of the current (2011) fishing mortality and spawning stock biomass for Gulf of Mexico cobia, the values of the MFMT and MSST benchmarks for this stock, and the results of the stock determination for each of the models that were explored in the assessment. The only one of these models, for which the current fishing mortality exceeded MFMT (*i.e.*, overfishing was occurring) or the current SSB was less than MSST (*i.e.*, the stock was overfished), was the sensitivity trial in which a low value of natural mortality was employed as the base level when scaling the Lorenzen (1996) estimates to determine age-dependent estimates of natural mortality.

Quoted from Assessment Workshop Report: "Table 3.8, Assessment Workshop Report. Reference points and benchmarks from sensitivity runs for Gulf of Mexico cobia from SS. Benchmarks are reported for SPR 30%. Current refers to the geometric mean of 2009-2011 for F. MSST = (1-M)*SSBSPR30% with M = 0.38 y^{-1} for all models except runs 2 (M = 0.26 y^{-1}) and 3 (M = 0.50 y^{-1})".

Run	Model	Fcurrent	SSB2011	MFMT	MSST	F/MFMT	SSB/MSST	Overfishing occurring?	Overfished?
1	Base model	0.24	2213	0.38	1280	0.63	1.73	No	No
2	M_Low	0.3	1872	0.29	2443	**1.05**	**0.77**	**Yes**	**Yes**
3	M_High	0.18	2587	0.45	804	0.4	3.22	No	No
4	D_High	0.24	2197	0.37	1302	0.65	1.69	No	No
5	Steepness=0.7	0.24	2121	0.39	1174	0.63	1.81	No	No
6	Steepness=0.8	0.24	2168	0.38	1257	0.64	1.73	No	No
7	MRFSS only	0.26	1921	0.37	1277	0.7	1.5	No	No
8	HB only	0.19	2940	0.37	1301	0.52	2.26	No	No
9	Stock synthesis weighted	0.22	2340	0.35	1273	0.58	1.85	No	No
10	Francis (2011) weighting	0.22	2415	0.38	1305	0.61	1.84	No	No

ToR 5. Evaluate the quality and applicability of the methods used to project future population status. Recommend appropriate estimates of future stock condition.

Conclusions

Stock Synthesis provides a well-tested procedure to project the model through a range of future years, using a fishing rate based on MSY, SPR, a specified target biomass, or a multiple of the recent average fishing rate, and producing estimates of yield and key management parameters, thereby allowing assessment of future stock condition. The methods used, which are recognised as being of high quality, are designed to produce the estimates of future population status that are needed by managers. For the base model, fishing mortality would be increased from F_{current} if adjusted to F_{OY} or $F_{30\%\text{SPR}}$. Projections from 2013 to 2019 suggest that spawning stock biomass would increase from $\text{SSB}_{\text{current}}$ if fishing mortality was maintained at F_{current}, increase to a lesser extent if fishing mortality was increased to F_{OY}, and decline very slightly if fishing mortality was increased to $F_{30\%\text{SPR}}$. Yield would be expected to increase under each of these three fishing mortalities. The condition of the stock would be expected to continue to be classified as "not overfished, with overfishing not occurring".

Strengths

Projections are undertaken using the well-tested procedures within Stock Synthesis.

Weaknesses

It would have been useful to have undertaken a projection using a model with a lower steepness, such as 0.8.

Summary

Stock Synthesis includes a well-tested procedure to project the future stock status that would be expected to result when using a fishing rate based on MSY, SPR, a specified target biomass, or a multiple of the recent average fishing rate. Use of this procedure ensures consistency of model predictions with the assumptions, with the parameter estimates obtained by fitting the model, and with the length and age structure predicted as the current state of the stock. It is thus highly applicable for use with the Gulf of Mexico stock of cobia.

Deterministic projections for 2013 to 2019 were run for the Gulf of Mexico stock of cobia using three models, *i.e.*, the base model (Run 1), and the low and high mortality models (Runs 2 and 3, respectively), which the Assessment Panel considered representative of possible alternative states of nature. The projections were made using fishing rates set to MFMT (*i.e.*, the proxy $F_{30\%SPR}$ for F_{MSY}), F_{OY} (*i.e.*, 75% of $F_{30\%SPR}$), and $F_{current}$, where this last value was calculated as the geometric mean of the annual values of F for the last three years, *i.e.*, 2009-2011. The fishing mortality of the shrimp fishery during the projection period was assumed to remain constant, and was set to the geometric mean of the annual fishing mortalities for this fishery over the last three years, *i.e.*, 2009-2011. Selectivity, discarding, and retention patterns were assumed to be the same as those experienced in the five most recent years, *i.e.*, 2007-2011, while the distribution of catches among the fishing fleets, *i.e.*, fisheries, reflected the distribution of average fishing intensities among those fleets in 2009-2011. Recruitment during the projection period was calculated as the value predicted by the stock-recruitment relationship. The base model was also projected using a fishing mortality of $F_{30\%SPR}$ for 1000 samples generated using the bootstrap facility within Stock Synthesis to produce distributions of the estimated yields predicted by the model for each year between 2012 and 2019 (Fig. 3.63, Assessment Workshop Report).

The final year of the time series of data used in the assessment for the Gulf of Mexico stock of cobia was 2011. In order to carry out projections, it was therefore necessary to estimate the removals that were likely to have occurred in 2012. Accordingly, removals of cobia for each of the fisheries in 2012 were estimated using a fixed fishing mortality set to the geometric average of the annual fishing mortalities in 2009-2011.

The methods used in Stock Synthesis to predict the outcomes expected between 2013 and 2019 were considered to be of a high quality. The quality of the resulting projections depends, however, on the extent to which the alternative states of nature represented by the different models used in the projection are likely to be representative of the true state of nature, and the extent to which each of those alternative models provides a reliable representation of the dynamics of the stock. The results of the projections should thus be considered in the context of the accuracy and precision of the predictions made by the model with respect to the input data they were intended to represent.

Although the three models used in the projections bracket the range of estimates of natural mortality for cobia, the estimates of steepness for these models range only between 0.92 and 0.96, *i.e.*, there will be little reduction in recruitment as spawning stock biomass declines, until the depletion in spawning stock biomass becomes severe. There would have been value in considering a model with a considerably lower value of steepness, *e.g.*, 0.8, to represent an alternative state of nature, which, given the nature of the input data and the uncertainty of the estimate of steepness, appears feasible.

The results obtained from the projections are presented in Table 3.9 and Figures 3.59-3.70 of the Assessment Workshop Report. Estimates of stock condition depend on which of the states of nature explored in the assessment is most likely to reflect the true state of nature. Of the three scenarios considered in the assessment, that represented by the base model (Run 1) would be considered to provide the best description of the data that were available, given the assumptions that were made regarding those data, the biology of the cobia stock, and the fisheries exploiting this stock. For the base model, fishing mortality would be increased from F_{current} if adjusted to F_{OY} or $F_{30\%\text{SPR}}$. The base model predicts that spawning stock biomass would be expected to increase from $\text{SSB}_{\text{current}}$ if fishing mortality was maintained at F_{current}, increase to a lesser extent if fishing mortality was increased to F_{OY}, and decline very slightly if fishing mortality was increased to $F_{30\%\text{SPR}}$. Yield would increase under each of these three fishing mortalities. If the model with the lower natural mortality, *i.e.*, Run 2, represented the true state of nature, continued fishing with a fishing mortality of F_{current} is predicted to allow the spawning biomass to increase beyond the MSST by 2014, *i.e.*, become no longer overfished, despite the fact that overfishing was continuing. The reduction in fishing mortality associated with F_{OY} or $F_{30\%\text{SPR}}$ would result in overfishing no longer occurring and would produce an increase in spawning stock biomass such that, by 2014, the stock would no longer be classified as being overfished. If natural mortality was greater, *i.e.*, Run 3, spawning stock biomass would increase if fishing mortality was maintained at F_{current} but would decline if it was set to F_{OY}, and would decline to an even greater extent if fishing mortality was set to $F_{30\%\text{SPR}}$.

It would have been informative to explore the consequences (for each pair of putative states of nature) of incorrectly assuming that one of these alternative states of nature was true, and setting allowable catches accordingly, when in fact one of the alternative states of nature was the "true" state. Such an analysis allows an assessment of the robustness of an incorrect decision relating to which of the alternative models is considered most likely to represent the true state of nature.

ToR 6. Evaluate the quality and applicability of methods used to characterize uncertainty in estimated parameters.

- **Provide measures of uncertainty for estimated parameters**
- **Ensure that the implications of uncertainty in technical conclusions are clearly stated**
- **If there are significant changes to the base model, or to the choice of alternate states of nature, then provide a probability distribution function for the base model, or a combination of models that represent alternative states of nature, presented for review.**
- **Determine the yield associated with a probability of exceeding OFL at P* values of 30% to 50% in single percentage increments**
- **Provide justification for the weightings used in producing the combinations of models**

Conclusions

The methods within Stock Synthesis that may be used to explore uncertainty include calculation of estimates of asymptotic standard errors, calculation of likelihood profiles, MCMC analyses, and bootstrapping. These tools are complemented by auxiliary routines that allow production of diagnostic plots, which also assist in communicating the uncertainty of estimates. The software encourages exploration of alternative model structures and sensitivity to alternative values of parameters or functional forms. The model that was developed for the Gulf of Mexico stock of cobia employed an appropriate set of these methods. Probability distributions were produced for initial equilibrium biomass and steepness, unfished total and spawning biomass, and spawning biomass in 2011. As the iterative approach required to calculate P^* cannot be implemented in Stock Synthesis, Stock Synthesis "calculates the expected time series of probabilities that the F resulting from a specified harvest policy would exceed a specified level" (Methot and Wetzel, 2012).

Strengths

- Stock Synthesis provides an extensive suite of methods that may be used to explore uncertainty.
- The retrospective analysis revealed no strong systematic patterns.
- Bootstrapping was used to produce probability distributions

Summary

Stock Synthesis provides a number of methods that may be used to characterize the uncertainty associated with the estimates of parameters, benchmark estimates, and predicted values of parameters. These include options to generate likelihood profiles and to run a bootstrapping or Markov Chain Monte Carlo (MCMC) analysis. The software is well suited for use in exploring the uncertainty associated with the models that were fitted to the Gulf of Mexico stock of cobia. Thus, for each run of the Stock Synthesis model for this stock, estimates of asymptotic standard errors would have been calculated for each of the parameters that were estimated (see Table 3.1, Assessment Workshop Report, for parameter estimates and estimates of asymptotic standard errors for the base model, Run 1, for which the average value of natural mortality for fully-selected cobia was M = 0.38 y^{-1} and estimated steepness = 0.925). These standard errors may be considered to represent minimum values for the uncertainty of the estimated parameters. The uncertainty of selected parameter estimates for the Gulf of Mexico cobia stock was also characterized using the results from bootstrapping (Table 3.2, Figs 3.26 and 3.27). Additional uncertainties (sensitivities) arising from differences in model structure or data input for the cobia model were also assessed by re-running Stock Synthesis using those alternative model structures or data sets.

The initial run (Run 1) was carried out using the model structure that had been proposed for the Gulf of Mexico stock of cobia and estimating the steepness parameter of the Beverton and Holt stock-recruitment relationship. Bootstrapping of this model demonstrated that, given the data that were available, the steepness of the stock recruitment relationship was estimated imprecisely, a result which was confirmed by constructing likelihood profiles for this parameter. A number of sensitivity runs of Stock Synthesis were then run to explore the effect of varying this and other parameters, or the methods employed in the analysis.

As is typical in stock assessment, exploratory runs for the Gulf of Mexico stock of cobia were first employed to determine a base model for the assessment, *i.e.*, a model that is considered the most likely of the alternative model configurations that have been proposed. Despite the imprecision of the estimate of steepness, the decision was made at the Assessment Workshop to retain Run 1 as the base model as parameter estimates and patterns of stock dynamics were similar for the models using alterative estimates of steepness.

The Assessment Workshop selected the models with low M (Run 2) and high M (Run 3) as representative of alternative states of nature. Projections using these models were explored.

While the iterative approach required to calculate P^* cannot be implemented in Stock Synthesis, a complementary approach has been developed to produce estimates of the probability that F, the fishing rate based on MSY, SPR, a specified target biomass, or a multiple of the recent average fishing rate that is employed in the projection, exceeds the OFL (Methot and Wetzel, 2012). These authors advise that, whereas the P^* approach calculates the future stream of annual catches that would have a specified annual probability of $F >$ OFL, Stock Synthesis "calculates the expected time series of probabilities that the F resulting from a specified harvest policy would exceed a specified level".

The models were not combined, but presented as alternatives for consideration by the Review Panel.

ToR 7. If available, ensure that stock assessment results are accurately presented in the Stock Assessment Report and that stated results are consistent with Review Panel recommendations.

The Review was undertaken as a desktop review, rather than a review within a workshop setting. Accordingly, it was not possible for the recommendations made in review reports to be acted upon, nor to ensure that the results were incorporated accurately in the resultant Stock Assessment Report.

ToR 8. Evaluate the quality and applicability of the SEDAR Process as applied to the reviewed assessment and identify the degree to which Terms of Reference were addressed during the assessment process.

The SEDAR Process provides a very sound basis for stock assessment. It has ensured that all aspects of the assessment process for the Gulf of Mexico cobia, from collation of data through to model development, exploration, and production of management advice, have been documented in detail, including the underlying reasons for decisions that were made concerning data to be used and model structure to be employed. For the reviewer, it has thus provided a thorough understanding of the details of the assessment and assisted in identifying opportunities for improvement and in detecting errors or inadequacies.

The Terms of Reference for the Assessment Process, which are presented below, are now examined and comment is made on the degree to which these were addressed.

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

   Accomplished.

2. Recommend a model configuration which is deemed most reliable for providing management advice using available compatible data. Document all input data, assumptions, and equations.

   The configuration of the model for cobia that was set up within the Stock Synthesis framework was described. The equations used within Stock Synthesis were not described in the Assessment Workshop Report. This is understandable as, to some extent, the rate of development of this software has outpaced the development of the technical descriptions relating to the features within the Stock Synthesis software. Methot and Wetzel (2012) have recently addressed this issue, however, and their recent paper should be cited in the Assessment Workshop Report.

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

   No environmental covariates were identified by the Data or Assessment Workshops.

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

   Accomplished.

5. Characterize uncertainty in the assessment and estimated values.
   • Consider components such as input data, modeling approach, and model configuration
   • Provide appropriate measures of model performance, reliability, and 'goodness of fit'

   Accomplished.

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

   Accomplished.

7. Provide estimates of stock status relative to management criteria consistent with applicable FMPs, proposed FMPs and Amendments, other ongoing or proposed management programs, and National Standards for each model run presented for review.

   Accomplished.

8. Project future stock conditions and develop rebuilding schedules if warranted, including estimated generation time. Develop stock projections in accordance with the following:
   A) If stock is overfished:
      F=0, FCurrent, FMSY, FOY
      F=FRebuild (max that permits rebuild in allowed time)
   B) If stock is undergoing overfishing:
      F= FCurrent, FMSY, FOY
   C) If stock is neither overfished nor undergoing overfishing:
      F= FCurrent, FMSY, FOY
   D) If data limitations preclude classic projections (i.e. A, B, C above), explore alternate models to provide management advice

   Accomplished.

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

   The Assessment Workshop Report noted that three of the sensitivity runs had been considered as alternate states of nature, and projections had been run for each of these The Assessment Workshop Report advised that probability distribution functions had been developed for the subset of three runs and would “be made available to the Scientific and Statistical Committee (SSC) for the development of management advice, including OFL and ABC”. No information relating to these probability distribution functions was presented in the Report.

10. Provide recommendations for future research and data collection. Be as specific as possible in describing sampling design and intensity, and emphasize items which will improve assessment capabilities and reliability. Recommend the interval and type for the next assessment.

    Attention was directed to the research recommendations that were made in the Data Workshop Report. The Workshop Assessment Report identified gaps in data, which, if addressed, would improve the assessment capabilities and reliability. Specific sampling design and intensity were not discussed. No recommendations relating to the interval and type for the next assessment were made by the Assessment Workshop.

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

    A spreadsheet was not provided in the documentation that was circulated to the Review Panel. The Assessment Workshop addressed this Term of Reference in its Report by providing a table listing the estimates for all parameters used in the model and presenting a listing of each of the input files required to run the Stock Synthesis model for Gulf of Mexico cobia.

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

    Accomplished.

ToR 9. Make any additional recommendations or prioritizations warranted.

- **Clearly denote research and monitoring needs that could improve the reliability of future assessments**

A number of research needs, which are listed below in order of priority, were identified in the course of the desk review. As expected, these were highly consistent with, and thus overlap, many of the research needs that had been identified by the Data and Assessment workshops.

1. Review or establish programs to collect data on the length composition and age-at-length compositions of landings and discards from each commercial gear and from each recreational fishing mode, and of bycatch of cobia from the shrimp fishery. Ensure that the statistical design and spatial coverage of survey or sampling programs are appropriate and that survey or sampling intensity is sufficient to produce estimates of the required precision for Gulf of Mexico cobia. Set goals for performance and establish and monitor performance criteria to assess the quality and completeness of data collection programs. This item is of the highest priority as it will provide information required by Stock Synthesis to determine the selectivity and retention curves for cobia for the commercial, recreational, and shrimp fisheries, the lack of which is a key source of uncertainty in the model.
2. Undertake research to determine reliable relationships between the proportion of females that are mature and both length and age for the Gulf of Mexico stock of cobia. This item is also of high priority, as the maturity information that is currently used is imprecise. The calculation of spawning stock biomass, a crucial parameter in the calculation of benchmarks and assessment of stock status, should be based on reliable data.
3. Review programs that are used to collect discard data for cobia (and data on the bycatch of cobia by the shrimp fishery), and refine these programs to ensure that accurate and complete data estimates of the discards (and bycatch) are collected. Ensure that the statistical design and spatial coverage of survey or sampling programs are appropriate

and that survey or sampling intensity is sufficient to produce estimates for Gulf of Mexico cobia that are of the required precision. Set goals for performance and establish and monitor performance criteria to assess the quality and completeness of data collection programs and provide feedback regarding performance to those programs. While this research item will not provide immediate improvement in the quality of the assessment, it is important that action is taken as soon as possible to improve the accuracy and precision of the data relating to the quantities of fish that are discarded from each of the fisheries, such that, in the future, the time series of discards become more reliable.

4. A comprehensive genetic study of cobia should be undertaken, with the following objectives:
    a. to confirm the preliminary genetic findings of Darden for cobia in the Gulf of Mexico and US Atlantic Coast, using samples with sample sizes greater than 100 at all sites, thereby addressing the issue in that earlier study that sizes of samples from the north of the Gulf of Mexico and from waters off the west coast of Florida had been small;
    b. to increase the spatial resolution of the genetic sampling in the region of overlap of the two stocks, such that the boundary between the stocks or extent of overlap can be determined;
    c. to extend sampling into Mexican waters and thereby determine the southern boundary of the Gulf of Mexico stock;
    d. to reconcile the differences in the findings reported in SEDAR28-DW01 and those reported in SEDAR28-RD09, where the former advises that collections from offshore in the Gulf of Mexico were genetically distinct from those offshore in the South Atlantic region while the latter reports that the results of the study "suggest the offshore groups are genetically homogenous, even between the SA and GOM";
    e. to extend sampling beyond the spawning season and ascertain whether catches of fish may be assigned reliably to either the Gulf of Mexico or South Atlantic stock on the basis of the area in which they are caught.

    Some of the objectives of this study, *e.g.*, identification of the southern boundary of the stock, would also benefit from tagging or other studies. As this study will take some time before completion, it has been assigned a lower priority than the previous items. Determination of the southern stock boundary, however, is important to ensure that other removals from the stock are not occurring in Mexican waters, as such removals are not taken into account in the current assessment.
5. Undertake research to determine the discard mortality of Gulf of Mexico cobia that are discarded from the catches of each commercial fishing gear or each recreational fishing mode, recognising that such mortality is likely to differ among different categories into which the discarded fish are classified, *e.g.*, "alive", "mostly alive", and "mostly dead".
6. In future stock assessments for the Gulf of Mexico stock of cobia, explore whether the use of an age-dependent rather than constant *M* results in a significant improvement in fit, considering the Lorenzen and alternative functional forms of the relationship with age and the alternative of estimating the value of the age-dependent *M* at each age (or range of ages).

7. In future stock assessments, explore the sensitivity of the model to the uncertainty of the landings data.
8. Develop an ageing error matrix for Gulf of Mexico cobia.
9. A research study should be undertaken to determine an approach (or approaches) by which an appropriate range (or ranges) of feasible values of *M* for a species might be selected for use in stock assessment as alternate plausible states of nature. The need to determine an appropriate range for sensitivity runs arose in both the cobia and Spanish mackerel assessments, but the final decisions on the range to use were rather arbitrary and subjective. The issue arises in almost all assessments and it would be useful to establish an objective protocol to determine an appropriate range of values of *M* to be explored.
10. Develop a fishery-independent survey for Gulf of Mexico cobia, or investigate what changes would be required to make data from an existing fishery-independent survey appropriate for use as an index of abundance.
11. As a low research priority, assess whether, in future refinement of the Stock Synthesis model, sexually dimorphic growth should be introduced. Note that the benefit of this might only be realised if appropriate sex composition data for landings and discards are available for input, and length and age-at-length compositions are sexually disaggregated.

*4.2 Gulf of Mexico Spanish Mackerel (***Scomberomorus maculates***)*

ToR 10. Evaluate the quality and applicability of data used in the assessment.

Conclusions

The data compiled for the Gulf of Mexico stock of Spanish mackerel by the Data Workshop are the best that are available. Certainly, some aspects of the data are imprecise, *e.g.*, discards from commercial catches, and there are data gaps, such as the lack of length and age-at-length composition data for discards. Nevertheless, the data that are available are of a quality that would allow a broad assessment of the likely condition of the stock, which, although uncertain, would be useful to fisheries managers.

Strengths

- The collation of life history data for the Gulf of Mexico stock of Spanish mackerel.
- The collation of commercial landings data to produce time series of landings by gillnet, handline, and other gears from 1887, and, particularly, more precise data from 1950.
- The collation of a time series of estimates of bycatch of Spanish mackerel by the shrimp fishery from 1972, using a Bayesian model.
- The collation of recreational fisheries data from different sources to produce sound time series of landings by fishing mode from 1955, and, particularly, more precise data from 1981.
- The collation of data to produce time series of discards from the commercial gears and recreational fishing modes.

- The collation of length composition data to characterize the landings by the commercial and recreational fisheries.
- The collation of a fishery-independent and two fishery-dependent indices of abundance, and the use of appropriate statistical analyses to standardize those indices of abundance.

Weaknesses

- Lack of definition of the southern boundary of the Gulf of Mexico stock of Spanish mackerel.
- Uncertainty of the age at which 50% of Spanish mackerel are mature.
- The unreliable nature of the discard data due to low reporting, low intercept rates, and inadequate data collection programs.
- Inadequate sampling of length and age composition data from commercial landings and from bycatch of Spanish mackerel from the shrimp fishery.
- Lack of length and age composition sampling from commercial and recreational discards.

Specific comments

Stock structure

Spanish mackerel from US waters within the Gulf of Mexico and to the north of Highway 1 in Monroe County, Florida, which have been designated the "Gulf of Mexico stock", were the subject of the stock assessment. The Data Workshop Report acknowledged that studies of stock structure for Spanish mackerel in the Gulf of Mexico and off the US South Atlantic coast have produced conflicting results. The Report advised that, while early morphometric, meristic, allozyme, and electrophoresis studies and a more recent study of otolith shape and chemistry identify differences between fish from the Gulf of Mexico and those from the South Atlantic coast, a recent mitochondrial and nuclear DNA study did not detect a difference, which suggests at least a small amount of genetic flow between the two regions sufficient to homogenize allele frequencies. Based on results of the earlier studies, and taking into account spawning locations, stock distribution patterns, and catch history, the two groups of fish were recognized as separate management units, with a boundary at US Highway 1 in Monroe County, Florida, which has served as the boundary for data collection from the commercial and recreational fisheries. The evidence supporting the proposed stock structure and, in particular, the boundary separating the two putative stocks is not strong. Further studies to improve understanding of stock composition, *e.g.*, genetic, otolith microchemistry, species composition of parasites, tagging studies, should be initiated.

In the review of data relating to stock structure for Spanish mackerel, the Data Workshop Report makes no mention of the southern boundary of the putative Gulf of Mexico stock, and whether this stock extends into Mexican waters. If such extension is the case, failure to take into account Mexican catches of Spanish mackerel would result in bias in assessment results. The stock assessment that has been undertaken implicitly assumes that the Gulf of Mexico stock of Spanish mackerel is confined to US waters, and thus conclusions from the assessment must be considered conditional on the validity of this assumption.

Biological data

The use of Hoenig's (1983) equation for fish and maximum age to produce an estimate of natural mortality *M* for a fish stock is accepted practice when no data are available from the stock to allow direct estimation of this parameter. Thus, noting also that other methods of estimating *M* from life history data were investigated, its use of Hoenig's (1983) equation to estimate the base value of *M* for Gulf of Mexico Spanish mackerel is endorsed. The Data and Assessment Workshops also correctly recognized that this estimate of *M* was imprecise, and that the results of stock assessment were likely to be sensitive to this uncertainty.

For the reasons noted earlier when discussing the assessment for Gulf of Mexico cobia, use of the Lorenzen (1996) equation to derive age-dependent estimates of natural mortality *M* for Gulf of Mexico Spanish mackerel is not endorsed. In his report to the CIE on the stock assessments conducted for yellowtail flounder and Atlantic herring at Woods Hole in 2012, Francis (2012) advised that prediction of *M*, and, through body weight, its variation with age for an individual species, using Lorenzen's (1996) equation was likely to be highly imprecise, as was evident in the wide scatter about the regression line in Lorenzen's Figure 1. Francis observed that, for about one-third of Lorenzen's data points, predicted and observed *M*s appeared to differ by a factor of more than 2. Furthermore, in the case of both herring and yellowtail, the values of *M* estimated by Lorenzen's equation differed markedly from the values estimated using Hoenig's (1983) equation and had to be scaled substantially for use in the yellowtail flounder and Atlantic herring assessments. Francis (2012) raised the very valid point that, if the estimates produced for a species by Lorenzen's equation provide such unreliable estimates that the mean *M* differs from the estimate calculated using Hoenig's (1983) equation by a factor that differs markedly from 1, can it be considered sufficiently reliable to estimate how *M* varies with age within these species?

There has been no test to assess whether the introduction of the additional complexity associated with age-dependent natural mortality to the model for Gulf of Mexico Spanish mackerel is justified by the resultant improvement in fit that was obtained. It is recommended that a model employing a constant value of *M* is fitted to the Spanish mackerel data. If this model fits just as well as the model that employs an age-dependent *M*, then the simpler model should be used. If the age-dependent model produces a better fit, it would be better to estimate age-dependent *M* within the assessment model rather than assuming that it is of the form predicted by the Lorenzen (1996) equation.

Data on the rate of mortality for discarded hook and line caught Spanish mackerel are limited, and thus the estimates of discard mortality are imprecise. It was pleasing to note that the Assessment Workshop investigated the implications of uncertainty in the estimate of discard mortality by conducting a sensitivity run. Further research is required to produce a more reliable estimate.

Although only the parameter estimates of the von Bertalanffy growth curve fitted to the length at age data using the Diaz *et al.* (2004) model are input to Stock Synthesis to provide the initial values of the growth curve fitted within the assessment model, the growth curve developed for the Data Workshop is of value as a basis of comparison with the growth curve fitted by Stock Synthesis. Fitting the growth curve within Stock Synthesis ensures that the assumptions regarding selectivity are consistent with those employed in other parts of the model and that uncertainty in the estimates of growth is reflected in the estimates of the spawning stock biomass, fishing mortality and benchmarks.

Spanish mackerel exhibit dimorphic growth, yet the Stock Synthesis model considers only pooled data. In future refinement of the model, consideration should be given to modelling both females and males rather than combined sexes, noting that the benefit of this might only be realised if appropriate sex composition data for landings and discards are available for input, and length and age-at-length compositions are sexually disaggregated.

The Data Workshop Report advises that, due to a paucity of age data, percentage maturity was related to size class rather than age. It is not clear whether the data reported in Tables 2.3 and 2.4 represent only fish collected during the spawning season, *i.e.*, when mature fish can be distinguished readily from immature fish on the basis of macroscopic examination of their gonads. It is unclear how the age at 50% maturity for females was estimated, *i.e.*, was this obtained by transforming from length to age using the fitted growth curve. Further details are required. The value of 0.2 y seems surprisingly low for the age at 50% maturity of females. This low value drew comment from the Data Workshop, which suggested that it might have been due to identification of mature fish using macroscopic examination and recommended the use of the age at 50% maturity that was determined for the Atlantic stock of Spanish mackerel, *i.e.*, 0.7 y. Using the relationship between age at maturity and maximum age determined by Froese and Binohlan (2000), a species with an age at maturity of 0.2 y would be expected to have a maximum age of 0.8 y, a value far lower than the 11 years that the Data Workshop employed when estimating *M*. Further research to determine the relationship between percentage mature and age appears to be necessary given this unusually low value and the statement in Section 2.8 of the Data Workshop Report that there is a paucity of age data for Gulf of Mexico Spanish mackerel.

Commercial landings

The decision to extend the time series of landings data as far back in time as possible was endorsed, although it is noted that (1) the data in Table 3.2 of the Data Workshop Report were very sparse until 1927, and (2) the reliability of commercial data improved substantially in 1950. Note that it would be useful to state in the heading of Table 3.2 whether the gaps in data prior to 1927 represent missing years, or, as reported in Table 3.4, represent zero landings. As an alternative to using data extending back to 1887, it might be interesting to compare the results obtained from the model by using a shorter time series ranging from 1927 to 2011, noting that the imprecision associated with imputing the missing landings between 1887 and 1926 should also be considered.

The decision made by the Data Workshop to combine landings from commercial fishing gears other than gillnets and handlines was not explained. Was it to reduce the number of time series of landings considered in Stock Synthesis, and thereby reduce complexity, or was the decision made in recognition of a lack of data to characterize the length composition of each of the miscellaneous gears? A decision made because of the latter reason would indicate an inadequacy of the data collection programs, which might need to be addressed.

Until 1996, the annual landings of the combined commercial gears, other than gillnets and handlines, were typically of a greater magnitude than the landings made by handlines, and subsequently were of similar magnitude. As recommended by the Data Workshop, the Assessment Workshop apportioned these combined landings of the miscellaneous commercial gears to the landings of the two primary gears in proportion to the annual landings of those last two gears. The length composition of the resultant time series of landings thus reflect a weighted combination of the length compositions of the catches from the different fishing gears, each of which would have reflected the selectivity curve of that gear. Length composition data collected from the landings taken using gillnets or those taken using handlines will therefore fail to reflect the length compositions of the mixtures of landings of those primary gears and the contribution from the landings of the miscellaneous gears, particularly in the case of the length composition data for the handline landings.

Comment is made in Section 3.3.5 of the Data Workshop Report that there was a precipitous decrease in landings in 1977 and subsequent years following cold weather in Florida in 1976-77. This environmental event was not explored by the Assessment Workshop, but it might be interesting to consider whether the cold weather caused increased mortality or reduced growth, and whether this could explain the reduced landings that followed the 1977 event.

The Data Workshop is commended for its collation of the commercial landings data from the various sources and development of a time series of commercial landings suitable for use in the stock assessment process for the Gulf of Mexico stock of Spanish mackerel. It would be useful to assess and report the imprecision of the annual estimates.

Although the Data Workshop Report advised that the decision was made that discarded fish, which were designated as “kept”, should be removed from the amount of discards and added to landings, it is unclear whether this was done when preparing the landings and discard data for the Assessment Workshop.

Discards recorded for the commercial fisheries are highly uncertain due to low reporting rates and are likely to represent minimum values. Programs to collect discard data from commercial fishers need to be reviewed to identify ways in which more reliable discard data might be obtained.

The Bayesian model, which assumed that counts within cells had a negative binomial distribution, appeared an appropriate approach to estimating the bycatch of Spanish mackerel by the shrimp fishery. The Data Workshop advised, however, that, as a consequence of low encounter rate of Spanish mackerel by the shrimp fishery and irregular observer coverage, estimates of bycatch of Spanish mackerel are imprecise, although the mean is likely to be of the appropriate scale.

The Data Workshop Report advised that “sample sizes for developing length compositions were inadequate for a considerable number of year and gear strata”. Sampling to determine the age compositions of commercial landings has also been sparse, particularly for gillnet landings in recent years. There appear to be no data that could be used to characterize the length or age compositions of discards from the commercial fisheries. Data collection programs should be reviewed to identify how they could be improved to collect representative samples of length and age compositions from the landings and discards of the commercial fisheries.

Recreational landings

As with the commercial landings data, the Data Workshop is commended for its collation of the recreational landings of Gulf of Mexico Spanish mackerel from the various data sources, and, in particular, the extension of this time series of data back to 1955.

The Assessment Workshop reported that the estimates of discards of Spanish mackerel from the recreational fishery were highly uncertain, due to low intercept rates and the changes in quality control and assurance that had occurred between 1981 and 2011.

Age samples for the recreational fishery were collected by the Southeast Region Headboat Survey (SRHS), as lengths but not ages are typically collected within the MRFSS. No samples were available to characterize the length and age compositions of discards of Spanish mackerel by recreational fishers. Consideration should be given to developing a program to collect representative length and age data from Spanish mackerel that are discarded by the recreational fishery.

Survey indices

The recommendation reported in the Data Workshop Report that the fishery-independent SEAMAP survey and the fishery-dependent MRFSS, and FL trip ticket handline/trolling indices, are appropriate for use in the assessment, and that other putative indices should not be used, appears sound. Both the SEAMAP and MRFSS surveys used a delta lognormal model to standardize the data and thereby determine annual indices of abundance. The trip ticket data were standardized using a general linear model with forward stepwise selection.

In Section 5.4.4.6 of the Data Workshop Report, the Working Group advised that the index of abundance based on data from headboats was adequate for use in the assessment, yet the report card for the index advises that, because of the small proportion of observations that reported catches of Spanish mackerel, the Working Group did not endorse the use of the index in the assessment. Table 5.4.4.1 in the Data Workshop Report incorrectly divides total trips by total positive trips and reports the result, 38.89, as the overall percentage of positive trips instead of 2.6%. The incorrect value is then taken from the table and reported as 38.89% in Section 5.4.4.2 of the Data Workshop Report. The overall summary in section 5.1 correctly advises that the headboat index was not recommended for use. Accordingly, the Assessment Workshop did not include this as a survey to be used by Stock Synthesis.

ToR 11. Evaluate the quality and applicability of methods used to assess the stock.

Conclusions

Stock Synthesis 3, the software within which the model for the Gulf of Mexico stock of Spanish mackerel was developed, has gained international recognition for its quality and the applicability of the methods it uses to assess the condition of fish stocks. The model for Spanish mackerel was of an appropriate structure given the data that were available. Values predicted by the model for Spanish mackerel, including those of benchmarks, were imprecise, however, due to the nature of the input data. Further imprecision of model outputs due to alternative values of key parameters, such as natural mortality and steepness of the stock-recruitment relationship, was explored. Recognising the types of data that were available for input and the uncertainty of model outputs that arose as a consequence of the nature of those input data, the Stock Synthesis base model for Spanish mackerel is of a quality consistent with that which would be considered “best practice”, and is able to provide a valuable assessment of the likely condition of the stock in 2011, and, when projected, the likely trajectory of yields and stock condition over the next five to six years.

Strengths

- The decision to use Stock Synthesis 3 as the modelling framework and to complement this with the Fishery Simulation Graphics User Interface (Lee *et al*., 2012).
- The structure of the model developed within the Stock Synthesis framework was appropriate given the data that were available.
- The enhancement of Stock Synthesis to allow modelling of a fishery for which the only source of mortality is that associated with discarding of bycatch.
- Use of super periods when data are too imprecise to fit individual values but the median value is considered to be informative.
- The assessment of the uncertainty of parameter estimates was thorough.
- Selectivity runs explored key uncertainties and demonstrated appropriateness of conclusions regarding the current condition of the stock.
- Benchmarks were appropriately calculated.
- Projections were undertaken using two states of nature.

Weaknesses

- Subjective decision to set effective sample size to actual sample size capped at a maximum of 100 rather than to use iterative reweighting, such as proposed by Francis (2011).
- Lack of information in abundance indices, and shortness of history of length and age-at-length data.
- Lack of length and age composition data to provide information on the length and age compositions of discards and the shape of the retention curves.
- The assumption that natural mortality is age-dependent and has a form that is proportional to the values predicted by the Lorenzen (1996) has not been tested against the simpler assumption of constant natural mortality over age.
- Imprecision in the estimate of steepness of the stock-recruitment relationship.
- Lack of exploration of uncertainty associated with the time series of commercial and recreational landings.

The assessment was undertaken using Stock Synthesis 3, a fully integrated model that allowed use of all available data for Spanish mackerel in the Gulf of Mexico, including life history data, removals, discards, length compositions of catches, conditional age-at length compositions, and survey indices. Other software packages, which were used in the assessment of the Gulf of Mexico Spanish mackerel stock, were r4SS, which produces graphic displays and explores output from Stock Synthesis, and the “Fishery Simulation” Graphics User Interface (GUI) software (Lee *et al*., 2012), which adds bootstrapping analysis support to Stock Synthesis. Stock Synthesis, supported by these software packages, provides a very flexible assessment framework that produces estimates of key population parameters and their uncertainty. The software allowed exploration of the sensitivity of parameters, stock status indicators, and reference points to changes in the structure of the Spanish mackerel model and its assumptions, and to the exclusion of various survey indices when fitting. It also allowed investigation of yield per recruit, spawner per recruit, and stock-recruitment relationships for Spanish mackerel, and produced estimates of reference points to be used when determining stock status. The Stock Synthesis model was also employed to project the effect of different levels of fishing mortality on future catches and condition of the Gulf of Mexico Spanish mackerel stock. Through bootstrapping, Stock Synthesis was used to develop probability distributions for various variables of interest.

The Assessment Workshop Report advised that, apart from the FWC trip ticket vertical line index, which showed a slight increase in abundance after 2003, predicted values of the abundance indices, which exhibited considerable imprecision, were relatively constant over the periods for which abundance indices were available. As noted by the Assessment Workshop, this implies that the survey indices carry little information regarding trends in abundance. The Assessment Workshop also noted that length and conditional length-at-age data cover only a limited recent period, and thus provide limited information on recruitment to inform the model.

Concern that the estimate of steepness produced when fitting the initial model, *i.e*., 0.52, was too low, led the Assessment Panel to profile log-likelihood over a range of values of steepness (Fig. 3.31, Assessment Workshop Report), thereby to assess whether the data were sufficiently informative to allow reliable estimation of this parameter. After examining the results of this and other sensitivity runs, retrospective analyses, profiling, and bootstrap runs, the Assessment Panel concluded that a value of 0.8 for steepness "was more reasonable for this species than that estimated by the model (0.52)" (see further comment regarding this decision below), and adopted this configuration (Run 3) as the base model for the assessment. That is, Run 3 was recommended by the Assessment Panel for final projections and status determinations.

The use within Stock Synthesis of super periods when fitting discards of Spanish mackerel from the commercial line gear fishery, the recreational fishery, and the shrimp fishery, is very appropriate given the high uncertainty associated with the estimates of the annual discards for these three fisheries. By fitting estimates of discards to the average value of discards over these super periods, the model "accepts" the overall level but "ignores" inter-annual variability within the discard time series.

The assumption that was made in the assessment that age data were conditional on length is very appropriate. If it had been assumed that the length and age composition data were independent, the fact that some fish were included in both the length and age composition data would introduce bias. Such potential bias is removed by considering ages to be conditional on length.

The decision that, because of a lack of strong evidence that selectivity was dome-shaped and the fact that little improvement in fit was obtained when using such a selectivity pattern, selectivity functions for the commercial line gears and recreational fisheries would be constrained to those with an asymptotic pattern is endorsed. It was good to note that some exploration had been undertaken before coming to this conclusion, but it would have been useful if the results of that exploration had been presented in the Assessment Workshop Report. The representation of the retention curves using two time blocks, *i.e.* the period before 1993 and the period from 1993 onward, to reflect the change in size limit in 1993, is appropriate.

It would have been appropriate to explore whether the improvement in likelihood of the fitted model justified the additional complexity of considering mortality to be age dependent rather than constant. If not justified, the simpler model would be preferred. If use of an age-dependent model was justified, it would be better to estimate the values of the age-dependent mortalities directly, rather than assuming that the relationship has a form that is a scaled version of the values of mortality at age calculated using Lorenzen's (1996) equation.

The use of a maximum effective sample size of 100 fish is arbitrary, however, it is noted that Sensitivity Run 12 explored the effect of reweighting using the MacAllister and Ianelli (1997) approach. It is recommended that, in future analyses, consideration should be given to the methods described by Francis (2011), such that, for example, effective sample sizes for length compositions are calculated using iterative reweighting based on mean length, and possibly reflecting the relative magnitudes of initial sample sizes.

No length or age composition data were available to characterize the discards from the commercial or recreational catches, thus little information was available to estimate the parameters of the logistic retention curves for these fisheries.

The use of a Beverton and Holt stock-recruitment curve is endorsed, but the choice of the value of 0.7 as the value of the standard deviation in recruitment appears arbitrary. The Assessment Workshop Report advised that the profile of likelihoods over a range of values "did not indicate disparity" with the value chosen (Fig. 3.33). It might be pertinent to note, however, that both Smith and Punt (1998) and Maunder and Deriso set $\sigma^2_{\log_e R} = 0.6$. Beddington and Cooke (1983) are cited as reporting from a meta-analysis over many fish species that recruitment is typically log-normally distributed with the average of $\sigma^2_{\log_e R}$ being around 0.6. Mertz and Myers (1996) are reported to have conducted a further meta-analysis and again found that the average value of $\sigma^2_{\log_e R}$ was around 0.6. Interestingly, the likelihood profile (Fig 3.33) suggests that 0.6 might be slightly more appropriate than 0.7.

As advised in the Assessment Workshop Report, Stock Synthesis effectively treats landings as being known without error and thus fits them precisely. Imprecision associated with the early values within the time series of commercial or recreational landings is thus not assessed unless explored through sensitivity runs using alternative scenarios of landings data. It is not apparent from the Assessment Workshop Report that such sensitivity runs were made and thus the implications of the uncertainty associated with the landings data have not been assessed.

In describing Fig. 3.35, it is unclear whether the 14 of the 1000 bootstrap runs, which produced "large convergence values and illogical estimates of virgin biomass" were not simply the results of poor choices of initial values for the parameters used in Stock Synthesis, given that the jitter analysis produced four out of 100 results that failed to converge to the expected values.

The vertical scale used in the profile of change in log-likelihood over the range of values of steepness (Fig. 3.31, Assessment Workshop Report) compresses the range of values of log-likelihood change for values of steepness ranging from (say) 0.4 to 0.9, which is the region of interest. A maximum value on the y-axis of (say) 100, would have more clearly revealed the trend in log-likelihood change.

The conclusion by the Assessment Workshop that the estimate of steepness is imprecise is valid, however, although the range of values that, given the model structure and data, might be considered to fall within a 95% confidence region would probably extend from about 0.4 to about 0.8. The basis for the decision by the Assessment Panel that a value of steepness of 0.8 is "more reasonable" than the estimated value of 0.52 for the Gulf of Mexico stock of Spanish mackerel is not stated. In this context, it is possibly pertinent to note that Francis (2012) has suggested that, when the steepness of the stock-recruitment relationship is imprecise or cannot be estimated reliably, he considers it better to fix the value of steepness at a value, such as 0.75, *i.e.*, the default value recommended in Francis (1993), and which is frequently used in Australia and New Zealand, or the average of published values for the same or similar species. Francis (2012) advises that the uncertainty associated with this parameter should then be explored using sensitivity runs with lower and higher values of steepness. The value of steepness selected by the Assessment Workshop, *i.e.*, 0.8, is of similar magnitude to the value suggested by Francis (2012), *i.e.*, 0.75. Thus, the decision by the Workshop to use a model with a structure similar to that of the original base model but with a fixed value of steepness of 0.8, *i.e.*, the model of Run 3, as the new base model for the Spanish mackerel stock, and to explore the uncertainty associated with this steepness using sensitivity runs with alternative values of steepness, is consistent with best practice, and is therefore endorsed.

The use of the base model, and of a model with similar structure but with steepness fixed at 0.9, as alternative states of nature is endorsed. Given the results of the sensitivity runs, however, it might also have been useful to include a low natural mortality version of the base model as a third state of nature.

ToR 12. Recommend appropriate estimates of stock abundance, biomass, and exploitation.

Conclusions

Estimates of stock abundance, biomass, and exploitation are produced when the Stock Synthesis model is fitted. The estimates of total biomass and annual exploitation in 2011, which were estimated when the base model for the Gulf of Mexico stock of Spanish mackerel was fitted, were 28,367 mt and 0.1197, respectively.

Strengths

Stock Synthesis 3 calculates time series of abundance, total biomass, and annual exploitation.

Stock abundance:

The report file that is produced by Stock Synthesis, report.sso, contains a time series section, in which the time series of abundance, recruitment and catch for each of the areas are reported. Output quantities include summary biomass and summary numbers for each gender and growth pattern. The Assessment Workshop Report for the Gulf of Mexico Spanish Mackerel stock has not reported these abundance estimates, but they will be available in the output file for the base model, *i.e.*, Run 3.

Biomass:

Stock Synthesis produces an estimate of total annual biomass (Table 3.5, Fig. 3.41). The estimate (for the base model, *i.e.*, Run 3) of total biomass for 2011 was 28,367 mt.

Exploitation:

Stock synthesis calculates the value of annual exploitation rate as the ratio of the weight of the total catch (including discards) to the total biomass (Section 3.26, Assessment Workshop Report; Table 3.6, Fig. 3.42). The calculated value of the annual exploitation rate is used as a proxy for the annual value of fishing mortality, *F*. The estimate (for the base model, *i.e*., Run 3) of the annual exploitation rate for 2011 was 0.1197.

ToR 13. Evaluate the methods used to estimate population benchmarks and management parameters. Recommend and provide estimated values for appropriate management benchmarks and declarations of stock status for each model run presented for review.

Conclusions

Stock Synthesis calculates a range of population benchmarks and management parameters. Benchmarks calculated for Spanish mackerel were MFMT = $F_{30\%SPR}$ and MSST = (1 – *M*) $SSB_{30\%SPR}$. The estimates of $F_{current}$ and $SSB_{current}$, which were calculated for 2011 using the base model, were 0.14 and 19,645 mt, respectively. The ratios $F_{current}/MFMT$ and $SSB_{current}/MSST$, which were calculated using the base model, were 0.38 and 3.06, respectively. These results, which were consistent with those produced by all but one (the model with natural mortality set to 0.27 y^{-1}) of the models used in the various sensitivity runs, imply that, in 2011, the Gulf of Mexico stock of Spanish mackerel was not experiencing overfishing and was not overfished.

Strengths

Stock Synthesis possesses well-tested procedures to calculate and output a range of population benchmarks and management parameters.

Weaknesses

Inconsistencies in the values recorded in one of the columns in Table 3.8 made it difficult to assess, with full confidence, whether or not the stock was experiencing overfishing.

Summary

The methods used by Stock Synthesis to estimate population benchmarks and management parameters are sound. Stock Synthesis is able to produce estimates for indicator variables and reference points based on maximum sustainable yield (MSY), spawning potential ratio (SPR), and spawning stock biomass (SSB), and taking the stock-recruitment relationship into account. SPR is calculated as the equilibrium spawning biomass per recruit that would result from a given year's pattern and the levels of F's and selectivities for that year. For MSY-based reference points, Stock Synthesis searches for a fishing mortality that would maximise the equilibrium yield. For SPR-based reference points, the computer program searches for an F that would produce the specified level of SPR. For spawning biomass-based reference points, the software searches for an F that would produce the specified level of spawning biomass relative to the unfished value.

The management benchmarks, *i.e.*, the Maximum Fishing Mortality Threshold (MFMT) and Minimum Stock Size Threshold (MSST), which were proposed for the fishery by the Assessment Workshop, are appropriate for use in determining the status of the Gulf of Mexico stock of Spanish mackerel. These two benchmarks were

$$\mathrm{MFMT} = F_{\mathrm{MSY}} \quad \text{and} \quad \mathrm{MSST} = (1 - M)\ \mathrm{SSB}_{\mathrm{MSY}},$$

where F_{MSY} is the fishing mortality that produces the maximum sustainable yield MSY, M is the point estimate of natural mortality for fully recruited ages calculated using Hoenig's (1983) equation, *i.e.* 0.38 y^{-1}, and $\mathrm{SSB}_{\mathrm{MSY}}$ is the equilibrium spawning stock biomass that produces MSY. The Assessment Workshop Report advises that proxies were used when calculating the above benchmarks, where these proxies were based on a spawning potential ratio (SPR) of 30%. Thus, the proxy that was used for F_{MSY} was the fishing mortality, $F_{30\%\mathrm{SPR}}$, which produces a spawning stock biomass per recruit that is 30% of the spawning stock biomass per recruit produced when the stock is not fished, *i.e.* an SPR of 30%. The proxy that was used for $\mathrm{SSB}_{\mathrm{MSY}}$ was the corresponding value of equilibrium spawning stock biomass, *i.e.* the spawning stock biomass $\mathrm{SSB}_{30\%\mathrm{SPR}}$ that is produced with a fishing mortality of $F_{30\%\mathrm{SPR}}$.

It is surprising to note that, although Stock Synthesis was able to estimate MSY-based rather than SPR-based reference points, the Assessment Panel chose to use the proxies $F_{30\%\mathrm{SPR}}$ and $\mathrm{SSB}_{30\%\mathrm{SPR}}$ rather than F_{MSY} and $\mathrm{SSB}_{\mathrm{MSY}}$. The latter two benchmarks are possibly more appropriate.

For the Gulf of Mexico stock of Spanish mackerel, the benchmarks that were used in determining stock status by the Assessment Workshop were

$$\mathrm{MFMT} = F_{30\%\mathrm{SPR}} \quad \text{and} \quad \mathrm{MSST} = (1 - M)\ \mathrm{SSB}_{30\%\mathrm{SPR}},$$

where it was concluded that overfishing was occurring if $F_{\mathrm{current}} > \mathrm{MFMT}$, *i.e.*, $F_{\mathrm{current}}/\mathrm{MFMT} > 1$, and the stock was considered to be overfished if $\mathrm{SSB}_{\mathrm{current}} < \mathrm{MSST}$, *i.e.*, $\mathrm{SSB}_{\mathrm{current}}/\mathrm{MSST} < 1$. F_{current} was calculated as the geometric mean of the estimates of the three most recent annual fishing mortalities, *i.e.*, the fishing mortalities for 2009-2011, where annual fishing mortality was estimated by its proxy, exploitation rate, calculated as the ratio of the total catch (including discards) to estimated total biomass. $\mathrm{SSB}_{\mathrm{current}}$ was the estimate of spawning stock biomass for 2011.

Note that the specification of the reference points in Section 3.1.9 of the Assessment Workshop Report could be improved, *e.g.* overfished is currently defined as the value of the ratio of $\mathrm{SSB}_{\mathrm{current}}$ to MSST rather than a logical expression.

Table 3.8 of the Assessment Workshop Report, which is reproduced below, contains the values of the current (2011) fishing mortality and spawning stock biomass of the Gulf of Mexico stock of Spanish mackerel, and purports to contain the values of the MFMT and MSST benchmarks, and the results of stock determination for each of the models that were explored in the assessment. According to the caption for this table in the Assessment Workshop Report, F_{ref} represents $F_{30\%\text{SPR}}$, and thus, as MFMT has been set to $F_{30\%\text{SPR}}$, the values of MFMT should be equal to those of F_{ref}. As is evident in Table 3.8, this is clearly not the case. There are inconsistencies between the values of F_{ref} and MFMT for all but three of the 17 runs presented in the Table, Quite frequently, however, the values of F_{ref} and the ratio of F_{current} to MFMT in the rows of this Table are equal. The caption to Figure 3.9 advises that, for this figure, the value of F_{ref} represents the ratio of F_{current} to MFMT, and it appears likely that this inconsistency between definitions of F_{ref} has led to the inconsistent values presented in Table 3.8. The fact that there is such inconsistency makes it difficult to accept the accuracy of the estimates of the ratio of F_{current} to MFMT for any of the runs. Accordingly, while it is not possible from the reported data to assess with complete confidence whether or not the stock is experiencing overfishing, if the values in the column headed "F/MFMT" are correct, then $F_{\text{current}}/\text{MFMT} = 0.38$. From this, and noting the values for this ratio for other selectivity runs, it is very likely that the Gulf of Mexico stock of Spanish mackerel is not currently being subjected to overfishing.

Quoted from Assessment Workshop Report: "Table 3.8. Reference points and benchmarks from sensitivity runs for Gulf of Mexico Spanish mackerel from SS. Benchmarks are reported for SPR 30%. Current refers to geometric mean of 2009-2011 values. MSST is (1-M)*SSBref with M = 0.38, or M=0.27, or M=0.49 representing the M value from the Hoenig maximum age mortality estimator for fully recruited ages from the SEDAR DW corresponding to the Base Model M or the M_LO or M-HI scenario. Ref refers to reference metric, either F30% SPR or SSB 30% SPR. Fratio is Fcurrent / Fref. SSBratio is SSBcurrent / MSST. Spawning biomass units are weight in mtons, and yield units are mtons whole weight".

Name	Fcurrent	SSBcurrent	Yref	Fref	SSBref	MFMT	MSST	F/MFMT	SSB/MSST
Run 1 Configuration	0.19	11,195	3,563	0.37	6,626	0.37	4,108	0.51	2.73
Run 1 Configuration, Steepness=0.9	0.14	18998	3090	0.39	10701	0.35	6634	0.39	2.86
Run 1 Configuration, Steepness=0.8	0.14	19,645	3,053	0.39	10,339	0.36	6,410	0.38	3.06
Run 1 Configuration, Steepness=0.7	0.14	18,235	3,056	0.41	10,264	0.35	6,363	0.41	2.87
Run 3 Configuration, M HI	0.1	23,551	3,682	0.2	8,746	0.5	4,461	0.2	5.28
Run 3 Configuration, M LO	0.2	13,150	4,040	0.83	18,283	0.24	13,347	0.83	**0.99**
Run 3 Configuration, M REF Age 3	0.15	18,140	3,138	0.47	11,862	0.32	7,354	0.47	2.47
Run 3 Configuration, Discard Mortality	0.14	18,995	3,029	0.41	10,730	0.35	6,653	0.41	2.86
Run 3 Configuration, NO MRFSS	0.14	19,886	3,054	0.39	10,637	0.35	6,595	0.39	3.02
Run 3 Configuration, NO FWC	0.12	25,700	2,821	0.34	11,132	0.34	6,902	0.34	3.72
Run 3 Configuration, NO SEAMAP Survey	0.13	20,364	3,053	0.38	10,715	0.35	6,643	0.38	3.07
Run 1 Configuration, SS Reweighting	0.19	11,050	3,743	0.37	7,011	0.37	4,347	0.5	2.54
Run 3 Configuration, RETROSPECITVE_2010	0.15	18,383	3,163	0.43	10,882	0.35	6,747	0.43	2.72
Run 3 Configuration, RETROSPECTIVE_2009	0.16	17,503	2,991	0.46	11,022	0.34	6,834	0.46	2.56
Run 3 Configuration, RETROSPECTIVE_2008	0.15	18,121	2,968	0.44	11,182	0.35	6,933	0.44	2.61
Run 3 Configuration, RETROSPECTIVE_2007	0.15	16,832	3,072	0.46	11,362	0.33	7,044	0.46	2.39
Run 3 Configuration, RETROSPECTIVE_2006	0.16	19,528	3,040	0.48	10,986	0.34	6,811	0.48	2.87

The point estimates of the ratio of $\text{SSB}_{\text{current}}/\text{MSST}$ exceed 1 in all but one case of Table 3.8 of the Assessment Workshop Report, *i.e.*, that for the run in which *M* was set at the lower value, MLO = 0.27 y^{-1}, when this ratio became 0.99, *i.e.*, the SSB was only just below MSST. Apart from this run, the results of the model runs that were undertaken indicate that that it is highly likely that the stock of Spanish mackerel is currently not overfished.

The value of F_{current} for the model with steepness set to 0.8 is reported as 0.14 in Table 3.8 and 0.13 in Table 3.9 of the Assessment Workshop Report. The ratio of F_{current} to MFMT is reported in Tables 3.8 and 3.9 as 0.38 and, 0.50, respectively for this model, and, for the model with steepness of 0.9, as 0.39 and 0.52, respectively. The values of $\text{SSB}_{\text{current}}$ reported in Table 3.8 for the models with steepness values of 0.8 and 0.9 are transposed in Table 3.9. The values of the ratio of $\text{SSB}_{\text{current}}/\text{MSST}$ in Table 3.9 do not match the values reported in Table 3.8 for either model. These inconsistencies should be resolved.

ToR 14. Evaluate the quality and applicability of the methods used to project future population status. Recommend appropriate estimates of future stock condition.

Conclusions

Stock Synthesis provides a well-tested procedure to project the model through a range of future years, using a fishing rate based on MSY, SPR, a specified target biomass, or a multiple of the recent average fishing rate and producing estimates of yield and key management parameters, thereby allowing assessment of future stock condition. The methods used, which are recognised as being of high quality, are designed to produce the estimates of future population status that are needed by managers. If the current fishing rate is maintained over the next 10 years, the projections produced for the base model for the Gulf of Mexico Spanish mackerel stock suggest that there will be little change in spawning stock biomass. If, however, fishing mortality is increased to the level that is estimated as required to produce OY, or further increased to that which would produce a spawning potential ratio of 30%, the spawning stock biomass would be expected to be reduced by approximately 20%. The condition of the stock would be expected to continue to be classified as “not overfished, with overfishing not occurring”.

Strengths

Projections are undertaken using the well-tested procedures provided within Stock Synthesis.

Summary

Stock Synthesis includes a well-tested procedure to project the future stock status that would result when using a fishing rate based on MSY, SPR, a specified target biomass, or a multiple of the recent average fishing rate. Use of this procedure ensures consistency of model predictions with assumptions and parameter estimates used in fitting the model and the age structure predicted as the current state of the stock from which the projection commences. It is thus highly applicable for use with the Gulf of Mexico stock of Spanish mackerel.

For the Gulf of Mexico stock of Spanish mackerel, deterministic projections were run by the Assessment Panel for the models with steepness of 0.8 and 0.9 and using fishing rates set to MFMT (*i.e.*, the proxy $F_{30\%\text{SPR}}$ for F_{MSY}), F_{OY} (*i.e.*, 75% of $F_{30\%\text{SPR}}$), and F_{current}. Using the bootstrapping facility provided by the Fishery Simulation GUI software, stochastic projections were also run for the two models with the fishing rate set to MFMT (the Assessment Workshop report only presents the results for the model with steepness set to 0.8).

The final year of the time series of data used in the assessment for the Gulf of Mexico stock of Spanish mackerel was 2011. In order to carry out projections for 20 years from 2013 (only results from 2013 to 2022 being reported), the 2012 landings "were characterized as the landings [of the different fisheries] from the most recent three years (2009-2011)" (Assessment Workshop Report). Stock Synthesis was used to estimate the fishing mortality for 2012 required to achieve these landings, and used the 2012 estimate of SSB to calculate an estimate of age 0 recruitment from the fitted stock-recruitment relationship.

If the current fishing rate is maintained over the next 10 years, the projections produced for the models with steepness set to 0.8 and 0.9 suggest that there will be little change in spawning stock biomass. If, however, fishing mortality is increased to the level that is estimated as required to produce OY, or further increased to that which would produce a spawning potential ratio of 30%, the spawning stock biomass would be expected to be reduced by approximately 20 or 30%, respectively.

ToR 15. Evaluate the quality and applicability of methods used to characterize uncertainty in estimated parameters.

- **Provide measures of uncertainty for estimated parameters**
- **Ensure that the implications of uncertainty in technical conclusions are clearly stated**
- **If there are significant changes to the base model, or to the choice of alternate states of nature, then provide a probability distribution function for the base model, or a combination of models that represent alternate states of nature, presented for review.**
- **Determine the yield associated with a probability of exceeding OFL at P* values of 30% to 50% in single percentage increments**
- **Provide justification for the weightings used in producing the combinations of models**

Conclusions

The methods within Stock Synthesis that may be used to explore uncertainty include calculation of estimates of asymptotic standard errors, calculation of likelihood profiles, MCMC analyses, and bootstrapping. These tools are complemented by auxiliary software that allows production of diagnostic plots, which also assist in communicating the uncertainty of estimates. The software encourages exploration of alternative model structures and sensitivity to alternative values of parameters of functional forms. The model that was developed for the Gulf of Mexico stock of Spanish mackerel employed an appropriate set of these methods. As a result of the exploration of the uncertainty of the estimate of steepness, the base model was modified by fixing steepness to 0.8. Probability distributions were produced for a set of key parameters using both the original and new base models. As the iterative approach required to calculate P^* cannot be implemented in Stock Synthesis, Stock Synthesis "calculates the expected time series of probabilities that the *F* resulting from a specified harvest policy would exceed a specified level" (Methot and Wetzel, 2012).

Strengths

- Stock Synthesis provides an extensive suite of methods that may be used to explore uncertainty.
- Bootstrapping was used to produce probability distributions

Summary

Stock Synthesis provides a number of methods that may be used to characterize the uncertainty associated with the estimates of parameters, benchmark estimates, and predicted values of parameters. These are supplemented by the bootstrapping tools provided by the Fishery Simulation GUI. Together, the software is well suited for use in exploring the uncertainty associated with the models that were fitted to the Gulf Of Mexico Spanish mackerel stock. Thus, for each run of the Stock Synthesis model for the Gulf of Mexico Spanish mackerel, asymptotic standard errors were calculated for each of the parameters that were estimated (see Table 3.1, Assessment Workshop Report, for parameter estimates and estimates of asymptotic standard errors for the base model, with $M = 0.38\ y^{-1}$ and steepness = 0.8). These estimates of asymptotic standard errors may be considered to represent minimum values for the uncertainty of the estimated parameters. The uncertainty of selected parameter estimates for the Gulf of Mexico Spanish mackerel stock was also characterized using the results from bootstrapping.

The initial run (Run 1) was carried out using the model structure that had been proposed for the Gulf of Mexico stock of Spanish mackerel and estimating the steepness parameter of the Beverton and Holt stock-recruitment relationship. This demonstrated that, given the data that were available, the steepness of the stock recruitment relationship was estimated very imprecisely. A number of sensitivity runs of Stock Synthesis were then run to explore the effect of varying the configuration or methods employed in the analysis.

As is typical in stock assessment, exploratory runs for the Gulf of Mexico Spanish mackerel stock were first employed to determine a base model for the assessment, *i.e.*, a model that is considered the most likely of the alternative model configurations that have been proposed. The decision was made at the Assessment Workshop to reject Run 1 and use Run 3 as the base model. As noted above, a justification for this decision, *i.e.*, to use the initial model structure, *i.e.*, that for Run 1, and to fix the value of steepness at 0.8, was not reported in the Assessment Workshop Report other than to state that the Assessment Workshop found the low estimate of steepness produced when fitting the model in Run 1 to be unacceptable. Probability distributions of the key parameters estimated for the initial model, Run 1, and the new base model, Run 3, were produced and plotted (Figs 3.34 and 3.35 of the Assessment Workshop Report).

The level to which the initial spawning stock biomass had been depleted by 2011 was far less for Run 1, *i.e.*, 0.16 SSB_{B0} than for Run 3, *i.e.*, 0.51 SSB_{B0} (Table 3.7, Assessment Workshop Report). A similar level of depletion, *i.e.*, 0.18 SSB_{B0} as that of Run 1 was estimated to have resulted when the value of natural mortality used in the Run 3 configuration was lowered to $0.27\ y^{-1}$. When Run 1 was re-fitted, estimating steepness (with a resulting value of 0.53) and iteratively adjusting the weights of the survey indices and the length and age compositions to match the estimated variances of the input data with those of the fitted model, the level of depletion was again low, *i.e*., 0.16 SSB_{B0}. The level of depletion of spawning stock biomass appears sensitive to reduced values of steepness and/or natural mortality. Given the estimated level of depletion of spawning stock biomass for these runs, it is interesting to note that SPR had been reduced in these three model configurations to only 0.51, 0.41, and 0.53, respectively (Table 3.7, Assessment Workshop Report). Again, these results suggest that, when MSY-based reference points are available, these should be used in preference to SPR-based proxies.

While the Assessment Workshop Report provided a comparison of the key parameters, benchmarks, and projections for the base model that was adopted at the workshop, *i.e*., Run 3, with steepness of 0.8, and an alternative model, which had an identical configuration but used a steepness of 0.9, the relative probabilities of the two models was not assessed. The base model was subjected to a bootstrapping analysis, however, and distributions of the resulting estimates of the benchmark estimates are provided in Figures 3.48 and 3.49 of the Assessment Workshop Report, while distributions of projected yields for 2013-2022 are plotted in Fig. 3.53.

The caption of Table 3.9 advises that the table provides results of the required SFA and MSRA evaluations using a SPR 30% reference point for "4 states of nature of steepness at 3 levels of natural mortality". The table, however, only presents results for models representing two values of steepness for one value of natural mortality.

While the iterative approach required to calculate *P** cannot be implemented in Stock Synthesis, a complementary approach has been developed to produce estimates of the probability that *F*, the fishing rate based on MSY, SPR, a specified target biomass, or a multiple of the recent average fishing rate that is employed in the projection, exceeds the OFL (Methot and Wetzel, 2012). These authors advise that, whereas the *P** approach calculates the future stream of annual catches that would have a specified annual probability of $F >$ OFL, Stock Synthesis "calculates the expected time series of probabilities that the *F* resulting from a specified harvest policy would exceed a specified level".

ToR 16. If available, ensure that stock assessment results are accurately presented in the Stock Assessment Report and that stated results are consistent with Review Panel recommendations.

The Review was undertaken as a desktop review, rather than in a Workshop setting. Accordingly, it was not possible for the recommendations made in review reports to be acted upon, nor to ensure that the results were incorporated accurately in the resultant Stock Assessment Report.

ToR 17. Evaluate the quality and applicability of the SEDAR Process as applied to the reviewed assessment and identify the degree to which Terms of Reference were addressed during the assessment process.

The SEDAR Process has ensured that all aspects of the assessment process for the Gulf of Mexico stock of Spanish mackerel, from collation of data through to model development, exploration, and production of management advice, have been documented in detail, including the underlying reasons for the decisions that were made concerning data to be used and model structure to be employed. The structure imposed on the Data and Assessment Workshops by their Terms of Reference has assisted by providing a logical framework for the process, and thereby ensuring that key aspects of the assessment were not overlooked. For the reviewer, the documentation of the Spanish mackerel assessment, which was produced through the SEDAR process, proved invaluable in gaining an understanding of the details of the assessment and assisted in identifying opportunities for improvement and in detecting errors or inadequacies.

The Terms of Reference for the Assessment Process, which are presented below, are now examined and comment is made on the degree to which these were addressed.

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

   Accomplished.

2. Recommend a model configuration which is deemed most reliable for providing management advice using available compatible data. Document all input data, assumptions, and equations.

   Accomplished.

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

   No environmental covariates were identified by either the Data or Assessment Workshops.

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

   Accomplished.

5. Characterize uncertainty in the assessment and estimated values.
   - Considering components such as input data, modeling approach, and model configuration
   - Provide appropriate measures of model performance, reliability, and ‘goodness of fit’

   Accomplished.

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

   Accomplished.

7. Provide estimates of stock status relative to management criteria consistent with applicable FMPs, proposed FMPs and Amendments, other ongoing or proposed management programs, and National Standards for each model run presented for review.

   Accomplished.

8. Project future stock conditions and develop rebuilding schedules if warranted, including estimated generation time. Develop stock yield projections in both biomass and numbers of fish in accordance with the following:
   A) If stock is overfished:
      F=0, FCurrent, FMSY, FOY
      F=FRebuild (max that permits rebuild in allowed time)
   B) If stock is undergoing overfishing:
      F= FCurrent, FMSY, FOY
   C) If stock is neither overfished nor undergoing overfishing:
      F= FCurrent, FMSY, FOY
   D) If data limitations preclude classic projections (i.e. A, B, C above), explore alternate models to provide management advice

   Accomplished.

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

   The Assessment Workshop Report noted that ten sensitivity runs had been considered, one of which had been subjected to stochastic projection. The Assessment Workshop Report advised that "probability distribution functions will be developed for the subset of model recommended by the SEDAR AP for projections … and made available to the Scientific and Statistical Committee (SSC) for the development of management advice, including OFL and ABC". No information relating to these probability distribution functions was presented in the Report.

10. Provide recommendations for future research and data collection. Be as specific as possible in describing sampling design and intensity, and emphasize items which will improve assessment capabilities and reliability. Recommend the interval and type for the next assessment.

Attention was directed to the research recommendations that were made in the Data Workshop Report. The Workshop Assessment Report identified gaps in data, which, if addressed, would improve the assessment capabilities and reliability. Specific sampling design and intensity were not discussed. No recommendations relating to the interval and type for the next Assessment were made by the Assessment Workshop

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

    A spreadsheet was not provided in the documentation that was circulated to the Review Panel. The Assessment Workshop addressed this Term of Reference in its Report by providing a table listing the estimates for all parameters used in the model and presenting a listing of each of the input files required to run the Stock Synthesis model for Gulf of Mexico Spanish mackerel.

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

    Accomplished.

ToR 18. Make any additional recommendations or prioritizations warranted.

- **Clearly denote research and monitoring needs that could improve the reliability of future assessments**

A number of research needs, which are listed below in priority order, were identified in the course of the desk review. As expected, these were highly consistent with, and thus overlap, a number of the research needs that had been identified by the Data and Assessment workshops.

1. Review or establish programs to collect data on the length composition and age-at-length compositions of landings and discards from each commercial gear and from each recreational fishing mode, and of bycatch of Spanish mackerel from the shrimp fishery. Ensure that the statistical design and spatial coverage of survey or sampling programs are appropriate and that survey or sampling intensity is sufficient to produce estimates of the required precision for the Gulf of Mexico stock of Spanish mackerel. Set goals for performance and establish and monitor performance criteria to assess the quality and completeness of data collection programs. This research need is of the highest priority as it will provide information required by Stock Synthesis to determine the selectivity and retention curves for Spanish mackerel for the commercial, recreational, and shrimp fisheries, the lack of which is a key source of uncertainty in the model.
2. Undertake research to determine reliable relationships between the proportion of females that are mature and both length and age for the Gulf of Mexico stock of Spanish mackerel. This is also of high priority, as the maturity information that is currently used is imprecise. The calculation of spawning stock biomass, a crucial

parameter in the calculation of benchmarks and assessment of stock status, should be based on reliable data.

3. Review programs that are used to collect discard data for Spanish mackerel (and data on the bycatch of Spanish mackerel by the shrimp fishery), and refine these programs to ensure that accurate and complete data estimates of the discards (and bycatch) are collected. Ensure that the statistical design and spatial coverage of survey or sampling programs are appropriate and that survey or sampling intensity is sufficient to produce estimates of the required precision. Set goals for performance and establish and monitor performance criteria to assess the quality and completeness of data collection programs. While this research will not produce immediate improvement in the quality of the assessment, it is important that action is taken as soon as possible to improve the accuracy and precision of the data relating to the quantities of fish that are discarded from each of the fisheries, such that, in the future, the time series of discards become more reliable.
4. A comprehensive study of the stock structure of Spanish mackerel should be undertaken, with the following objectives:
    a. to determine stock structure and the areas occupied by each stock;

    and, assuming that the current view that there are two stocks, *i.e.*, a Gulf of Mexico and a South Atlantic stock, is substantiated,

    b. to determine more reliably the boundary between the Gulf of Mexico and South Atlantic stocks or the extent of overlap;
    c. to extend sampling into Mexican waters and thereby determine the southern boundary of the Gulf of Mexico stock;
    d. to ascertain whether, regardless of the time of year, catches of fish may be assigned reliably to either the Gulf of Mexico or South Atlantic stock on the basis of the area in which they are caught.

    As this study will take some time before completion, it has been assigned a lower priority than the previous items. Determination of the southern stock boundary, however, is important to ensure that other removals from the stock are not occurring in Mexican waters, as such removals are not taken into account in the current assessment.
5. Undertake research to determine the discard mortality of Gulf of Mexico Spanish mackerel that are discarded from the catches of each commercial fishing gear or each recreational fishing mode, recognising that such mortality is likely to differ among different categories into which the discarded fish are classified, *e.g.*, “alive”, “mostly alive”, and “mostly dead”.
6. In future stock assessments for the Gulf of Mexico stock of Spanish mackerel, explore whether the use of an age-dependent rather than constant M results in a significant improvement in fit, considering the Lorenzen and alternative functional forms of the relationship with age and the alternative of estimating the value of the age-dependent M at each age (or range of ages).
7. In future stock assessments, explore the sensitivity of the model to the uncertainty of the landings data.
8. As a low research priority, assess whether, in future refinement of the Stock Synthesis model, sexually dimorphic growth should be introduced. Note that the benefit of this might only be realised if appropriate sex composition data for landings and discards are

available for input, and length and age-at-length compositions are sexually disaggregated.

5. Conclusions and recommendations

After considering the information relating to stock structure, the data that were available for the Gulf of Mexico stocks of cobia and Spanish mackerel, and the details of the assessment for each species, the base model that had been proposed by the Assessment Workshop for each assessment was accepted for use in assessing stock status and in projecting the potential yield and likely stock status over the next six years. The results of the accepted base models, which had been developed using the Stock Synthesis 3 framework, suggested that both stocks were currently (in 2011) not overfished and that overfishing was not currently occurring. While the results of the assessment were imprecise, reflecting the quality and nature of the input data, the results of sensitivity runs for each model suggested that the conclusions drawn regarding stock status were likely to be robust to the uncertainty of the base model results.

Although some of the components of the data for the Gulf of Mexico stocks of cobia and Spanish mackerel were limited and/or uncertain, the datasets that had been collated by the Data Workshops represented the best data currently available for those stocks and appeared adequate for use in assessing, albeit imprecisely, the condition of the two stocks. The models that were developed within Stock Synthesis using these datasets were of appropriate structure and were of a standard that would be considered "best practice" given the types and quality of the data that were available. The explorations of uncertainty and decisions made in the assessments were appropriate. The advice regarding the condition of each stock, *i.e.*, that it is not overfished and overfishing is not occurring, appears sound.

Improvement of the assessments will require the collection of adequate and appropriate data sufficient to characterize the length and age-at-length compositions of catches and discards from both the commercial and recreational fisheries and of bycatches of cobia and Spanish mackerel by the shrimp fishery. These data are essential if selectivity and retention curves are to be accurately determined within the assessment models. Reliable data on maturity are also essential if reliable estimates of spawning stock biomass are to be calculated by the models. Further improvement of the models will require the collection of discard and bycatch data of higher quality from the commercial and recreational fisheries and from the shrimp fishery, and determination of the southern boundaries of both the Gulf of Mexico stocks of cobia and Spanish mackerel.

6. References

Beddington, J. R., and Cooke, J. G. 1983. The potential yield of fish stocks. *FAO Fish. Tech. Pap.*, 242: 1–47.

Diaz, G. A., Porch, C. E., and Ortiz, M. 2004. Growth models for red snapper in US Gulf of Mexico Waters estimated from landings with minimum size limit restrictions. NMFS/SFD Contribution SFD-2004-038. SEDAR7-AW1.

Francis, R. I. C. C. (1993). Monte Carlo evaluation of risks for biological reference points used in New Zealand fishery assessments. *Canadian Special Publication of Fisheries and Aquatic Sciences* **120**: 221-230.

Francis, R. I. C. C. 2011. Data weighting in statistical fisheries stock assessment models. *Canadian Journal of Fisheries and Aquatic Sciences*, **68**: 1124-1138.

Francis, R. I. C. C. 2012. Report on the 2012 assessments of yellowtail flounder and herring at Woods Hole. National Institute of Water & Atmospheric Research Ltd., Wellington, New Zealand.

Froese, R. and Binohlan, C. 2000. Empirical relationships to estimate asymptotic length, length at first maturity and length at maximum yield per recruit in fishes, with a simple method to evaluate length frequency data. *Journal of Fish Biology* **56**:758-773.

Froese, R., and Pauly, D. (Editors). 2012. FishBase. World Wide Web electronic publication. www.fishbase.org, version (12/2012).

Hoenig, J. M. 1983. Empirical use of longevity data to estimate mortality rates. *Fishery Bulletin*, **82**: 898-903.

Lee, H-H., Maunder, M. N., Piner, K. R., and Methot, R. D. (2012). Can steepness of the stock–recruitment relationship be estimated in fishery stock assessment models? *Fisheries Research*, **125–126**: 254– 261.

Lee, Hua-hui, Cheng-Yu Yang, R., and Taylor, I. 2012. User manual for Fishery Simulation Tool. Joint Institute for Marine and Atmospheric Research, University of Hawaii, Pacific Islands Fisheries Science Center, NOAA Fisheries Honolulu, HI USA, 7pp.

Lorenzen, K. 1996. The relationship between body weight and natural mortality in juvenile and adult fish: a comparison of natural ecosystems and aquaculture. *Journal of Fish Biology*, **49**: 627-642.

MacCall, A. 2011. What is the precision of *M*? Abstract *In*: Brodziak, J., J. Ianelli, K. Lorenzen, and R.D. Methot Jr. (eds). 2011. Estimating natural mortality in stock assessment applications. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-F/SPO-119, 38 p.

Maunder, M. N. and Deriso, R. B. 2003. Estimation of recruitment in catch-at-age models. *Can. J. Fish. Aquat. Sci.*, **60**: 1204-1216.

Mertz, G., and Myers, R. A. 1996. Influence of fecundity on recruitment variability of marine fish. *Can. J. Fish. Aquat. Sci.*, **53**: 1618 - 1625.

Methot, R.D. 2011. User manual for Stock Synthesis: model version 3.23b. Nov 7, 2011. NOAA Fisheries Service, Seattle, WA.

Methot Jr., R. D., and Wetzel, C. R., 2012. Stock Synthesis: A biological and statistical framework for fish stock assessment and fishery management. *Fish. Res.* (in press).

Smith, A. D. M., and Punt, A. E. 1998. Stock assessment of gemfish (*Rexea solandri*) in eastern Australia using maximum likelihood and Bayesian methods. *In* Fisheries stock assessment models. Edited by T. J. Quinn II, F. Funk, J. Heifetz, J. N. Ianelli, J. E. Powers, J. F. Schweigert, P. J. Sullivan, and C-I. Zhang. Alaska Sea Grant College Program, AK-SG-98-01. pp. 245–286.

Appendix 1: Bibliography of all material provided

SEDAR 28 - Gulf and South Atlantic -- Spanish Mackerel and Cobia
Workshop Document List

Document #	Title	Authors
	Data and Assessment Workshop Reports considered in CIE Desktop Review	
	SEDAR 28 – Gulf of Mexico Cobia – Data Workshop Report – May 2012	
	SEDAR 28 – Gulf of Mexico Spanish Mackerel – Data Workshop Report – May 2012	
	SEDAR 28 – Gulf of Mexico Cobia – Assessment Process Report – December 2012	
	SEDAR 28 – Gulf of Mexico Spanish – Mackerel Assessment Workshop Report – December 2012	
	Documents Prepared for the Data Workshop	
SEDAR28-DW01	Cobia preliminary data analyses – US Atlantic and GOM genetic population structure	Darden 2012
SEDAR28-DW02	South Carolina experimental stocking of cobia *Rachycentron canadum*	Denson 2012
SEDAR28-DW03	Spanish Mackerel and Cobia Abundance Indices from SEAMAP Groundfish Surveys in the Northern Gulf of Mexico	Pollack and Ingram, 2012
SEDAR28-DW04	Calculated discards of Spanish mackerel and cobia from commercial fishing vessels in the Gulf of Mexico and US South Atlantic	K. McCarthy
SEDAR28-DW05	Evaluation of cobia movement and distribution using tagging data from the Gulf of Mexico and South Atlantic coast of the United States	M. Perkinson and M. Denson 2012
SEDAR28-DW06	Methods for Estimating Shrimp Bycatch of Gulf of Mexico Spanish Mackerel and Cobia	B. Linton 2012
SEDAR28-DW07	Size Frequency Distribution of Spanish Mackerel from Dockside Sampling of Recreational and Commercial Landings in the Gulf of Mexico 1981-2011	N.Cummings, J. Isely
SEDAR28-DW08	Size Frequency Distribution of Cobia from Dockside Sampling of Recreational and Commercial Landings in the Gulf of Mexico 1986-2011	J. Isely and N. Cummings
SEDAR28-DW09	Texas Parks and Wildlife Catch Per unit of Effort Abundance Information for Spanish mackerel	N. Cummings, J. Isely

Document #	Title	Authors
SEDAR28-DW10	Texas Parks and Wildlife Catch Per unit of Effort Abundance Information for cobia	J. Isely, N. Cummings
SEDAR28-DW11	Size Frequency Distribution of Cobia and Spanish Mackerel from the Galveston, Texas, Reef Fish Observer Program 2006-2011	J Isely and N Cummings
SEDAR28-DW12	Estimated conversion factors for calibrating MRFSS charterboat landings and effort estimates for the South Atlantic and Gulf of Mexico in 1981-1985 with For Hire Survey estimates with application to Spanish mackerel and cobia landings	V. Matter, N Cummings, J Isely, K Brennen, and K Fitzpatrick
SEDAR28-DW13	Constituent based tagging of cobia in the Atlantic and Gulf of Mexico waters	E. Orbesen
SEDAR28-DW14	Recreational Survey Data for Spanish Mackerel and Cobia in the Atlantic and the Gulf of Mexico from the MRFSS and TPWD Surveys	V. Matter
SEDAR28-DW15	Commercial Vertical Line and Gillnet Vessel Standardized Catch Rates of Spanish Mackerel in the US Gulf of Mexico, 1998-2010	N. Baertlein, K. McCarthy
SEDAR28-DW16	Commercial Vertical Line Vessel Standardized Catch Rates of Cobia in the US Gulf of Mexico, 1993-2010	K. McCarthy
SEDAR28-DW17	Standardized Catch Rates of Spanish Mackerel from Commercial Handline, Trolling and Gillnet Fishing Vessels in the US South Atlantic, 1998-2010	K. McCarthy
SEDAR28-DW18	Standardized catch rates of cobia from commercial handline and trolling fishing vessels in the US South Atlantic, 1993-2010	K. McCarthy
SEDAR28-DW19	MRFSS Index for Atlantic Spanish mackerel and cobia	Drew et al.
SEDAR28-DW20	Preliminary standardized catch rates of Southeast US Atlantic cobia (*Rachycentron canadum*) from headboat data	NMFS Beaufort
SEDAR28-DW21	Spanish mackerel preliminary data summary: SEAMAP-SA Coastal Survey	Boylan and Webster
SEDAR28-DW22	Recreational indices for cobia and Spanish mackerel in the Gulf of Mexico	Bryan and Saul
SEDAR28-DW23	A review of Gulf of Mexico and Atlantic Spanish mackerel (*Scomberomorus maculatus*) age data, 1987-2011, from the Panama City Laboratory, Southeast Fisheries Science Center, NOAA Fisheries Service	Palmer, DeVries, and Fioramonti

Document #	Title	Authors
SEDAR28-DW24	SCDNR Charterboat Logbook Program Data, 1993 - 2010	Errigo, Hiltz, and Byrd
SEDAR28-DW25	South Carolina Department of Natural Resources State Finfish Survey (SFS)	Hiltz and Byrd
SEDAR28-DW26	Cobia bycatch on the VIMS elasmobranch longline survey:1989-2011	Parsons et al.
	Documents Prepared for the Assessment Workshop	
SEDAR28-AW01	Florida Trip Tickets	S. Brown
SEDAR28-AW02	SEDAR 28 Spanish mackerel bycatch estimates from US Atlantic coast shrimp trawls	NMFS Beaufort
	Documents Prepared for the Review Workshop	
SEDAR28-RW01	The Beaufort Assessment Model (BAM) with application to cobia: mathematical description, implementation details, and computer code	Craig
SEDAR28-RW02	Development and diagnostics of the Beaufort assessment model applied to Cobia	Craig
SEDAR28-RW03	The Beaufort Assessment Model (BAM) with application to Spanish mackerel: mathematical description, implementation details, and computer code	Andrews
SEDAR28-RW04	Development and diagnostics of the Beaufort assessment model applied to Spanish mackerel	Andrews
	Final Assessment Reports (Not available at time of desktop review)	
SEDAR28-SAR1	Assessment of Spanish mackerel in the US South Atlantic	To be prepared by SEDAR 28
SEDAR28-SAR2	Assessment of Spanish mackerel in the US Gulf of Mexico	To be prepared by SEDAR 28
SEDAR28-SAR3	Assessment of cobia in the US South Atlantic	To be prepared by SEDAR 28
SEDAR28-SAR4	Assessment of cobia in the US Gulf of Mexico	To be prepared by SEDAR 28
	Reference Documents	
SEDAR28-RD01	List of documents and working papers for SEDAR17 (South Atlantic Spanish mackerel) – all documents available on the SEDAR website	SEDAR 17
SEDAR28-RD02	2003 Report of the mackerel Stock Assessment Panel	GMFMC and SAFMC, 2003
SEDAR28-RD03	Assessment of cobia, *Rachycentron canadum*, in the waters of the U.S. Gulf of Mexico	Williams, 2001
SEDAR28-RD04	Biological-statistical census of the species entering fisheries in the Cape Canaveral area	Anderson and Gehringer, 1965

Document #	Title	Authors
SEDAR28-RD05	A survey of offshore fishing in Florida	Moe 1963
SEDAR28-RD06	Age, growth, maturity, and spawning of Spanish mackerel, *Scomberomorus maculates* (Mitchill), from the Atlantic Coast of the southeastern United States	Schmidt et al. 1993
SEDAR28-RD07	Omnibus amendment to the Interstate Fishery Management Plans for Spanish mackerel, spot, and spotted seatrout	ASMFC 2011
SEDAR28-RD08	Life history of Cobia, *Rachycentron canadum* (Osteichthyes: Rachycentridae), in North Carolina waters	Smith 1995
SEDAR28-RD09	Population genetics of cobia *Rachycentron canadum*: Management implications along the Southeastern US coast	Darden et al, 2012
SEDAR28-RD10	Inshore spawning of cobia (*Rachycentron canadum*) in South Carolina	Lefebvre and Denson, 2012
SEDAR28-RD11	A review of age, growth, and reproduction of cobia *Rachycentron canadum*, from US water of the Gulf of Mexico and Atlantic ocean	Franks and Brown-Peterson, 2002
SEDAR28-RD12	An assessment of cobia in Southeast US waters	Thompson 1995
SEDAR28-RD13	Reproductive biology of cobia, *Rachycentron canadum*, from coastal waters of the southern United States	Brown-Peterson et al. 2001
SEDAR28-RD14	Larval development, distribution, and ecology of cobia *Rachycentron canadum* (Family: Rachycentridae) in the northern Gulf of Mexico	Ditty and Shaw 1992
SEDAR28-RD15	Age and growth of cobia, *Rachycentron canadum*, from the northeastern Gulf of Mexico	Franks et al 1999
SEDAR28-RD16	Age and growth of Spanish mackerel, *Scomberomorus maculates*, in the Chesapeake Bay region	Gaichas, 1997
SEDAR28-RD17	Status of the South Carolina fisheries for cobia	Hammond, 2001
SEDAR28-RD18	Age, growth and fecundity of the cobia, *Rachycentron canadum*, from Chesapeake Bay and adjacent Mid-Atlantic waters	Richards 1967
SEDAR28-RD19	Cobia (*Rachycentron canadum*) tagging within Cheasapeake Bay and updating of growth equations	Richards 1977
SEDAR28-RD20	Synopsis of biological data on the cobia *Rachycentron canadum* (Pisces: Rachycentridae)	Shaffer and Nakamura 1989
SEDAR28-RD21	South Carolina marine game fish tagging program 1978-2009	Wiggers, 2010

Document #	Title	Authors
SEDAR28-RD22	Cobia (*Rachycentron canadum*), amberjack (*Seriola dumerili*), and dolphin (*Coryphaena hipurus*) migration and life history study off the southwest coast of Florida	MARFIN 1992
SEDAR28-RD23	Sport fish tag and release in Mississippi coastal water and the adjacent Gulf of Mexico	Hendon and Franks 2010
SEDAR28-RD24	VMRC Cobia otolith preparation protocol	VMRC
SEDAR28-RD25	VMRC Cobia otolith ageing protocol	VMRC
SEDAR28-RD26	Age, growth, and reproductive biology of greater amberjack and cobia from Louisiana waters	Thompson et al. 1991
SEDAR28-RD27	Gonadal maturation in the cobia, *Rachycentron canadum*, from the northcentral Gulf of Mexico	Lotz et al. 1996
SEDAR28-RD28	Cobia (*Rachycentron canadum*) stock assessment study in the Gulf of Mexico and in the South Atlantic	Burns et al. 1998
SEDAR28-RD29	Total mortality estimates for Spanish mackerel captured in the Gulf of Mexico commercial and recreational fisheries 1983 to 2011	Bryan 2012

Appendix 2: Copy of the CIE Statement of Work

Attachment A: Statement of Work for Dr. Norm Hall

Amended Statement of Work

External Independent Peer Review by the Center for Independent Experts

SEDAR 28: Gulf of Mexico Cobia and Spanish Mackerel Assessment Desk Review

Scope of Work and CIE Process: The National Marine Fisheries Service's (NMFS) Office of Science and Technology coordinates and manages a contract providing external expertise through the Center for Independent Experts (CIE) to conduct independent peer reviews of NMFS scientific projects. The Statement of Work (SoW) described herein was established by the NMFS Project Contact and Contracting Officer's Representative (COR), and reviewed by CIE for compliance with their policy for providing independent expertise that can provide impartial and independent peer review without conflicts of interest. CIE reviewers are selected by the CIE Steering Committee and CIE Coordination Team to conduct the independent peer review of NMFS science in compliance the predetermined Terms of Reference (ToRs) of the peer review. Each CIE reviewer is contracted to deliver an independent peer review report to be approved by the CIE Steering Committee and the report is to be formatted with content requirements as specified in **Annex 1**. This SoW describes the work tasks and deliverables of the CIE reviewer for conducting an independent peer review of the following NMFS project. Further information on the CIE process can be obtained from www.ciereviews.org.

Project Description SEDAR 28 will be a compilation of data, an assessment of the stocks, and an assessment review conducted for Gulf of Mexico Spanish mackerel and cobia. The CIE peer review is ultimately responsible for ensuring that the best possible assessment has been provided through the SEDAR process. The stocks assessed through SEDAR 28 are within the jurisdiction of the Gulf of Mexico Fisheries Management Councils and states in the Gulf of Mexico region. The Terms of Reference (ToRs) of the peer review are attached in **Annex 2**.

Requirements for CIE Reviewers: Three CIE reviewers shall have the necessary qualifications to complete an impartial and independent peer review in accordance with the statement of work (SoW) tasks and terms of reference (ToRs) specified herein. The CIE reviewers shall have expertise in stock assessment, statistics, fisheries science, and marine biology sufficient to complete the tasks of the peer-review described herein. Each CIE reviewer's duties shall not exceed a maximum of 10 days to complete all work tasks of the peer review described herein.

Location of Peer Review: Each CIE reviewer shall participate and conduct an independent peer review as a desk review, therefore travel will not be required.

Statement of Tasks: Each CIE reviewer shall complete the following tasks in accordance with the SoW and Schedule of Milestones and Deliverables herein.

Prior to the Peer Review: Upon completion of the CIE reviewer selection by the CIE Steering Committee, the CIE shall provide the CIE reviewer contact information to the COR, who forwards this information to the NMFS Project Contact no later the date specified in the Schedule of Milestones and Deliverables. The CIE is responsible for providing the SoW and ToRs to the CIE reviewers. The

NMFS Project Contact is responsible for providing the CIE reviewers with the assessment and other pertinent background documents for the peer review. Any changes to the SoW or ToRs must be made through the COR prior to the commencement of the peer review.

Pre-review Background Documents: Two weeks before the peer review, the NMFS Project Contact will send (by electronic mail or make available at an FTP site) to the CIE reviewers the necessary background information and reports for the peer review. In the case where the documents need to be mailed, the NMFS Project Contact will consult with the CIE Lead Coordinator on where to send documents. CIE reviewers are responsible only for the pre-review documents that are delivered to the reviewer in accordance to the SoW scheduled deadlines specified herein. The CIE reviewers shall read all documents in preparation for the peer review.

Desk Review: Each CIE reviewer shall conduct the independent peer review in accordance with the SoW and ToRs, and shall not serve in any other role unless specified herein. Modifications to the SoW and ToRs shall not be made during the peer review, and any SoW or ToRs modifications prior to the peer review shall be approved by the COR and CIE Lead Coordinator. The CIE Lead Coordinator can contact the Project Contact to confirm any peer review arrangements.

Contract Deliverables - Independent CIE Peer Review Reports: Each CIE reviewer shall complete an independent peer review report in accordance with the SoW. Each CIE reviewer shall complete the independent peer review according to required format and content as described in Annex 1. Each CIE reviewer shall complete the independent peer review addressing each ToR as described in Annex 2.

Specific Tasks for CIE Reviewers: The following chronological list of tasks shall be completed by each CIE reviewer in a timely manner as specified in the **Schedule of Milestones and Deliverables**.

1) Conduct necessary pre-review preparations, including the review of background material and reports provided by the NMFS Project Contact in advance of the peer review.
2) Conduct an impartial and independent peer review in accordance with the tasks and ToRs specified herein, and each ToRs must be addressed (**Annex 2**).
3) No later than January 25, 2013, each CIE reviewer shall submit an independent peer review report addressed to the "Center for Independent Experts," and sent to Mr. Manoj Shivlani, CIE Lead Coordinator, via email to shivlanim@bellsouth.net, and CIE Regional Coordinator, via email to Dr. David Sampson david.sampson@oregonstate.edu. Each CIE report shall be written using the format and content requirements specified in **Annex 1**, and address each ToR in **Annex 2**.

Schedule of Milestones and Deliverables: CIE shall complete the tasks and deliverables described in this SoW in accordance with the following schedule.

21 December 2012	CIE sends reviewer contact information to the COR, who then sends this to the NMFS Project Contact
2 January 2013	NMFS Project Contact sends the CIE Reviewers the assessment report and background documents
9-24 January 2013	Each reviewer conducts an independent peer review as a desk review
25 January 2013	CIE reviewers submit draft CIE independent peer review reports to the CIE Lead Coordinator and CIE Regional Coordinator
8 February 2013	CIE submits CIE independent peer review reports to the COR
15 February 2013	The COR distributes the final CIE reports to the NMFS Project Contact and regional Center Director

Modifications to the Statement of Work: This 'Time and Materials' task order may require an update or modification due to possible changes to the terms of reference or schedule of milestones resulting from the fishery management decision process of the NOAA Leadership, Fishery Management Council, and Council's SSC advisory committee. A request to modify this SoW must be approved by the Contracting Officer at least 15 working days prior to making any permanent changes. The Contracting Officer will notify the COR within 10 working days after receipt of all required information of the decision on changes. The COR can approve changes to the milestone dates, list of pre-review documents, and ToRs within the SoW as long as the role and ability of the CIE reviewers to complete the deliverable in accordance with the SoW is not adversely impacted. The SoW and ToRs shall not be changed once the peer review has begun.

Acceptance of Deliverables: Upon review and acceptance of the CIE independent peer review reports by the CIE Lead Coordinator, Regional Coordinator, and Steering Committee, these reports shall be sent to the COR for final approval as contract deliverables based on compliance with the SoW and ToRs. As specified in the Schedule of Milestones and Deliverables, the CIE shall send via e-mail the contract deliverables (CIE independent peer review reports) to the COR (William Michaels, via William.Michaels@noaa.gov).

Applicable Performance Standards: The contract is successfully completed when the COR provides final approval of the contract deliverables. The acceptance of the contract deliverables shall be based on three performance standards:
(1) The CIE report shall completed with the format and content in accordance with **Annex 1**,
(2) The CIE report shall address each ToR as specified in **Annex 2**,
(3) The CIE reports shall be delivered in a timely manner as specified in the schedule of milestones and deliverables.

Distribution of Approved Deliverables: Upon acceptance by the COR, the CIE Lead Coordinator shall send via e-mail the final CIE reports in *.PDF format to the COR. The COR will distribute the CIE reports to the NMFS Project Contact and Center Director.

Support Personnel:

William Michaels, Program Manager, COR
NMFS Office of Science and Technology
1315 East West Hwy, SSMC3, F/ST4, Silver Spring, MD 20910
William.Michaels@noaa.gov Phone: 301-427-8155

Manoj Shivlani, CIE Lead Coordinator
Northern Taiga Ventures, Inc.
10600 SW 131st Court, Miami, FL 33186
shivlanim@bellsouth.net Phone: 305-383-4229

Roger W. Peretti, Executive Vice President
Northern Taiga Ventures, Inc. (NTVI)
22375 Broderick Drive, Suite 215, Sterling, VA 20166
RPerretti@ntvifederal.com Phone: 571-223-7717

Key Personnel:

NMFS Project Contact:

Ryan Rindone, SEDAR Coordinator
2203 N. Lois Avenue, Suite 1100
Tampa, FL 33607
Ryan.Rindone@gulfcouncil.org Phone: 813-348-1630

Annex 1: Format and Contents of CIE Independent Peer Review Report

1. The CIE independent report shall be prefaced with an Executive Summary providing a concise summary of the findings and recommendations, and specify whether the science reviewed is the best scientific information available.

2. The main body of the reviewer report shall consist of a Background, Description of the Individual Reviewer's Role in the Review Activities, Summary of Findings for each ToR in which the weaknesses and strengths are described, and Conclusions and Recommendations in accordance with the ToRs.

   The CIE independent report shall be a stand-alone document for others to understand the weaknesses and strengths of the science reviewed, regardless of whether or not they read the summary report. The CIE independent report shall be an independent peer review of each ToRs, and shall not simply repeat the contents of the summary report.

3. The reviewer report shall include the following appendices:

   Appendix 1: Bibliography of materials provided for review
   Appendix 2: A copy of the CIE Statement of Work

Annex 2a – Terms of Reference for

SEDAR 28: Gulf of Mexico Cobia Assessment Desk Review

1. Evaluate the quality and applicability of data used in the assessment.
2. Evaluate the quality and applicability of methods used to assess the stock.
3. Recommend appropriate estimates of stock abundance, biomass, and exploitation.
4. Evaluate the methods used to estimate population benchmarks and management parameters. Recommend and provide estimated values for appropriate management benchmarks and declarations of stock status for each model run presented for review.
5. Evaluate the quality and applicability of the methods used to project future population status. Recommend appropriate estimates of future stock condition.
6. Evaluate the quality and applicability of methods used to characterize uncertainty in estimated parameters.
    - Provide measures of uncertainty for estimated parameters
    - Ensure that the implications of uncertainty in technical conclusions are clearly stated
    - If there are significant changes to the base model, or to the choice of alternate states of nature, then provide a probability distribution function for the base model, or a combination of models that represent alternative states of nature, presented for review.
        - Determine the yield associated with a probability of exceeding OFL at P* values of 30% to 50% in single percentage increments
        - Provide justification for the weightings used in producing the combinations of models
7. If available, ensure that stock assessment results are accurately presented in the Stock Assessment Report and that stated results are consistent with Review Panel recommendations.
8. Evaluate the quality and applicability of the SEDAR Process as applied to the reviewed assessment and identify the degree to which Terms of Reference were addressed during the assessment process.
9. Make any additional recommendations or prioritizations warranted.
    - Clearly denote research and monitoring needs that could improve the reliability of future assessments

Table 1. Required MSRA Evaluations for cobia assessment:

Criteria	Definition* (2001)	Current Value* (2001)
Mortality Rate Criteria		
F_{MSY}	F_{MSY}	0.34
MFMT	F_{MSY}	0.34
F_{OY}	75% of F_{MSY}	0.26
$F_{CURRENT}$	F_{2000}	0.30
$F_{CURRENT}$/ F_{MSY}	Percentage of $F_{Current}/F_{MSY}$ > MFMT	0.40
Base M		0.30
Biomass Criteria		
SSB_{MSY}	Equilibrium SSB_{MSY} @ F_{MSY}	3.02 mp
MSST	(1-M)*SSB_{MSY}: M=0.30	2.11 mp
$SSB_{CURRENT}$	SSB_{2000}	
$SSB_{CURRENT}$/ SSB_{MSY}	Percentage of $SSB_{Current}/SSB_{MSY}$ < MSST	0.30
Equilibrium MSY	Equilibrium Yield @ F_{MSY}	1.50 mp
Equilibrium OY	Equilibrium Yield @ F_{OY}	1.45 mp
OFL	Annual Yield @ MFMT	
	2013	
	2014	
	2015	
	2016	
	2017	
	2018	
Annual OY**	Annual Yield @ F_{OY}	
	2013	
	2014	
	2015	
	2016	
	2017	
	2018	

*Definitions and values are subject to change as per guidance from this assessment.

**Based upon current definitions of OY, where OY = 75% of F_{MSY}

Table 2. Projection Scenario Details for cobia assessment

2.1 Initial Assumptions:

OPTION	Value
2012 base TAC	TBD
2012 Recruits	TBD by Panel
2012 Selectivity	TBD by Panel
Projection Period	6 yrs (2013-2018)
1st year of change F, Yield	2013

2.2 Scenarios to Evaluate (preliminary, to be modified as appropriate)

1. Landings fixed at 2013 target
2. F_{OY}= 65%, 75%, 85% F_{MSY} (project when OY will be achieved)
3. F_{MSY}
4. $F_{REBUILD}$ (if necessary)
5. F=0 (if necessary)

2.3 Output values

1. Landings
2. Discards (including dead discards)
3. Exploitation
4. F/F_{MSY}
5. B/B_{MSY}

10. Evaluate the quality and applicability of data used in the assessment.
11. Evaluate the quality and applicability of methods used to assess the stock.
12. Recommend appropriate estimates of stock abundance, biomass, and exploitation.
13. Evaluate the methods used to estimate population benchmarks and management parameters. Recommend and provide estimated values for appropriate management benchmarks and declarations of stock status for each model run presented for review.
14. Evaluate the quality and applicability of the methods used to project future population status. Recommend appropriate estimates of future stock condition.
15. Evaluate the quality and applicability of methods used to characterize uncertainty in estimated parameters.
    - Provide measures of uncertainty for estimated parameters
    - Ensure that the implications of uncertainty in technical conclusions are clearly stated
    - If there are significant changes to the base model, or to the choice of alternate states of nature, then provide a probability distribution function for the base model, or a combination of models that represent alternate states of nature, presented for review.
        - Determine the yield associated with a probability of exceeding OFL at P* values of 30% to 50% in single percentage increments
        - Provide justification for the weightings used in producing the combinations of models
16. If available, ensure that stock assessment results are accurately presented in the Stock Assessment Report and that stated results are consistent with Review Panel recommendations.
17. Evaluate the quality and applicability of the SEDAR Process as applied to the reviewed assessment and identify the degree to which Terms of Reference were addressed during the assessment process.
18. Make any additional recommendations or prioritizations warranted.
    - Clearly denote research and monitoring needs that could improve the reliability of future assessments

Table 1. Required MSRA Evaluations for Spanish mackerel assessment:

Note: te = trillion eggs

Criteria	Definition* (as of 2002/2003)	Current Value* (2002/03)
Mortality Rate Criteria		
F_{MSY}	$F_{30\%SPR}$	
MFMT	$F_{30\%SPR}$	
F_{OY}	75% of $F_{30\%SPR}$	0.40
$F_{CURRENT}$	$F_{2002/03}$	
$F_{CURRENT}$/MFMT		0.53
Base M		0.30
Biomass Criteria		
SSB_{MSY}	Equilibrium SSB_{MSY} @ $F_{30\%SPR}$	19.10 te
MSST	(1-M)*SSB_{MSY}: M=0.30	13.40 te
$SSB_{CURRENT}$	SSB_{2003}	17.96 te
$SSB_{CURRENT}$/ MSST		1.34
Equilibrium MSY	Equilibrium Yield @ $F_{30\%SPR}$	8.7 mp
Equilibrium OY	Equil. Yield @ 75% of $F_{30\%SPR}$	8.3 mp
OFL	Annual Yield @ MFMT	
	2013	
	2014	
	2015	
	2016	
	2017	
	2018	
Annual OY**	Annual Yield @ F_{OY}	
	2013	
	2014	
	2015	
	2016	
	2017	
	2018	

*Definitions and values are subject to change as per guidance from this assessment.

**Based upon current definitions of OY, where OY = 75% of F_{MSY}

Table 2. Projection Scenario Details for Spanish mackerel assessment

2.1 Initial Assumptions:

OPTION	Value
2012 base TAC	TBD
2012 Recruits	TBD by Panel
2012 Selectivity	TBD by Panel
Projection Period	6 yrs (2013-2018)
1^{st} year of change F, Yield	2013

2.2 Scenarios to Evaluate (preliminary, to be modified as appropriate)

1. Landings fixed at 2013 target
2. F_{OY}= 65%, 75%, 85% F_{MSY} (project when OY will be achieved)
3. F_{MSY}
4. $F_{REBUILD}$ (if necessary)
5. F=0 (if necessary)

2.3 Output values

1. Landings
2. Discards (including dead discards)
3. Exploitation
4. F/F_{MSY}
5. B/B_{MSY}