Southeast Data, Assessment, and Review

SEDAR 28

Stock Assessment Report

South Atlantic Spanish Mackerel

December 2012*

*Revised May 2013

SEDAR
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I. Introduction

1. SEDAR Process Description

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

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

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

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

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

2. Management Overview

Table 1. General Management Information

Species	Spanish Mackerel (*Scomberomorus maculatus*)
Management Unit	Southeastern US
Management Unit Definition	The management unit for the Atlantic migratory group of Spanish mackerel extends from 25°20.4' N. lat., which is a line directly east from the Miami-Dade/Monroe County, FL, boundary to the outer limit of the EEZ[1] to the Mid-Atlantic Council Boundaries[2].
Management Entity	South Atlantic Fishery Management Council
Management Contacts SERO / Council	Steve Branstetter, Jack McGovern/ Gregg Waugh
Current stock exploitation status	Not Overfishing
Current stock biomass status	Not Overfished

*Electronic Code of Federal Regulations

1. § 622.2 Spanish mackerel. The boundary separating the Gulf and Atlantic migratory groups of Spanish mackerel is 25°20.4' N. lat., which is a line directly east from the Miami-Dade/Monroe County, FL, boundary to the outer limit of the EEZ.

§ 600.105 (a) New England and Mid-Atlantic Councils. The boundary begins at the intersection point of Connecticut, Rhode Island, and New York at 41°18'16.249" N. lat. and 71°54'28.477" W. long. and proceeds south 37°22'32.75" East to the point of intersection with the outward boundary of the EEZ as specified in the Magnuson-Stevens Act.

Table 2. Specific Management Criteria

Criteria	Current		Results from SEDAR 28	
	Definition	Value	Definition	Value
MSST	MSST = [(1-M) or 0.7 whichever is greater]*B_{MSY}	8.5 to 11.1	MSST = [(1-M) or 0.7 whichever is greater]*B_{MSY}	TBD
MFMT	MFMT = F_{MSY} where F_{MSY} = $F_{30\%SPR}$	0.42 (0.38 – 0.48)	F_{MSY}	TBD
MSY	Yield at F_{MSY}	5.242 (4.372 – 6.392) mp	Yield at F_{MSY}	TBD
F_{MSY}	F_{MAX}	0.42 (0.38 – 0.48)	F_{MAX}	TBD
OY	Yield at F_{OY}	Not Specified	Yield at F_{OY}	TBD
F_{OY}	$F4_{0\%SPR}$	0.30 (0.27 – 0.34)	F_{OY} = 65%,75%, 85% F_{MSY}	TBD
M	n/a	0.30	M	TBD

Stock Assessment on Spanish and King Mackerel Stocks; 2003 Report of the Mackerel Stock Assessment Panel; SFD 2003.

Table 3. Stock Rebuilding Information

Spanish mackerel is not overfished; no rebuilding plan required.

Table 4. Stock projection information

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

Requested Information	Value
First Year of Management	2009
Projection Criteria during interim years should be based on (e.g., exploitation or harvest)	Fixed Exploitation; Modified Exploitation; Fixed Harvest*
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.

First year of Management: Earliest year in which management changes resulting from this assessment are expected to become effective

interim years: those between the terminal assessment year and the first year that any management could realistically become effective.

Projection Criteria: The parameter which should be used to determine population removals, typically either an exploitation rate or an average landings value or a pre-specified landings target.

Table 5. Quota Calculation Details

Quota Detail	Value
Current Quota Value	Commercial quota set at 3.87 mp. Recreational allocation set at 3.17 mp.
Next Scheduled Quota Change	None scheduled
Annual or averaged quota ?	annual
If averaged, number of years to average	n/a

How is the quota calculated - conditioned upon exploitation or average landings?

A 2000 seasonal adjustment of harvest levels established a TAC of 7.04 million pounds for Atlantic group Spanish mackerel. This value is based on framework procedures, which specify the Council may not set TAC to exceed the best point estimate of MSY by more than 10 percent. The estimate of MSY from the 1999 Assessment Panel Report is 6.4 million pounds with a range of 5.7 to 7.5 million pounds. With a 7.04 million pound TAC, the commercial allocation is 3.87 million pounds (55%) and the recreational allocation is 3.17 million pounds.

Does the quota include bycatch/discard estimates?

The quota is not adjusted for bycatch estimates.

Are there additional details of which the analysts should be aware to properly determine quotas for this stock?

Table 6. Federal Regulatory and FMP History

Description of Action	FMP/Amendment	Effective Date
Established TAC of 27 MP; limited purse seine harvest to 300,000 lbs in Atlantic and 300,000 lbs in Gulf; minimum size limit for Rec/Comm is 12 inches FL except for incidental catch allowance of 5% of the total catch by weight aboard;	Original FMP (SAFMC 1982) 48 FR 5274	February 4, 1983
Final Rule for Amendment 1. Provided framework procedure for pre-season adjustment of TAC. TAC of 27 mp for Atlantic, purse seine harvest to 300,000 lbs in Atlantic and 300,000 lbs in Gulf and a minimum size limit for the commercial and recreational sectors are 12 inches FL or 14 inches TL.	50 FR 34846 Amendment 1 (SAFMC 1985)	August 28, 1985
Emergency rule beginning January 1, 1987 through March 31, 1987 would divide 3.716 mp quota into three areas with 1.869 mp going to the Atlantic. The Atlantic boundary was bounded by the NC/VA border and a line directly east of the Dade/Monroe County, Florida boundary to the seaward boundary of the EEZ. The emergency action also established a bag limit of 4 Spanish mackerel per trip and allowed sale of recreationally caught Spanish mackerel under the bag limit.	52 FR 290	January 5, 1987
Spanish mackerel commercial fishery was closed January 14, 1987 to March 31, 1987 because 1.869 mo quota was met.	52 FR 2113	January 20,1987
90 day extension of January 1, 1987 to March 31, 1987 emergency rule for Spanish mackerel.	52 FR 10762	April 3, 1987
Revised MSY, recognized two migratory groups, set TAC at 2.9 mp, established commercial (2.2 mp, 76%) and recreational (0.7 mp, 24%) allocations for TAC, established April 1 to March 31 fishing year, established Dade/Monroe county line as the migratory group boundary, and set commercial quotas and bag limits. A bag limit of 4 fish in FL and 10 in NC, SC, and GA. Charterboat permits were required and it was clarified TAC must be set below the upper range of the ABC.	52 FR 23836 Amendment 2 (SAFMC 1987)	June 25,1987
Framework action – commercial allocation is 2.36 mp and recreational allocation is 0.74 mp, bag limits is 4 fish from FL and 10 fish north of FL.	52 FR 25012	July 2, 1987
Bag limit for Atlantic Spanish mackerel set to 0 for remainder of year because 0.74 mp recreational allocation was reached.	52 FR 35720	September 23, 1987

Final Rule on technical amendment that allows catch of Spanish mackerel under minimum size limit equal to 5% by weight of total catch or Spanish mackerel on board.	52 FR 36578	September 30, 1987
Commercial fishery for Atlantic Spanish mackerel closed December 29, 1987 because 2.36 mp quota met.	52 FR 49415	December 31, 1987
Framework action changed TAC to 4.0 mp for Atlantic Spanish mackerel with 0.96 mp allocated to the recreational sector and 3.04 mp allocated to the commercial sector.	53 FR 25611	July 8, 1988
Bag limit for Atlantic Spanish mackerel reduced to 0 on October 3, 1988 for remainder of year because recreational allocation of 0.96 mp was reached.	53 FR 39097	October 5, 1988
Commercial fishery for Atlantic Spanish mackerel closed December 29, 1988 because the 3.04 mp quota was reached.	54 FR 153	January 4, 1989
Effective April 1, 1989, TAC for Atlantic Spanish mackerel was increased to 6 mp with 1.44 mp allocated to the recreational sector and 4.56 mp allocated to the commercial sector.	54 FR 24920	June 12, 1989
Prohibited drift gill nets for coastal pelagics and purse seines for the overfished group of mackerels.	54 FR 29561 Amendment 3 (SAFMC 1989)	July 13, 1989
Reallocated Atlantic group Spanish mackerel equally between recreational and commercial fishermen. TAC = 6.0 mp.	54 FR 38526 Amendment 4 (SAFMC 1989)	September 19, 1989
Framework action changed TAC for Atlantic Spanish mackerel to 5.0 mp, 3.14 mp allocated to the commercial sector and 1.86 mp allocated to the recreational sector.	55 FR 25986	June 26, 1990
Extended the management area for the Atlantic groups of mackerels through the MAFMCs area of jurisdiction, revised the definition of overfishing, redefined recreational bag limits as daily limits, and deleted a provision specifying that bag limit caught mackerel may be sold. Size limit for Spanish mackerel is 12 " FL or 14" TL. Bag limit is 4 fish from area off FL and 10 fish north of FL.	55 FR 29370 Amendment 5 (SAFMC 1990)	July 19, 1990
Closed commercial fishery for Atlantic Spanish mackerel on January 25, 1991 because 3.14 mp commercial quota was met.	56 FR 3422	January 30, 1991

TAC for Atlantic Spanish mackerel increased to 7.0 mp with 3.5 mp allocated to commercial sector and 3.5 mp allocated to recreational sector. Bag limit is 10 fish for areas north of FL and 5 fish for FL.	56 FR 29920	July 1, 1991
Closed commercial fishery for Atlantic Spanish mackerel on December 17, 1991 because 3.5 commercial quota was reached.	56 FR 66001	December 20, 1991
Proposed Rule to increase bag limit in FL for Atlantic Spanish mackerel to that adopted by the state of FL but not to exceed 10 fish.	57 FR 33924	July 31, 1992
Specified rebuilding periods for overfished mackerel stocks, provided for commercial Atlantic Spanish mackerel possession limits, discontinued the reversion of the bag limit to 0 when the recreational quota is filled, modified the recreational fishing year to the calendar year, changed commercial permit requirements to allow qualification in one of three preceding years, and changed all size limits to fork length only. Minimum size limit is 12 inches FL. In northern zone, boats are restricted to possession limits of 3,500 pounds. In southern zone trip limit are 1,500 pounds per vessel per day during April 1 to November 30. From December 1 until 80% of quota is taken: unlimited harvest on Monday, Wednesday, and Friday; 1,500 pounds per vessel per day on Tuesday and Thursday; 500 pounds per vessel per day on Saturday and Sunday. Trip limit 1,000 pounds per vessel per day when 80% of quota is reached. Adjusted quota for Spanish mackerel is 3.25 mp.	57 FR 58151 Amendment 6 (SAFMC 1992)	December 9, 1992
Trip limit reduced to 1,000 pounds per day in Southern zone on January 7, 1993 because 80% of the quota had been reached.	58 FR 4093	January 13, 1993
Trip limit reduced to 500 pounds per day in Southern zone on February 20, 1993 because 100% of the adjusted commercial allocation was reached.	58 FR 11198	February 24, 1993
Commercial TAC for Atlantic Spanish mackerel increased to 9 mp with 4.5 mp commercial and 4.5 mp recreational. The initial change in the trip limit occurs when 75% of the quota is met instead of 80%.	58 FR 40613	July 29, 1993
Trip limit reduced to 1,000 pounds per day on December 22, 1993 because 75% of the quota had been met.	58 FR 68327	December 23, 1993

Trip limit reduced to 500 pounds per day on February 18, 1994.	59 FR 8868	February 24, 1994
Effective April 1, 1994, TAC for Atlantic Spanish mackerel is increased to 9.2 mp (4.6 mp commercial and 4.6 mp recreational).	59 FR 40509	August 9, 1994
Trip limit reduced to 1,000 pounds per day on January 29, 195 because 75% of the quota had been met.	60 FR 4866	January 25, 1995
Effective April 1, 1995, TAC for Atlantic Spanish mackerel increased to 9.4 mp (4.7 mp commercial and 4.7 mp recreational).	60 FR 39698	August 3, 1995
Reduce TAC for Atlantic Spanish mackerel to 7.0 mp (3.5 mp commercial and 3.5 mp recreational). Modify trip regime for commercial vessels off Florida east coast: Nov 1 rather than Dec 1 start for unlimited harvest season and increase the Saturday-Sunday daily trip limit from 500 to 1,500 pounds during that season, and increase the daily trip limit from 1,000 to 1,500 pounds for all days of the week during the period that follows the unlimited season and continues until the adjusted quota is taken.	62 FR 23671	May 1, 1997
Effective with the fishing year that began April 1, 1997, increase the TAC for Atlantic Spanish mackerel to 8.0 mp (4.0 mp commercial, 4.0 mp recreational).	62 FR 53278	October 14, 1997
Reduce trip limit to 1,500 pounds per day on December 16, 1997.	62 FR 66304	December 18, 1997
Modified requirements for a king or Spanish mackerel permit, set the OY target to 40% static SPR for the Atlantic, and modified the seasonal framework adjustment measures.	63 FR 10561 Amendment 8 (SAFMC 1994)	March 4, 1998
Reduce trip limit to 1,500 pounds per day on February 10, 1999.	64 FR 7556	February 16, 1999
Decrease the TAC for Atlantic Spanish mackerel from 8.0 mp to 6.6 mp and change the allocation from 50/50 to 55% commercial (3.63 mp) and 45% recreational (2.97 mp).	64 FR 45457	August 20, 1999
Allowed the retention and sale of damaged, legal sized king and Spanish mackerel within established trip limits.	64 FR 16336 Amendment 9 (SAFMC 1998)	March 28, 2000

Increase TAC from 6.06 mp to 7.04 mp for Atlantic Spanish mackerel with 3.87 mp commercial and 3.17 mp recreational. The trip limit from April 1 to November 30 would be 3,500 lb; from December 1 until 75% of the adjusted quota is taken there would be no trip limit on Monday through Friday and on Saturday and Sunday the trip limit would be 1,500 lbs. The recreational bag limit is increased from 10 to 15 fish per person per day. MSY = 5.7-7.5 mp, Bmsy = 12.2-15.8, MSST = 8.5-11.1, MFMT = 0.38-0.48. Effective June 12, 2000.	65 FR 41015	July 3, 2000
Addressed Sustainable Fishery Act definitions.	Amendment 11 (SAFMC 1999)	December 1999
Reduce Atlantic Spanish mackerel trip limit to 1,500 lbs per day from March 1, 2004 to March 31, 2004.	69 FR 9969	March 3, 2004
Reduce trip limit for Atlantic Spanish mackerel to 1,500 lbs from February 1, 2005 to March 31, 2005.	70 FR 5569	February 3, 2005
Changed the fishing year for Atlantic group Spanish mackerel to March 1 through February 28/29.	70 FR 39187 Amendment 15 SAFMC (2004)	July 7, 2005
Reduce Atlantic Spanish mackerel trip limit to 1,500 lbs from February 5, 2007 to February 28, 2007.	72 FR 5345	February 6, 2007
Change start date for commercial trip limit of the Atlantic Spanish mackerel in southern zone (off FL) to March 1. Effective March 12, 2008.	73FR439	January 3, 2008

Table 7a. State Regulatory History – North Carolina and South Carolina as provided by the state management agencies.

Description of Action	State	Effective Date
1500 pounds max per day, land and sell aggregate king and Spanish mackerel combined	NC	08/04/80
2000 pounds max per day, land and sell aggregate king and Spanish mackerel combined	NC	10/01/81
3500 pounds max per day, land and sell aggregate king and Spanish mackerel combined	NC	10/01/82
Proclamation authority established to specify areas, seasons, quantity, means/methods, size limits	NC	12/01/87
Creel limit: 10 fish/person/fishing trip by hook and line	NC	6/15/88
Creel limit: 10 fish/person/fishing trip by hook and line unless person is in possession of Federal Permit to fish on Spanish mackerel quota. Charter boats with federal Coastal migratory Charter Permit shall not exceed 10 fish per person with more than 3 person on board including captain and mate.	NC	6/22/88
All coastal waters closed to harvest and retention of king and Spanish mackerel taken by any method. Proclamation expires 3/31/89	NC	3/7/89
Creel limit: 10 fish/person/dishing trip by hook and line unless person is in possession of Federal Permit to fish on Spanish mackerel quota. Charter boats with federal Coastal migratory Charter Permit shall not exceed 10 fish per person with more than 3 person on board including captain and mate. Creel limits do not apply to commercial fishermen using nets. Proclamation expires 3/31/90	NC	5/9/89
Creel limit: 10 fish/person/dishing trip by hook and line unless person is in possession of Federal Permit to fish on Spanish mackerel quota. Charter boats with federal Coastal migratory Charter Permit shall not exceed 10 fish per person with more than 3 person on board including captain and mate. Creel limits do not apply to commercial fishermen using nets.	NC	4/1/90
It is unlawful to have a purse gill net on board a vessel when taking or landing Spanish or King Mackerel.	NC	1/1/91
Commercial season closes, reopens 4/1/92	NC	1/5/92

12 inch FL minimum size.	NC	2/15/94
Creel limit: 10 fish/person/dishing trip by hook and line unless person is in possession of Federal Permit to fish on Spanish mackerel quota. Charter boats with federal Coastal migratory Charter Permit shall not exceed 10 fish per person with more than 3 person on board including captain and mate. Creel limits do not apply to commercial fishermen using nets except as specified by NCAC 3M/.0301.	NC	2/15/94
Proclamation authority for hook and line deleted. Entered into rule: Creel limit: 10 fish/person/dishing trip by hook and line unless person is in possession of Federal Permit to fish on Spanish mackerel quota. Charter boats with federal Coastal migratory Charter Permit shall not exceed 10 fish per person with more than 3 person on board including captain and mate	NC	3/1/96
Temporary rule change: Recreational purpose wording added and commercial gear working changed to commercial fishing operation. 12 inch minimum size Creel limit: 10 fish per person per day if taken by hook & line or for recreational purpose Holders of valid federal permits may exceed creel limit. Charterboats with valid federal permits shall not exceed 10 fish per person while fishing with more than 3 persons on board including captain and mate.	NC	7/1/99
It is unlawful to possess more than 15 Spanish mackerel per person per day taken for recreational purposes. It is unlawful to possess more than 15 Spanish mackerel per person per day in the Atlantic Ocean beyond three miles in a commercial fishing operation except for persons holding a valid National Marine Fisheries Service Spanish Mackerel Commercial Vessel Permit.	NC	4/1/01
Full consistency with federal regulations	SC	06/88-2007

Table 7b. State Regulatory History - North Carolina through Florida for Spanish mackerel as of 1990 as recorded in the Fishery Management Plan for Spanish Mackerel, Fishery Management Report No. 18, Atlantic States Marine Fisheries Commission, November 1990.

State	Bag Limit	Size Limit	Other
NC	10 fish	none	3,500 lb commercial trip limit
SC	10 fish	12" FL min.	Season closes with EEZ closure
GA	10 fish	12" FL min.	Recreational season open 3/16-11/30; 5% size tolerance by weight on trawlers
FL	5 fish	12" FL min.	1,850,000 lb quota for power assisted gill nets; season: Dec 15-Oct31. 205,000lb quota for all other forms of commercial fishing gears; season: Nov 1-Oct 31. 3 1/2 inch minimum stretched mesh.

Table 7c. State Regulatory History - New York through Florida, for Spanish Mackerel at specific times as taken from annual ASMFC FMP Reviews for Spanish Mackerel.

As of December 1995

State	Bag Limit	Size Limit	Other
NY	10 fish	14" TL min.	3,500 lb commercial trip limit
NJ	10 fish	14" TL min.	
DE	10 fish	14" TL min.	
MD	10 fish	14" TL min.	Declaration allowing regulation through framework. Gill net mesh sizes for Chesapeake Bay.
VA	10 fish	14" TL min.	Size limit exemption for pound net fishery; closure when quota reached; 3500 lb trip limit.

NC	10 fish	12" FL min.	3,500 lb commercial trip limit (Spanish and king mackerel combined); finfish excluder devices required in shrimp trawls. Purse gill net prohibition.
SC	10 fish	12" FL min.	3,500 lb commercial trip limit tracking by reference the federal FMP.
GA	10 fish	12" FL min.	Season closed December 1 - March 15.
FL	10 fish	12" FL min.	3 1/2 inch minimum mesh size, 600 yd. maximum length net. Commercial daily trip limits: 1,500 lb April 1 - November 30; December 1 until 75% of adjusted quota reached-unlimited harvest on Monday, Wednesday, and Friday; 1,500 lb per vessel per day on Tuesday and Thursday; 500 lb per vessel per day on Saturday and Sunday; >75% adjusted quota until quota fulfilled-1,000 lb per vessel per day; >100% of adjusted quota-500 lb per vessel per day.

As of September 1998

State	Bag Limit	Size Limit	Other
NY	10 fish	14" TL min.	3,500 lb. commercial trip limit
NJ	10 fish	14" TL min	
DE	10 fish	14" TL min	
MD	10 fish	14" TL min	Declaration allowing regulation through framework. Gill net mesh sizes for Chesapeake Bay
VA	10 fish	14" TL min	Size limit exemption for pound net fishery; closure when quota reached; 3,500 lb. trip limit
NC	10 fish	12" FL min	3,500 lb. commercial trip limit (Spanish and king mackerel combined); finfish excluder devices required in shrimp trawls. Purse gill net prohibition.
SC	10 fish	12" FL min	3,500 lb. commercial trip limit tracking by reference the federal FMP.
GA	10 fish	12" FL min	Season closed December 1 - March 15.

FL	10 fish	12" FL min	3½ " minimum mesh size, 600 yd. maximum length net. Commercial daily trip limits: 1,500 lb. April 1 - November 30; December 1 until 75% of adjusted quota reached - unlimited harvest on Monday, Wednesday and Friday; 1,500 lb. per vessel per day on Tuesday and Thursday; 500 lb. per vessel on Saturday and Sunday; >75% adjusted quota until quota filled - 1,500 lb. per vessel per day; > 100%of adjusted quota - 500 lb. per vessel per day.

As of October 2001

State	Recreational	Commercial	Notes
NY	14"; 15 fish	14"	3,500 lb. commercial possession limit/vessel
NJ	14"; 10 fish	14" TL	
DE	14" TL; 10 fish	no fishery	
MD	14"; 15 fish	14"	Declaration allowing regulation through framework; gill net mesh sizes for Chesapeake Bay
PRFC	14"; 15 fish	14"	
VA	14" TL; 15 fish	14" TL	Size limit exemption for pound net fishery; closure when quota reached; 3,500 lb. trip limit
NC	12" FL; 15 fish	12" FL	3,500 lb. commercial trip limit (Spanish and king mackerel combined); finfish excluder devices required in shrimp trawls. Purse gill net prohibition.
SC	12" FL; 15 fish	12" FL	Federal commercial harvest restrictions apply; federal permit required to exceed bag limit; state license required to land/sell.
GA	12" FL; 15 fish	12" FL	Commercial landings from state waters limited to bag limits; gillnets/longline gear prohibited in state waters; state waters closed December 1 - March 15 for harvest of Spanish mackerel; commercial landings (3,500 lb. trip limit) from EEZ by federally permitted vessels allowed throughout year as long as the federal quota remains open.

FL	12" FL; 15 fish	12" FL	3½ " minimum mesh size, 600 yd. maximum length net; Commercial daily trip limits: 1,500 lb. April 1 - November 30; December 1 until 75% of adjusted quota reached - unlimited harvest Mon-Fri, 1,500 lb. per vessel/day Sat-Sun; >75% adjusted quota until quota filled - 1,500 lb. per vessel/day; > 100% of adjusted quota - 500 lb. per vessel/day.

As of October 2002

State	Recreational	Commercial	Notes
NY	14"; 15 fish	14"	3,500 lb. commercial possession limit/vessel
NJ	14"; 10 fish	14" TL	
DE	14" TL; 10 fish	no fishery	
MD	14"; 15 fish	14"	Declaration allowing regulation through framework; gill net mesh sizes for Chesapeake Bay
PRFC	14"; 15 fish	14"	
VA	14" TL; 15 fish	14" TL	Size limit exemption for pound net fishery; closure when quota reached; 3,500 lb. trip limit
NC	12" FL; 15 fish	12" FL	3,500 lb. commercial trip limit (Spanish and king mackerel combined); finfish excluder devices required in shrimp trawls. Purse gill net prohibition.
SC	12" FL; 15 fish	12" FL	Federal commercial harvest restrictions apply; federal permit required to exceed bag limit; state license required to land/sell.
GA	12" FL; 15 fish	12" FL	Commercial landings from state waters limited to bag limits; gillnets/longline gear prohibited in state waters; state waters closed December 1 - March 15 for harvest of Spanish mackerel; commercial landings (3,500 lb. trip limit) from EEZ by federally permitted vessels allowed throughout year as long as the federal quota remains open.
FL	12" FL; 15 fish	12" FL	3½ " minimum mesh size, 600 yd. maximum length net; Commercial daily trip limits: 1,500 lb. April 1 - November 30; December 1 until 75% of adjusted quota reached - unlimited harvest Mon-Fri, 1,500 lb. per vessel/day Sat-Sun; >75% adjusted quota until quota filled - 1,500 lb. per vessel/day; > 100% of adjusted quota - 500 lb. per vessel/day.

As of October 2004

State	Recreational	Commercial	Notes
NY	14"; 15 fish	14"	3,500 lb. commercial possession limit/vessel
NJ	14"; 10 fish	14" TL	
DE	14" TL; 10 fish	no fishery	
MD	14"; 15 fish	14"	Declaration allowing regulation through framework; gill net mesh sizes for Chesapeake Bay
PRFC	14"; 15 fish	14"	
VA	14" TL; 15 fish	14" TL	Size limit exemption for pound net fishery; closure when quota reached; 3,500 lb. trip limit
NC	12" FL; 15 fish	12" FL	3,500 lb. commercial trip limit (Spanish and king mackerel combined); finfish excluder devices required in shrimp trawls. Purse gill net prohibition.
SC	12" FL; 15 fish	12" FL	Federal commercial harvest restrictions apply; federal permit required to exceed bag limit; state license required to land/sell.
GA	12" FL; 15 fish	12" FL	Commercial landings from state waters limited to bag limits; gillnets/longline gear prohibited in state waters; state waters closed December 1 - March 15 for harvest of Spanish mackerel; commercial landings (3,500 lb. trip limit) from EEZ by federally permitted vessels allowed throughout year as long as the federal quota remains open.
FL	12" FL; 15 fish	12" FL	3½ " minimum mesh size, 600 yd. maximum length net; Commercial daily trip limits: 1,500 lb. April 1 - November 30; December 1 until 75% of adjusted quota reached - unlimited harvest Mon-Fri, 1,500 lb. per vessel/day Sat-Sun; >75% adjusted quota until quota filled - 1,500 lb. per vessel/day; > 100% of adjusted quota - 500 lb. per vessel/day.

As of October 2005

State	Recreational	Commercial	Notes
NY	14" TL; 15 fish	14" TL	3,500 lb. commercial possession limit/vessel
NJ	14" TL; 10 fish	14" TL	
DE	14" TL; 10 fish	14" TL	Gill net and drift net restrictions
MD	14" TL; 15 fish	14" TL	Declaration allowing regulation through framework; gill net mesh sizes for Chesapeake Bay
PRFC	14" TL; 15 fish	14" TL	Closure when quota reached
VA	14" TL; 15 fish	14" TL	Size limit exemption for pound net fishery; closure when quota reached; 3,500 lb. trip limit
NC	12" FL; 15 fish	12" FL	3,500 lb. commercial trip limit (Spanish and king mackerel combined); finfish excluder devices required in shrimp trawls. Purse gill net prohibition.
SC	12" FL; 15 fish	12" FL	Federal commercial harvest restrictions apply; federal permit required to exceed bag limit; state license required to land/sell.
GA	12" FL; 15 fish	12" FL	Commercial landings from state waters limited to bag limits; gillnets/longline gear prohibited in state waters; state waters closed December 1 - March 15 for harvest of Spanish mackerel; commercial landings (3,500 lb. trip limit) from EEZ by federally permitted vessels allowed throughout year as long as the federal quota remains open.
FL	12" FL; 15 fish Transfer at sea prohibited.	12" FL	3½ " minimum mesh size, 600 yd. maximum length net. Commercial daily trip limits: 3,500 lb. April 1 - November 30; December 1 until 75% of adjusted quota reached - 3,500 lb. per vessel/day Mon-Fri, 1,500 lb. per vessel/day Sat-Sun; >75% adjusted quota until quota filled - 1,500 lb. per vessel/day; > 100% of adjusted quota - 500 lb. per vessel/day.

In 2006

Notes: commercial license required to sell Spanish mackerel in all states; other general gear restrictions apply to the harvest of Spanish mackerel.

State	Recreational	Commercial
NY	14" TL, 15 fish	14" TL. 3,500 lb. trip limit
NJ	14" TL, 10 fish	14" TL.
DE	14" TL, 10 fish	14" TL.
MD	14" TL, 15 fish	14" TL.
PRFC	14" TL, 15 fish	14" TL. Closure when quota reached.
VA	14" TL, 15 fish	14" TL; size limit exemption for pound net fishery. 3,500 lb. trip limit. Closure when quota reached.
NC	12" FL, 15 fish	12" FL. 3,500 lb. trip limit (Spanish and king mackerel combined). Purse gill nets prohibited.
SC	12" FL, 15 fish	12" FL, 15 fish
GA	12" FL, 15 fish	12" FL. State waters: 15 fish limit, closure from December 1 - March 15. 3,500 trip limit in federal waters. Closure when quota reached.
FL	12" FL, 15 fish	12" FL. Trip limits: April 1 – Nov. 30 - 3,500 lb.; Dec. 1 until 75% of adjusted quota reached - 3,500 lb. Mon-Fri. & 1,500 lb. Sat-Sun; >75% adjusted quota until quota filled -1,500 lb.; > 100% of adjusted quota - 500 lb.

Table 8. Annual Regulatory Summary

See Table 6 for annual regulatory summary of Federal regulatory history.

References

Stock Assessment on Spanish and King Mackerel Stocks; 2003 Report of the Mackerel Stock Assessment Panel; SFD 2003.

Fishery Management Plan for Spanish Mackerel, Fishery Management Report No. 18, Atlantic States Marine Fisheries Commission, November 1990.

3. Assessment History & Review

Full stock assessments of the south Atlantic Spanish mackerel were conducted by Powers et al. (1996), Legault et al. (1998) and the Sustainable Fisheries Division (2003 and 2007). Historically, the Mackerel Stock Assessment Panel (MSAP) met regularly to oversee and review these assessments and provide advice to the SAFMC and GMFMC. The most recent full stock assessment for south Atlantic Spanish mackerel was conducted in 2007 in SEDAR 17 using three separate models: ASPIC , BAM, and SRA. The SEDAR 17 Review Panel was presented with a base model using BAM, as neither ASPIC nor SRA were considered appropriate to produce standalone representations of the stock dynamics. The BAM was used with the following as input data: five fisheries and their corresponding age and length compositions, three fishery discard series, shrimp bycatch, seven fishery-dependent indices, two fishery-independent indices, one combined index and discard mortality rates. The base run was configured as a two sex model incorporating differences in growth by sex. Natural mortality was constant through time, but varied by age. The panel did not accept the base model of the assessment as appropriate for making biomass determinations. They concluded that there is an overall increasing trend in biomass, but that a biomass decline was observed from 2003 to 2007. The panel noted that the fishing mortality at the terminal year of the model (2007) did not seem to be inhibiting stock growth. Although the panel did not accept the model conclusions regarding biomass, they accepted model results that the stock was not undergoing overfishing. The panel remarked that the major issues with the assessment were the shrimp bycatch uncertainty, the historical recreational catch derivation, and the lack of an objective likelihood weighting method.

The assessment previous to SEDAR 17 was in 2003 through the Mackerel Stock Assessment Panel (MSAP), which included data through the 2001/2002 fishing year (Sustainable Fisheries Division 2003). Estimated fishing mortality for Atlantic group Spanish mackerel was found to be below F_{MSY} and F_{OY} since 1995. Estimated stock abundance had increased since 1995 and was found to be at a high for the analysis period. Probabilities that the Spanish mackerel was overfished were less than 1% and that overfishing had occurred in the most recent fishing year of the assessment were 3%; therefore, the MSAP concluded that south Atlantic Spanish mackerel was not overfished and overfishing did not occur 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.

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.

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

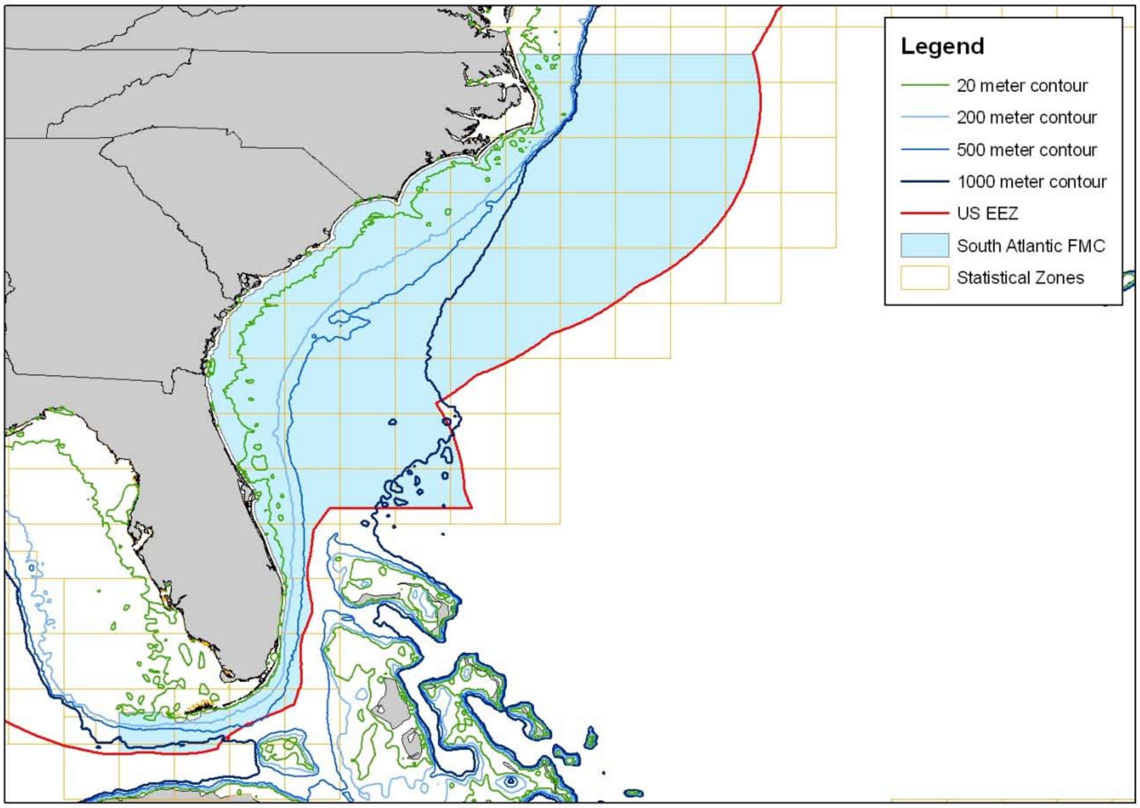


Figure 4.1 South Atlantic Fishery Management Council and EEZ boundaries.

5. Assessment Summary Report

The Summary Report provides a broad but concise view of the salient aspects of the 2012 South Atlantic Spanish mackerel 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 one or more assessment models, and identification of the base-run model configuration by the Assessment Workshop (AW); and (c) the findings and advice determined during the Review Workshop.

Executive Summary

The South Atlantic Spanish mackerel stock assessment presented by the SEDAR 28 Assessment Workshop (AW) provided the Review Panel (RP) with outputs and results from two assessment models. The primary model was a statistical catch-age model, the Beaufort Assessment Model (BAM); while a secondary, surplus-production model (ASPIC) provided a comparison of model results. The Review Panel concluded that the BAM was the most appropriate model to characterize the stock status for management purposes.

The current stock biomass status in the base run from the BAM was estimated to be $SSB_{2011}/MSST=2.29$. The current level of fishing (exploitation rate) was $F_{2009\text{-}2011}/F_{MSY} = 0.526$, with $F_{2011}/F_{MSY} = 0.521$. Therefore, the Review Panel concluded that the stock is not overfished and is not undergoing overfishing. The qualitative results on terminal stock status were similar across presented sensitivity runs, indicating that the stock status results were robust given the provided data and can be used for management. The outcomes of sensitivity analyses done with BAM were in general agreement with those of the Monte Carlo Bootstrap analysis (an additional way to examine uncertainty) in BAM. In general, stock status results from ASPIC were qualitatively similar to those from BAM.

Stock Status and Determination Criteria

Point estimates from the base model indicated that the U.S. southeast stock of Spanish mackerel (*Scomberomorus maculatus*) is currently not overfished and overfishing is not occurring.

Estimated time series of B/B_{MSY} and SSB/SSB_{MSY} show similar patterns: the stock was at a steady size until the mid 1970s when the stock quickly declined to the lowest biomass in the mid-1980s. The stock size stayed at a low level for about 10 years and has been steadily increasing since 1995 (Figures 5.4 and 5.7). Current stock status was estimated to be $SSB_{2011}/SSB_{MSY} = 1.49$ and $SSB_{2011}/MSST = 2.29$, indicating that the stock is not overfished (Table 5.1).

The estimated time series of F/F_{MSY} showed a generally steady value until the mid 1970s when increased fishing pressure changed the magnitude of the overall fishing mortality. The general trend was decreasing since the early 1990s (Figure 5.7), and the most recent estimate ($F_{current}$ = 0.36) indicated that the stock is not experiencing overfishing (Table 5.1).

Table 5.1 Summary of stock status determination criteria. Estimated status indicators, benchmarks, and related quantities from the Beaufort catch-age model, conditional on estimated current selectivities averaged across fisheries. Rate estimates (F) are in units of y^{-1}; status indicators are dimensionless; and biomass estimates are in units of metric tons or pounds, as indicated. Spawning stock biomass (SSB) and minimum stock size threshold (MSST) are measured by total biomass of mature females.

Criteria	Recommended Values from SEDAR 28	
	Definition	Value
M (Instantaneous natural mortality; per year)	Average of Lorenzen M (if used)	0. 35
Fcurrent (per year)	Geometric mean of full fishing mortality rates for 2009-2011 ($F_{2009-2011}$)	0.36
F_{MSY} (per year)	F_{MSY}	0.69
B_{MSY} (metric tons)	Biomasss at MSY	9548
SSB_{2011} (metric tons)	Spawning stock biomass in 2011	4862
SSB_{MSY} (metric tons)	Spawning stock biomass at MSY	3266
MSST (metric tons)	MSST = [(1-M) or 0.7 whichever is greater]*B_{MSY}	2127
MFMT (per year)	F_{MSY}	0.69
MSY (metric tons)	Yield at F_{MSY}	2750
OY	Yield at F_{OY}	
F_{OY}	F_{OY} = 65%,75%, 85% F_{MSY}	65% F_{MSY} = 0.449 75% F_{MSY}=0.518 85% F_{MSY}=0.587
Biomass Status	SSB_{2011}/MSST	2.29
	SSB_{2011}/SSB_{MSY}	1.49
Exploitation Status	$F_{2009-2011}/F_{MSY}$	0.526
	F_{2011}/F_{MSY}	0.521

Stock Identification and Management Unit

The Atlantic stock and Gulf of Mexico stock were 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. 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 Gulf of Mexico stock and fish landed south of US Highway 1 were 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, and it was acknowledged there was little biological evidence for either the Council Boundary or Dade-Monroe County line as the stock division.

Assessment Methods

Following the Terms of Reference, two models of Spanish mackerel were discussed during the Assessment Workshop (AW): a statistical catch-age model and a surplus-production model (ASPIC). The statistical catch-age was selected at the AW to be the primary assessment model.

The primary model in this assessment was a statistical catch-age model, implemented with the AD Model Builder software. In essence, a statistical catch-age model simulates a population forward in time while including fishing processes. Quantities to be estimated are systematically varied until characteristics of the simulated populations match available data on the real population. Statistical catch-age models share many attributes with ADAPT-style tuned and untuned VPAs.

A logistic surplus production model, implemented in ASPIC, was used to estimate stock status of Spanish mackerel off the southeastern U.S. While primary assessment of the stock was performed via the age-structured model, the surplus production approach was intended as a complement, and for additional verification that the age-structured approach was providing reasonable results.

Assessment Data

The catch-age model was fit to data from one fishery-independent index, two fishery-dependent indices, estimates of bycatch in the shrimp fishery, and to data from each of the five primary fisheries on southeastern U.S. Spanish mackerel: commercial gill net, commercial pound net, commercial cast net, commercial handlines (including hook & line, trolling, and electric reels), and general recreational (including headboat). These data included annual landings by fishery (in total weight for commercial and in numbers for general recreational and shrimp bycatch), annual discards from the recreational sector, and annual age composition of landings by fishery. Discards from the commercial fisheries were added to landings as they were not a large enough proportion of total catch to model separately. Data on annual discard mortalities were not available, but an overall discard mortality rate for the recreational sector was applied to total discards as per the recommendation of the DW. All shrimp bycatch was assumed dead.

Release Mortality

Starting in 1986 with the implementation of size-limit regulations, time series of discard mortalities (in units of 1000 fish) were available for commercial handline and gill net fisheries. The magnitude of the commercial discards was trivial in comparison to the landings. As a result, the AW decided to include the commercial discards with the landings rather than model the discards separately. Recreational angler survey data indicated non-negligible discards prior to establishment of the size limit. Data from these years were used to calculate a ratio of discards to landings, which was used to extrapolate recreational discards back to year six of the assessment model. As with landings, discard mortalities were modeled via the Baranov catch equation, which required estimates of discard selectivities and release mortality rates.

Selectivities of discards were assumed to be dome-shaped. They were partially estimated, assuming that discards consisted primarily of undersized fish, as implied by observed length compositions of discards. The general approach taken was that age-specific values for ages 0–2 were estimated, age 3 was assumed to have full selection, and selectivity for each age 4+ was set equal to the age-specific probability of being below the size limit, given the estimated normal distribution of size at age. In this way, the descending limb of discard selectivities would change with modification in the size limit. The exception to the above approach was for commercial discards in years 2009–2010, when a commercial quota was in place. For those years, commercial discard selectivity included fish larger than the 10-inch size limit that would have been released during the closed season. The commercial discard selectivity for these years was computed as the combined selectivities of sublegal-sized fish and landed fish from commercial lines and pots, weighted by the geometric mean (2009-2010) of fleet-specific observed discards or landings.

Catch Trends

The commercial gillnet fishery peaked in the late 1970s then generally declined. Commercial cast net landings began in 1995. In the early 2000s cast net landings increased and have recently become one of the dominant gears in the fishery. Commercial pound net and handline landings were relatively low compared to the other gears. Commercial pound net landings increased in the late 1980s with a peak in 1990, followed by a decline through the mid-2000s. Commercial handline landings remained low from 1960 – 2000 with the exception of 1976, and have been increasing since the early 2000s. Commercial discards from the shrimp bycatch fishery increased from 1950 through the early 1980s and then generally declined.

The observed recreational landings began in 1981 and were variable over the entire time series. An increasing trend was seen in the late 1980s with a peak in 1988. The recreational landings remained relatively stable from the late 1990s - 2011. Recreational discards began in 1981 and have generally been increasing over the time series. See Figures 5.1 and 5.2 for detail on landings and discard trends.

Fishing Mortality Trends

The estimated time series of fishing mortality rate (F) showed a peak in the late 1970s followed by about ten years of similarly high rates. The rates dropped substantially in the mid-1990s, likely due to the Florida net ban (Figure 5.3). Since 2000, the model suggests that fishing mortality rates have been between 0.35 and 0.5. Historically, the majority of the full F was dominated by gill net and recreational fisheries, with a shift in the most recent years to include a larger percentage of mortality attributable to the commercial cast net and handline fisheries (Figure 5.3).

Stock Abundance and Biomass Trends

Estimated abundance at age showed truncation of the oldest ages during the late 1970s through the mid 1980s; however, the stock appears to have rebounded to numbers last seen in the mid 1970s. Recruitment in recent years was estimated to be below average overall.

Estimated biomass at age followed a similar pattern of truncation as did abundance. Total biomass and spawning biomass showed nearly identical trends - sharp decline in the 1970s and early 1980's ostensibly due to a high volume of landings in the commercial gill net fishery. The stock was estimated to be at its lowest point in the early-mid 1980s, and since has added substantial biomass (Figure 5.4).

Scientific Uncertainty

Uncertainty in results of the base assessment model was evaluated through sensitivity and retrospective analyses. In Section III, part 3.7 of the assessment report, time series are plotted of F/F_{MSY} and SSB/SSB_{MSY} for variation in natural mortality, the influence of early recreational angling records, different assumptions of the proportion female, and differences in steepness. Retrospective analyses did not show any trends, and in general, results of sensitivity analyses were similar to those in the base model run. In particular, the runs indicated that the stock was not overfished and that the stock is not experiencing overfishing.

The Monte Carlo bootstrap (MCB) results indicated that there is some uncertainty around the estimates of stock status. In general, there appeared to be a small probability of overfishing and/or overfished status under certain combinations of input data. Although all possible combinations of data used by the MCB analysis are not equally likely, the uncertainty is demonstrated in the plots of F/F_{MSY} and SSB/SSB_{MSY}. Conclusions about stock status during the MCB analysis were most sensitive to different combinations of input data and variance around fixed parameters (steepness, recreational discard mortality, historical recreational landings and natural mortality).

Significant Assessment Modifications

The review panel accepted the base run as developed by the assessment panel.

SEDAR 28 differed from SEDAR 17 in a number of ways. The changes to the data included the following: shrimp bycatch was calculated using a simplified method; the method for back-calculating the historical recreational catch was changed; the discard mortality was assumed to be substantially lower; and discards were not modeled separately for all fleets. The assessment model was changed as follows: the steepness was fixed; a separate fishery-specific von Bertalanffy growth curve was used to scale landings, robust multinomial likelihoods were used to model the age composition data, and a Monte Carlo bootstrap method was used to illustrate the uncertainty in the assessment.

Sources of Information

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

Figures

Figure 5.1a: Time series of commercial landings for handline (HL), pound net (PN), gillnet (GN), and cast net. Landings are in units of 1000 lb whole weight. *(Generated from data in Table 2.2 of the Assessment Report.)*

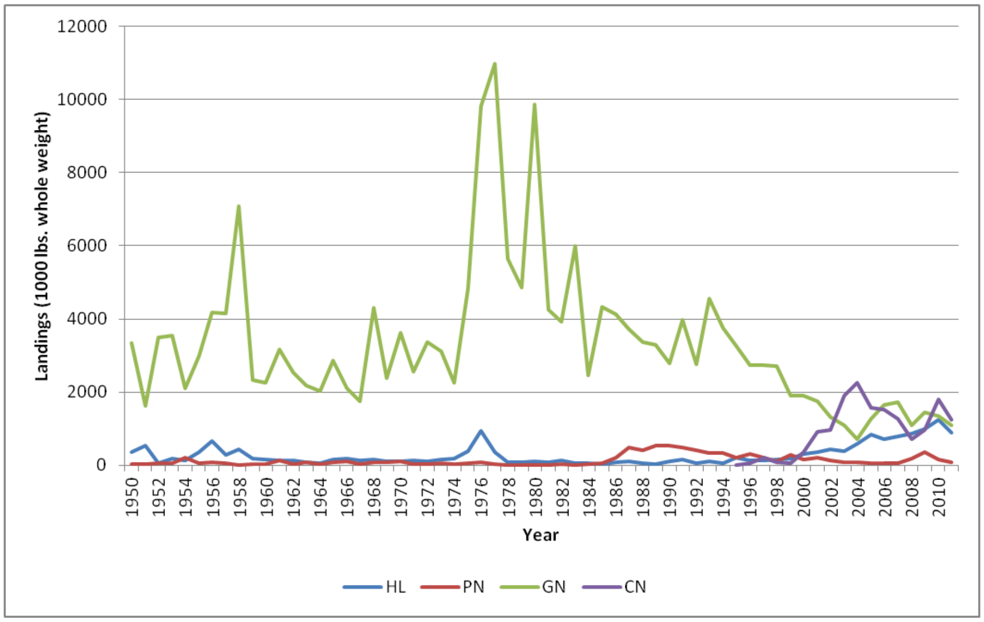


Figure 5.1b: Time series of general recreational landings. Landings are in units of 1000 fish. *(Generated from data in Table 2.2 of the Assessment Report.)*

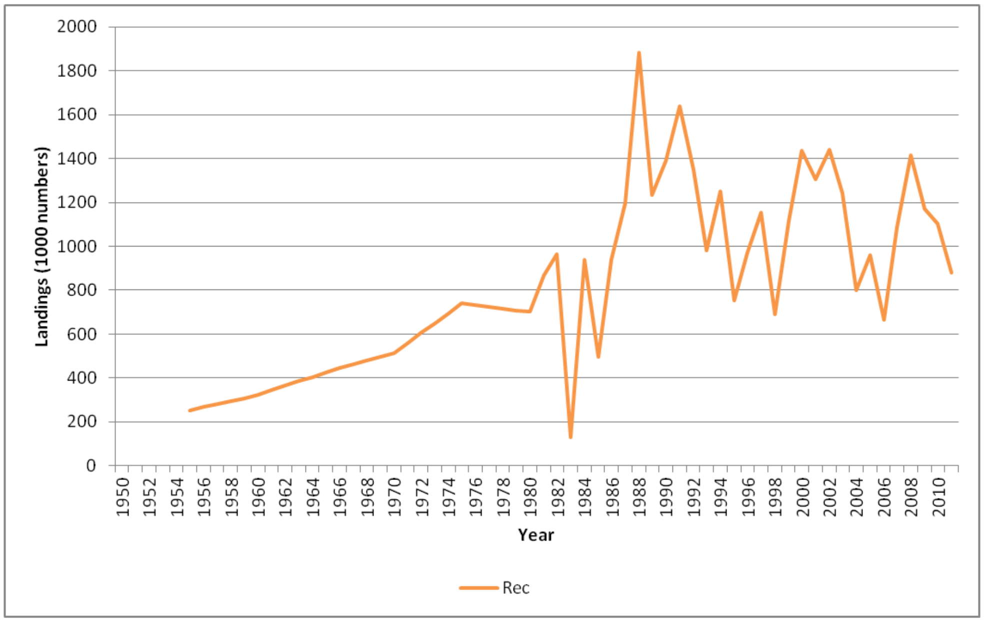


Figure 5.2: Observed time series of discards for the general recreational fleet (Rec) and from bycatch from the shrimp fishery (Shrimp). Discards are in units of 1000 fish. Discards include all released fish, live or dead. *(Generated from data in Table 2.2 of the Assessment Report.)*

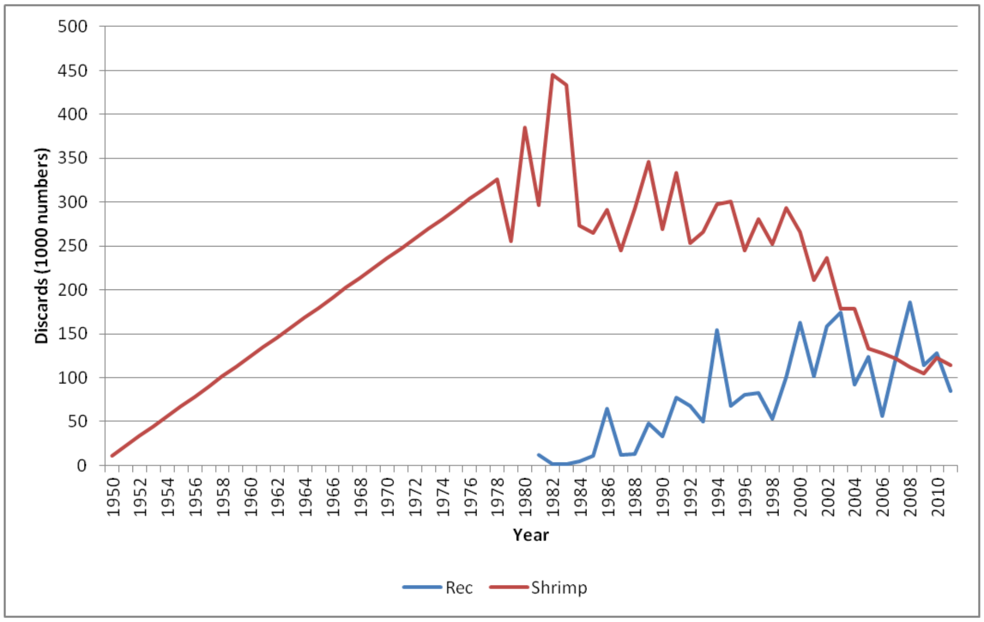


Figure 5.3: Estimated fully selected fishing mortality rate (per year) by fishery. HL refers to commercial handline, PN to commercial pound net, GN to commercial gill net, CN to commercial cast net, Rec for recreational, Rec.D for recreational discards, and shrimp.B for shrimp bycatch. *(Extracted from Figure 3.28 of the Assessment Report.)*

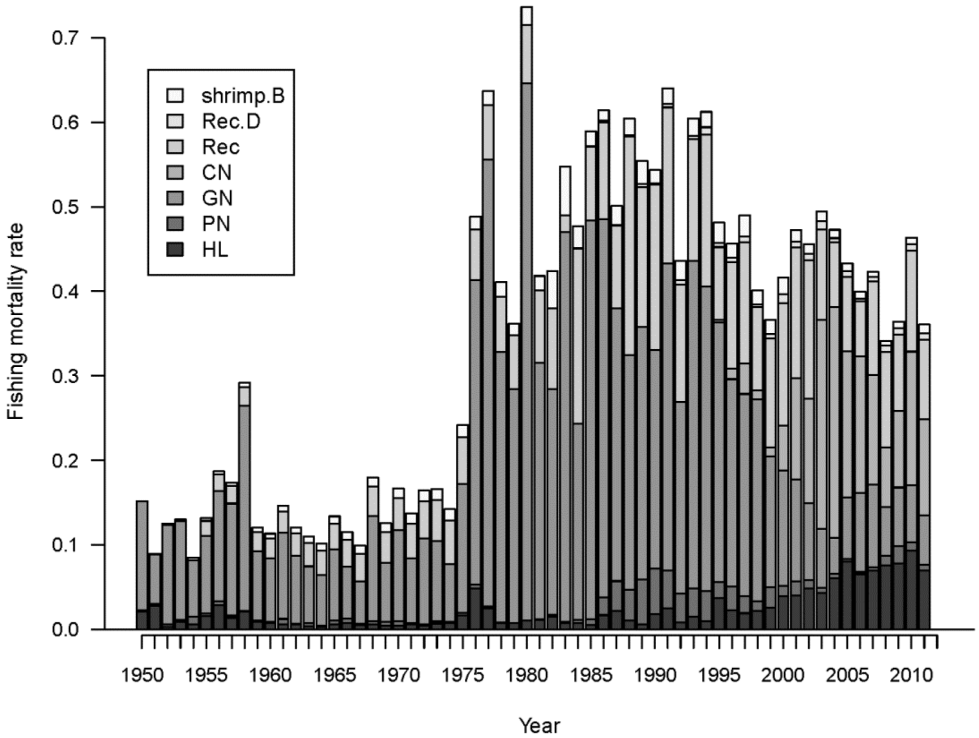


Figure 5.4a: Estimated total biomass (metric tons) at start of year. Horizontal dashed line indicates B_{MSY}. *(Extracted from Figure 3.38 of the Assessment Report.)*

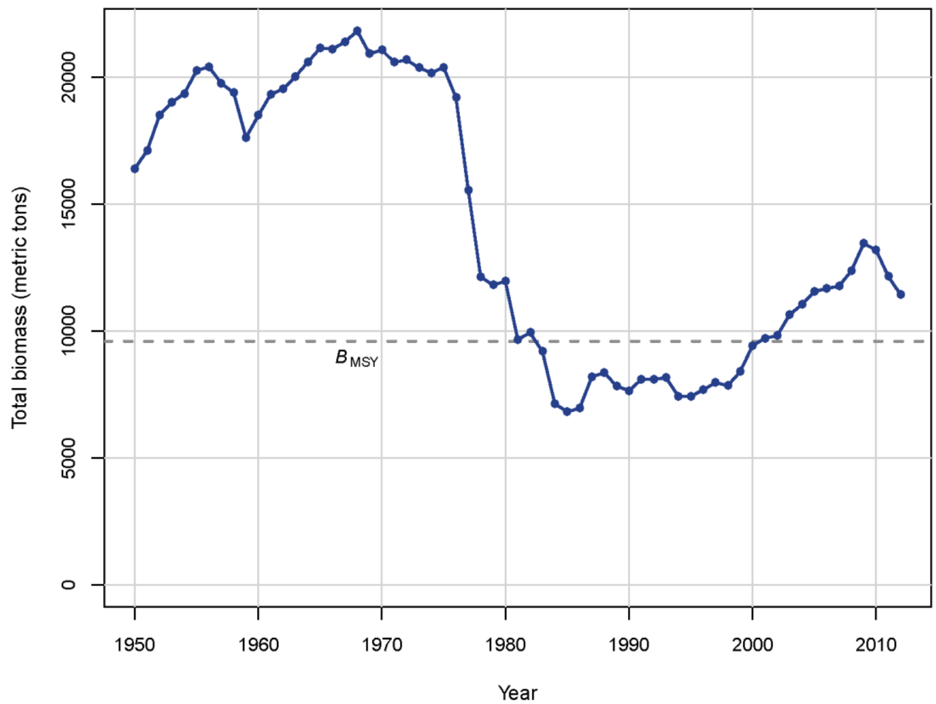


Figure 5.4b: Estimated spawning stock (gonad biomass of mature females) at time of peak spawning. *(Extracted from Figure 3.38 of the Assessment Report.)*

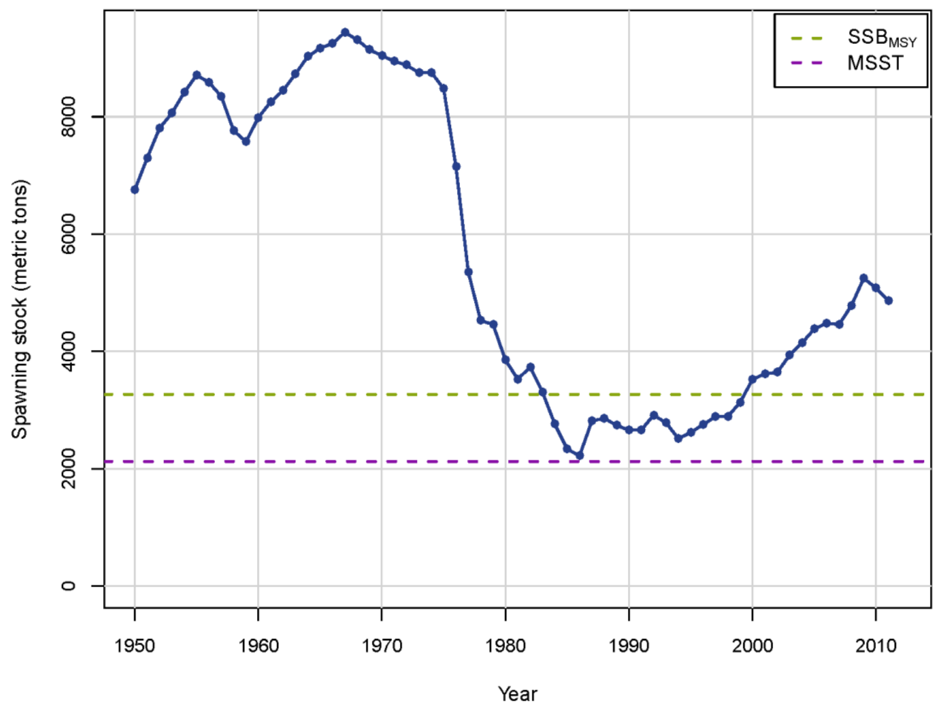


Figure 5.5: Observed indices of abundance from Florida handline trip ticket (FL.HL), MRFSS (MRFSS), and the SEAMAP YOY survey (SEAMAP). *(Generated from data in Table 2.8 of the Assessment Report.)*

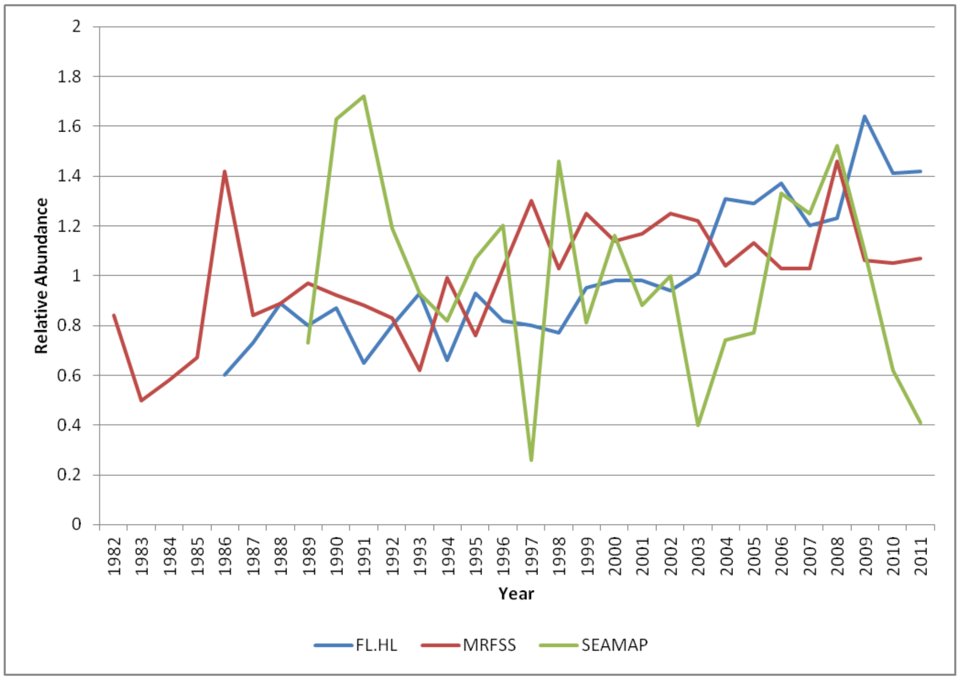


Figure 5.6: Beverton-Holt spawner-recruit curves, with and without lognormal bias correction. The expected (upper) curve was used for computing management benchmarks. Years within panel indicate year of recruitment generated from spawning biomass one year prior. *(Extracted from Figure 3.31 of the Assessment Report.)*

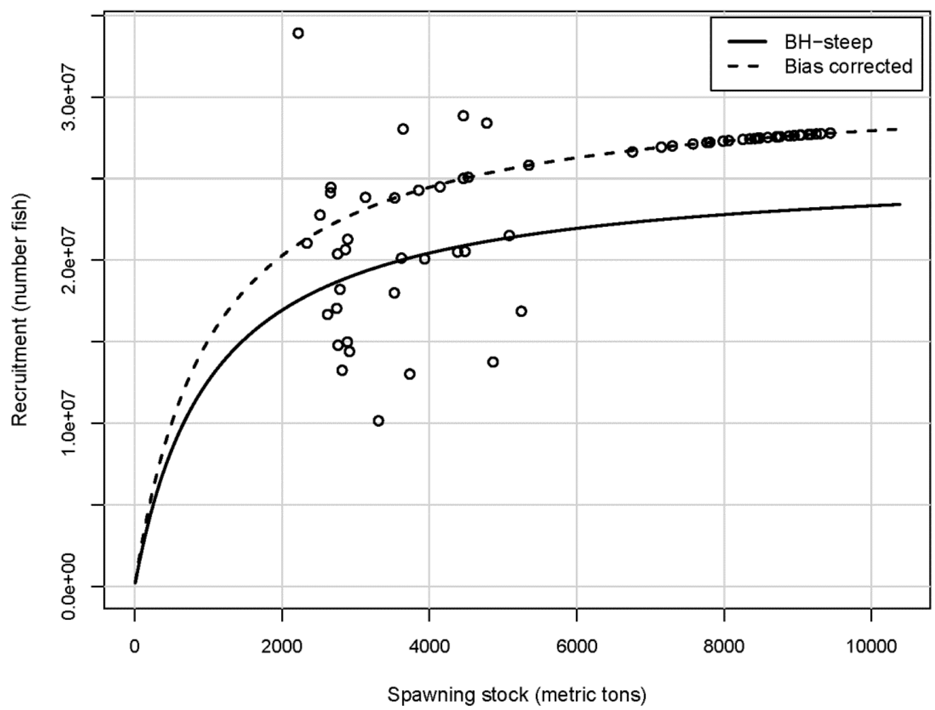


Figure 5.7a: Estimated time series relative to benchmarks. Solid line indicates estimates from base run of the Beaufort Assessment Model; gray error bands indicate 5th and 95th percentiles of the MCB trials. Spawning biomass relative to the spawning stock biomass at MSY. *(Extracted from Figure 3.37 of the Assessment Report.)*

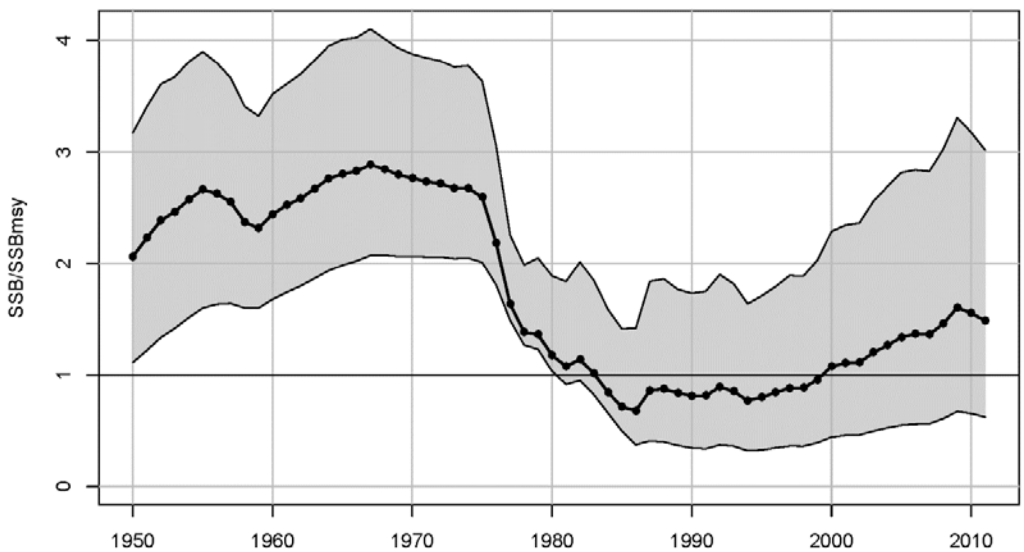


Figure 5.7b: Estimated time series relative to benchmarks. Solid line indicates estimates from base run of the Beaufort Assessment Model; gray error bands indicate 5th and 95th percentiles of the MCB trials. F relative to F_{MSY}. *(Extracted from Figure 3.37of the Assessment Report.)*

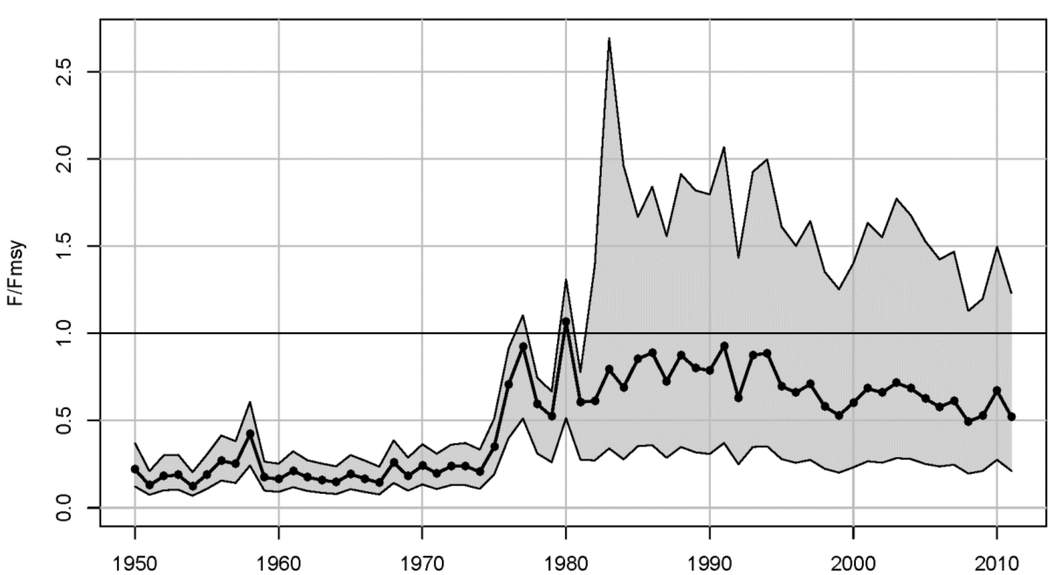
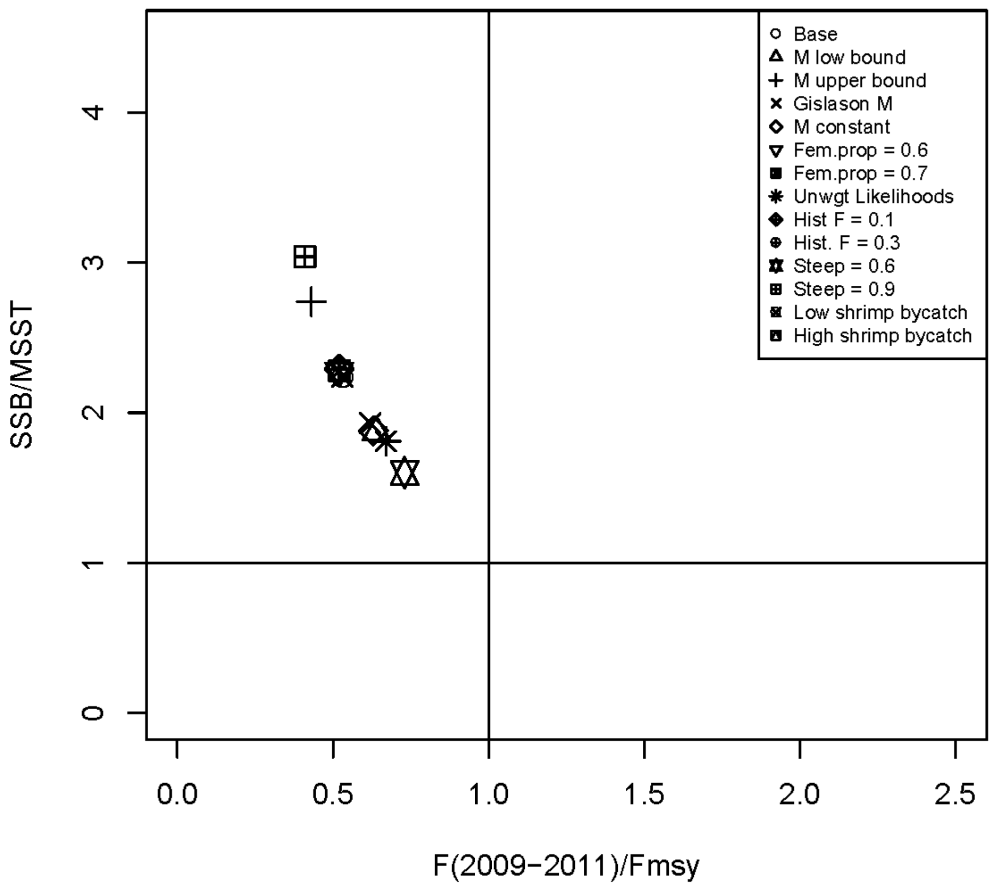


Figure 5.8: Phase plot of terminal status estimates from base and sensitivity runs of the Beaufort Assessment Model. *(Extracted from Figure 3.42 of the Assessment Report.)*



6. SEDAR Abbreviations

ABC	Allowable 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 that will result in retaining XX% of the maximum spawning production under equilibrium conditions
FMAX	fishing mortality that maximizes the average weight yield per fish recruited to the fishery
F0	a fishing mortality close to, but slightly less than, Fmax
FL FWCC	Florida Fish and Wildlife Conservation Commission
FWRI	(State of) Florida 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	Fisheries Southeast Fisheries Science Center, National Marine Fisheries Service
SERO	Fisheries Southeast Regional Office, National Marine Fisheries Service
SPR	spawning potential ratio, stock biomass relative to an unfished state of the stock
SSB	Spawning Stock Biomass
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

South Atlantic 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. Review stock structure and unit stock definitions and consider whether changes are required.
2. Review, discuss, and tabulate available life history information
   - e.g., age, growth, natural mortality, reproductive characteristics
   - provide appropriate models to describe growth, maturation, and fecundity by age, sex, or length as applicable
   - Evaluate the adequacy of available life-history information for conducting stock assessments and recommend life history information for use in population modeling
3. Recommend discard mortality rates.
   - Review available research and published literature, considering that addressing the stocks in this assessment as well as similar species in this and other areas
   - Provide estimates of discard mortality rate by fishery, gear type, depth, and other feasible or appropriate strata
   - Include thorough rationale for recommended discard mortality rates
   - Provided justification for any recommendations that deviate from the range of discard mortality provided in available research and published literature
4. Provide measures of population abundance that are appropriate for stock assessment.
   - Consider and discuss all available and relevant fishery dependent and independent data sources
   - Document all programs evaluated; address program objectives, methods, coverage, sampling intensity, and other relevant characteristics
   - Provide maps of fishery and survey coverage
   - Develop fishery and survey CPUE indices by appropriate strata (e.g., age, size, area, and fishery) and include measures of precision and accuracy
   - Discuss the degree to which available indices adequately represent fishery and population conditions
   - Recommend which data sources are considered adequate and reliable for use in assessment modeling
   - Complete the SEDAR Index evaluation worksheet
5. Provide commercial catch statistics, including both landings and discards in both pounds and number.

- Evaluate and discuss the adequacy of available data for accurately characterizing harvest and discard by species and fishery sector or gear
- Provide length and age distributions, for both landings and discards, if feasible
- Provide maps of fishery effort and harvest

6. Provide recreational catch statistics, including both landings and discards in both pounds and number.
   - Evaluate and discuss the adequacy of available data for accurately characterizing harvest and discard by species and fishery sector or gear
   - Provide length and age distributions, for both landings and discards, if feasible
   - Provide maps of fishery effort and harvest
   - Evaluate historic recreational catch information and modify, as necessary, pre-MRFSS estimates provided in SEDAR 17
7. Provide a single table showing landings by sector in whole weight, using the methods developed by SEFSC for ACL tracking to estimate recreational landings by weight.
8. Provide estimates of shrimp trawl bycatch.
   - Compare and contrast current and historic estimates
   - Thoroughly document input data and estimation procedures
9. Discuss progress on research recommendations suggested by SEDAR 17 and indicate where such recommendations are addressed in this assessment.
   - Provide recommendations for future research in areas such as sampling, fishery monitoring, and stock assessment
   - Include specific guidance on sampling intensity (number of samples including age and length structures) and appropriate strata and coverage
10. Develop a spreadsheet of assessment model input data that reflects the decisions and recommendations of the Data Workshop.
11. Develop a list of tasks to be completed following the workshop.
12. Prepare the Data Workshop report providing complete documentation of workshop actions and decisions (Section II. of the SEDAR assessment report).

II. Assessment Process

1. Review any changes in data following the data workshop and any analyses suggested by the data workshop. Summarize data as used in each assessment model. Provide justification for any deviations from Data Workshop recommendations.
2. Develop population assessment models that are compatible with available data.
   - Consider multiple models, including multispecies models, if data limitations preclude single species assessments
   - Consider a model approach that can be applied to both Gulf and South Atlantic migratory groups.
   - Consider the modeling recommendations of the SEDAR 17 AW and RW, and discuss how they are addressed in this assessment
   - Provide a continuity model consistent with the pre-SEDAR MSAP assessment method.
   - Recommend models and configurations considered most reliable or useful for providing advice
   - Document all input data, assumptions, and equations for each model prepared

3. Provide estimates of stock population parameters.
   - Include fishing mortality, abundance, biomass, selectivity, and other parameters as appropriate given data availability and modeling approaches
   - Include appropriate and representative measures of precision for parameter estimates
4. Characterize uncertainty in the assessment and estimated values.
   - Consider uncertainty in input data, modeling approach, and model configuration
   - Consider other sources as appropriate for this assessment
   - Provide appropriate measures of model performance, reliability, and 'goodness of fit'
5. Provide evaluations of yield and productivity
   - Include yield-per-recruit, spawner-per-recruit, and stock-recruitment evaluations
6. Provide estimates of population benchmarks or management criteria consistent with the available data, applicable FMPs, proposed FMPs and Amendments, other ongoing or proposed management programs, and National Standards.
   - Evaluate existing or proposed management criteria as specified in the management summary
   - Recommend proxy values when necessary
7. Provide declarations of stock status relative to management benchmarks or, if necessary, alternative data-poor approaches.
8. Perform a probabilistic analysis of proposed reference points, stock status, and yield.
   - Provide the probability of overfishing at various harvest or exploitation levels
   - Provide a probability density function for biological reference point estimates
   - If the stock is overfished, provide the probability of rebuilding within mandated time periods as described in the management summary or applicable federal regulations
9. Project future stock conditions (biomass, abundance, landings, discards and exploitation) and develop rebuilding schedules if warranted; include estimated generation time. Stock projections shall be developed in accordance with the following:

   A) If stock is overfished:

   F=0, F=current, F=Fmsy, Ftarget,
   F=Frebuild (max that rebuild in allowed time)

   B) If stock is overfishing

   F=Fcurrent, F=Fmsy, F= Ftarget

   C) If stock is neither overfished nor overfishing

   F=Fcurrent, F=Fmsy, F=Ftarget

   D) If data-limitations preclude classic projections (i.e. A, B, C above), explore alternate models to provide management advice.
10. Provide recommendations for future research and data collection.
    - Be as specific as practicable in describing sampling design and sampling intensity
    - Emphasize items which will improve future assessment capabilities and reliability
    - Consider data, monitoring, and assessment needs
11. Prepare an accessible, documented, labeled, and formatted spreadsheet containing all model parameter estimates and all relevant population information resulting from model estimates and any 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 for Review (Section III of the 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. Evaluate the assessment with respect to the following:
   - Is the stock overfished? What information helps you reach this conclusion?
   - Is the stock undergoing overfishing? What information helps you reach this conclusion?
   - Is there an informative stock recruitment relationship? Is the stock recruitment curve reliable and useful for evaluation of productivity and future stock conditions?
   - Are quantitative estimates of the status determination criteria for this stock reliable? If not, are there other indicators that may be used to inform managers about stock trends and condition?
4. Evaluate the adequacy, appropriateness, and application of the methods used to project future population status with regard to accepted practices and data available for this assessment.
5. 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. Provide justification for the weightings used in producing the combinations of models.
6. Consider how uncertainties in the assessment, and their potential consequences, have been addressed.
   - Comment on the degree to which methods used to evaluate uncertainty reflect and capture the significant sources of uncertainty
   - Ensure that the implications of uncertainty in technical conclusions are clearly stated
7. Consider the research recommendations provided by the Data and Assessment workshops and make any additional recommendations or prioritizations warranted.
   - Clearly denote research and monitoring needs that could improve the reliability of, and information provided by, future assessments
8. Prepare a Peer Review Summary summarizing the Panel's evaluation of the stock assessment and addressing each Term of Reference. Develop a list of tasks to be completed following the workshop. Complete and submit the Peer Review Summary Report in accordance with the project guidelines.

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 in the assessment, alternative 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	K. McCarthy

	Mexico and US South Atlantic	
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 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 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	Drew et al.

	cobia	
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	Darden et al, 2012

	Southeastern US coast	
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. More age-0 samples were needed 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 methodologies. The data are reviewed using rigorous quality assurance, quality control procedures, and validation rules for data entry and proofed against original data sheets. Ages were validated for precision using published techniques. Indexes of precision between readers are 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 is sought after by both the commercial and recreational sectors throughout their range (Trent and Anthony 1978). Based on electrophoresis studies, spawning locations, stock distribution patterns, 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 a 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. 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, and it was acknowledged there was little biological evidence for either the Council Boundary or Dade-Monroe County line as the stock division. Each workgroup will divide the data as best appropriate for the data source.

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 Management 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 3.69. Other estimates that rely heavily on K from the von Bertalanffy parameters include Ralston, Jenson and Pauly, which also estimated high M, 0.63 – 1.73. 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 0.22 – 0.37. Hoenig (1983), Hewitt and Hoenig (2005), and Alagaraja (1984), which all use maximum age exclusively, averaged 0.34. The Hoenig estimate from the "fish" equation was 0.35. 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 12 years. This data point came from an aging study by Nobel et al. (1992).

<u>Recommendation for the AW:</u>
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 - 12 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 fish 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.

<u>Recommendation for the AW:</u>
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 = 16,667) of Spanish mackerel collected from 1987-2011 in Atlantic waters, including those south of U.S. Highway 1 in Monroe County Florida (Figure 2.2). 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.

In addition to ages provided by the PCLAB, the same SCDNR data set (and methods used to incorporate those ages) used in SEDAR 17 were included in the SEDAR 28 data set. The Virginia Marine Resources Commission (VMRC)(n = 3,137) and a M.S. thesis data set (Gaichas, 1997)(n = 1,355) also provided age data to be reviewed for inclusion with Atlantic age data. After review of VMRC aging methodology and comparison of PCLAB (all modes) versus VMRC (all commercial modes) mean size at age plots (Figures 2.3a and 2.3b), the LHG agreed that VMRC Spanish mackerel age data should be used in the SEDAR 28 assessment. Because younger fish in the Gaichas data set had lower mean sizes at age than those in all other Atlantic aged samples (Figures 2.3a and 2.3b), possibly due to differences in aging methodology or gear selectivity issues, the LHG decided it would not be appropriate to include that data in the SEDAR 28 assessment.

Approximately 400 samples from 2011 from the North Carolina Division of Marine Fisheries, not available prior to the data workshop, were processed and aged shortly thereafter. After comparison of mean size at age plots of the 2011 data with all aged samples from North Carolina through 2010 (Figures 2.4a and 2.4b), the LHG agreed that data should be included with the assessment.

Recommendations for the AW:
Use the combined Panama City NMFS (Atlantic stock), SCDNR, and VMRC data set for ageing the catch.

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 weighting (Figure 2.5). The initial model run for all data combined resulted in the following parameter estimates: $t_0 = -2.01$, $K = 0.24$, and $L_\infty = 646.8$. This t_0, which predicts an unrealistic size at age-0 (Figure 2.6), 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 -0.5and when this was done, the resulting parameters were $K = 0.45$ and $L\infty = 595.0$ (Figure 2.6). 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 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 2.5). For females, the resulting parameter estimates were $t_0 = -0.5$, $K = 0.42$, and $L\infty = 637.8$. For males, the resulting parameter estimates were $t_0 = -0.5$, $K = 0.56$, and $L\infty = 528.6$.

Recommendations for the AW:
Because most of the fishery data does not identify sex of the fish, use the model for the sexes combined, corrected for the minimum size limit bias and inversely 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).

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. The smallest samples from the Atlantic were in the 151-175mm FL size class (n=3) and none of those fish were reported as mature. The smallest mature female was 251 mm FL and the size at 50% maturity was approximately 301-325 mm FL (Figure 2.7). Age at 50% maturity for Atlantic females was 0.70 yr (std. err. 0.41-1.16) (Figure 2.8). The youngest mature female was age 0 from both regions. The smallest size-class of Atlantic males (Table 2.4) was 151-175 mm FL (n=5) and one was mature. That smallest mature male was 167 mm FL and the size at 50% maturity was approximately 201-225 mm FL (Figure 2.9). The youngest mature male was age 0 from both regions. The apparent lower size-at-maturity for Atlantic males is likely more a reflection of low or zero sample sizes in the smaller size-classes, and the fact that Atlantic fish, except for the Finucane and Collins (1986) samples, were staged histologically, a more accurate method (especially for males) than the macroscopic staging used on all Gulf samples.

2.8.3 Sex ratio

Strong sexual dimorphism in Spanish mackerel (females larger than males at ages 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 0 – 8 year old females made up 58% of all gill net samples from commercial and scientific surveys and recreational hook-and-line samples (Figure 2.10, 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 ages 0 - 7 made up 61% of the catch (Table 2.6). However, above 40 cm, females make up 70% of gill net sampled fish (Figure 2.11). Recreationally caught females above 40 cm made up 71% of the samples (Figure 2.12). 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.

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

Over all ages and gears, weighted percent females is 59%.

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.

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2.13 Tables

Table 2.1. Point estimates of natural mortality (M) for the Atlantic stock of Spanish mackerel based on maximum age = 12 years and von Bertalanffy parameter estimates: t_0 = -0.5, k = 0.45 and L_∞ = 595.

Equations for Estimating M:	**Parameters**	**M**
Alverson & Carney	k, tmax	0.20
Beverton	k, am	3.65
Hoenig	tmax	0.35
$\text{Hoenig}_{\text{all taxa}}$	tmax	0.37
Pauly		0.83
Ralston	k	0.95
Ralston (geometric mean)	k	1.80
Ralston Method II	k	1.60
Hewitt & Hoenig	tmax	0.33
Jensen	k	0.68
Rule of thumb	tmax	0.25
Alagaraja	survivorship to tmax: 0.01	0.38
	survivorship to tmax: 0.02	0.33
	survivorship to tmax: 0.05	0.25

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 Atlantic Spanish mackerel gill net samples by age from commercial and scientific surveys in the PCLAB data set; 5% to 95% confidence intervals.

Age	Females	Males	Total	% Females	F : M	low C.I.	high C.I.
0	376	308	684	55	1.2 : 1.0	51	59
1	1,158	654	1,812	64	1.8 : 1.0	62	66
2	1,111	591	1,702	65	1.9 : 1.0	63	68
3	733	387	1,120	65	1.9 : 1.0	63	68
4	447	300	747	60	1.5 : 1.0	56	63
5	190	153	343	55	1.2 : 1.0	50	61
6	73	71	144	51	1.0 : 1.0	43	59
7	34	29	63	54	1.2 : 1.0	42	66
8	13	12	25	52	1.1 : 1.0	34	70
9	3	5	8	38	0.6 : 1.0	14	70
10	2	2	4	50	1.0 : 1.0	15	85
Total	4,140	2,512	6,652	58*	1.6 : 1.0		

* ages 0 – 8

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

Sex ratios of ATL recreational hook-and-line SMK samples by age

Age	Females	Males	Total	% Females	F : M	low C.I.	high C.I.
0	144	111	255	56	1.3 : 1.0	50	62
1	1,111	1,042	2,153	52	1.1 : 1.0	49	54
2	287	283	570	50	1.0 : 1.0	46	54
3	144	119	263	55	1.2 : 1.0	49	61
4	126	55	181	70	2.3 : 1.0	63	76
5	70	22	92	76	3.2 : 1.0	66	84
6	35	18	53	66	1.9 : 1.0	53	77
7	23	15	38	61	1.5 : 1.0	45	74
8	14	4	18	78	3.5 : 1.0	55	91
9	3	1	4	75	3.0 : 1.0	30	95
10	2	0	2	100	2.0 : 0.0	34	100
11	2	1	3	67	2.0 : 1.0	21	94
Total	1,961	1,671	3,632	61*	1.2 : 1.0		

* ages 0 - 7

Table 2.7. Spanish mackerel meristics and conversion factors. Recommended equations are shaded in gray.

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 Atlantic stock of Spanish mackerel.

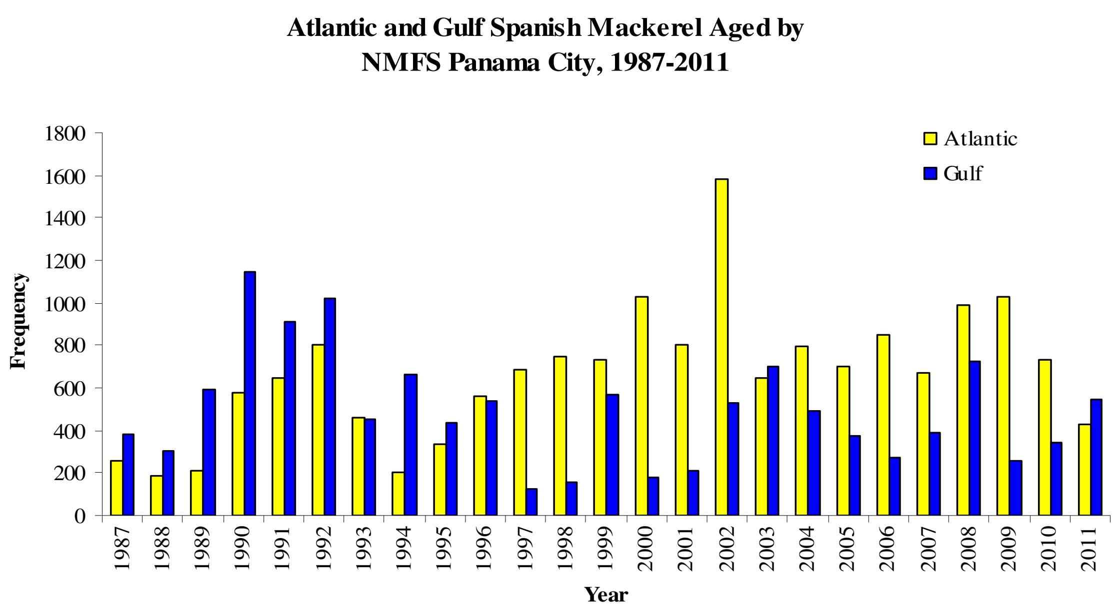

Figure 2.2. Atlantic and Gulf Spanish mackerel aged by NMFS Panama City, 1987-2011.

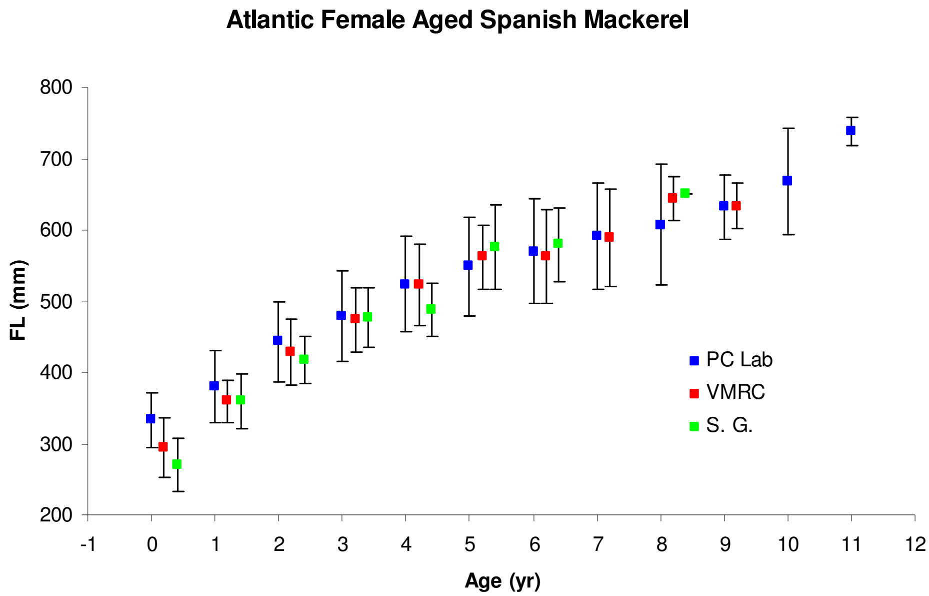

Figure 2.3a. Atlantic female Spanish mackerel aged by NMFS Panama City (1988-2011), VMRC (2002-2010), and Sarah Gaichas (1988, 1993 – 1995). Error bars are +/- 1 standard deviation. Ages are given by each full year, but symbols are off-set to increase readability of the figure. Data from S.G. were not included in further analyses.

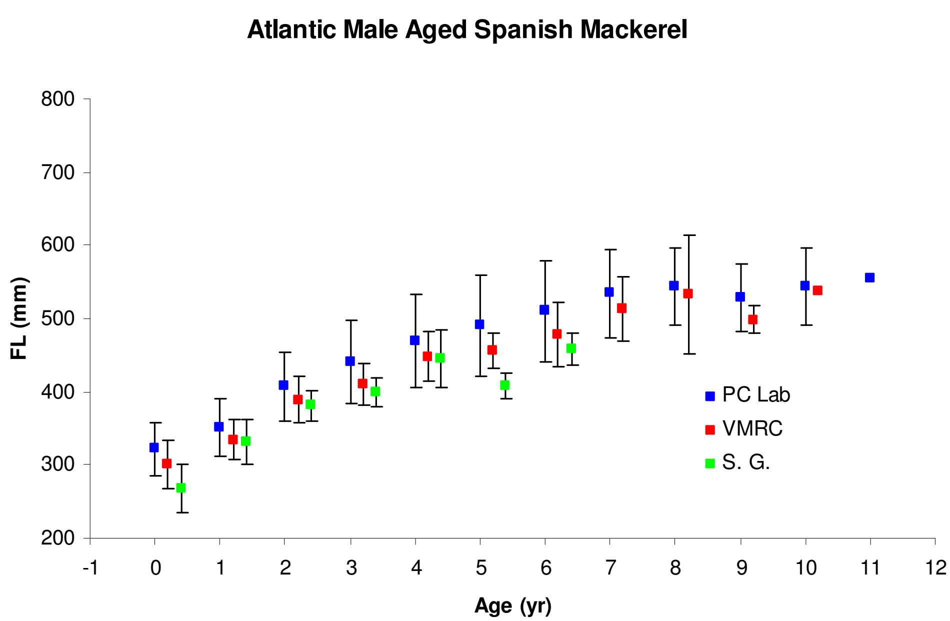

Figure 2.3b. Atlantic male Spanish mackerel aged by NMFS Panama City (1988-2011), VMRC (2002-2010), and Sarah Gaichas (1988, 1993-1995). Error bars are +/- 1 standard deviation. Data from S.G. were not included in further analyses.

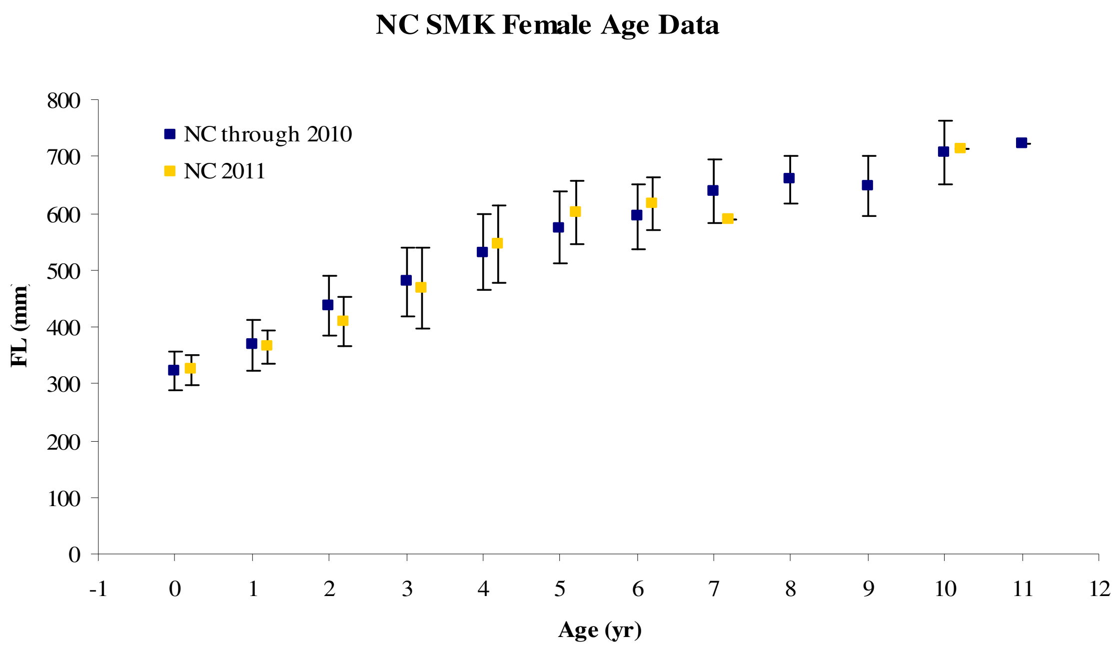

Figure 2.4a. Female Spanish mackerel from North Carolina aged by NMFS Panama City (1988 – 2010) and 2011. Error bars are +/- 1 standard deviation.

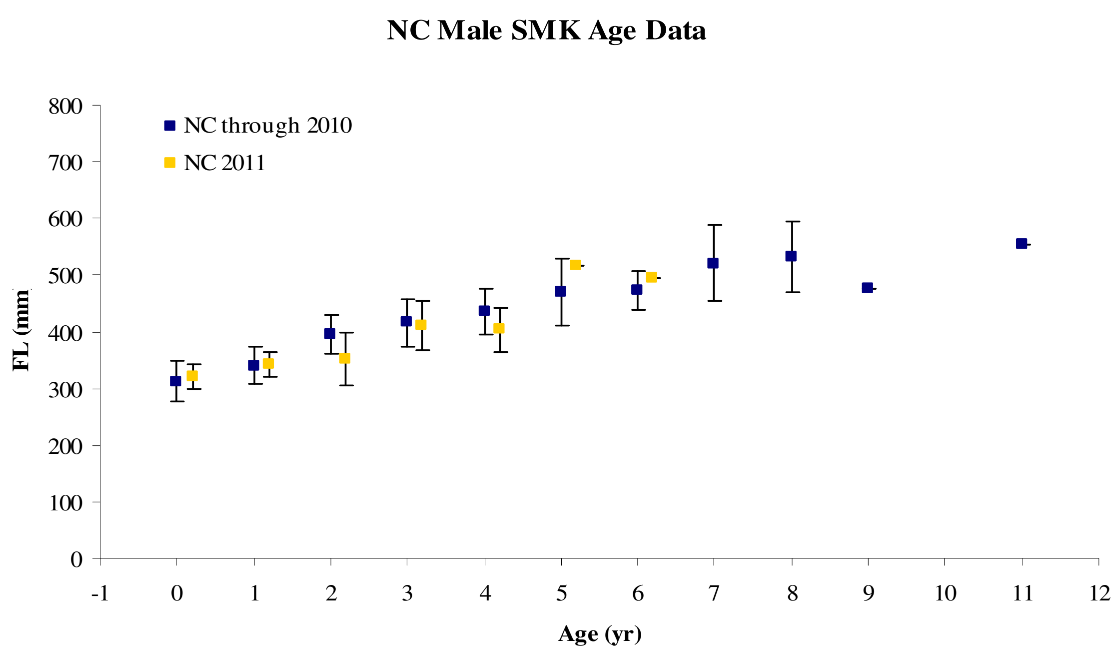

Figure 2.4b. Male Spanish mackerel from North Carolina aged by NMFS Panama City (1988 – 2010) and 2011. Error bars are +/- 1 standard deviation.

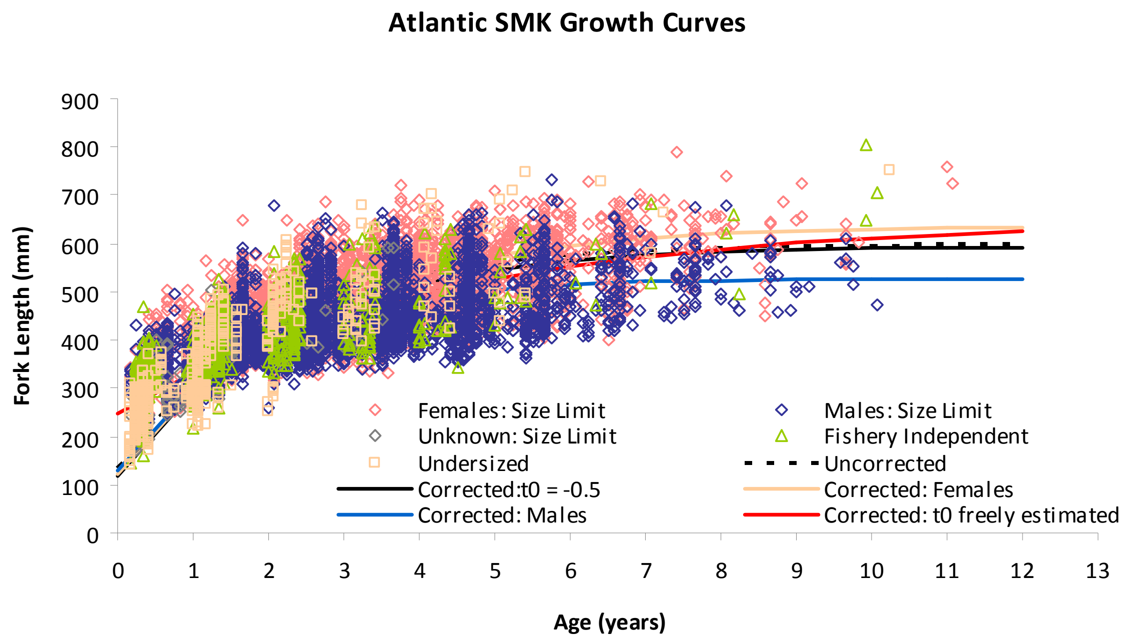

Figure 2.5. Atlantic Spanish mackerel inversely weighted von Bertalanffy growth curves and raw data from the PCLAB data set. "Corrected" refers to the Diaz et al. correction in the growth model to handle the bias in the size-at-age data under the influence of the minimum size limit regulation.

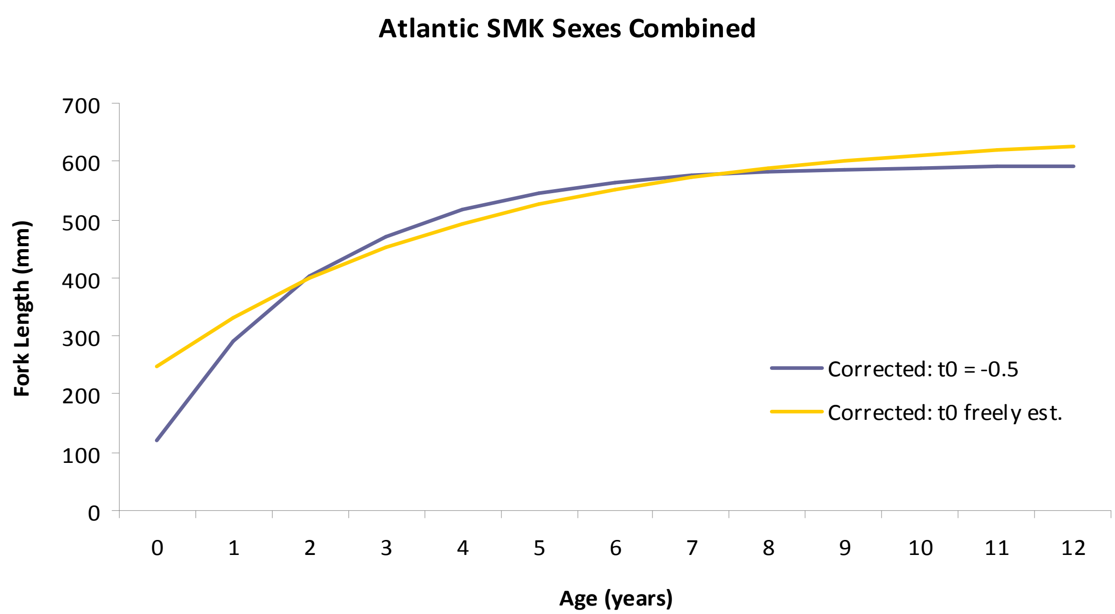

Figure 2.6. Spanish mackerel overall von Bertalanffy growth curves: corrected for size limit bias and inverse weighted with fixed $t_0 = -0.5$ and freely estimated $t_0 = -2.01$.

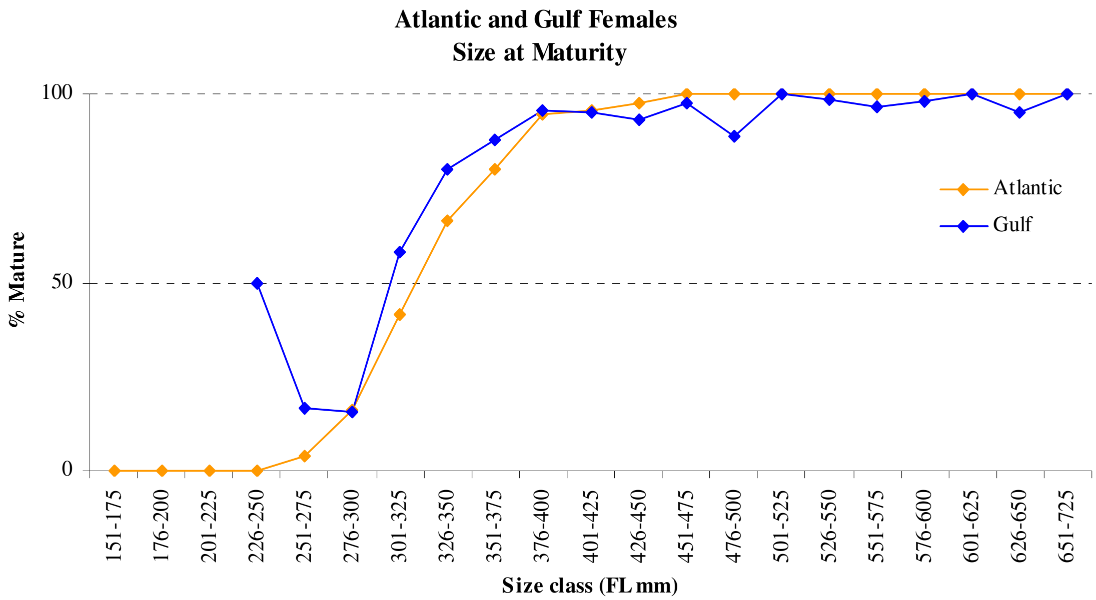

Figure 2.7. Size at maturity of female Spanish mackerel from the Atlantic and Gulf; Finucane and Collins (1986), MARMAP, PCLAB, and SEAMAP combined data sets.

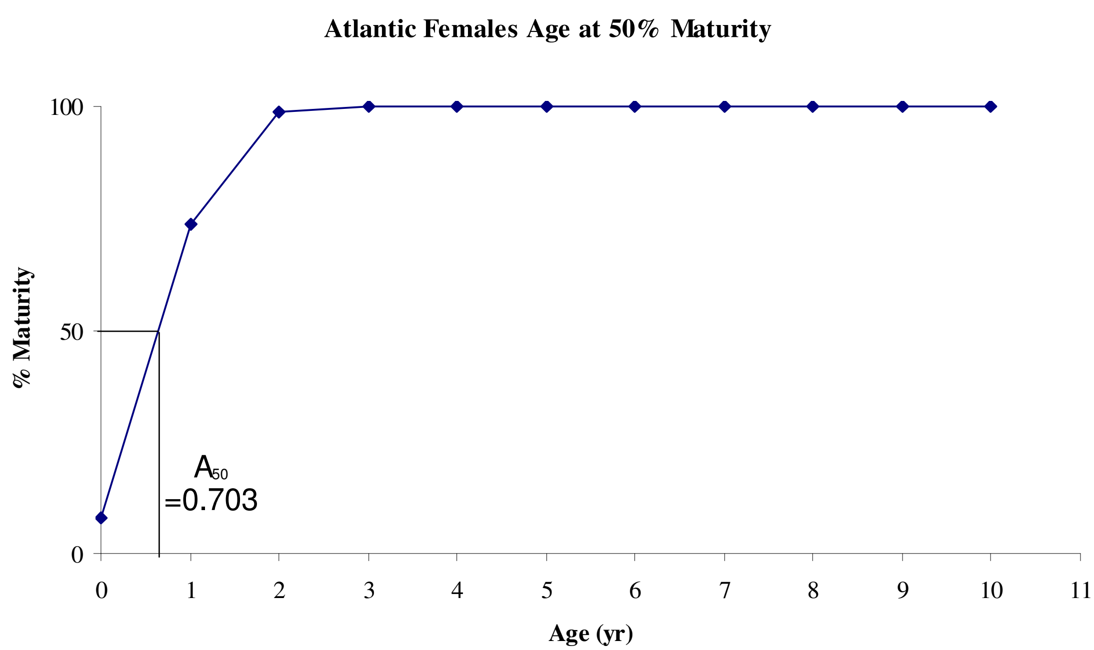

Figure 2.8. Age at 50% maturity of Atlantic females, MARMAP, PCLAB, and SEAMAP combined data sets.

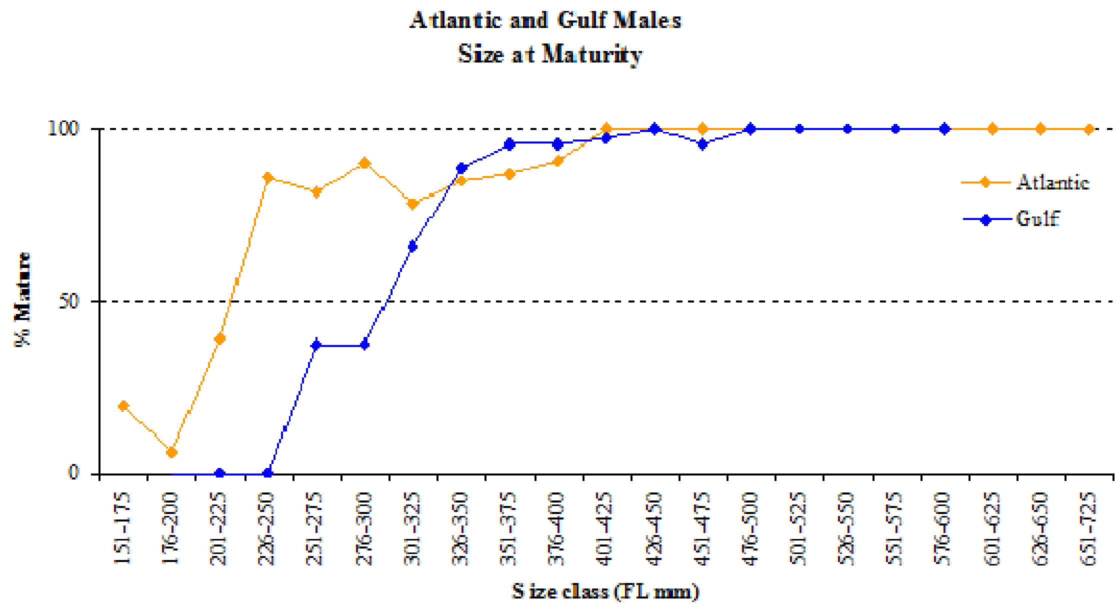

Figure 2.9. Size at maturity of male Spanish mackerel from the Atlantic and Gulf; Finucane and Collins (1986), MARMAP, PCLAB, and SEAMAP combined data sets.

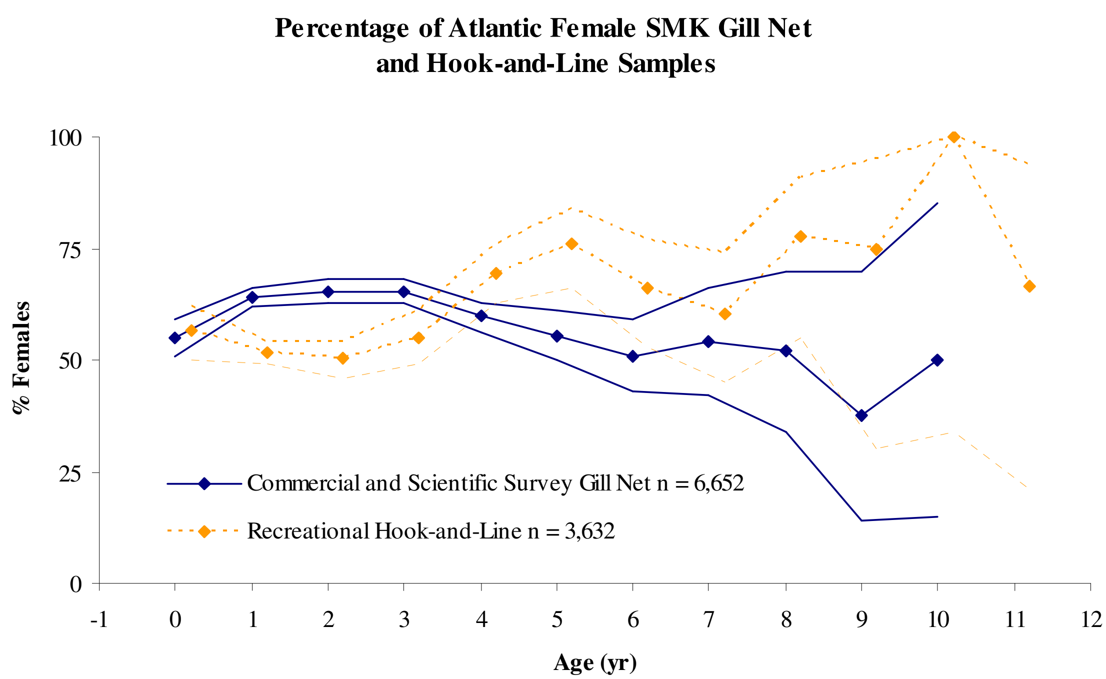

Figure 2.10. Percentage by age of Atlantic female Spanish mackerel commercial and scientific survey gill nets, and recreational hook-and-line samples in the PCLAB data set; 5% and 95% confidence intervals.

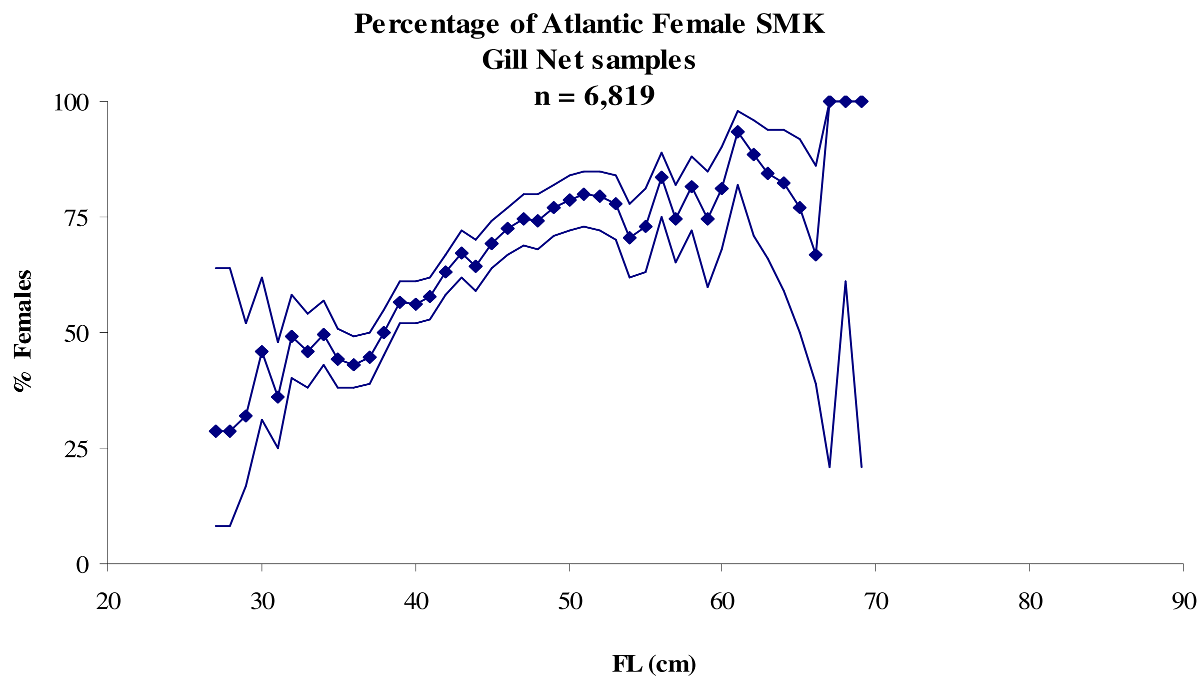

Figure 2.11. Percentage of Atlantic females by size in the PCLAB data set from commercial and scientific survey gill nets; 5% to 95% confidence intervals.

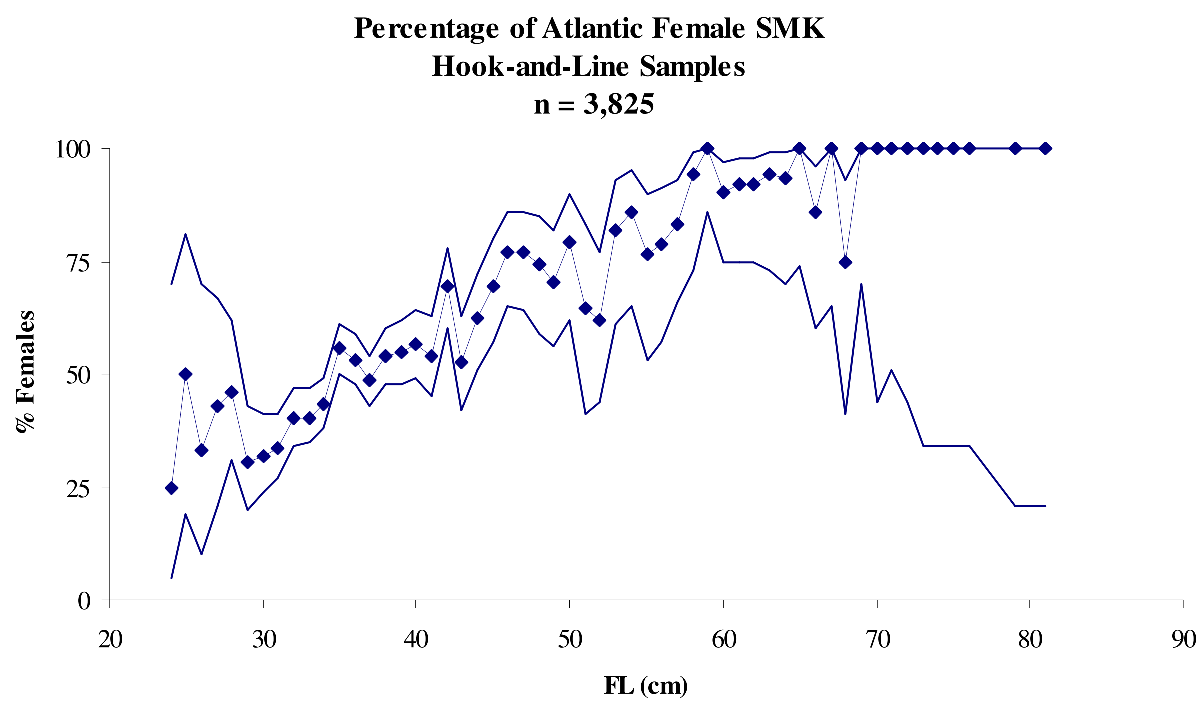

Figure 2.12. Percentage of Atlantic females by size in the PCLAB data set from recreational hook-and-line samples; 5% and 95% confidence intervals.

3 Commercial Fishery Statistics

3.1 Overview

Commercial landings for the U.S. South Atlantic Spanish mackerel stock were developed by gear (gillnet, castnet, poundnets, handlines, and miscellaneous) in whole weight for the period 1889–2010 based on federal and state databases. Corresponding landings in numbers were based on mean weights estimated from TIP by gear, state, and year.

Commercial discards were calculated from vessels fishing in the US South Atlantic. Shrimp bycatch of Spanish mackerel was estimated from observer data and scaled using shrimping effort.

Sampling intensity for lengths and age by gear and year were considered, and length and age compositions were developed by gear and year for which sample size was deemed adequate.

3.1.2 Participants Commercial Workgroup

David Gloeckner	Workgroup leader; Gulf	NMFS Miami
Kyle Shertzer	Workgroup leader; SA	NMFS Beaufort
Stephanie McInerney	Rapporteur/Data Provider	NC DMF
Steve Brown	Data Provider	FL MRRI
Julie Califf*	Data Provider	GADNR
Julie Defilippi	Data Provider	ACCSP
Tim Sartwell	Data Provider	ACCSP
Joe Cimino	Data Provider	VMRC
Amy Dukes	Data Provider	SC DMF
Donna Bellais	Data Provider	GSMFC
Liz Scott-Denton*	Data Provider	NMFS Galveston
Rusty Hudson	Commercial Fisherman	FL
Ben Hartig	SAFMC; Commercial Fisherman	FL
Kevin McCarthy	Data Provider	NMFS Miami
Rob Cheshire*	Data provider	NMFS Beaufort
Brian Linton*	Data Provider	NMFS Miami

* Did not attend data workshop

3.2 Review of Working Papers

The Working Group (WG) reviewed three working papers. All three of these papers were focused on Gulf of Mexico (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.

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 1889, the first year of available data, but the reliability of information improved substantially in 1950 with several additional improvements since (described along with methods).

The terminal year considered for this report was 2010. However, the intent is to provide data through 2011 in time for the assessment workshop, if feasible. 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.

3.3.2 Stock Boundaries

Commercial landings were compiled from FL through ME (Figure 3.1). The southern boundary was the Florida Keys along the South Atlantic and Gulf of Mexico Council Boundary (Figure 3.2). Landings north of the Keys were considered to be from the Gulf of Mexico stock, and landings south of the keys were considered to be from the Atlantic stock.

3.3.3 Identification Issues

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

3.3.4 Commercial Gears

The WG evaluated the distribution of gears in the landings and in the TIP data, and concluded that decisions made during SEDAR 17 about commercial gears should be maintained in this assessment. Thus, commercial landings were apportioned into five gear types: gillnet, castnet, handline (including trolling), poundnet, and miscellaneous (including longline). Gillnets were the dominant gear type, with castnets becoming increasingly popular since the mid-1990s, likely in response to Florida's net ban. The WG recommended that, for the assessment model, landings from the miscellaneous gear might be distributed among the other four gears according to their annual proportions of total landings.

3.3.5 Commercial Landings by Gear

Landings prior to 1950 were compiled from reports by the Bureau of Commercial Fisheries or US Fish and Fisheries Commission, available from the NMFS office of Science and Technology. These historical landings are also reported in NMFS (1990). Prior to 1927, landings estimates were not available by gear for all states, therefore are presented in total in the years available.

Statistics on commercial landings (1950 to present) for all species on the Atlantic coast are maintained in the Atlantic Coastal Cooperative Statistics Program (ACCSP) Data Warehouse. The Data Warehouse is an on-line database of fisheries dependent data provided by the ACCSP state and federal partners. Data sources and collection methods are illustrated by state in Figure 3.3. The Data Warehouse was queried in February 2012 for all Spanish mackerel landings (annual summaries by gear category) from 1950–2010 from Florida (east coast including Monroe County) through Maine (ACCSP, 2012). Data are presented using the gear categories as determined at the DW. The specific ACCSP 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 1950–2010.

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, and 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 line to the Florida-Georgia line (Figure 3.2). The first full year of available data from Florida trip tickets is 1986.

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

South Carolina –The landings data for South Carolina come from two different sources. The first, 1980–2003, is from the old NMFS Canvass data system. This system involved wholesale seafood dealers reporting total monthly landings by species to the state. The second source, 2004–present, is the SC Trip Ticket Program with data available in the ACCSP data warehouse. The Trip Ticket Program requires wholesale seafood dealers to fill out an individual trip ticket for each trip made. The landings are broken down by species, gear type, and area fished. The ALS data base was used to extend landings back to 1962.

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

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

Virginia – The Virginia Marine Resources Commission provided VA landings data from 1993 through current. Virginia landings from prior to 1993 were provided by ACCSP.

Combined State Results – Approximately 75% of Spanish mackerel commercial landings come from FL (Figure 3.4A,B), and effort is similarly distributed geographically (Figure 3.5A,B). Landings by gear category are presented in Table 3.2 and Figure 3.6. Throughout most of the time series, gillnets were the dominant gear, but use of castnets has increased substantially since the FL gillnet ban. In the most recent years (2000–2010), gillnets comprise 39% of the total landings, castnets 37%, handlines 19%, poundnets 4%, and miscellaneous other gears <1%.

The Workgroup made the following decisions for reporting of commercial landings:

- Landings should be reported as whole weight (rather than gutted)
- Landings would be presented by calendar year/gear and as far back as monthly data are available across all states
- Final landings data (1950–2010) would come from the following sources:
  North of Virginia:
  ACCSP 1950–2010
  Virginia:
  ACCSP 1950–1993
  VA 1993–2010
  North Carolina:
  ACCSP 1950–1971, 1978–1993
  NC 1972–1977, 1994–2010
  South Carolina:
  ACCSP 1950–2010
  Georgia:

ACCSP 1950–2010
Florida:
ACCSP 1950–1975, 1997–2010
FL 1976–1996

Confidentiality – Issues of confidentiality often arise when landings are reported by area (e.g., state). This was not done here, and landings reported by gear met the "rule of 3," so there is no breach of confidentiality.

3.3.6 Converting Landings in Weight to Landings in Numbers

The weight in pounds for each sample was calculated using the mean weight of fish by gear and year. Mean weights of fish were weighted by the weight of fish in the sample, trip weight, and strata landing weight (all in pounds whole weight). Where the sample size was fewer than 20, the mean across all years for that gear was used (Table 3.3). A minimum sample size of 50 fish was also examined, because it had been used in some previous assessments. However, the 50 fish threshold resulted in an average difference of only 0.02 pounds relative to the 20 fish threshold, so the 20 fish minimum sample size was maintained. The landings in pounds whole weight were then divided by the mean weight for that stratum to derive landings in numbers (Table 3.4). For early landings prior to when gears were documented, average weight from gillnets (dominant gear) was applied to estimate landings in numbers.

Although landings are supplied here in numbers of fish (to satisfy TOR 5), the WG recommends that the assessment fit to commercial landings in weight. Landings in weight are considered to be more reliable, because 1) landings data were collected in units of weight, and 2) landings in number include the additional uncertainty imposed by calculations or assumptions of the applied average weights.

3.4 Commercial Discards

3.4.1 Discards from Commercial Fishing

Spanish mackerel discards from the commercial vertical line, trolling, and gillnet fisheries were calculated for the US South Atlantic (statistical areas 2300-3700; Figure 3.1) and Gulf of Mexico (statistical areas 1-21; Figure 3.1). 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 SEDAR 28-DW04 and are summarized below. For the Atlantic, these methods are similar to those of SEDAR 17 (SEDAR17-DW10), with the exception of extending the southern boundary in the current analysis (from 25^0N latitude to 23^0N).

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 gillnet 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; gillnet 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 be erroneously low for years prior to 1998.

Approximately 1.3 percent of all Spanish mackerel discard reports for the period 2002–2010 was from trips reporting fishing gears other than vertical lines, trolling, and gillnets. 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 South Atlantic are provided in Tables 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 10 of 13 years, fewer than 15,000 Spanish mackerel were discarded in the South Atlantic. Calculated Spanish mackerel commercial discards were generally higher in the Gulf of Mexico than the South Atlantic, but were always less than 20,000 fish 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 a commercial fishing trip suggesting that under-reporting of discards may be occurring. These results should, therefore, be used with caution. Discards calculated here likely 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 gillnet 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.

3.4.2 Discards from Shrimp Bycatch

In SEDAR 17, Spanish mackerel bycatch from shrimp fishing was estimated, first by fitting a delta-GLM for years with observer coverage, and then by fitting a "hockey stick" model to predict discards from shrimp landings for remaining years (SEDAR17-DW12, SEDAR17-AW07). In SEDAR 28, the approach was reevaluated and modified for simplicity, consistent with comments from the SEDAR 17 Review.

Encounter rate and catch rate

Evaluation of the shrimp bycatch data from the South Atlantic Shrimp System (SAS) observer data revealed large gaps in the coverage of shrimp effort even when summarized at the state and season levels (Table 3.8). Trips identified as rock shrimp trips and trips in depths greater than 70 feet were excluded from this analysis (Figure 3.7). Relative to SEDAR 17, a more simplistic approach was adopted here based on the data available. Years with adequate samples spread across the shrimp season were identified and an encounter rate was calculated as the number of positive Spanish mackerel trips divided by the total trips. An empirical mean encounter rate was determined separately for each area (NC:2008−2010, GA/SC: 2005,2007, and 2009). There was not enough data to determine an encounter rate for Florida. The working group recommended applying the encounter rate from GA/SC to Florida. The annual area-specific catch rate was calculated as the average number of Spanish mackerel caught per trip from positive Spanish mackerel trips (SEDAR28-AW02).

Shrimping effort

The estimates of shrimp effort were provided by each of the states (NC, SC, GA, FL) for the most recent period. NMFS SAS estimates of effort were available for earlier years (SEDAR28-AW02). In addition, ACCSP provided shrimping effort estimates for comparison with other data sources. In general, data provided from the state representatives were considered most reliable and were used whenever available. For all other years, the NMFS SAS estimates of shrimp effort were used.

Effort was calculated as net-hours (hours fished multiplied by an estimate of the number of nets per vessel) to match estimates of catch rate from the observer data. Because no depth information is available in the effort files, deepwater/offshore trawling was excluded, as trawling at those depths is not likely to encounter juvenile Spanish mackerel. Trips were limited to those fishing in estuaries or out to 3 miles from shore. Further details about use of the various data sources are below:

<u>NC trip ticket</u>

North Carolina shrimp effort data were provided (1994−2010) and summarized by year, month, water body (estuarine and state ocean), and gear. Only the "shrimp trawl" and "skimmer trawl" gear categories were retained. The average number of nets per vessel was provided for 2000−2010 for shrimp trawls. Skimmer trawls were assumed to have 2 nets per vessel. The average number of nets per vessel from 2000−2002 was used for 1994−1999 (SEDAR28-AW02). The net-hours were calculated as the average number of nets per vessel multiplied by the total annual hours of shrimping. The total hours were calculated as hours per trip (assuming 12 hours fished per day) multiplied by the annual number of trips.

<u>SC trip ticket</u>

South Carolina shrimp effort was provided for 2003−2010 and summarized by year, month, distance (estuarine, 0-3 miles, 3-12 miles, and >12 miles). Only the "shrimp trawl" effort in waters less than 3 miles offshore was retained. A weighted average of the annual number of nets per vessel and the average number of hours fished per vessel was calculated from the data provided. The number of trips for each year, month, and distance was used as the weighting factor. The annual net-hours were calculated as the sum of hours towed times the average number of nets per vessel.

<u>GA trip ticket</u>

Georgia shrimp effort was provided for 2002−2010 and was summarized by year. The net-hours were calculated as the number of trips multiplied by the average number of hours fished per trip and the average number of nets per vessel.

<u>FL trip ticket</u>

Florida shrimp effort was provided for 1985–2010 and was summarized by year. The net-hours were calculated as the number of trips multiplied by the average number of hours fished per trip and the average number of nets per vessel. The number of nets per vessel started in 1991. The average number of nets per vessel from 1991–1993 was used for earlier years.

<u>NMFS SAS</u>

The number of shrimp trips was totaled from the South Atlantic Shrimp system effort data provided by NMFS staff. Trips designated as 3-12 and >12 miles from shore were excluded as were all gear types except butterfly nets, skimmer trawls and shrimp trawls. The number of trips was then multiplied by the number of average nets per vessel and average hours fished per trip to get the number of net-hours.

The effort in net-hours was then multiplied by the Spanish mackerel encounter rate and catch rate to get an estimate of the Spanish mackerel bycatch from shrimp trawling (Table 3.9, Figure 3.8).

Shrimp bycatch discussion

Shrimp bycatch depends on two primary factors, shrimping effort and age structure of the Spanish mackerel population. That is, for a given age structure, we would expect more bycatch with more effort, and for a given level of effort, we would expect more bycatch when the population has more young fish (e.g., when strong year classes are present).

The approach taken here applied encounter rates (by area) averaged across years to the total shrimping effort (by area). The exception was 2009 when data were considered sufficient to estimate encounter rates for all areas, such that multi-year averages were not required (Table 3.8). Thus, the approach accounts for one of the important factors (effort) in all years, but both of the important factors in only one year (2009).

The DW discussed how these estimates of shrimping bycatch could be used in the assessment. Some assessment software packages (e.g., Stock Synthesis, ASPIC) require estimated time series of removals by year as input, while other packages (e.g., BAM) allow flexibility for alternative approaches. For example, an alternative approach might estimate annual bycatch mortality rates (F_t) by fitting to observed bycatch in years when those observations are most plausible (e.g., 2009). Those estimates could provide information on catchability (q), such that in other years, bycatch would be predicted by the model but not fitted to observations, by applying $F_t=qE_t$. An advantage to this approach is that predicted bycatch could account for patterns in Spanish mackerel recruitment as well as shrimping effort; a possible disadvantage is the required assumption that bycatch catchability has remained constant. This assumption may not be far from truth, unless substantial changes have occurred in shrimping behavior.

3.5 Commercial Effort

The geographic distribution of fishing effort is plotted in Figure 3.5 and tabulated in Table 3.10. Florida is the primary state for Spanish mackerel effort, followed by North Carolina. Relatively little effort is observed in Georgia and South Carolina.

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.

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.

3.6.1 Sampling Intensity

The number of trips sampled for lengths ranged from a high of 83 for poundnet gear in 1992 to a low of zero in many strata (Table 3.11). The number of fish sampled for lengths ranged from a high of 7,864 for poundnet gear in 1992 to a low of zero in many of the strata (Table 3.11). In year-by-gear cells where fish were measured, the sample size was typically on the order of hundreds or thousands of fish.

The number of trips sampled for ages was not provided; the number of fish sampled for ages was zero in many strata. In year-by-gear cells where fish were aged, the sample size was typically on the order of tens or hundreds of fish (Table 3.12). In some strata, the number of fish aged exceeded the number of fish measured for length (Table 3.12).

3.6.2 Length and Age Compositions of Commercial Landings

Lengths, measured in fork length (cm), were binned into one centimeter groups with a floor of 0.6 cm and a ceiling of 0.5 cm. Length compositions by gear and year 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 Figure 3.9.

Raw age compositions are summarized by year and gear (Figure 3.10). These age compositions may not be representative of the landings, because an unknown proportion of the aged fish were sampled from length or market categories.

To address potential bias in the age compositions, the commercial group suggests that ages be 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 (Chih, 2009). This weighting corrects for a potential sampling bias of age samples relative to length samples (Chih, 2009), which have already been corrected. 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 Figure 3.10 are un-weighted.

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 1889. 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 years 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 is about 1% during 2006–2010, and is typically less than 1% in years prior (Table 3.11).

3.8 Literature Cited

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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 late 1800s (inaugural year is species dependent). Fairly serious collection activity began in the 1920s. The data set maintained by the Southeast Fisheries Science Center (SEFSC) in the 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
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Although the data processing and database management responsibility were transferred from the Headquarters in Washington DC to the SEFSC during this period, the data collection procedures remained essentially the same. Trained data collection personnel, referred to as fishery reporting specialists or port agents, were stationed at major fishing ports throughout the Southeast Region. The data collection procedures for commercial landings included two parts.

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

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

There are two problems with the commercial fishery statistics that were collected from seafood dealers. First, dealers do not always record the specific species that are caught and second, fish or shellfish are not always purchased at the same location where they are unloaded, i.e., landed.

Dealers have always recorded fishery products in ways that meet their needs, which sometimes make it ambiguous for scientific uses. Although the port agents can readily identify individual species, they usually were not at the fish house when fish were being unloaded and thus, could not observe and identify the fish.

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

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

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

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

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

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

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

South Carolina began collecting TIP length frequencies in 1983 as part of the Cooperative Statistics Program. Target species and length quotas were supplied by NMFS and sampling targets of 10% of monthly commercial trips by gear were set to collect those species and length frequencies. In 2005, South Carolina began collecting age structures (otoliths) in addition to length frequencies, using ACCSP funding to supplement CSP funding.

North Carolina

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

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

NMFS 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 a 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. Specific ACCSP gears in each gear category for Spanish mackerel commercial landings.

GEAR_ CODE	ACCSP GEAR NAME	ACCSP CATEGORY NAME	ACCSP TYPE NAME	SEDAR 28 GEAR CATEGORY
551	CAST NETS	DIP NETS	DIP NETS AND CAST NETS	CAST NETS
201	GILL NETS, FLOATING DRIFT	GILL NETS	GILL NETS	GILL NETS
204	GILL NETS, SINK ANCHOR	GILL NETS	GILL NETS	GILL NETS
206	GILL NETS, STAKE	GILL NETS	GILL NETS	GILL NETS
207	GILL NETS, OTHER	GILL NETS	GILL NETS	GILL NETS
210	TRAMMEL NETS	TRAMMEL NETS	GILL NETS	GILL NETS
200	GILL NETS	GILL NETS	GILL NETS	GILL NETS
203	GILL NETS, FLOATING ANCHOR	GILL NETS	GILL NETS	GILL NETS
205	GILL NETS, RUNAROUND	GILL NETS	GILL NETS	GILL NETS
300	HOOK AND LINE	HOOK AND LINE	HOOK AND LINE	HAND LINES
301	HOOK AND LINE, MANUAL	HOOK AND LINE	HOOK AND LINE	HAND LINES
302	HOOK AND LINE, ELECTRIC	HOOK AND LINE	HOOK AND LINE	HAND LINES
303	ELECTRIC/HYDRAULIC, BANDIT REELS	HOOK AND LINE	HOOK AND LINE	HAND LINES
701	TROLL AND HAND LINES CMB	HAND LINE	HAND LINE	HAND LINES
320	TROLL LINES	TROLL LINES	HOOK AND LINE	HAND LINES
700	HAND LINE	HAND LINE	HAND LINE	HAND LINES
010	HAUL SEINES	HAUL SEINES	HAUL SEINES	OTHER
020	OTHER SEINES	OTHER SEINES	HAUL SEINES	OTHER
022	COMMON SEINE	OTHER SEINES	HAUL SEINES	OTHER
023	SWIPE NET	OTHER SEINES	HAUL SEINES	OTHER
060	FYKE NETS	FYKE NETS	FIXED NETS	OTHER
000	NOT CODED	NOT CODED	NOT CODED	OTHER
070	OTHER FIXED NETS	OTHER FIXED NETS	FIXED NETS	OTHER
071	WEIRS	OTHER FIXED NETS	FIXED NETS	OTHER
075	CHANNEL NETS	OTHER FIXED NETS	FIXED NETS	OTHER
091	OTTER TRAWL BOTTOM, CRAB	OTTER TRAWLS	TRAWLS	OTHER
092	OTTER TRAWL BOTTOM, FISH	OTTER TRAWLS	TRAWLS	OTHER
094	OTTER TRAWL BOTTOM, SCALLOP	OTTER TRAWLS	TRAWLS	OTHER
095	OTTER TRAWL BOTTOM, SHRIMP	OTTER TRAWLS	TRAWLS	OTHER
096	OTTER TRAWL BOTTOM, OTHER	OTTER TRAWLS	TRAWLS	OTHER
097	OTTER TRAWL MIDWATER	OTTER TRAWLS	TRAWLS	OTHER
110	OTHER TRAWLS	OTHER TRAWLS	TRAWLS	OTHER
114	TRAWL, ROLLER	OTHER TRAWLS	TRAWLS	OTHER
116	TRAWL, SKIMMER	OTHER TRAWLS	TRAWLS	OTHER

120	FLY NET	OTHER TRAWLS	TRAWLS	OTHER
130	POTS AND TRAPS	POTS AND TRAPS	POTS AND TRAPS	OTHER
131	POTS AND TRAPS, CONCH	POTS AND TRAPS	POTS AND TRAPS	OTHER
132	POTS AND TRAPS, BLUE CRAB	POTS AND TRAPS	POTS AND TRAPS	OTHER
136	POTS AND TRAPS, CRAB, PEELER	POTS AND TRAPS	POTS AND TRAPS	OTHER
139	POTS AND TRAPS, FISH	POTS AND TRAPS	POTS AND TRAPS	OTHER
146	POTS AND TRAPS, SCUP	POTS AND TRAPS	POTS AND TRAPS	OTHER
162	POTS AND TRAPS, LOBSTER OFFSHORE	POTS & TRAPS, LOBSTER	POTS AND TRAPS	OTHER
401	LONG LINES, VERTICAL	LONG LINES	LONG LINES	OTHER
402	LONG LINES, SURFACE	LONG LINES	LONG LINES	OTHER
403	LONG LINES, BOTTOM	LONG LINES	LONG LINES	OTHER
404	LONG LINES, SURFACE, MIDWATER	LONG LINES	LONG LINES	OTHER
602	PATENT TONGS	TONGS	RAKES, HOES, AND TONGS	OTHER
621	RAKES, BULL	RAKES, BULL	RAKES, HOES, AND TONGS	OTHER
623	RAKES, HAND	RAKES, HAND	RAKES, HOES, AND TONGS	OTHER
661	SPEARS, DIVING	SPEARS	SPEARS AND GIGS	OTHER
662	GIGS	SPEARS	SPEARS AND GIGS	OTHER
800	OTHER GEARS	OTHER GEARS	OTHER GEARS	OTHER
801	UNSPECIFIED GEAR	OTHER GEARS	OTHER GEARS	OTHER
802	COMBINED GEARS	OTHER GEARS	OTHER GEARS	OTHER
803	AQUACULTURE	OTHER GEARS	OTHER GEARS	OTHER
072	TRAP NETS	OTHER FIXED NETS	FIXED NETS	OTHER
090	OTTER TRAWLS	OTTER TRAWLS	TRAWLS	OTHER
112	OTTER TRAWL MIDWATER, PAIRED	OTHER TRAWLS	TRAWLS	OTHER
500	DREDGE	DREDGE	DREDGE	OTHER
760	BY HAND, NO DIVING GEAR	BY HAND, NO DIVING GEAR	BY HAND	OTHER
750	BY HAND, DIVING GEAR	BY HAND, DIVING GEAR	BY HAND	OTHER
660	SPEARS	SPEARS	SPEARS AND GIGS	OTHER
400	LONG LINES	LONG LINES	LONG LINES	OTHER
073	FLOATING TRAPS (SHALLOW)	OTHER FIXED NETS	FIXED NETS	OTHER
040	LAMPARA/RING NETS	LAMPARA/RING NETS	PURSE SEINES	OTHER
030	PURSE SEINE	PURSE SEINE	PURSE SEINES	OTHER
050	POUND NETS	POUND NETS	FIXED NETS	POUND NETS

Table 3.2. Spanish mackerel landings in weight (pounds whole weight) by gear from the U.S. South Atlantic, 1889–2010. Historic landings prior to 1926 were not available by gear for all states, but are provided simply in total (thus, the grand total exceeds the sum of column totals). The 1926 reporting (*) appears incomplete.

YEAR	CAST NETS	GILL NETS	HANDLINES	POUND NETS	MISC.	TOTAL
1889						82,000
1890						100,000
1891						
1892						
1893						
1894						
1895						
1896						
1897						362,000
1898						
1899						
1900						
1901						
1902						1,013,000
1903						
1904						
1905						
1906						
1907						
1908						1,685,000
1909						
1910						
1911						
1912						
1913						
1914						
1915						
1916						
1917						
1918						3,211,000
1919						
1920						
1921						
1922						
1923						2,652,000
1924						
1925						
1926			1,500*			
1927		1,849,787	111,500	114,869	45,519	2,121,675
1928		2,108,118	59,658	38,910	43,576	2,250,262
1929		2,316,861	334,060	114,869	424,210	3,190,000

1930		2,491,025	62,670	38,910	644,942	3,237,547
1931		2,042,535	95,702	148,905	555,515	2,842,658
1932		2,648,514	99,143	94,593	452,397	3,294,647
1933				260,927		260,927
1934		2,916,123	99,309	95,579	315,890	3,426,901
1935						
1936		3,741,447	220,239	89,066	769,779	4,820,530
1937		2,615,713	136,472	870,100	1,346,399	4,968,683
1938		2,716,800	212,646	77,950	931,359	3,938,755
1939		2,990,194	271,027	920,768	454,140	4,636,129
1940		2,339,674	460,997	517,595	366,038	3,684,304
1941			4,000	171,065	23,300	198,365
1942			4,800	89,900	14,900	109,600
1943				23,300	1,200	24,500
1944				14,900	274,700	289,600
1945		283,600	8,400	1,200	532,700	825,900
1946				252,700	123,500	376,200
1947				404,200	5,200	409,400
1948				117,900	33,200	151,100
1949				5,200	17,700	22,900
1950		3,219,700	358,100	25,300	134,500	3,737,600
1951		1,560,100	511,400	37,300	80,900	2,189,700
1952		3,441,200	62,400	54,600	53,600	3,611,800
1953		3,267,500	170,600	47,300	292,800	3,778,200
1954		2,038,600	118,900	188,500	88,100	2,434,100
1955		2,644,500	325,800	53,300	384,800	3,408,400
1956		3,957,600	626,300	84,900	272,000	4,940,800
1957		3,869,600	274,900	53,400	294,700	4,492,600
1958		6,935,800	425,700	15,000	155,200	7,531,700
1959		2,210,500	162,100	24,600	130,400	2,527,600
1960		2,167,400	152,300	23,700	83,400	2,426,800
1961		3,081,200	120,200	133,500	84,200	3,419,100
1962		2,480,300	125,800	20,300	63,300	2,689,700
1963		2,087,600	75,700	79,400	104,500	2,347,200
1964		1,958,500	64,900	32,200	60,600	2,116,200
1965		2,788,100	144,900	89,300	84,300	3,106,600
1966		2,060,900	176,700	111,800	55,400	2,404,800
1967		1,693,800	130,800	23,300	60,900	1,908,800
1968		4,232,100	152,200	72,900	87,300	4,544,500
1969		2,242,400	100,300	83,900	148,900	2,575,500
1970		3,512,900	110,200	104,900	113,500	3,841,500
1971		2,490,000	136,100	25,700	81,600	2,733,400
1972		3,292,300	106,300	22,800	77,000	3,498,400
1973		3,044,600	154,800	50,700	76,400	3,326,500
1974		2,207,200	169,400	25,200	45,900	2,447,700
1975		4,784,600	375,200	61,600	55,700	5,277,100
1976		9,768,000	928,500	77,100	53,000	10,826,600

1977		10,963,200	348,600	28,900	21,600	11,362,300
1978		5,638,922	82,796	2,401	8,851	5,732,970
1979		4,847,075	75,270	726	3,901	4,926,972
1980		9,844,693	93,704	5,849	17,363	9,961,609
1981		4,250,730	89,009	5,570	7,559	4,352,868
1982		3,928,030	128,267	24,013	8,830	4,089,140
1983		5,981,615	58,463	16,397	14,480	6,070,955
1984		2,435,867	56,002	23,270	21,629	2,536,768
1985		4,277,965	30,675	47,217	44,426	4,400,283
1986		4,060,803	78,442	201,695	81,515	4,422,455
1987		3,616,769	106,502	470,433	134,977	4,328,681
1988		3,281,064	64,864	402,161	98,975	3,847,064
1989		3,180,917	39,666	509,040	142,492	3,872,115
1990		2,696,706	111,857	509,415	100,634	3,418,612
1991	361	3,798,945	144,012	468,247	200,270	4,611,835
1992	798	2,689,151	50,239	396,725	75,576	3,212,489
1993	0	4,415,277	99,073	328,326	145,373	4,988,049
1994	0	3,705,920	58,246	329,600	51,896	4,145,661
1995	15,419	3,236,740	209,640	199,030	40,686	3,701,514
1996	65,924	2,679,097	139,445	294,389	59,753	3,238,609
1997	210,195	2,674,398	126,978	207,188	62,236	3,280,994
1998	68,323	2,693,649	149,026	115,481	31,087	3,057,565
1999	66,391	1,887,672	188,060	271,264	25,750	2,439,136
2000	361,425	1,864,970	311,524	161,842	34,772	2,734,533
2001	892,775	1,705,136	348,824	196,164	59,022	3,201,921
2002	968,866	1,318,160	438,663	121,274	8,334	2,855,297
2003	1,897,957	1,092,584	390,936	90,685	6,033	3,478,195
2004	2,242,104	714,569	590,759	71,085	18,728	3,637,245
2005	1,574,132	1,254,570	841,431	47,026	21,484	3,738,643
2006	1,524,472	1,648,798	707,656	42,924	14,129	3,937,978
2007	1,268,365	1,715,951	775,882	50,048	20,334	3,830,580
2008	702,770	1,079,737	869,796	192,347	8,576	2,853,226
2009	966,518	1,439,253	977,720	363,026	15,238	3,761,753
2010	1,798,217	1,346,250	1,228,006	144,150	23,385	4,540,007
Total	14,625,012	230,062,574	18,452,651	12,423,811	12,228,955	242,710,923

Table 3.3. Mean weights in pounds whole weight used to derive landings in numbers by year and gear.

Year	Mean weight (lb whole weight)					Standard deviation				
	CAST NET	GILL NET	HAND LINE	MISC.	POUND NET	CAST NET	GILL NET	HAND LINE	MISC.	POUND NET
1889-1981	3.39	3.49	4.34	2.64	1.75	3.85	15.38	4.78	2.54	1.95
1982	3.39	9.93	4.34	7.08	1.46	3.85	4.70	4.78	7.01	0.71
1983	3.39	3.49	4.34	2.64	1.56	3.85	15.38	4.78	2.54	0.89
1984	3.39	3.49	4.34	2.64	1.51	3.85	15.38	4.78	2.54	1.10
1985	3.39	3.49	4.34	0.84	0.71	3.85	15.38	4.78	0.29	0.37
1986	3.39	2.97	4.34	0.85	1.58	3.85	2.85	4.78	0.22	0.93
1987	3.39	1.10	8.31	2.77	1.42	3.85	0.24	7.75	1.78	0.96
1988	3.39	3.49	4.34	1.61	1.82	3.85	15.38	4.78	1.04	1.32
1989	3.39	3.49	4.34	2.80	1.22	3.85	15.38	4.78	2.49	0.91
1990	3.39	3.49	4.34	1.95	1.55	3.85	15.38	4.78	1.55	1.63
1991	3.39	3.49	4.34	1.68	1.61	3.85	15.38	4.78	1.65	1.20
1992	3.39	2.81	3.41	2.53	1.40	3.85	2.27	2.77	2.15	0.89
1993	3.39	3.49	4.34	2.03	1.75	3.85	15.38	4.78	1.26	1.15
1994	3.39	3.49	4.34	2.48	1.47	3.85	15.38	4.78	2.22	1.03
1995	3.39	1.79	4.34	1.92	3.02	3.85	0.48	4.78	0.79	5.48
1996	3.39	2.73	4.34	2.64	1.86	3.85	1.43	4.78	3.18	1.00
1997	3.39	2.50	4.34	3.04	2.18	3.85	1.27	4.78	2.26	1.53
1998	3.39	3.45	4.34	3.35	3.19	3.85	2.31	4.78	2.88	2.80
1999	3.39	2.57	4.34	2.67	1.99	3.85	1.25	4.78	2.29	1.51
2000	3.39	2.82	4.34	1.89	2.28	3.85	2.25	4.78	1.20	1.31
2001	3.39	2.34	4.34	2.42	3.59	3.85	1.96	4.78	2.00	3.52
2002	3.39	2.32	4.34	2.60	2.30	3.85	1.94	4.78	2.02	1.17
2003	3.39	2.45	4.34	2.53	2.16	3.85	2.38	4.78	2.21	2.36
2004	3.39	2.57	5.30	3.27	1.75	3.85	1.85	4.55	2.06	1.95
2005	2.46	2.33	2.69	4.08	0.96	3.17	2.09	2.80	3.77	0.44
2006	3.23	2.92	3.49	7.54	1.75	4.94	1.89	2.73	7.03	1.95
2007	3.01	2.15	2.82	1.62	2.65	2.63	1.68	1.87	0.93	2.14
2008	3.39	2.65	5.00	2.98	3.21	3.85	2.49	4.07	2.86	2.25
2009	4.70	7.76	4.29	3.44	1.75	3.52	36.91	3.60	3.18	1.95
2010	3.52	2.06	4.33	3.38	1.75	3.54	1.24	4.14	2.73	1.95

Table 3.4. Spanish mackerel landings in numbers (thousands of fish) by gear from the U.S. South Atlantic, 1889–2010. Historic landings prior to 1926 were not available by gear for all states, but are provided simply in total. The 1926 reporting (*) appears incomplete. Historic, total landings (prior to 1926) were estimated assuming average weight from gillnets.

YEAR	CAST NETS	GILL NETS	HANDLINES	POUND NETS	MISC.	TOTAL
1889						23.511
1890						28.672
1891						
1892						
1893						
1894						
1895						
1896						
1897						103.792
1898						
1899						
1900						
1901						
1902						290.444
1903						
1904						
1905						
1906						
1907						
1908						483.118
1909						
1910						
1911						
1912						
1913						
1914						
1915						
1916						
1917						
1918						920.649
1919						
1920						
1921						
1922						
1923						760.374
1924						
1925						
1926			0.345			
1927		530.366	25.667	65.663	17.219	638.915
1928		604.434	13.733	22.242	16.484	656.893
1929		664.284	76.900	65.663	160.469	967.316
1930		714.220	14.427	22.242	243.968	994.856
1931		585.630	22.030	85.119	210.139	902.919

1932		759.374	22.823	54.073	171.132	1007.402
1933				149.155		149.155
1934		836.102	22.861	54.636	119.494	1033.094
1935						
1936		1072.737	50.699	50.913	291.191	1465.540
1937		749.970	31.416	497.380	509.314	1788.079
1938		778.953	48.951	44.559	352.313	1224.776
1939		857.340	62.390	526.344	171.791	1617.865
1940		670.825	106.121	295.876	138.464	1211.285
1941			0.921	97.787	8.814	107.521
1942			1.105	51.390	5.636	58.131
1943				13.319	0.454	13.773
1944				8.517	103.913	112.430
1945		81.313	1.934	0.686	201.509	285.442
1946				144.452	46.717	191.170
1947				231.055	1.967	233.022
1948				67.396	12.559	79.955
1949				2.973	6.696	9.668
1950		923.143	82.434	14.462	50.878	1070.918
1951		447.307	117.723	21.322	30.603	616.955
1952		986.651	14.364	31.211	20.276	1052.502
1953		936.848	39.272	27.038	110.760	1113.918
1954		584.502	27.371	107.753	33.326	752.952
1955		758.223	74.999	30.468	145.562	1009.252
1956		1134.712	144.173	48.532	102.892	1430.308
1957		1109.481	63.281	30.525	111.479	1314.766
1958		1988.613	97.995	8.575	58.709	2153.891
1959		633.788	37.315	14.062	49.328	734.493
1960		621.431	35.059	13.548	31.548	701.586
1961		883.433	27.670	76.313	31.851	1019.267
1962		711.144	28.959	11.604	23.945	775.653
1963		598.551	17.426	45.388	39.530	700.895
1964		561.535	14.940	18.407	22.924	617.806
1965		799.396	33.356	51.047	31.889	915.688
1966		590.895	40.676	63.909	20.957	716.437
1967		485.641	30.110	13.319	23.037	552.108
1968		1213.416	35.036	41.672	33.024	1323.148
1969		642.934	23.089	47.960	56.326	770.309
1970		1007.209	25.368	59.965	42.935	1135.476
1971		713.926	31.330	14.691	30.868	790.814
1972		943.959	24.470	13.033	29.127	1010.590
1973		872.939	35.635	28.982	28.900	966.456
1974		632.842	38.996	14.405	17.363	703.606
1975		1371.827	86.370	35.213	21.070	1514.480
1976		2800.653	213.739	44.073	20.049	3078.514
1977		3143.337	80.247	16.520	8.171	3248.275
1978		1616.775	19.059	1.372	3.348	1640.556
1979		1389.739	17.327	0.415	1.476	1408.957
1980		2822.642	21.570	2.440	6.568	2853.220
1981		1218.757	20.490	3.184	2.859	1245.290
1982		395.718	29.527	16.392	1.248	442.885
1983		1715.031	13.458	10.530	5.477	1744.497
1984		698.405	12.892	15.450	8.182	734.928
1985		1226.566	7.061	66.398	52.817	1352.842

1986		1366.910	18.057	127.382	96.202	1608.551
1987		3290.728	12.821	332.155	48.799	3684.503
1988		940.737	14.932	220.594	61.413	1237.676
1989		912.023	9.131	415.934	50.859	1387.947
1990		773.192	25.749	328.491	51.647	1179.079
1991	0.106	1089.223	33.151	291.219	119.242	1532.941
1992	0.235	956.379	14.725	283.770	29.826	1284.934
1993	0.000	1265.936	22.806	187.889	71.755	1548.386
1994	0.000	1062.551	13.408	223.826	20.921	1320.706
1995	4.545	1809.892	48.259	65.907	21.244	1949.846
1996	19.431	982.890	32.100	158.407	22.624	1215.452
1997	61.956	1071.161	29.230	95.000	20.492	1277.838
1998	20.139	780.121	34.306	36.215	9.275	880.056
1999	19.569	734.125	43.291	136.655	9.645	943.285
2000	106.532	660.605	71.712	70.923	18.440	928.212
2001	263.150	729.524	80.299	54.696	24.400	1152.068
2002	285.578	567.529	100.979	52.735	3.207	1010.028
2003	559.432	445.464	89.993	42.007	2.385	1139.280
2004	660.870	277.518	111.380	40.635	5.722	1096.125
2005	638.701	539.225	312.822	48.754	5.265	1544.768
2006	471.447	564.083	202.750	24.537	1.875	1264.692
2007	421.530	797.333	275.493	18.896	12.587	1525.839
2008	207.145	407.494	173.822	59.833	2.876	851.169
2009	205.480	185.536	228.029	207.519	4.435	830.998
2010	511.270	652.545	283.463	82.401	6.918	1536.598

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 gillnet, vertical line, and trolling vessels with federal fishing permits in the US South Atlantic (Florida Keys to 37°N latitude). Discards are reported as number of fish.

Year	Gillnet	Vertical line	Trolling	Calculated discards
1998	7,979	3,027	2,531	13,537
1999	14,339	2,674	2,497	19,510
2000	10,588	2,706	2,754	16,048
2001	9,990	2,713	2,105	14,808
2002	17,374	2,502	1,710	21,587
2003	7,329	2,132	1,562	11,023
2004	6,629	1,883	1,262	9,774
2005	8,060	1,724	1,115	10,899
2006	6,999	1,931	1,224	10,154
2007	6,458	2,098	1,510	10,066
2008	5,739	2,126	1,453	9,318
2009	4,515	2,237	1,591	8,343
2010	4,927	1,883	1,269	8,079

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 gillnet 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
	Handline/Electric	3%	3%	21%	4%	47%	23%	0%	577
	Trolling	1%	0%	33%	8%	58%	0%	0%	722
Gulf of Mexico	Gillnet	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0
	Handline/Electric	12%	4%	3%	31%	41%	0%	9%	625
	Trolling	1%	0%	19%	21%	59%	0%	0%	126

Table 3.8. Encounter and catch rates from the SAS observer data for years with adequate coverage across months and sample size (unshaded). Average rates across all years by area were applied when data were too limited for reasonable estimation (shaded).

	Encounter Rate		Catch rate (fish/net-hour)	
Year	NC	SC/GA/FL	NC	SC/GA/FL
1978	0.21	0.40	0.785	1.277
1979	0.21	0.40	0.785	1.277
1980	0.21	0.40	0.785	1.277
1981	0.21	0.40	0.785	1.277
1982	0.21	0.40	0.785	1.277
1983	0.21	0.40	0.785	1.277
1984	0.21	0.40	0.785	1.277
1985	0.21	0.40	0.785	1.277
1986	0.21	0.40	0.785	1.277
1987	0.21	0.40	0.785	1.277
1988	0.21	0.40	0.785	1.277
1989	0.21	0.40	0.785	1.277
1990	0.21	0.40	0.785	1.277
1991	0.21	0.40	0.785	1.277
1992	0.21	0.40	0.785	1.277
1993	0.21	0.40	0.785	1.277
1994	0.21	0.40	0.785	1.277
1995	0.21	0.40	0.785	1.277
1996	0.21	0.40	0.785	1.277
1997	0.21	0.40	0.785	1.277
1998	0.21	0.40	0.785	1.277
1999	0.21	0.40	0.785	1.277
2000	0.21	0.40	0.785	1.277
2001	0.21	0.40	0.785	1.277
2002	0.21	0.40	0.785	1.277
2003	0.21	0.40	0.785	1.277
2004	0.21	0.40	0.785	1.277
2005	0.21	0.35	0.785	1.925
2006	0.21	0.40	0.785	1.277
2007	0.21	0.46	0.785	0.973
2008	0.26	0.40	0.795	1.277
2009	0.19	0.19	1.019	0.449
2010	0.18	0.40	0.410	1.277

Table 3.9. Estimates of Spanish mackerel bycatch (number fish) from shrimping. The SEDAR17 (s17) estimates are included for comparison.

Year	NC	SC	GA	FL	Total	s17
1978	89894	226037	357895	140619	814445	751667
1979	111612	218333	142076	140619	612640	1515334
1980	221756	284851	251825	140619	899050	5613758
1981	166161	174929	209631	140619	691339	751667
1982	257157	272197	368974	140619	1038947	6863411
1983	249358	205133	416050	140619	1011160	7430291
1984	184414	107438	186434	140619	618904	751667
1985	164140	106348	206515	132852	609855	8149058
1986	164255	193910	180194	140391	678750	6101833
1987	131269	221811	77292	144429	574800	4606309
1988	168893	163849	195436	151522	679700	6204944
1989	204967	198519	253400	144935	801821	11121667
1990	132356	191802	161421	150877	636455	11097002
1991	169645	288567	196388	134923	789523	11121667
1992	65403	258299	172110	136924	632736	7388148
1993	98035	234371	176481	141654	650540	2377186
1994	129865	225806	181674	176944	714289	631400
1995	139931	262970	164840	151678	719418	7982573
1996	101600	196671	145452	147228	590951	511133
1997	119614	243016	173105	139584	675319	3382461
1998	84254	186873	200889	147653	619669	417000
1999	112888	192974	280214	129452	715529	7005000
2000	99745	183455	254422	111390	649010	6341000
2001	80229	131366	181414	119965	512973	1416000
2002	116270	141024	173402	129469	560166	266000
2003	70557	64600	154169	139950	429277	363000
2004	78056	93592	119467	134889	426003	130000
2005	33074	90528	119568	177008	420179	451000
2006	45513	54146	82852	127296	309807	116000
2007	57556	35567	59307	103917	256348	451000
2008	76142	43346	59777	97322	276588	
2009	53557	6621	11115	15080	86373	
2010	20084	54499	74043	125186	273811	

Table 3.10. Number of commercial trips that caught Spanish mackerel by state and year

YEAR	FL	GA-SC	NC	NORTH (VA-ME)
1986	10450			
1987	12239			
1988	9307			
1989	8362			
1990	12277			
1991	12595			
1992	11060			
1993	10211			
1994	10721		4714	755
1995	6799		4303	1103
1996	2671		3955	1100
1997	4322		5983	1228
1998	4278		4137	1428
1999	3445		3571	1545
2000	3940		4620	1148
2001	4388		3809	1215
2002	4860		3294	881
2003	4710		2506	919
2004	5081		2222	585
2005	5853	2	2728	926
2006	5571	1	2488	1470
2007	6690	4	2764	1429
2008	5995	2	2431	830
2009	7304	0	4043	934
2010	7467	1	3610	154

Table 3.11. Number of fish and trips sampled for lengths by year and gear. Sample sizes represent the number of valid samples (i.e., biased samples removed).

	Number of fish sampled					Number of trips sampled					Proportion of trips sampled
YEAR	Cast net	Gill net	Hand line	Misc.	Pound net	Cast net	Gill net	Hand line	Misc.	Pound net	
1980				6	27				2	3	
1982		45		21	777		7		4	31	
1983				12	126				2	15	
1984			4	3	168			2	1	18	
1985		15		51	888		3		8	23	
1986		89	13	123	459		1	11	5	30	
1987		375	26	136	1533		2	15	12	42	
1988		12		618	1515		1		16	44	
1989			1	441	2745			1	28	37	
1990			5	1518	2784			5	23	48	
1991		6	2	786	3918		1	1	27	49	
1992		154	5	838	7864		7	2	30	83	
1993		49		582	1608		1		14	27	
1994				156	1317				13	21	0.002
1995		33		81	2133		1		9	34	0.004
1996		42		249	1164		1		12	19	0.004
1997		699		75	270		14		7	10	0.003
1998		48		138	264		5		12	15	0.003
1999		45	1	348	612		3	1	14	15	0.004
2000	1	849	4	702	99	1	14	3	17	4	0.004
2001	2	675	10	474	156	1	13	4	14	6	0.004
2002		573	3	220	126		10	3	16	4	0.004
2003		420		180	141		9		4	3	0.002
2004	656	962	327	48		6	19	13	4		0.005
2005	1490	1397	339	207	240	16	22	7	8	4	0.006
2006	2599	551	1190	33	84	26	28	23	5	4	0.009
2007	4603	2624	3646	430	162	31	26	39	11	1	0.010
2008	1119	1604	2002	395	72	12	16	29	14	4	0.008
2009	446	1302	1272	945	75	15	51	46	25	4	0.011
2010	1526	925	979	312	27	28	28	46	9	2	0.010

Table 3.12. Number of fish sampled for lengths and ages by year and gear.

	Handline		Castnet		Gillnet		Poundnet		Misc.	
Year	length	age	length	age	length	age	length	age	length	age
1980							27		6	
1981										
1982					45		777		21	
1983							126		12	
1984	4						168		3	
1985					15		888		51	
1986	13				89	1	459		123	4
1987	26				375	52	1533		136	2
1988		9			12	87	1515		618	5
1989	1	22				232	2745		441	41
1990	5	79				203	2784	6	1518	28
1991	2				6	190	3918		786	214
1992	5	81			154	150	7864	28	838	85
1993					49	10	1608		582	16
1994		6				167	1317		156	7
1995		25			33	417	2133	20	81	34
1996		35			42	246	1164		249	38
1997		19		34	699	363	270	4	75	83
1998		31			48	447	264	50	138	38
1999		120			45	588	612	23	348	58
2000	1	147	1	3	849	315	99		702	20
2001	4	242	2	110	675	365	156	60	474	954
2002	10	61			573	365	126	773	220	0
2003	3				420	551	141	328	180	16
2004	327	2	656		962	255		400	48	12
2005	339	5	1490	147	1397	358	240	341	207	3
2006	1190		2599	211	551	234	84	288	33	3
2007	3646	177	4603	50	2624	350	162	226	430	57
2008	2002	185	1119	199	1604	348	72	111	395	8
2009	1272	104	446	331	1302	287	75	99	945	0
2010	979		1526	138	925	268	27	186	312	0

3.10 Figures

Figure 3.1. Map of U.S. Atlantic and Gulf coast with shrimp area designations.

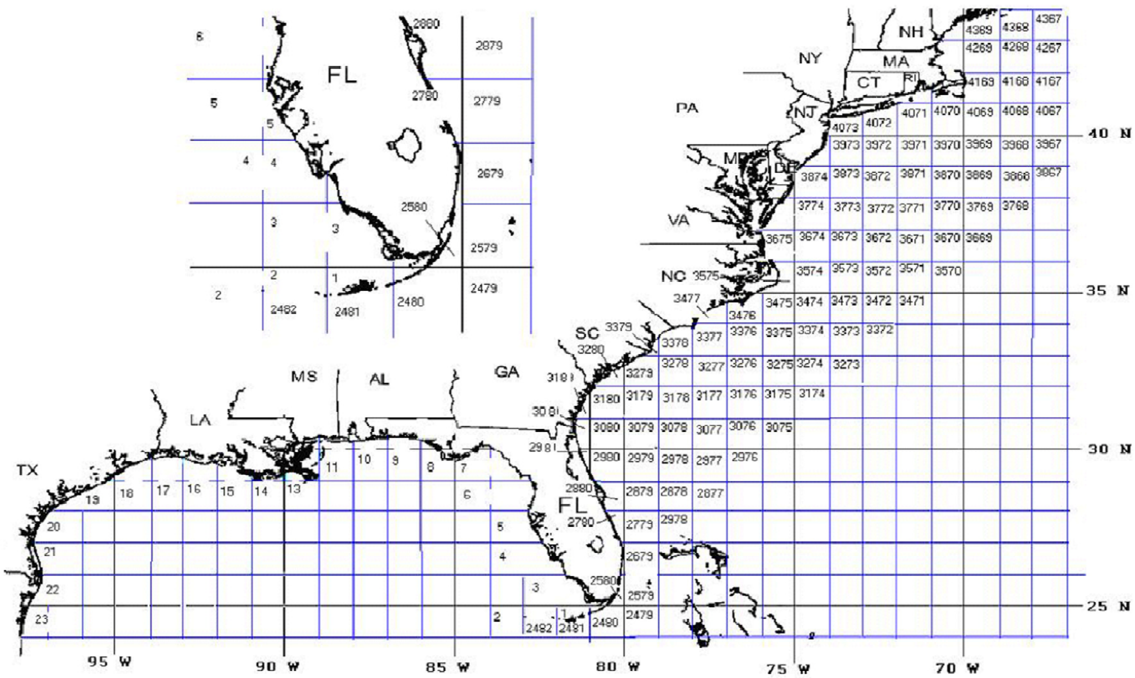


Figure 3.2. Map showing marine fisheries trip ticket fishing area code map for Florida.

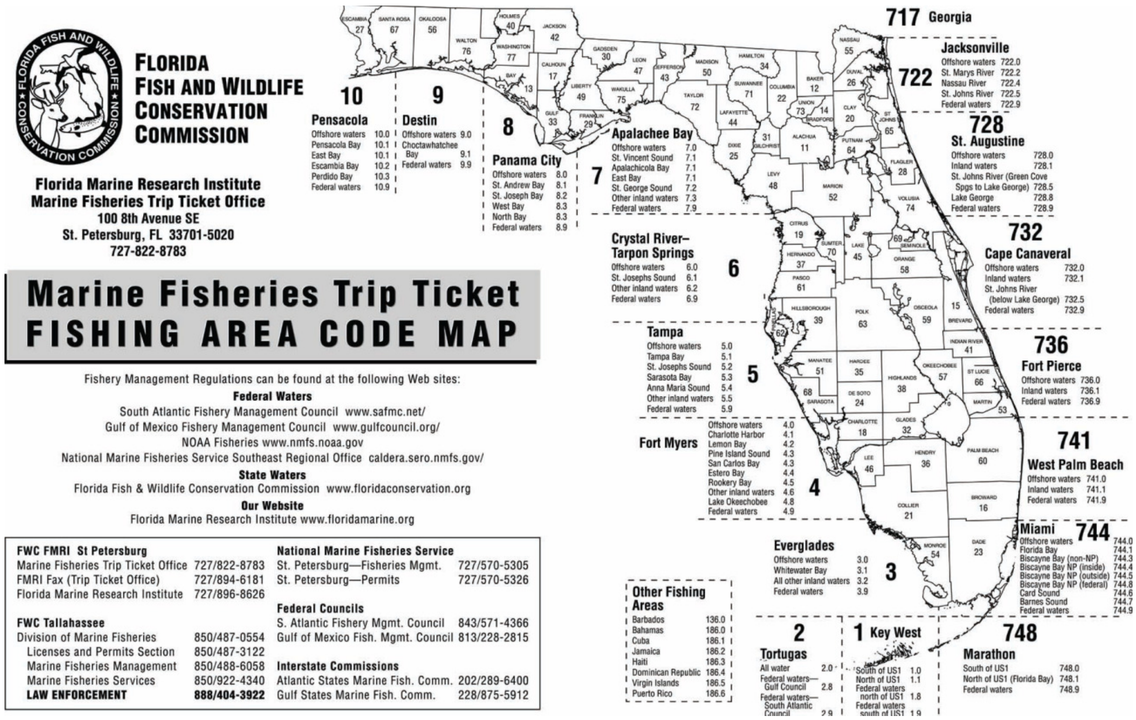


Figure 3.3. Atlantic Coastal Cooperative Statistics Program (ACCSP) Data Warehouse - data sources and collection methods by state. Early summaries provided by NMFS.

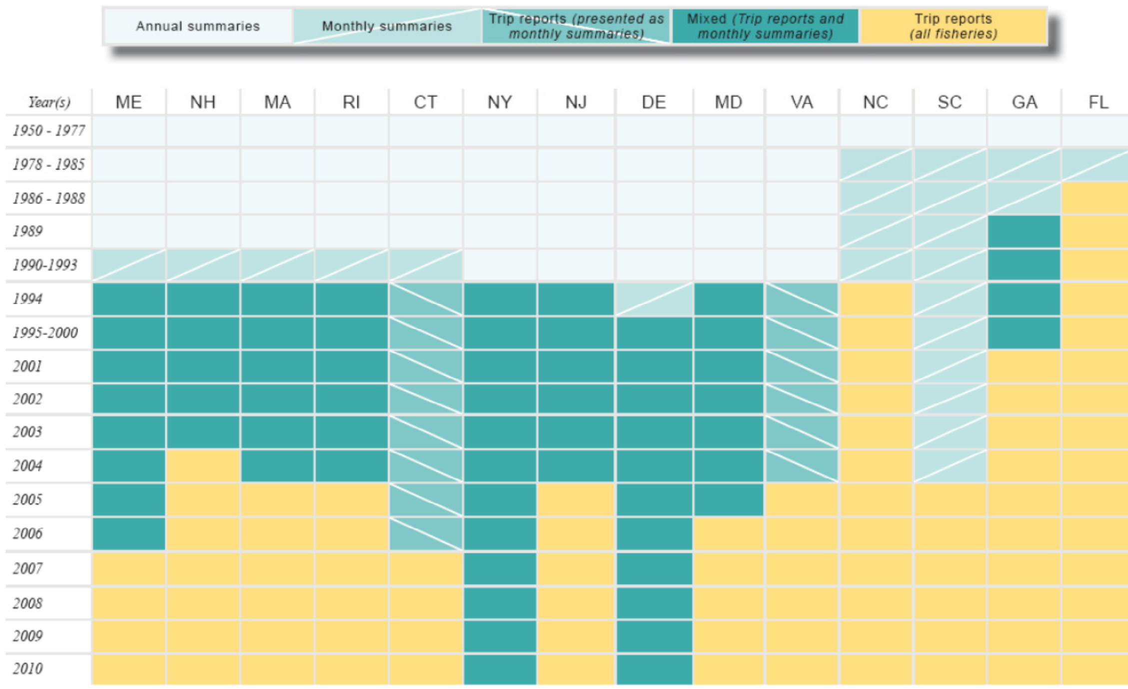


Figure 3.4A. Geographic distribution of Spanish mackerel landings (lb gutted weight) reported in logbooks during 1990–1999. Areas north of NC were not part of this data set.

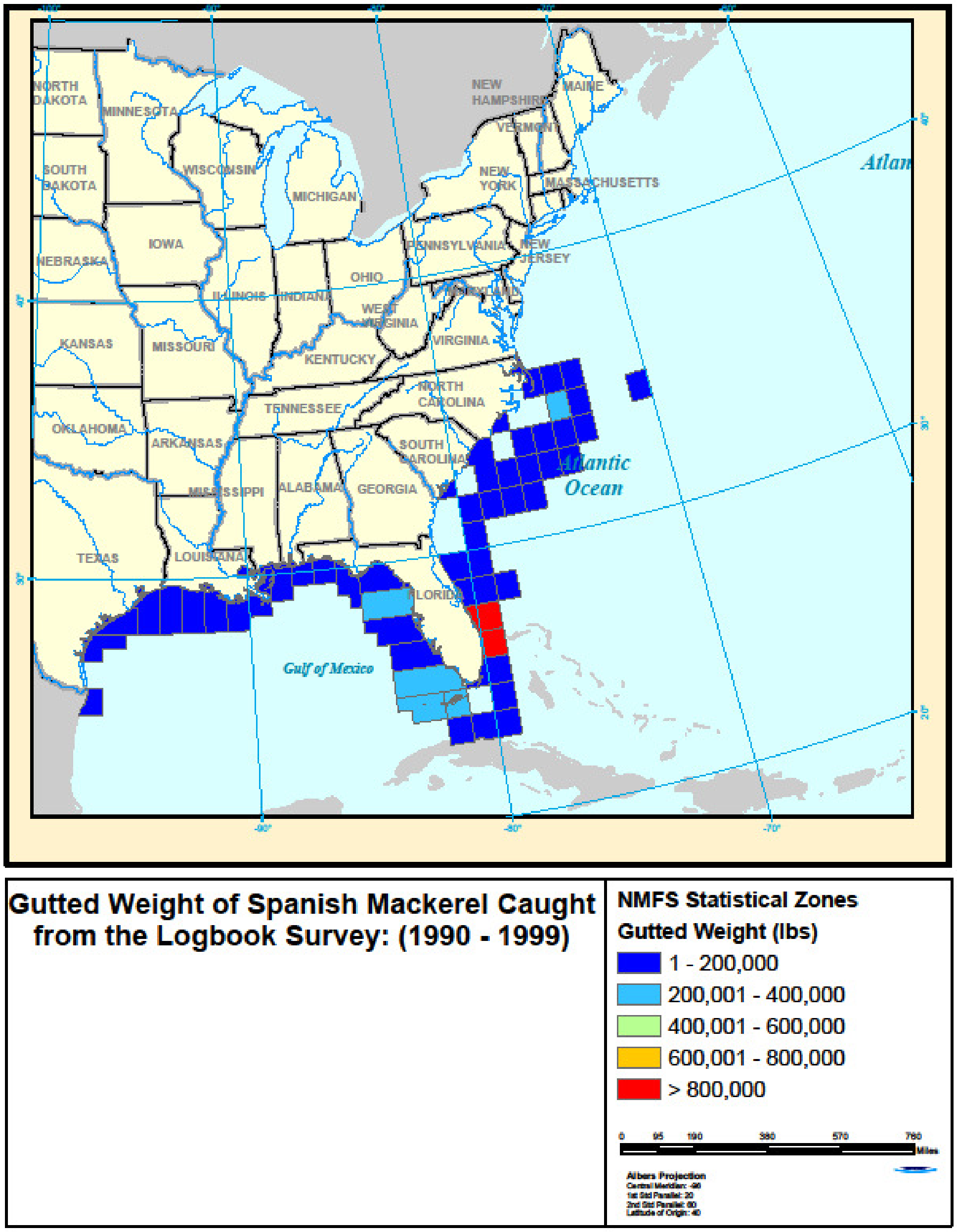


Figure 3.4B. Geographic distribution of Spanish mackerel landings (lb gutted weight) reported in logbooks during 2000–2010. Areas north of NC were not part of this data set.

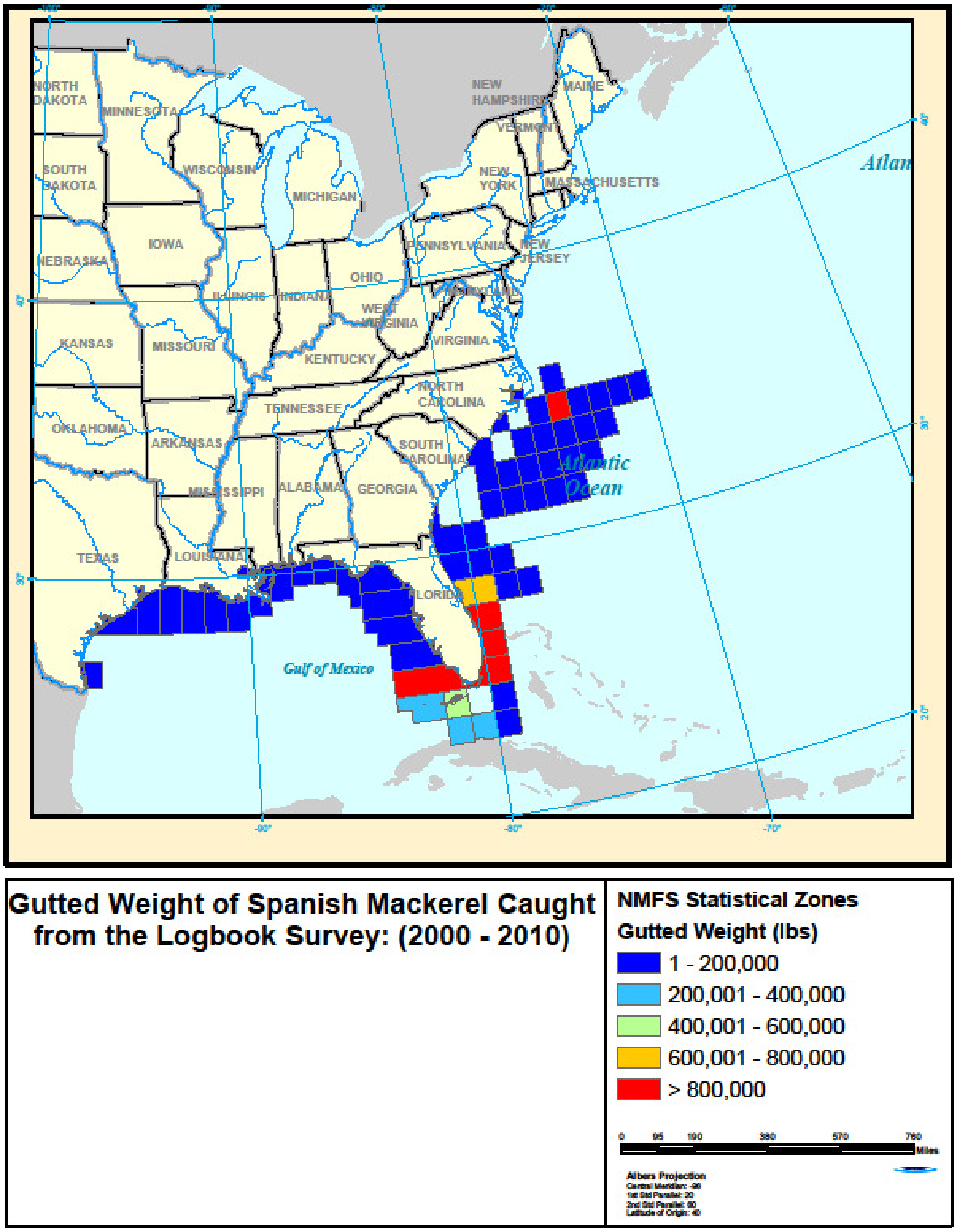


Figure 3.5A. Geographic distribution of Spanish mackerel fishing effort (number trips) reported in logbooks during 1990–1999. Areas north of NC were not part of this data set.

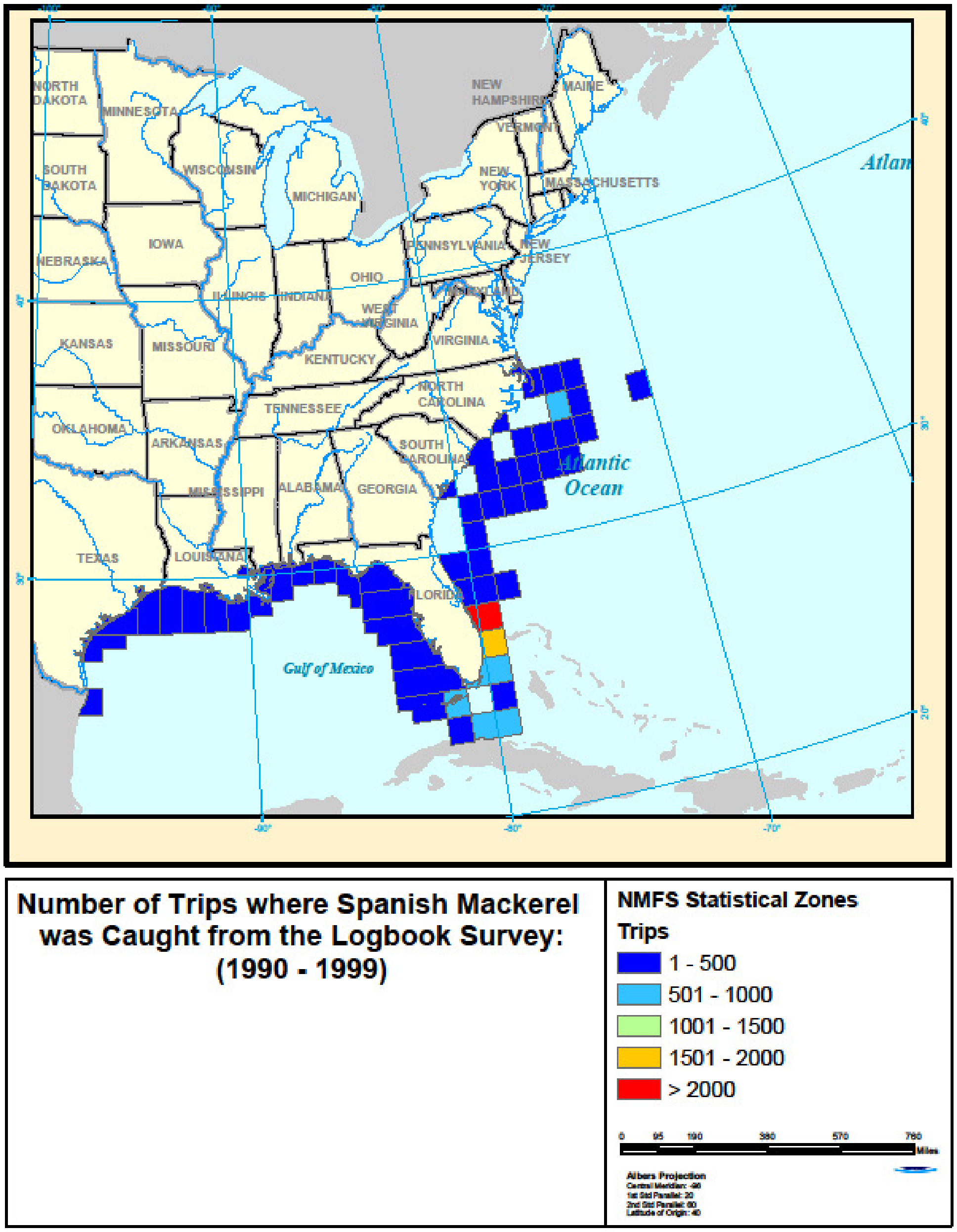


Figure 3.5B. Geographic distribution of Spanish mackerel fishing effort (number trips) reported in logbooks during 2000–2010. Areas north of NC were not part of this data set.

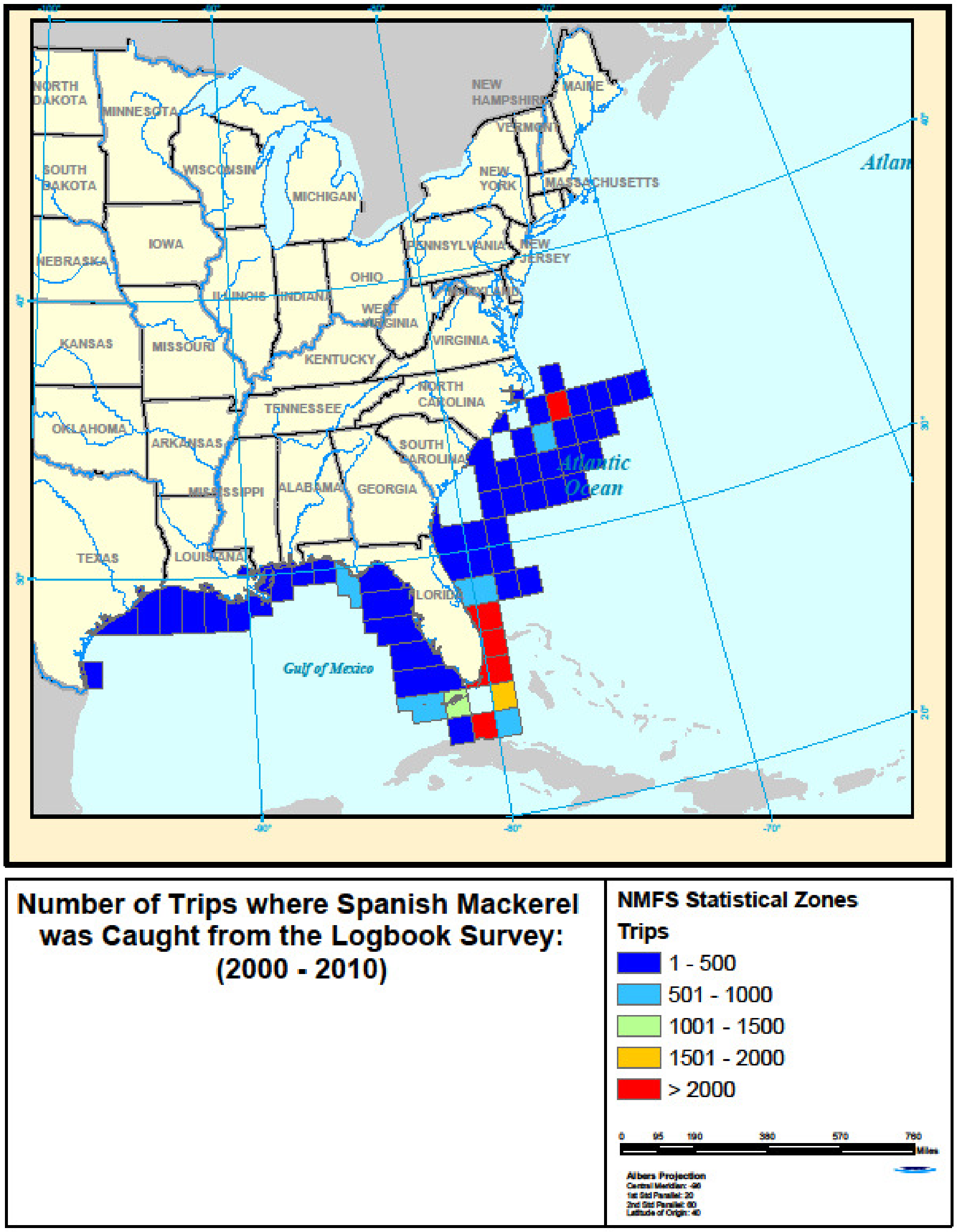


Figure 3.6. Spanish mackerel commercial landings in thousands of pounds (whole weight) by gear from the U.S. South Atlantic, 1889–2010.

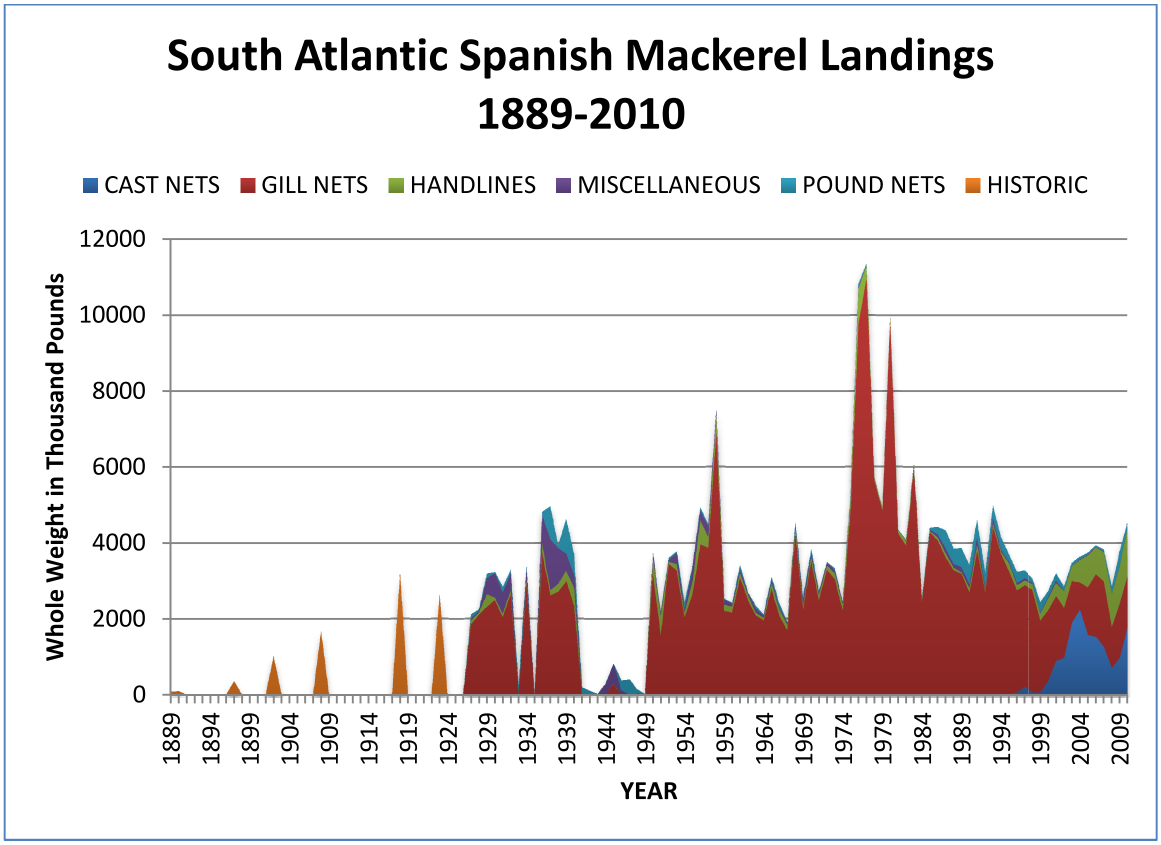


Figure 3.7. Approximate locations of shrimp observer samples in the Southeast U.S. Latitude and longitude were jittered randomly from 0-6 miles to preserve confidentiality. The excluded stations were either rock shrimp trips or in depths greater than 70 feet.

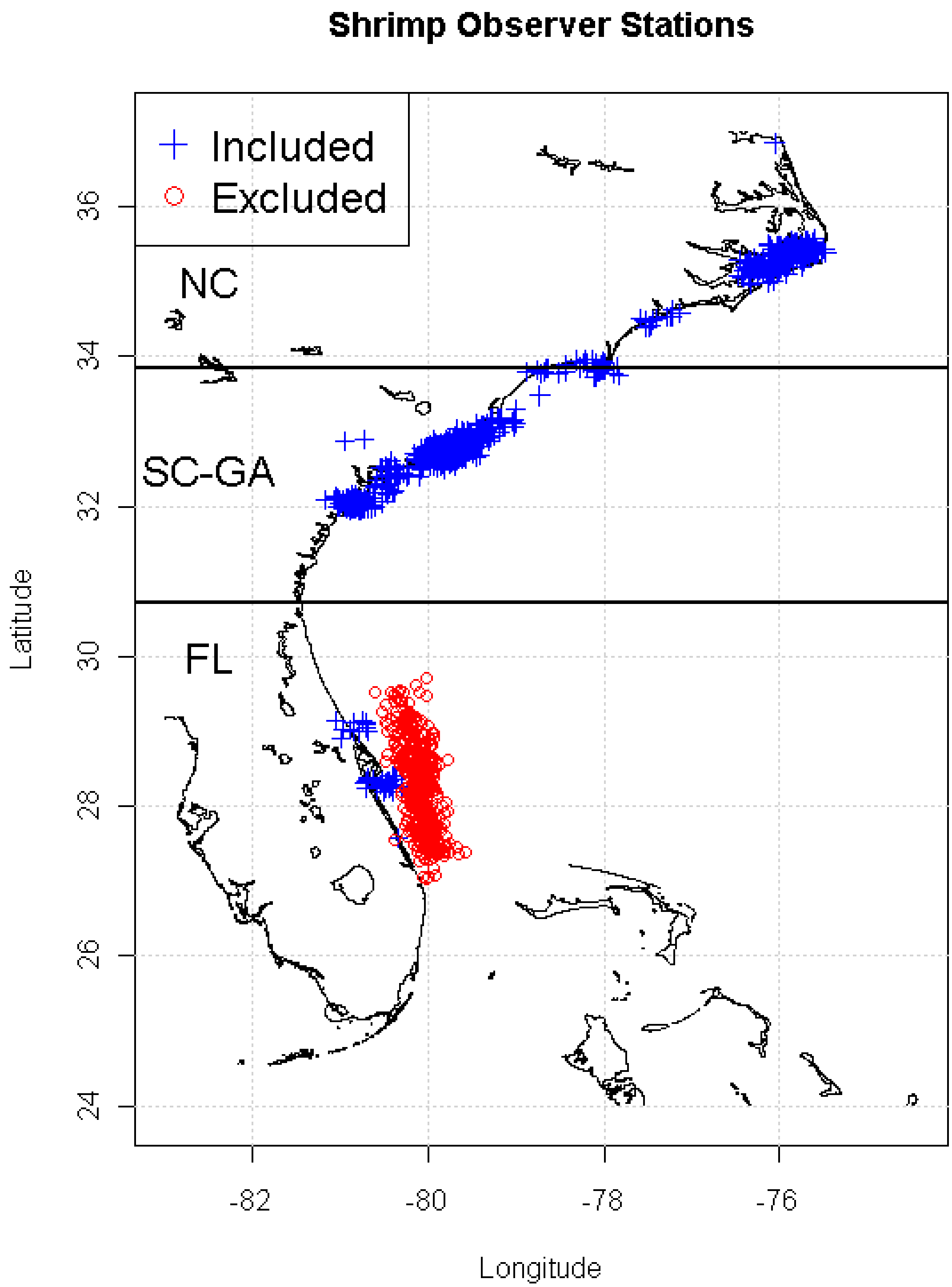
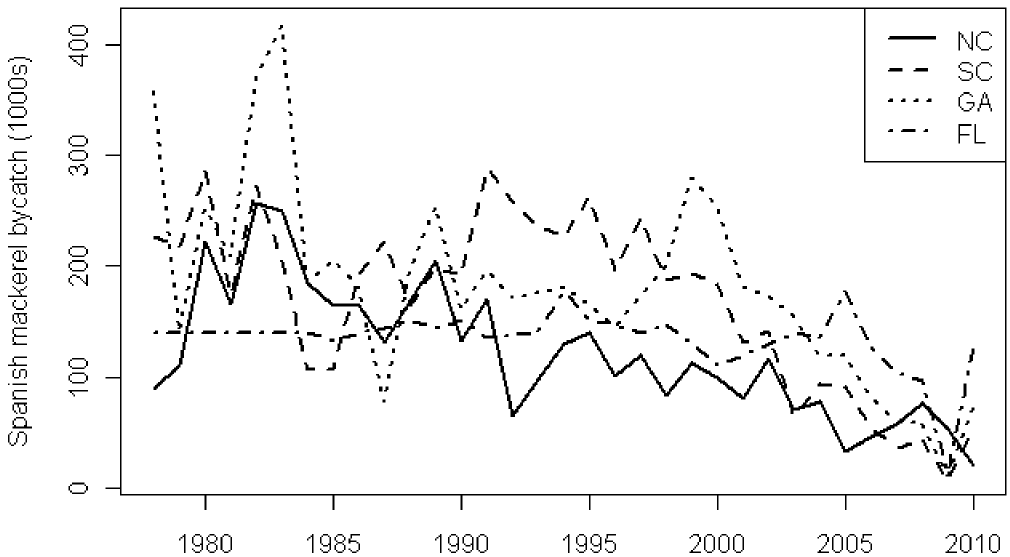


Figure 3.8. Estimates of Spanish mackerel bycatch by state for SEDAR 28 (upper panel) and a comparison of the total SEDAR 28 and SEDAR17 estimates (lower panel).



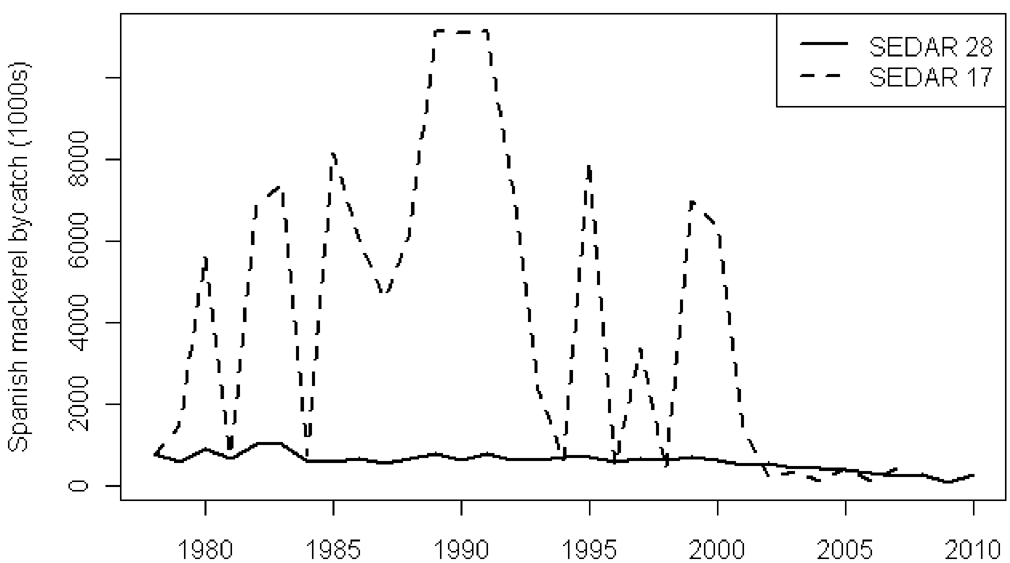
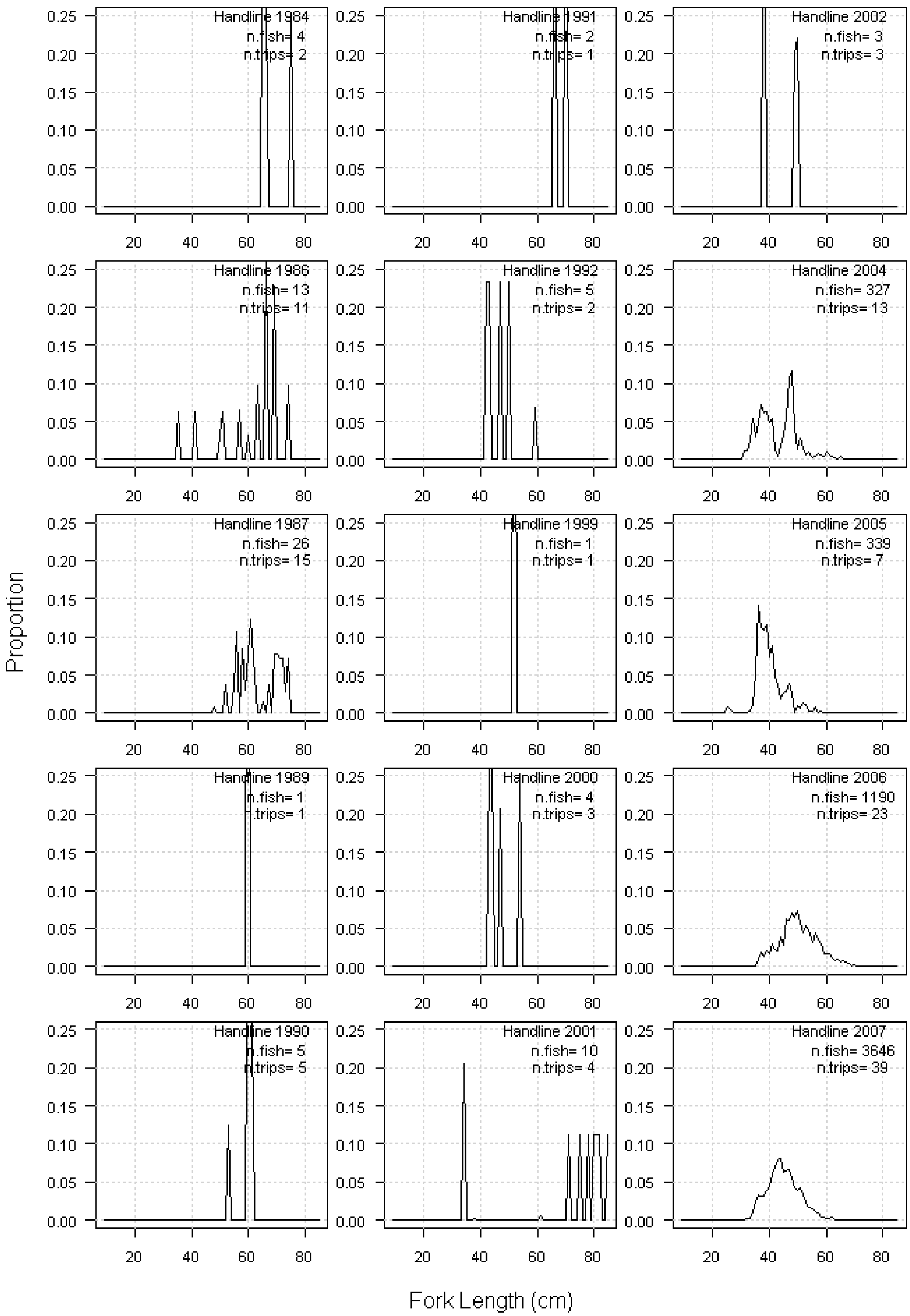
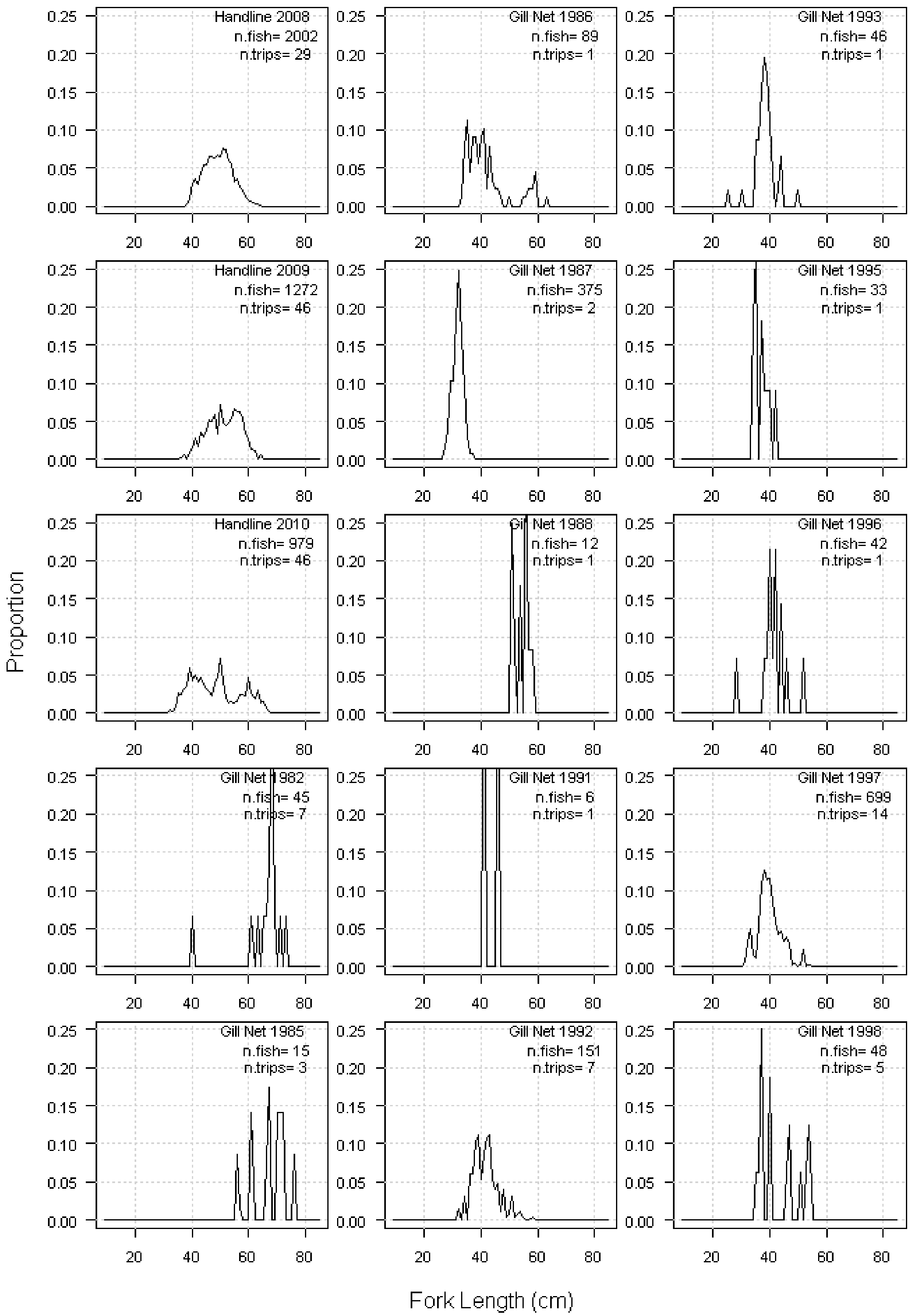
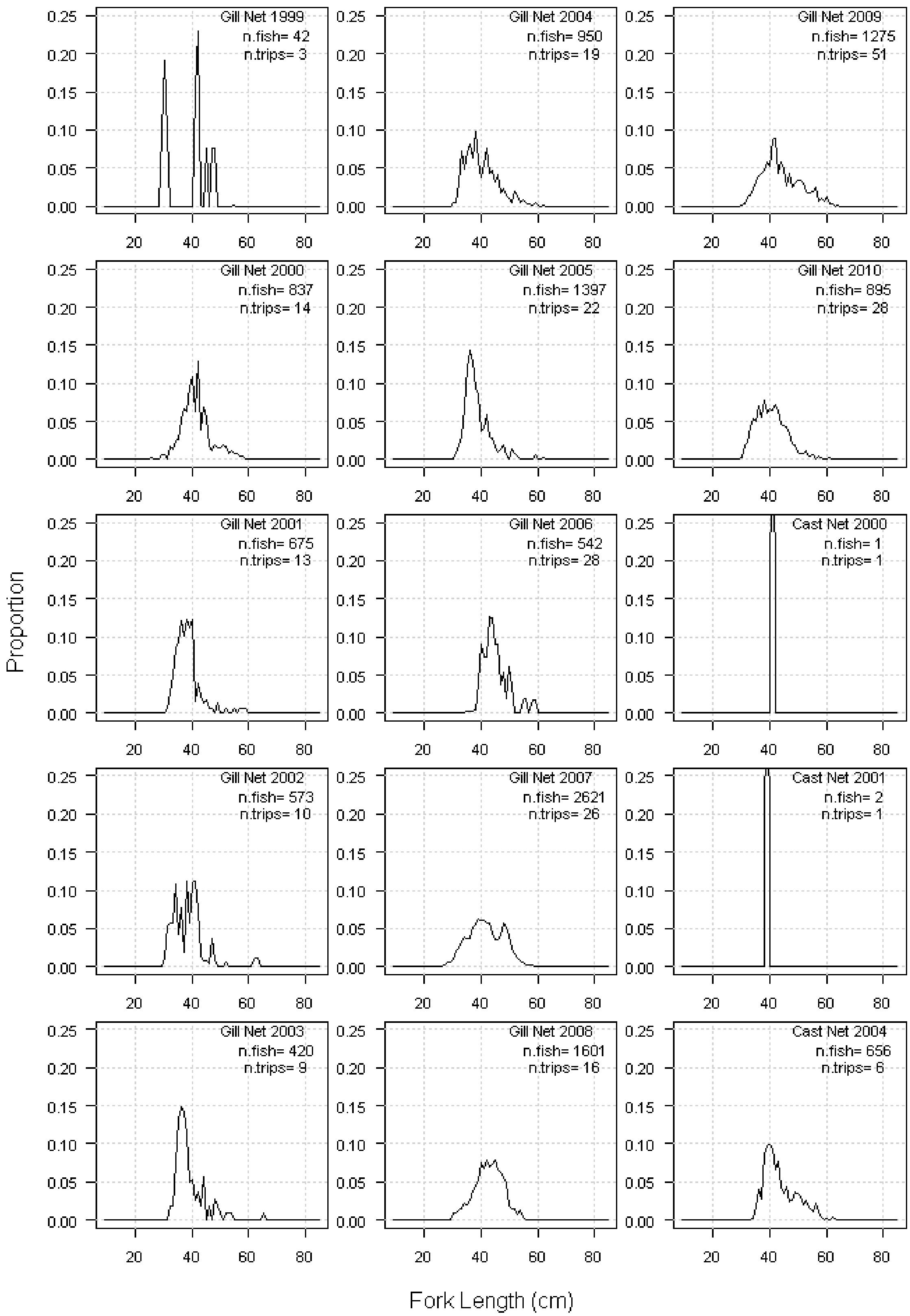
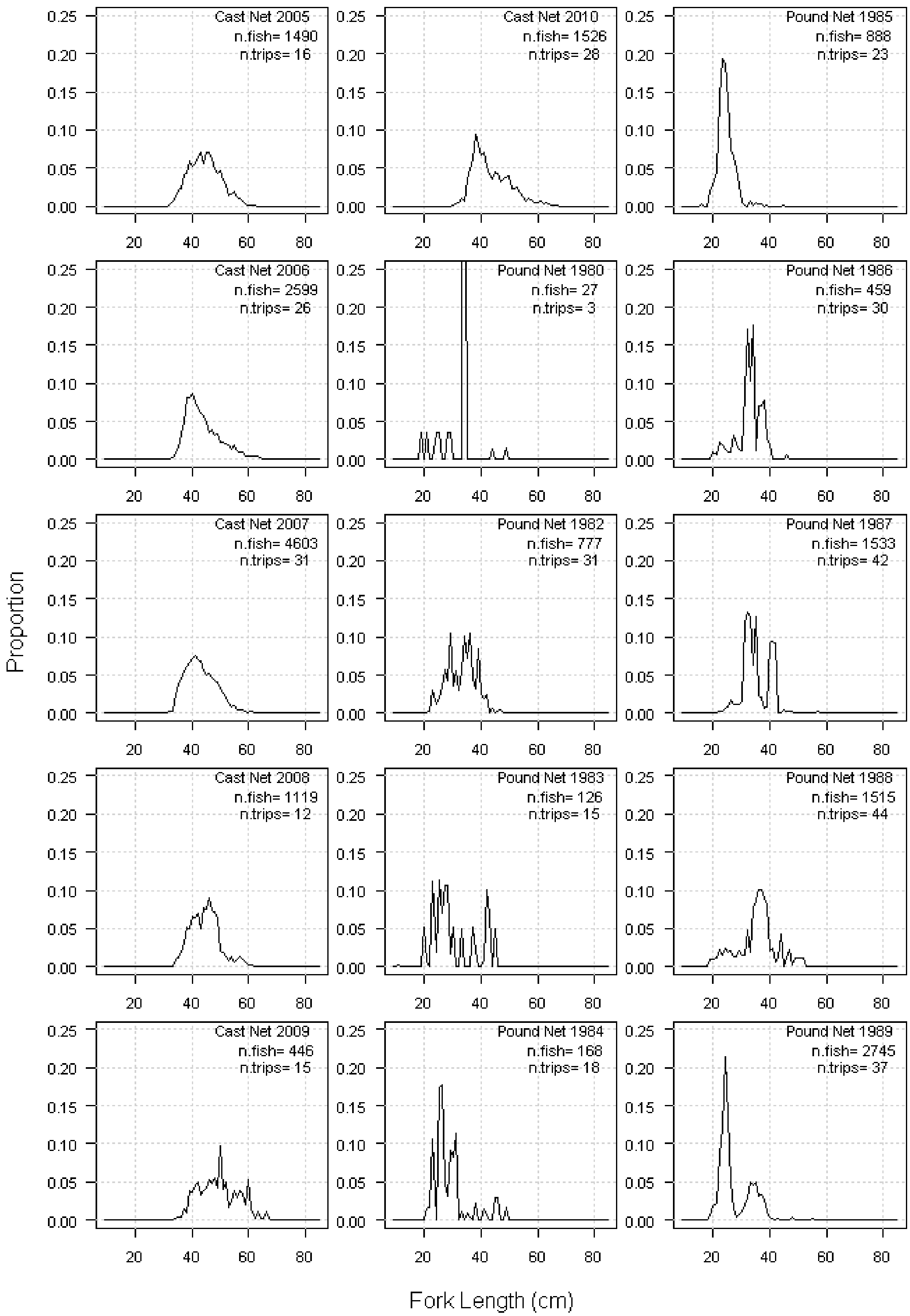


Figure 3.9. Relative length compositions of commercial length (FL in cm) samples by year and gear. Gear and sample size indicated on each panel.

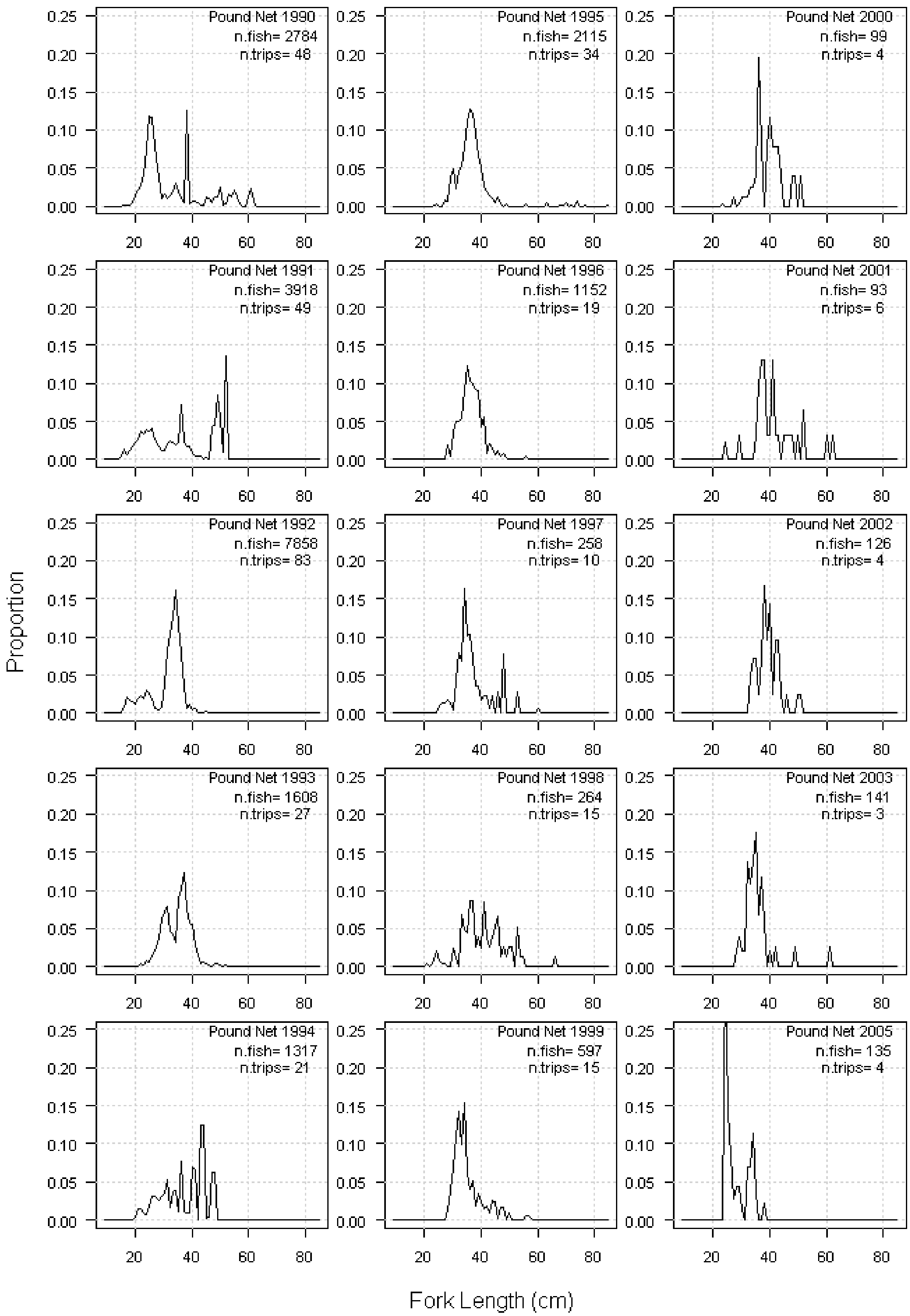


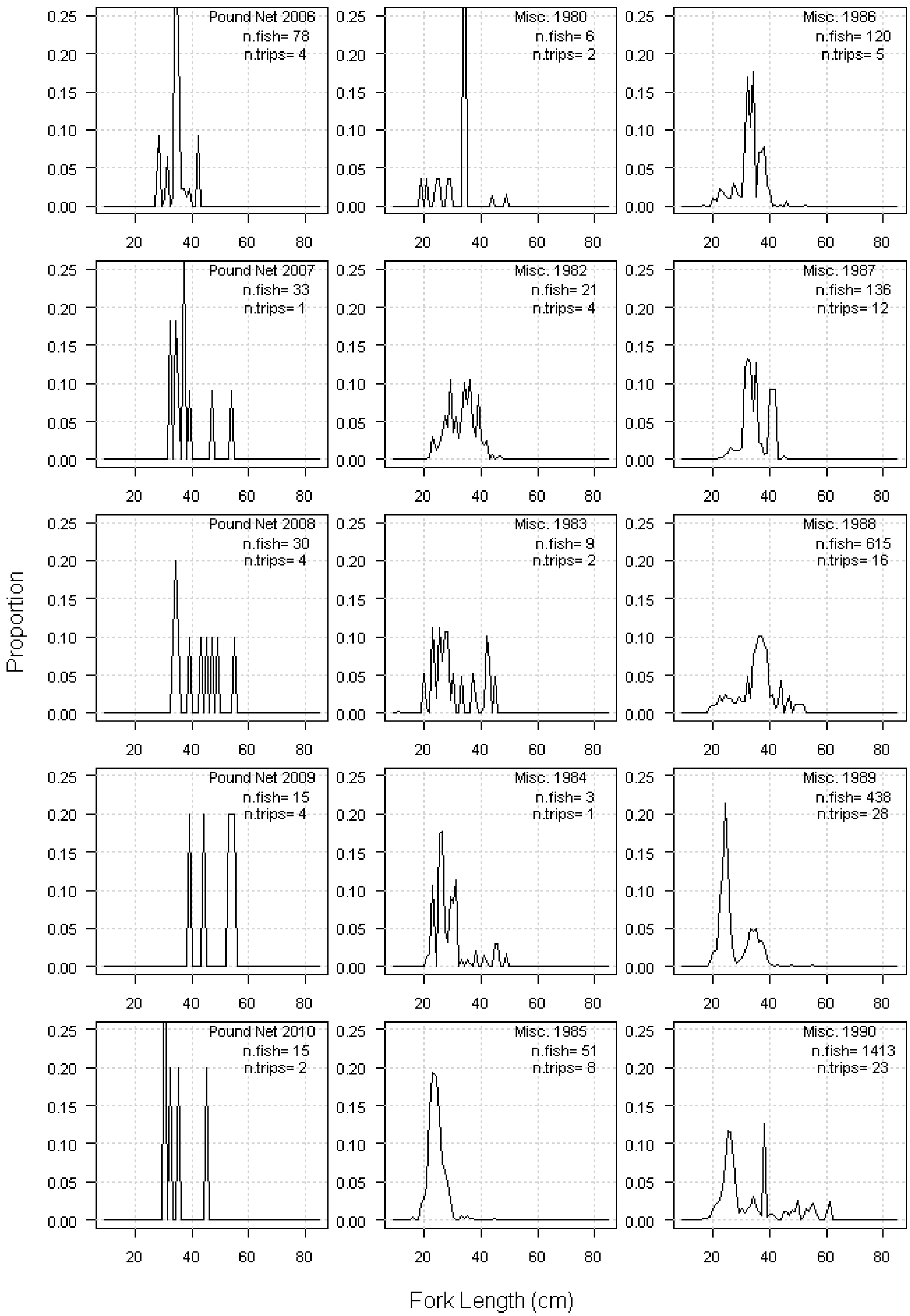

Handline 2008
n.fish= 2002
n.trips= 29
Gill Net 1986
n.fish= 89
n.trips= 1
Gill Net 1993
n.fish= 46
n.trips= 1
Handline 2009
n.fish= 1272
n.trips= 46
Gill Net 1987
n.fish= 375
n.trips= 2
Gill Net 1995
n.fish= 33
n.trips= 1
Handline 2010
n.fish= 979
n.trips= 46
Gill Net 1988
n.fish= 12
n.trips= 1
Gill Net 1996
n.fish= 42
n.trips= 1
Gill Net 1982
n.fish= 45
n.trips= 7
Gill Net 1991
n.fish= 6
n.trips= 1
Gill Net 1997
n.fish= 699
n.trips= 14
Gill Net 1985
n.fish= 15
n.trips= 3
Gill Net 1992
n.fish= 151
n.trips= 7
Gill Net 1998
n.fish= 48
n.trips= 5
Proportion
0.00
0.05
0.10
0.15
0.20
0.25
20
40
60
80
Fork Length (cm)

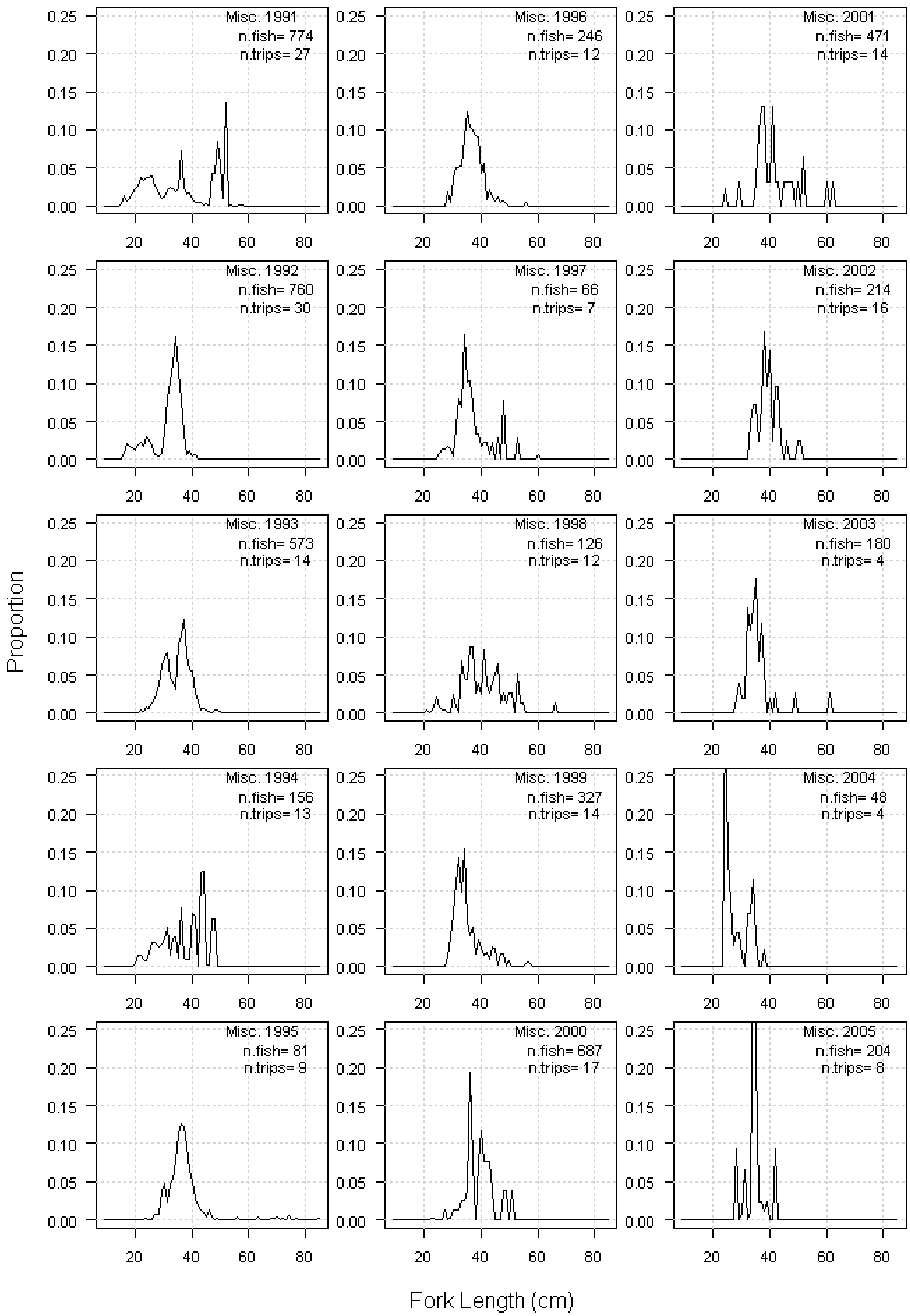

Gill Net 1999
n.fish= 42
n.trips= 3
Gill Net 2004
n.fish= 950
n.trips= 19
Gill Net 2009
n.fish= 1275
n.trips= 51
Gill Net 2000
n.fish= 837
n.trips= 14
Gill Net 2005
n.fish= 1397
n.trips= 22
Gill Net 2010
n.fish= 895
n.trips= 28
Gill Net 2001
n.fish= 675
n.trips= 13
Gill Net 2006
n.fish= 542
n.trips= 28
Cast Net 2000
n.fish= 1
n.trips= 1
Gill Net 2002
n.fish= 573
n.trips= 10
Gill Net 2007
n.fish= 2621
n.trips= 26
Cast Net 2001
n.fish= 2
n.trips= 1
Gill Net 2003
n.fish= 420
n.trips= 9
Gill Net 2008
n.fish= 1601
n.trips= 16
Cast Net 2004
n.fish= 656
n.trips= 6
Proportion
Fork Length (cm)



Cast Net 2005
n.fish= 1490
n.trips= 16
Cast Net 2010
n.fish= 1526
n.trips= 28
Pound Net 1985
n.fish= 888
n.trips= 23
Cast Net 2006
n.fish= 2599
n.trips= 26
Pound Net 1980
n.fish= 27
n.trips= 3
Pound Net 1986
n.fish= 459
n.trips= 30
Cast Net 2007
n.fish= 4603
n.trips= 31
Pound Net 1982
n.fish= 777
n.trips= 31
Pound Net 1987
n.fish= 1533
n.trips= 42
Cast Net 2008
n.fish= 1119
n.trips= 12
Pound Net 1983
n.fish= 126
n.trips= 15
Pound Net 1988
n.fish= 1515
n.trips= 44
Cast Net 2009
n.fish= 446
n.trips= 15
Pound Net 1984
n.fish= 168
n.trips= 18
Pound Net 1989
n.fish= 2745
n.trips= 37
Proportion
Fork Length (cm)


Pound Net 1990
n.fish= 2784
n.trips= 48
Pound Net 1995
n.fish= 2115
n.trips= 34
Pound Net 2000
n.fish= 99
n.trips= 4
Pound Net 1991
n.fish= 3918
n.trips= 49
Pound Net 1996
n.fish= 1152
n.trips= 19
Pound Net 2001
n.fish= 93
n.trips= 6
Pound Net 1992
n.fish= 7858
n.trips= 83
Pound Net 1997
n.fish= 258
n.trips= 10
Pound Net 2002
n.fish= 126
n.trips= 4
Pound Net 1993
n.fish= 1608
n.trips= 27
Pound Net 1998
n.fish= 264
n.trips= 15
Pound Net 2003
n.fish= 141
n.trips= 3
Pound Net 1994
n.fish= 1317
n.trips= 21
Pound Net 1999
n.fish= 597
n.trips= 15
Pound Net 2005
n.fish= 135
n.trips= 4
Proportion
Fork Length (cm)


Pound Net 2006
n.fish= 78
n.trips= 4
Misc. 1980
n.fish= 6
n.trips= 2
Misc. 1986
n.fish= 120
n.trips= 5
Pound Net 2007
n.fish= 33
n.trips= 1
Misc. 1982
n.fish= 21
n.trips= 4
Misc. 1987
n.fish= 136
n.trips= 12
Pound Net 2008
n.fish= 30
n.trips= 4
Misc. 1983
n.fish= 9
n.trips= 2
Misc. 1988
n.fish= 615
n.trips= 16
Pound Net 2009
n.fish= 15
n.trips= 4
Misc. 1984
n.fish= 3
n.trips= 1
Misc. 1989
n.fish= 438
n.trips= 28
Pound Net 2010
n.fish= 15
n.trips= 2
Misc. 1985
n.fish= 51
n.trips= 8
Misc. 1990
n.fish= 1413
n.trips= 23
Proportion
Fork Length (cm)


Misc. 1991
n.fish= 774
n.trips= 27
Misc. 1996
n.fish= 246
n.trips= 12
Misc. 2001
n.fish= 471
n.trips= 14
Misc. 1992
n.fish= 760
n.trips= 30
Misc. 1997
n.fish= 66
n.trips= 7
Misc. 2002
n.fish= 214
n.trips= 16
Misc. 1993
n.fish= 573
n.trips= 14
Misc. 1998
n.fish= 126
n.trips= 12
Misc. 2003
n.fish= 180
n.trips= 4
Misc. 1994
n.fish= 156
n.trips= 13
Misc. 1999
n.fish= 327
n.trips= 14
Misc. 2004
n.fish= 48
n.trips= 4
Misc. 1995
n.fish= 81
n.trips= 9
Misc. 2000
n.fish= 687
n.trips= 17
Misc. 2005
n.fish= 204
n.trips= 8
Proportion
Fork Length (cm)

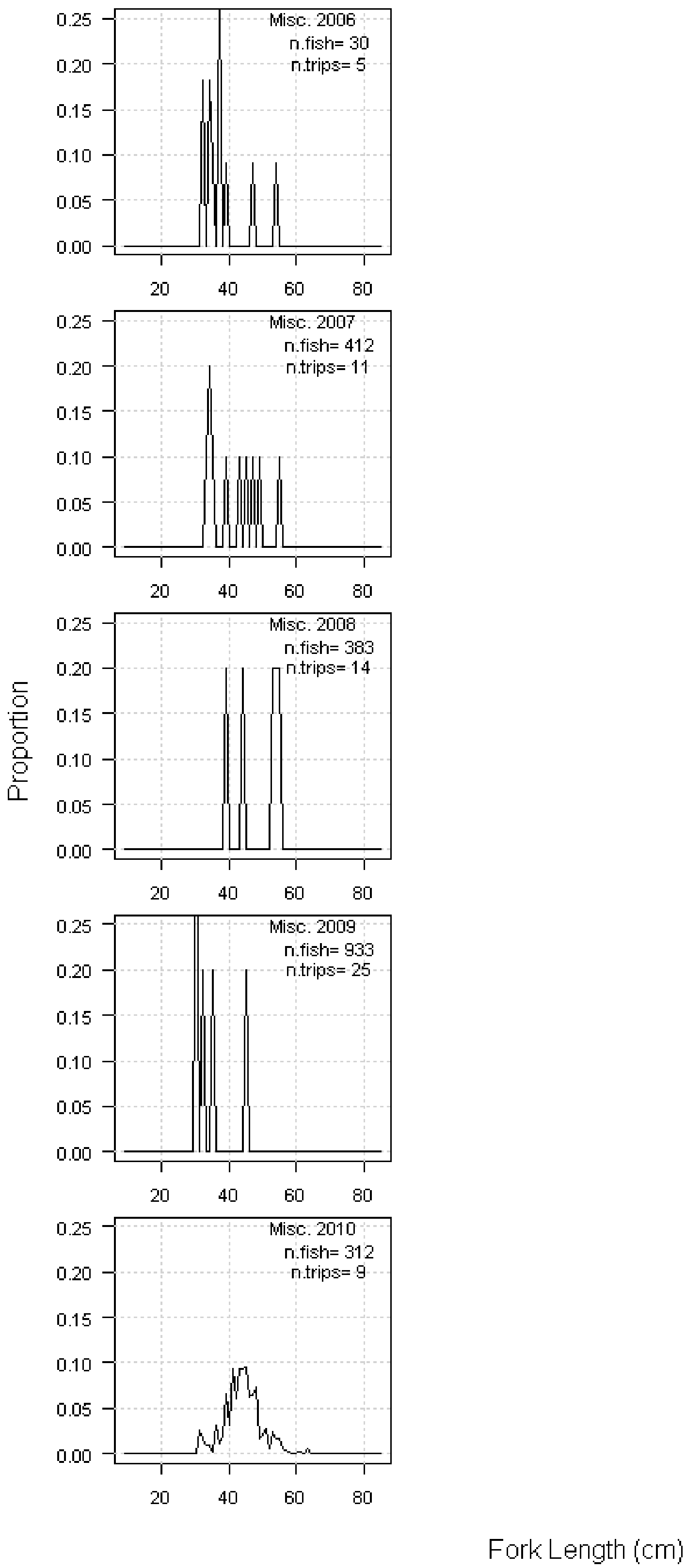
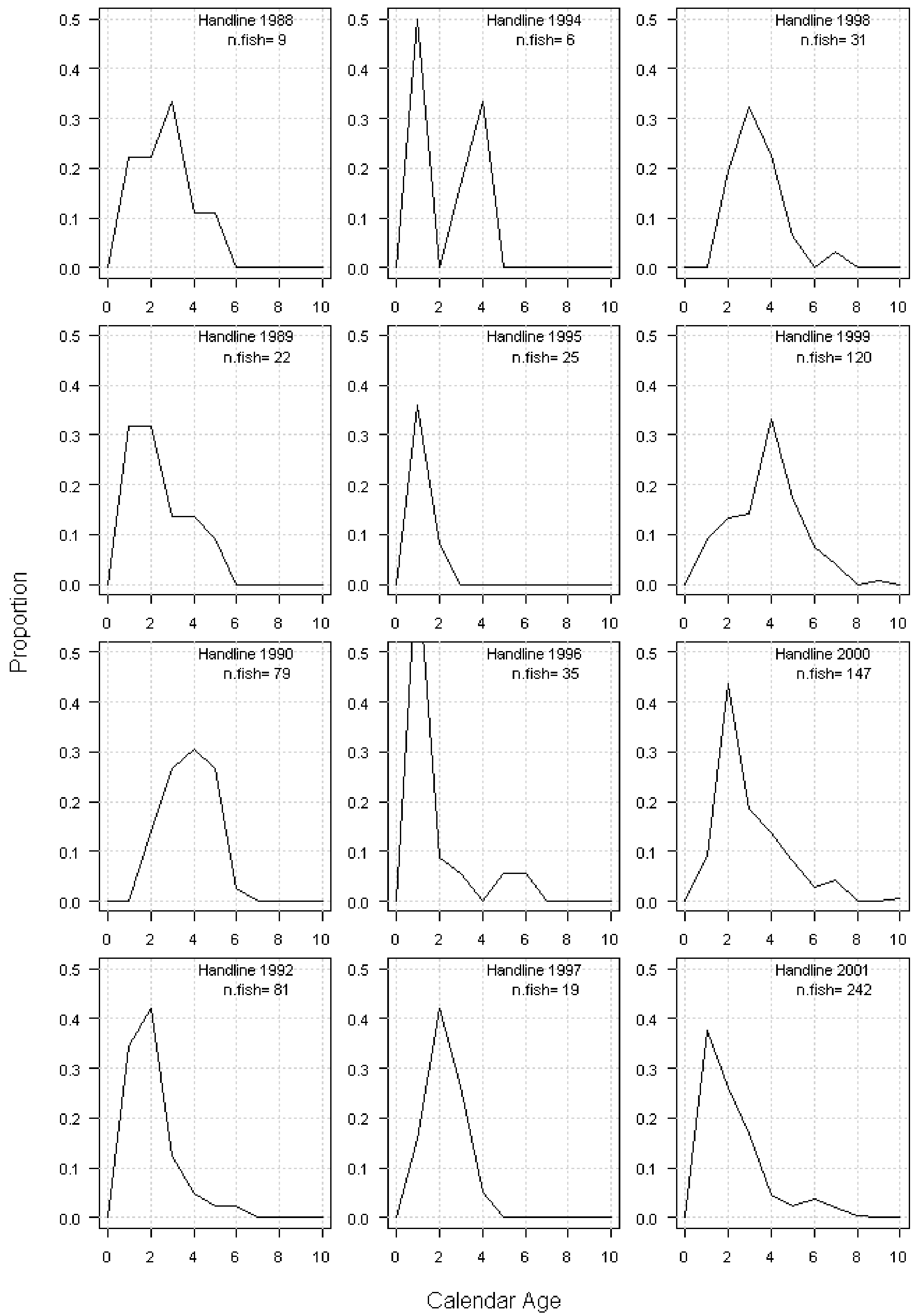
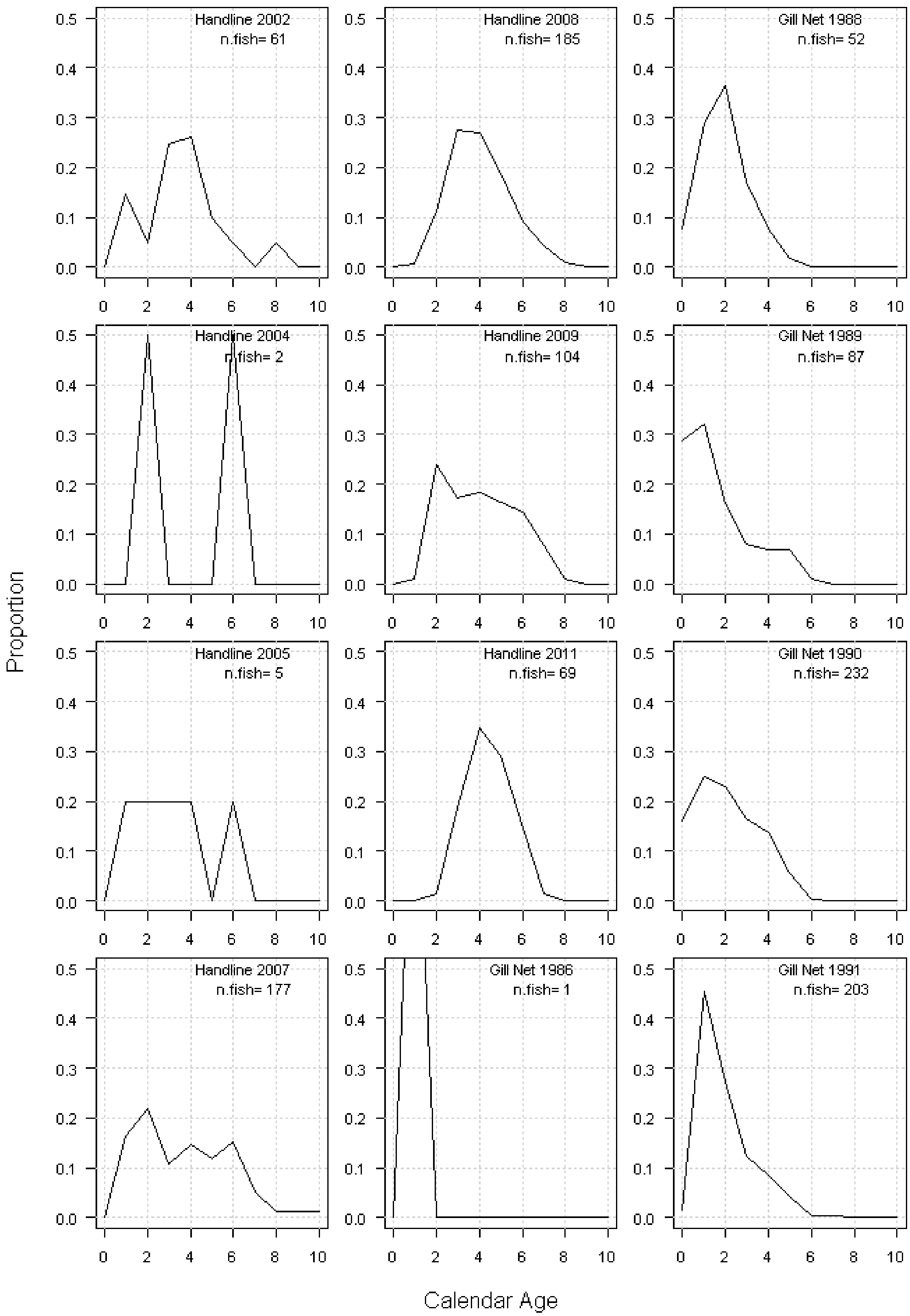
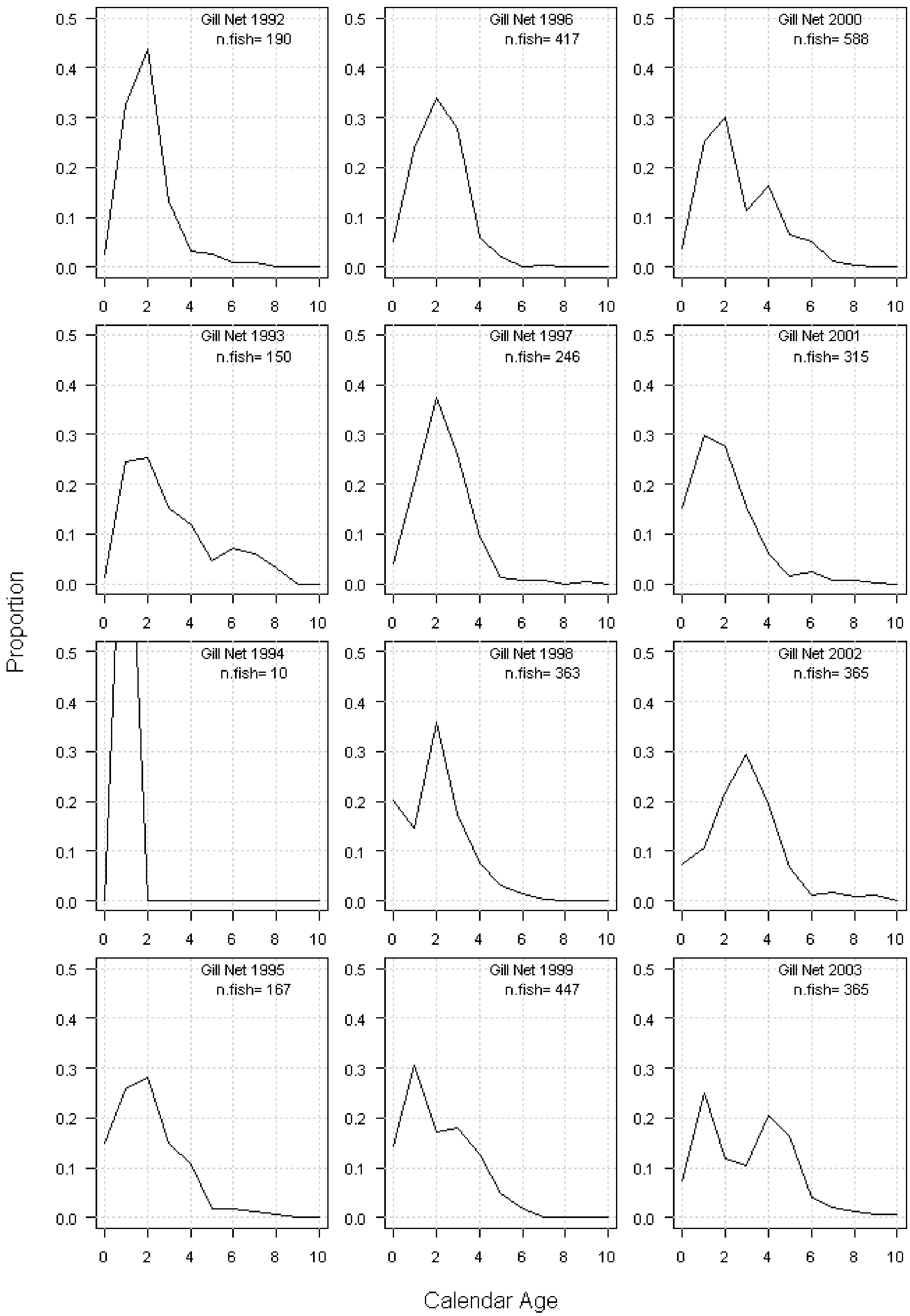
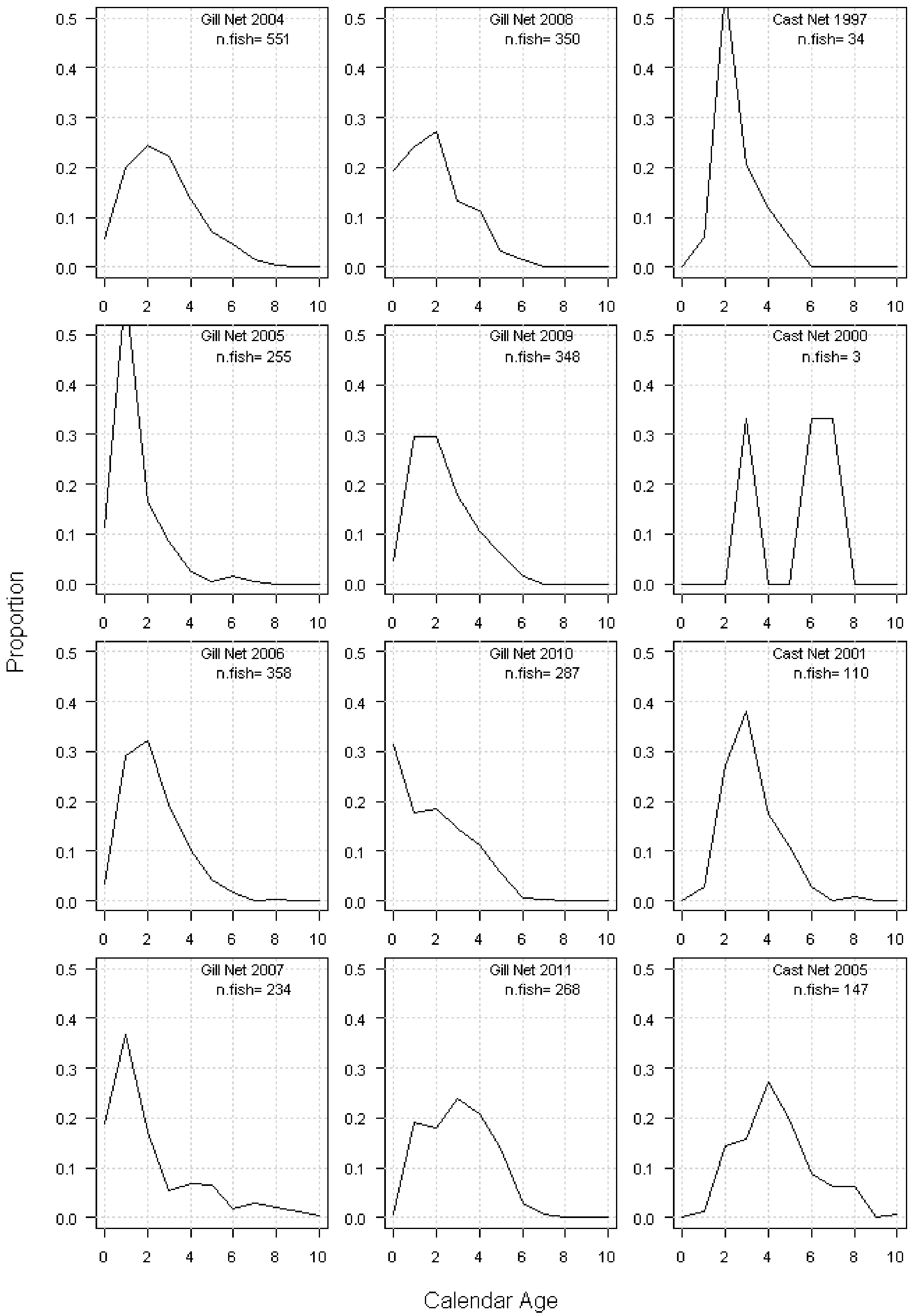

Misc. 2006
n.fish= 30
n.trips= 5
Misc. 2007
n.fish= 412
n.trips= 11
Misc. 2008
n.fish= 383
n.trips= 14
Misc. 2009
n.fish= 933
n.trips= 25
Misc. 2010
n.fish= 312
n.trips= 9
Proportion
0.25
0.20
0.15
0.10
0.05
0.00
20
40
60
80
Fork Length (cm)

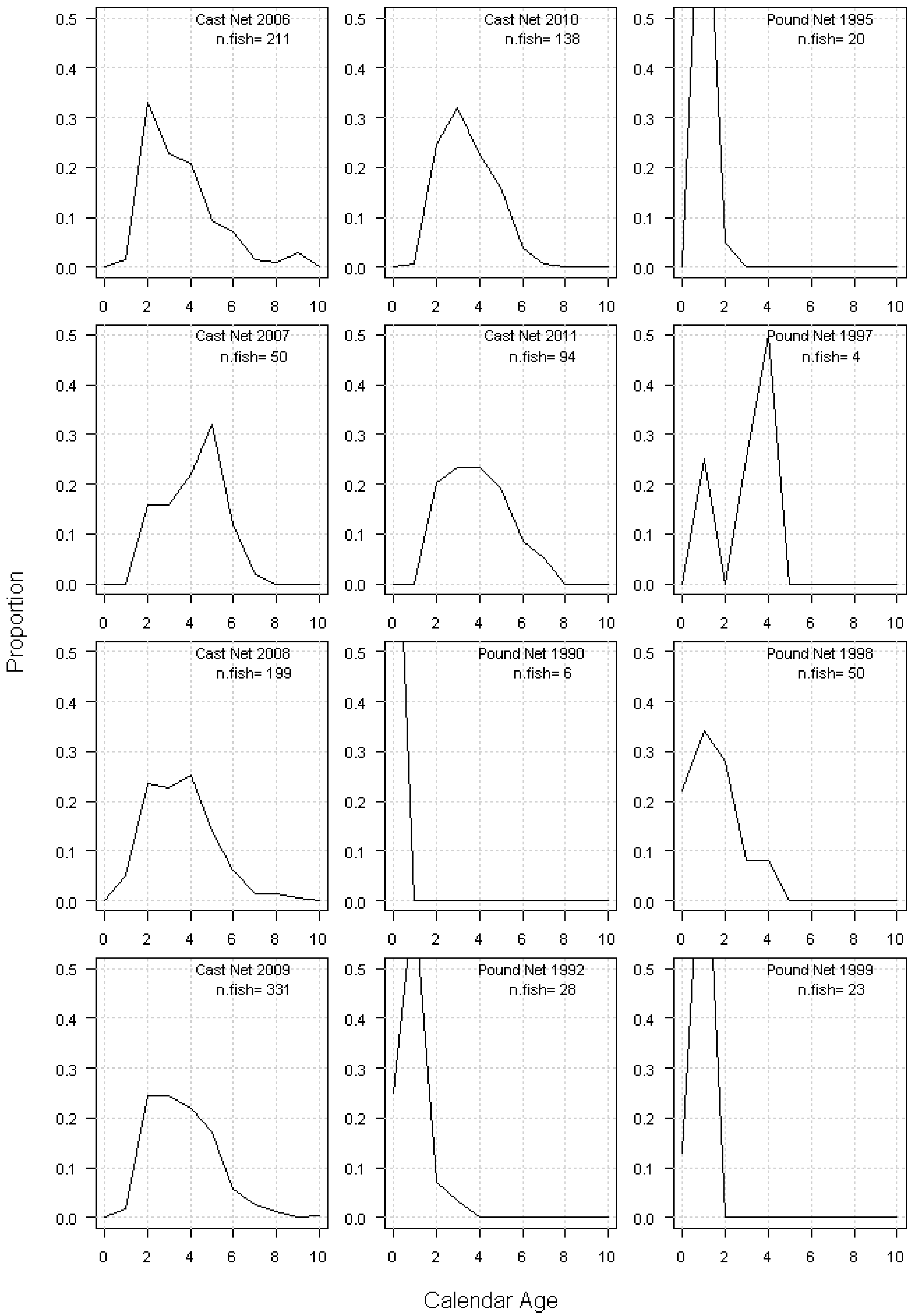
Figure 3.10. Relative age compositions of commercial age samples by year and gear (n.fish = number of fish). These compositions are raw (unweighted) and may be affected by sampling bias (e.g., fish sampled for length or market categories).

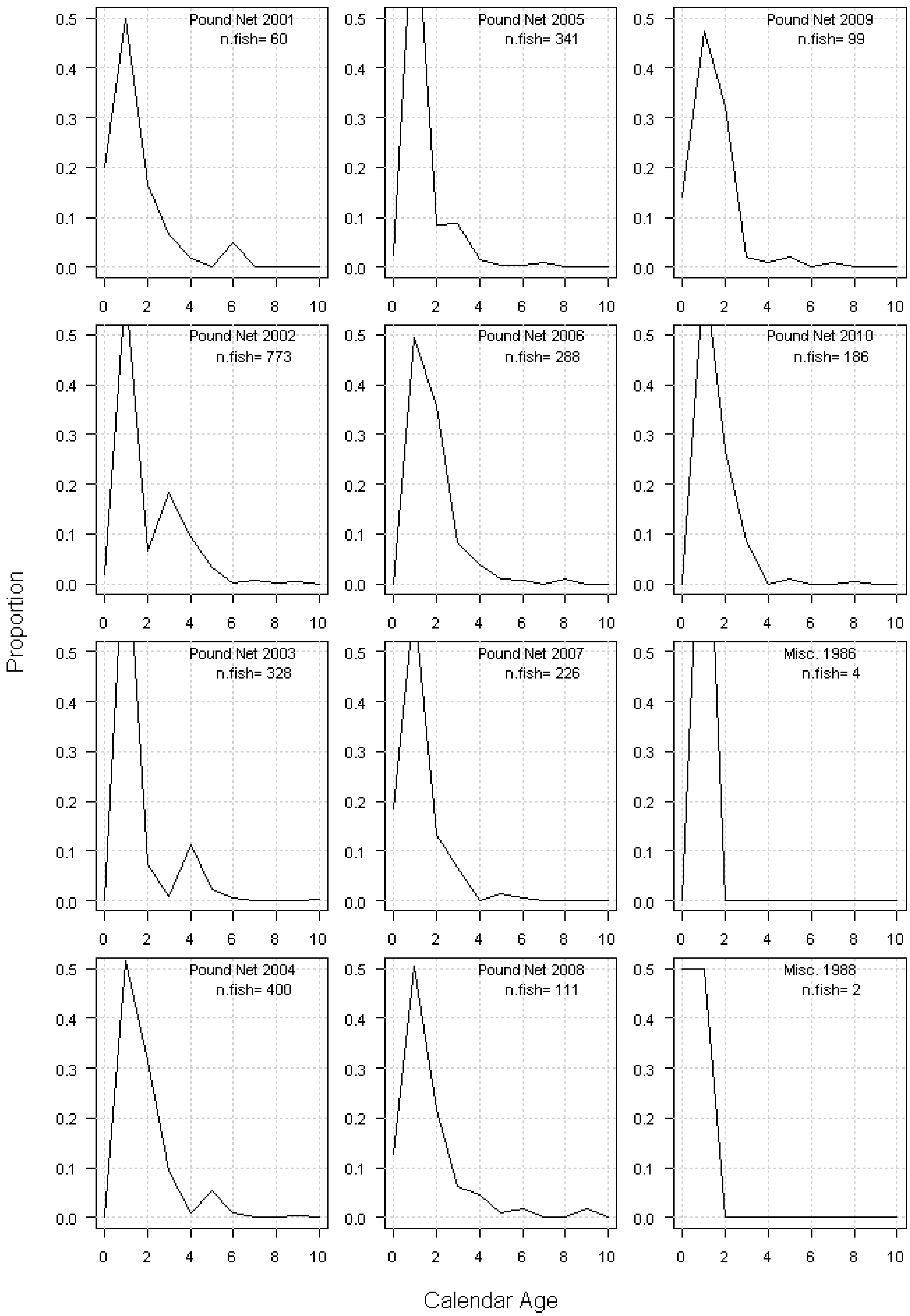


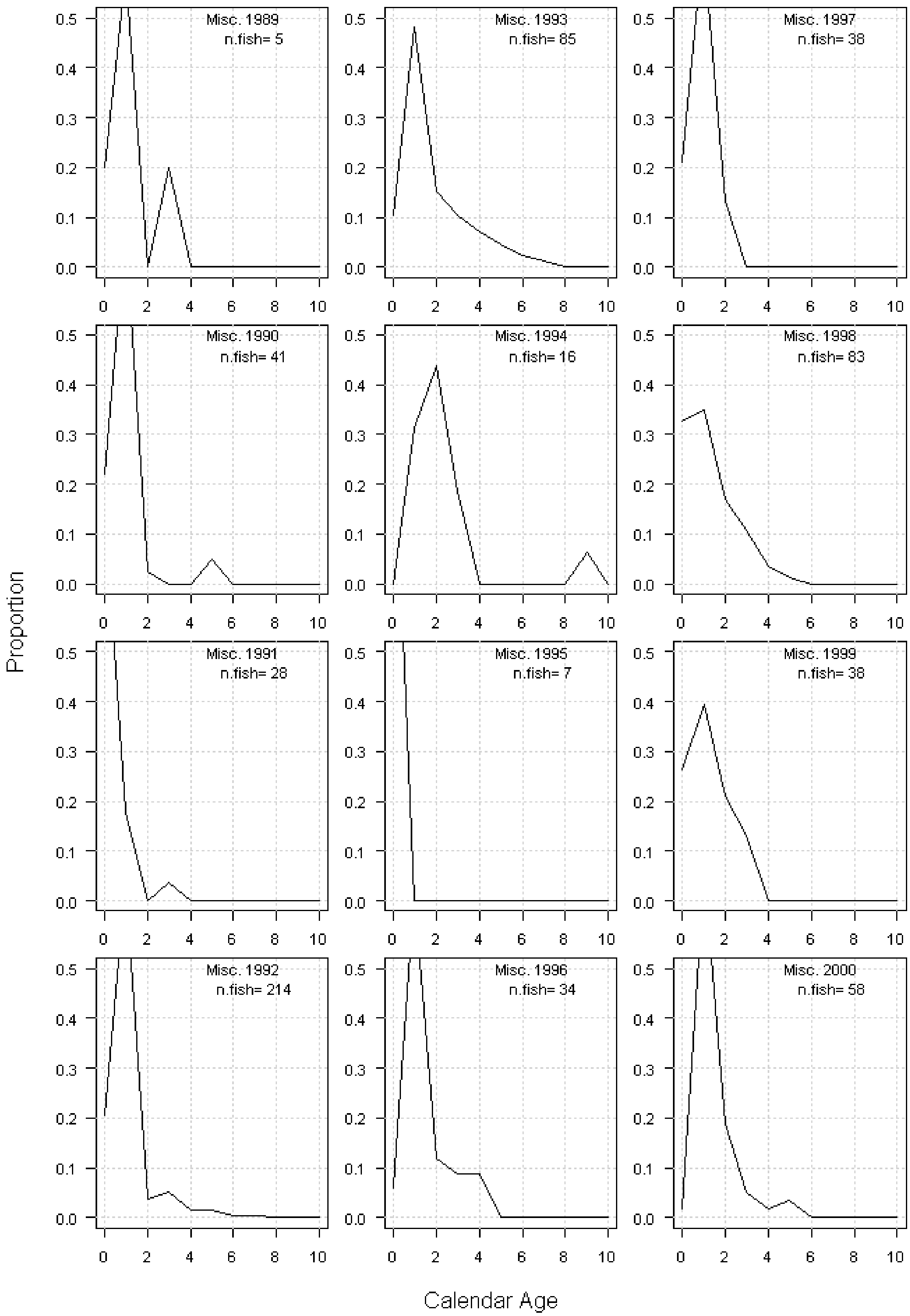

Handline 2002
n.fish= 61
Handline 2008
n.fish= 185
Gill Net 1988
n.fish= 52
Handline 2004
n.fish= 2
Handline 2009
n.fish= 104
Gill Net 1989
n.fish= 87
Handline 2005
n.fish= 5
Handline 2011
n.fish= 69
Gill Net 1990
n.fish= 232
Handline 2007
n.fish= 177
Gill Net 1986
n.fish= 1
Gill Net 1991
n.fish= 203
Proportion
Calendar Age

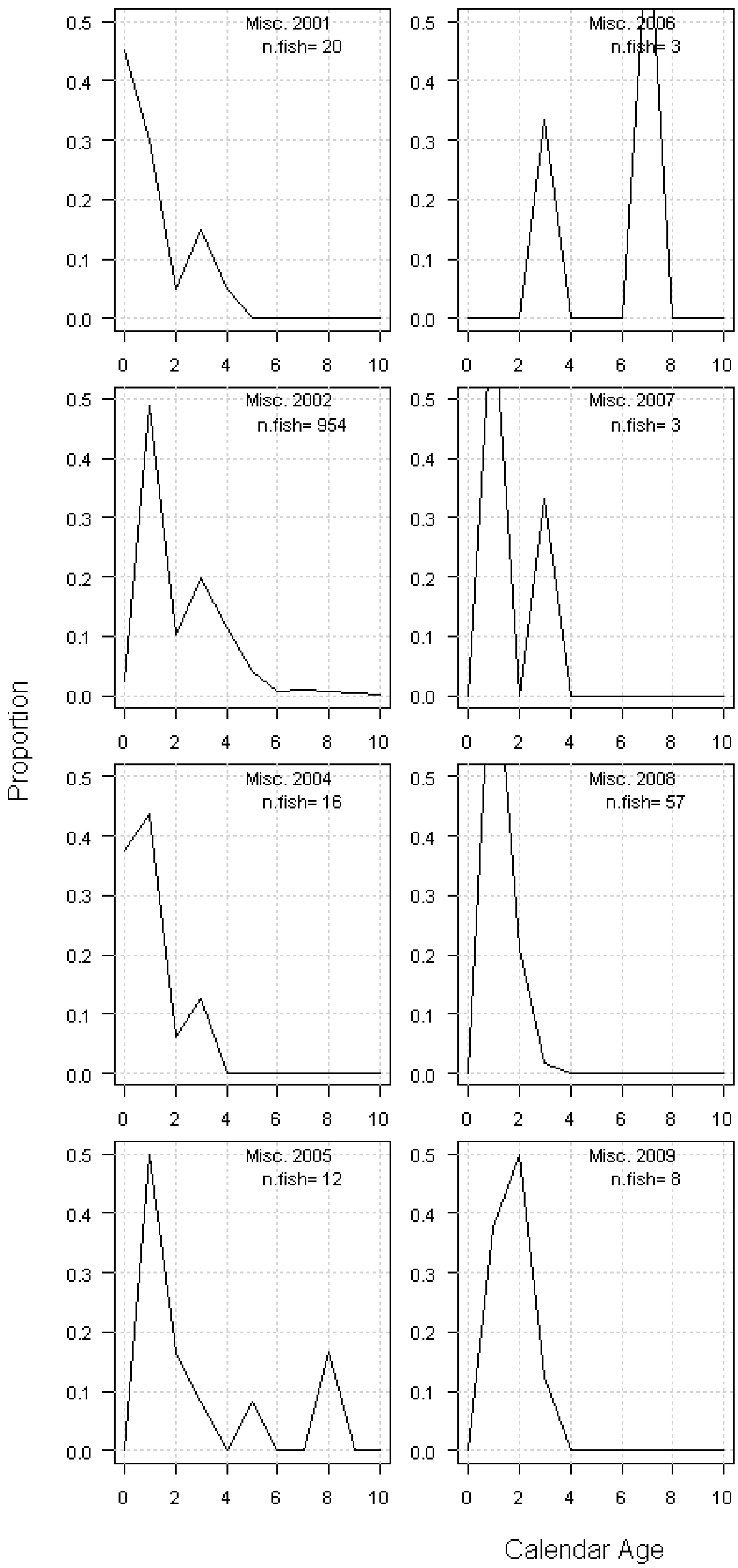

Gill Net 1992
n.fish= 190
Gill Net 1996
n.fish= 417
Gill Net 2000
n.fish= 588
Gill Net 1993
n.fish= 150
Gill Net 1997
n.fish= 246
Gill Net 2001
n.fish= 315
Gill Net 1994
n.fish= 10
Gill Net 1998
n.fish= 363
Gill Net 2002
n.fish= 365
Gill Net 1995
n.fish= 167
Gill Net 1999
n.fish= 447
Gill Net 2003
n.fish= 365
Proportion
Calendar Age


Gill Net 2004
n.fish= 551
Gill Net 2008
n.fish= 350
Cast Net 1997
n.fish= 34
Gill Net 2005
n.fish= 255
Gill Net 2009
n.fish= 348
Cast Net 2000
n.fish= 3
Gill Net 2006
n.fish= 358
Gill Net 2010
n.fish= 287
Cast Net 2001
n.fish= 110
Gill Net 2007
n.fish= 234
Gill Net 2011
n.fish= 268
Cast Net 2005
n.fish= 147
Proportion
Calendar Age


Cast Net 2006
n.fish= 211
Cast Net 2010
n.fish= 138
Pound Net 1995
n.fish= 20
Cast Net 2007
n.fish= 50
Cast Net 2011
n.fish= 94
Pound Net 1997
n.fish= 4
Cast Net 2008
n.fish= 199
Pound Net 1990
n.fish= 6
Pound Net 1998
n.fish= 50
Cast Net 2009
n.fish= 331
Pound Net 1992
n.fish= 28
Pound Net 1999
n.fish= 23
Proportion
Calendar Age


Pound Net 2001
n.fish= 60
Pound Net 2005
n.fish= 341
Pound Net 2009
n.fish= 99
Pound Net 2002
n.fish= 773
Pound Net 2006
n.fish= 288
Pound Net 2010
n.fish= 186
Pound Net 2003
n.fish= 328
Pound Net 2007
n.fish= 226
Misc. 1986
n.fish= 4
Pound Net 2004
n.fish= 400
Pound Net 2008
n.fish= 111
Misc. 1988
n.fish= 2
Proportion
Calendar Age


Misc. 1989
n.fish= 5
Misc. 1993
n.fish= 85
Misc. 1997
n.fish= 38
Misc. 1990
n.fish= 41
Misc. 1994
n.fish= 16
Misc. 1998
n.fish= 83
Misc. 1991
n.fish= 28
Misc. 1995
n.fish= 7
Misc. 1999
n.fish= 38
Misc. 1992
n.fish= 214
Misc. 1996
n.fish= 34
Misc. 2000
n.fish= 58
Proportion
Calendar Age


Misc. 2001
n.fish= 20
Misc. 2006
n.fish= 3
Misc. 2002
n.fish= 954
Misc. 2007
n.fish= 3
Misc. 2004
n.fish= 16
Misc. 2008
n.fish= 57
Misc. 2005
n.fish= 12
Misc. 2009
n.fish= 8
Proportion
Calendar Age

4 Recreational Fishery Statistics

4.1 Overview

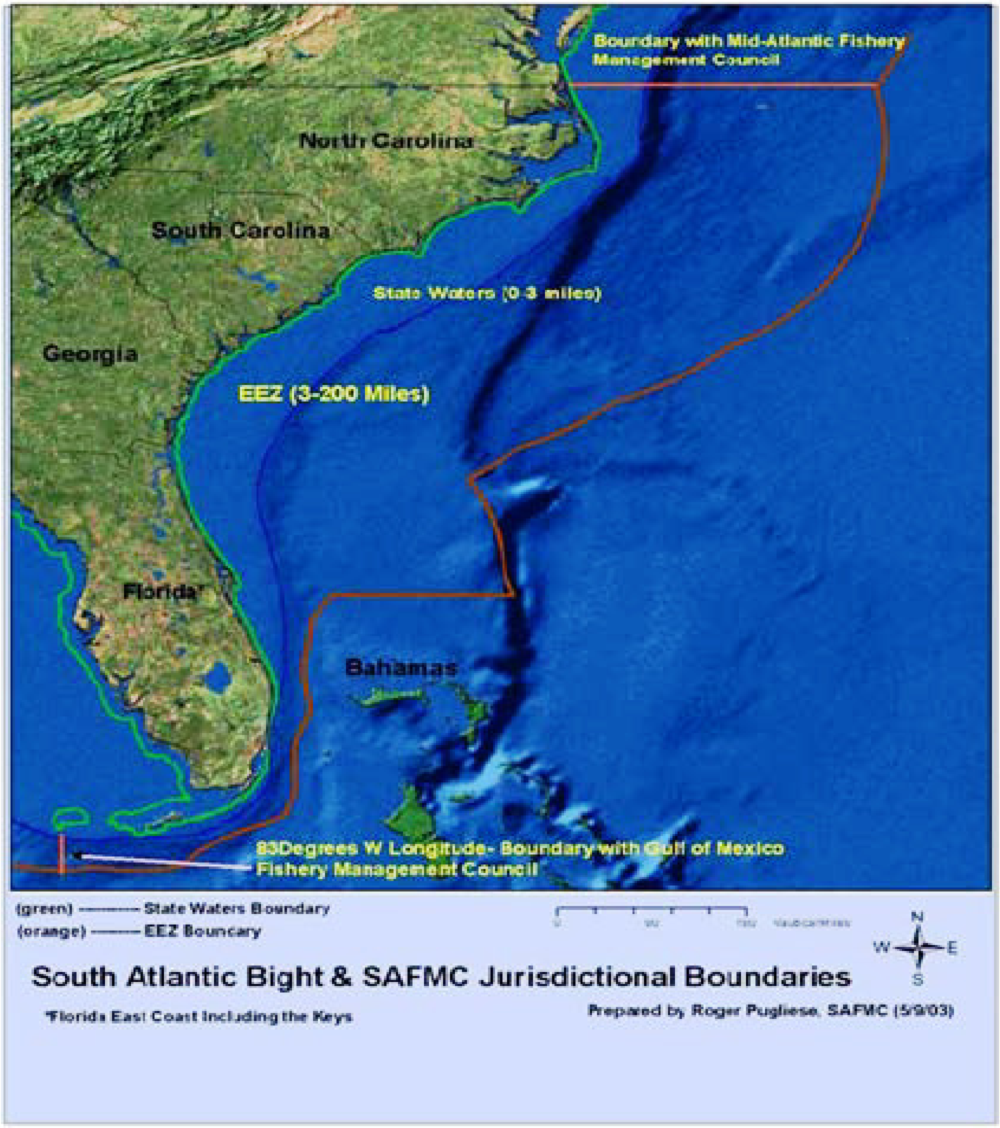
4.1.1 Group membership

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) Headboat logbook forms did not include Spanish mackerel on a universal form until 1984.
3) Missing weight estimates for some recreational "cells" (i.e., specific year, state, fishing mode, wave combinations).
4) 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.
5) Charter boat landings: MRFSS charter survey methods changed in 2003 in East Florida and in 2004 for Georgia and north.
6) Combined charter boat/head boat landings, 1981-1985: Official head boat landings are available from the SRHS. Therefore, the head boat component of the MRFSS combined charter boat/head boat mode must be parsed out.
7) 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.
8) New MRIP weighted estimates are available for 2004-2011: Determine appropriate use of datasets to cover the entire period from 1981-2011.

4.1.3 South Atlantic 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.

SEDAR28-DW24 *South Carolina Department of Natural Resources (SCDNR) Charter boat Logbook Program. Mike Errigo, Eric Hiltz and Julia Byrd.*

This working paper presents an index of abundance that was developed from the South Carolina Department of Natural Resources (SCDNR) charter boat logbook program for 1993-2010. The index of abundance developed is standardized catch per unit effort (CPUE; catch per angler hour) of Spanish mackerel using a delta-GLM model. Two model runs, using slightly different explanatory variables, are included in the working paper for Spanish mackerel. The first modeling approach used the year, the locale of the catch, and the month as explanatory variables (referred to as the "monthly" standardization). The second modeling approach used the year, the locale of the catch, and the season as explanatory variables (referred to as the "seasonal" standardization). The analysis is meant to describe the population trends of fish caught by V1 (6-pack) charter vessels in nearshore and offshore waters operating in or off of South Carolina. These data represent 49,132 fishing trips where anglers caught 186,444 and harvested 147,141 Spanish mackerel. The catch data presented in this working paper was further discussed by the Recreational Fisheries Working Group and the index was further discussed by the Indices Working Group.

SEDAR28-DW25, *South Carolina Department of Natural Resources (SCDNR) State Finfish Survey. Eric Hiltz and Julia Byrd*

This working paper presents a summary of the Spanish mackerel catch, disposition, and size information collected through the South Carolina Department of Natural Resources (SCDNR) State Finfish Survey (SFS) from 1988 to 2011. The SFS collects finfish intercept data in South Carolina through a non-random intercept survey at public boat landings along the SC coast. The survey focuses on known productive sample sites, targets primarily private boat mode, and is conducted year-round (January- December) using a questionnaire and interview procedure similar to those of the intercept portion of the MRFSS. From 1988 to 2011, 742 fishing parties were interviewed where Spanish mackerel were caught, representing between 0.18% and 11.52% of the total number of interviews in each year. Fishing parties interviewed through the SFS caught 3,684 Spanish mackerel from 1988 to 2011. Of those fish, a total of 2,411 were harvested (plus 46 harvested for use as bait) and 1,413 length measurements were obtained. The length frequency data presented in this working paper were further discussed by the Recreational Fisheries Working Group to potentially be used to supplement the MRFSS data for length compositions.

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 Atlantic states from Maine to Florida. The state of Florida is sampled as two sub-regions. The east Florida sub-region includes counties adjacent to the Atlantic coast from Nassau County south through Miami-Dade County, and the west Florida sub-region includes Monroe County (Florida Keys) and counties adjacent to the Gulf of Mexico. Separate estimates are generated for each Florida sub-region, and those estimates may be post-stratified into smaller regions based on proportional sampling. Sampling is not conducted in Wave 1 (Jan/Feb) north of Florida because fishing effort is very low or non-existent, with the exception of NC, where wave 1 has been sampled since 2006.

The MRFSS 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 east Florida in 2000 and officially adopted in 2003. The FHS was then expanded to the rest of the Atlantic (GA and north) in 2005, wave 2. There is one unofficial year of FHS for this group of states from 2004, which has been used in SEDARs for other species (SEDAR 16 king mackerel).

A further improvement in the FHS method was the pre-stratification of Florida into smaller sub-regions for estimating effort. Pre-stratification defines the sample unit on a sub-state level to produce separate effort estimates by these finer geographical regions. The FHS sub-regions include three distinct regions bordering the Atlantic coast: 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 (SEDAR 17-Data Workshop Report, 2008). 1986-2003 South Atlantic calibration factors were updated in 2011 (SEDAR 25 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 Headboat 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-DW-12).

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.

Separation of SA combined charter/headboat mode
In the South Atlantic, 1981-1985 charter and headboat modes were combined into one single mode for estimation purposes. Since the NMFS Southeast Region Headboat Survey (SRHS) began in this region in 1981, the MRFSS combined charter/headboat mode must be split in order to not double estimate the headboat mode for these years. MRFSS charter/headboat mode was split in these years by using a ratio of SRHS headboat angler trip estimates to MRFSS charter boat angler trip estimates for 1986-1990. A similar method (using landings data instead of effort data) has been used in the past (SEDAR 25- black sea bass). The mean ratio was calculated by state (or state equivalent to match SRHS areas to MRFSS states) and then applied to the 1981-1985 estimates to strip out the headboat component when needed.

For Spanish mackerel, which is considered a low profile species in the headboat catches, the SRHS estimates will start in 1984 due to inconsistent forms between 1981-1983 requiring Spanish mackerel to be entered as a write-in. Spanish mackerel MRFSS charter/headboat mode was split for all years 1981-1985, and both modes were retained in the MRFSS dataset for 1981-1983. For 1984-1985 the headboat component was deleted from the MRFSS dataset to avoid duplication with the SRHS.

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 numbers 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).

This ratio method is the preferred way to estimate 1981, wave 1 catches when the ratios are reasonably stable from year to year. When ratios are highly variable from year to year, the mean wave 1 catch estimates from 1982-1984 is used instead. This occurs in one cell for Spanish mackerel on the east Florida coast (shore mode and ocean less than 3 miles).

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. Due to headboat area definitions and confidentiality issues, Georgia and East Florida landings must be combined. The SRHS began in the Gulf of Mexico in 1986 and extends from Naples, FL to South Padre Island, TX. 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.

The headboat logbook was changed several times during the early years of the Headboat Survey. In the case of Spanish mackerel, the logbook used in North Carolina and South Carolina did not list Spanish mackerel until 1984. Georgia and Florida had a mix of the different versions in use from 1980 to 1983. The Headboat Survey did not have a universal logbook form that included Spanish mackerel for all areas until 1984.

Issue: From 1981-1983 Spanish mackerel was only listed on 1 of 3 versions of the Headboat Survey logbook form being used in the South Atlantic.

Option 1: Start headboat time series in 1984 when a universal form was in use in all areas from NC- FL. MFRSS headboat landings will be used 1981-1983.

Option 2: Use estimated headboat landings based on available logbook data 1981- 2011.

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 1-17 are included in the Atlantic Spanish mackerel stock. Figures 4.12.7, 4.12.8, 4.12.9, and 4.12.10 show the South Atlantic Spanish mackerel headboat landings from 1973-1979, 1980-1989, 1990-1999, and 2000-2011 respectively. Headboat landings of Spanish mackerel in the South Atlantic, from the 1970's to present, have mostly been concentrated in 3 areas: South Carolina, Fort Pierce, FL and Miami, FL. South Florida accounted for a large portion of the catch in the 1980s (Figure 4.12.8), however, since 1990 headboat landings indicate that Spanish mackerel are caught predominantly off Fort Pierce, FL and South Carolina (Figures 4.12.9 and 4.12.10).

4.3.3 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 SEDAR 17 included historical recreational landings estimates for 1950 – 1980, based on linear interpolation using the Saltwater Angling Surveys (SWAS) from 1960, 1965 & 1970. Concerns were raised that these historical landings were overestimated due to recall bias, rounding bias and changes in methodologies in the SWAS.

The Recreational Working Group was tasked with reviewing the SWAS used in SEDAR 17 and to evaluate 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) from 1960, 1965 &1970.
- Anderson, 1965, DW Reference Document 31.
- The U.S Fish and Wildlife Service (USFWS), 2001 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation Survey (FHWAR).

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 (SEDAR24-DW11). This information was used to develop an alternative method for estimating recreational landings prior to 1981.

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 3 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.

Anderson, 1965

The RWG discussed SEDAR-RD04 as a possible source of information for historical Spanish mackerel landings. The study area designated as the Cape Canveral area included Brevard and Volusia counties in Florida. The recreational data was obtained from field surveys from February to October, 1963. The RWG considered this spatially and temporally limiting for possibly expanding estimated landings prior to 1981.

FHWAR census method

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 from New England to the South Atlantic (NE-SA) 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 NE-SA to yield the total saltwater anglers for NE-SA. The same method was used to calculate the total saltwater days for the NE-SA from the FHWAR surveys from 1955-1985.

The FHWAR surveys the South Atlantic included the entire state of Florida, east and west coasts. In order to address the management boundaries for Spanish mackerel the saltwater angler days for Florida's west coast (FLW) were separated from the NE-SA saltwater angler days using the ratio of the MRFSS total angler trips for FLW to the MRFSS total angler trips for the South Atlantic (Delaware to FLW). The average ratio from 1984-1986 was applied to the total saltwater days for the NE-SA 1955-1985 to remove 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, as was case in SEDAR 17, an adjustment for recall bias was necessary. The total saltwater days for the NE-SA 1955-1985 were adjusted for recall bias in the FHWAR surveys. The MRFSS total angler trips for the east coast 1984 to1986 was averaged and divided by the total saltwater days for 1985 from the FHWAR survey. This multiplier was then applied to the total NE-SA saltwater days 1955-1985 to adjust for recall bias.

The mean CPUE for Spanish mackerel in the South Atlantic from the MRFSS estimates from 1981 to 1985 was then applied to the adjusted saltwater angler days for the NE-SA 1955-1985 to estimate the historical Spanish mackerel landings for those years (Table 4.11.4).

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 4.12.11).

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

Option 1: Use the Adjusted SWAS (SEDAR 17)

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: Use FHWAR census method to estimate Spanish mackerel landing 1955-1980 in the South Atlantic and Gulf of Mexico. Use interpolation to complete time series.

Decision: *Option 4*. Total Spanish mackerel landings using the FHWAR census menthod (NE-FLE 1955-1984) are presented with the MRFSS Spanish mackerel landings (NE-FLE 1981-2003) and MRIP Spanish Mackerel landings (NE-FLE 2004-2011) in Table 4.11.5 and Figure 4.12.12.

4.3.4 Potential Sources for Additional Landings Data

SCDNR Charter boat Logbook Program Data, 1993 – 2011

The Recreational Fisheries Working Group discussed the possibility of replacing the MRFSS charter mode estimates for South Carolina from 1993 to 2011 with the SCDNR Charter boat Logbook Program estimates. The SCDNR Charter boat Logbook Program is a mandatory logbook program and is a complete census. However, the data is self-reported and no field validation is done on catch or effort. SCDNR charter boat logbook data were compared with MRFSS/MRIP charter mode estimates (Figure 4.12.13). The Recreational Fisheries Working Group recommended not replacing the MRFSS/MRIP charter boat estimates with the SCDNR Charter boat Logbook Program estimates for 1993 – 2011. The MRFSS estimates represent a longer time series and switching from the MRFSS dataset (1981 – 1992) to the SCDNR Charter boat logbook dataset (1993-2011) would artificially reduce the total catch potentially due to the change in methodology that would not necessarily be indicative of a change in the Spanish mackerel population which could affect the stock assessment model. Concern was also expressed about replacing the MRFSS/MRIP dataset with the SCDNR Charter boat logbook dataset because the data would only be replaced for one state (SC) and one mode (charter). Additionally since MRFSS/MRIP estimates are currently used to monitor annual catch limits (ACL's), the group thought it would be appropriate to use these estimates for the recreational landings data.

4.4 Recreational Discards

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 4.11.6 by year and mode and in Figure 4.12.14.

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 4.12.15).

- 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.

Final discard estimates from the SRHS are shown in Table 4.11.7 by year and state and in Figure 4.12.16.

4.4.3 Headboat At-Sea Observer Survey Discards

An observer survey of the recreational headboat fishery was launched in NC and SC in 2004 and in GA and FL in 2005 to collect more detailed information on recreational headboat catch, particularly for discarded fish. 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). 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 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 South Atlantic 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 Atlantic (ME-FLE) in the MRFSS charter fleet, private-rental mode, and shore mode are summarized by year and state in tables 4.11.8, 4.11.9, and 4.11.10, respectively. The number of angler trips with measured or weighed Spanish mackerel in the Atlantic (ME-FLE) in the MRFSS charter fleet, private-rental mode, and shore mode are summarized by year and state in tables 4.11.11, 4.11.12, and 4.11.13, respectively. The number of MRFSS intercept trips conducted in the Atlantic (ME-FLE) and the percentage of intercepts that encountered Spanish mackerel are summarized by year and mode in Table 4.11.14. Dockside mean weights of Spanish mackerel weighed from the MRFSS in the Atlantic (ME-FLE) are tabulated for 1981-2011 in Table 4.11.15.

Headboat Survey Biological Sampling

Lengths were collected from 1972 to 2011 by headboat dockside samplers. From 1972 to 1975, only North Carolina and South Carolina were sampled whereas Georgia and northeast Florida were sampled beginning in 1976. The Southeast Region Headboat Survey conducted dockside sampling for the entire range of Atlantic waters along the southeast portion of the US from the NC-VA border through the Florida Keys beginning in 1978. 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 4.11.16. The number of Spanish mackerel aged from the headboat fleet by year and state are summarized in Table 4.11.17. Dockside mean weights for the headboat fishery are tabulated for 1973-2010 in Table 4.11.18.

SCDNR State Finfish Survey (SFS)

Spanish mackerel lengths were collected through the SCDNR State Finfish Survey (SFS) from 1988 to 2011. The SFS collects finfish intercept data in South Carolina through a non-random intercept survey at public boat landings along the SC coast. The survey focuses on known productive sample sites, targets primarily private boat mode, and is conducted year-round (January- December) using a questionnaire and interview procedure similar to the intercept portion of the MRFSS. From 1988 through March 2009 mid-line lengths were measured and from April 2009 to 2011 total lengths were measured. From 1988 to 2011 1,413 Spanish mackerel lengths were collected by SFS personnel. The Recreational Fisheries Working Group recommended the SCDNR SFS length data for all modes be used to supplement the MRFSS/MRIP length data for length compositions. Total length measurements from 2009-2011 were converted to fork length measurements using the following equation derived for the combined South Atlantic and Gulf stocks by the Life History Working Group at the SEDAR 28 data workshop:

$$FL = -11.8218 + 0.8816TL \ (N = 20288, R^2 = 0.9886)$$

Summarized length data from 1988 – 2011 can be found in Table 4.11.19.

Aging data

The number of Spanish mackerel aged from the SRHS by year and state is summarized in Table 4.11.17. 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 4.11.20. The number of Spanish mackerel aged from the private fleet by year and state is summarized in Table 4.11.21. The number of Spanish mackerel aged from the recreational fishery (mode unknown) by year and state is summarized in Table 4.11.22. 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. Trips for the age samples taken in most states were recorded as both angler trips and vessel trips. Also, for age samples taken in North Carolina, the mode of fishing was recorded but trip information was not. Therefore it was not possible to determine the number of trips with age samples in North Carolina. For these reasons number of trips is not reported for the age samples and compositions.

4.5.2. Length – Age distributions

MRFSS and SCDNR SFS 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 4.12.17).

Lengths were taken from the MRFSS (charter boat, private/rental boat, and shore modes) during 1981 to 2011. Lengths were taken from the SCDNR SFS during 1988 to 2011. The number of vessel trips sampled were not available from the MRFSS. However, the number of trips sampled in the SCDNR SFS are vessel trips. Therefore the total number of trips with Spanish mackerel length measurements taken is an amalgam of vessel and angler trips during 1988 to 2011.

Southeast Region Headboat Survey Length Frequency Analysis Protocol
Headboat landings (1981to 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; NC, SC, GA/FLE (Georgia and east Florida). 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 4.12.18).

Recreational Age Frequency
Due to low age sample sizes in the headboat sector unweighted age compositions were calculated for the entire recreational fishery. (Figure 4.12.19, see SEDAR 28 data summary workbook for data). Ages 0-11 were plotted.

Trips for the age samples taken in most states were recorded as both angler trips and vessel trips. Also, for age samples taken in North Carolina, the mode of fishing was recorded but trip information was not. Therefore it was not possible to determine the number of trips with age samples in North Carolina. For these reasons number of trips is not reported for the age samples and compositions.

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 tables 4.11.23 and 4.11.24 by year and mode. An angler-trip is a single day of fishing in the specified mode, not to exceed 24 hours.

Figures 4.12.20, 4.12.21, and 4.12.22 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 4.12.23, 4.12.24, 4.12.25, and 4.12.26 show the South Atlantic Spanish mackerel positive headboat trips from 1973-1979, 1980-1989, 1990-1999, and 2000-2011 respectively. Headboat trips positive for Spanish mackerel in the South Atlantic, from the 1970's to present, have mostly been concentrated in 3 areas, South Carolina, Fort Pierce, FL and Miami, FL. South Florida accounted for a large portion of trips in the 1980s (Figure 4.12.24), however, since 1990 headboat Spanish mackerel trips are primarily conducted off Fort Pierce, FL and South Carolina (Figures 4.12.25 and 4.12.26).

Estimated headboat angler days have decreased in the South Atlantic in recent years (Table 4.11.25). 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 South Atlantic 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.

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

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4.10 Tables

Table 4.11.1. Atlantic (ME-FLE) Spanish mackerel landings (numbers of fish and whole weight in pounds) for charter boat mode, headboat 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 2004. CH/HB mode landings are from the Mid-Atlantic and North Atlantic (sub-regions 4 and 5) through 2003. After 2004 CH and HB modes are estimated separately in these sub-regions. HB mode estimates from 1981-1983 are from the South Atlantic (sub-region 6). 2011 data is preliminary and through October.

	Estimated CH Landings			Estimated CH/HB Landings			Estimated HB Landings		
YEAR	Number	CV	Pounds	Number	CV	Pounds	Number	CV	Pounds
1981	22,221	0.63	27,950	4,277	1.00	6,611	17,201	0.77	20,225
1982	224,947	0.44	365,593	0	0.00	0	24,479	4.04	39,611
1983	6,198	0.52	11,754	0	0.00	0	4,667	0.69	8,646
1984	27,210	0.51	37,740	0	0.00	0			
1985	82,293	0.40	148,097	0	0.00	0			
1986	246,504	0.34	320,256	7,557	0.65	11,740			
1987	290,214	0.24	358,600	1,520	0.87	2,234			
1988	341,499	0.17	591,241	0	0.00	0			
1989	259,830	0.18	366,119	16,482	0.43	22,765			
1990	334,240	0.18	477,051	7,519	0.32	10,194			
1991	265,031	0.16	439,013	121,587	0.27	157,079			
1992	183,395	0.16	305,653	16,699	0.37	23,531			
1993	105,780	0.16	172,096	71,577	0.44	108,105			
1994	278,943	0.13	317,716	46,562	0.65	49,772			
1995	162,406	0.23	186,277	45,891	0.88	59,981			
1996	308,155	0.19	469,013	0	0.00	0			
1997	283,592	0.19	407,347	0	0.00	0			
1998	153,412	0.17	224,066	3,329	0.77	4,930			
1999	381,480	0.18	397,858	342	1.00	519			
2000	143,912	0.15	133,712	7,459	0.72	10,076			
2001	98,926	0.20	131,703	5,854	1.13	10,969			
2002	155,832	0.21	149,619	0	0.00	0			
2003	83,912	0.32	100,039	4,603	0.56	5,101			
2004	99,141	0.19	139,769				0	0.00	0
2005	105,581	0.33	115,365				0	0.00	0
2006	58,068	0.32	134,240				40	0.99	70
2007	42,882	0.37	62,920				0	0.00	0
2008	306,419	0.26	465,877				0	0.00	0
2009	193,193	0.24	218,836				5	1.02	3
2010	129,437	0.19	135,253				0	0.00	0
2011	111,871	0.19	106,129				0	0.00	0

Table 4.11.2. Atlantic (ME-FLE) 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). 2011 data is preliminary and through October.

	Estimated PR Landings			Estimated SH Landings		
YEAR	Number	CV	Pounds	Number	CV	Pounds
1981	425,762	0.25	953,269	398,031	0.30	545,891
1982	578,430	0.43	756,204	138,062	0.36	174,341
1983	76,628	0.38	160,143	42,745	0.32	58,431
1984	863,422	0.35	1,257,602	46,772	0.26	83,185
1985	386,695	0.25	539,595	25,596	0.36	43,384
1986	444,802	0.17	772,771	236,952	0.27	253,939
1987	840,540	0.08	1,440,033	61,993	0.26	91,768
1988	1,313,489	0.08	2,305,246	229,179	0.18	440,084
1989	625,845	0.08	891,681	329,392	0.16	361,352
1990	844,047	0.07	1,127,024	205,034	0.23	330,904
1991	878,390	0.07	1,499,342	371,735	0.13	606,538
1992	876,840	0.06	1,304,734	268,612	0.11	467,169
1993	658,016	0.07	1,020,598	144,019	0.12	250,591
1994	740,346	0.06	908,578	184,092	0.12	240,703
1995	452,803	0.13	570,579	91,108	0.17	104,305
1996	537,987	0.12	674,367	121,870	0.18	157,945
1997	701,013	0.10	1,022,078	167,613	0.15	298,215
1998	407,694	0.12	704,466	123,553	0.15	173,450
1999	582,922	0.10	767,687	143,992	0.12	198,371
2000	1,016,514	0.09	1,336,521	265,497	0.15	400,249
2001	912,579	0.09	1,318,867	285,821	0.12	437,555
2002	1,082,016	0.10	1,627,357	196,952	0.12	295,055
2003	883,282	0.09	1,192,092	269,466	0.11	318,783
2004	546,789	0.17	987,029	149,722	0.20	241,229
2005	629,191	0.16	822,349	221,493	0.25	415,651
2006	429,739	0.14	767,940	171,826	0.35	233,588
2007	856,795	0.15	1,429,998	181,728	0.18	240,924
2008	873,030	0.13	1,321,404	227,257	0.20	298,346
2009	726,255	0.12	1,064,336	241,604	0.19	381,723
2010	541,551	0.11	932,719	426,673	0.26	644,647
2011	452,740	0.17	770,440	301,400	0.29	480,206

Table 4.11.3. Estimated headboat landings of Spanish mackerel in the South Atlantic 1984-2011. Due to headboat area definitions and confidentiality issues, Georgia and East Florida landings must be combined.

Year	NC		SC		GA/FLE	
	Number	Weight	Number	Weight	Number	Weight
1984	-	-	134	399	524	1,680
1985	9	31	47	161	714	2,964
1986	33	94	198	563	1,384	4,424
1987	5	13	91	235	3,745	9,602
1988	83	112	33	77	314	655
1989	-	-	181	487	585	1,108
1990	13	14	232	273	546	1,865
1991	14	30	1,099	1,823	752	2,036
1992	38	53	303	422	1,056	2,689
1993	5	11	271	577	688	1,484
1994	2	5	716	1,755	1,809	4,436
1995	5	12	63	150	731	2,210
1996	6	15	466	1,025	592	1,131
1997	106	105	1,910	2,417	803	2,656
1998	30	75	2,073	5,180	405	1,298
1999	197	202	5,828	5,987	1,884	7,599
2000	816	818	2,529	1,986	603	1,446
2001	30	81	3,265	9,025	687	2,639
2002	9	8	4,072	3,678	567	2,145
2003	47	51	1,304	1,420	483	1,466
2004	51	186	3,445	10,920	1,795	4,925
2005	28	65	4,707	8,530	1,090	3,439
2006	11	11	2,562	2,622	989	2,029
2007	525	479	4,114	3,585	1,369	3,136
2008	138	134	8,171	7,355	554	1,099
2009	167	197	9,386	9,820	285	648
2010	470	322	5,108	4,783	709	1,648
2011	616	587	12,074	17,357	529	1,315

Table 4.11.4. FHWAR estimation method for historical Spanish mackerel landings (1955-1985).

Year	US saltwater angler days	Proportion anglers ME-FLE	Saltwater angler days (ME-FLE)	Mean CPUE (MRFSS 1981-1985)	Recall bias adjustment	Adjusted saltwater angler days (ME-FLE)	Adjusted Spanish mackerel landings (n)
1955	58,621,000	0.32	11,155,577	0.02	1.18	13,189,903	252,837
1960	80,602,000	0.29	14,227,869	0.02	1.18	16,822,457	322,469
1965	95,837,000	0.33	18,820,617	0.02	1.18	22,252,737	426,562
1970	113,694,000	0.33	22,702,248	0.02	1.18	26,842,220	514,538
1975	167,499,000	0.33	32,615,326	0.02	1.18	38,563,044	739,214
1980	164,040,000	0.32	30,962,335	0.02	1.18	36,608,614	701,750
1985	171,055,000	0.33	33,390,373	0.02	1.18	39,479,427	756,780

Table 4.11.5. Estimated Spanish mackerel landings (number) using FHWAR census method (1955-1980), MRFSS (1981-2003), MRIP (2004-2011), and SRHS (84-11) estimation methods.

Year	Estimatedlandings(n)	Year	Estimatedlandings(n)
1955	252,837	1984	938,061
1956	266,763	1985	495,354
1957	280,690	1986	937,429
1958	294,616	1987	1,198,109
1959	308,543	1988	1,884,597
1960	322,469	1989	1,232,315
1961	343,288	1990	1,391,631
1962	364,106	1991	1,638,608
1963	384,925	1992	1,346,942
1964	405,744	1993	980,356
1965	426,562	1994	1,252,470
1966	444,157	1995	753,008
1967	461,752	1996	969,077
1968	479,348	1997	1,155,037
1969	496,943	1998	690,496
1970	514,538	1999	1,116,645
1971	559,473	2000	1,437,330
1972	604,408	2001	1,307,163
1973	649,344	2002	1,439,449
1974	694,279	2003	1,243,097
1975	739,214	2004	800,943
1976	731,721	2005	962,090
1977	724,228	2006	663,235
1978	716,735	2007	1,087,412
1979	709,243	2008	1,415,570
1980	701,750	2009	1,170,894
1981	867,492	2010	1,103,948
1982	965,918	2011	879,230
1983	130,237		

Table 4.11.6. Atlantic (ME-FLE) Spanish mackerel discards for the recreational fishing modes by year (MRFSS, NMFS, 1981-2003; MRIP, NMFS, 2004-2011). 2011 data is preliminary and through October. CH and CH/HB mode adjusted for FHS conversion prior to 2004. CH/HB mode landings are from the Mid-Atlantic and North Atlantic (sub-regions 4 and 5) through 2003. After 2004 CH and HB modes are estimated separately in these sub-regions. HB mode estimates from 1981-1983 are from the South Atlantic (sub-region 6). 2011 data is preliminary and through October.

	Estimated CH Discards		Estimated CH/HB Discards		Estimated HB Discards		Estimated PR Discards		Estimated SH Discards	
YEAR	Number	CV	Number	CV	Number	CV	Number	CV	Number	CV
1981	0	0.00	0	0.00	0	0.00	7,798	0.61	54,191	0.57
1982	0	0.00	0	0.00	0	0.00	0	0.00	6,613	0.60
1983	62	1.90	0	0.00	56	2.12	4,089	0.66	1,236	1.00
1984	729	1.32	0	0.00			20,229	0.60	4,498	0.70
1985	2,356	0.97	0	0.00			48,408	0.59	3,116	0.62
1986	23,610	0.52	24	1.39			23,805	0.30	274,730	0.51
1987	5,978	0.44	0	0.00			47,777	0.32	4,683	0.63
1988	7,197	0.64	0	0.00			32,721	0.27	27,506	0.86
1989	10,302	0.40	0	0.00			146,204	0.33	81,307	0.45
1990	6,262	0.43	131	1.39			119,839	0.18	36,855	0.40
1991	19,170	0.29	11,537	0.73			236,006	0.14	117,339	0.27
1992	15,686	0.30	0	0.00			267,235	0.10	56,148	0.23
1993	1,524	0.55	5,179	1.08			188,991	0.12	53,547	0.24
1994	76,618	0.18	2,859	0.60			437,416	0.14	252,202	0.20
1995	25,733	0.24	0	0.00			230,623	0.14	85,088	0.26
1996	45,724	0.29	438	0.92			221,716	0.13	135,685	0.20
1997	48,855	0.19	0	0.00			199,947	0.12	165,116	0.18
1998	17,623	0.23	0	0.00			206,699	0.14	42,143	0.21
1999	40,499	0.20	0	0.00			336,560	0.11	122,842	0.17
2000	20,108	0.30	0	0.00			671,565	0.11	122,203	0.18
2001	10,983	0.47	0	0.00			425,743	0.16	72,440	0.22
2002	31,155	0.24	951	0.95			675,918	0.16	82,781	0.21
2003	9,923	0.34	0	0.00			594,122	0.12	265,352	0.39
2004	20,373	0.48			0	0.00	350,859	0.17	91,089	0.32
2005	11,678	0.31			0	0.00	339,245	0.17	268,903	0.44
2006	7,401	0.32			0	0.00	212,594	0.18	63,347	0.30
2007	21,124	0.40			51	1.01	469,070	0.18	124,688	0.39
2008	90,421	0.45			0	0.00	551,583	0.14	288,420	0.36
2009	64,845	0.48			0	0.00	335,136	0.18	170,807	0.25
2010	22,989	0.58			0	0.00	359,132	0.16	255,848	0.32
2011	8,413	0.27			0	0.00	258,237	0.20	126,395	0.24

Table 4.11.7. Estimated South Atlantic Spanish mackerel discards for SRHS by year and state.† Due to headboat area definitions and confidentiality issues, Georgia and East Florida landings must be combined.

Year	NC	SC	GA/FLE	South Atlantic
1981	-	-	-	-
1982	-	-	-	-
1983	-	-	-	-
1984	-	-	1	1
1985	-	1	-	1
1986	-	25	-	25
1987	0	5	-	5
1988	0	2	-	2
1989	-	2	-	2
1990	0	5	-	5
1991	0	8	-	8
1992	1	10	190	201
1993	0	33	1	35
1994	0	7	-	7
1995	1	5	-	6
1996	1	36	-	37
1997	8	117	1	126
1998	2	296	105	404
1999	9	496	24	529
2000	37	156	66	259
2001	2	549	17	569
2002	0	-	20	20
2003	3	-	80	83
2004	-	498	34	532
2005	1	839	18	858
2006	-	190	65	255
2007	178	870	27	1,075
2008	2	1,166	107	1,275
2009	31	1,769	24	1,824
2010	1	1,026	30	1,057
2011	11	1,687	27	1,725
Total	289	9,800	838	10,927

†1981-2003 HB mode uses MRFSS CH discard ratio.

Table 4.11.8. Number of Spanish mackerel measured or weighed in the Atlantic (ME-FLE) in the MRFSS charter fleet by year and state.

YEAR	FLE	GA	SC	NC	VA	MD	DE	NJ	NY	TOTAL
1981			11							11
1982			8	1						9
1983	11	2	11	1						25
1984	12	11	73	2						98
1985		1	20	12						33
1986	5		156	27	2	2				192
1987		8	122	403		1				534
1988	15		135	536						686
1989	16		125	960	5			15		1,121
1990	5	3	120	741	12	1			1	883
1991		1	78	951	11	9	5			1,055
1992	5	3	57	337	4	18				424
1993	9		15	343		6				373
1994	3	5	59	1,238	6	3				1,314
1995	13		29	371		7				420
1996	12	1	21	567						601
1997	2		9	845						856
1998	15	4	32	493	10					554
1999	36		23	864		1				924
2000	19	14	4	505		2				544
2001	52	6		356		4				418
2002	51	4	2	462						519
2003	42	115		217		14				388
2004	92	14	58	108	9	4				285
2005	37	84	27	136		60				344
2006	11	2	30	74		10				127
2007	4	53	8	45		20				130
2008	24	6	43	225	27	5		2		332
2009	10	38	17	74	1	2		2		144
2010	61	8	19	182	4	14				288
2011	17	28	27	206	73	11				362
Grand Total	579	411	1,339	11,282	164	194	5	19	1	13,994

Table 4.11.9. Number of Spanish mackerel measured or weighed in the Atlantic (ME-FLE) in the MRFSS private fleet by year and state.

YEAR	FLE	GA	SC	NC	VA	MD	DE	NJ	NY	CT	RI	MA	TOTAL
1981	22	1	3	62									88
1982	29	1	14	48									92
1983	8	2		3									13
1984	29		2	26									57
1985	10	10	6	39									65
1986	54	50	52	47	2								205
1987	43	90	29	516	1	2			1				682
1988	37	15	60	556	17								685
1989	37	19	90	798	60			5	2		1		1,012
1990	68	10	22	1,374	54		3	2	3				1,536
1991	118	2	29	958	10	1	8	9	14	2		1	1,152
1992	186	22	50	886	72	3		4	4				1,227
1993	101	2	22	648	38	3		1	5			1	821
1994	58	9	12	902	106			5					1,092
1995	69	19	2	387	10	2							489
1996	62	9	31	468	8			1					579
1997	86	1	28	863	5								983
1998	94	3	31	347	15	3	1	3					497
1999	256	1		349	44	2		1			1		654
2000	247	22	16	722	24	10			2				1,043
2001	354	6	3	436	17	1			1				818
2002	200	3	3	305	15								526
2003	142	15	6	204	10	2							379
2004	67	18	24	166		8		1					284
2005	73	4	21	136	11	5							250
2006	138		10	157	4	1							310
2007	148	7	30	192	1	2							380
2008	135	6	14	341	61								557
2009	106	7	19	589	8	4							733
2010	101	5	12	475	23	3							619
2011	47	5	5	267	15	4							343
Grand Total	3,125	364	646	13,267	631	56	12	32	32	2	2	2	18,171

Table 4.11.10. Number of Spanish mackerel measured or weighed in the Atlantic (ME-FLE) in the MRFSS shore mode by year and state.

YEAR	FLE	GA	SC	NC	VA	CT	MA	TOTAL
1981	124			1				125
1982	32			4				36
1983	17							17
1984	27							27
1985	13							13
1986	7			37				44
1987	2			39				41
1988	40			54	1			95
1989	14		14	143				171
1990	16		1	48				65
1991	42		7	228	3	2	1	283
1992	21	1	9	141	4			176
1993	10	4	9	69				92
1994	43		4	130	5			182
1995	36		2	50	1			89
1996	14		13	71	8			106
1997	46		8	138	6			198
1998	22		4	56	2			84
1999	85		5	73				163
2000	79	1	7	58			1	146
2001	54		5	121	4		3	187
2002	71		3	60				134
2003	78		2	55	3			138
2004	6		34	31	3			74
2005	25		6	19				50
2006	50		6	5				61
2007	74	7	14	7				102
2008	65	2	13	32	4			116
2009	41		7	125				173
2010	124		35	109	1			269
2011	17	2	31	72				122
Grand Total	1,295	17	239	1,976	45	2	5	3,579

Table 4.11.11 Number of angler trips with measured or weighed Spanish mackerel in the Atlantic (ME-FLE) in the MRFSS charter fleet by year and state.

YEAR	FLE	GA	SC	NC	VA	MD	DE	NJ	NY	TOTAL
1981			2							2
1982			2	1						3
1983	3	1	5	1						10
1984	7	4	20	2						33
1985		1	8	6						15
1986	2		37	7	2	1				49
1987		4	54	75		1				134
1988	5		39	59						103
1989	7		34	80	3			2		126
1990	2	2	22	93	5	1			1	126
1991		1	23	111	3	3	2			143
1992	5	3	17	51	1	3				80
1993	9		4	45		2				60
1994	2	2	14	116	2	3				139
1995	4		5	46		2				57
1996	5	1	10	84						100
1997	2		4	118						124
1998	5	2	6	67	1					81
1999	20		4	87		1				112
2000	6	6	4	50		2				68
2001	13	3		46		1				63
2002	18	3	1	54						76
2003	20	10		21		5				56
2004	7	2	21	12	2	1				45
2005	9	1	17	12		7				46
2006	6	2	5	15		4				32
2007	2	6	4	14		4				30
2008	5	2	11	20	2	2		2		44
2009	8	5	6	11	1	2		2		35
2010	14	2	13	34	1	7				71
2011	5	5	10	34	5	5				64
Grand Total	191	68	402	1,372	28	57	2	6	1	2,127

Table 4.11.12. Number of angler trips with measured or weighed Spanish mackerel in the Atlantic (ME-FLE) in the MRFSS private fleet by year and state.

YEAR	FLE	GA	SC	NC	VA	MD	DE	NJ	NY	CT	RI	MA	TOTAL
1981	10	1	2	13									26
1982	13	1	3	15									32
1983	6	2		1									9
1984	16		1	4									21
1985	4	4	3	18									29
1986	22	11	19	19	2								73
1987	21	23	10	147	1	1			1				204
1988	18	11	22	152	5								208
1989	12	8	29	209	17			3	2		1		281
1990	30	3	8	309	17		1	2	3				373
1991	40	2	8	241	5	1	6	6	13	2		1	325
1992	50	16	15	181	13	1		3	2				281
1993	30	2	9	139	15	2		1	4			1	203
1994	33	6	4	186	35			1					265
1995	26	3	2	95	3	1							130
1996	28	7	13	102	5			1					156
1997	33	1	9	160	3								206
1998	34	2	13	79	9	3	1	2					143
1999	84	1		69	12	2		1			1		170
2000	60	7	5	124	12	1			2				211
2001	71	3	2	108	6	1			1				192
2002	59	3	3	84	2								151
2003	46	3	3	47	6	2							107
2004	22	5	6	48		1		1					83
2005	27	3	10	40	3	5							88
2006	45		4	57	1	1							108
2007	57	4	13	53	1	2							130
2008	53	4	4	72	12								145
2009	46	6	5	123	4	2							186
2010	57	1	9	166	7	2							242
2011	30	2	3	89	3	3							130
Grand Total	1,083	145	237	3,150	199	31	8	21	28	2	2	2	4,908

Table 4.11.13. Number of angler trips with measured or weighed Spanish mackerel in the Atlantic (ME-FLE) in the MRFSS shore fleet by year and state.

YEAR	FLE	GA	SC	NC	VA	CT	MA	TOTAL
1981	33			1				34
1982	9			3				12
1983	11							11
1984	17							17
1985	7							7
1986	3			15				18
1987	2			26				28
1988	27			27	1			55
1989	10		8	55				73
1990	13		1	32				46
1991	23		4	99	3	1	1	131
1992	13	1	5	58	2			79
1993	10	2	4	26				42
1994	18		2	61	2			83
1995	14		2	27	1			44
1996	7		4	29	3			43
1997	17		3	51	3			74
1998	15		3	24	2			44
1999	37		3	39				79
2000	30	1	4	21			1	57
2001	30		2	39	4		2	77
2002	32		1	34				67
2003	32		2	25	2			61
2004	4		7	17	2			30
2005	16		4	11				31
2006	21		4	5				30
2007	45	2	8	7				62
2008	26	1	4	20	2			53
2009	23		6	32				61
2010	54		16	56	1			127
2011	24	1	14	26				65
Grand Total	623	8	111	866	28	1	4	1,641

Table 4.11.14. Number of MRFSS intercept angler trips conducted in the Atlantic (ME-FLE) by year and mode with the percentage of intercepts that encountered Spanish mackerel.

	Shore			Cbt			Priv		
YEAR	TOT int	SM int	%sm	TOT int	SM int	%sm	TOT int	SM int	%sm
1981	6,333	46	0.73%	1154	3	0.26%	6,938	34	0.49%
1982	9,802	25	0.26%	573	7	1.22%	9,591	44	0.46%
1983	11,511	21	0.18%	1771	15	0.85%	10,271	17	0.17%
1984	9,877	30	0.30%	1703	45	2.64%	7,298	31	0.42%
1985	13,134	13	0.10%	2542	38	1.49%	11,225	44	0.39%
1986	6,054	33	0.55%	3689	156	4.23%	18,258	113	0.62%
1987	7,543	38	0.50%	4527	245	5.41%	18,781	378	2.01%
1988	11,747	68	0.58%	4536	191	4.21%	20,957	375	1.79%
1989	15,666	146	0.93%	6317	209	3.31%	26,343	453	1.72%
1990	13,398	83	0.62%	5084	225	4.43%	31,275	569	1.82%
1991	19,791	237	1.20%	5860	271	4.62%	32,082	595	1.85%
1992	19,429	191	0.98%	6476	156	2.41%	35,810	582	1.63%
1993	24,074	135	0.56%	5751	78	1.36%	31,532	399	1.27%
1994	27,602	198	0.72%	7258	304	4.19%	34,366	524	1.52%
1995	27,797	122	0.44%	6518	96	1.47%	31,020	326	1.05%
1996	24,677	141	0.57%	9376	198	2.11%	32,420	370	1.14%
1997	24,613	158	0.64%	9926	240	2.42%	35,011	426	1.22%
1998	24,932	124	0.50%	9938	197	1.98%	34,649	359	1.04%
1999	26,369	228	0.86%	7473	245	3.28%	35,158	443	1.26%
2000	23,543	164	0.70%	8729	177	2.03%	34,429	555	1.61%
2001	27,725	187	0.67%	9603	135	1.41%	44,355	505	1.14%
2002	27,904	228	0.82%	9343	162	1.73%	39,503	530	1.34%
2003	26,715	188	0.70%	10314	106	1.03%	38,004	516	1.36%
2004	21,831	110	0.50%	9613	123	1.28%	34,032	421	1.24%
2005	18,716	150	0.80%	11768	130	1.10%	29,739	366	1.23%
2006	17,361	90	0.52%	10381	71	0.68%	34,023	352	1.03%
2007	19,661	162	0.82%	10396	87	0.84%	34,574	446	1.29%
2008	19,318	226	1.17%	10106	146	1.44%	32,662	500	1.53%
2009	16,623	64	0.39%	8627	60	0.70%	29,850	267	0.89%
2010	20,778	284	1.37%	10423	182	1.75%	33,469	667	1.99%

Table 4.11.15. Mean weight (lb) of Spanish mackerel weighed from the MRFSS in the Atlantic (ME-FLE) by year and mode, 1981-2011.

	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	10	1.34	0.88	2.87	88	1.94	0.22	4.19	125	1.40	0.66	2.87
1982	9	1.94	0.66	5.07	91	1.92	0.22	14.33	36	1.27	0.44	3.31
1983	16	1.43	0.22	3.09	12	2.24	0.88	3.31	17	1.44	0.88	3.09
1984	98	1.38	0.44	4.41	57	1.37	0.66	4.41	24	2.01	0.66	4.63
1985	33	1.74	0.88	6.83	64	1.33	0.22	6.17	12	1.78	1.10	2.43
1986	186	1.97	0.44	9.92	186	1.67	0.22	7.28	44	1.10	0.22	2.20
1987	457	1.80	0.22	7.72	633	1.75	0.22	7.72	41	1.10	0.22	3.31
1988	586	1.34	0.22	5.29	636	1.65	0.22	9.26	95	1.71	0.22	8.60
1989	1,035	1.20	0.22	10.14	935	1.44	0.22	8.16	166	1.08	0.22	5.07
1990	736	1.46	0.22	11.02	1,435	1.32	0.22	8.38	60	2.08	0.44	7.50
1991	1,018	1.61	0.22	10.58	1,139	1.65	0.22	11.46	277	1.57	0.22	17.86
1992	400	1.61	0.22	7.94	1,178	1.40	0.22	8.82	174	1.31	0.22	7.28
1993	354	1.34	0.22	7.50	774	1.51	0.22	7.94	89	1.43	0.22	4.41
1994	1,229	1.12	0.11	16.98	1,028	1.13	0.22	8.16	173	1.23	0.33	4.85
1995	412	1.06	0.33	6.83	392	1.24	0.22	6.61	83	1.19	0.33	4.41
1996	465	1.26	0.22	10.47	460	1.19	0.22	7.72	76	1.28	0.44	4.41
1997	836	1.34	0.33	9.04	881	1.41	0.33	8.82	197	1.76	0.44	5.29
1998	553	1.37	0.44	26.46	487	1.52	0.22	9.04	82	1.29	0.55	5.51
1999	911	1.18	0.22	8.16	651	1.31	0.22	6.61	156	1.30	0.44	4.45
2000	544	1.02	0.22	11.68	1,033	1.20	0.22	6.17	136	1.38	0.44	4.41
2001	404	1.20	0.44	8.82	797	1.36	0.22	10.58	179	1.39	0.55	5.95
2002	491	0.96	0.22	4.59	478	1.37	0.33	5.51	122	1.44	0.44	4.67
2003	376	1.36	0.44	7.05	333	1.37	0.33	7.05	115	1.10	0.44	3.20
2004	221	1.37	0.40	7.58	256	1.72	0.33	6.97	74	1.11	0.55	4.63
2005	329	1.31	0.44	6.17	236	1.22	0.22	7.16	48	1.50	0.55	5.07
2006	127	1.86	0.55	11.02	300	1.90	0.44	12.68	51	1.52	0.44	5.51
2007	123	1.23	0.44	3.97	342	1.56	0.44	6.50	93	1.35	0.44	5.07
2008	318	1.20	0.44	5.95	518	1.27	0.33	7.16	110	1.15	0.44	3.70
2009	144	1.33	0.44	5.07	719	1.33	0.33	8.82	164	1.54	0.33	5.95
2010	259	1.35	0.44	5.51	596	1.49	0.33	6.61	260	1.44	0.44	5.51
2011	359	1.23	0.22	6.83	328	1.37	0.44	5.69	111	0.94	0.44	3.09

Table 4.11.16. Number of Spanish mackerel measured and positive trips in the SRHS by year and state.

	Fish (N)				Trips (N)			
YEAR	NC	SC	GA/FLE	Total	NC	SC	GA/FLE	Total
1972	-	-	-	-	-	-	-	-
1973	-	-	-	-	-	-	-	-
1974	-	1	-	1	-	1	-	1
1975	-	-	-	-	-	-	-	-
1976	-	-	-	-	-	-	-	-
1977	-	-	-	-	-	-	-	-
1978	-	-	4	4	-	-	2	2
1979	-	-	6	6	-	-	6	6
1980	-	-	6	6	-	-	4	4
1981	-	-	15	15	-	-	10	10
1982	3	-	2	5	2	-	2	4
1983	2	-	69	71	2	-	15	17
1984	-	-	20	20	-	-	15	15
1985	-	-	13	13	-	-	12	12
1986	-	2	16	18	-	1	10	11
1987	1	4	118	123	1	3	25	29
1988	2	2	15	19	1	1	8	10
1989	-	2	8	10	-	1	6	7
1990	1	30	22	53	1	8	12	21
1991	2	23	21	46	2	9	15	26
1992	1	13	13	27	1	5	13	19
1993	-	3	8	11	-	3	8	11
1994	-	-	12	12	-	-	10	10
1995	-	4	26	30	-	4	16	20
1996	-	1	4	5	-	1	3	4
1997	28	16	32	76	4	1	23	28
1998	1	13	33	47	1	4	23	28
1999	1	9	50	60	1	1	24	26
2000	22	14	24	60	4	3	20	27
2001	5	-	20	25	2	-	17	19
2002	5	9	22	36	3	3	9	15
2003	32	21	62	115	6	5	36	47
2004	13	7	28	48	8	2	22	32
2005	10	8	11	29	5	1	10	16
2006	13	55	27	95	3	7	19	29
2007	21	41	36	98	4	7	26	37
2008	1	125	27	153	1	8	15	24
2009	5	78	30	113	3	15	17	35
2010	19	37	18	74	6	9	11	26
2011	6	41	25	72	5	8	19	32

Table 4.11.17. Number of South Atlantic Spanish mackerel aged from the SRHS by year and state. Due to headboat area definitions and confidentiality issues, Georgia and East Florida landings must be combined.

Year	NC	SC	GA/FLE	Total
1981	-	-	-	-
1982	-	-	-	-
1983	-	-	-	-
1984	-	-	-	-
1985	-	-	-	-
1986	-	-	-	-
1987	-	-	-	-
1988	-	-	-	-
1989	-	-	-	-
1990	-	-	-	-
1991	-	-	-	-
1992	-	-	-	-
1993	-	-	-	-
1994	-	-	-	-
1995	-	-	-	-
1996	-	-	-	-
1997	-	-	-	-
1998	31	-	-	31
1999	-	-	-	-
2000	-	-	-	-
2001	-	-	-	-
2002	-	-	-	-
2003	-	-	-	-
2004	131	-	4	135
2005	-	-	1	1
2006	-	-	4	4
2007	-	-	-	-
2008	-	-	1	1
2009	-	-	1	1
2010	-	-	-	-
2011	-	-	-	-
Total	162	-	11	173

Table 4.11.18. Mean weight (kg) of Spanish mackerel measured in the SRHS by year and state, 1972-2011.

	NC				SC				FLE/GA			
Year	N	Mean(kg)	Min(kg)	Max(kg)	N	Mean(kg)	Min(kg)	Max(kg)	N	Mean(kg)	Min(kg)	Max(kg)
1972	-	-	-	-	-	-	-	-	-	-	-	-
1973	-	-	-	-	-	-	-	-	-	-	-	-
1974	-	-	-	-	1	1.64	1.64	1.64	-	-	-	-
1975	-	-	-	-	-	-	-	-	-	-	-	-
1976	-	-	-	-	-	-	-	-	-	-	-	-
1977	-	-	-	-	-	-	-	-	-	-	-	-
1978	-	-	-	-	-	-	-	-	4	1.15	0.82	1.50
1979	-	-	-	-	-	-	-	-	6	2.44	0.96	5.50
1980	-	-	-	-	-	-	-	-	6	1.32	0.38	2.36
1981	-	-	-	-	-	-	-	-	15	1.13	0.52	2.55
1982	3	2.52	1.81	3.05	-	-	-	-	2	1.84	1.69	2.00
1983	2	1.30	1.10	1.50	-	-	-	-	69	0.74	0.43	2.40
1984	-	-	-	-	-	-	-	-	20	1.38	0.50	3.00
1985	-	-	-	-	-	-	-	-	14	1.62	0.13	3.60
1986	-	-	-	-	2	0.67	0.38	0.95	16	1.33	0.47	2.30
1987	1	2.20	2.20	2.20	4	0.41	0.31	0.53	118	1.18	0.17	3.50
1988	2	1.33	1.31	1.34	2	1.65	1.48	1.82	15	0.85	0.52	1.80
1989	-	-	-	-	2	0.44	0.34	0.53	8	0.95	0.26	2.50
1990	1	0.79	0.79	0.79	30	0.56	0.31	1.72	22	1.39	0.22	2.80
1991	2	1.32	0.95	1.69	23	0.85	0.38	2.65	21	1.24	0.35	2.52
1992	1	0.76	0.76	0.76	13	0.60	0.25	1.80	13	1.21	0.47	2.52
1993	-	-	-	-	3	0.65	0.20	1.14	8	1.06	0.44	2.00
1994	-	-	-	-	-	-	-	-	12	1.06	0.20	3.32
1995	-	-	-	-	4	0.37	0.16	0.62	26	1.34	0.62	3.07
1996	-	-	-	-	1	0.80	0.80	0.80	4	0.64	0.21	0.94
1997	28	0.46	0.23	0.90	16	0.57	0.41	0.96	32	1.39	0.43	3.59
1998	1	0.30	0.30	0.30	13	0.41	0.28	0.65	33	1.44	0.42	2.55
1999	1	1.73	1.73	1.73	9	0.33	0.28	0.41	50	1.71	0.56	3.28
2000	22	0.46	0.27	0.77	14	0.36	0.28	0.42	24	1.05	0.30	2.65
2001	5	0.67	0.29	1.44	-	-	-	-	20	1.66	0.41	3.18
2002	5	0.39	0.32	0.55	9	0.42	0.27	0.84	22	1.84	0.68	2.66
2003	32	0.40	0.24	0.69	21	0.50	0.23	1.04	62	1.21	0.34	2.76
2004	13	1.65	0.71	3.21	7	0.43	0.29	0.59	28	1.15	0.37	2.44
2005	10	1.14	0.30	2.29	8	0.32	0.22	0.39	11	1.49	0.85	2.74
2006	13	0.42	0.36	0.52	55	0.48	0.04	1.99	27	0.95	0.45	2.68
2007	21	0.43	0.26	0.72	41	0.41	0.17	0.81	36	0.92	0.43	1.87
2008	1	0.61	0.61	0.61	125	0.41	0.23	1.00	27	0.94	0.26	2.35
2009	5	0.38	0.25	0.53	78	0.47	0.24	1.91	30	1.08	0.30	1.89
2010	19	0.39	0.25	1.00	37	0.40	0.12	1.00	18	1.19	0.37	2.94
2011	6	0.34	0.21	0.57	41	0.46	0.20	1.57	25	1.22	0.26	2.66

Table 4.11.19. SCDNR State Finfish Survey number of Spanish Mackerel measured (total and by mode), mean length, standard deviation of length, and minimum and maximum size range (all modes combined). No length measurements were recorded during 1997. Total length measurements from 2009-2011 were converted to fork length using the following equation developed for the combined South Atlantic and Gulf stocks at the SEDAR 28 data workshop: FL = -11.8218 + 0.8816TL (N = 20288, R^2 = 0.9886).

	Number of Spanish Mackerel	Number of fish measured by mode						
Year	Measured	Charter	Private	Shore	Mean FL (mm)	SD FL (mm)	Minimum FL (mm)	Maximum FL (mm)
1988	44	42	2		409.5	57.0	315	575
1989	57	56	1		406.4	66.8	270	595
1990	1			1	310.0		310	310
1991	66		66		456.8	113.3	317	721
1992	10		10		438.8	118.7	320	702
1993	103	8	95		445.5	99.5	239	805
1994	10		10		342.2	11.6	324	363
1995	4		4		410.0	23.6	380	433
1996	132		132		425.4	48.2	333	622
1997								
1998	63	24	39		426.5	87.8	278	635
1999	183	61	122		385.9	81.9	285	781
2000	140	11	129		399.5	72.1	307	628
2001	66		66		413.6	65.0	307	530
2002	80		80		439.9	62.0	332	610
2003	36	1	33	2	430.7	96.2	315	765
2004	32		32		466.4	125.8	325	700
2005	24		24		431.6	85.1	325	624
2006	25		25		399.9	72.0	330	570
2007	33		33		411.7	51.0	307	567
2008	70		70		408.8	72.1	285	624
2009	115		115		346.8	73.8	258	561
2010	109		109		341.9	68.2	238	589
2011	10		10		342.1	84.3	291	573

Table 4.11.20. Number of Spanish mackerel aged in the Atlantic (ME-FLE) from the charter boat fleet by year and state. States not shown did not age any Spanish mackerels for this time period.

Year	NC	SC	GA/FLE	Total
1981	-	-	-	-
1982	-	-	-	-
1983	-	-	-	-
1984	-	-	-	-
1985	-	-	-	-
1986	-	-	-	-
1987	-	-	-	-
1988	-	-	6	6
1989	-	-	-	-
1990	50	16	-	66
1991	3	8	11	22
1992	162	20	-	182
1993	-	13	-	13
1994	171	-	-	171
1995	68	-	2	70
1996	72	-	1	73
1997	228	-	-	228
1998	165	-	-	165
1999	40	-	-	40
2000	76	-	-	76
2001	38	-	-	38
2002	155	-	6	161
2003	218	-	15	233
2004	91	-	6	97
2005	191	-	3	194
2006	240	-	-	240
2007	182	-	1	183
2008	153	-	-	153
2009	36	-	-	36
2010	275	-	1	276
2011	274	-	-	274
Total	2,888	57	52	2,997

Table 4.11.21. Number of Spanish mackerel aged in the Atlantic (ME-FLE) from the private/rental fleet by year and state. States not shown did not age any Spanish mackerels for this time period.

Year	NC	SC	GA/FLE	Total
1981	-	-	-	-
1982	-	-	-	-
1983	-	-	-	-
1984	-	-	-	-
1985	-	-	-	-
1986	-	-	-	-
1987	-	-	-	-
1988	90	19	-	109
1989	4	30	-	34
1990	203	2	-	205
1991	170	-	-	170
1992	-	16	-	16
1993	75	16	-	91
1994	-	-	-	-
1995	-	-	-	-
1996	5	-	-	5
1997	88	-	-	88
1998	23	-	-	23
1999	49	-	-	49
2000	54	-	-	54
2001	11	-	-	11
2002	7	-	36	43
2003	-	-	2	2
2004	7	-	-	7
2005	-	-	9	9
2006	11	-	-	11
2007	-	-	-	-
2008	25	-	-	25
2009	-	-	-	-
2010	-	-	-	-
2011	-	-	-	-
Total	822	83	47	952

Table 4.11.22. Number of Spanish mackerel aged in the Atlantic (ME-FLE) from the recreational fishery (mode unknown) by year and state. States not shown did not age any Spanish mackerels for this time period.

Year	VA	NC	SC	GA/FLE	Total
1981	-	-	-	-	-
1982	-	-	-	-	-
1983	-	-	-	-	-
1984	-	-	-	-	-
1985	-	-	-	-	-
1986	-	-	-	-	-
1987	-	-	-	-	-
1988	-	-	-	-	-
1989	-	-	-	-	-
1990	-	-	-	-	-
1991	-	-	-	-	-
1992	-	-	-	-	-
1993	-	-	-	-	-
1994	-	-	-	-	-
1995	-	-	-	-	-
1996	-	-	-	-	-
1997	-	-	-	-	-
1998	-	-	-	-	-
1999	-	-	-	-	-
2000	-	-	-	-	-
2001	-	-	-	-	-
2002	-	-	-	-	-
2003	-	-	-	-	-
2004	-	-	-	-	-
2005	-	-	-	-	-
2006	-	-	-	-	-
2007	-	-	-	-	-
2008	3	-	-	-	3
2009	26	-	-	-	26
2010	20	-	-	-	20
2011	6	-	-	-	6

Table 4.11.23. Atlantic (ME-FLE) estimated number of angler trips for charter boat mode, headboat 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 2004. CH/HB mode estimates are from the South Atlantic (sub_reg=6) from 1981-1985 and from the Mid-Atlantic and North Atlantic (sub-regions 4 and 5) from 1981-2003. After 2004 CH and HB modes are estimated separately in sub-regions 4 and 5. 2011 data is preliminary and through October.

	Estimated CH Angler Trips		Estimated CH/HB Angler Trips		Estimated HB Angler Trips	
YEAR	Trips	CV	Trips	CV	Trips	CV
1981			5,958,226	0.08		
1982			7,417,792	0.15		
1983			7,238,989	0.10		
1984			5,041,917	0.08		
1985			6,450,643	0.13		
1986	1,046,581	0.17	4,808,719	0.09		
1987	744,484	0.16	3,517,564	0.08		
1988	1,019,369	0.13	2,892,058	0.07		
1989	795,017	0.13	2,400,947	0.07		
1990	505,373	0.12	2,531,303	0.06		
1991	528,549	0.11	2,993,819	0.07		
1992	600,009	0.10	2,071,191	0.07		
1993	784,034	0.09	3,666,103	0.08		
1994	1,028,348	0.07	3,198,441	0.07		
1995	1,178,551	0.07	2,986,512	0.08		
1996	1,306,227	0.08	2,080,684	0.07		
1997	1,279,959	0.08	2,680,613	0.07		
1998	1,073,517	0.07	1,680,101	0.07		
1999	874,133	0.08	1,535,047	0.07		
2000	680,796	0.09	1,987,412	0.07		
2001	685,504	0.10	2,216,717	0.06		
2002	635,191	0.09	1,660,987	0.06		
2003	619,013	0.10	2,026,445	0.06		
2004	1,248,144	0.04			674,070	0.08
2005	1,562,374	0.08			628,369	0.04
2006	1,363,486	0.04			886,331	0.03
2007	1,774,142	0.03			937,197	0.04
2008	1,255,407	0.03			814,575	0.02
2009	1,190,772	0.04			774,156	0.01
2010	998,759	0.03			562,826	0.01
2011	1,034,237	0.05			563,057	0.07

Table 4.11.24. Atlantic (ME-FLE) estimated number of angler trips for private/rental boat mode and shore mode (MRFSS, NMFS, 1981-2003; MRIP, NMFS, 2004-2011). 2011 data is preliminary and through October.

	Estimated PR Angler Trips		Estimated SH Angler Trips	
YEAR	Trips	CV	Trips	CV
1981	11,321,426	0.04	12,543,680	0.06
1982	13,728,004	0.04	16,275,838	0.06
1983	17,001,060	0.04	18,115,249	0.06
1984	16,954,899	0.04	15,527,081	0.06
1985	16,333,082	0.04	15,588,671	0.05
1986	20,378,033	0.03	16,308,658	0.04
1987	19,607,656	0.02	14,710,942	0.04
1988	19,933,330	0.02	16,428,031	0.04
1989	16,867,225	0.02	14,428,085	0.04
1990	17,094,711	0.02	13,047,188	0.03
1991	19,346,128	0.02	18,120,445	0.03
1992	16,959,698	0.02	15,669,426	0.03
1993	18,596,766	0.02	16,457,625	0.02
1994	20,327,199	0.02	18,992,426	0.02
1995	19,103,937	0.02	18,904,134	0.02
1996	19,342,857	0.02	18,088,143	0.02
1997	21,481,941	0.02	18,861,681	0.02
1998	19,486,636	0.02	16,594,935	0.02
1999	18,156,979	0.02	15,062,302	0.03
2000	25,178,960	0.02	21,149,334	0.02
2001	26,404,181	0.02	23,309,025	0.02
2002	22,329,597	0.02	18,971,379	0.02
2003	25,674,761	0.02	22,088,704	0.02
2004	25,514,780	0.02	21,007,268	0.03
2005	26,854,489	0.02	22,006,305	0.03
2006	26,335,518	0.02	22,725,099	0.03
2007	28,727,641	0.02	22,031,105	0.03
2008	27,368,998	0.02	22,209,088	0.03
2009	22,005,700	0.02	18,888,050	0.03
2010	22,846,628	0.02	18,456,036	0.03
2011	17,811,401	0.03	15,662,982	0.04

Table 4.11.25. South Atlantic headboat estimated angler days by year and state, 1981-2011.

Year	NC	SC	FLE/GA
1981	38,746	118,060	597,408
1982	53,878	135,078	586,266
1983	47,660	131,446	555,726
1984	57,730	134,627	577,988
1985	62,730	132,002	561,689
1986	62,374	134,454	634,119
1987	70,522	157,612	666,082
1988	84,842	152,936	603,549
1989	77,356	125,416	633,728
1990	86,480	114,302	645,790
1991	81,872	135,964	560,044
1992	82,353	123,580	529,047
1993	85,571	128,914	473,945
1994	73,384	126,462	485,561
1995	80,589	123,478	412,325
1996	70,284	109,858	399,710
1997	74,378	120,297	346,539
1998	74,798	122,684	310,682
1999	63,192	110,998	327,864
2000	62,674	80,582	364,498
2001	63,558	98,528	326,776
2002	55,202	84,934	303,092
2003	45,996	73,112	290,022
2004	54,510	97,526	350,800
2005	63,146	68,072	345,678
2006	51,466	112,144	351,072
2007	57,999	121,454	314,294
2008	34,314	94,572	247,874
2009	38,931	81,835	272,833
2010	42,137	89,898	247,317
2011	36,910	89,285	248,077

4.11 Figures

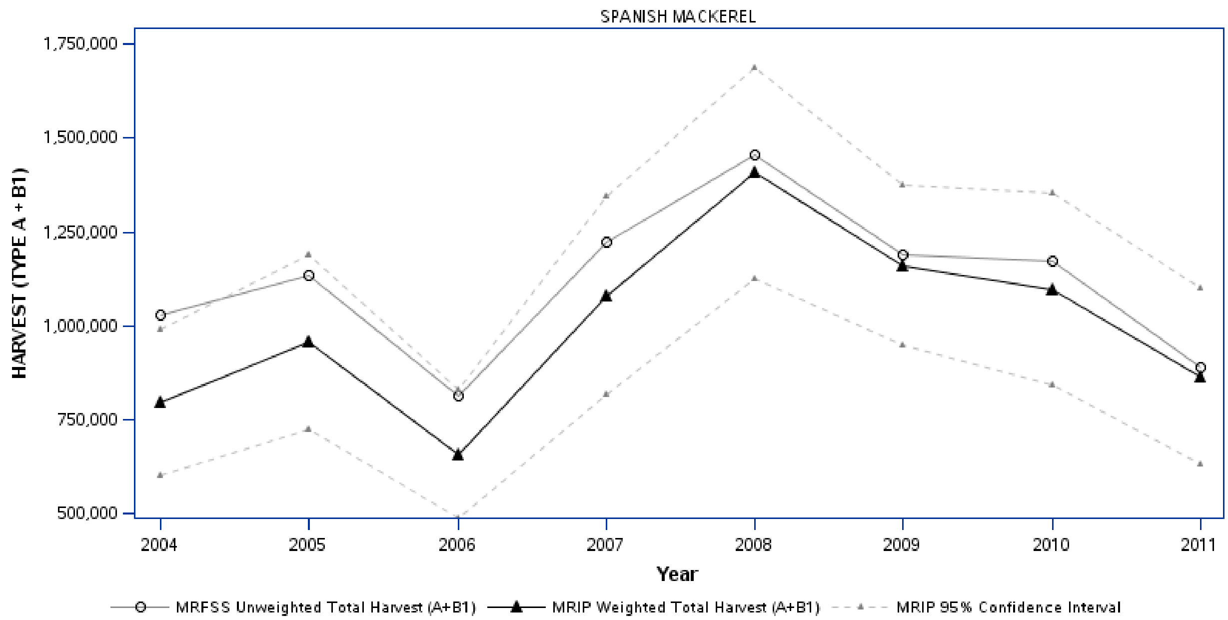

Figure 4.12.1. Comparison of MRIP and MRFSS landings (A+B1) for Atlantic Spanish mackerel (FLE-ME).

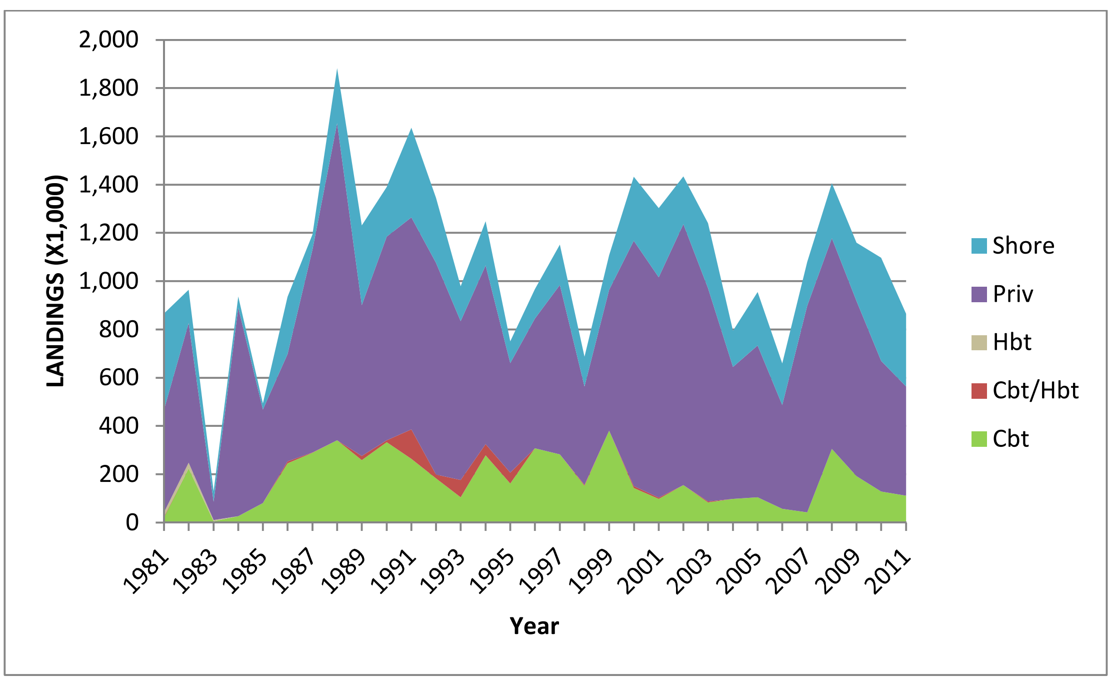

Figure 4.12.2. Atlantic (ME-FLE) Spanish mackerel landings (numbers of fish) by year and mode (MRFSS, NMFS, 1981-2003; MRIP, NMFS, 2004-2011). 2011 data is preliminary and through October.

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

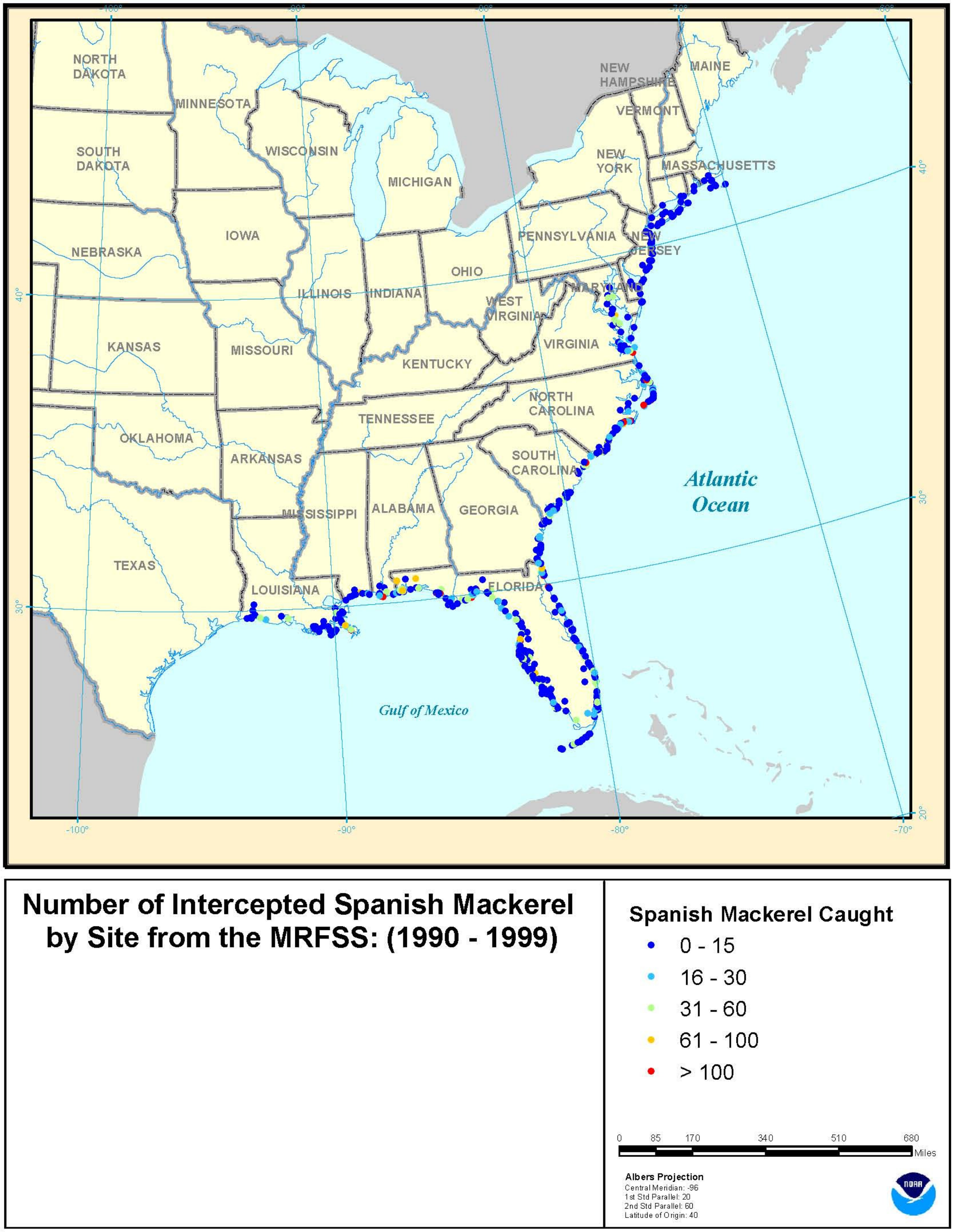

Figure 4.12.4. The number of Spanish mackerel intercepted by the MRFSS from 1990-1999.

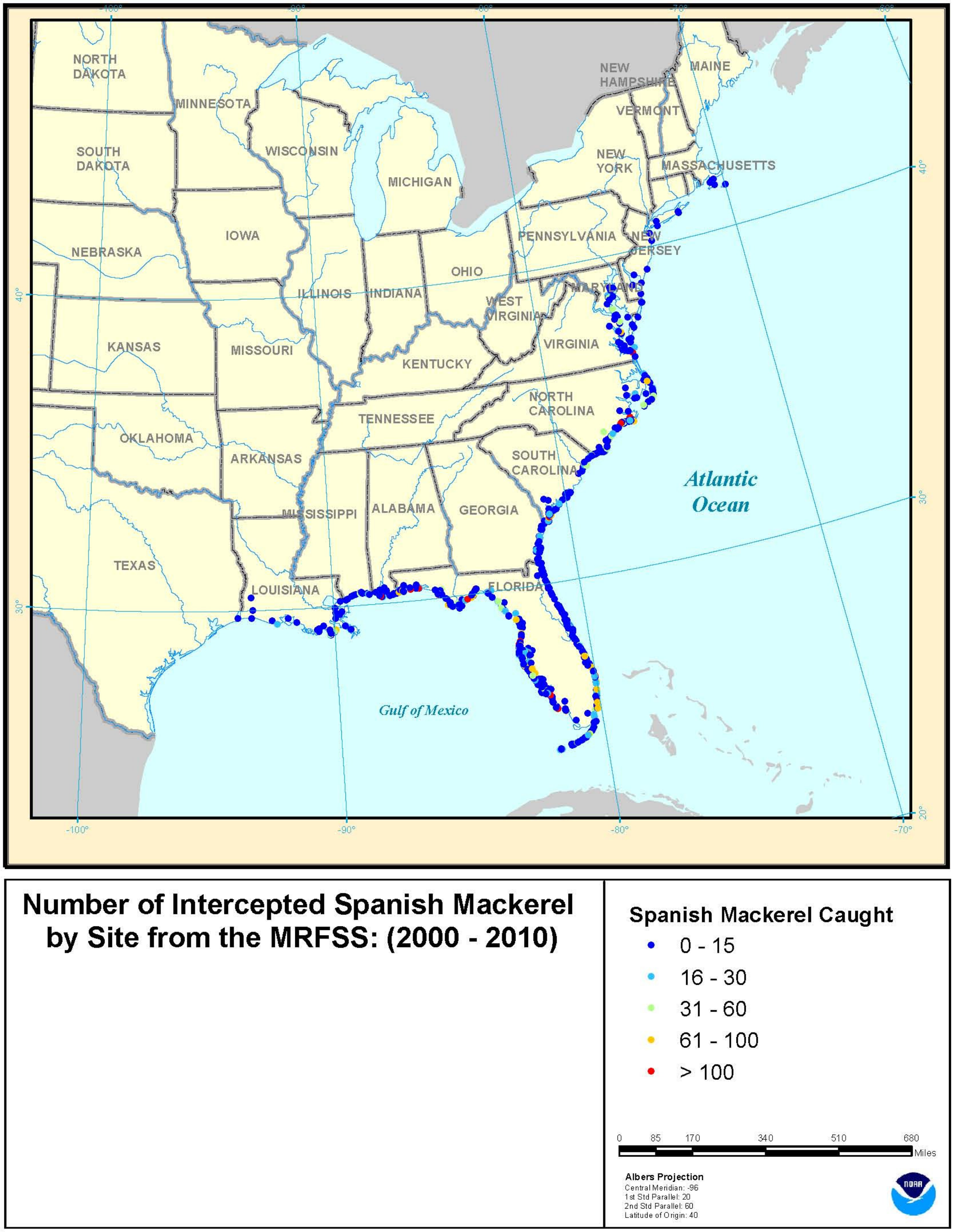

Figure 4.12.5. The number of Spanish mackerel intercepted by the MRFSS from 2000-2010.

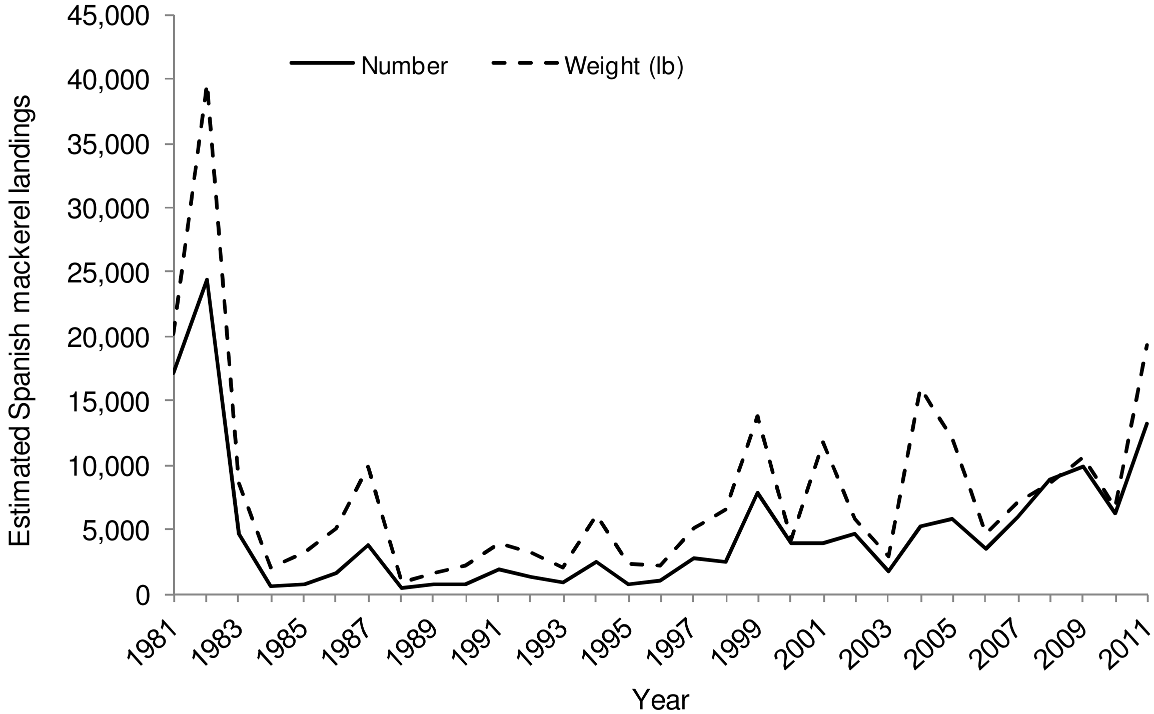

Figure 4.12.6. South Atlantic estimated Spanish mackerel landings (number and pounds) for the headboat fishery, 1981-2011.

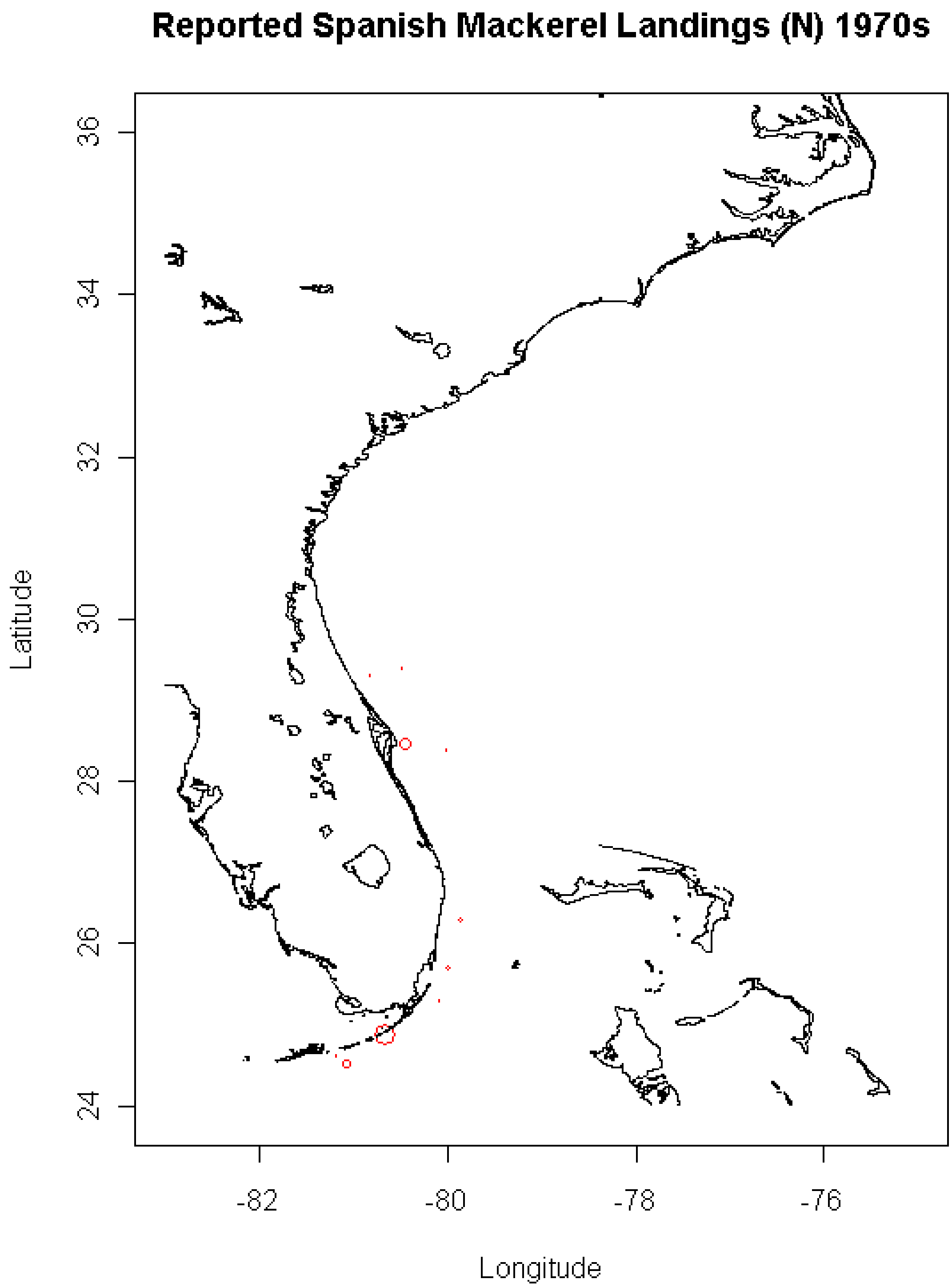

Figure 4.12.7. Reported Spanish mackerel landings (numbers of fish) from SRHS, 1973-1979. The size of each point is proportional to the reported landings at the given location.

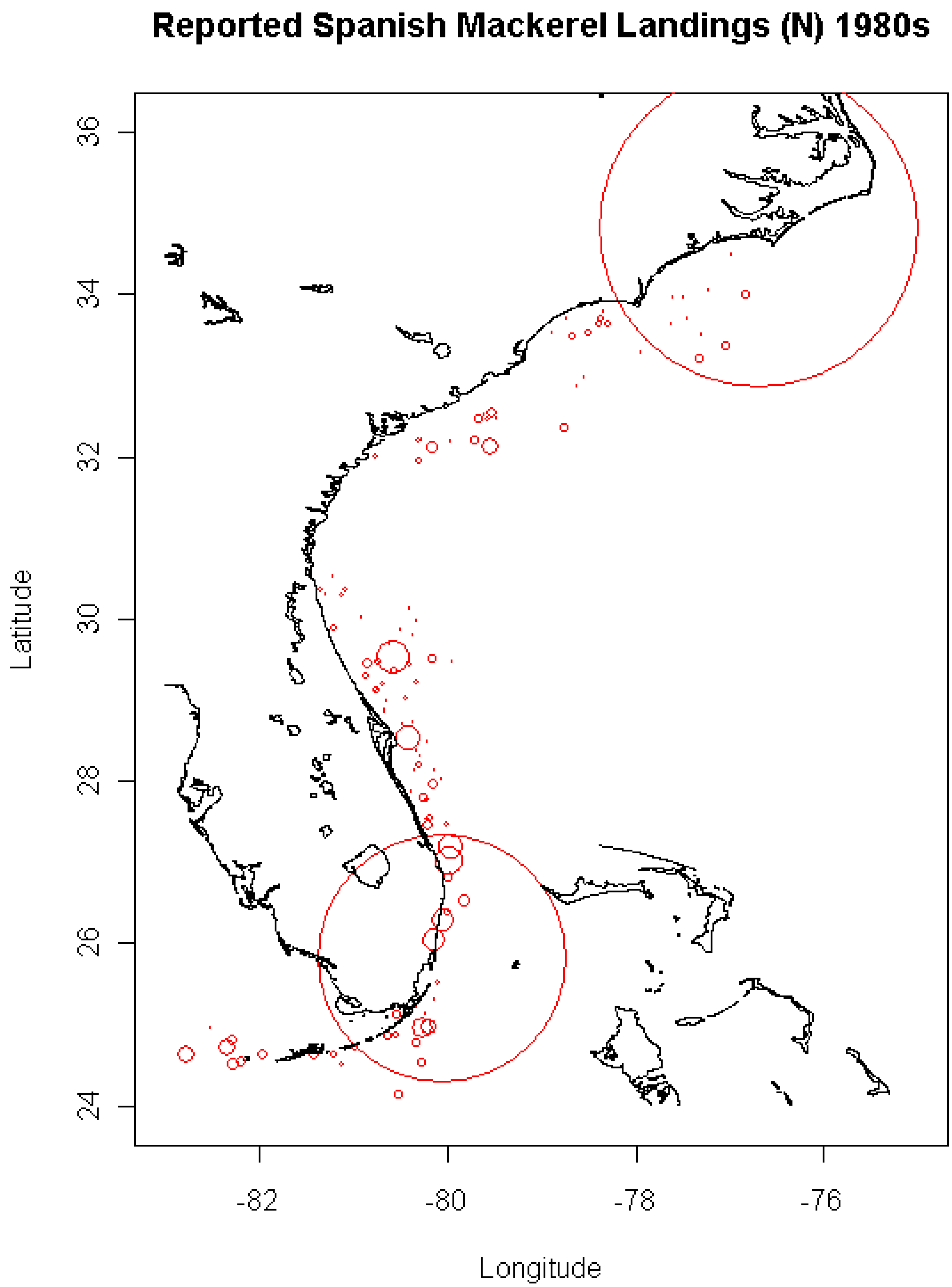

Figure 4.12.8. Reported Spanish mackerel landings (numbers of fish) from SRHS, 1980-1989. The size of each point is proportional to the reported landings at the given location.

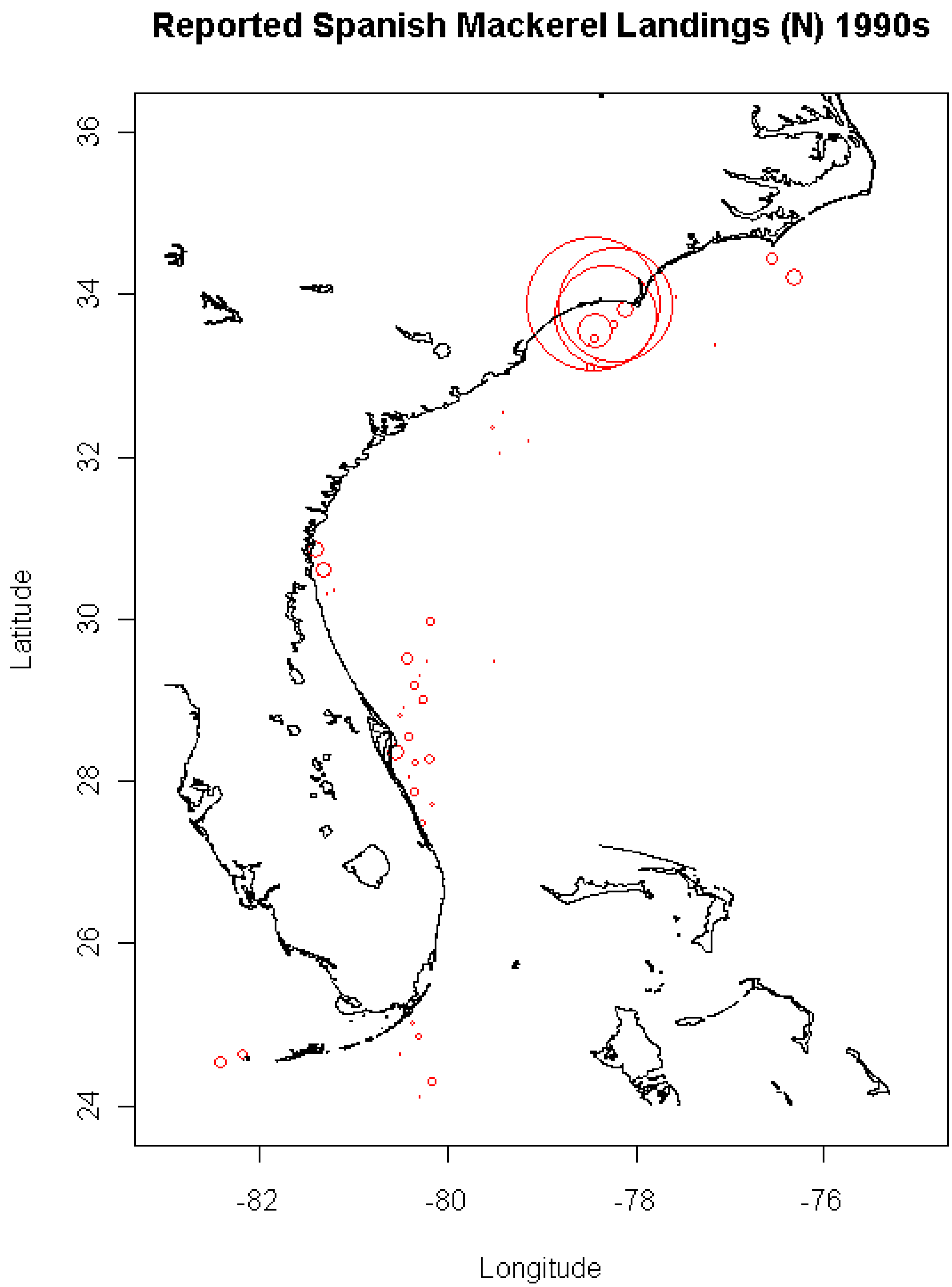

Figure 4.12.9. Reported Spanish mackerel landings (numbers of fish) from SRHS, 1990-1999. The size of each point is proportional to the reported landings at the given location.

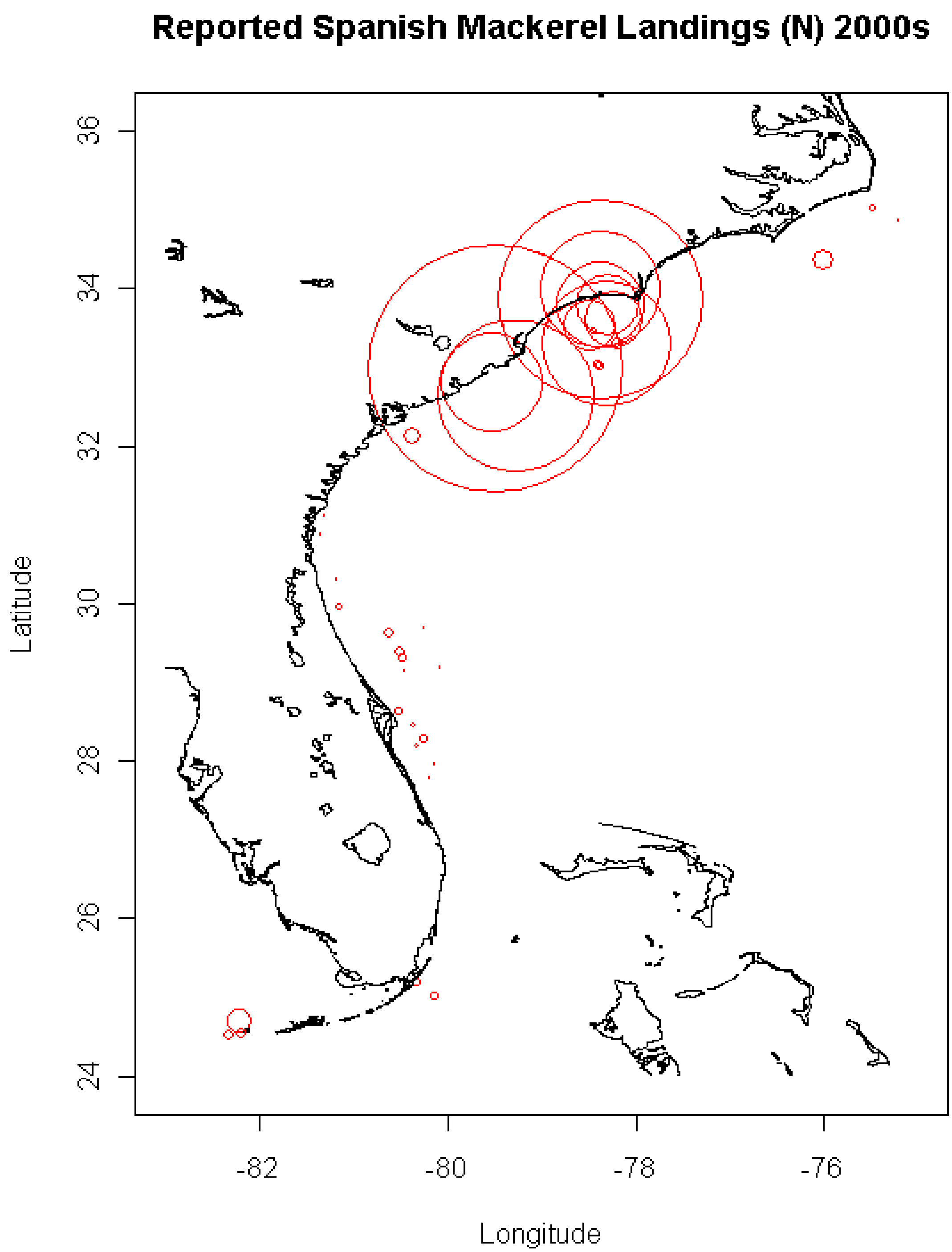

Figure 4.12.10. Reported Spanish mackerel landings (numbers of fish) from SRHS, 2000-2011. The size of each point is proportional to the reported landings at the given location.

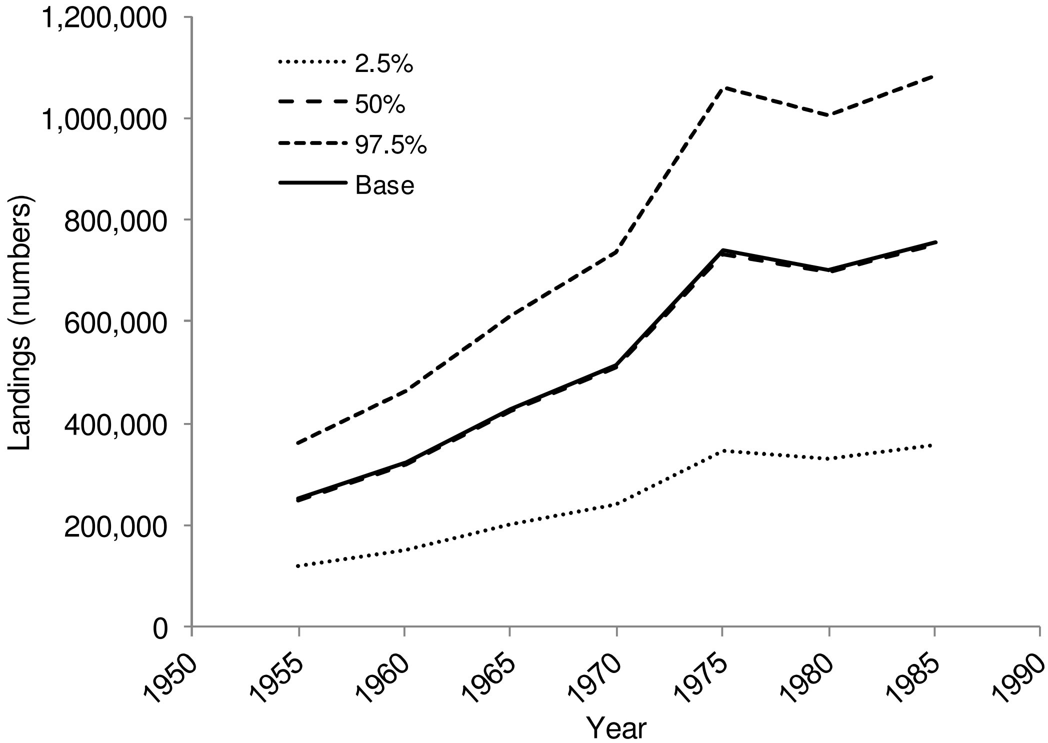

Figure 4.12.11. Bootstrap analysis of FHWAR census method (1955-1984) Spanish mackerel landings estimtes.

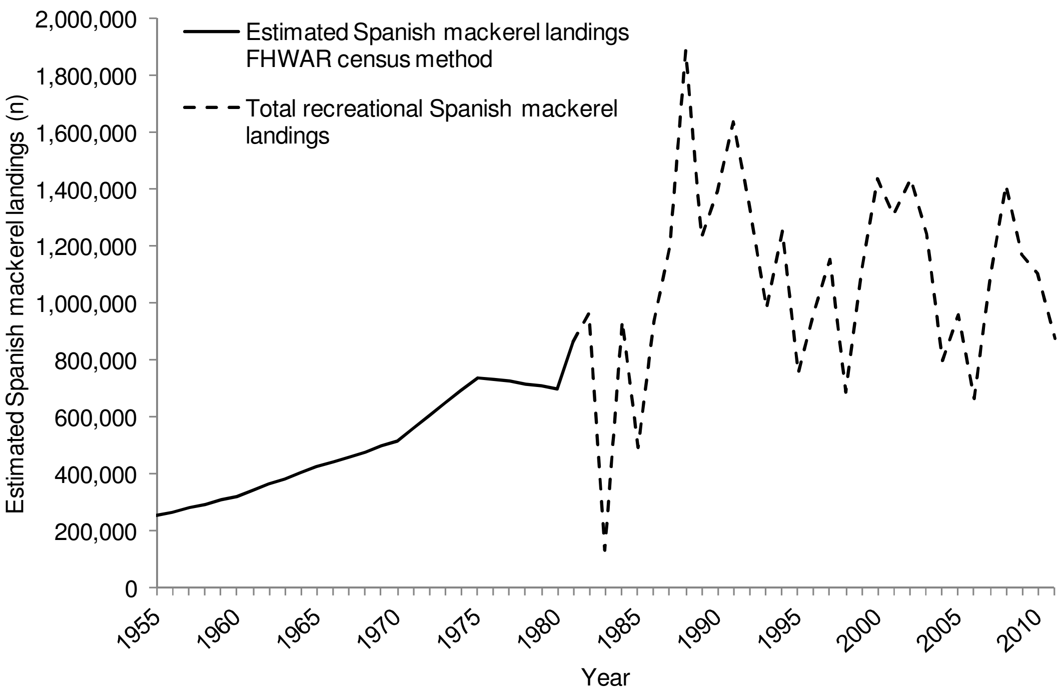

Figure 4.12.12. Estimated Spanish mackerel landings (number) using FHWAR census method (1955-1980), MRFSS (1981-2003), MRIP (2004-2011), and SRHS (84-11) estimation methods.

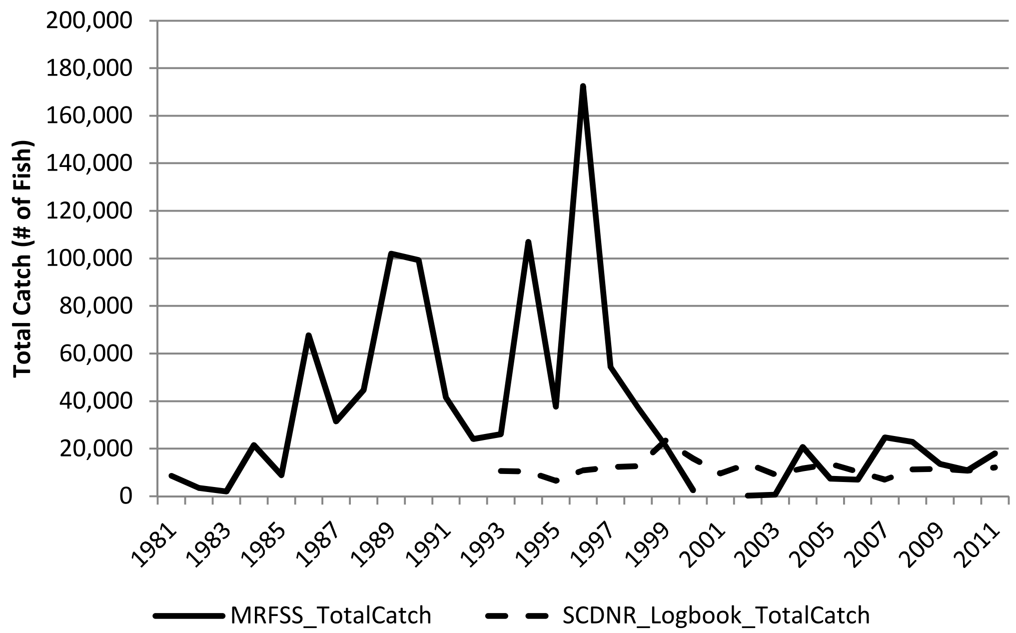

Figure 4.12.13. Comparison of SC total catch (a+b1+b2) from MRFSS charter mode and SCDNR charter boat logbook program, 1993-2011. 2011 data is preliminary for both datasets.

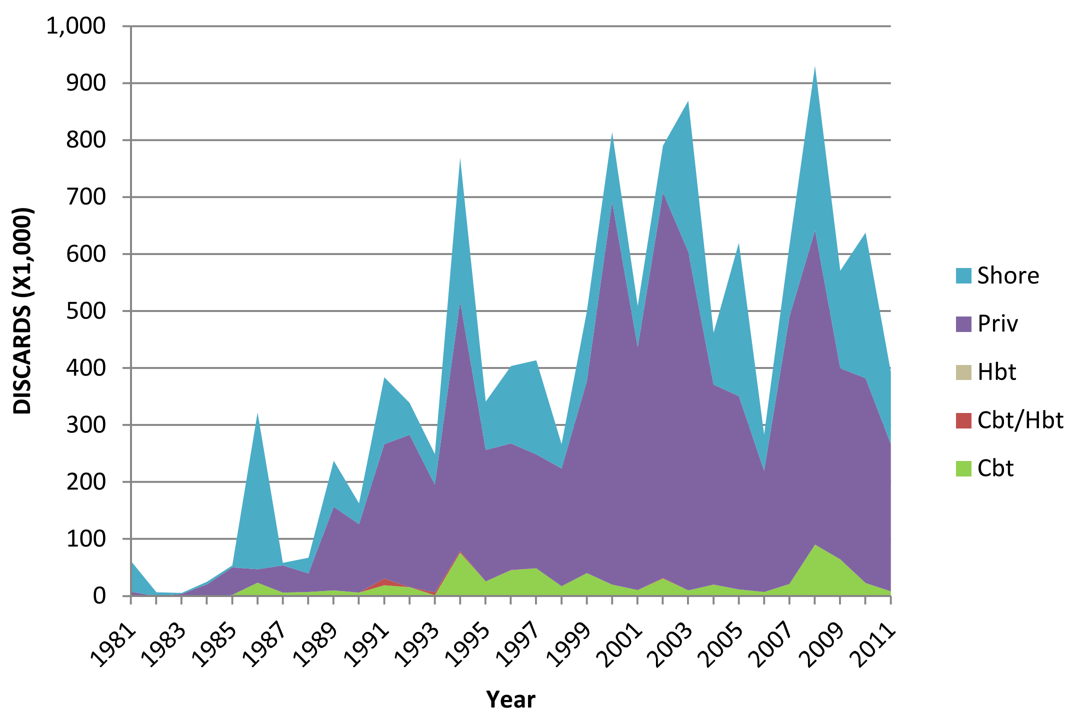

Figure 4.12.14. Atlantic (ME-FLE) Spanish mackerel discards (numbers of fish) by year and mode (MRFSS, NMFS, 1981-2003; MRIP, NMFS, 2004-2011). 2011 data is preliminary and through October.

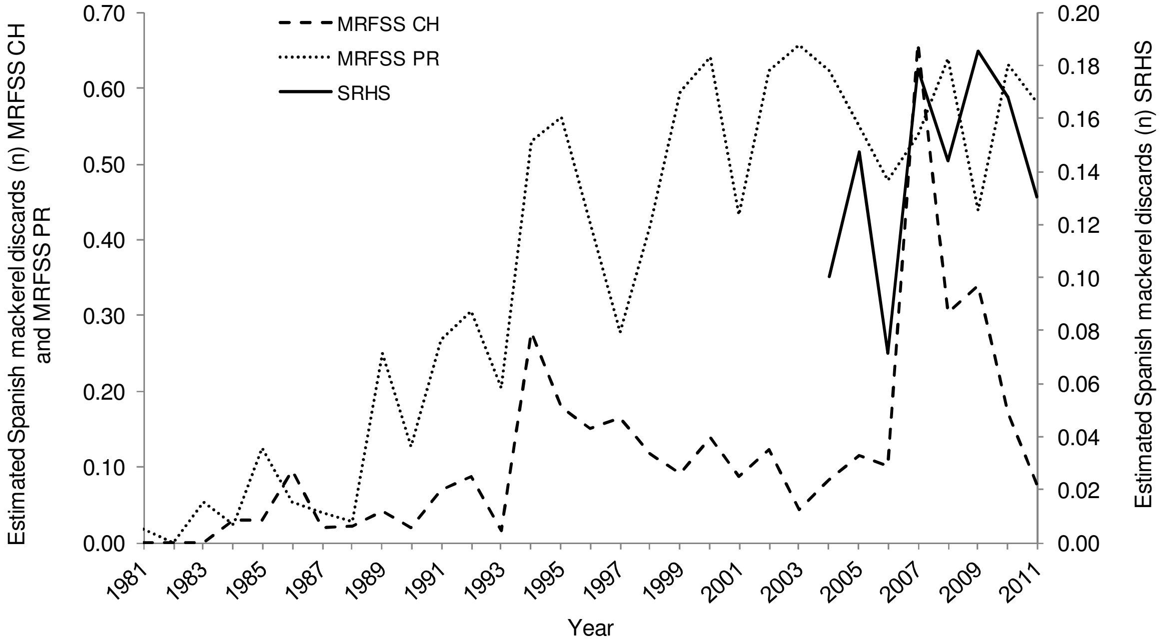

Figure 4.12.15. Percentage of Spanish mackerel discards in the recreational fishery, 1981-2011.

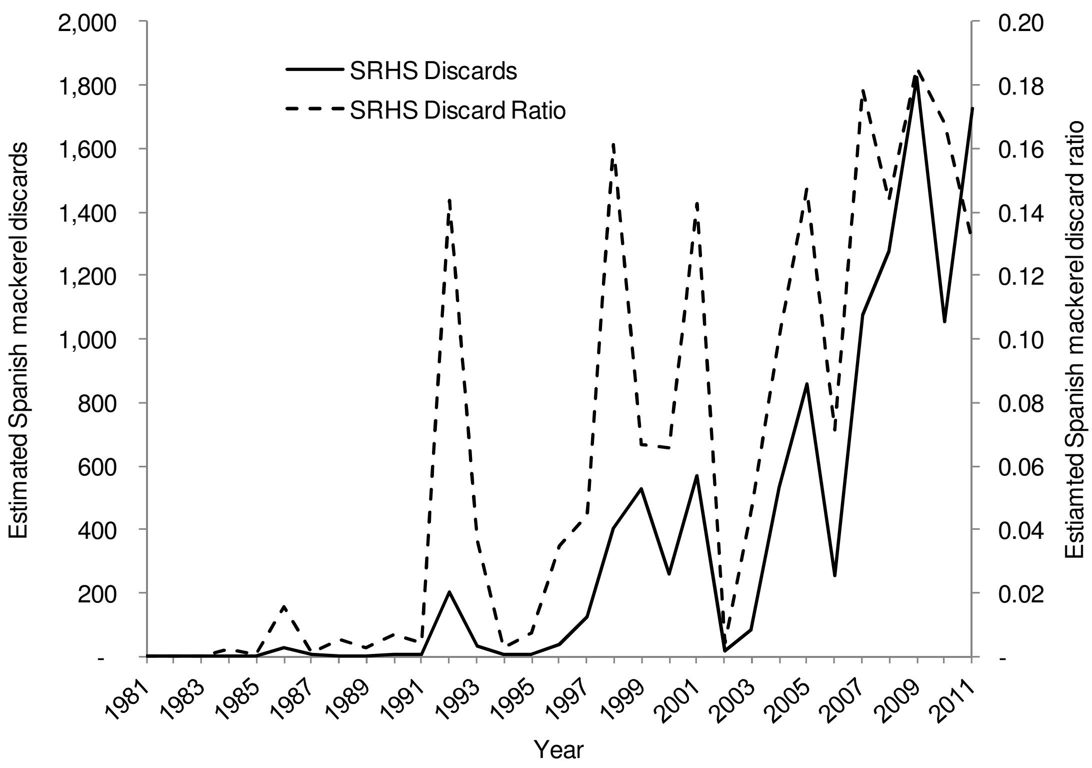

Figure 4.12.16. South Atlantic estimated Spanish mackerel discards and discard ratio for the headboat fishery (MRFSS proxy 1981-2003; SRHS 2004-2011).

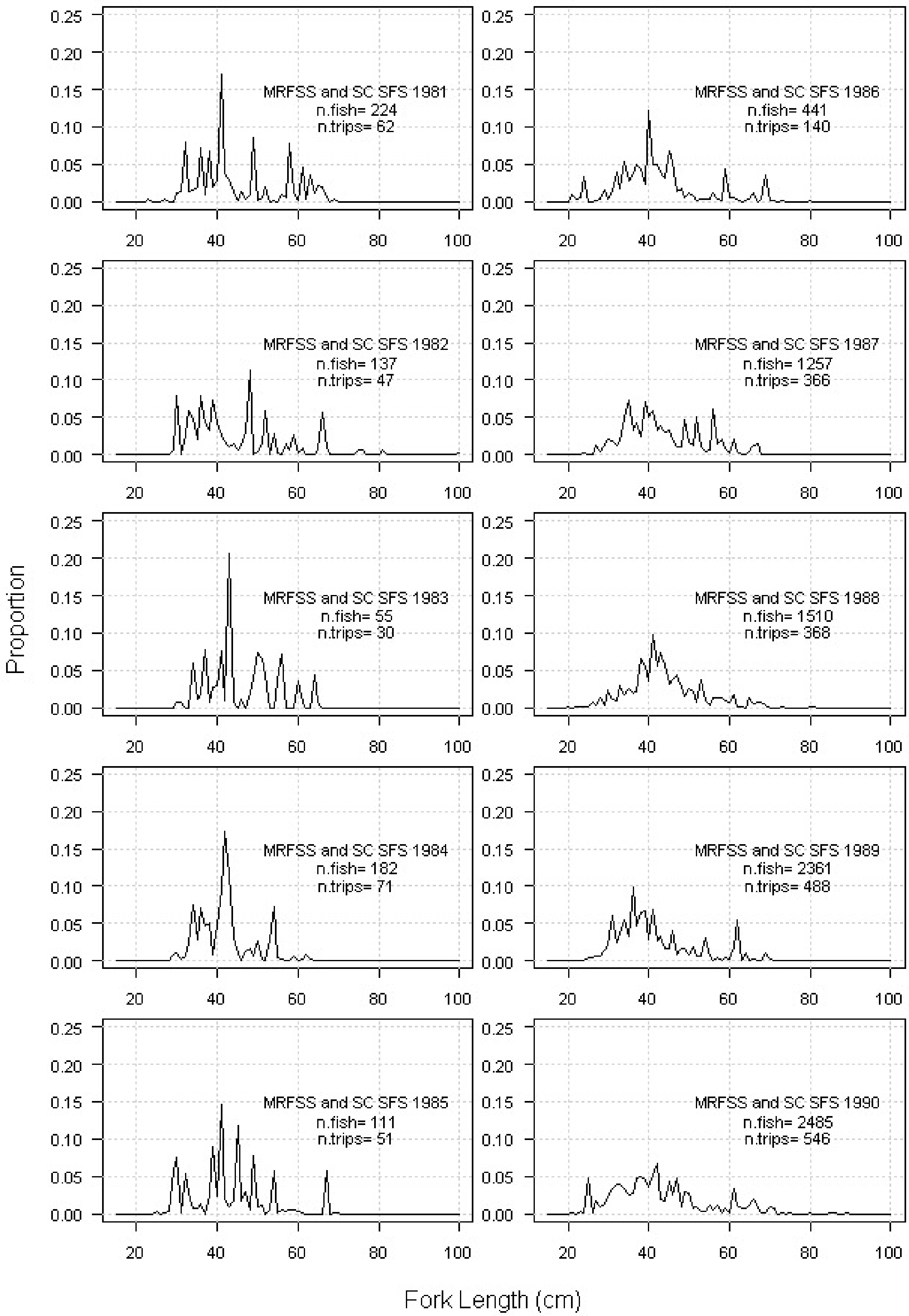

Figure 4.12.17. Length composition from the MRFSS (1981-2011) and SCDNR SFS (1988-2011). The number of trips reported includes both angler and vessel trips for years 1988-2011.

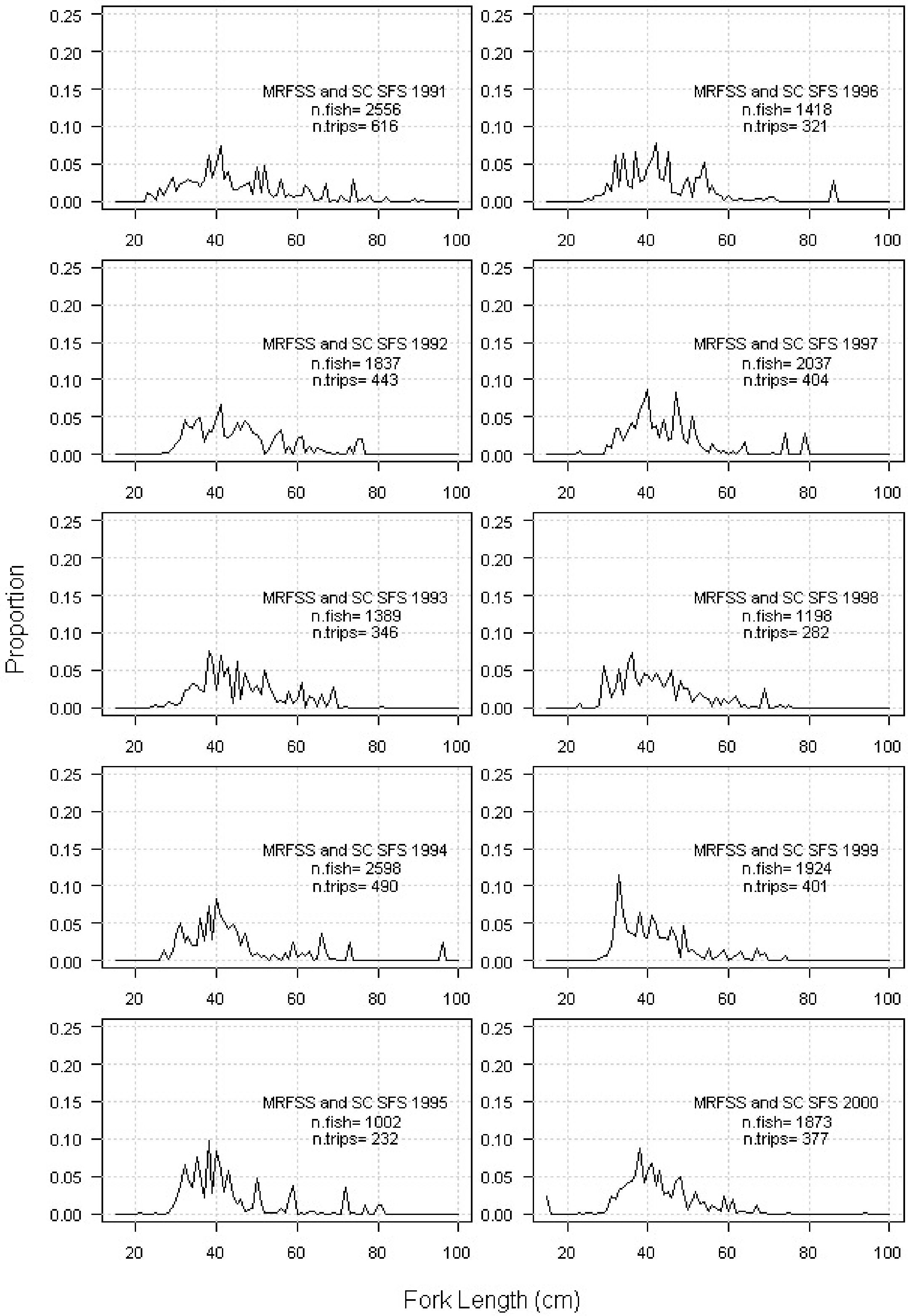

Figure 4.12.17. Length composition from the MRFSS (1981-2011) and SCDNR SFS (1988-2011) (continued). The number of trips reported includes both angler and vessel trips for years 1988-2011.

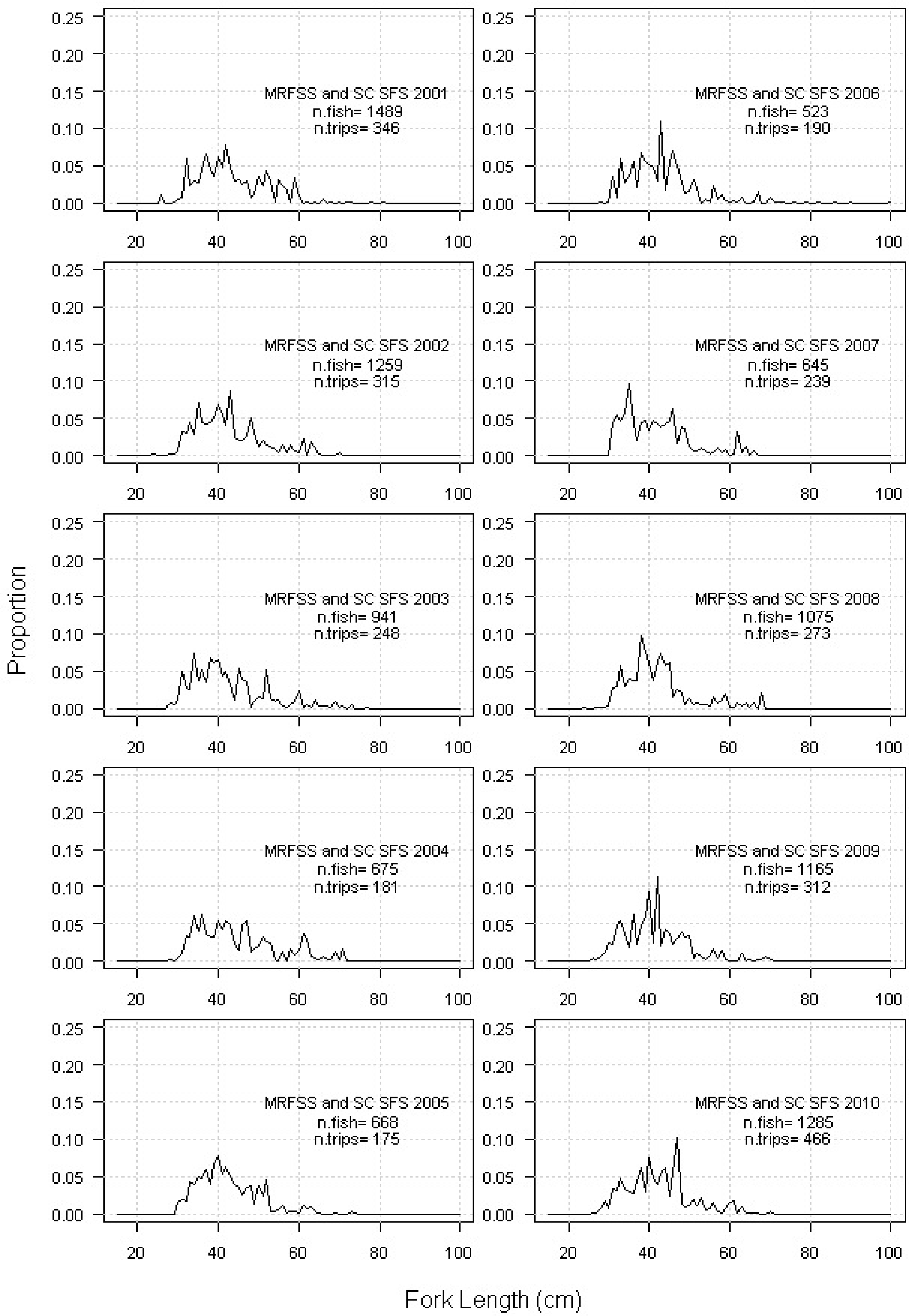

Figure 4.12.17. Length composition from the MRFSS (1981-2011) and SCDNR SFS (1988-2011) (continued). The number of trips reported includes both angler and vessel trips for years 1988-2011.

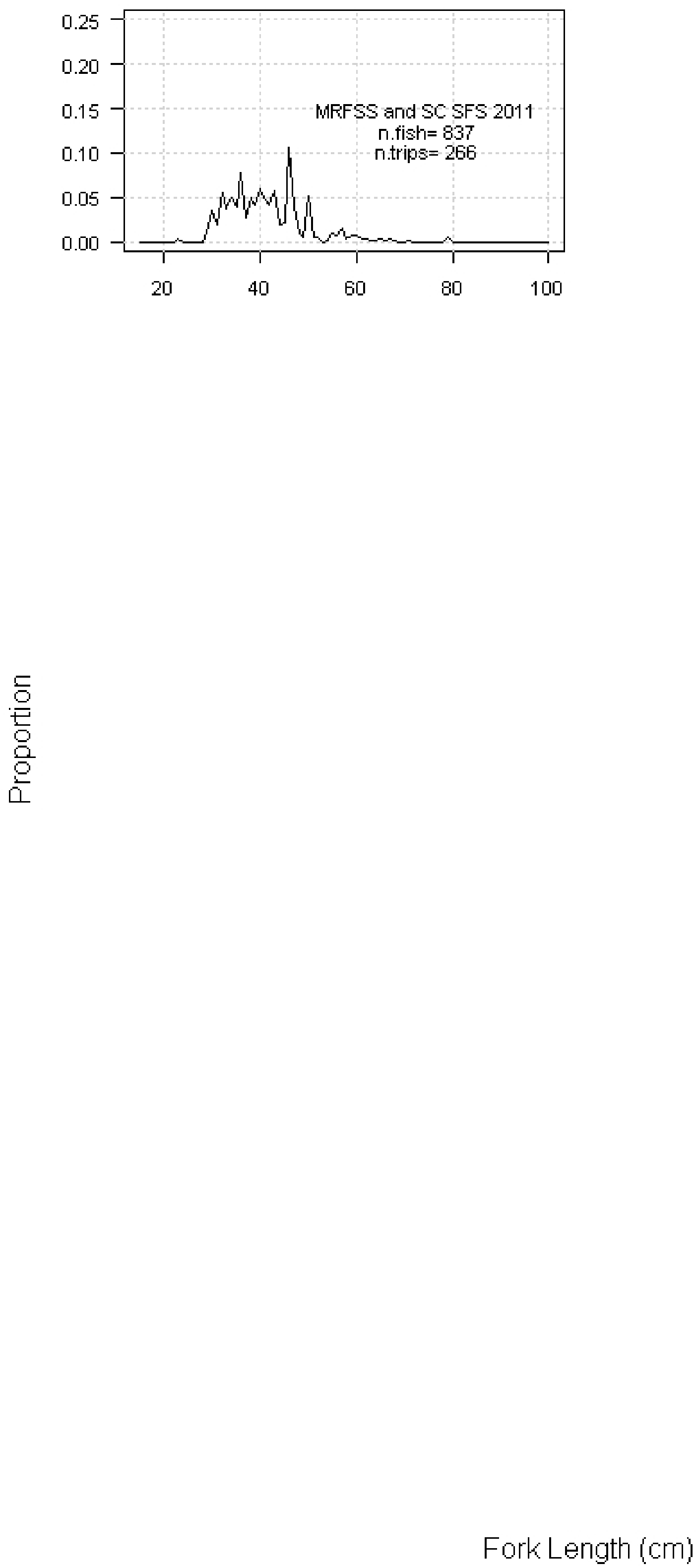

Figure 4.12.17. Length composition from the MRFSS (1981-2011) and SCDNR SFS (1988-2011) (continued). The number of trips reported includes both angler and vessel trips for years 1988-2011.

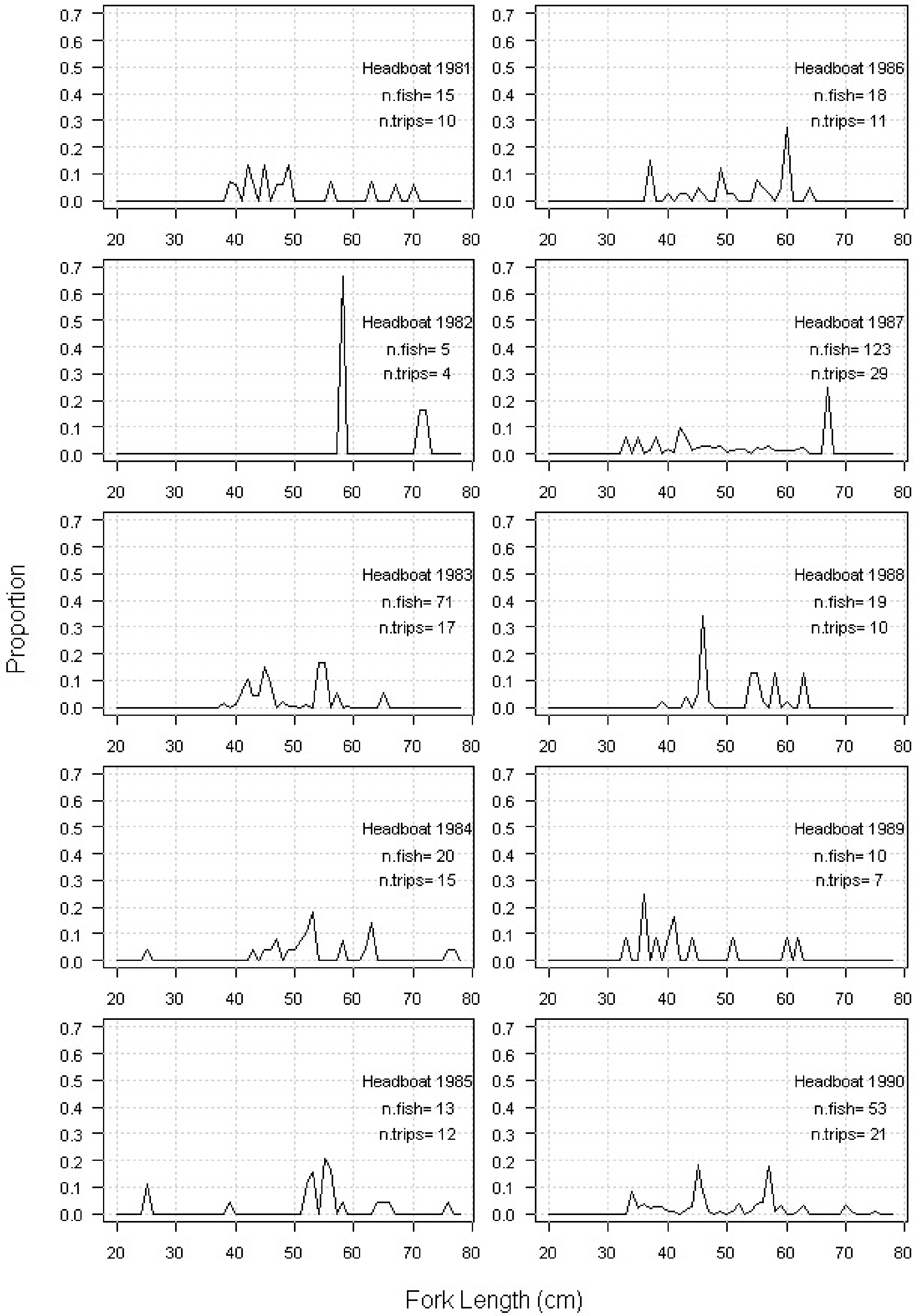

Figure 4.12.18. Headboat length composition 1981-2011.

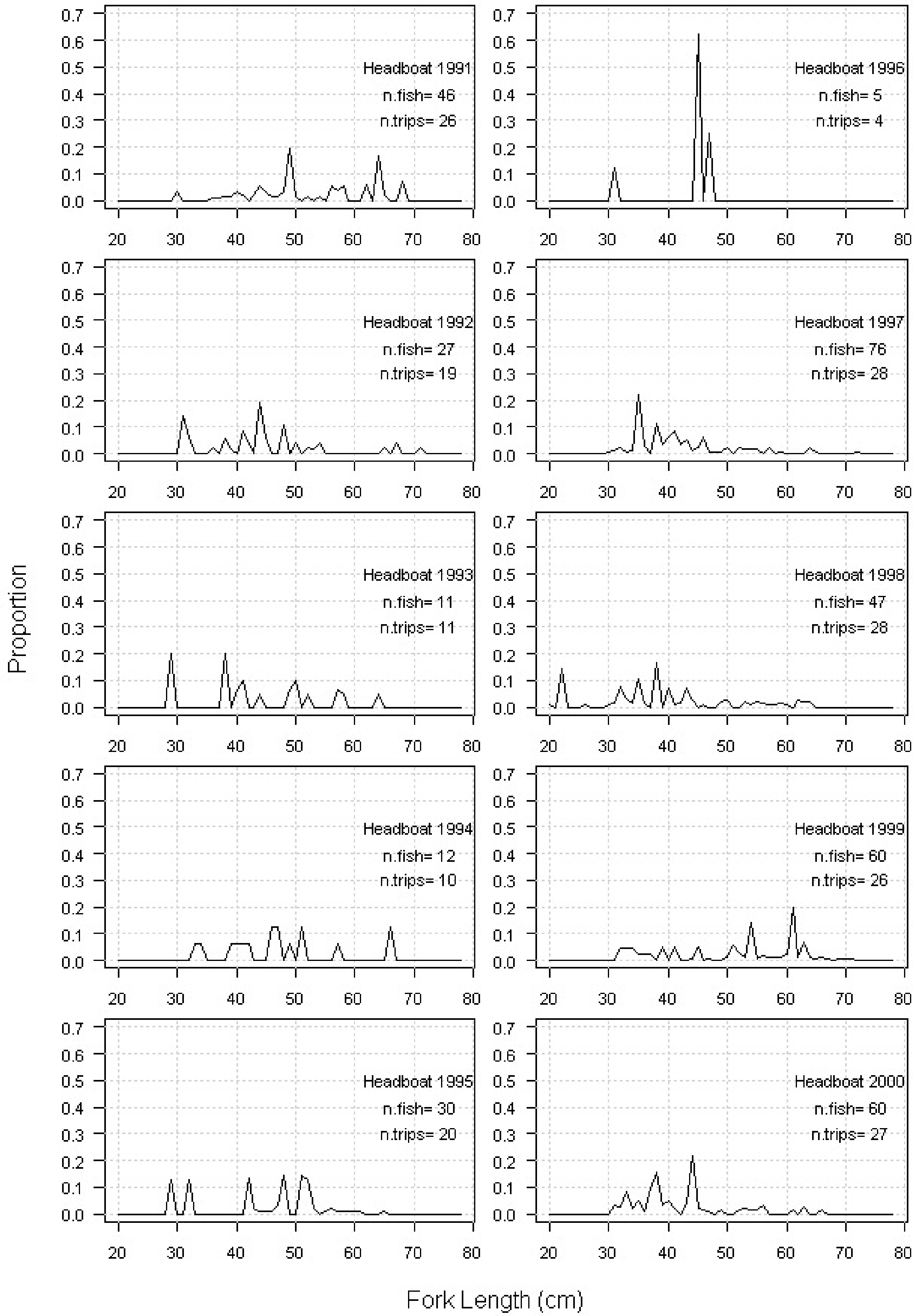

Figure 4.12.18. Headboat length composition 1981-2011 (Continued).

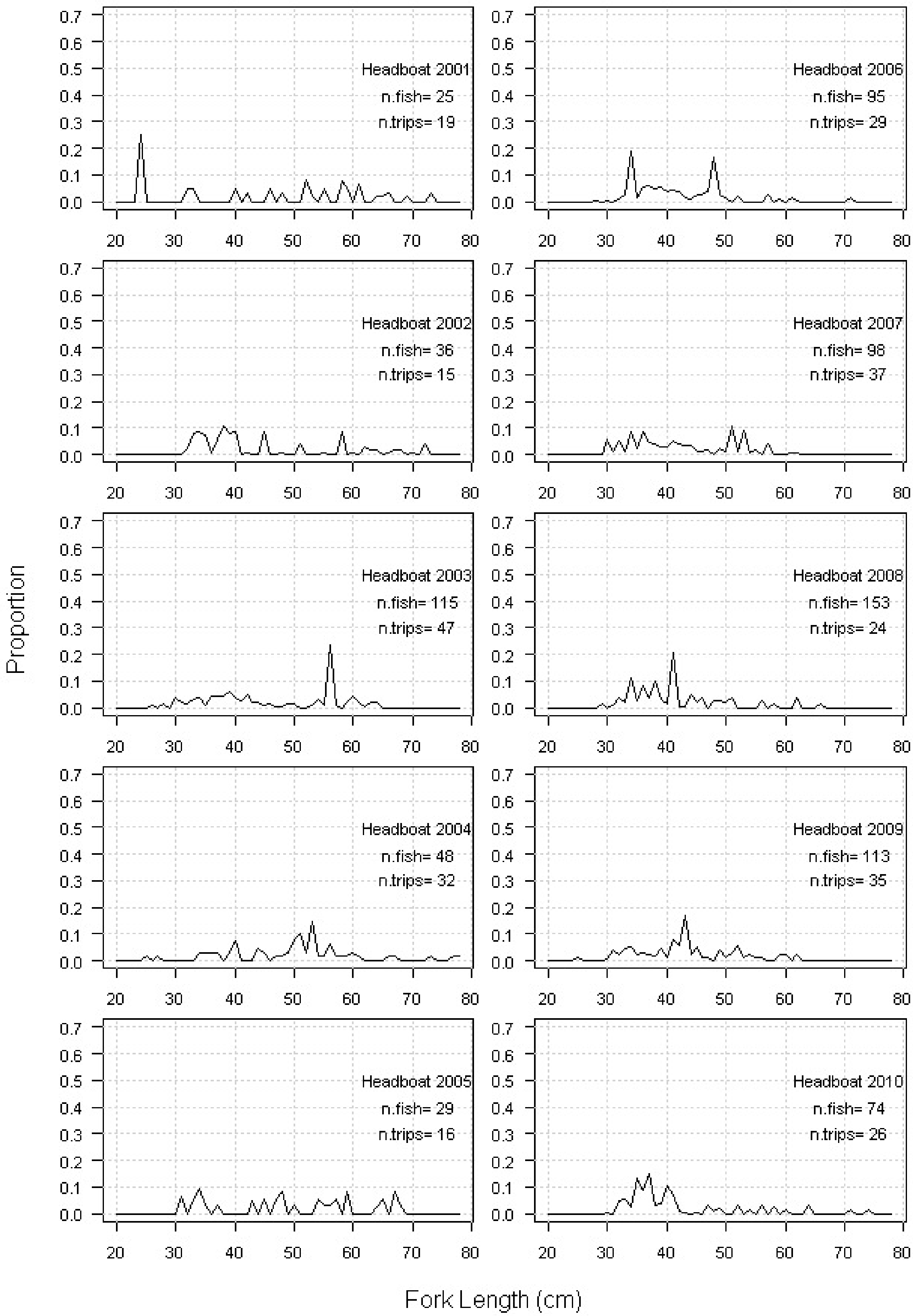

Figure 4.12.18. Headboat length composition 1981-2011 (Continued).

Figure 4.12.18. Headboat length composition 1981-2011 (Continued).

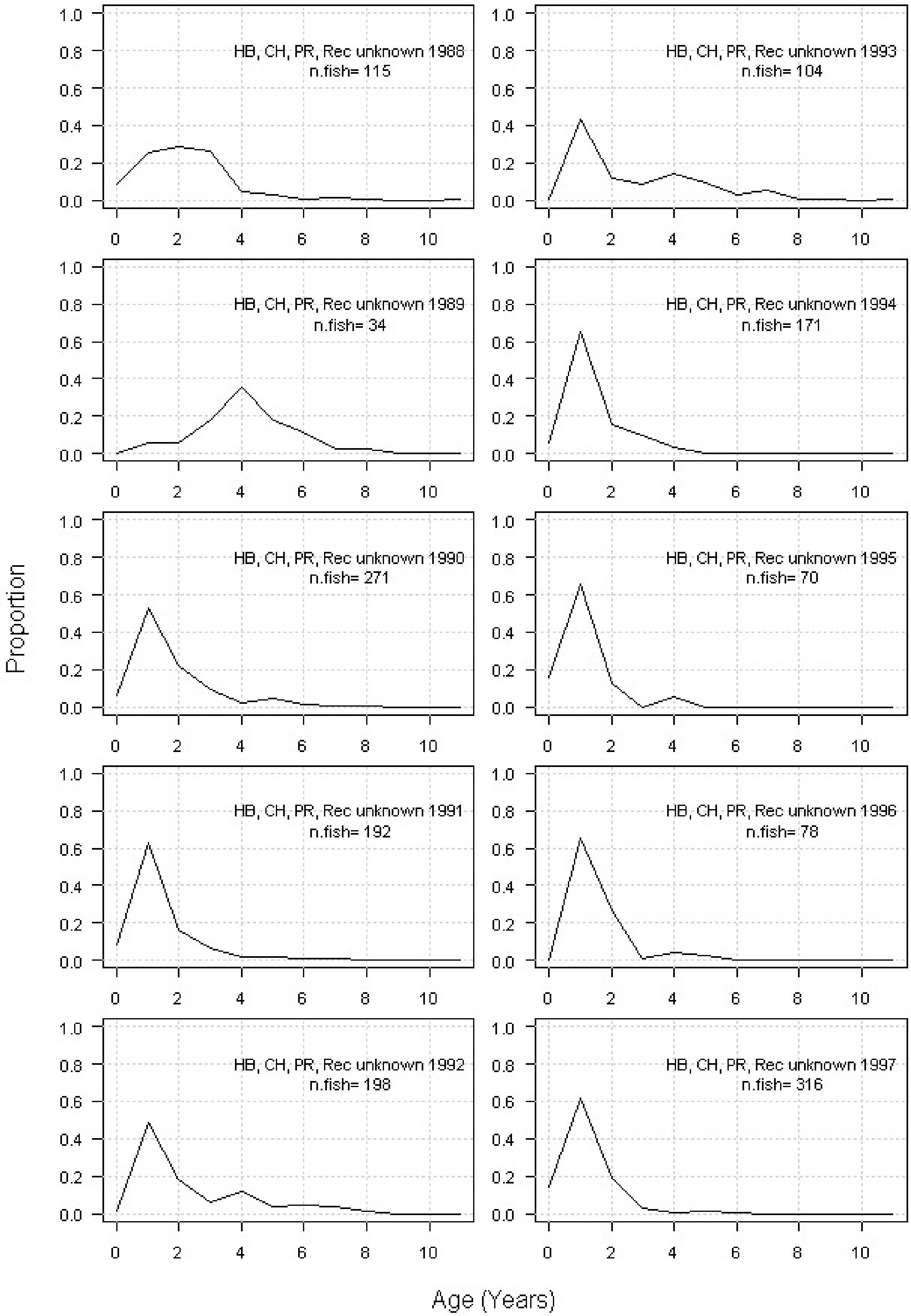

Figure 4.12.19. Age composition of Spanish mackerel from the headboat, charter boat, private/rental boat, recreational fishery (mode unknown) (1988-2011).

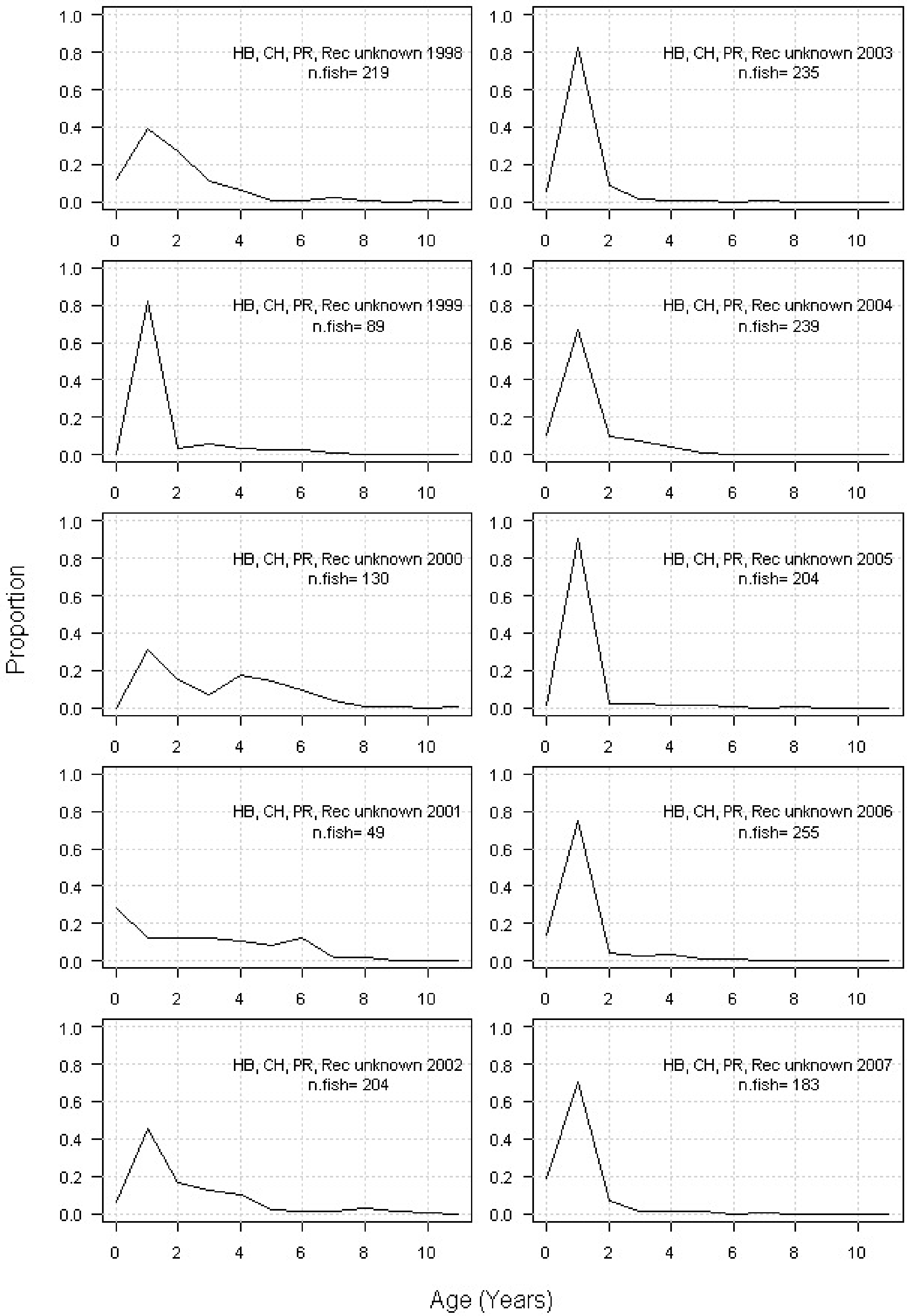

Figure 4.12.19. Age composition of Spanish mackerel from the headboat, charter boat, private/rental boat, recreational fishery (mode unknown) (1988-2011) (continued).

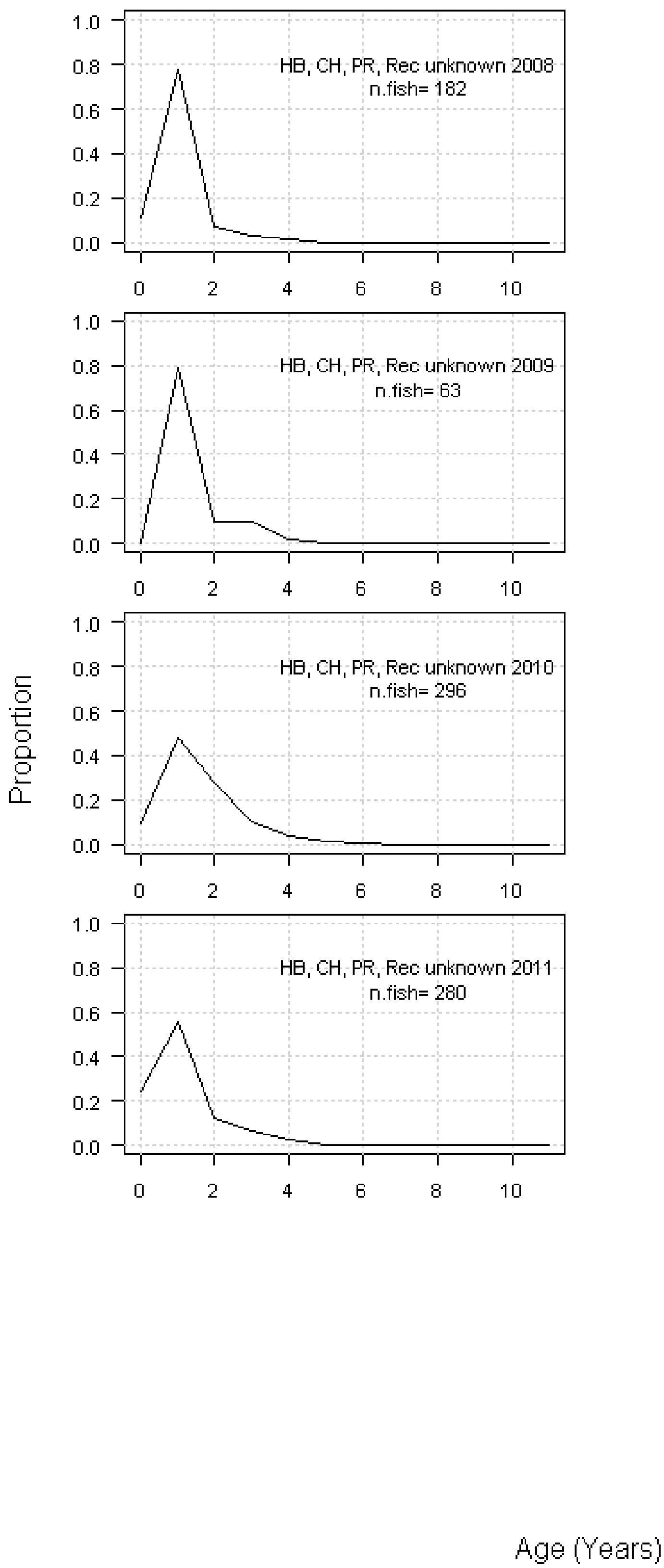

Figure 4.12.19. Age composition of Spanish mackerel from the headboat, charter boat, private/rental boat, recreational fishery (mode unknown) (1988-2011) (continued).

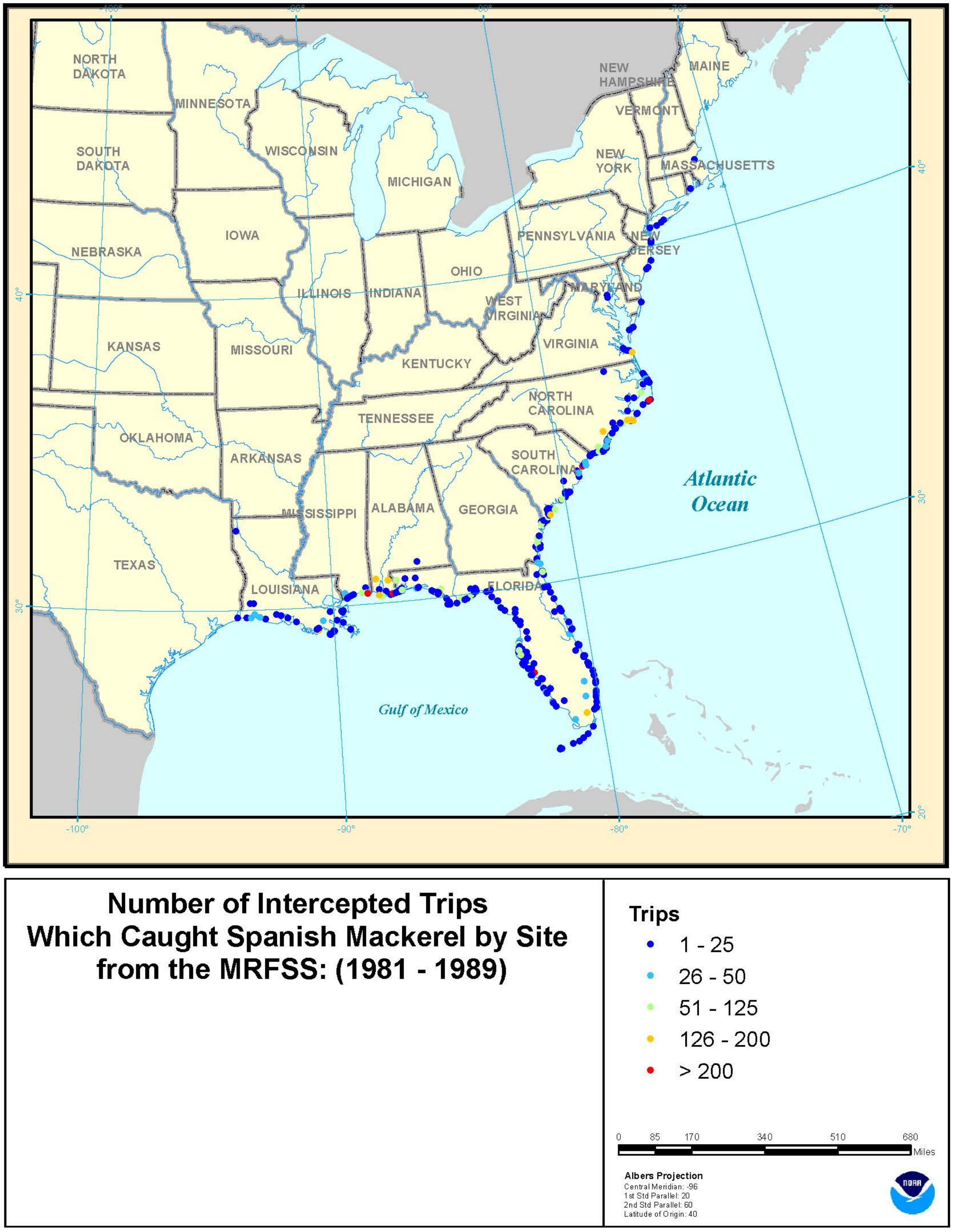

Figure 4.12.20. The number MRFSS intercepted trips which caught Spanish mackerel from 1981-1989.

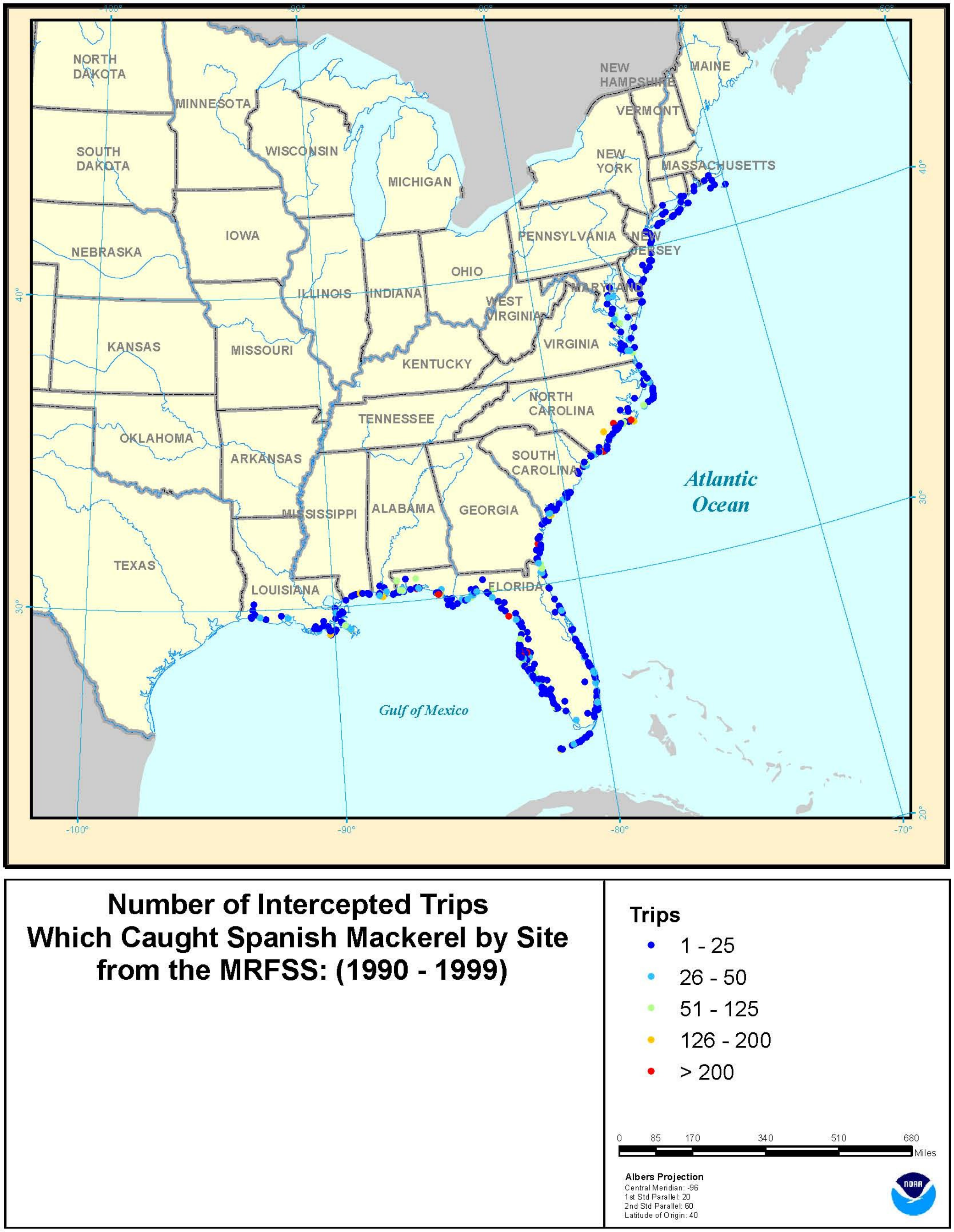

Figure 4.12.21. The number MRFSS intercepted trips which caught Spanish mackerel from 1990-1999.

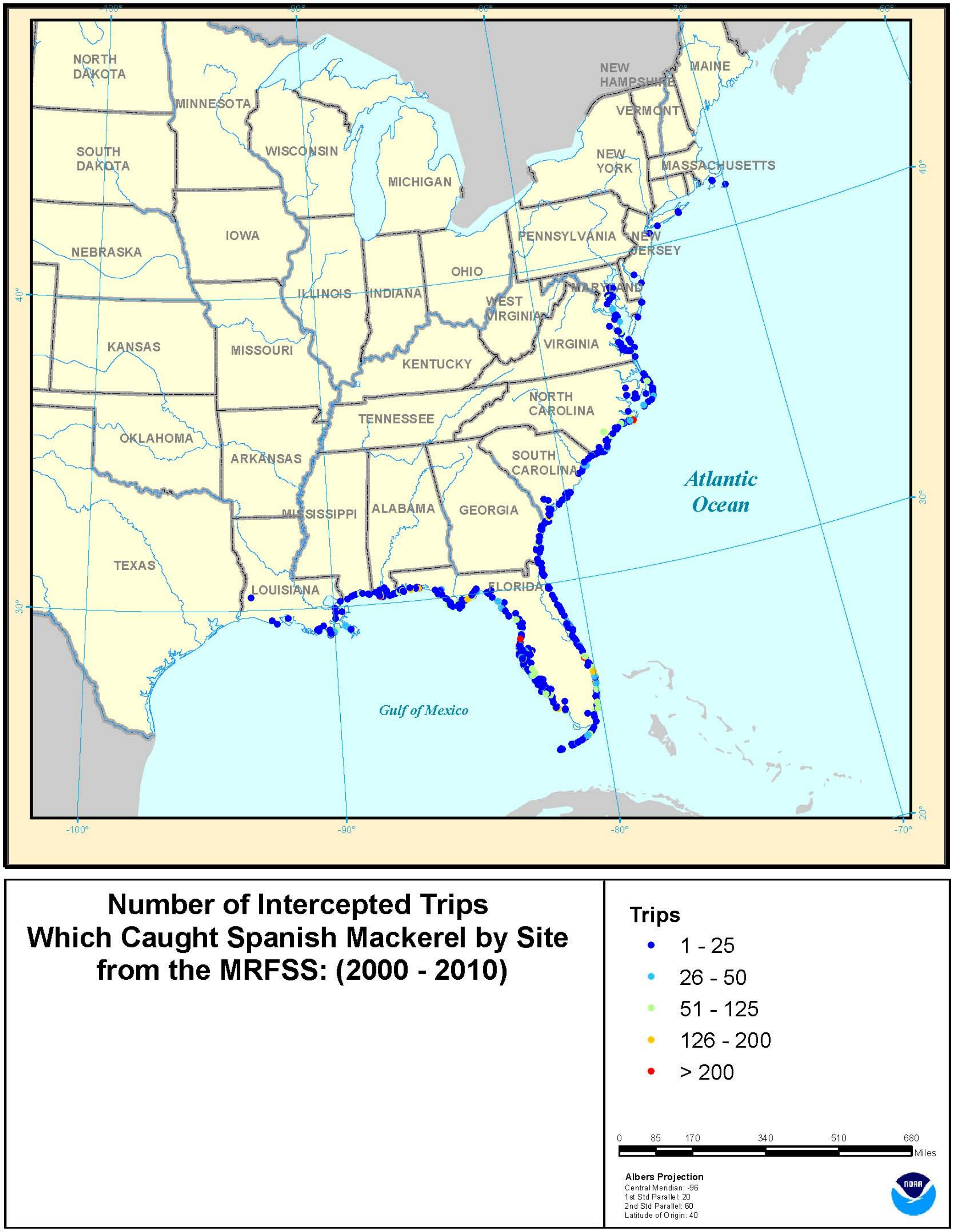

Figure 4.12.22. The number MRFSS intercepted trips which caught Spanish mackerel from 2000-2010.

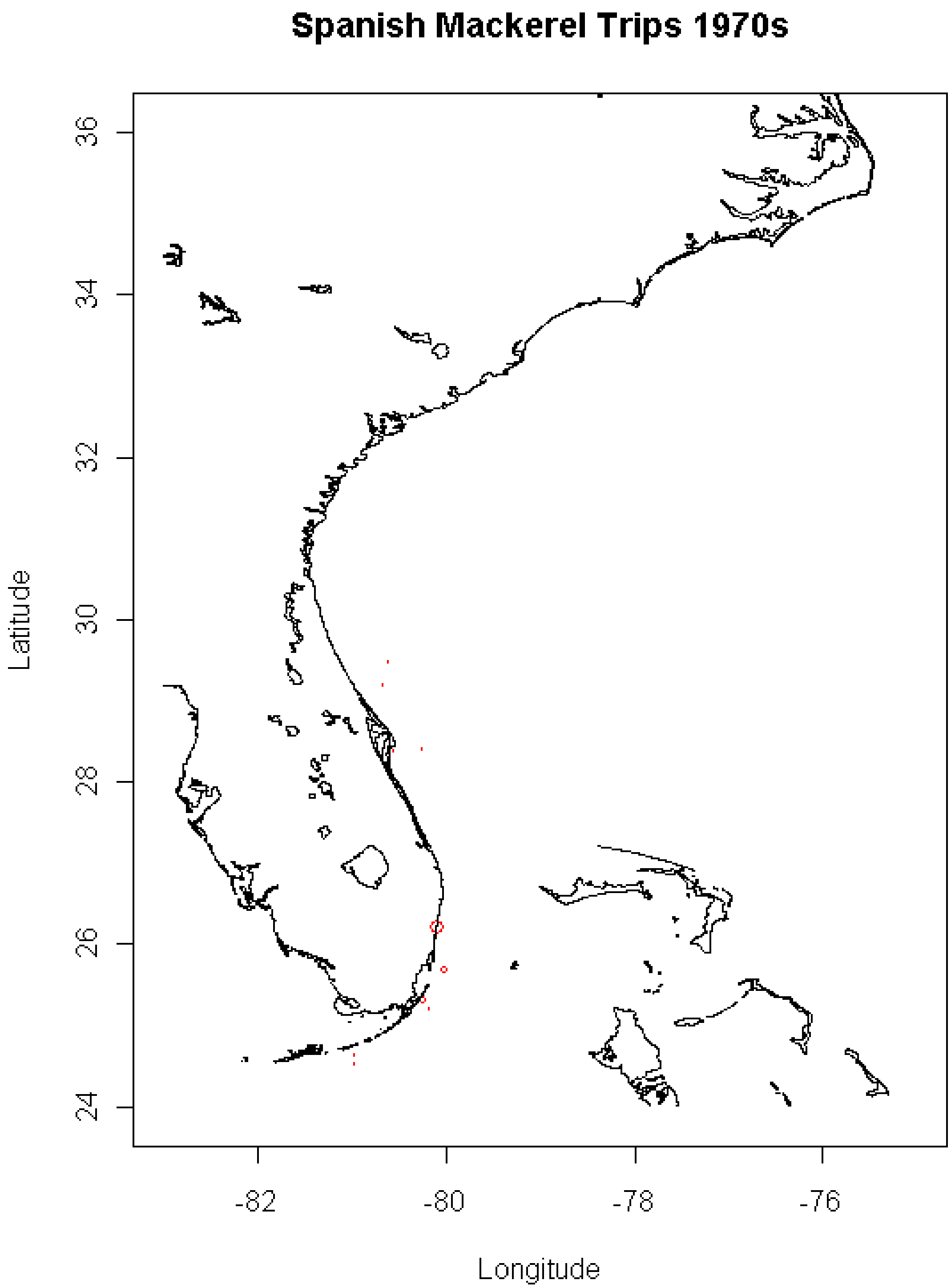

Figure 4.12.23. Reported Spanish mackerel trips from SRHS, 1973-1979. The size of each point is proportional to the frequency of reported trips at the given location.

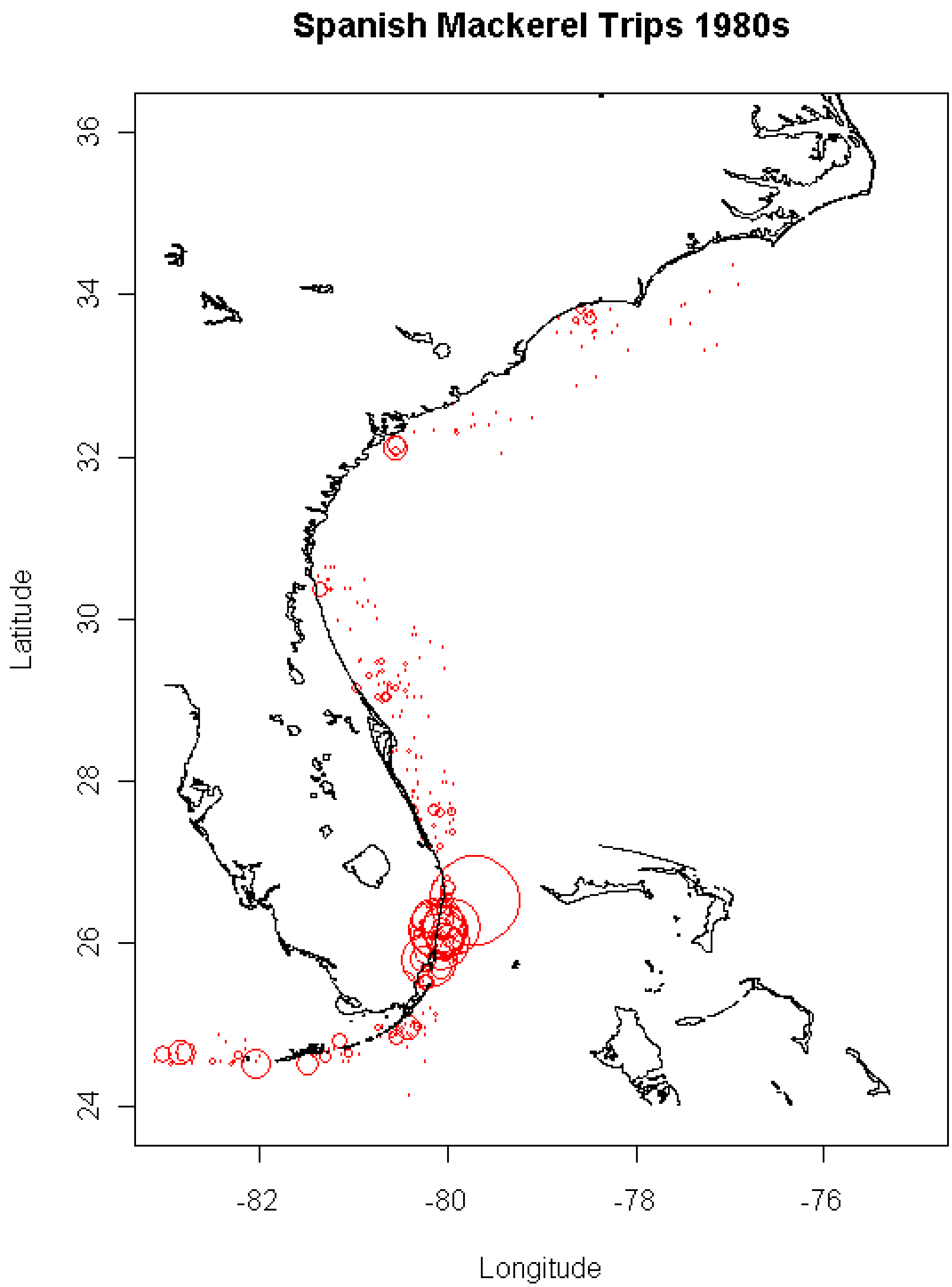

Figure 4.12.24. Reported Spanish mackerel trips from SRHS, 1980-1989. The size of each point is proportional to the frequency of reported trips at the given location.

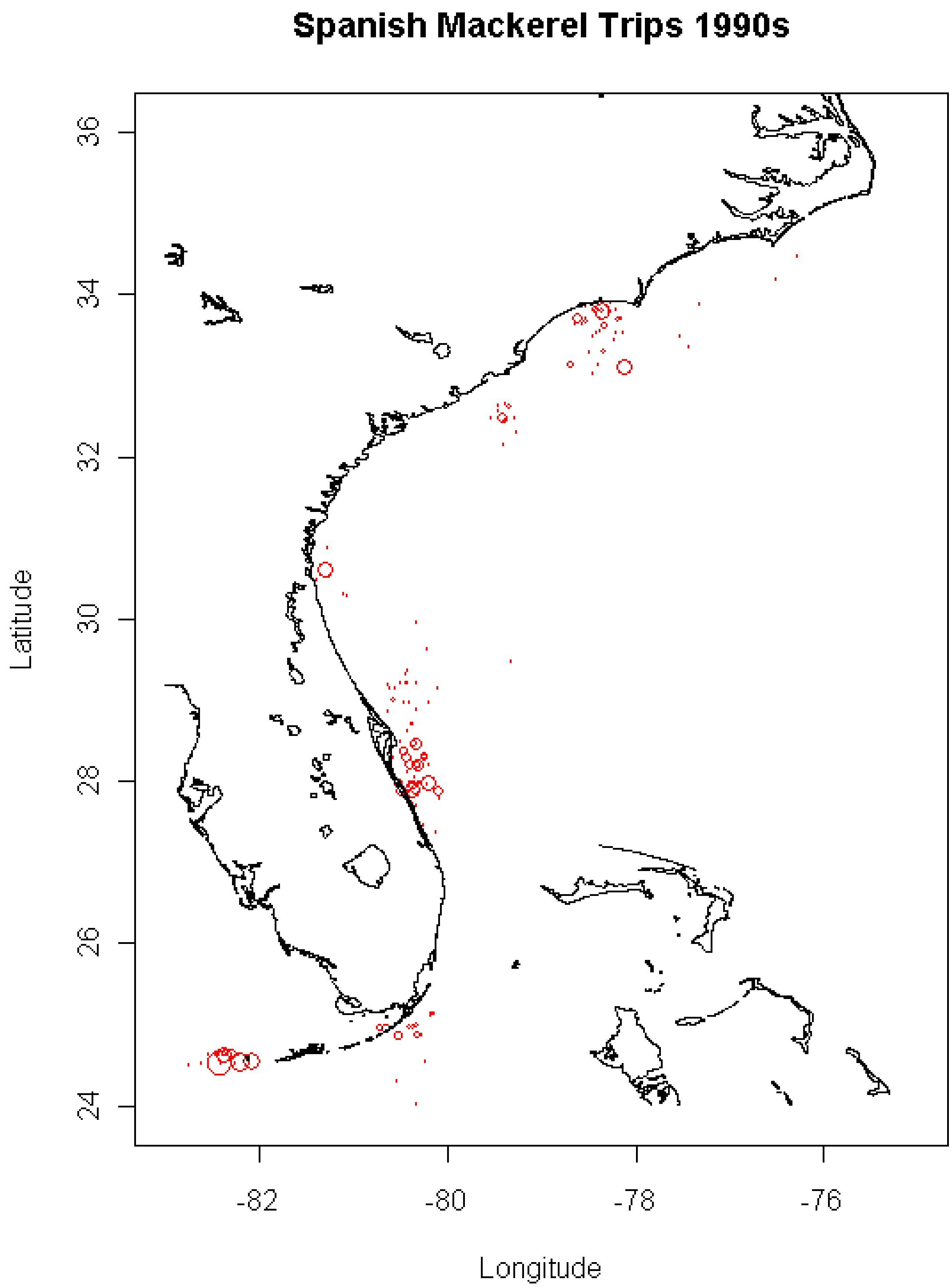

Figure 4.12.25. Reported Spanish mackerel trips from SRHS, 1990-1999. The size of each point is proportional to the frequency of reported trips at the given location.

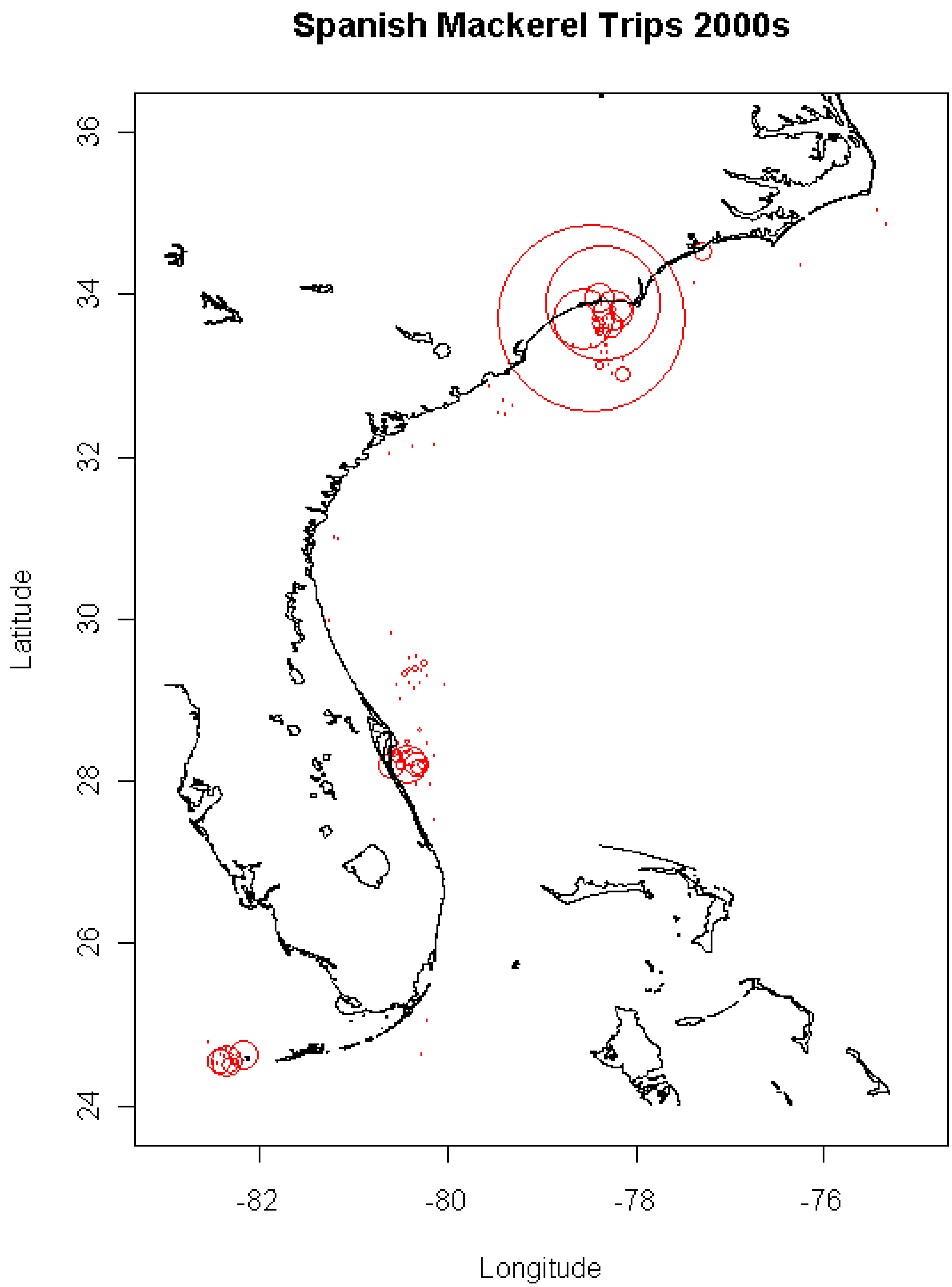

Figure 4.12.26. Reported Spanish mackerel trips from SRHS, 2000-2011. The size of each point is proportional to the frequency of reported trips at the given location.

5 Measures of Population Abundance

5.1 Overview

Several fishery independent data sets were considered for use as an index of abundance both during the data webinar and data workshop. During the data webinar, several datasets were deemed as needing no further consideration because of small sample sizes, limited geographic extent, or difficulty in determining effort. The NMFS bottom longline survey was not further considered due to zero catches of Spanish mackerel in all years. MARMAP was also not further considered due to extremely low sample sizes of Spanish mackerel.

Several fishery dependent data sets were considered for use as an index of abundance both during the data webinar and data workshop. During the data webinar, several datasets were deemed as needing no further consideration because of small sample sizes, limited geographic extent, or difficulty in determining effort. VA harvest reports were not further considered due to extremely low sample sizes of Spanish mackerel, difficulty in determining effort, and only a small area of the species range being sampled. Data from the headboat at-sea observer program was also considered, but sample sizes were extremely low for Spanish mackerel. The headboat data had low sample sizes, an unexplained increase in trips in South Carolina, subsetting trips led to even smaller sample sizes, and a small percentage of trips with positive catches, which was concerning given this species is fairly ubiquitous; therefore, headboat data were not recommended for further consideration, which followed the recommendation of SEDAR 17.

Several indices of abundance were considered for potential use in the south Atlantic Spanish mackerel assessment model. These indices are listed in Table 5.1.1, with pros and cons of each listed in Table 5.1.2. Ten indices were discussed from fishery independent and fishery dependent data sources. The DW recommended two fishery independent indices (SEAMAP age-0 and age-1-spring indices) and two fishery dependent indices (recreational MRFSS index and Florida trip ticket handline/trolling) for potential use in the South Atlantic Spanish mackerel stock assessment.

Group membership

Membership of this DW Index Working Group (IWG) included Amy Schueller (work group leader), Eric Fitzpatrick (Rapporteur), Walter Ingram, Jeanne Boylan, Pearse Webster, Clay Porch, Neil Baertlein, Kevin McCarthy Steve Saul, Meaghan Bryan, Katie Andrews, Kevin Craig, Micheal Schirrippa, Nancie Cummings, Julie Byrd and Mike Errigo. Several other participants of the data workshop contributed in the IWG discussions throughout the week.

5.2 Review of Working Papers

The working group reviewed four working papers describing index construction, including: SEDAR28-DW17; SEDAR28-DW19; SEDAR28-DW21; SEDAR28-DW24; and SEDAR28-AW01. SEDAR28-DW17 described the computation of a fishery dependent index from the commercial logbook handline and trolling data. SEDAR28-DW19 described the computation of a fishery dependent index from the MRFSS recreational data. SEDAR28-DW21 described the computation of fishery independent SEAMAP data. SEDAR28-DW24 described the computation of a fishery dependent index from the SCDNR charterboat logbook data. SEDAR28-AW01 described the computation of a fishery dependent index from the Florida trip ticket data.

These working papers were helpful for determining which indices should be recommended for use and addendums to each working paper (if applicable) are described below in each index description.

Index report cards for data considered at the workshop can be found in Appendix 5.

5.3 Fishery Independent Indices

5.3.1 SEAMAP

Based on the recommendations from the IWG, two standardized indices (age-0 and age-1-spring) were developed.

5.3.1.1 Methods, Gears, and Coverage

The Southeast Area Monitoring and Assessment Program - South Atlantic (SEAMAP-SA) Coastal Survey provides long-term, fishery-independent data on seasonal abundance and biomass of all finfish, elasmobranchs, decapod and stomatopod crustaceans, sea turtles, horseshoe crabs, and cephalopods that are accessible by high-rise trawls in coastal nearshore waters. Samples are taken by trawl from the coastal zone of the South Atlantic Bight between Cape Hatteras, North Carolina, and Cape Canaveral, Florida. Multi-legged cruises are conducted in spring (early April to mid-May), summer (mid-July to early August), and fall (October to mid-November).

Tow duration is 20 minutes at 2.5 knots using the R/V Lady Lisa pulling double rigged demersal 75-ft (22.9-m) mongoose-type Falcon trawl nets (manufactured by Beaufort Marine Supply; Beaufort, S.C.) without TED's. The R/V Lady Lisa is a 75-ft (23-m) wooden-hulled, double-rigged, St. Augustine shrimp trawler owned and operated by the South Carolina Department of Natural Resources (SCDNR). The body of the trawl was constructed of #15 twine with 1.875-in (47.6-mm) stretch mesh. The cod end of the net was constructed of #30 twine with 1.625-in (41.3-mm) stretch mesh and was protected by chafing gear of #84 twine with 4-in (10-cm) stretch "scallop" mesh. A 300 ft (91.4-m) three-lead bridle was attached to each of a pair of wooden chain doors which measured 10 ft x 40 in (3.0-m x 1.0m), and to a tongue centered on the head-rope. The 86-ft (26.3-m) head-rope, excluding the tongue, had one large (60-cm) Norwegian "polyball" float attached top center of the net between the end of the tongue and the tongue bridle cable and two 9-in (22.3-cm) PVC foam floats located one-quarter of the distance from each end of the net webbing. A 1-ft chain drop-back was used to attach the 89-ft foot-rope to the trawl door. A 0.25-in (0.6-cm) tickler chain, which was 3.0-ft (0.9-m) shorter than the combined length of the foot-rope and drop-back, was connected to the door alongside the foot-rope.

The Spanish mackerel is a priority species for the SEAMAP-South Atlantic Coastal Survey trawl survey. Data are available from 1990-2011. From 1990-2010, only centimeter lengths were taken on individual specimens. In 2011, the Spanish mackerel was added to a group of species receiving more detailed life history processing, including millimeter lengths, individual weights, sex, age, and maturity for a subset of specimens.

Data Filtering

Tows containing missing bottom temperature values (32 records) or area values (26 records) were removed for both the age0 dataset and the age1 dataset (age-0: 6,131 remaining records; age-1-spring: 1,997 remaining records).

To assign ages using length, a seasonal (spring, summer, fall) age0-age1 length cutoff was determined by analyzing seasonal length frequencies in conjunction with current age information. The spring age0-age1 length cut-off was 18.0 cm. The summer age0-age1 length cut-off was 28.2 cm. The fall age0-age1 length cut-off was 33.4 cm.

Model Input

Response and explanatory variables

CPUE – Catch per unit effort (CPUE) was defined as fish/tow and was calculated as the number of Spanish mackerel caught per tow. CPUE was the response variable.

Year- 1989-2011.

Season- SEAMAP sampling occurs in spring, summer, and fall. Season was a factor for the age-0 index. Season was not a factor for the age-1 index because only the spring data were used in the creation of that index.

Bottom Temperature- Bottom temperature ranged from 8.7° C to 30.7° C with a mean of 23.1° C. Bottom temperature was a continuous variable in the model.

Area- Area was defined as hectares towed. Area ranged from 2.5 ha to 5.5 ha with a mean of 3.75 ha. Area was a continuous variable in the model.

Latitude- Data were grouped by latitude into 6 categories (lat29=21,23,25,27; lat30=29,31,33; lat31=35,37,39; lat32=41,43,45,47; lat33=49,51,53,55,57; lat34=59,61,63,65,67).

Standardization

CPUE for both the age-0 and age-1-spring were modeled using the delta-glm approach (Lo et al. 1992; Dick 2004; Maunder and Punt 2004). In particular, fits of lognormal and gamma models were compared for positive CPUE. Also, the combination of predictor variables was examined to best explain CPUE patterns (both for positive CPUE and for presence/absence). Bootstrap estimates of variance were computed. All analysis was performed in the R programming language, with much of the code adapted from Dick (2004).

BERNOULLI SUBMODEL

One component of the delta-GLM is a logistic regression model that attempts to explain the probability of either catching or not catching Spanish mackerel on a particular trip. First, a model was fit with all main effects in order to determine which effects should remain in the binomial component of the delta-GLM. Stepwise AIC (Venables and Ripley1997) with a backwards selection algorithm was then used to eliminate those that did not improve model fit. For the age-0 and the age-1-spring indices, the stepwise AIC procedure did not remove any predictor variables.

POSITIVE CPUE SUBMODEL

Then, to determine predictor variables important for predicting positive CPUE, the positive portion of the model was fitted with all main effects using both the lognormal and gamma distributions. Stepwise AIC (Venables and Ripley1997) with a backwards selection algorithm was then used to eliminate those that did not improve model fit. For the age-0 and the age-1 spring indices, bottom temperature was removed. All remaining predictor variables were modeled as fixed effects.

Both components of the model were then fit together (with the code adapted from Dick 2004) using the lognormal and gamma distributions and compared them using AIC. With CPUE as the dependent variable, the lognormal distribution outperformed the gamma distribution with lower AIC values when all factors were included and when using only those factors that were selected in the previous step.

For both the age-0 and age-1-spring indices, the lognormal model excluding bottom temperature was used for computing the positive component of the index, and the binomial with all factors was used for computing the Bernoulli component of the index. Standard model diagnostics (Figures 5.3.1.1-5.3.1.9) appeared reasonable for the positive component of the model (Dunn and Smyth 1996).

Index

The distribution of lognormal CPUE for the indices appeared reasonable (Figure 5.3.1.6 and Figure 5.3.1.7), as did the QQ plot of the residuals (Figure 5.3.1.8 and Figure 5.3.1.9). The age-0 index is presented in Table 5.3.1.1 and in Figure 5.3.1.10. The age-1-spring index is presented in Table 5.3.1.2 and and Figure 5.3.1.11.

Pearson correlation analysis between the age-0 index and the age-1-spring index (lagged) indicated a positive correlation (corr=0.454, p-value=0.0335). The age-0 and age-1-spring (lagged) indices are presented in Figure 5.3.1.12.

5.3.1.2 Sampling intensity and time series

From 2001 to 2008, a total of 102 stations were randomly selected from a pool of stations within each of twenty-four strata and sampled each season (306 stations/year), representing an increase from 78 stations previously sampled in those strata by the trawl survey (1990-2000). In 2009, the number of stations sampled each season increased to 112 (336 total). The time series for SEAMAP spans from 1989 to 2011.

5.3.1.3 Size/Age data

A total of 29,709 (5.2 individuals/tow) Spanish mackerel were taken in shallow strata over all seasons in 1990-2010. Fork lengths ranged from 2 to 58 cm (mean=21.8 cm). Ages are not available for the 1990-2010 dataset.

5.3.1.4 Catch Rates

Index results for age-0 and age-1-spring are listed in Table 5.3.1.1 and Table 5.3.1.2 and shown graphically in Figure 5.3.1.10 and Figure 5.3.1.11.

5.3.1.5 Uncertainty and Measures of Precision

Coefficients of variation (CV) were in the range of 0.46-0.59 over the entire time series for the age-0 index. Coefficients of variation (CV) were in the range of 0.15-0.38 over the entire time series for the age-1-spring index.

5.3.1.6 Comments on Adequacy for assessment

The index work group recommends that the assessment panel consider the use of the age-0 SEAMAP index presented above. The age-0 index should be a good representation of age-0 recruitment based on the spatial extent of the fishery independent survey, the use of the seasonal size cut-offs to ensure the use of only age-0 samples, and adequate sample sizes over time.

The index work group recommends that the assessment panel consider the use of the age-1 SEAMAP index presented above, but with some caveats. The two SEAMAP indices are positively correlated, which led the group to discuss what the addition of the age-1 index would provide. The age-1 index could be useful to provide the model with information on fishing mortality during the first year of life. The index work group recommends that the age-1 index be included preliminarily, but if the spikes in the index do not line up with year class strength from the age compositions, then the age-1 index should be dropped. If the age-1 index doesn't match up with year class strength from the age compositions, this could mean that most of the age-1 individuals are recruiting out of the SEAMAP gears, meaning that they out swim the trawl, or that the spatial overlap between the survey and age-1 habitat is low. There is some indication that the age-1 Spanish mackerels move to waters deeper than those sampled by the SEAMAP survey.

5.4 Fishery Dependent Indices

5.4.1 MRFSS

The MRFSS access-point angler intercept survey is conducted at public marine fishing access points to collect data on the individual catch of fishers, including species identification, total number and disposition of each species, and length and weight measurements of retained fish, as well as information about the fishing trip and the angler's fishing behavior. For more information on the methodology and variables collected, see the MRFSS Data User's Manual (available at http://www.st.nmfs.noaa.gov/st1/recreational/pubs/data_users/index.html).

5.4.1.1 Methods of Estimation

Data from 1982 – 2010 were used. Wave 1 was not sampled in 1981, and data for 2011 were not yet finalized.

The unit of effort used was directed angler-hour. The MRFSS intercept database was subset to trips that either targeted or caught (regardless of disposition) Spanish mackerel and by hook-and-line gear. Total available catch (Type A catch) was divided by the number of A-anglers that contributed to that catch multiplied by the number of hours fished to obtain Type A catch-per-angler-hour. The number of unavailable fish (Type B1 + B2 catch) was summed over all Type B records in the group trip set and divided by the number of unavailable catch records for that group trip multiplied by the number of hours fished to obtain Type B catch-per-angler-hour. The Type A and Type B catch per angler-hour estimates were added together to get total catch per angler-hour.

The MRFSS intercept survey only counts anglers who contribute to the total catch, thus estimates of total catch per angler-hour may be biased high in cases where anglers in the group fished but did not catch anything. In addition, the directed trips designation may not adequately identify zero trips. Anglers targeting other species or who do not report a target species may still have taken a trip that could have caught the species of interest, and that zero trip would not have been included in the directed trips subset.

Atlantic observations were defined as Miami-Dade County north; intercepts from the Florida Keys were assigned to the Gulf. The index reflects private/rental boats, shore and charter modes.

Bag limits were established in 1987 and increased in 1992 and 2000. Since the CPUE measures both retained and discarded or released fish, the index should not be strongly affected by changes in regulations.

A delta-lognormal approach (Lo *et al.,* 1992) was used to standardize each index. A forward selection method was used to select the factors based on reductions in deviance for each component of the model. Factors considered included year, region, area fished, wave, mode and hours fished. A factor was included in the model if it reduced the deviance by 5% or more.

5.4.1.2 Sampling Intensity

In the Atlantic, a total of 30,564 interviews were conducted from 1982 – 2010 that caught or targeted Spanish mackerel and used hook-and-line gear.

5.4.1.3 Size/Age data

The recreational fisheries target adult fish of both species. The median fork length for Spanish mackerel was 38 cm, with individuals ranging from 15 to 178 cm (Figure 5.4.1.1). The sizes/ages represented in this index should be the same as those of landings from the corresponding fleet (See section 4 of this data report).

5.4.1.4 Catch Rates

Both the nominal and standardized indices were variable but were higher in the more recent time period (Table 5.4.1.1., Figure 5.4.1.4.; Figure 5.5.2).

5.4.1.5 Uncertainty and Measures of Precision

For Spanish mackerel, year, area fished, mode and wave provided the greatest reductions in deviance for the positive trips model and year, area fished, mode and hours fished for the proportion positive model (Table 5.4.1.2, Table 5.4.1.3; Figure 5.4.1.2; Figure 5.2.1.3). Spanish mackerel positive intercepts deviated slightly from the lognormal distribution. Standard errors were derived from the estimated covariance matrix of the estimated coefficients.

5.4.1.6 Comments on Adequacy for Assessment

The index created from the MRFSS data set is recommended for potential use in the South Atlantic Spanish mackerel stock assessment. The data set samples the extent of the population range as defined above and includes a long time series. There are no concerns over species identification, and because discards are included, problems relating to the bag limit were not a concern. Given the difficulty interpreting the catch per angler-hour from the MRFSS dataset, which was not designed to produce a CPUE index caution should be used when interpreting and applying these indices.

5.4.2 FL trip ticket – handline and trolling

There were four 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 2011

(ATL_GN_after), ATL cast nets for 1996-2011 (ATL_CN), ATL hook and line gears for 1985-2011 (ATL_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.

Detailed information regarding background information for Florida Trip Ticket can be found in the SEDAR28-AW01.

5.4.2.1 Methods of Estimation

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. 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. 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 applied to this data set 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). However, for this species, the potential procedures above did not prove to be useful for selecting trips with zero catches for other data sets.

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 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.

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.

For model results from the forward stepwise selection of variables for the linear models refer to SEDAR-AW01. 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 in Figure 5.4.2.1. The adjusted average catch rates (pounds per trip), coefficient of variation (as a percentage of the mean), and the scaled index values are in Table 5.4.2.1.

5.4.2.2 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 2011 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.

5.4.2.3 Size/Age data

The sizes/ages represented in this index should be the same as those of landings from the corresponding fleet (See section 3 of this report).

5.4.2.4 Catch Rates

See Table 5.4.2.1.

5.4.2.5 Uncertainty and Measures of Precision

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.

5.4.2.6 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, seventeen years for gill nets for the 1995-2011 period, sixteen years for cast nets over 1996-2011, and 26 years for hook and line gears over 1986-2011). 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).

Both the Florida trip ticket hook and line gears index and the commercial logbook index have the same trend. While the commercial logbook index contains data from NC to FL, the fact that the two indices are similar leads one to believe that there is no area effect to worry about across states. Also, the coarse scale at which effort is defined for the Florida trip ticket dataset did not seem to diminish the potential usefulness of the index. The agreement among these indices lends support that both indices capture the same dynamics. Support for the Florida trip ticket hook and line gears index as opposed to the commercial logbook index was based on the longer time series (12 additional years) of the FL trip ticket index; FL being the heart of the Spanish mackerel population, where individuals migrate through; and FL trip tickets capture vessel information from vessels that do not have federal permits in addition to those that do.

5.4.4 Other Data Sources Considered

Several datasets were introduced at the SEDAR 28 data workshop that were considered but not recommended by the IWG or at the plenary session.

5.4.4.1 Commercial logbook – hook and line

Self-reported commercial logbook hook and line (handline, electric and hydraulic reel, and trolling) catch per unit effort (CPUE) data were used to construct standardized abundance indices for Spanish mackerel in the US South Atlantic. Spanish mackerel data were sufficient to construct indices including the years 1998-2010. Prior to 1998, Spanish mackerel landings and effort data were not required to be reported to the coastal logbook program. Methods and results of the analyses are described in SEDAR28-DW17.

An initial index (continuity index) was constructed following the methods used in SEDAR 17 with data limited to the region 31^{o}N to 40^{o}N latitude. A second index (2012 index) was constructed with data limited to the region from the Florida Keys to 37^{o}N latitude. Data from fishing trips north of 37^{o}N latitude were not required to be reported to the coastal logbook program in the US South Atlantic, although a small number of trips north of 37^{o}N latitude have been reported. For both analyses, data were filtered to remove records missing landings or effort data, records with logical inconsistencies (e.g., fishing more than 24 hours/day), and records with obvious data entry errors (vessels reporting 50 lines fished, for example). Data used to construct the 2012 index were also filtered to remove records from reports submitted more than 45 days following the fishing trip. Such lengthy delays in reporting may have resulted in less accurate data than data reported with less delay.

For each analysis, only trips reporting Spanish mackerel landings were included. Those positive commercial fishing trip data were used in lognormal models on catch rates to construct standardized indices of abundance. Parameterization of the 2012 model was accomplished using a GLM procedure (GENMOD; Version 9.1 of the SAS System for Windows © 2002-03. SAS Institute Inc., Cary, NC, USA). The continuity index used the SEDAR 17 model. The final lognormal models (continuity and 2012 models) were fit using a mixed model (PROC MIXED; Version 9.1 of the SAS System for Windows © 2002-03. SAS Institute Inc., Cary, NC, USA).

The final model reported in SEDAR 17 and used in the continuity analysis for the lognormal on CPUE of successful trips was:
LOG(CPUE) = Year + Triparea + Gear Fished

The final model for the lognormal on CPUE of successful trips for the 2012 index was:
LOG(CPUE) = Year + Subregion + Quarter + Gear Fished +Subregion*Quarter + Quarter*Year + Subregion*Year + Quarter*Gear + Subregion*Gear

Relative nominal CPUE, number of trips, and relative abundance indices are provided in Tables 5.4.4.1 and 5.4.4.2 for each of the Spanish mackerel hook and line analyses. The continuity and 2012 lognormal abundance indices are shown in Figures 5.4.4.1 and Figure 5.4.4.2.

No clear long term change in yearly mean cpue was found in any of the Spanish mackerel indices. A small increase in cpue was found in the hook and line 2012 index, however confidence intervals were large. As with any index of abundance constructed using fisheries dependent data, the yearly mean cpues reported here may not reflect Spanish mackerel abundance; but rather the ability of fishers to successfully target the species.

5.4.4.1.1 Comments on Adequacy for Assessment

Neither of the South Atlantic commercial hook and line indices constructed using coastal logbook data were recommended for use in the South Atlantic Spanish mackerel assessment. Most of the South Atlantic 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, was a longer time series and was similar to the commercial logbook index, was recommended (see Section 5.4.2.6 for further discussion).

5.4.4.2 Commercial logbook – gillnet

Self-reported commercial logbook gillnet catch per unit effort (CPUE) data were used to construct standardized abundance indices for Spanish mackerel in the US South Atlantic. Spanish mackerel data were sufficient to construct indices including the years 1998-2010. Prior to 1998, Spanish mackerel landings and effort data were not required to be reported to the coastal logbook program. Methods and results of the analyses are described in SEDAR28-DW17.

An initial index (continuity index) was constructed following the methods used in SEDAR 17 with data limited to the region 31^{o}N to 40^{o}N latitude. A second index (2012 index) was constructed with data limited to the region from the Florida Keys to 37^{o}N latitude. In both analyses, data were filtered to remove records missing landings or effort data, records with logical errors (e.g., fishing more than 24 hours/day), and records with obvious data entry errors (vessels reporting five mile long gillnets, for example). Data used to construct the 2012 index were also filtered to remove records from reports submitted more than 45 days following the fishing trip. Such lengthy delays in reporting may have resulted in less accurate data than that reported with less delay. For each index, data from all gillnet trips within the area defined for the analysis were included in the construction of the index.

The delta lognormal model approach (Lo et al. 1992) was used to construct standardized indices of abundance from the gillnet data. This method combines separate general 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 the 2012 models was accomplished using a GLM analysis (GENMOD; Version 8.02 of the SAS System for Windows © 2000. SAS Institute Inc., Cary, NC, USA). The continuity index used the models reported from SEDAR 17. The final delta-lognormal models (continuity and 2012 indices) were fit using a SAS macro, GLIMMIX (Russ Wolfinger, SAS Institute).

The final continuity models (those defined in SEDAR 17) for the binomial on proportion positive trips (PPT) and the lognormal on CPUE of successful trips were:

PPT = Year + Triparea

LOG(CPUE) = Year + Triparea

The 2012 analysis final models for the binomial on proportion positive trips (PPT) and the lognormal on CPUE of successful trips were:

PPT = Year* + Crew + Subregion + Quarter + Trip effort + Subregion*Quarter + Subregion*Trip effort + Crew*Subregion + Crew*Quarter

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

Relative nominal CPUE, number of trips, and relative abundance indices are provided in Tables 5.4.4.3 and Table 5.4.4.4 for each of the Spanish mackerel gillnet analyses. The continuity and 2012 delta-lognormal abundance indices are shown in Figures 5.4.4.3 and 5.4.4.4.

5.4.4.2.1 Comments on Adequacy for Assessment

No clear trend in yearly mean cpue was found in either South Atlantic Spanish mackerel commercial gillnet index of abundance. Nominal cpues were much higher during the final four years of the time series in the gillnet 2012 index, however the standardized index did not have the same pattern in yearly mean cpue. Neither of the South Atlantic commercial gillnet indices constructed using coastal logbook data was recommended for potential use in the South Atlantic Spanish mackerel assessment. The working group believed that much of the gillnet effort may include run around gillnets that were effectively fishing similarly to purse seines. The working group further noted that such fishing practices often result in index hyperstability and do not reflect fish abundance.

5.4.4.3 FL trip ticket- gill net and cast nets

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.

5.4.4.3.1 Comments on Adequacy for Assessment

Neither the cast net nor the gill net index based on the Florida trip ticket data was recommended for potential use in the South Atlantic Spanish mackerel assessment. These indices were not recommended due to concerns over trip limits and gear saturation and hyperstability given Spanish mackerel are a schooling fish.

5.4.4.4 SC Charterboat logbook

In 1993, SCDNR's Marine Resources Division (MRD) initiated a mandatory logbook reporting system for all charter vessels to collect basic catch and effort data. Under state law, vessel owners/operators carrying fishermen on a for-hire basis are required to submit monthly trip level reports of their fishing activity in waters off of SC. The charter boat logbook program is a complete census and should theoretically represent the total catch and effort of the charter boat trips in waters off of SC. The charter logbook reports include: date, number of fishermen, fishing locale (inshore, 0-3 miles, >3miles), fishing location (based on a 10x10 mile grid map), fishing method, hours fished, target species, and catch (number of landed and released fish by species) per vessel per trip. The logbook forms have remained similar throughout the program's existence with a few exceptions: in 1999 the logbooks forms were altered to begin collecting the number of fish released alive and the number of fish released dead (prior to 1999 only the total number of fish released were recorded) and in 2008 additional fishing methods were added to the logbook forms, including cast, cast and bottom, and gig. Data represents 6-pack charter vessels only and is self-reported with no field validation.

All SCDNR charterboat logbook entries which reported using trolling as a method of fishing in nearshore (0-3 miles) and offshore (>3 miles) waters were included in the index calculation. The CPUE index was standardized using a Delta-GLM approach following the methods of Dick (2004). The factors include in the model that were significant are Year (1998-2010), Locale (Nearshore (0-3 miles), Offshore (outside of 3 miles)), and either Month (1-12) or Season (Winter, Spring, Summer, Fall). A Jackknife approach was used to estimate the amount of variation in the model run as per Dick (2004).

Data represents SC licensed 6-pack charter vessel trips operating in or off of SC from 1993 – 2010. SCDNR charterboat logbook vessel trips included in this analysis represent trolling fishing trips in nearshore and offshore waters. The SCDNR charterboat logbook data represent 49,132 fishing trips in which anglers caught 186,444 Spanish mackerel and harvested 147,141 Spanish mackerel.

Catch per unit effort was calculated as the number of fish caught per angler-hour (Figure 5.4.4.5).

5.4.4.4.1. Comments on Adequacy for Assessment

The data workshop did not recommend this index be included in the South Atlantic Spanish mackerel stock assessment. The index was not recommended for use since it is a fishery dependent dataset, is self-reported data without field validation, South Carolina is a small portion of the Atlantic stock's geographic range and accounts for a relatively small percentage of the catch, and the MRFSS index included charterboat mode. Other indices were deemed more appropriate for use in the stock assessment.

5.5 Consensus Recommendations and Survey Evaluations

Two fishery independent indices were recommended for potential use in the South Atlantic Spanish mackerel stock assessment, and two fishery dependent indices were recommended for potential use: SEAMAP age-0 index, SEAMAP age-1-spring index, commercial FL trip ticket handline/trolling index, and MRFSS index. Fishery independent indices that have been computed are compared graphically in Figure 5.5.1. Fishery dependent indices that have been computed are compared graphically in Figure 5.5.2. Pearson correlations and significance values (p-value) between the fishery independent indices are presented in Table 5.5.1. Pearson correlations and significance values (p-value) between the fishery dependent indices are presented in Table 5.5.2. Indices recommended for use are presented in Table 5.5.3.

The relative ranking of the ability of each index to represent true population abundance was discussed. Based on these discussions, the indices recommended for the assessment were ranked as follows with a bulleted list of discussion points below each index:

1. SEAMAP (both age-0 and age-1)
   - Fishery independent, large sample size, long time series, good spatial coverage
   - Selectivity issues, limited depth range
2. FL Trip Ticket- handline/trolling
   - Similar trend as commercial logbook, but longer time series
   - Captures both state and federally permitted vessels
   - Florida is the center of the population's range with migration occurring through the Florida region
3. MRFSS
   - Good spatial coverage
   - Long time series
   - MRFSS sampling design considerations

5.6 Literature Cited

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5.7 Tables

Table 5.1.1. Table of the data considered for the construction of a CPUE index.

Fishery Type	Data Source	Area	Years	Units	Standardization Method	Issues	Use
Independent	SEAMAP age-0	NC-FL	1989-2011	Number/tow	Delta-GLM		Yes
Independent	SEAMAP age-1-spring	NC-FL	1990-2011	Number/tow	Delta-GLM	Age-0 recruitment index is more appropriate due to age-1 escapement issues; possibility that depths covered by the survey do not fully overlap depths where age-1 individuals are found	Yes
Recreational	MRFSS	FL-ME	1982-2010	Number/angler hour	Delta-GLM: lognormal	Fishery dependent	Yes
Commercial	FL trip ticket - Gillnet pre-netban	FL in South Atlantic	1986-1995	Whole pounds per trip	GLM: gamma	Configuration types (run around or passively set) not usually identified; limited to federal waters after net ban; restrictions on soak time, catch transfers at sea; only positive trips	No
Commercial	FL trip ticket - Gillnet post-netban	FL in South Atlantic	1995-2011	Whole pounds per trip	GLM: lognormal	Configuration types (run around or passively set) not usually identified; limited to federal waters after net ban; restrictions on soak time, catch transfers at sea; only positive trips	No
Commercial	FL trip ticket - Cast net	FL in South Atlantic	1996-2011	Whole pounds per trip	GLM: lognormal	Shorter time series; active gear targeting Spanish; only positive trips	No
Commercial	FL trip ticket - Hand lines	FL in South Atlantic	1986-2011	Whole pounds per trip	GLM: gamma	Fishery dependent; only positive trips	Yes
Commercial	Commercial logbook - gillnet	FL-NC	1998-2010	Wgt/sq yd hrs	Delta-GLM	Self reported, effects of gillnet ban, wrap around fishery, concerns of hyperstability	No

Commercial	Commercial logbook - handline/ trolling	FL-NC	1998-2010	Wgt/# of lines fished	Delta-GLM	Consistent with FL Trip Ticket handline/trolling, but may be missing inshore fishery	No
Recreational	SCDNR Charter boat Logbooks	SC nearshore and offshore waters	1993-2010	# fish / Angler Hour	Delta-GLM	Overlap with MRFSS; SC represents small portion of stock's geographic range and small portion of catch	No

Table 5.1.2. Table of the pros and cons for each data set considered at the data workshop.

Fishery independent indices
SEAMAP both age-0 and age-1 (*Recommended for use*)
Pros:

- Fishery independent
- Adequate spatial coverage
- Random sampling
- Good sample size
- Recruitment index

Cons:

- Selectivity issues
- Mix of age-0 and age-1 fish
- Limited depth range (15-30 ft)

Fishery dependent indices
MRFSS *(Recommended for use)*
Pros:

- Includes discards
- Good spatial coverage
- Long time series
- Target known
- No bag limit issues

Cons:

- MRFSS sampling design considerations
- Fishery dependent

FL Trip ticket – handline and trolling (*Recommended for use*)
Pros:

- Long time series
- Similar trends to commercial logbook
- Sampling entire fishery (inshore and offshore)

Cons:

- Florida only
- Fishery-dependent

FL Trip ticket – castnet (*Not recommended for use*)
Pros:

- Potentially useful as a year class indicator

Cons:

- Gear saturation effects
- Limited spatial extent
- Hyperstability issues since setting on schools
- Trip limit effects

FL Trip ticket – gillnet (*Not recommended for use*)

Pros:
- Long time series
- Intercepts S. Atlantic population
- Similar trends to commercial logbook

Cons:
- Hyperstability issues
- Gear saturation and trip limit effects

Commercial Logbook – handline and trolling (*Not recommended for use*)

Pros:
- Census of commercial vessels
- Consistent with FL trip index

Cons:
- Self reported
- Fishery-dependent
- Driven by South Florida
- May be missing inshore fishery (only federally permitted vessels required to report)

Commercial Logbook – gillnet (*Not recommended for use*)

Pros:
- More passively fished

Cons:
- Self reported
- Fishery dependent
- Only federally permitted vessels required to report
- Effects of gillnet ban

SCDNR Charterboat *(Not recommended for use)*

Pros:
- Census of charterboats
- Includes discards

Cons:
- No field validation, self reported data
- Charter boats only in SC (limited spatial coverage – center in FL)
- Data reproducible in MRFSS at larger scale
- Gear uncertainty (mix of bottom fishing/trolling)

Table 5.3.1.1. Relative nominal CPUE, number of trips, proportion positive trips, index standardized to its mean, and CV for SEAMAP age-0 Spanish mackerel in the south Atlantic.

Year	Nominal CPUE	N	Proportion positive	Standardized index	CV
1989	0.63	104	0.47	0.73	0.56
1990	1.32	228	0.44	1.63	0.46
1991	1.87	232	0.40	1.72	0.48
1992	1.07	232	0.31	1.19	0.52
1993	0.63	234	0.31	0.93	0.49
1994	0.62	234	0.34	0.82	0.47
1995	1.14	233	0.38	1.07	0.50
1996	0.62	229	0.38	1.20	0.47
1997	0.30	233	0.21	0.26	0.59
1998	1.01	230	0.31	1.46	0.52
1999	0.68	230	0.30	0.81	0.51
2000	1.09	233	0.36	1.16	0.50
2001	1.99	297	0.36	0.88	0.47
2002	1.22	301	0.32	1.00	0.48
2003	0.63	304	0.22	0.40	0.55
2004	0.72	304	0.27	0.74	0.53
2005	1.13	299	0.25	0.77	0.53
2006	1.23	303	0.26	1.33	0.53
2007	1.29	304	0.32	1.25	0.51
2008	1.61	304	0.35	1.52	0.48
2009	1.08	336	0.33	1.10	0.49
2010	0.78	334	0.27	0.62	0.54
2011	0.35	333	0.22	0.41	0.56

Table 5.3.1.2. Relative nominal CPUE, number of trips, proportion positive trips, index standardized to its mean, and CV for SEAMAP age-1 Spanish mackerel in the south Atlantic.

Year	Nominal CPUE	N	Proportion positive	Standardized index	CV
1990	0.94	76	0.45	0.44	0.28
1991	0.70	78	0.69	0.89	0.21
1992	1.80	78	0.79	3.19	0.15
1993	0.56	78	0.23	0.59	0.35
1994	1.17	78	0.65	1.60	0.19
1995	0.56	78	0.36	0.88	0.31
1996	1.03	78	0.33	1.60	0.24
1997	0.75	78	0.32	0.57	0.31
1998	1.02	77	0.32	0.28	0.31
1999	1.69	75	0.47	1.79	0.29
2000	1.85	77	0.74	2.21	0.17
2001	1.08	102	0.48	0.73	0.19
2002	0.79	101	0.47	0.50	0.22
2003	0.82	102	0.39	0.68	0.21
2004	1.14	102	0.36	0.71	0.24
2005	0.50	99	0.19	0.57	0.38
2006	1.52	102	0.34	0.99	0.28
2007	0.93	100	0.48	0.99	0.17
2008	0.80	101	0.42	0.73	0.22
2009	1.16	112	0.53	1.01	0.18
2010	0.48	112	0.42	0.41	0.18
2011	0.70	112	0.57	0.64	0.16

Table 5.4.1.1. Standardized index, CV, nominal index, and sample size for Atlantic Spanish mackerel for MRFSS.

Year	Standardized	CV	Nominal Mean	Sample Size
1982	0.29	0.20	0.53	139
1983	0.17	0.15	0.21	100
1984	0.2	0.15	0.31	166
1985	0.23	0.12	0.43	169
1986	0.49	0.06	0.62	350
1987	0.29	0.07	0.59	948
1988	0.31	0.07	0.58	986
1989	0.34	0.06	0.55	1245
1990	0.32	0.06	0.56	1291
1991	0.31	0.06	0.5	1754
1992	0.28	0.07	0.4	1642
1993	0.22	0.06	0.31	1276
1994	0.34	0.07	0.61	1615
1995	0.26	0.07	0.42	1105
1996	0.35	0.07	0.53	1152
1997	0.45	0.06	0.64	1154
1998	0.36	0.06	0.47	1000
1999	0.43	0.06	0.66	1229
2000	0.39	0.06	0.63	1358
2001	0.41	0.06	0.68	1272
2002	0.43	0.06	0.73	1437
2003	0.42	0.06	0.73	1247
2004	0.36	0.07	0.63	982
2005	0.39	0.07	0.57	980
2006	0.36	0.06	0.55	774
2007	0.36	0.06	0.51	1030
2008	0.51	0.06	0.71	1225
2009	0.37	0.05	0.47	1162
2010	0.36	0.15	0.53	1776

Table 5.4.1.2. Deviance table for positive trips model for Atlantic Spanish mackerel for MRFSS.

	D.F.	Deviance	Resid. D.F.	Resid. Dev	Pr(>Chi)	Percent Deviance Explained
NULL	.	.	18191	23902.6	.	.
YEAR	28	316.8	18163	23585.8	0.0000	15.1
AREA_FISHED	2	877.2	18161	22708.6	0.0000	41.7
WAVE	5	292.1	18156	22416.5	0.0000	13.9
REGION	2	32.0	18154	22384.5	0.0000	1.5
MODE	2	586.1	18152	21798.4	0.0000	27.9

Table 5.4.1.3. Deviance table for proportion positive model for Atlantic Spanish mackerel for MRFSS.

	D.F.	Deviance	Resid. D.F.	Resid. Dev	Pr(>Chi)	Percent Deviance Explained
NULL	.	.	30563	41255.66	.	.
YEAR	28	491.0	30535	40764.7	0.0000	11.4
AREA_FISHED	2	578.7	30533	40186.0	0.0000	13.5
WAVE	5	82.6	30528	40103.4	0.0000	1.9
REGION	2	32.7	30526	40070.7	0.0000	0.8
MODE	2	1949.2	30524	38121.5	0.0000	45.4
HOURS_FISHED	1	1162.9	30523	36958.6	0.0000	27.1

Table 5.4.2.1.

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

Atlantic Coast, Florida Trip Ticket indices

	Gill nets, 1986-1995			Gill nets, 1995-2011			Cast Nets, 1996-2011			Hook-and-Line Gears		
Year	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	293.24	3.78	1.164							20.62	3.97	0.539
1987	262.02	3.86	1.040							25.12	3.96	0.657
1988	260.39	3.84	1.034							30.33	4.74	0.793
1989	318.31	3.78	1.264							27.58	4.76	0.721
1990	222.93	3.47	0.885							29.90	3.89	0.782
1991	221.00	3.31	0.878							22.27	3.07	0.582
1992	196.26	3.24	0.779							27.40	4.15	0.717
1993	317.67	7.87	1.261							32.02	4.23	0.838
1994	267.17	7.23	1.061							22.64	4.48	0.592
1995	411.52	7.06	1.634	198.14	18.97	1.068				31.88	4.13	0.834
1996				257.11	8.57	1.386	3.60	13.37	0.244	27.96	3.37	0.731
1997				124.62	8.93	0.672	9.08	10.15	0.616	27.36	2.86	0.716
1998				189.21	12.17	1.020	0.83	28.38	0.056	26.54	3.01	0.694
1999				166.75	8.53	0.899	1.71	15.91	0.116	32.59	3.08	0.852
2000				181.08	5.93	0.976	9.17	7.63	0.622	33.65	2.84	0.880
2001				175.01	6.53	0.943	10.92	6.93	0.741	33.44	2.85	0.875
2002				155.66	7.51	0.839	9.96	6.28	0.676	32.07	2.68	0.839
2003				195.44	8.90	1.054	16.43	6.05	1.115	34.59	3.03	0.905

2004		114.90	9.23	0.619	18.86	6.10	1.280	45.03	2.99	1.178
2005		225.18	6.79	1.214	15.33	6.66	1.040	44.15	2.75	1.155
2006		231.65	6.74	1.249	15.44	6.12	1.047	47.05	2.77	1.231
2007		215.35	6.49	1.161	9.83	6.41	0.667	41.01	2.51	1.073
2008		212.12	6.89	1.143	11.62	6.38	0.788	42.23	2.42	1.105
2009		193.16	6.40	1.041	12.24	6.18	0.830	56.27	2.25	1.472
2010		152.79	7.44	0.824	19.90	5.79	1.350	48.32	2.21	1.264
2011		100.07	7.26	0.539	20.45	5.87	1.387	48.79	2.20	1.276

Table 5.4.4.1. Commercial Spanish mackerel handline and trolling relative nominal CPUE, number of trips, standardized abundance index, and associated confidence interval (CI) and CV in the South Atlantic (continuity index from SEDAR 17).

YEAR	Relative nominal CPUE	Number of Trips	Standardized Index	Lower 95% CI (Index)	Upper 95% CI (Index)	CV (Index)
1998	0.781017	124	0.897685	0.686	1.175	0.135
1999	1.097137	145	1.120625	0.870	1.443	0.127
2000	0.908808	125	0.908444	0.694	1.189	0.135
2001	0.993453	99	1.004748	0.746	1.353	0.150
2002	1.322812	88	1.240505	0.906	1.699	0.158
2003	1.112789	75	0.962054	0.686	1.349	0.170
2004	1.349282	74	1.035624	0.737	1.455	0.171
2005	0.933657	136	0.926864	0.713	1.205	0.132
2006	1.269081	80	1.203024	0.865	1.673	0.166
2007	0.721231	113	0.811365	0.611	1.077	0.143
2008	0.97385	53	1.112263	0.748	1.653	0.200
2009	0.874882	139	0.859442	0.664	1.112	0.130
2010	0.662001	81	0.917356	0.661	1.273	0.165

Table 5.4.4.2. Commercial Spanish mackerel 2012 handline and trolling relative nominal CPUE, number of trips, standardized abundance index, and associated confidence interval (CI) and CV in the South Atlantic.

YEAR	Relative nominal CPUE	Number of Trips	Standardized Index	Lower 95% CI (Index)	Upper 95% CI (Index)	CV (Index)
1998	0.381386	1,159	0.755857	0.387	1.476	0.344
1999	0.439209	1,303	0.932353	0.479	1.816	0.343
2000	0.654737	1,493	0.902788	0.463	1.760	0.343
2001	0.637523	1,547	0.869272	0.447	1.692	0.342
2002	0.611767	1,622	0.759367	0.390	1.478	0.342
2003	0.868865	1,315	0.846332	0.434	1.651	0.344
2004	1.215625	1,277	1.090223	0.559	2.126	0.344
2005	1.512291	1,401	0.96869	0.497	1.887	0.343
2006	1.584756	1,529	1.114079	0.572	2.171	0.343
2007	1.290086	1,941	0.962192	0.494	1.873	0.343
2008	1.205476	1,717	0.986909	0.506	1.925	0.344
2009	1.085695	1,925	1.301718	0.669	2.534	0.343
2010	1.512584	1,915	1.510221	0.775	2.944	0.343

Table 5.4.4.3. Commercial Spanish mackerel continuity gillnet relative nominal CPUE, number of trips, proportion positive trips, standardized abundance index, and associated confidence interval (CI) and CV in the South Atlantic.

YEAR	Normalized Nominal CPUE	Number of Trips	Proportion Positive	Standardized Index	Lower 95% CI (Index)	Upper 95% CI (Index)	CV (Index)
1998	0.933	610	0.68	0.824	0.528	1.285	0.225
1999	0.921	729	0.70	0.702	0.455	1.084	0.219
2000	0.982	935	0.64	0.801	0.518	1.238	0.220
2001	1.465	851	0.65	1.179	0.755	1.841	0.226
2002	1.252	968	0.74	1.297	0.871	1.931	0.201
2003	0.819	895	0.76	1.060	0.716	1.568	0.198
2004	1.112	941	0.68	1.156	0.763	1.751	0.210
2005	0.635	892	0.64	0.690	0.453	1.053	0.214
2006	0.753	958	0.70	0.831	0.559	1.234	0.200
2007	0.905	935	0.72	1.124	0.751	1.682	0.204
2008	1.057	812	0.67	0.881	0.575	1.349	0.216
2009	1.186	933	0.64	1.402	0.906	2.170	0.221
2010	0.979	942	0.61	1.053	0.669	1.657	0.230

Table 5.4.4.4. Commercial Spanish mackerel 2012 gillnet relative nominal CPUE, number of trips, proportion positive trips, standardized abundance index, and associated confidence interval (CI) and CV in the South Atlantic.

YEAR	Normalized Nominal CPUE	Number of Trips	Proportion Positive	Standardized Index	Lower 95% CI (Index)	Upper 95% CI (Index)	CV (Index)
1998	0.420	1,761	0.758	0.618	0.262	1.458	0.450
1999	0.307	1,296	0.759	0.710	0.300	1.679	0.451
2000	0.272	1,469	0.741	0.696	0.295	1.640	0.449
2001	0.250	1,376	0.719	1.015	0.430	2.394	0.450
2002	0.262	1,394	0.755	0.860	0.365	2.026	0.449
2003	0.688	1,098	0.759	0.996	0.422	2.350	0.450
2004	0.312	1,139	0.705	0.923	0.391	2.180	0.450
2005	0.656	1,270	0.721	1.063	0.451	2.505	0.449
2006	0.977	1,545	0.766	1.281	0.545	3.012	0.448
2007	2.510	1,623	0.784	1.317	0.557	3.111	0.450
2008	2.567	1,338	0.708	1.494	0.636	3.511	0.448
2009	1.961	1,469	0.743	1.176	0.497	2.780	0.451
2010	1.819	1,142	0.690	0.852	0.357	2.030	0.455

Table 5.5.1. Pearson correlation analysis (p-value) for fishery independent indices recommended for use with a one year lag.

	SEAMAP age-0	SEAMAP age-1-spring
SEAMAP age-0	1	
SEAMAP age-1 spring	0.45 (0.03)	1

Table 5.5.2. Pearson correlation analysis (p-value) for fishery dependent indices recommended for use.

	FL Trip Ticket – handline/ trolling	MRFSS
FL Trip Ticket-handline/trolling	1	
MRFSS	0.15 (0.46)	1

Table 5.5.3. SEDAR 28 South Atlantic Spanish mackerel indices and associated cvs recommended for potential use scaled to their mean value.

Year	SEAMAP age-0	SEAMAP age-1	FL trip ticket handline/trolling	MRFSS	SEAMAP age-0 cv	SEAMAP age-1 cv	FL trip ticket hanline/trolling cv	MRFSS cv
1982				0.84				0.20
1983				0.49				0.15
1984				0.58				0.15
1985				0.67				0.12
1986			0.60	1.42			0.04	0.06
1987			0.73	0.84			0.04	0.07
1988			0.89	0.90			0.05	0.07
1989	0.73		0.80	0.99	0.56		0.05	0.06
1990	1.63	0.44	0.87	0.93	0.46	0.28	0.04	0.06
1991	1.72	0.89	0.65	0.90	0.48	0.21	0.03	0.06
1992	1.19	3.19	0.80	0.81	0.52	0.15	0.04	0.07
1993	0.93	0.59	0.93	0.64	0.49	0.35	0.04	0.06
1994	0.82	1.60	0.66	0.99	0.47	0.19	0.04	0.07
1995	1.07	0.88	0.93	0.75	0.5	0.31	0.04	0.07
1996	1.20	1.60	0.82	1.02	0.47	0.24	0.03	0.07
1997	0.26	0.57	0.80	1.31	0.59	0.31	0.03	0.06
1998	1.46	0.28	0.77	1.04	0.52	0.31	0.03	0.06
1999	0.81	1.79	0.95	1.25	0.51	0.29	0.03	0.06
2000	1.16	2.21	0.98	1.13	0.5	0.17	0.03	0.06
2001	0.88	0.73	0.98	1.19	0.47	0.19	0.03	0.06
2002	1.00	0.50	0.94	1.25	0.48	0.22	0.03	0.06
2003	0.40	0.68	1.01	1.22	0.55	0.21	0.03	0.06
2004	0.74	0.71	1.31	1.04	0.53	0.24	0.03	0.07
2005	0.77	0.57	1.29	1.13	0.53	0.38	0.03	0.07
2006	1.33	0.99	1.37	1.04	0.53	0.28	0.03	0.06
2007	1.25	0.99	1.20	1.04	0.51	0.17	0.03	0.06
2008	1.52	0.73	1.23	1.48	0.48	0.22	0.02	0.06
2009	1.10	1.01	1.64	1.07	0.49	0.18	0.02	0.05
2010	0.62	0.41	1.41	1.04	0.54	0.18	0.02	0.15
2011	0.41	0.64	1.42		0.56	0.16	0.02	

5.8 Figures

Figure 5.3.1.1. Observed CPUE for age-0 Spanish mackerel by year from south Atlantic SEAMAP data.

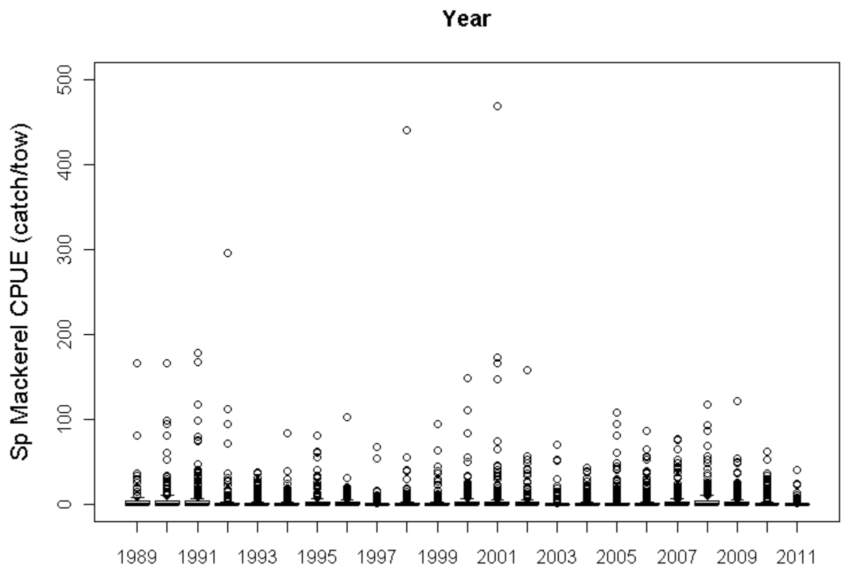


Figure 5.3.1.2. Observed CPUE for age-1-spring Spanish mackerel by year from south Atlantic SEAMAP data.

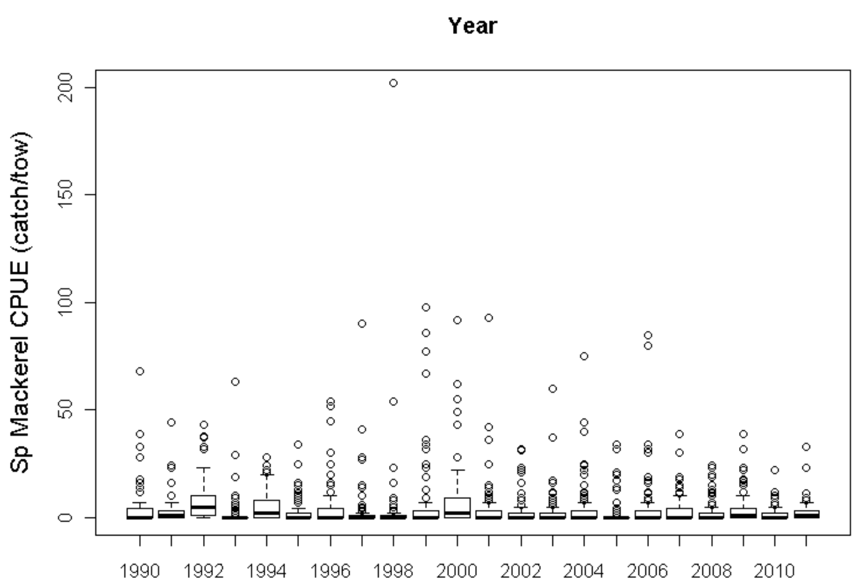


Figure 5.3.1.3. Observed CPUE for age-0 Spanish mackerel by season from south Atlantic SEAMAP data.

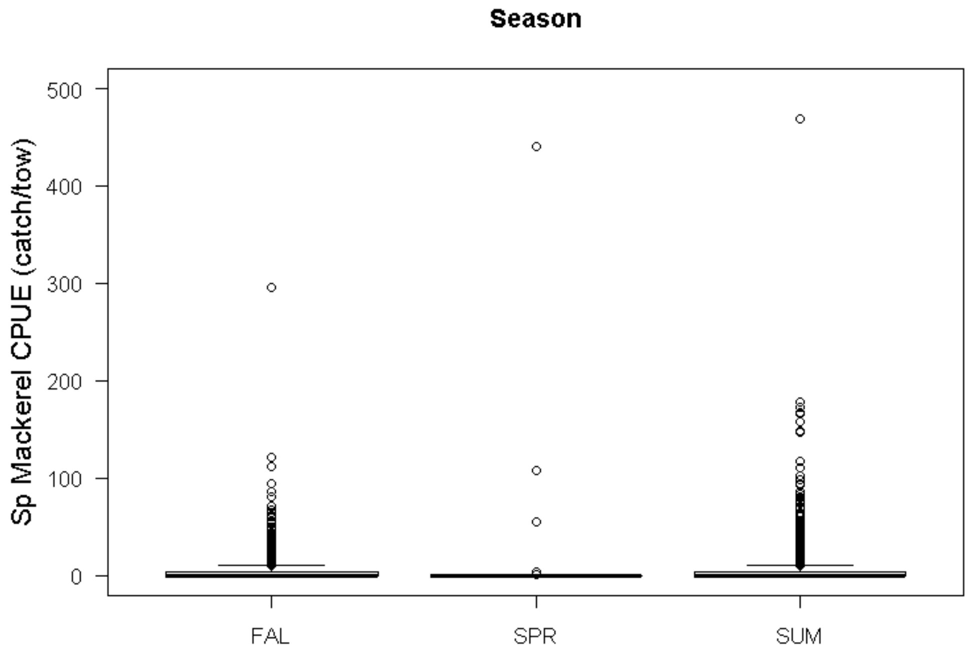


Figure 5.3.1.4. Observed CPUE for age-0 Spanish mackerel by latitude (strata) from south Atlantic SEAMAP data.

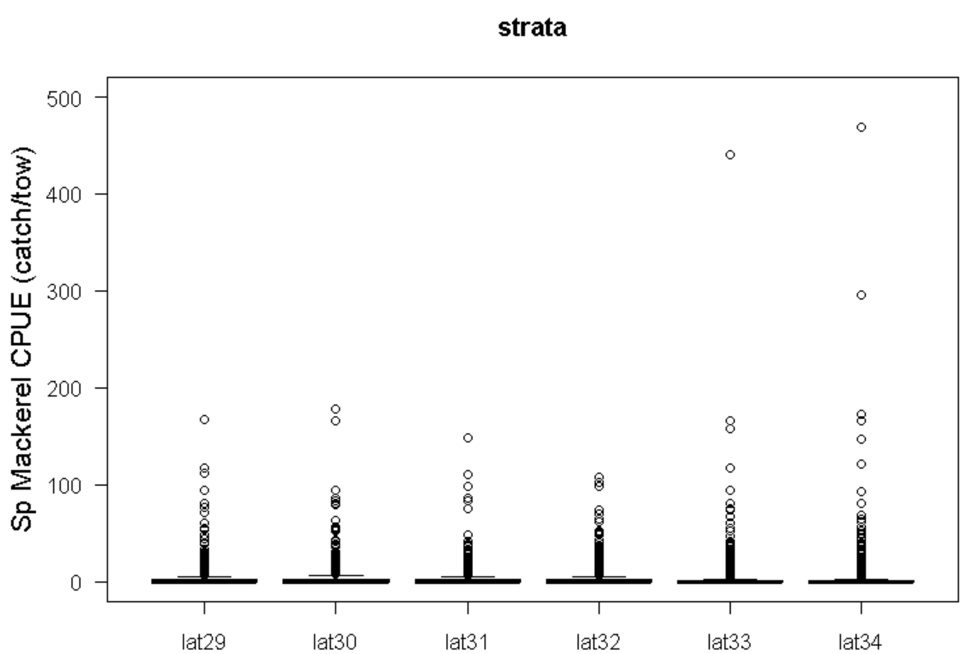


Figure 5.3.1.5. Observed CPUE for age-1-spring Spanish mackerel by latitude (strata) from south Atlantic SEAMAP data.

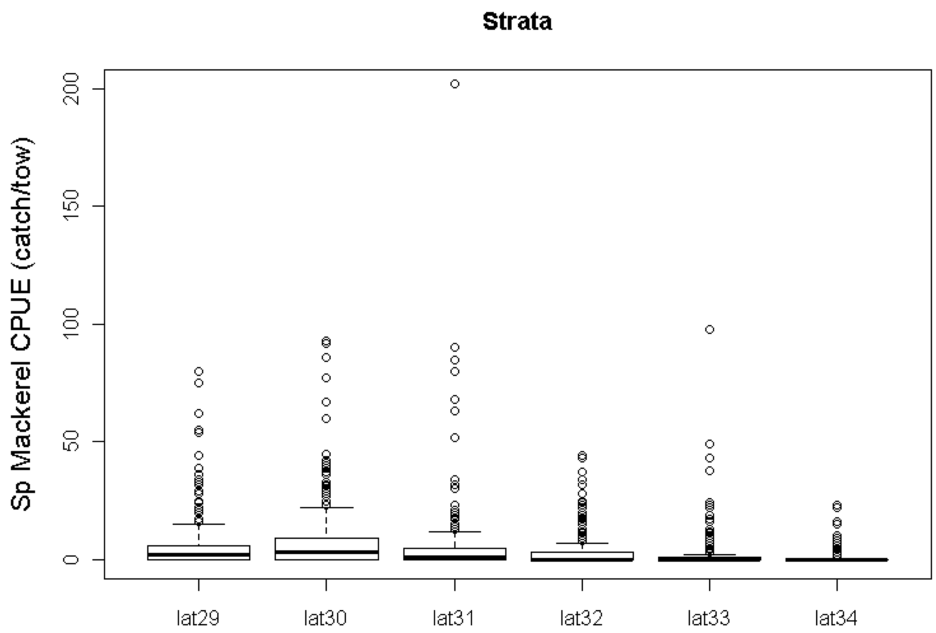


Figure 5.3.1.6. Lognormal distribution of CPUE for age-0 Spanish mackerel south Atlantic SEAMAP data.

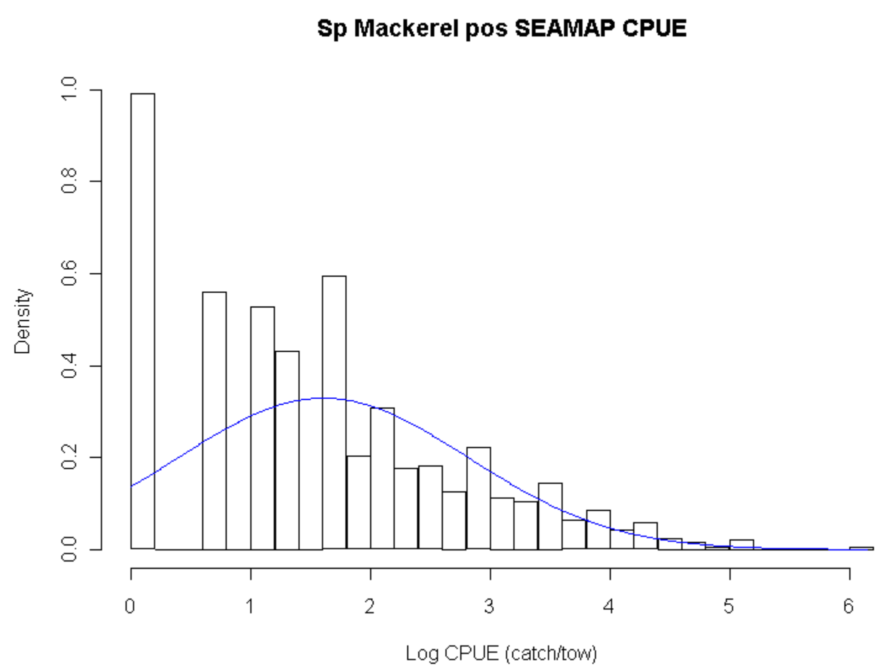


Figure 5.3.1.7. Lognormal distribution of CPUE for age-1-spring Spanish mackerel south Atlantic SEAMAP data.

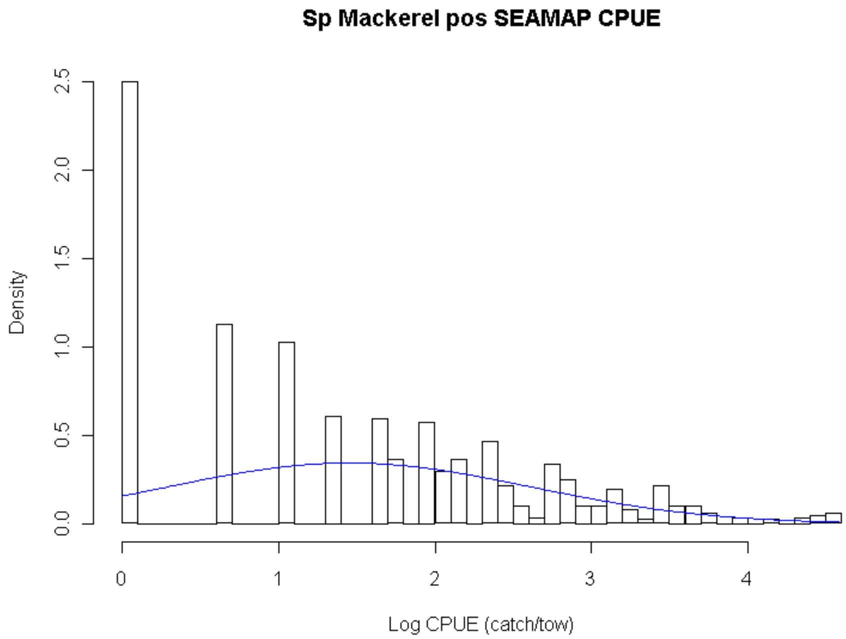


Figure 5.3.1.8. QQ plot of lognormal residuals for Spanish mackerel age-0 CPUE.

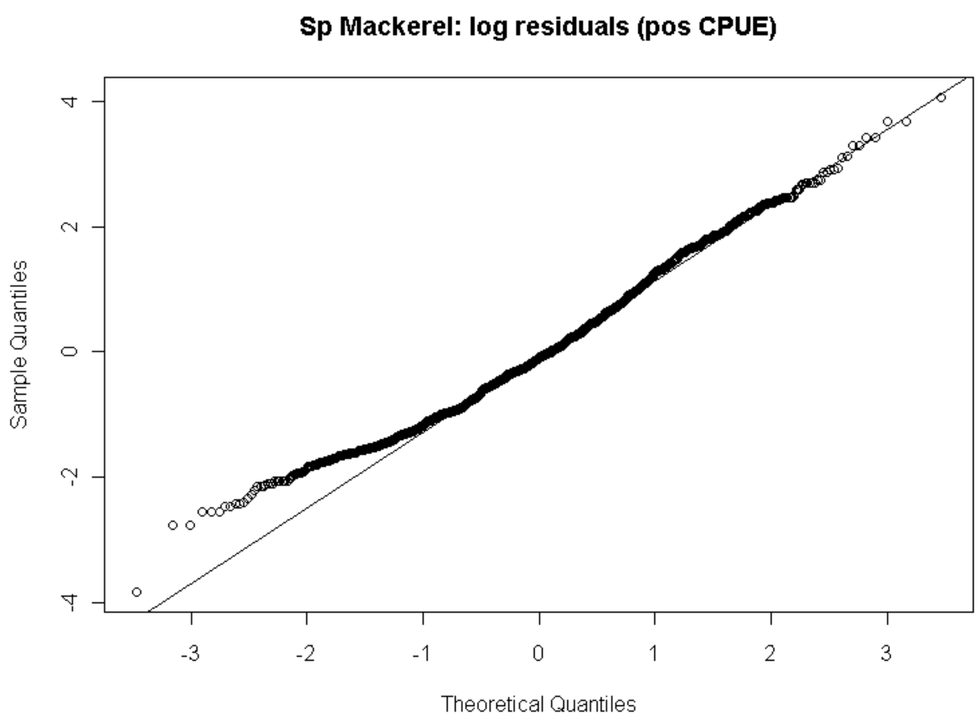


Figure 5.3.1.9. QQ plot of lognormal residuals for Spanish mackerel age-1-spring CPUE.

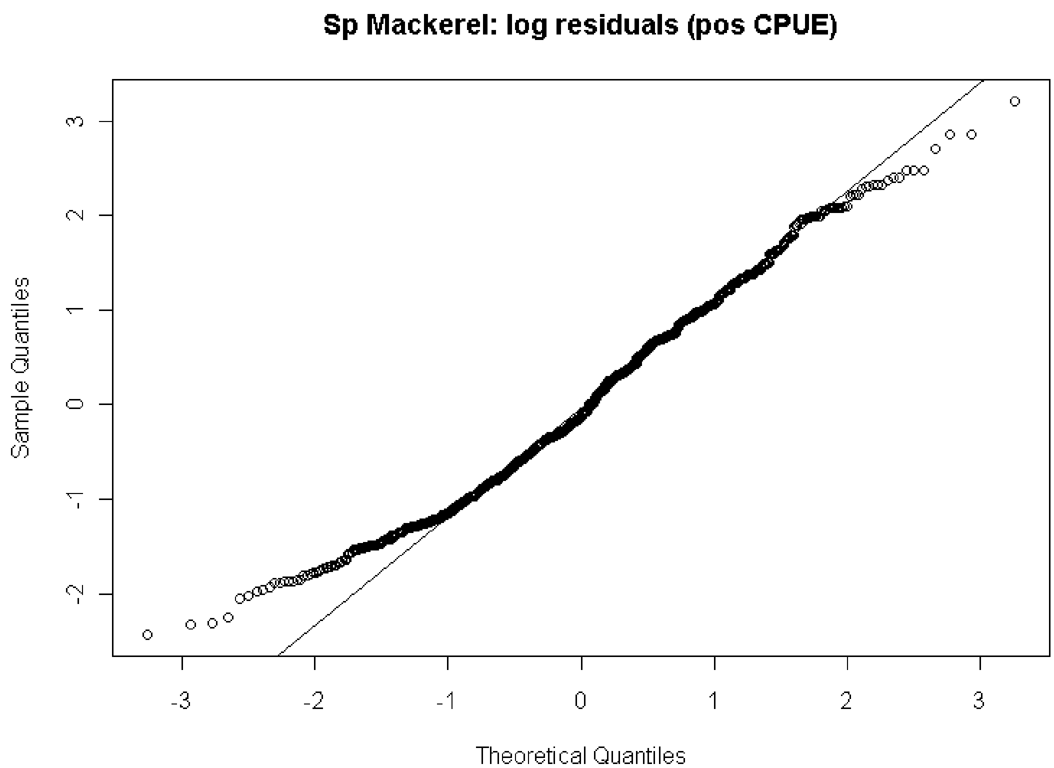


Figure 5.3.1.10. The standardized and nominal age-0 SEAMAP index computed for Spanish mackerel in the south Atlantic during 1989-2011.

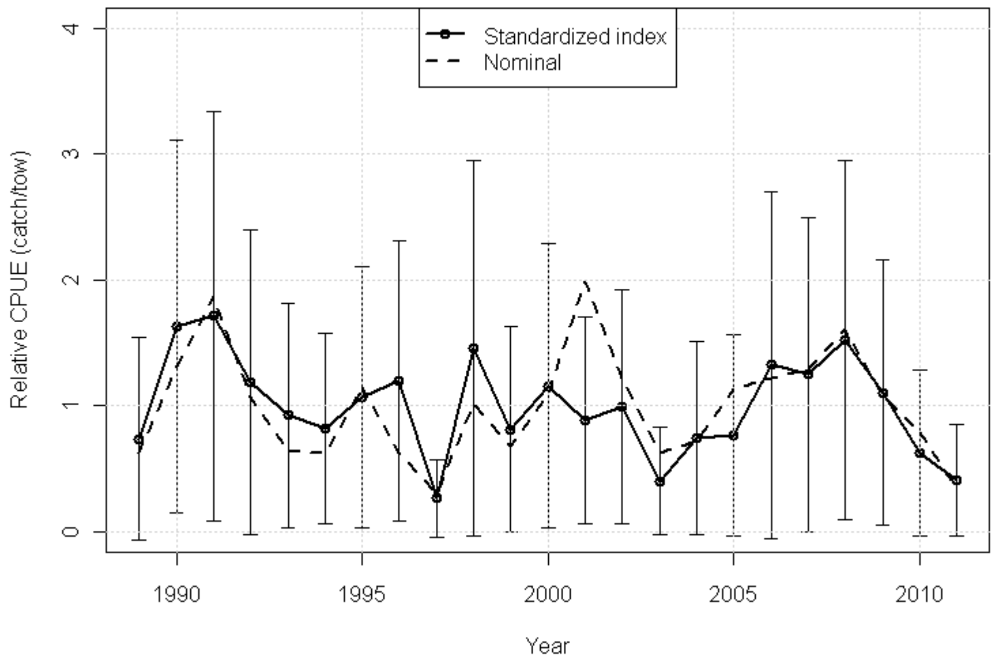


Figure 5.3.1.11. Standardized and nominal age-1 SEAMAP index computed for Spanish mackerel in the south Atlantic during 1990-2011.

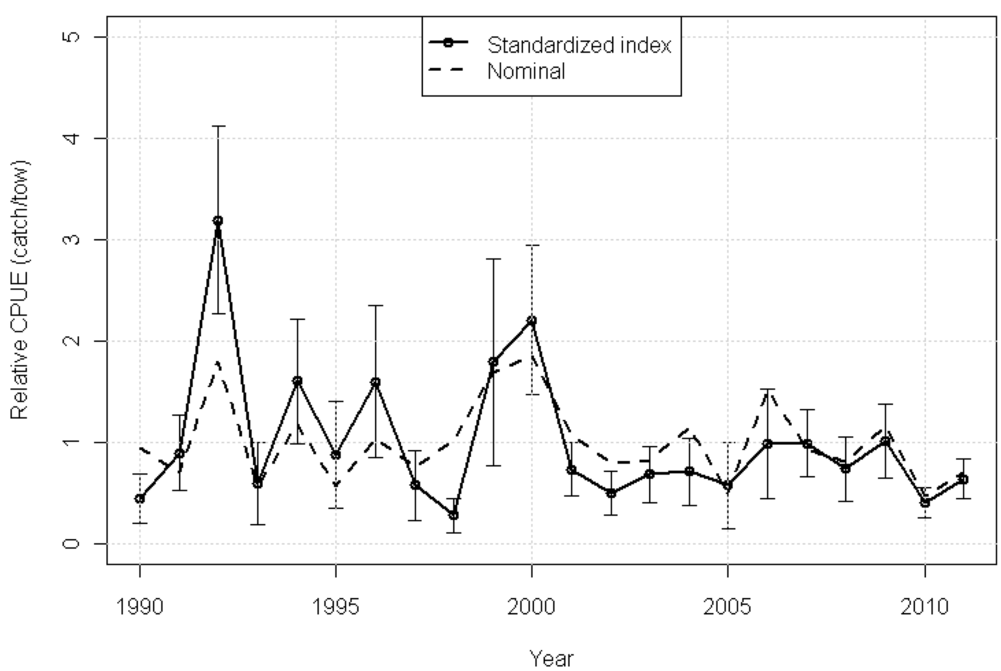


Figure 5.3.1.12. SEAMAP Age-0 and Age-1-spring (lagged) indices.

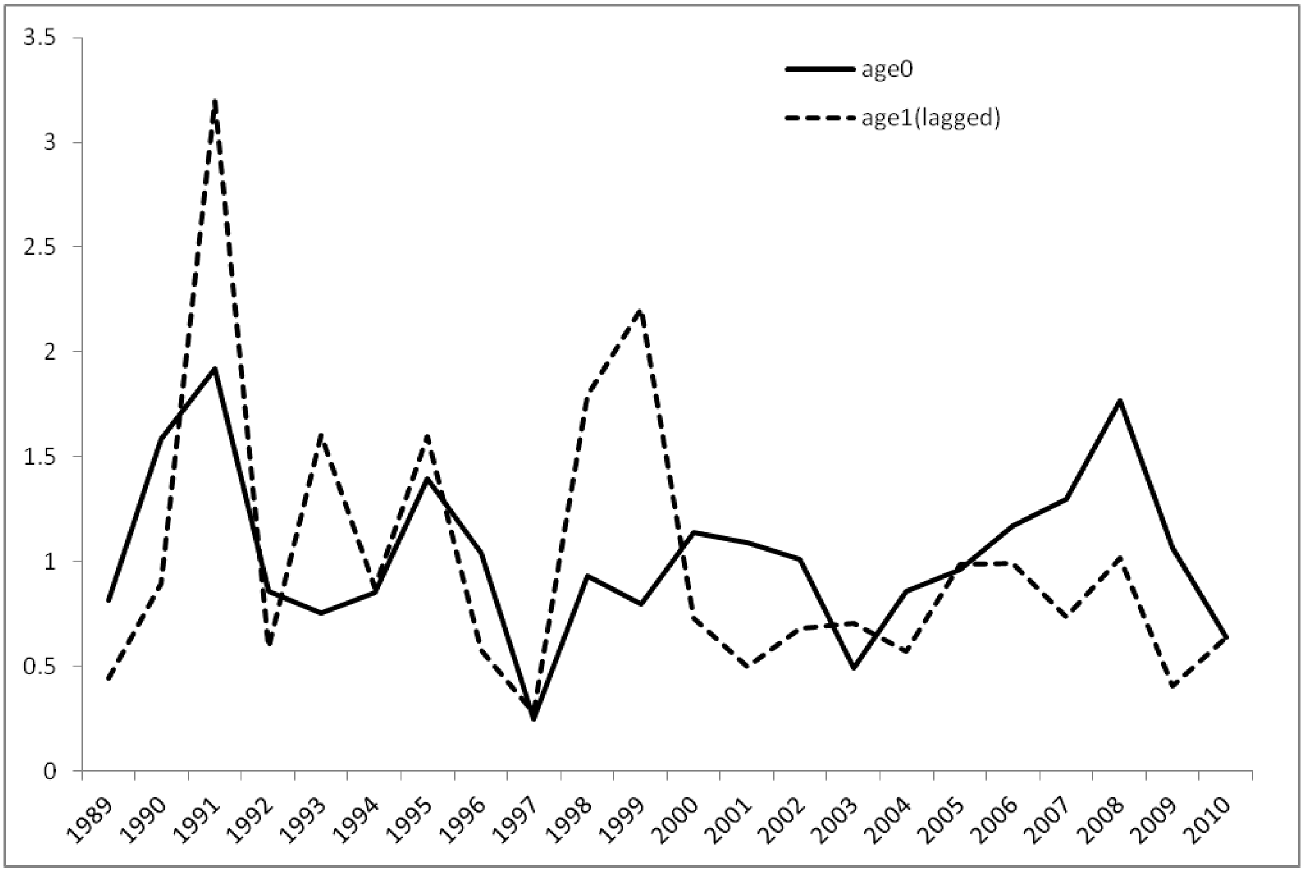


Figure 5.4.1.1. Length frequency of landed Spanish mackerel from the Atlantic by year from the MRFSS database.

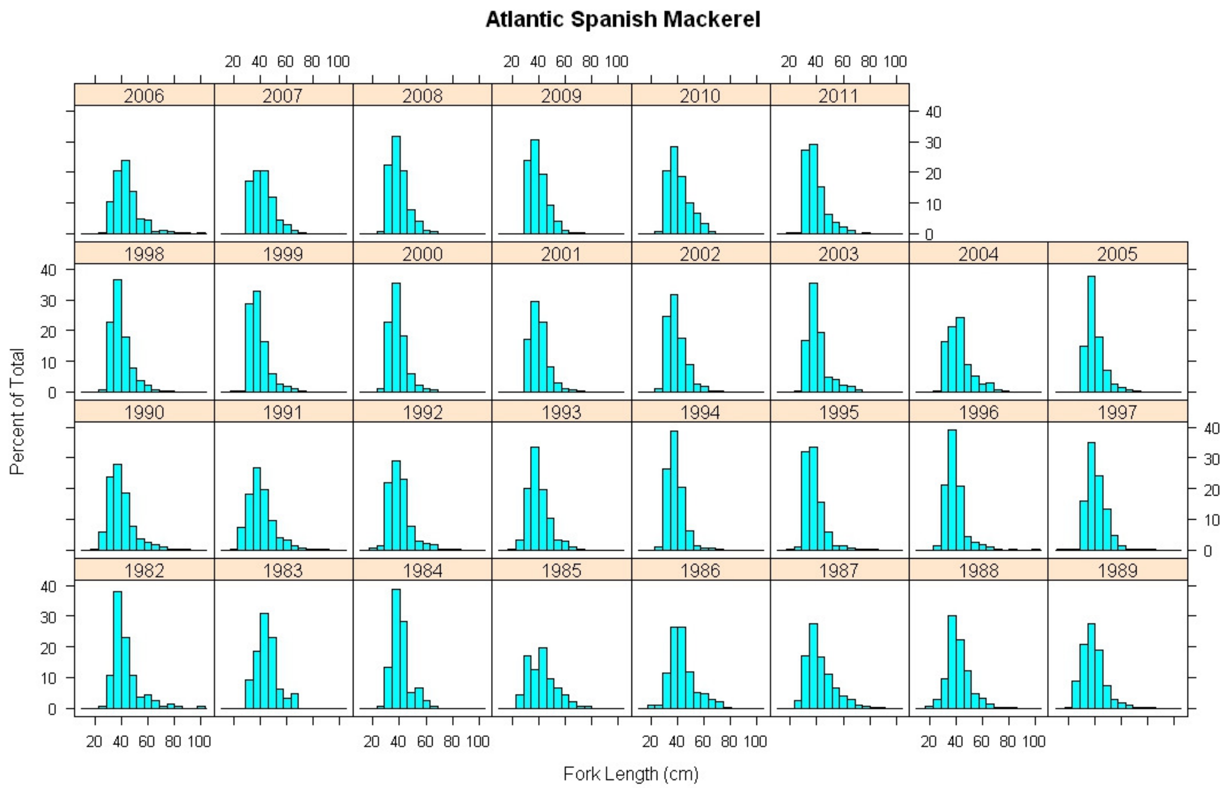


Figure 5.4.1.2. Residuals by year and factor for the sub-model for the positive trips for south Atlantic Spanish mackerel for MRFSS.

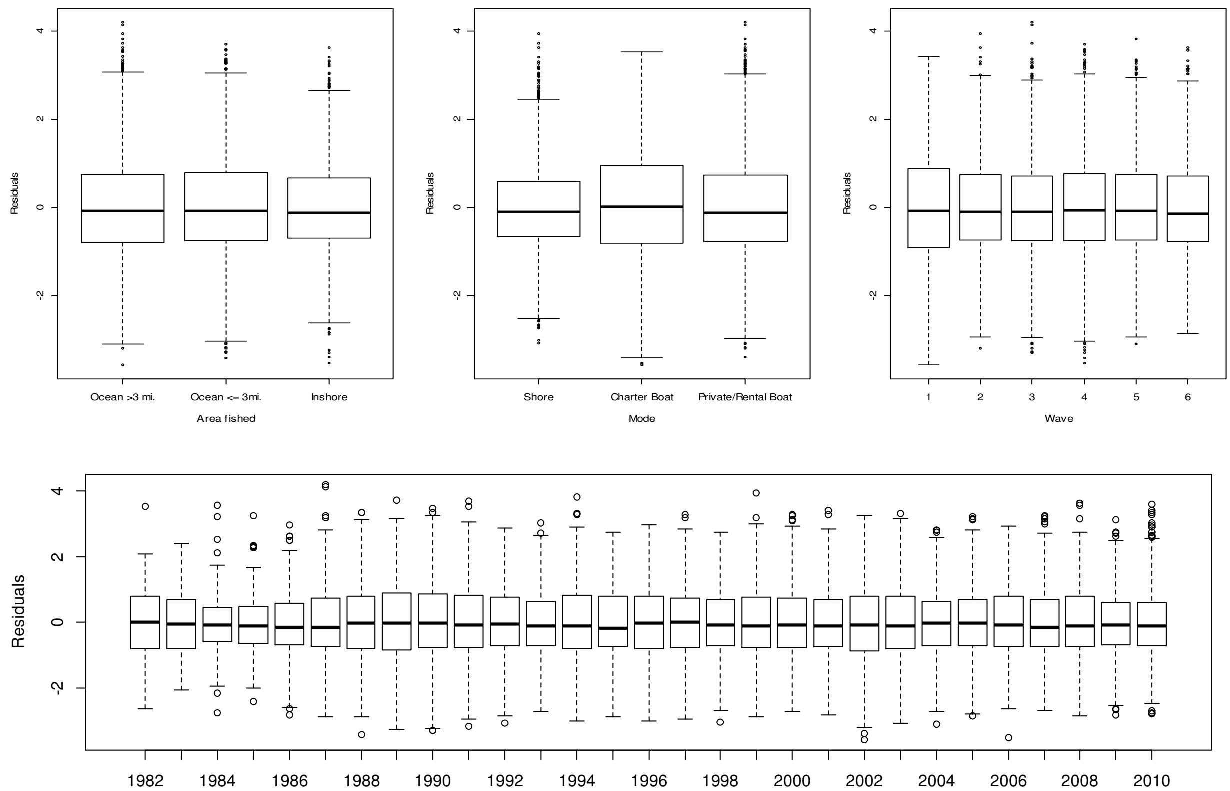


Figure 5.4.1.3. Residuals by year and factor for the binomial sub-model for south Atlantic Spanish mackerel for MRFSS.

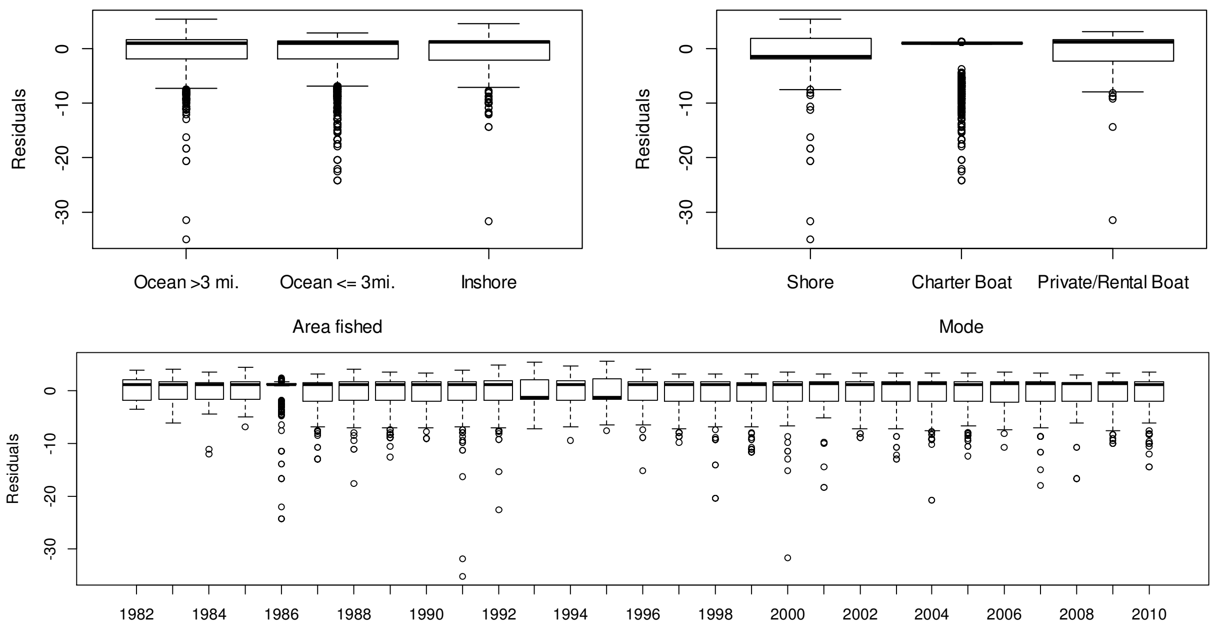


Figure 5.4.1.4. Nominal and standardized CPUE for Atlantic Spanish mackerel based on MRFSS data.

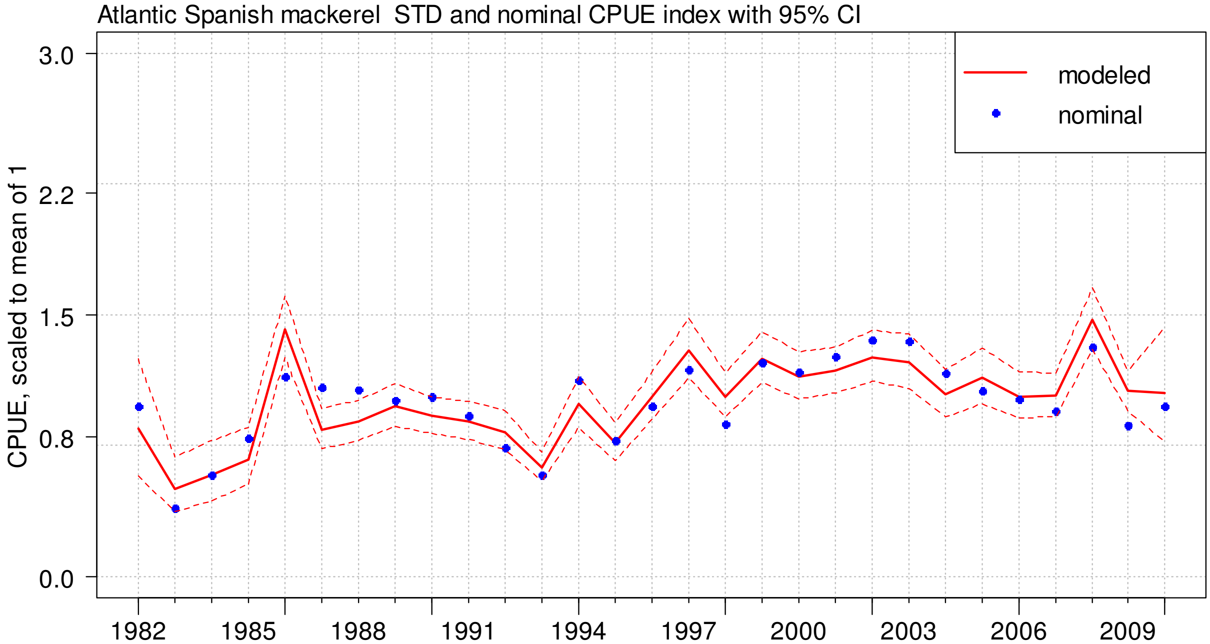
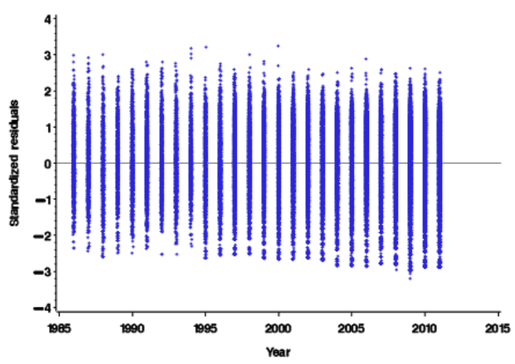
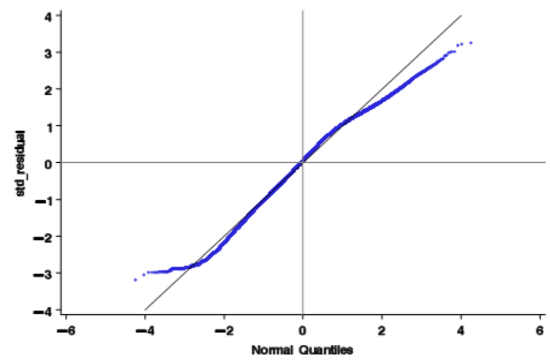


Figure 5.4.2.1. Diagnostics and scaled index for Florida Atlantic Coast Spanish mackerel, hook and line gear trip landings 1986-2011.

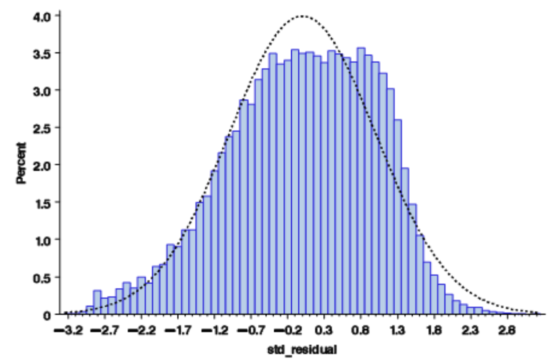
a.) Standardized residuals by year.



b.) Q-Q plot



c.) Histogram of standardized residuals and fitted distribution.



d.) Scaled index

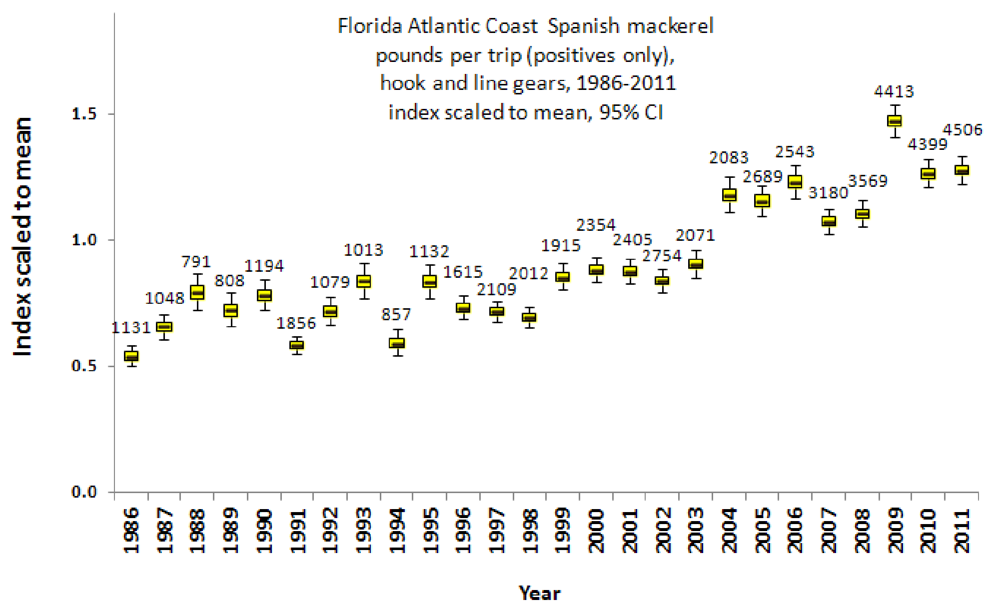


Figure 5.4.4.1. Spanish mackerel nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits (dashed lines) for commercial handline and trolling fishing vessels in the South Atlantic (continuity index from SEDAR 17). CPUE = pounds Spanish mackerel/hook hour fished.

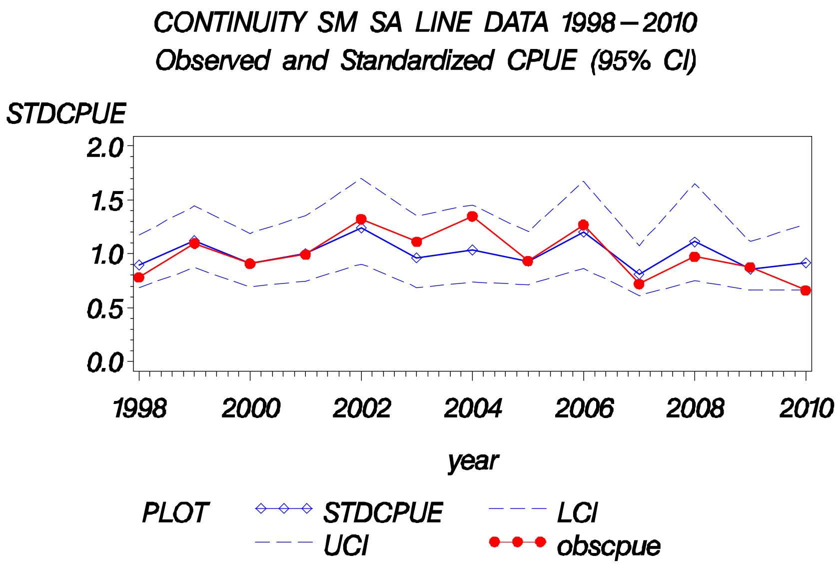


Figure 5.4.4.2. Spanish mackerel 2012 nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits (dashed lines) for commercial handline and trolling fishing vessels in the South Atlantic. CPUE = pounds Spanish mackerel/hook hour fished.

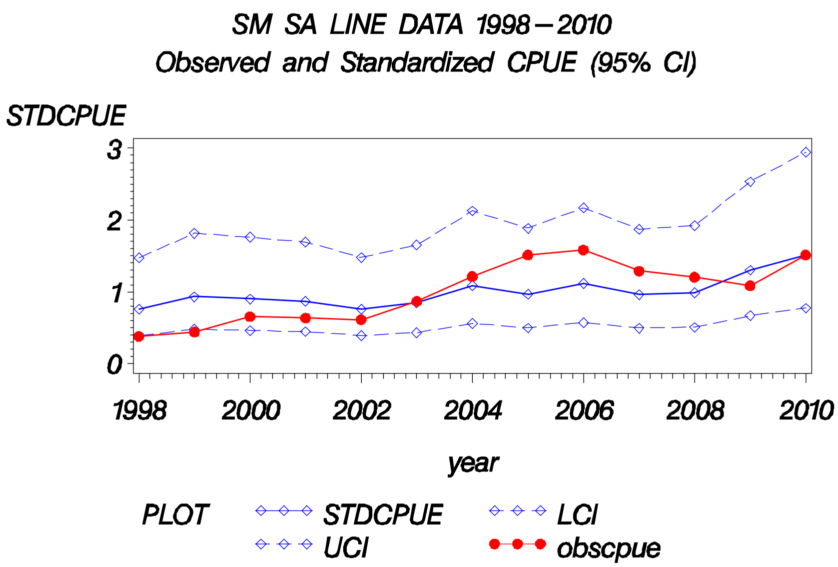


Figure 5.4.4.3. Spanish mackerel nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits (dashed lines) for commercial gillnet fishing vessels in the South Atlantic (continuity index from SEDAR 17). CPUE = pounds Spanish mackerel per square yard hour of gillnet fished.

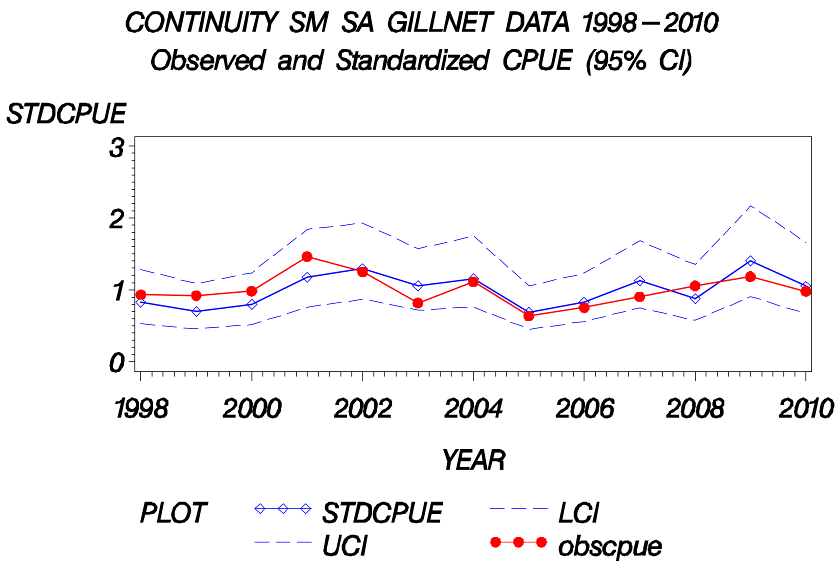


Figure 5.4.4.4. Spanish mackerel 2012 nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits (dashed lines) for commercial gillnet fishing vessels in the South Atlantic. CPUE = pounds Spanish mackerel per square yard hour of gillnet fished.

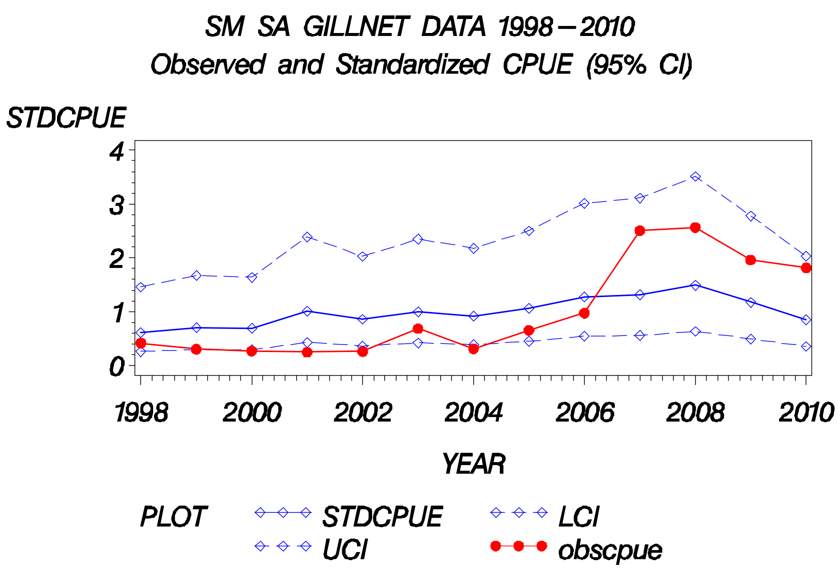


Figure 5.4.4.5 Spanish mackerel CPUE from SCDNR Charter boat Logbook data from 1993-2010. Nominal (blue), monthly standardized (green), and seasonal standardized (red) catch per angler-hour are shown. The dotted lines show one standard error from the standardized CPUE.

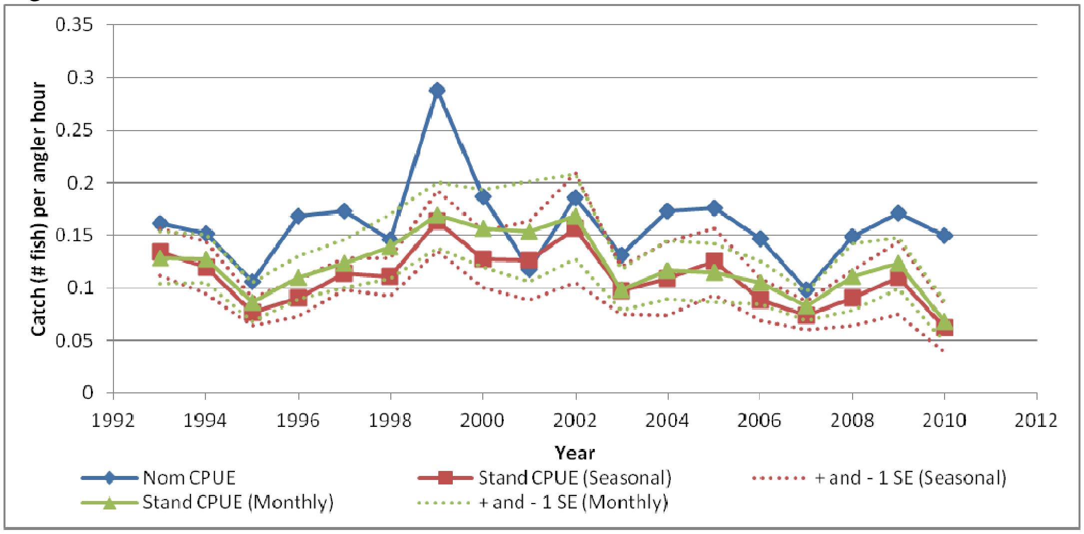


Figure 5.5.1. Fishery independent indices (scaled to respective means) discussed and recommended for potential use for the South Atlantic Spanish mackerel assessment at SEDAR 28.

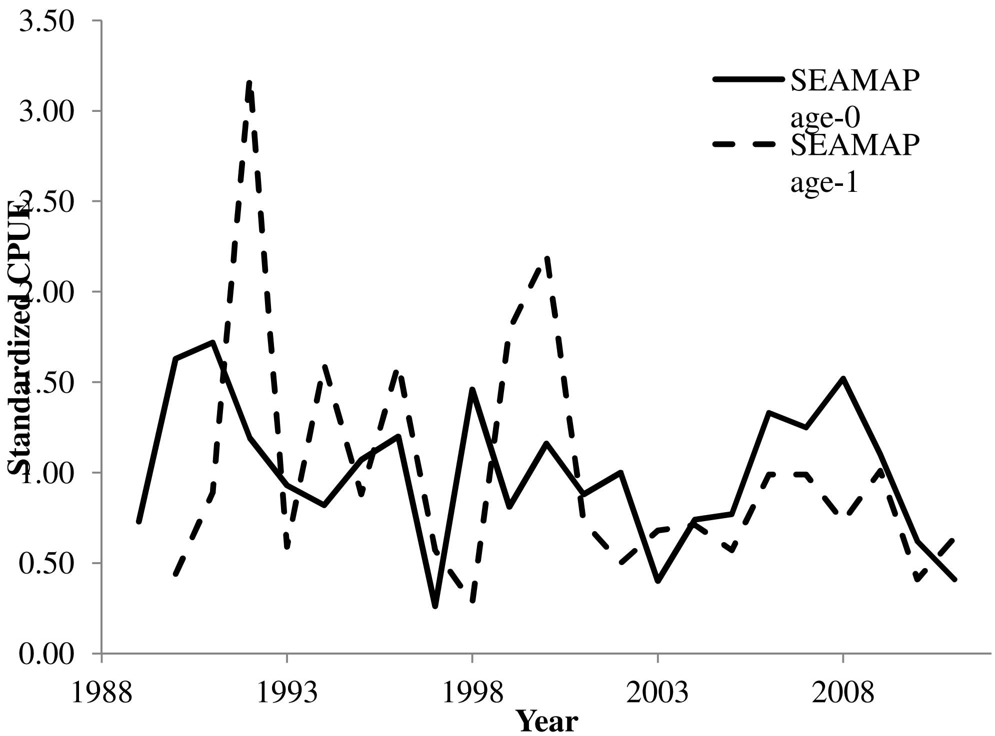
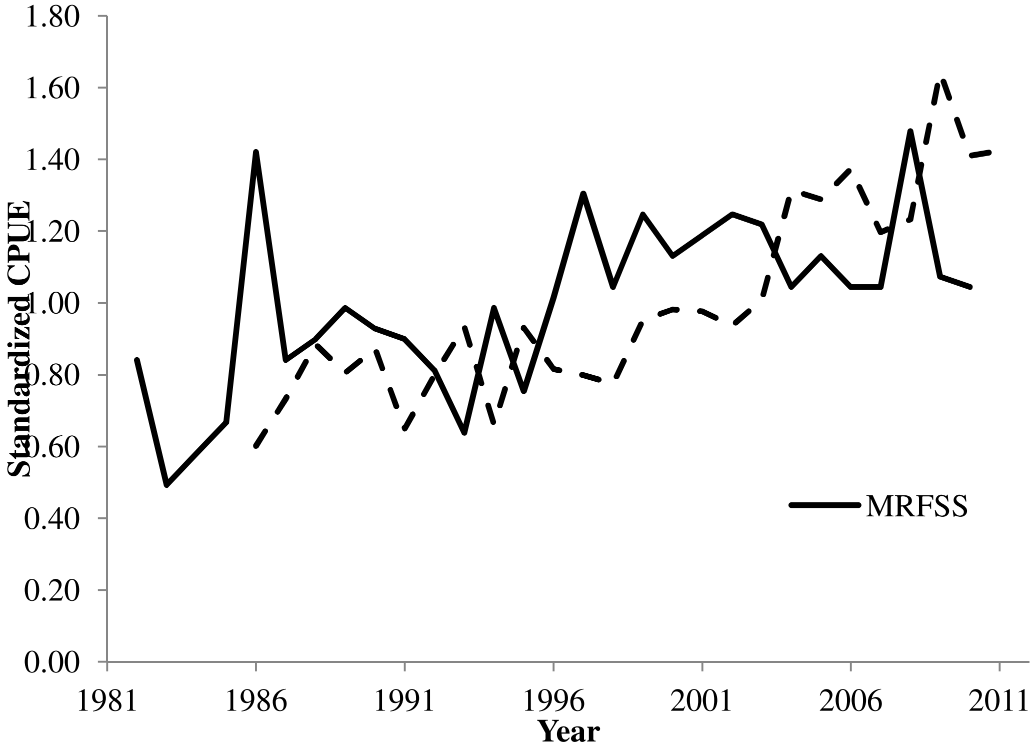


Figure 5.5.2. Fishery dependent indices (scaled to respective means) discussed and recommended for potential use for the South Atlantic Spanish mackerel assessment at SEDAR 28.



6 Analytic Approach

Suggested analytic approach given the data – Atlantic Spanish mackerel

The data gathered during the data workshop, and in efforts subsequent to the workshop, are sufficient to consider the use of both a statistical catch-age model and a surplus production model. Data provided include the following: age and length composition of the catches, age and growth relationships, complete landings and a recommended set of indices of abundance. The Beaufort Assessment Model (BAM) will be used for the age-structured modeling, and for a simpler counterpart, the ASPIC model will be used.

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

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.

7.2 Commercial

Although under the category of research recommendations, this list is not research per se, but rather suggestions to improve data collection. The first three recommendations were taken verbatim from the SEDAR17 DW report.

1. Need observer coverage for the fisheries for Spanish mackerel (gillnets, castnets (FL), handlines, poundnets, and shrimp trawls for bycatch):
   - 5-10% allocated by strata within states
   - possible to use exemption to bring in everything with no sale
   - get maximum information from fish
2. Expand TIP sampling to better cover all statistical strata
   - Predominantly from Florida and by gillnet & castnet gears
   - In that sense, we have decent coverage for lengths
3. Trade off with lengths versus ages, need for more ages (i.e., hard parts)
4. Consider the use of VMS to improve spatial resolution of data

5. During discussions at the data workshop it was noted that the logbook categories for discards (all dead, majority dead, majority alive, all alive) are not useful for informing discard mortality. Consider simplified logbook language in regard to discards (e.g., list them as dead or alive)
6. Uniformity between state and federal reporting systems/forms would vastly improve the ease and efficiency of data compilation.
7. Establish online reporting and use logbooks as a backup.
8. 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.
9. 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

- Collect and analyze fishery independent data for adult Spanish mackerel
- Using simulation analysis, evaluate the utility of including interaction terms in the development of a standardized index and identify the potential effects these interaction terms have on stock assessments

Section 5 Appendix - Index Report Cards

Appendix 5.1
South Atlantic Spanish Mackerel
SEAMAP Age-0 Index

DESCRIPTION OF THE DATA SOURCE

Working Group Comments:

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:

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.				✓	
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				
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

1. SEAMAP (both age-0 and age-1)
• Fishery independent, large sample size, long time series, good spatial coverage
• Selectivity issues, limited depth range

Reset Fields

Appendix 5.2
South Atlantic Spanish Mackerel
SEAMAP Age-1 Index

DESCRIPTION OF THE DATA SOURCE

Working Group Comments:

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?				✓

	Not Applicable	Absent	Incomplete	Complete	Working Group Comments:
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.		✓			

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				
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

1. SEAMAP (both age-0 and age-1)
• Fishery independent, large sample size, long time series, good spatial coverage
• Selectivity issues, limited depth range

Reset Fields

Evaluation of Abundance Indices of list species: List data set (SEDAR28-DW-##)

Appendix 5.3
South Atlantic 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.

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).					
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				
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

Appendix 5.4
South Atlantic Spanish Mackerel
Florida Trip Ticket, Handline/Trolling

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

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	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 5.5
South Atlantic 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.

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.

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 a shortened time series overall due to gear changes pre and post netban. There are also hyperstability issues with limited spatial extent for passive gear, mostly between Cape Canaveral and Miami. 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.

Appendix 5.6
South Atlantic 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.

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 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 5.7
South Atlantic Spanish Mackerel
Commercial Logbook, Hook and Line

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

Working Group Comments:

3A-E. confidential data
4G. Available on demand

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
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 South Atlantic 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.

Reset Fields

Appendix 5.8
South Atlantic Spanish Mackerel
Commercial Logbook, 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:

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
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:

1B, 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. The working group believed that much of the gillnet effort may include run around gillnets that were effectively fishing similarly to purse seines. The working group further noted that such fishing practices often result in index hyperstability and do not reflect fish abundance.

The working group did recommend that an additional index, spatially limited to southeastern Florida from 25-29 degrees N latitude, be constructed. Commercial fishers reported to the group that gillnet fishing in that region is likely passive. It was also suggested that during the fall (Sep-Nov) Spanish mackerel from throughout the south Atlantic have migrated to southeastern Florida and are subject to capture in passively fished gillnets.

Reset Fields

Appendix 5.9
South Atlantic Spanish Mackerel
SC DNR Charterboat Logbook

DESCRIPTION OF THE DATA SOURCE

Working Group Comments:

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?	✓			

2. Management Regulations (for FD Indices)	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.).				✓	
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	Working Group Comments:
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.		✓			Available upon request.
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	Working Group Comments:
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?		✓			Available upon request.
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).		✓			Available upon request.
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.		✓			Available upon request.
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	2/3/2012	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

The index was not recommended for use since it is a fishery dependent dataset, is self-reported data without field validation, South Carolina is a small portion of the Atlantic stock's geographic range and accounts for a relatively small percentage of the catch, and the MRFSS index could be reproduced to include charterboat mode. Other indices were deemed more appropriate for use in the stock assessment.

Reset Fields

SEDAR

Southeast Data, Assessment, and Review

SEDAR 28

South Atlantic Spanish Mackerel

SECTION III: Assessment Workshop Report

October 2012*

*Revised May 2013

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

Document History

October, 2012 Original release.

May, 2013 Appendix C added. Appendix C tabulates $P^{\star}$=0.4 and $P^{\star}$=0.5 projections, as requested by the SSC during their April 2013 review of this assessment. Table 3.11 was also corrected (MSY units corrected to metric tons).

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 eight webinars. Webinars were held on May 22, June 19, July 10, July 24, August 9, August 17, August 30, and September 12th.

1.1.2 Terms of Reference

1. Review any changes in data following the data workshop and any analyses suggested by the data workshop. Summarize data as used in each assessment model. Provide justification for any deviations from Data Workshop recommendations.
2. Develop population assessment models that are compatible with available data.
    - Consider multiple models, including multispecies models, if data limitations preclude single species assessments
    - Consider a model approach that can be applied to both Gulf and South Atlantic migratory groups.
    - Consider the modeling recommendations of the SEDAR 17 AW and RW, and discuss how they are addressed in this assessment
    - Provide a continuity model consistent with the pre-SEDAR MSAP assessment method.
    - Recommend models and configurations considered most reliable or useful for providing advice
    - Document all input data, assumptions, and equations for each model prepared
3. Provide estimates of stock population parameters.
    - Include fishing mortality, abundance, biomass, selectivity, and other parameters as appropriate given data availability and modeling approaches
    - Include appropriate and representative measures of precision for parameter estimates
4. Characterize uncertainty in the assessment and estimated values.
    - Consider uncertainty in input data, modeling approach, and model configuration
    - Consider other sources as appropriate for this assessment
    - Provide appropriate measures of model performance, reliability, and ‘goodness of fit’
5. Provide evaluations of yield and productivity
    - Include yield-per-recruit, spawner-per-recruit, and stock-recruitment evaluations
6. Provide estimates of population benchmarks or management criteria consistent with the available data, applicable FMPs, proposed FMPs and Amendments, other ongoing or proposed management programs, and National Standards.

- Evaluate existing or proposed management criteria as specified in the management summary
- Recommend proxy values when necessary

7. Provide declarations of stock status relative to management benchmarks or, if necessary, alternative data-poor approaches.
8. Perform a probabilistic analysis of proposed reference points, stock status, and yield.
   - Provide the probability of overfishing at various harvest or exploitation levels
   - Provide a probability density function for biological reference point estimates
   - If the stock is overfished, provide the probability of rebuilding within mandated time periods as described in the management summary or applicable federal regulations
9. Project future stock conditions (biomass, abundance, landings, discards and exploitation) and develop rebuilding schedules if warranted; include estimated generation time. Stock projections shall be developed in accordance with the following:

   A) If stock is overfished:
   F=0, F=current, F=Fmsy, Ftarget,
   F=Frebuild (max that rebuild in allowed time)
   B) If stock is overfishing
   F=Fcurrent, F=Fmsy, F= Ftarget
   C) If stock is neither overfished nor overfishing
   F=Fcurrent, F=Fmsy, F=Ftarget
   D) If data-limitations preclude classic projections (i.e. A, B, C above), explore alternate models to provide management advice.
10. Provide recommendations for future research and data collection.
    - Be as specific as practicable in describing sampling design and sampling intensity
    - Emphasize items which will improve future assessment capabilities and reliability
    - Consider data, monitoring, and assessment needs
11. Prepare an accessible, documented, labeled, and formatted spreadsheet containing all model parameter estimates and all relevant population information resulting from model estimates and any 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 for Review (Section III of the 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 Statements Addressing each Term of Reference

Assessment Workshop TOR

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

   Data are summarized in the DW report, and updates to the data are described in Section 2 of the AW report.

2. Develop population assessment models that are compatible with available data.
   - Consider multiple models, including multispecies models, if data limitations preclude single species assessments
   - Consider a model approach that can be applied to both Gulf and South Atlantic migratory groups.
   - Consider the modeling recommendations of the SEDAR 17 AW and RW, and discuss how they are addressed in this assessment
   - Provide a continuity model consistent with the pre-SEDAR MSAP assessment method.
   - Recommend models and configurations considered most reliable or useful for providing advice
   - Document all input data, assumptions, and equations for each model prepared

   Data were available for a single species assessment of Spanish mackerel in the south Atlantic, and the Beaufort Assessment Model and ASPIC were chosen as appropriate modeling platforms. The continuity case was deemed inappropriate by the AW panel as newer modeling approaches are more suited to the available data. BAM and ASPIC implementation are described in section 3 of the AW report. Input data are documented in the DW report and in section 2 of the AW report. Model assumptions and equations are detailed in SEDAR28-RW03, and those for ASPIC in Prager (2005).

3. Provide estimates of stock population parameters.
   - Include fishing mortality, abundance, biomass, selectivity, and other parameters as appropriate given data availability and modeling approaches
   - Include appropriate and representative measures of precision for parameter estimates

   These estimates and measures of precision are described in section 3 of the AW report.

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

   Measures of uncertainty, model performance, and goodness of fit are detailed in section 3 of the AW report and in SEDAR28-RW04.

5. Provide evaluations of yield and productivity

- Include yield-per-recruit, spawner-per-recruit, and stock-recruitment evaluations

These estimates are provided in the section 3 of the AW report.

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

   Management benchmark estimates are provided in section 3 of the AW report.

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

   Stock status and its associated uncertainty is declared in section 3 of the AW report.

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

   The uncertainty analysis provides pdfs of the reference points and the stochastic projections provide a probability of overfishing. All are outlined in section 3 of the AW report. The stock is not overfished, so a rebuilding analysis was not necessary.

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

   A) If stock is overfished:
   F=0, F=current, F=Fmsy, Ftarget,
   F=Frebuild (max that rebuild in allowed time)
   B) If stock is overfishing
   F=Fcurrent, F=Fmsy, F= Ftarget
   C) If stock is neither overfished nor overfishing
   F=Fcurrent, F=Fmsy, F=Ftarget
   D) If data-limitations preclude classic projections (i.e. A, B, C above), explore alternate models to provide management advice.

   The stock is neither overfished nor experiencing overfishing, therefore analyses requested in category C were carried out and reported in section 3 of the AW report.

10. Provide recommendations for future research and data collection.
    - Be as specific as practicable in describing sampling design and sampling intensity
    - Emphasize items which will improve future assessment capabilities and reliability
    - Consider data, monitoring, and assessment needs

Research recommendations are listed in section 3 of the report.

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

    A Microsoft Excel workbook is provided with the data inputs and model output. The data are also provided in both the DW and AW reports.

12. Complete the Assessment Workshop Report for Review (Section III of the SEDAR Stock Assessment Report).
    The report is completed.

2 Data Review and Updates

Several of the data inputs to the BAM were modified from the decisions made by the SEDAR 28 DW as presented in the DW report. These changes are typically implemented for several reasons including, corrections supplied by DW participants, previous model constructs, standard procedures which are decided based on finalized data such as binning and pooling composition data, or unrealistic values. The 2011 data, which were mostly incomplete during the DW, were added. In some cases, the addition of the final year of data changed estimates for earlier years. An explanation of these changes and a summary of the data used in modeling Spanish mackerel for SEDAR 28 are presented in this section.

2.1 Life History

The relationship between weight and length, $WetWeight(Kg) = 2.15^{-8} * ForkLength(mm)^{2.853}$, was defined at the DW and used as model input. Age–based natural mortality estimates were developed during the SEDAR-28 DW (Table 2.1). The cumulative survival of age 2+ based on a point estimate of natural mortality, 0.35, was used to scale the age–based estimates of natural mortality. Female and male von Bertalanffy growth equations were provided by the DW and used in the model. The L_{inf}, and K were estimated at (637.8mm, 0.42) for females and (528.6mm, 0.56) for males with t_0 fixed at -0.5 for both by the DW. The female growth estimates were used to model SSB. A third growth curve was also calculated for the fished population only, and that curve was used to scale landings. Length at age for all growth models are given in Table 2.1. The initial (1950) sex ratio was assumed equal as recommended by the AW. Females were assumed fully mature at age 2 and the proportion mature at ages 1, 2, were assumed to be 0.0, and 0.939 (Table 2.1).

2.2 Landings

Landings estimates provided by the SEDAR-28 DW were combined into five categories: commercial handline, gill net, cast net, pound net and recreational (including estimates of headboat and MRIP private, charter, and shore–based landings). The commercial estimated landings were input as whole pounds. The commercial "other" estimated landings were divided between commercial gears based on the annual proportion of each (Table 2.2). Recreational landings were input in numbers (thousands).

2.3 Discards

Discards were estimated for commercial gill net, handline, and trolling in numbers. The commercial discards were converted to pounds based on the average weight of fish less than the 12 inch size limit weighted by the observed proportion in the overall length composition. These minor removals were then combined with their respective catch time series. Recreational discards and bycatch from the shrimp trawl fishery were estimated in numbers and were modeled separately as recommended by the AW panel (Table 2.2).

2.4 Bycatch

Spanish mackerel are observed in the shrimp trawl fishery in the south Atlantic. However, the observer coverage is extremely sparse and effort data are questionable. Estimates were provided by the data workshop that assumed a constant relationship over time between the rate of bycatch and effort by state. The data were updated after the DW to correct incomplete records and to include 2011 information (SEDAR 2011*b*). The estimates were then interpolated between 1950 and 1978 (Table 2.2).

2.5 Length Composition

Length data were not used to inform the model for a number of reasons. The data are more noisy than informative, and lack any information of distinct size classes moving through the population. Since age composition data are available, and are comprised of directly aged fish samples, the AW decided to not use the length compositions for the assessment.

2.6 Age Composition

Age data were available from the commercial handline, pound net, gill net, cast net and recreational sampling programs. The annual age compositions were developed for Spanish mackerel by the SEDAR-28 DW. The AW preferred to weight the age composition by the length composition for years where adequate samples were available (Chih 2009). Ages greater than 10 were pooled to age 10 creating a plus group (age 10+; Tables 2.3–2.7).

2.7 Indices of abundance

The MRFSS index and associated CVs were updated through 2011 using the same methods discussed above in Section 5 of the Data Workshop report. All finalized indices for potential use in the Spanish mackerel stock assessment and associated CVs are in Table 2.8.

2.8 Surplus–production model input

The total removals in pounds and associated indices in weight input to the surplus–production model are given in Table 2.9. The details of the development of the data are given in section 3.1.

2.9 Tables

Table 2.1. Life-history characteristics at age including average fork length (F.length) for males, females, and the fished population, whole weight for males and females (mid-year), proportion females mature, and natural mortality at age. The CV of length at age was fixed at 0.1.

	F. Length (mm)			F. Length (in)	Whole Weight (lb)		Whole Weight (kg)		Proportion	Maturity	Natural
Age	Male	Female	Population	Population	Male	Female	Male	Female	Female	Female	mortality
0	129.1	120.8	276.9	10.9	0.05	0.03	0.02	0.01	0.5	0.000	0.793
1	300.4	298.1	360.9	14.2	0.54	0.50	0.24	0.23	0.5	0.939	0.516
2	398.2	414.6	421.9	16.6	1.21	1.36	0.55	0.62	0.5	1.000	0.426
3	454.1	491.2	466.2	18.4	1.77	2.27	0.80	1.03	0.5	1.000	0.384
4	486.1	541.4	498.4	19.6	2.16	3.05	0.98	1.39	0.5	1.000	0.361
5	504.3	574.5	521.7	20.5	2.40	3.65	1.09	1.66	0.5	1.000	0.349
6	514.7	596.2	538.7	21.2	2.55	4.09	1.16	1.85	0.5	1.000	0.341
7	520.7	610.5	551.0	21.7	2.63	4.39	1.19	1.99	0.5	1.000	0.336
8	524.1	619.8	559.9	22.0	2.68	4.60	1.22	2.09	0.5	1.000	0.333
9	526.0	626.0	566.4	22.3	2.71	4.74	1.23	2.15	0.5	1.000	0.331
10	527.1	630.0	571.1	22.5	2.73	4.83	1.24	2.19	0.5	1.000	0.330

Table 2.2. Observed time series of landings (L) and discards (D) for commercial handline (HL), commercial pound net (PN), commercial gill net(GN), commercial cast net(CN), and general recreational (Rec). Commercial landings are in units of 1000 lb whole weight. Recreational landings and all discards are in units of 1000 fish. Discards include all released fish, live or dead.

Year	L.HL	L.PN	L.GN	L.CN	L.Rec	D.Shrimp	D.Rec
1950	371.468	26.244	3339.888	.	.	11.240	.
1951	531.019	38.731	1619.950	.	.	22.480	.
1952	63.340	55.422	3493.038	.	.	33.720	.
1953	184.932	51.274	3541.995	.	.	44.960	.
1954	123.365	195.579	2115.156	.	.	56.200	.
1955	367.263	60.083	2981.054	.	252.837	67.440	.
1956	662.788	89.846	4188.166	.	266.763	78.680	.
1957	294.198	57.149	4141.253	.	280.690	89.919	.
1958	434.657	15.316	7081.728	.	294.616	101.159	.
1959	170.918	25.938	2330.744	.	308.543	112.399	.
1960	157.720	24.543	2244.536	.	322.469	123.639	.
1961	123.235	136.871	3158.995	.	343.288	134.879	.
1962	128.832	20.789	2540.079	.	364.106	146.119	.
1963	79.227	83.100	2184.873	.	384.925	157.359	.
1964	66.813	33.149	2016.237	.	405.744	168.599	.
1965	148.942	91.791	2865.868	.	426.562	179.839	.
1966	180.867	114.436	2109.497	.	444.157	191.079	.
1967	135.111	24.068	1749.621	.	461.752	202.319	.
1968	155.181	74.328	4314.991	.	479.348	213.559	.
1969	106.455	89.048	2379.997	.	496.943	224.799	.
1970	113.555	108.094	3619.851	.	514.538	236.038	.
1971	140.288	26.491	2566.621	.	559.473	247.278	.
1972	108.692	23.313	3366.395	.	604.408	258.518	.
1973	158.439	51.892	3116.169	.	649.344	269.758	.
1974	172.637	25.682	2249.381	.	694.279	280.998	.
1975	379.202	62.257	4835.640	.	739.214	292.238	.
1976	933.068	77.479	9816.053	.	731.721	303.478	.
1977	349.264	28.955	10984.080	.	724.228	314.718	.
1978	82.924	2.405	5647.641	.	716.735	325.958	.
1979	75.330	0.727	4850.916	.	709.243	255.174	.
1980	93.868	5.859	9861.882	.	701.750	385.437	.
1981	89.164	5.580	4258.124	.	867.492	296.101	12.398
1982	128.545	24.065	3936.530	.	965.918	445.174	1.323
1983	58.603	16.436	5995.916	.	130.237	433.147	1.089
1984	56.484	23.470	2456.814	.	938.061	272.905	5.092
1985	30.988	47.699	4321.597	.	495.354	265.087	10.777
1986	79.915	205.482	4137.058	.	937.429	290.992	64.436
1987	109.930	485.574	3733.177	.	1198.109	245.271	11.689
1988	66.577	412.781	3367.706	.	1884.597	292.545	13.485
1989	41.181	528.488	3302.445	.	1232.315	345.656	47.563
1990	115.250	524.866	2778.497	.	1391.631	268.655	32.618
1991	150.550	489.504	3971.404	.	1638.608	333.399	76.845
1992	51.449	406.283	2753.939	.	1346.942	252.838	67.822
1993	102.047	338.182	4547.820	.	980.356	266.479	49.849
1994	58.984	333.778	3752.899	.	1252.470	297.710	153.831
1995	211.970	201.242	3272.712	15.590	753.008	301.260	68.290
1996	142.066	299.923	2729.457	67.163	969.077	245.085	80.719
1997	129.433	211.194	2726.108	214.259	1155.037	280.256	82.884
1998	151.327	116.667	2723.804	69.025	690.496	252.153	53.331
1999	190.787	274.158	1912.282	67.099	1116.645	293.655	100.099
2000	316.299	163.927	1892.290	366.080	1437.330	265.678	162.879
2001	356.040	199.847	1740.271	909.541	1307.163	210.908	101.838
2002	440.526	121.629	1327.352	971.702	1439.449	236.341	158.180
2003	392.125	90.843	1096.767	1901.255	1243.097	177.993	174.461
2004	594.248	71.453	720.336	2253.709	800.943	178.256	92.571
2005	846.684	47.298	1264.334	1583.229	962.090	132.934	124.137
2006	710.637	43.079	1656.917	1529.961	663.235	127.828	56.719
2007	780.521	50.315	1727.173	1275.134	1087.412	121.889	123.202
2008	872.909	192.927	1085.148	704.889	1415.570	112.480	186.340
2009	982.224	364.502	1446.879	970.449	1170.894	104.385	114.522
2010	1234.796	144.896	1354.809	1807.528	1103.948	122.974	127.805
2011	898.517	88.109	1094.010	1248.089	879.230	113.875	85.170

Table 2.3. Observed age composition from commercial handline.

Year	n.fish	0	1	2	3	4	5	6	7	8	9	10
1989	22	0.0000	0.3182	0.3182	0.1364	0.1364	0.0909	0.0000	0.0000	0.0000	0.0000	0.0000
1990	79	0.0000	0.0000	0.1392	0.2658	0.3038	0.2658	0.0253	0.0000	0.0000	0.0000	0.0000
1992	81	0.0123	0.3457	0.4198	0.1235	0.0494	0.0247	0.0247	0.0000	0.0000	0.0000	0.0000
1995	25	0.5600	0.3600	0.0800	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1996	35	0.0571	0.6857	0.0857	0.0571	0.0000	0.0571	0.0571	0.0000	0.0000	0.0000	0.0000
1997	19	0.1053	0.1579	0.4211	0.2632	0.0526	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1998	31	0.1613	0.0000	0.1935	0.3226	0.2258	0.0645	0.0000	0.0323	0.0000	0.0000	0.0000
1999	120	0.0000	0.0917	0.1333	0.1417	0.3333	0.1750	0.0750	0.0417	0.0000	0.0083	0.0000
2000	147	0.0000	0.0884	0.4354	0.1837	0.1361	0.0816	0.0272	0.0408	0.0000	0.0000	0.0068
2001	242	0.0620	0.3760	0.2603	0.1694	0.0455	0.0248	0.0372	0.0207	0.0041	0.0000	0.0000
2002	61	0.0984	0.1475	0.0492	0.2459	0.2623	0.0984	0.0492	0.0000	0.0492	0.0000	0.0000
2007	177	0.0067	0.1797	0.2977	0.1471	0.1886	0.0725	0.0698	0.0275	0.0019	0.0065	0.0021
2008	185	0.0000	0.0070	0.1330	0.3108	0.2609	0.1756	0.0667	0.0449	0.0011	0.0000	0.0000
2009	104	0.0000	0.0036	0.2498	0.1629	0.2122	0.1539	0.1316	0.0747	0.0113	0.0000	0.0000
2011	72	0.0000	0.0000	0.0171	0.2269	0.3661	0.2413	0.1307	0.0179	0.0000	0.0000	0.0000

Table 2.4. Observed age composition from commercial pound net.

Year	n.fish	0	1	2	3	4	5	6	7	8	9	10
1992	28	0.6747	0.3224	0.0017	0.0012	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1995	20	0.0000	0.9079	0.0921	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1998	50	0.2200	0.3400	0.2800	0.0800	0.0800	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1999	23	0.1304	0.8696	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2001	60	0.0659	0.6593	0.1978	0.0549	0.0110	0.0000	0.0110	0.0000	0.0000	0.0000	0.0000
2002	773	0.0039	0.6715	0.1143	0.1925	0.0158	0.0013	0.0000	0.0000	0.0000	0.0007	0.0000
2003	328	0.0000	0.9834	0.0087	0.0000	0.0069	0.0011	0.0000	0.0000	0.0000	0.0000	0.0000
2004	400	0.0000	0.5150	0.3150	0.0925	0.0100	0.0550	0.0100	0.0000	0.0000	0.0025	0.0000
2005	341	0.0783	0.9031	0.0163	0.0022	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2006	288	0.0000	0.6720	0.3028	0.0201	0.0000	0.0051	0.0000	0.0000	0.0000	0.0000	0.0000
2007	226	0.0288	0.8777	0.0576	0.0216	0.0000	0.0144	0.0000	0.0000	0.0000	0.0000	0.0000
2008	111	0.1042	0.6042	0.1667	0.0625	0.0625	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2009	99	0.0000	0.4286	0.5000	0.0000	0.0714	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2010	186	0.0000	0.6290	0.2688	0.0860	0.0000	0.0108	0.0000	0.0000	0.0054	0.0000	0.0000
2011	210	0.0000	0.4667	0.2048	0.1762	0.0857	0.0429	0.0048	0.0143	0.0000	0.0048	0.0000

Table 2.5. Observed age composition from commercial gill net.

Year	n.fish	0	1	2	3	4	5	6	7	8	9	10
1988	52	0.0769	0.2885	0.3654	0.1731	0.0769	0.0192	0.0000	0.0000	0.0000	0.0000	0.0000
1989	87	0.2874	0.3218	0.1609	0.0805	0.0690	0.0690	0.0115	0.0000	0.0000	0.0000	0.0000
1990	232	0.1595	0.2500	0.2284	0.1638	0.1379	0.0560	0.0043	0.0000	0.0000	0.0000	0.0000
1991	203	0.0148	0.4532	0.2709	0.1232	0.0837	0.0443	0.0049	0.0049	0.0000	0.0000	0.0000
1992	190	0.0035	0.4045	0.4604	0.1094	0.0132	0.0090	0.0000	0.0000	0.0000	0.0000	0.0000
1993	150	0.0133	0.2467	0.2533	0.1533	0.1200	0.0467	0.0733	0.0600	0.0333	0.0000	0.0000
1995	167	0.1497	0.2575	0.2814	0.1497	0.1078	0.0180	0.0180	0.0120	0.0060	0.0000	0.0000
1996	417	0.0528	0.2398	0.3381	0.2782	0.0600	0.0216	0.0024	0.0048	0.0024	0.0000	0.0000
1997	246	0.0347	0.2801	0.4729	0.1751	0.0241	0.0003	0.0044	0.0042	0.0000	0.0041	0.0000
1998	363	0.2011	0.1460	0.3581	0.1736	0.0744	0.0303	0.0138	0.0028	0.0000	0.0000	0.0000
1999	447	0.1432	0.3065	0.1723	0.1812	0.1275	0.0492	0.0179	0.0022	0.0000	0.0000	0.0000
2000	588	0.0174	0.3802	0.3700	0.1060	0.0895	0.0215	0.0122	0.0025	0.0006	0.0000	0.0000
2001	315	0.1720	0.4121	0.3093	0.0819	0.0227	0.0007	0.0007	0.0003	0.0003	0.0000	0.0000
2002	365	0.1073	0.1449	0.2678	0.3124	0.1148	0.0439	0.0067	0.0000	0.0000	0.0022	0.0000
2003	365	0.1362	0.5275	0.1146	0.0771	0.0854	0.0414	0.0121	0.0032	0.0000	0.0019	0.0006
2004	551	0.0803	0.2789	0.3040	0.1840	0.0850	0.0450	0.0147	0.0077	0.0003	0.0000	0.0001
2005	255	0.1097	0.6960	0.1330	0.0512	0.0074	0.0002	0.0023	0.0004	0.0000	0.0000	0.0000
2006	358	0.0072	0.2459	0.3757	0.2366	0.1036	0.0218	0.0091	0.0000	0.0000	0.0000	0.0000
2007	234	0.1796	0.4874	0.2276	0.0516	0.0263	0.0100	0.0040	0.0104	0.0028	0.0002	0.0000
2008	350	0.1252	0.2944	0.3007	0.1338	0.1119	0.0246	0.0094	0.0000	0.0000	0.0000	0.0000
2009	348	0.0315	0.3072	0.3222	0.1777	0.0923	0.0488	0.0204	0.0000	0.0000	0.0000	0.0000
2010	287	0.2985	0.2110	0.1811	0.1281	0.1258	0.0534	0.0014	0.0008	0.0000	0.0000	0.0000
2011	325	0.0124	0.2553	0.2017	0.2015	0.1904	0.1206	0.0158	0.0023	0.0000	0.0000	0.0000

Table 2.6. Observed age composition from commercial cast net.

Year	n.fish	0	1	2	3	4	5	6	7	8	9	10
1997	34	0	0.0588	0.5588	0.2059	0.1176	0.0588	0.0000	0.0000	0.0000	0.0000	0.0000
2001	110	0	0.0273	0.2727	0.3818	0.1727	0.1091	0.0273	0.0000	0.0091	0.0000	0.0000
2005	147	0	0.0105	0.2844	0.2827	0.2568	0.0944	0.0296	0.0088	0.0303	0.0000	0.0025
2006	211	0	0.0247	0.4764	0.2697	0.1487	0.0505	0.0176	0.0024	0.0049	0.0052	0.0000
2007	50	0	0.0000	0.2226	0.1768	0.2363	0.2628	0.0767	0.0249	0.0000	0.0000	0.0000
2008	199	0	0.0818	0.2423	0.2521	0.2147	0.1484	0.0382	0.0040	0.0174	0.0010	0.0000
2009	331	0	0.0078	0.2452	0.2479	0.2339	0.1820	0.0471	0.0257	0.0079	0.0000	0.0023
2010	138	0	0.0031	0.2439	0.3345	0.2249	0.1553	0.0327	0.0057	0.0000	0.0000	0.0000
2011	94	0	0.0000	0.2042	0.2395	0.2598	0.1952	0.0706	0.0306	0.0000	0.0000	0.0000

Table 2.7. Observed age composition from the recreational fishery.

Year	n.fish	0	1	2	3	4	5	6	7	8	9	10
1988	115	0.0138	0.1209	0.4754	0.3695	0.0107	0.0056	0.0020	0.0011	0.0011	0.0000	0.0000
1989	34	0.0000	0.1869	0.0406	0.1971	0.3268	0.1443	0.0952	0.0091	0.0000	0.0000	0.0000
1990	271	0.0305	0.5137	0.2631	0.1279	0.0329	0.0175	0.0139	0.0005	0.0000	0.0000	0.0000
1991	192	0.0315	0.5431	0.2373	0.1140	0.0167	0.0290	0.0209	0.0073	0.0000	0.0000	0.0000
1992	198	0.0029	0.5329	0.2766	0.0653	0.0907	0.0109	0.0085	0.0056	0.0066	0.0000	0.0000
1993	104	0.0016	0.5374	0.2331	0.0444	0.1221	0.0380	0.0078	0.0133	0.0019	0.0000	0.0004
1994	171	0.0330	0.6050	0.2269	0.1116	0.0234	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1995	70	0.1070	0.7513	0.1194	0.0000	0.0222	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1996	78	0.0000	0.5935	0.3122	0.0060	0.0494	0.0389	0.0000	0.0000	0.0000	0.0000	0.0000
1997	316	0.0325	0.6640	0.2478	0.0401	0.0037	0.0086	0.0033	0.0000	0.0000	0.0000	0.0000
1998	219	0.0870	0.4704	0.3113	0.0710	0.0361	0.0038	0.0023	0.0153	0.0027	0.0000	0.0001
1999	89	0.0000	0.8823	0.0345	0.0478	0.0194	0.0097	0.0052	0.0011	0.0000	0.0000	0.0000
2000	130	0.0000	0.4520	0.2595	0.0415	0.1001	0.0609	0.0401	0.0306	0.0066	0.0002	0.0085
2001	49	0.0474	0.2464	0.2154	0.0859	0.1930	0.1237	0.0743	0.0002	0.0137	0.0000	0.0000
2002	204	0.0734	0.4353	0.2212	0.1494	0.0808	0.0168	0.0012	0.0085	0.0071	0.0044	0.0018
2003	235	0.0313	0.8660	0.0855	0.0122	0.0031	0.0017	0.0000	0.0002	0.0000	0.0000	0.0000
2004	239	0.0342	0.7176	0.1158	0.0925	0.0305	0.0044	0.0050	0.0000	0.0000	0.0000	0.0000
2005	204	0.0165	0.9258	0.0184	0.0175	0.0081	0.0086	0.0024	0.0000	0.0027	0.0000	0.0000
2006	255	0.1262	0.7967	0.0363	0.0202	0.0157	0.0013	0.0033	0.0002	0.0000	0.0000	0.0000
2007	183	0.1734	0.7573	0.0494	0.0080	0.0045	0.0055	0.0000	0.0019	0.0000	0.0000	0.0000
2008	182	0.0135	0.8306	0.0905	0.0549	0.0106	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2009	63	0.0000	0.7776	0.1046	0.1004	0.0174	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2010	296	0.0877	0.4732	0.2954	0.1027	0.0333	0.0034	0.0042	0.0000	0.0000	0.0000	0.0000
2011	280	0.2165	0.6110	0.0936	0.0592	0.0197	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table 2.8. Observed indices of abundance and CVs from Florida Handline trip ticket(FL.HL), MRFSS (MRFSS), and the SEAMAP YOY survey (SEAMAP).

Year	FL.HL	FL.HL CV	MRFSS	MRFSS CV	SEAMAP	SEAMAP CV
1982	.	.	0.84	0.20	.	.
1983	.	.	0.50	0.15	.	.
1984	.	.	0.58	0.15	.	.
1985	.	.	0.67	0.12	.	.
1986	0.60	0.04	1.42	0.06	.	.
1987	0.73	0.04	0.84	0.07	.	.
1988	0.89	0.05	0.89	0.07	.	.
1989	0.80	0.05	0.97	0.06	0.73	0.56
1990	0.87	0.04	0.92	0.06	1.63	0.46
1991	0.65	0.03	0.88	0.06	1.72	0.48
1992	0.80	0.04	0.83	0.07	1.19	0.52
1993	0.93	0.04	0.62	0.06	0.93	0.49
1994	0.66	0.04	0.99	0.07	0.82	0.47
1995	0.93	0.04	0.76	0.07	1.07	0.50
1996	0.82	0.03	1.03	0.07	1.20	0.47
1997	0.80	0.03	1.30	0.06	0.26	0.59
1998	0.77	0.03	1.03	0.06	1.46	0.52
1999	0.95	0.03	1.25	0.06	0.81	0.51
2000	0.98	0.03	1.14	0.06	1.16	0.50
2001	0.98	0.03	1.17	0.06	0.88	0.47
2002	0.94	0.03	1.25	0.06	1.00	0.48
2003	1.01	0.03	1.22	0.06	0.40	0.55
2004	1.31	0.03	1.04	0.06	0.74	0.53
2005	1.29	0.03	1.13	0.07	0.77	0.53
2006	1.37	0.03	1.03	0.06	1.33	0.53
2007	1.20	0.03	1.03	0.06	1.25	0.51
2008	1.23	0.02	1.46	0.06	1.52	0.48
2009	1.64	0.02	1.06	0.05	1.10	0.49
2010	1.41	0.02	1.05	0.06	0.62	0.54
2011	1.42	0.02	1.07	0.16	0.41	0.56

Table 2.9. Observed time series of total removals in pounds (1000) and indices (in weight) as input to the surplus–production model, ASPIC.

Year	Removals 1000 lbs	MRFSS Index	FL Commercial Trip Ticket Index
1950	3739.23		
1951	2192.96		
1952	3616.69		
1953	3784.72		
1954	2442.25		
1955	3840.42		
1956	5397.71		
1957	4974.40		
1958	8038.39		
1959	3059.18		
1960	2983.26		
1961	4011.96		
1962	3318.96		
1963	3012.86		
1964	2818.26		
1965	3845.05		
1966	3174.27		
1967	2709.28		
1968	5376.00		
1969	3438.01		
1970	4735.03		
1971	3703.60		
1972	4545.27		
1973	4450.05		
1974	3647.92		
1975	6553.99		
1976	12092.61		
1977	12617.43		
1978	6977.22		
1979	6148.43		
1980	11189.46		
1981	6011.77		
1982	5496.10	0.841	
1983	6378.22	0.501	
1984	3982.43	0.579	
1985	5226.87	0.671	
1986	6150.65	1.422	0.602
1987	6325.20	0.843	0.733
1988	7294.35	0.888	0.885
1989	5803.60	0.973	0.805
1990	5568.01	0.922	0.873
1991	7750.30	0.885	0.650
1992	5692.54	0.826	0.800
1993	6829.42	0.623	0.935
1994	6480.98	0.989	0.661
1995	5010.19	0.760	0.930
1996	4981.26	1.029	0.816
1997	5468.90	1.297	0.799
1998	4476.84	1.033	0.775
1999	4365.01	1.247	0.951
2000	5475.66	1.143	0.982
2001	5655.74	1.174	0.976
2002	5763.75	1.252	0.936
2003	5997.61	1.221	1.010
2004	5512.13	1.041	1.314
2005	5746.57	1.133	1.289
2006	5382.85	1.030	1.373
2007	6207.43	1.031	1.197
2008	5897.67	1.464	1.233
2009	6026.90	1.058	1.642
2010	6917.88	1.054	1.410
2011	5280.75	1.071	1.424

3 Model 1: Catch-age model

3.0.1 Model 1 Methods

3.0.1.1 Overview The primary model in this assessment was a statistical catch-age model (Quinn and Deriso 1999), implemented with the AD Model Builder software (ADMB Foundation 2012). In essence, a statistical catch-age model simulates a population forward in time while including fishing processes. Quantities to be estimated are systematically varied until characteristics of the simulated populations match available data on the real population. Statistical catch-age models share many attributes with ADAPT-style tuned and untuned VPAs.

The method of forward projection has a long history in fishery models. It was introduced by Pella and Tomlinson (1969) for fitting production models and then used by Fournier and Archibald (1982), Deriso et al. (1985) in their CAGEAN model, and Methot (1989) in his stock-synthesis model. The catch-age model of this assessment is similar in structure to the CAGEAN and stock-synthesis models. Versions of this assessment model have been used in a previous SEDAR assessment of Spanish mackerel SEDAR (2008) as well as red porgy, black sea bass, tilefish, snowy grouper, gag grouper, greater amberjack, and red snapper.

3.0.1.2 Data Sources The catch-age model was fit to data from one fishery–independent index, two fishery–dependent indices, estimates of bycatch in the shrimp fishery, and to data from each of the five primary fisheries on southeastern U.S. Spanish mackerel: commercial gill net, commercial pound net, commercial cast net, commercial handlines (including hook & line, trolling, and electric reels), and general recreational (including headboat). These data included annual landings by fishery (in total weight for commercial and in numbers for general recreational and shrimp bycatch), annual discards from the recreational sector, and annual age composition of landings by fishery. Discards from the commercial fisheries were added to landings as they were not a large enough proportion of total catch to model separately. These data are tabulated in §2 of this report. Data on annual discard mortalities were not available, but an overall discard mortality rate for the recreational sector was applied to total discards as per the recommendation of the DW. All shrimp bycatch was assumed dead.

3.0.1.3 Model Configuration and Equations Model equations as well as the AD Model Builder code are detailed in SEDAR28-RW-03. A general description of the assessment model follows:

Natural mortality rate The natural mortality rate (M) was assumed constant over time, but decreasing with age. The form of M as a function of age was based on Lorenzen (1996). The Lorenzen (1996) approach inversely relates the natural mortality at age to mean weight at age W_a by the power function $\mathrm{M}_a = \alpha W_a^{\beta}$, where α is a scale parameter and β is a shape parameter. Lorenzen (1996) provided point estimates of α and β for oceanic fishes, which were used for this assessment. The Lorenzen estimates of M_a were rescaled using the calculated cumulative survival given a constant mortality (0.35), which is consistent with the findings of Hoenig (1983) and discussed in Hewitt and Hoenig (2005).

Initialization Initial (1950) abundance at age was estimated in the model as follows. First, the equilibrium age structure was computed for ages 1-10+ based on natural and fishing mortality (F), where F was set equal to a value of historical fishing mortality decided by the AW panel (0.2). The value was supported by that of the previous benchmark assessment and seemed reasonable given initial catches and the existence of both a commercial and recreational fishery prior to the start year of the model. Initial recruitment was then calculated (as described below) based on the initial equilibrium age structure of the stock (abundance in 1950).

Stock dynamics In the assessment model, new biomass was acquired through growth and recruitment, while abundance of existing cohorts experienced exponential decay from fishing and natural mortality, where the force of fishing mortality was assumed constant throughout annual intervals. The population was assumed closed to immigration and emigration. The oldest age class 10+ allowed for the accumulation of fish (i.e., plus group). The initial stock biomass was assumed to be less than the unfished (virgin) level, because moderate commercial landings had been documented and because of anecdotal reports of substantial recreational landings back into the 1800s. Indeed, historical records indicated exploitation had been occurring for decades prior to year 1 of the assessment model. Initial biomass and abundance were set assuming an equilibrium age structure (cf., Caswell 2001) at a constant level of assumed initial fishing mortality (0.2).

Growth and maturity Mean size at age (fork length) was input to the model as three separate length at age vectors derived from different von Bertalanffy growth equations (Figure 3.1). As suggested by the DW, separate growth curves were estimated for males and females to represent differential growth in the population as a whole. In addition, a von Bertalanffy growth curve was estimated using fishery-dependent samples to represent the fished population. Weight at age (whole weight) was input as a function of length, and maturity at age of females was modeled with a logistic equation. Parameters of growth, length-weight conversion, and maturity were estimated by the DW and were treated as input to the assessment model.

Sex ratio A 50 : 50 sex ratio was assumed at the time of recruitment to the fishery (age 0). Differential selectivities then allowed sex ratio to change throughout time.

Spawning biomass Spawning biomass (in units of mt) was modeled as the mature female biomass. It was computed each year from number at age when spawning peaks. For Spanish mackerel, peak spawning was considered to occur at the midpoint of the year.

Recruitment Recruitment was predicted from spawning biomass using a Beverton–Holt spawner-recruit model. In years when composition data could provide information on year-class strength (1982–2011), estimated recruitment was conditioned on the Beverton–Holt model. In years prior, recruitment followed the Beverton–Holt model precisely (similar to an age-structured production model).

Landings Time series of landing from five fisheries were modeled: commercial handlines, commercial gill net, commercial poundnet, commercial cast net, and general recreational (including headboat). Landings were modeled via the Baranov catch equation (Baranov 1918), in units of 1000 lb whole weight for commercial fisheries and in units of 1000 fish for the recreational fishery.

Discards Starting in 1986 with the implementation of size-limit regulations, time series of discard mortalities (in units of 1000 fish) were available for commercial handline and gill net fisheries. The magnitude of the commercial discards was trivial in comparison to the landings. As a result, the AW decided to include the commercial discards with the landings rather than model the discards separately. Recreational angler survey data indicated non-negligible discards prior to establishment of the size limit. Data from these years were used to calculate a ratio of discards to landings, which was used to extrapolate recreational discards back to year six of the assessment model. As with landings, discard mortalities were modeled via the Baranov catch equation (Baranov 1918), which required estimates of discard selectivities (described below) and release mortality rates.

Bycatch Spanish mackerel are observed in the shrimp trawl fishery in the south Atlantic. However, the observer coverage is extremely sparse and effort data are questionable. Estimates were provided by the data workshop that assumed a constant relationship over time between the rate of bycatch and effort by state (SEDAR 2011*b*). The estimates were then interpolated between 1950 and the first year estimates were provided (1978). Bycatch was modeled via the Baranov catch equation (Baranov 1918), assuming that only age 0 fish and a small proportion of age 1 fish were selected.

Fishing For each time series of landings and discard mortalities, a separate full fishing mortality rate (F) was estimated. Age-specific rates were then computed as the product of full F and selectivity at age.

Selectivities Selectivities were estimated using a parametric approach. Initial exploration of selectivity assumed a logistic function for all landings. However, lack of fit was detected in commercial pound net, cast net and recreational fisheries. In particular, it appeared that recreational and pound net fisheries predominantly targeted age one fish, perhaps because of mismatches between the availability of fish by age and the spatial distribution of effort. These selectivities were estimated using a double-logisitic equation (dome shaped curve). This parametric approach reduces the number of estimated parameters and imposes theoretical structure on the estimates. The gill net fishery was examined for a potential shift in selectivity following a gill net ban in Florida in 1995. The data did not support two separate selectivity periods for the gill net fishery.

In addition to standard selectivities, we attempted to account for differential selectivities between males and females. These were thought to result from differential growth rates. In order to do so, we calculated a delay constant, c, which minimized the squared difference in the von Bertalanffy growth equation between males and females:

$$\left[l_\infty^F(1-\exp(-K^F(a-a_0^F)))-l_\infty^M(1-\exp(-K^M(a+c-a_0^M)))\right]^2$$

Using this approach, c was estimated as 0.20, and was substituted into logistic selectivity equations. The result is that the selectivity of an age a male is equivalent to that of an age $a-0.2$ female.

Selectivities of discards could not be estimated directly, because composition data of discards were lacking. Instead, selectivities of discards were computed using the following approach. First, all discards were assumed to occur because of size of the fish in relation to the 12 inch FL size limit. Records of fish with both age and length compositions available were examined, indicating that fish below this size were either zero- or one-year-olds. Second, we determined l_g^{min} the minimum length ever recorded for a given gear type, using this length as a proxy for the length at which fish become vulnerable to a given gear. Third, the proportion of fish of a given age and sex that were greater than this size but less than the size limit was then calculated as

$$p_{g,a,s}=\int_{l_g^{\text{min}}}^{l^{\text{limit}}}\text{Normal}(l_{a,s};\sigma_{a,s}),$$

where g denotes gear, a denotes age, s denotes sex, and l^{limit} gives the minimum size limit. Although these were calculated for all discards, the recreational discard series was the only directed discard series that required a fixed selectivity.

Indices of abundance A total of four indices of abundance (two fishery–independent and two fishery–dependent) were recommended for use by the DW. However, one of the fishery–independent indices (SEAMAP age 1 index) was excluded by the AW. It was determined that the SEAMAP age 1 index was not a complete representation of the age 1 year class. Age 1 Spanish mackerel can be caught by the trawling nets of the SEAMAP gear, but an older age 1 fish is likely too fast for the standard tow speed of the survey. The signal from the age 0 index that was retained is likely to be a complete picture of the young of the year age class of the stock. The DW and AW agreed that catchability increases due to technology creep was unlikely to be an issue for Spanish mackerel. Thus, catchability was assumed constant over time for each index.

Biological reference points Biological reference points (benchmarks) were calculated based on maximum sustainable yield (MSY) estimates from the Beverton–Holt spawner-recruit model with bias correction, as described in §3.0.1.6. Computed benchmarks included MSY, fishing mortality rate at MSY (F_{MSY}), and total mature biomass at MSY (SSB_{MSY}). These benchmarks are conditional on the estimated selectivity functions. The selectivity pattern used here was the effort-weighted selectivities at age, with effort from each fishery (including discard and bycatch mortalities) estimated as the full F averaged over the last three years of the assessment.

Fitting criterion The fitting criterion was a tuned maximum likelihood approach in which the log likelihood for each data component (e.g. landings, age compositions, etc.) was given a different weight. Landings, discards, bycatch, and index data were fit using a lognormal likelihood. Composition data were fit using a robust multinomial likelihood. The total likelihood also included penalty terms to discourage fully selected F greater than 3.0 in any year In addition, a lognormal likelihood was applied:

$$\Lambda = \left[\frac{[R_{1982} + (\widehat{\sigma}_R^2/2)]^2}{2\widehat{\sigma}_R^2} + \sum_{y>1982} \frac{[(R_y - \widehat{\varrho} R_{y-1}) + (\widehat{\sigma}_R^2/2)]^2}{2\widehat{\sigma}_R^2} + n \log(\sigma_R) \right] \tag{1}$$

where Λ is the spawner-recruit likelihood component, R_y are annual recruitment deviations in log space, n is the number of years of recruitment deviations (here starting in 1982), $\widehat{\varrho}$ is the first-order autocorrelation (here, $\varrho = 0$), and $\widehat{\sigma}_R^2$ is the estimated recruitment variance. The total likelihood included a penalty term to discourage large deviation from zero in recruitment residuals during the last three assessment years.

Likelihood component weights In general, our weighting strategy was to fit landings, discard, and bycatch streams as closely as possible. The model includes the capability for each component of the likelihood to be weighted by user-supplied values (for instance, to give more influence to stronger data sources). For data components, these weights were applied by either scaling likelihood components or adjusting effective sample sizes (multinomial components). In this application to Spanish mackerel, CVs of landings and discards (in arithmetic space) were assumed equal to 0.05 to achieve a close fit to these data while allowing some imprecision. In practice, the small CVs are a matter of computational convenience, as they help achieve the desired result of close fits to the landings, while avoiding having to solve the Baranov equation iteratively (which is complex when there are multiple fisheries). Weights on other data components (indices and age compositions) were adjusted iteratively, starting from initial weights as follows. The CVs of indices were set equal to the values estimated by the DW. Effective sample sizes of the multinomial components were assumed equal to the number of fish sampled annually. These initial weights were then adjusted until standard deviations of normalized residuals (SDNRs) were near 1.0 (Francis (2011)).

Configuration of base run and sensitivity analyses A base model run was configured as described above and in the SEDAR28-RW-03. Steepness and the variance of recruitment were not reliably estimated. When the model attempted to estimate steepness, it would hit the upper bound of 0.99. In order to move the estimate away from the bound, an extremely informative prior was necessary (CV<0.10). A likelihood profile over steepness was carried out to determine an appropriate range of values for steepness, and the resulting range was 0.60 to 0.90 (see SEDAR28-RW-04). The AW decided to fix steepness at the center of that range and explore the uncertainty through sensitivities and uncertainty analyses. The sensitivity of results to the base configuration was examined through sensitivity and retrospective analyses. These runs vary from the base run as follows:

- S1: Use the Lorenzen M scaled to the low point estimate of M
- S2: Use the Lorenzen M scaled to the high point estimate of M
- S3: Use the Gislason (Gislason et al. 2010) estimate of M
- S4: Use constant value of M
- S5: Initial proportion female fixed at 0.6 for all ages
- S6: Initial proportion female fixed at 0.7 for all ages
- S7: All likelihood weights fixed at 1
- S8: Historical F fixed at 0.1
- S9: Historical F fixed at 0.3
- S10: Steepness fixed at 0.6
- S11: Steepness fixed at 0.9

- S12: Shrimp bycatch estimates reduced to 50% of estimate
- S13: Shrimp bycatch estimates increased to 150% of estimate
- S14: Retrospective run through 2010
- S15: Retrospective run through 2009
- S16: Retrospective run through 2008
- S17: Retrospective run through 2007
- S18: Retrospective run through 2006

3.0.1.4 **Parameters Estimated** The model estimated annual fishing mortality rates of each fishery, selectivity parameters for each fishery, Beverton–Holt parameters, annual recruitment deviations, and catchability coefficients associated with abundance indices. Estimated parameters are identified in SEDAR28-RW-03.

3.0.1.5 **Per Recruit and Equilibrium Analyses** Static spawning potential ratio (static SPR) of each year was computed as the asymptotic spawners per recruit given that year's fishery-specific Fs and selectivities, divided by spawners per recruit that would be obtained in an unexploited stock. In this form, static SPR ranges between zero and one, and represents SPR that would be achieved under an equilibrium age structure at the current F (hence the term *static*).

Yield per recruit and spawning potential ratio were computed as functions of F, as were equilibrium landings and spawning biomass. Equilibrium landings and discards were also computed as functions of biomass B, which itself is a function of F. As in computation of MSY-related benchmarks (described in §3.0.1.6), per recruit and equilibrium analyses applied the most recent selectivity patterns averaged across fisheries, weighted by F from the last three years (2009–2011).

3.0.1.6 **Benchmark/Reference Point Methods** In this assessment of Spanish mackerel, the quantities F_{MSY}, SSB_{MSY}, B_{MSY}, and MSY were estimated by the method of Shepherd (1982). In that method, the point of maximum yield is identified from the spawner-recruit curve and parameters describing growth, natural mortality, maturity, and selectivity.

On average, expected recruitment is higher than that estimated directly from the spawner-recruit curve because of lognormal deviation in recruitment. Thus, in this assessment, the method of benchmark estimation accounted for lognormal deviation by including a bias correction in equilibrium recruitment. The bias correction (ς) was computed from the estimated variance (σ^2) of recruitment deviation: $\varsigma = \exp(\sigma^2/2)$. Then, equilibrium recruitment (R_{eq}) associated with any F is,

$$R_{eq} = \frac{R_0 \left[\varsigma 0.8 h \Phi_F - 0.2(1-h)\right]}{(h-0.2)\Phi_F} \tag{2}$$

where R_0 is virgin recruitment, h is steepness, and Φ_F is spawning potential ratio given growth, maturity, and total mortality at age (including natural, fishing, and discard mortality rates). The R_{eq} and mortality schedule imply an equilibrium age structure and an average sustainable yield (ASY). The estimate of F_{MSY} is the F giving the highest ASY (excluding discards), and the estimate of MSY is that ASY. The estimate of SSB_{MSY} follows from the corresponding equilibrium age structure, as do the estimates of discard and bycatch mortalities (D_{MSY} and K_{MSY}, respectively), here separated from ASY (and consequently, MSY).

Estimates of MSY and related benchmarks are conditional on selectivity pattern. The selectivity pattern used here was the effort-weighted selectivities at age estimated over the last three years (2009–2011).

The maximum fishing mortality threshold (MFMT) is defined by the SAFMC as $F_{\rm MSY}$, and the minimum stock size threshold (MSST) as $(1 - M) \times {\rm SSB}_{\rm MSY}$ (Restrepo et al. 1998), with constant M defined here as 0.35. Overfishing is defined as $F >$ MFMT and overfished as SSB $<$ MSST. Current status of the stock and fishery are represented by the geometric mean of the last three assessment years (2009–2011).

In addition to the MSY-related benchmarks, proxies were computed based on per recruit analyses. These proxies include $F_{\rm max}$, $F_{30\%}$, and $F_{40\%}$, along with their associated yields. The value of $F_{\rm max}$ is defined as the F that maximizes yield per recruit; the values of $F_{30\%}$ and $F_{40\%}$ as those Fs corresponding to 30% and 40% spawning potential ratio (i.e., spawners per recruit relative to that at the unfished level). These quantities may serve as proxies for $F_{\rm MSY}$, if the spawner-recruit relationship cannot be estimated reliably. Mace (1994) recommended $F_{40\%}$ as a proxy; however, later studies have found that $F_{40\%}$ is too high across many life-history strategies (Williams and Shertzer 2003; Brooks et al. 2009) and can lead to undesirably low levels of biomass and recruitment (Clark 2002).

3.0.1.7 **Uncertainty and Measures of Precision** The effects of uncertainty in model structure was partially examined by applying many configurations of two assessment models—the catch-age model and a surplus-production model—with quite different mechanistic structure. For the base run of the catch-age model (BAM), uncertainty in results and precision of estimates was computed more thoroughly through a mixed Monte Carlo and bootstrap (MCB) approach. Monte Carlo and bootstrap methods (Efron and Tibshirani 1993; Manly 1997) are often used to characterize uncertainty in ecological studies, and the mixed approach has been applied successfully in stock assessment (Restrepo et al. 1992; Legault et al. 2001; SEDAR 2004; 2009; 2010; 2011a). The approach is among those recommended for use in SEDAR assessments (SEDAR Procedural Guidance 2010).

The approach translates uncertainty in model input into uncertainty in model output, by fitting the model many times with different values of "observed" data and key input parameters. A chief advantage of the approach is that the results describe a range of possible outcomes, so that uncertainty is characterized more thoroughly than it could be by any single fit or handful of sensitivity runs. A minor disadvantage of the approach is that computational demands are relatively high.

In this assessment, the BAM was successively re-fit in $n = 3200$ trials that differed from the original inputs by bootstrapping on data sources, and by Monte Carlo sampling of several key input parameters. The value of $n = 3200$ was chosen because at least 3000 runs were desired, and it was anticipated that not all runs would be valid. Of the 3200 trials, approximately 3.3% were discarded, because the model did not properly converge or provided unlikely combinations of data. This left $n = 3095$ trials used to characterize uncertainty, which was sufficient for convergence of standard errors in management quantities.

The MCB analysis should be interpreted as providing an approximation to the uncertainty associated with each output. The results are approximate for two related reasons. First, not all combinations of Monte Carlo parameter inputs are equally likely, as biological parameters might be correlated. Second, all runs are given equal weight in the results, yet some might provide better fits to data than others.

3.0.1.7.1 **Bootstrap of observed data** To include uncertainty in time series of observed landings, discards, and indices of abundance, multiplicative lognormal errors were applied through a parametric bootstrap. To implement this approach in the MCB trials, random variables ($x_{s,y}$) were drawn for each year y of time series s from a normal distribution with mean 0 and variance $\sigma^2_{s,y}$ [that is, $x_{s,y} \sim N(0, \sigma^2_{s,y})$]. Annual observations were then perturbed from their original values ($\hat{O}_{s,y}$),

$$O_{s,y} = \hat{O}_{s,y}[\exp(x_{s,y} - \sigma^2_{s,y}/2)] \quad (3)$$

The term $\sigma^2_{s,y}/2$ is a bias correction that centers the multiplicative error on the value of 1.0. Standard deviations in log space were computed from CVs in arithmetic space, $\sigma_{s,y} = \sqrt{\log(1.0 + CV^2_{s,y})}$. As used for fitting the base run, CVs of landings and discards were assumed to be 0.05, and CVs of indices of abundance were those provided by, or modified from, the DW (tabulated in §2 of this assessment report).

Uncertainty in age compositions were included by drawing new distributions for each year of each data source, following a multinomial sampling process. Ages of individual fish were drawn at random with replacement using the cell probabilities of the original data. For each year of each data source, the number of individuals sampled was the same as in the original data (number of fish).

3.0.1.7.2 **Monte Carlo sampling** In each successive fit of the model, several parameters were fixed (i.e., not estimated) at values drawn at random from distributions described below.

Steepness Steepness was fixed at 0.75 for the base run, and a likely range of 0.60 to 0.90 was determined by the AW after examining a likelihood profile over all potential values of steepness (see SEDAR28-RW-04). Uncertainty in the parameters was then characterized by a truncated normal distribution with 0.6 and 0.9 as the lower and upper bounds respectively.

Natural mortality Point estimates of natural mortality ($M = 0.35$) were provided by the DW, but with some uncertainty. To carry forward this source of uncertainty, Monte Carlo sampling was used to generate deviations from the point estimate. A new M value was drawn for each MCB trial from a truncated normal distribution (DW range [0.16, 0.54]) with mean equal to the point estimate ($M = 0.35$) and standard deviation set to provide 95% confidence limits at the bounds. Each realized value of M was used to scale the age-specific Lorenzen M, as in the base run.

Discard mortalities Similarly, discard mortalities δ were subjected to Monte Carlo variation as follows. A new value for recreational discard mortality was drawn for each MCB trial from a truncated normal distribution (DW range [0.10, 0.30]) with mean equal to the point estimate ($\delta = 0.20$) and standard deviation set to provide 95% confidence limits at the bounds.

Historical recreational landings (1950-1980) Annual estimates of historical recreational landings were provided by the DW with the associated 95% confidence interval. Monte Carlo sampling was used to generate deviations from the annual point estimates. A multiplier was drawn from a truncated normal distribution (range [0.51, 1.42] with a mean=1.0 and the standard deviation of 0.25, as recommended by the DW.

3.0.1.8 **Projection methods** Projections were run to predict stock status for ten years after the assessment, 2012–2021. The structure of the projection model was the same as that of the assessment model, and parameter estimates were those from the assessment base run. Time-varying quantities, such as fishery selectivity curves, were fixed to the most recent values of the assessment period. Fully selected F was apportioned between landings, discard, and bycatch mortalities according to the selectivity curves averaged across fisheries, using the geometric mean of F from the last three years of the assessment period.

Initialization of projections In projections, any change in fishing effort was assumed to start in 2013. The initial abundance at age in the projection (start of 2012), other than at age 0, was taken to be the 2011 estimates from the assessment, discounted by 2011 natural and fishing mortalities. The initial abundance at age 0 was computed using the estimated spawner-recruit model and the 2012 estimate of SSB. The fully selected fishing mortality rate in the initialization period was taken to be the geometric mean of fully selected F during 2009–2011.

Annual predictions of SSB (mid-year), F, recruits, landings, and discards were represented by deterministic projections. These projections were built on the estimated spawner-recruit relationship with bias correction, and were thus consistent with estimated benchmarks in the sense that long-term fishing at F_{MSY} would yield MSY from a stock size at $\mathrm{SSB}_{\mathrm{MSY}}$. Uncertainty in future time series was quantified through Monte Carlo simulations.

Stochasticity of projections The projections were run using the replicate assessment runs from the MCB analysis in order to carry forward the uncertainty around steepness, natural mortality, discard mortality and historical recreational landings. Projections used a Monte Carlo procedure to generate stochasticity in the spawner-recruit relationship. The Beverton–Holt model (without bias correction), fit by the assessment, was used to compute expected annual recruitment values ($\bar{R}_y$). Variability was added to the expected values by selecting multiplicative deviations at random from the recruitment deviations estimated for that particular MCB run (see SEDAR28-RW-04).

The Monte Carlo procedure generated 10000 replicate projections, each with a different stream of stochastic recruitments, and each with a different annual estimate of SSB, F, recruitment, landings, and discards. Precision of projections was represented by the 10^{th} and 90^{th} percentiles of the 10000 stochastic projections.

Projection scenarios Two constant-F projection scenarios were considered:

- Scenario 1: $F = F_{\mathrm{MSY}}$
- Scenario 2: $F = F_{\mathrm{current}}$, defined as the geometric mean F for 2009–2011

3.0.2 Model 1 Results

3.0.2.1 Measures of Overall Model Fit Overall, the catch-at-age model fit the available data well. Annual fits to age compositions from each fishery were reasonable in most years (Figure 3.2). Residuals of these fits, by year and fishery, are summarized with bubble plots; differences between annual observed and predicted vectors are summarized with angular deviation (Figures 3.3–3.7). Angular deviation is defined as the arc cosine of the dot product of two vectors.

The model was configured to fit observed commercial and recreational landings closely (Figures 3.8–3.12, and Tables 3.7–3.8). In addition, it fit well to observed recreational discards (Figure 3.13) and to "observed" shrimp bycatch (Figure 3.14).

Fits to indices of abundance were reasonable, though the MRFSS index was generally underfit between 1996 and 2003. (Figures 3.15–3.17). The SEAMAP index suggests highly variable recruitment from year to year; however, mismatches between trawl surveys and the timing of migration are an alternative explanation for the variability.

3.0.2.2 Parameter Estimates Estimates of all parameters from the catch-age model are shown in SEDAR28-RW-03.

3.0.2.3 Stock Abundance and Recruitment Estimated abundance at age shows truncation of the oldest ages during the late 1970s through the mid 1980s (Figure 3.18)); however, the stock appears to have rebounded to numbers last seen in the mid 1970s. Annual number of recruits is shown in Figure 3.19. Recruitment in recent years was estimated to be below average overall.

3.0.2.4 Stock Biomass (total and spawning stock) Estimated biomass at age follows a similar pattern of truncation as did abundance (Table 3.1 and Figure 3.20). Total biomass and spawning biomass show nearly identical trends—sharp decline in the 1970s and early 1980's ostensibly due to a high volume of landings in the commercial gill net fishery. The stock was estimated to be at its lowest point in the early-mid 1980s, and since has added substantial biomass (Table 3.2).

3.0.2.5 Fishery Selectivity Estimated selectivities of landings from recent years indicate that full selection occurs by age four for all fisheries (age 4 for handlines and cast nets, age 2 for gill nets and pound nets, and age 1 for recreational fisheries). Average selectivities of landings, discard mortality, and all fishing-related mortalities combined were computed from F-weighted selectivities in the most recent period of regulations. These average selectivities were used to compute benchmarks and in projections. All selectivities from the most recent period, including average selectivities, are presented in Table 3.3 and Figures 3.21–3.27.

3.0.2.6 Fishing Mortality The estimated time series of fishing mortality rate (F) shows a peak in the late 1970s followed by about ten years of similarly high rates. The rates dropped substantially in the mid-1990s, likely due to the Florida net ban (Figure 3.28). Since 2000, the model suggests that fishing mortality rates have been between 0.35 and 0.5.

Historically, the majority of the full F was dominated by gill net and recreational fisheries, with a shift in the most recent years to include a larger percentage of mortality attributable to the commercial cast net and handline fisheries (Figure 3.28, Table 3.4).

Total mortality Z at age is shown in Tables 3.5 & 3.6 for males and females, respectively.

In any given year, the maximum F at age may be less than that year's fully selected F. This inequality is due to the combination of two features of estimated selectivities: full selection occurs at different ages among gears and several sources of mortality (cast net, pound net, and recreational) have dome-shaped selectivity.

Throughout most of the assessment period, estimated landings and discard mortalities in number of fish have been dominated by commercial gill net and recreational sectors (Figures 3.29 and 3.30). Table 3.9 shows total landings at age in numbers, and Table 3.10 in 1000 lb. Total landings and discards by year and sector are presented in 1000 lb for landings and in number for discards and shrimp bycatch.

3.0.2.7 Stock-Recruitment Parameters The estimated Beverton–Holt spawner-recruit curve is shown in Figure 3.31. Variability about the curve was estimated only at relatively low levels of spawning biomass, because composition data required for estimating recruitment deviations became available only after spawning stock had been diminished. The effect of density dependence on recruitment can be examined graphically via the estimated recruits per spawner as a function of spawners (Figure 3.31).

3.0.2.8 Per Recruit and Equilibrium Analyses Static spawning potential ratio (static SPR) was variable but showed a decreasing trend from the late 1960s to a minimum 1980. Since then, static SPR has steadily increased (Figure 3.32, Table 3.2). This increase is likely attributable to a variety of factors, possibly including (a) increased prominence of the commercial handlines sector which typically select older fish, and (b) overall reduced fishing mortality.

Yield per recruit and spawning potential ratio were computed as functions of F (Figure 3.33), as were equilibrium landings and spawning biomass (Figures 3.34). Equilibrium landings and discards were also computed as functions of biomass B, which itself is a function of F (Figure 3.35). As in computation of MSY-related benchmarks, per recruit analyses applied the most recent selectivity patterns averaged across fisheries, weighted by F from the last three years (2009–2011).

3.0.2.9 **Benchmarks / Reference Points** As described in §3.0.1.6, biological reference points (benchmarks) were derived analytically assuming equilibrium dynamics, corresponding to the estimated spawner-recruit curve with bias correction (Figure 3.31). This approach is consistent with methods used in rebuilding projections (i.e., fishing at F_{MSY} yields MSY from a stock size of $\mathrm{SSB}_{\mathrm{MSY}}$). Reference points estimated were $F_{\mathrm{MSY}} = 0.69$, $B_{\mathrm{MSY}} = 9548$ and $\mathrm{SSB}_{\mathrm{MSY}} = 3266$. Based on F_{MSY}, three possible values of F at optimum yield (OY) were considered: $F_{\mathrm{OY}} = 65\%F_{\mathrm{MSY}}$, $F_{\mathrm{OY}} = 75\%F_{\mathrm{MSY}}$, and $F_{\mathrm{OY}} = 85\%F_{\mathrm{MSY}}$. Uncertainty of benchmarks was computed through bootstrap analysis of the spawner-recruit curve, as described in §3.0.1.7.

Estimates of benchmarks are summarized in Table 3.11. Distributions of these benchmarks are shown in Figure 3.36.

3.0.2.10 **Status of the Stock and Fishery** Estimated time series of B/B_{MSY} and $\mathrm{SSB}/\mathrm{SSB}_{\mathrm{MSY}}$ show similar patterns: the stock was at a steady size until the mid 1970s when the stock quickly declined to the lowest biomass in the mid-1980s. The stock size stayed at a low level for about 10 years and has been steadily increasing since 1995 (Figures 3.37 & 3.38, Table 3.2). Current stock status was estimated to be $\mathrm{SSB}_{2011}/\mathrm{SSB}_{\mathrm{MSY}} = 1.49$ and $\mathrm{SSB}_{2011}/\mathrm{MSST} = 2.29$, indicating that the stock is not overfished (Table 3.11).

The estimated time series of F/F_{MSY} shows a generally steady value until the mid 1970s when increased fishing pressure changed the magnitude of the overall fishing mortality. The general trend is decreasing since the early 1990s (Figure 3.37, Table 3.2), and the most recent estimate ($F_{\mathrm{current}} = 0.36$) indicates that the stock is not experiencing overfishing (Table 3.11).

3.0.2.11 **Uncertainty Analysis** The Monte Carlo bootstrap results indicate that there is some uncertainty around the estimates of stock status (Figure 3.39). In general, there appears to be a small probability of overfishing and/or and overfished status under certain combinations of input data (Figures 3.39–3.40). Although all possible combinations of data used by the MCB analysis are not equally likely, the uncertainty is demonstrated in the plots of F/F_{MSY} and $\mathrm{SSB}/\mathrm{SSB}_{\mathrm{MSY}}$ (Figures 3.36–3.41).

3.0.2.12 **Sensitivities and Retrospective Runs** Uncertainty in results of the base assessment model was evaluated through sensitivity and retrospective analyses, as described in §3.0.1.3 and is shown in Table 3.12 and Figure 3.42. Plotted are time series of F/F_{MSY} and $\mathrm{SSB}/\mathrm{SSB}_{\mathrm{MSY}}$ for variation in natural mortality, the influence of early recreational angling records, different assumptions of the proportion female, differences in steepness, and weighting of likelihood components (Figures 3.43 − 3.48). Retrospective analyses did not show any concerning trends, and in general, results of sensitivity analyses were similar to those in the base model run. (Figures 3.49–3.54). In particular, the runs indicated that the stock was not overfished and that the stock is not experiencing overfishing.

3.0.2.13 **Projections** Projection scenario 1, in which $F = Fmsy$, predicted the stock to reach MSY related benchmarks over time. The stock is currently fished at a fishing mortality rate that is less than F_{MSY}, so the increase in F would drive the stock size down (Figure 3.55, Table 3.13).

Projection scenario 2, in which $F = F_{\mathrm{current}}$, predicted the stock to increase over time, as the stock is not experiencing overfishing (Figure 3.56, Table 3.14). Since the stock status is not overfished or undergoing overfishing, these projections are provided for completeness.

3.1 Model 2: Surplus Production Model

3.1.1 Model 2 Methods

3.1.1.1 Overview Assessments based on age or length structure are often favored because they incorporate more data on the structure of the population. However, these approaches typically involve fitting a large number of parameters to the data, decomposing population change into a number of processes including growth, mortality, and recruitment. A simplified approach, which may sacrifice some bias in favor of precision, is to aggregate data across age or length classes, and to summarize the relationship between complex population processes by using a simple mathematical model such as a logistic population model.

A logistic surplus production model, implemented in ASPIC (Prager 2005), was used to estimate stock status of Spanish mackerel off the southeastern U.S. While primary assessment of the stock was performed via the age-structured model, the surplus production approach was intended as a complement, and for additional verification that the age-structured approach was providing reasonable results.

3.1.1.2 Data Sources The surplus-production model was fit using a single time series of removals, which included landings and dead discards, and the Florida trip ticket and MRFSS indices. All updates to the data after the data workshop, including final 2011 data and updated indices and shrimp bycatch estimates, were extended to the ASPIC model input.

Landings The SEDAR-28 DW provided estimates of commercial landings in pounds (whole weight) and recreational landings in numbers of fish. For use in the production model, all landings were combined into a single time series in units of pounds. Thus, recreational landings were converted to pounds, which was accomplished by multiplying landings in numbers by the annual mean weight of an individual from the MRFSS sampling program and developed at the DW.

Dead Discards Estimates of total discards (alive and dead) were provided in numbers for the recreational fishery. These estimates were converted to numbers of dead discards by applying the discard mortality rate suggested by the DW and then converted to units of pounds by multiplying by a factor of the proportion at length and weight at length of fish below the 12 inch size limit. The discards for shrimp bycatch were assumed to have 100% mortality and were converted to weight using the average size of Atlantic Spanish mackerel measured in the shrimp observer sampling across all years and the associated weight at length. The dead discards in weight were combined with the total landings for input to the ASPIC model.

Index of abundance Estimates of relative abundance were provided by the SEDAR-28 DW using data from commercial Florida trip tickets, MRFSS, and the SEAMAP trawl survey which samples young of the year fish. Only the Florida trip ticket and MRFSS indices were used in the production model. The MRFSS index was converted from units of fish per angler-hour to pounds per angler-hour using the annual estimate of individual mean weight of fish measured in the MRFSS sampling program.

The data input to the base production model run is provided in table 2.9.

3.1.1.3 Model Configuration and Equations Production modeling used the model formulation and ASPIC software of Prager (1994; 2005). This is an observation-error estimator of the continuous-time form of the Schaefer (logistic) production model (Schaefer 1954; 1957). Modeling was conditioned on catch.

The logistic model for population growth is the simplest form of a differential equation which satisfies a number of ecologically realistic constraints, such as a carrying capacity (a consequence of limited resources). When written in terms of stock biomass, this model specifies that

$$\frac{dB_t}{dt} = rB_t - \frac{r}{K}B_t^2, \tag{4}$$

where B_t is biomass in year t, r is the intrinsic rate of increase in absence of density dependence, and K is carrying capacity (Schaefer 1954; 1957). This equation may be rewritten to account for the effects of fishing by introducing an instantaneous fishing mortality term, F_t:

$$\frac{dB_t}{dt} = (r - F_t)B_t - \frac{r}{K}B_t^2. \tag{5}$$

By writing the term F_t as a function of catchability coefficients and effort expended by fishermen in different fisheries, Prager (1994) showed how to estimate model parameters from time series of yield and effort. Nonparametric confidence intervals on parameters were estimated through bootstrap.

The base run was structured to allow B_1/K to be estimated and initial guesses for MSY and K were set following the guidance in the ASPIC documentation. The updates to the data between the end of the DW and the final data had little influence on the models ability to converge or the results.

3.1.2 Model 2 Results

3.1.2.1 Model Fit Fits to indices from the base run of the surplus production model are shown in Figure 3.59. In general, fits to overall index trend was adequate, but missed some year to year variation.

The base run estimated B_1/K at 0.38 in 1950, which falls within the range of values expected.

3.1.2.2 Parameter Estimates and Uncertainty Parameter estimates and MSY benchmarks from the base surplus production model run are tabulated in SEDAR28-RW04, along with estimates of bias and precision.

3.1.2.3 Status of the Stock and Fishery Estimates of annual biomass from the base production model have been above MSY since the late 1990s, while estimates of F indicate some years of overfishing between 1975 and 1994. Since then, the base model suggests no overfishing from 1995-2011 (Figure 3.60). The estimate of F_{2011}/F_{MSY} indicates no overfishing in the terminal year..

Sensitivity analyses of the estimate of B_1/K in the production model was evaluated by fixing B_1/K at 0.2 0.5 and 0.9. The runs showed different trends during the early years but converged to very similar values to the base run in the terminal year. The F_{2011}/F_{MSY} was estimated at 0.55, 0.64, and 0.64 respectively compared to the base run F_{2011}/F_{MSY} estimate of 0.64. The B_{2012}/B_{MSY} was estimated at 1.20, 1.29, and 1.29 respectively compared to the base run B_{2012}/B_{MSY} estimate of 1.29.

3.2 Discussion

3.2.1 Comments on Assessment Results

Estimated benchmarks play a central role in this assessment. Values of $\mathrm{SSB}_{\mathrm{MSY}}$ and F_{MSY} are used to gauge status of the stock and fishery, and the computation of benchmarks is conditional on selectivity. If selectivity patterns change in the future, for example as a result of new management regulations or quota reallocations among fishery sectors, estimates of benchmarks would likely change as well.

The base run of the age-structured assessment model indicated that the stock is not overfished ($\mathrm{SSB}_{2009-2011}/\mathrm{SSB}_{\mathrm{MSY}} = 1.49$) and that overfishing is not occurring ($F_{2011}/F_{\mathrm{MSY}} = 0.57$). The sensitivity analyses yielded similar results and there was no retrospective pattern of concern. Conclusions about stock status during the MCB analysis were most sensitive to different combinations of input data and variance around fixed parameters (steepness, recreational discard mortality, historical recreational landings and natural mortality).

There is a lack of available fishery independent indices of abundance for this species. Many of the indices of abundance that were made available to the DW were rejected due to concerns about the way the fishers targeted Spanish mackerel. The schooling behavior of Spanish mackerel makes a random survey of their population particularly difficult. The one fishery independent index used (SEAMAP young of the year) highly variable, as would be expected for a recruitment index.

Steepness was not estimable for this configuration of a base run, and there is little guidance in the primary literature or from the DW to determine appropriate priors or expected values of steepness. Although steepness is a large source of uncertainty for this assessment, our treatment of the parameter in the MCB analysis fully explored plausible values for the parameter.

The qualitative findings between the catch-age model and the surplus production model agree, which is notable, due to the added complexity of the catch-age model.

3.3 Comments on the Projections

As usual, projections should be interpreted in light of the model assumptions and key aspects of the data. Some major considerations are the following:

- In general, projections of fish stocks are highly uncertain, particularly in the long term (e.g., beyond 5–10 years).
- Although projections included many major sources of uncertainty, they did not include structural (model) uncertainty. That is, projection results are conditional on one set of functional forms used to describe population dynamics, selectivity, recruitment, etc.
- Fisheries were assumed to continue fishing at their estimated current proportions of total effort, using the estimated current selectivity patterns. New management regulations that alter those proportions or selectivities would likely affect projection results.
- The projections assumed that the estimated spawner-recruit relationship applies in the future and that past residuals represent future uncertainty in recruitment. If future recruitment is characterized by runs of large or small year classes, possibly due to environmental or ecological conditions, stock trajectories may be affected.
- Projections apply the Baranov catch equation to relate F and landings using a one-year time step, as in the assessment. The catch equation implicitly assumes that mortality occurs throughout the year. This assumption is violated when seasonal closures are in effect, introducing additional and unquantified uncertainty into the projection results.

3.4 Research Recommendations

The research recommendations from the AW panel were as follows:

- Establish a fishery–independent survey meant to capture the population trends of coastal pelagics in the south Atlantic.
- Examine how schooling or migratory dynamics may influence the catchability of the species. In particular, research the assumption of the hyperstability of indices that sample the schooling portion of the stock.
- Determine whether it is important to model both sexes in the population for assessment purposes.

3.5 References

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3.6 Tables

Table 3.1. Estimated biomass at age (1000 lb) at start of year

Year	0	1	2	3	4	5	6	7	8	9	10	Total
1950	1055.4	6193.9	8289.6	6967.9	5004.5	3315.5	2099.0	1293.9	784.6	471.1	682.8	36158.0
1951	1069.9	6208.2	8599.4	7476.1	5275.7	3486.2	2207.0	1360.5	825.0	495.2	717.8	37720.9
1952	1078.7	6313.6	8904.0	8262.3	6034.5	3916.1	2472.7	1524.1	924.4	554.9	804.5	40789.3
1953	1082.7	6342.0	8805.9	8159.7	6422.9	4325.0	2682.8	1649.5	1000.2	600.5	870.6	41941.8
1954	1088.0	6362.8	8850.0	8066.1	6320.4	4585.6	2950.7	1781.8	1077.8	647.1	938.1	42668.5
1955	1091.9	6401.1	9033.0	8445.7	6559.9	4748.8	3296.4	2065.5	1227.3	735.0	1065.5	44670.1
1956	1090.4	6414.6	8868.1	8331.0	6658.8	4767.5	3298.1	2229.3	1373.9	808.2	1168.7	45008.5
1957	1087.1	6386.1	8694.4	7829.5	6240.4	4593.8	3143.6	2117.3	1408.1	859.1	1218.3	43577.5
1958	1078.1	6363.4	8655.1	7711.3	5936.4	4362.5	3069.9	2045.2	1355.4	892.2	1297.6	42767.0
1959	1074.8	6271.3	8184.9	6912.4	5211.5	3691.9	2592.0	1776.0	1164.0	763.5	1216.1	38858.5
1960	1081.6	6302.8	8698.3	7626.9	5539.3	3851.7	2607.6	1782.4	1201.5	779.6	1306.5	40778.2
1961	1085.6	6341.6	8766.0	8156.2	6163.5	4128.6	2743.2	1808.0	1215.8	811.3	1387.8	42607.4
1962	1088.4	6347.5	8649.4	7966.8	6404.6	4474.5	2866.0	1854.3	1202.4	800.5	1426.4	43080.8
1963	1092.4	6372.7	8779.7	8057.7	6408.4	4754.7	3175.3	1980.0	1260.2	808.9	1475.8	44165.4
1964	1096.1	6393.8	8834.8	8257.2	6572.0	4829.0	3426.0	2228.2	1366.9	861.1	1537.7	45402.7
1965	1097.9	6417.4	8901.2	8376.9	6793.3	4993.2	3506.9	2422.4	1550.3	941.4	1627.5	46628.2
1966	1098.8	6413.2	8793.6	8210.2	6699.6	5019.7	3528.1	2412.7	1639.8	1039.0	1695.8	46550.4
1967	1101.2	6421.8	8861.5	8265.6	6704.3	5056.1	3622.9	2479.8	1668.5	1122.6	1844.8	47148.7
1968	1099.7	6439.3	8947.7	8453.2	6853.3	5132.1	3699.4	2581.0	1738.1	1157.6	2028.7	48129.8
1969	1097.7	6398.7	8623.6	7927.2	6492.8	4862.3	3481.1	2443.4	1677.3	1118.2	2019.4	46141.6
1970	1096.4	6400.9	8776.6	8034.3	6435.7	4872.4	3489.3	2432.6	1679.9	1141.6	2103.7	46463.1
1971	1095.0	6376.0	8602.9	7877.1	6279.6	4649.5	3366.5	2347.7	1610.3	1101.0	2095.1	45400.7
1972	1094.4	6378.6	8696.4	7953.0	6351.1	4676.2	3308.9	2332.7	1600.6	1086.7	2124.4	45602.6
1973	1092.6	6361.2	8569.6	7840.7	6263.8	4620.0	3251.4	2239.9	1553.6	1055.4	2085.1	44933.1
1974	1092.6	6347.5	8527.7	7734.9	6196.1	4573.9	3224.9	2210.1	1497.8	1028.5	2047.2	44481.6
1975	1088.9	6353.9	8599.4	7880.9	6276.3	4644.5	3277.4	2249.8	1517.0	1017.7	2058.0	44963.7
1976	1067.0	6296.8	8218.2	7287.6	5831.9	4288.0	3033.3	2084.3	1407.7	939.6	1876.1	42330.7
1977	1023.2	6093.6	7331.0	5639.9	4256.9	3133.0	2201.5	1516.6	1025.4	685.6	1350.3	34257.2
1978	993.6	5784.9	6543.8	4335.8	2848.4	1979.1	1392.0	952.4	645.5	432.1	844.8	26752.4
1979	991.0	5676.9	6868.9	4744.1	2740.3	1660.3	1102.1	754.6	507.9	340.8	664.0	26051.4
1980	962.3	5696.3	6892.5	5188.6	3133.4	1669.6	966.1	624.3	420.6	280.2	545.9	26380.1
1981	943.6	5382.6	5798.4	3702.9	2389.6	1330.7	677.3	381.4	242.3	161.6	312.8	21322.7
1982	515.9	5391.6	6308.5	4200.9	2369.5	1412.1	751.6	372.1	206.1	129.6	250.0	21908.2
1983	402.3	2874.4	6318.0	4675.1	2775.8	1445.6	823.4	426.8	207.9	114.0	206.8	20270.0
1984	585.8	2194.7	3307.6	4141.2	2571.9	1407.7	700.2	388.2	198.0	95.5	145.1	15735.5
1985	833.8	3313.8	2344.8	2338.2	2834.3	1635.6	856.3	414.5	226.2	114.2	136.7	15048.3
1986	1343.9	4713.3	3560.9	1442.5	1265.9	1422.0	784.4	400.1	190.5	103.0	112.4	15338.9
1987	524.9	7611.9	4919.2	2158.8	786.4	640.9	690.3	371.0	186.3	87.7	97.9	18075.3
1988	818.1	2962.6	8440.0	3340.2	1319.0	447.8	350.1	368.2	194.7	96.8	95.2	18432.6
1989	675.3	4612.1	2856.1	5330.3	2138.5	794.1	258.8	197.3	204.4	106.9	104.1	17277.8
1990	956.1	3769.5	4749.2	1866.0	3335.2	1262.4	451.1	143.5	107.6	110.5	112.7	16863.8
1991	969.2	5413.7	3845.1	3135.4	1201.3	2021.4	737.7	257.3	80.5	59.7	122.4	17843.8
1992	570.6	5437.3	5347.3	2334.0	1816.8	653.2	1056.2	376.3	129.2	40.1	89.3	17850.4
1993	721.4	3217.0	6057.2	3877.9	1582.9	1152.8	397.9	627.2	220.2	75.0	73.9	18003.4
1994	901.9	4049.5	3306.3	3755.8	2230.6	850.1	594.1	200.0	310.4	108.0	71.9	16378.8
1995	660.5	5046.2	4056.9	2049.9	2223.1	1237.7	452.8	308.6	102.3	157.2	90.2	16385.2
1996	807.6	3721.0	5773.9	2844.2	1261.5	1266.6	675.5	241.0	162.0	53.1	127.0	16933.3
1997	593.9	4584.1	4182.6	4136.5	1859.2	766.8	739.0	385.8	136.2	90.8	99.4	17574.6
1998	843.0	3340.9	5103.0	2977.1	2675.8	1116.6	441.8	419.8	219.1	76.9	106.3	17320.6
1999	944.9	4812.7	3936.8	3816.4	1979.3	1646.9	658.3	254.6	239.2	123.9	102.1	18515.1
2000	713.0	5389.4	5649.6	3072.1	2730.6	1316.6	1050.9	410.9	157.0	146.4	136.7	20773.1
2001	797.4	4040.6	6320.4	4395.4	2138.0	1754.7	812.2	642.4	253.1	96.3	171.7	21422.5
2002	1110.9	4562.5	4713.3	4821.5	2911.4	1302.3	1031.3	483.3	396.8	157.4	164.9	21655.6
2003	795.6	6381.1	5377.5	3678.2	3263.9	1807.6	779.8	625.7	304.7	252.2	202.8	23469.3
2004	970.5	4573.5	8041.1	4303.9	2291.0	1840.9	990.1	450.2	397.1	198.4	294.3	24350.9
2005	812.4	5633.0	6027.4	6650.5	2655.5	1271.4	993.2	567.7	287.0	260.6	321.0	25479.5
2006	813.7	4702.2	7258.7	4945.9	4294.8	1551.8	716.9	576.5	350.5	179.9	360.9	25752.2
2007	1143.1	4728.7	6152.2	5997.0	3207.1	2526.1	880.5	416.9	354.5	218.3	333.1	25957.2
2008	1125.5	6632.4	5899.3	4938.1	3959.3	1927.3	1462.5	517.2	255.3	218.9	336.9	27272.7
2009	668.2	6522.2	8357.7	4962.2	3549.9	2610.3	1220.5	922.9	331.6	163.6	351.6	29660.8
2010	852.5	3860.1	8281.7	6952.3	3441.2	2256.7	1598.4	749.6	580.9	209.2	321.0	29103.4
2011	545.0	4927.1	4801.4	6633.3	4498.5	2021.4	1280.2	929.2	460.3	361.3	326.3	26784.4
2012	831.8	3149.7	6340.5	4057.6	4617.1	2855.9	1235.3	790.1	593.7	295.9	437.8	25205.2

Table 3.2. Estimated time series and status indicators. Fishing mortality rate is full F, which includes discard mortalities. Total biomass (B, mt) is at the start of the year, and spawning biomass (SSB, mt) at the end of July (time of peak spawning). The MSST *is defined by* $\text{MSST} = (1 - M)\text{SSB}_{\text{MSY}}$*, with constant* $M = 0.10$*. SPR is static spawning potential ratio.*

Year	F	F/F_{MSY}	B	B/B_{unfished}	SSB	$\text{SSB}/\text{SSB}_{\text{MSY}}$	SSB/MSST	SPR
1950	0.1517	0.219	16401	0.670	6753	2.068	10390	0.610
1951	0.0893	0.129	17110	0.699	7295	2.233	11223	0.745
1952	0.1253	0.181	18502	0.755	7804	2.389	12007	0.651
1953	0.1299	0.188	19025	0.777	8059	2.467	12399	0.646
1954	0.0846	0.122	19354	0.790	8415	2.576	12946	0.750
1955	0.1316	0.190	20262	0.827	8708	2.666	13396	0.664
1956	0.1869	0.270	20416	0.834	8589	2.630	13214	0.573
1957	0.1738	0.251	19766	0.807	8347	2.556	12842	0.586
1958	0.2916	0.421	19399	0.792	7764	2.377	11944	0.437
1959	0.1205	0.174	17626	0.720	7575	2.319	11654	0.689
1960	0.1131	0.163	18497	0.755	7986	2.445	12285	0.707
1961	0.1460	0.211	19326	0.789	8253	2.527	12696	0.641
1962	0.1207	0.174	19541	0.798	8447	2.586	12995	0.693
1963	0.1098	0.159	20033	0.818	8728	2.672	13428	0.721
1964	0.1015	0.147	20594	0.841	9026	2.763	13886	0.742
1965	0.1337	0.193	21150	0.864	9169	2.807	14106	0.673
1966	0.1151	0.166	21115	0.862	9247	2.831	14227	0.719
1967	0.0990	0.143	21386	0.873	9439	2.890	14522	0.757
1968	0.1793	0.259	21831	0.891	9312	2.851	14326	0.589
1969	0.1256	0.181	20930	0.855	9141	2.799	14063	0.699
1970	0.1664	0.240	21075	0.861	9042	2.768	13911	0.616
1971	0.1370	0.198	20593	0.841	8946	2.739	13763	0.678
1972	0.1642	0.237	20685	0.845	8881	2.719	13663	0.625
1973	0.1657	0.239	20381	0.832	8751	2.679	13463	0.627
1974	0.1421	0.205	20176	0.824	8756	2.681	13470	0.680
1975	0.2416	0.349	20395	0.833	8481	2.596	13047	0.513
1976	0.4881	0.705	19201	0.784	7146	2.188	10993	0.307
1977	0.6369	0.920	15539	0.634	5347	1.637	8226	0.236
1978	0.4107	0.593	12135	0.495	4525	1.385	6962	0.346
1979	0.3618	0.523	11817	0.482	4459	1.365	6860	0.381
1980	0.7366	1.064	11966	0.489	3853	1.180	5928	0.203
1981	0.4182	0.604	9672	0.395	3527	1.080	5426	0.345
1982	0.4238	0.612	9937	0.406	3731	1.142	5741	0.352
1983	0.5476	0.791	9194	0.375	3308	1.013	5088	0.272
1984	0.4769	0.689	7137	0.291	2759	0.845	4244	0.327
1985	0.5890	0.851	6826	0.279	2337	0.715	3595	0.251
1986	0.6144	0.888	6958	0.284	2218	0.679	3413	0.244
1987	0.5009	0.724	8199	0.335	2813	0.861	4328	0.299
1988	0.6044	0.873	8361	0.341	2859	0.875	4399	0.258
1989	0.5543	0.801	7837	0.320	2740	0.839	4216	0.276
1990	0.5434	0.785	7649	0.312	2656	0.813	4086	0.285
1991	0.6404	0.925	8094	0.330	2661	0.815	4094	0.239
1992	0.4360	0.630	8097	0.331	2913	0.892	4482	0.347
1993	0.6044	0.873	8166	0.333	2784	0.852	4283	0.250
1994	0.6124	0.885	7429	0.303	2514	0.770	3867	0.248
1995	0.4812	0.695	7432	0.303	2617	0.801	4025	0.315
1996	0.4564	0.660	7681	0.314	2752	0.843	4235	0.335
1997	0.4897	0.708	7972	0.325	2885	0.883	4439	0.324
1998	0.4010	0.580	7856	0.321	2889	0.885	4445	0.369
1999	0.3662	0.529	8398	0.343	3130	0.958	4815	0.414
2000	0.4161	0.601	9422	0.385	3522	1.078	5418	0.395
2001	0.4727	0.683	9717	0.397	3619	1.108	5567	0.372
2002	0.4559	0.659	9823	0.401	3642	1.115	5603	0.392
2003	0.4946	0.715	10645	0.435	3934	1.204	6052	0.395
2004	0.4728	0.683	11045	0.451	4142	1.268	6372	0.422
2005	0.4326	0.625	11557	0.472	4380	1.341	6739	0.424
2006	0.3997	0.578	11681	0.477	4481	1.372	6894	0.437
2007	0.4230	0.611	11774	0.481	4459	1.365	6859	0.414
2008	0.3414	0.493	12371	0.505	4776	1.462	7348	0.480
2009	0.3641	0.526	13454	0.549	5246	1.606	8070	0.459
2010	0.4633	0.670	13201	0.539	5082	1.556	7818	0.402
2011	0.3605	0.521	12149	0.496	4862	1.488	7479	0.472
2012	.	.	11433	0.467	.	.	.	.

Table 3.3. Selectivity at age (end-of-assessment time period) for commercial handline (HL), commercial pound net (PN), commercial gill net (GN), commercial cast net (CN), and recreational (Rec) landings. Selectivity at age for recreational discards (D), and selectivity of landings averaged across fisheries (L.avg). FL is fork length for males (M) and females (F).

Age	FL.M(mm)	FL.F(mm)	HL.M	HL.F	PN.M	PN.F	GN.M	GN.F	CN.M	CN.F	Rec.M	Rec.F	Rec.D.M	Rec.D.F	L.avg.M	L.avg.F
0	129.1	120.8	0.0	0.0	0.176	0.103	0.067	0.039	0.002	0.001	0.045	0.028	1.00	1.00	0.025	0.018
1	300.4	298.1	0.1	0.0	1.000	0.854	0.548	0.408	0.034	0.019	1.000	1.000	0.41	0.34	0.377	0.364
2	398.2	414.6	0.4	0.3	0.901	1.000	0.954	0.921	0.418	0.281	0.444	0.953	0.00	0.00	0.511	0.580
3	454.1	491.2	0.9	0.9	0.449	0.534	0.997	0.995	0.948	0.898	0.023	0.061	0.00	0.00	0.655	0.642
4	486.1	541.4	1.0	1.0	0.180	0.221	1.000	1.000	1.000	1.000	0.001	0.002	0.00	0.00	0.676	0.677
5	504.3	574.5	1.0	1.0	0.066	0.081	1.000	1.000	0.920	0.949	0.000	0.000	0.00	0.00	0.650	0.660
6	514.7	596.2	1.0	1.0	0.023	0.029	1.000	1.000	0.555	0.655	0.000	0.000	0.00	0.00	0.539	0.570
7	520.7	610.5	1.0	1.0	0.008	0.010	1.000	1.000	0.135	0.190	0.000	0.000	0.00	0.00	0.412	0.429
8	524.1	619.8	1.0	1.0	0.003	0.003	1.000	1.000	0.019	0.029	0.000	0.000	0.00	0.00	0.377	0.380
9	526.0	626.0	1.0	1.0	0.001	0.001	1.000	1.000	0.002	0.004	0.000	0.000	0.00	0.00	0.372	0.372
10	527.1	630.0	1.0	1.0	0.000	0.000	1.000	1.000	0.000	0.000	0.000	0.000	0.00	0.00	0.371	0.371

Table 3.4. Estimated time series of fully selected fishing mortality rates for commercial handline (F.HL), commercial pound net (F.PN), commercial gill net (F.GN), commercial cast net (F.CN), recreational (F.rec), recreational discards(F.rec.D), and shrimp bycatch (F.shrimp.B)

Year	F.HL	F.PN	F.GN	F.CN	F.Rec	F.Rec.D	F.shrimp.B	Full F
1950	0.021	0.001	0.128	0.000	0.000	0.000	0.001	0.152
1951	0.028	0.002	0.058	0.000	0.000	0.000	0.001	0.089
1952	0.003	0.003	0.118	0.000	0.000	0.000	0.002	0.125
1953	0.009	0.002	0.117	0.000	0.000	0.000	0.002	0.130
1954	0.006	0.009	0.067	0.000	0.000	0.000	0.003	0.085
1955	0.016	0.003	0.092	0.000	0.018	0.000	0.003	0.132
1956	0.029	0.004	0.131	0.000	0.019	0.000	0.004	0.187
1957	0.013	0.003	0.133	0.000	0.021	0.000	0.004	0.174
1958	0.021	0.001	0.242	0.000	0.022	0.000	0.005	0.292
1959	0.009	0.001	0.082	0.000	0.023	0.000	0.005	0.121
1960	0.008	0.001	0.075	0.000	0.023	0.000	0.006	0.113
1961	0.006	0.007	0.102	0.000	0.025	0.000	0.007	0.146
1962	0.006	0.001	0.080	0.000	0.026	0.000	0.007	0.121
1963	0.003	0.004	0.067	0.000	0.028	0.000	0.008	0.110
1964	0.003	0.002	0.060	0.000	0.029	0.000	0.008	0.101
1965	0.006	0.004	0.084	0.000	0.031	0.000	0.009	0.134
1966	0.007	0.005	0.061	0.000	0.032	0.000	0.009	0.115
1967	0.005	0.001	0.050	0.000	0.033	0.000	0.010	0.099
1968	0.006	0.004	0.125	0.000	0.035	0.000	0.010	0.179
1969	0.004	0.004	0.070	0.000	0.036	0.000	0.011	0.126
1970	0.005	0.005	0.108	0.000	0.038	0.000	0.011	0.166
1971	0.006	0.001	0.077	0.000	0.041	0.000	0.012	0.137
1972	0.005	0.001	0.102	0.000	0.044	0.000	0.012	0.164
1973	0.007	0.003	0.095	0.000	0.048	0.000	0.013	0.166
1974	0.007	0.001	0.069	0.000	0.051	0.000	0.014	0.142
1975	0.016	0.003	0.152	0.000	0.056	0.000	0.014	0.242
1976	0.048	0.004	0.361	0.000	0.059	0.000	0.015	0.488
1977	0.025	0.002	0.529	0.000	0.065	0.000	0.017	0.637
1978	0.008	0.000	0.321	0.000	0.065	0.000	0.018	0.411
1979	0.007	0.000	0.277	0.000	0.064	0.000	0.014	0.362
1980	0.010	0.000	0.636	0.000	0.069	0.000	0.022	0.737
1981	0.011	0.000	0.304	0.000	0.085	0.001	0.017	0.418
1982	0.015	0.002	0.268	0.000	0.096	0.000	0.044	0.424
1983	0.007	0.002	0.461	0.000	0.020	0.000	0.058	0.548
1984	0.008	0.003	0.233	0.000	0.207	0.000	0.026	0.477
1985	0.005	0.006	0.472	0.000	0.087	0.001	0.018	0.589
1986	0.017	0.021	0.448	0.000	0.114	0.003	0.012	0.614
1987	0.022	0.035	0.323	0.000	0.098	0.001	0.022	0.501
1988	0.010	0.036	0.278	0.000	0.259	0.001	0.020	0.604
1989	0.006	0.053	0.299	0.000	0.166	0.003	0.027	0.554
1990	0.018	0.054	0.259	0.000	0.195	0.002	0.016	0.543
1991	0.025	0.045	0.363	0.000	0.185	0.004	0.019	0.640
1992	0.008	0.034	0.227	0.000	0.139	0.005	0.023	0.436
1993	0.015	0.033	0.387	0.000	0.144	0.004	0.020	0.604
1994	0.010	0.036	0.360	0.000	0.179	0.009	0.018	0.612
1995	0.037	0.019	0.307	0.003	0.086	0.005	0.024	0.481
1996	0.023	0.028	0.245	0.012	0.126	0.005	0.017	0.456
1997	0.019	0.020	0.240	0.036	0.144	0.007	0.025	0.490
1998	0.022	0.012	0.239	0.011	0.098	0.003	0.016	0.401
1999	0.026	0.024	0.155	0.010	0.129	0.005	0.017	0.366
2000	0.039	0.013	0.137	0.053	0.145	0.011	0.019	0.416
2001	0.040	0.016	0.121	0.119	0.155	0.006	0.014	0.473
2002	0.048	0.010	0.091	0.123	0.164	0.007	0.012	0.456
2003	0.043	0.006	0.070	0.247	0.107	0.010	0.012	0.495
2004	0.061	0.005	0.043	0.273	0.077	0.005	0.010	0.473
2005	0.080	0.003	0.073	0.173	0.088	0.007	0.009	0.433
2006	0.065	0.003	0.094	0.161	0.065	0.003	0.008	0.400
2007	0.069	0.003	0.098	0.130	0.110	0.006	0.006	0.423
2008	0.075	0.012	0.057	0.071	0.113	0.008	0.005	0.341
2009	0.078	0.021	0.069	0.091	0.090	0.008	0.008	0.364
2010	0.093	0.010	0.068	0.159	0.119	0.008	0.008	0.463
2011	0.070	0.007	0.059	0.114	0.094	0.007	0.011	0.361

Table 3.5. Estimated instantaneous male total mortality rate (per yr) at age, including discard mortality

Year	0	2	3	4	5	6	7	8	9	10	Year
1950	0.802	0.590	0.559	0.532	0.511	0.498	0.491	0.486	0.483	0.481	0.480
1951	0.798	0.552	0.496	0.468	0.448	0.435	0.427	0.422	0.419	0.418	0.416
1952	0.803	0.584	0.542	0.505	0.483	0.470	0.462	0.457	0.454	0.452	0.451
1953	0.803	0.584	0.543	0.509	0.487	0.474	0.466	0.461	0.458	0.457	0.455
1954	0.802	0.563	0.501	0.460	0.436	0.422	0.414	0.409	0.406	0.404	0.403
1955	0.804	0.589	0.531	0.491	0.469	0.456	0.448	0.444	0.441	0.439	0.438
1956	0.807	0.614	0.576	0.543	0.521	0.508	0.500	0.496	0.493	0.491	0.490
1957	0.808	0.614	0.570	0.530	0.508	0.495	0.487	0.482	0.479	0.477	0.476
1958	0.815	0.675	0.677	0.646	0.625	0.612	0.604	0.600	0.597	0.595	0.594
1959	0.805	0.587	0.519	0.475	0.452	0.439	0.432	0.427	0.424	0.422	0.421
1960	0.805	0.584	0.512	0.467	0.444	0.431	0.423	0.419	0.416	0.414	0.413
1961	0.809	0.606	0.543	0.494	0.470	0.457	0.449	0.444	0.441	0.439	0.438
1962	0.807	0.590	0.518	0.470	0.448	0.435	0.427	0.422	0.419	0.417	0.416
1963	0.807	0.587	0.507	0.456	0.433	0.419	0.411	0.407	0.404	0.402	0.401
1964	0.807	0.582	0.499	0.448	0.425	0.411	0.404	0.399	0.396	0.394	0.393
1965	0.809	0.600	0.526	0.476	0.452	0.439	0.431	0.426	0.423	0.421	0.420
1966	0.809	0.590	0.507	0.455	0.431	0.418	0.410	0.405	0.402	0.400	0.399
1967	0.808	0.580	0.492	0.440	0.417	0.404	0.396	0.391	0.388	0.387	0.385
1968	0.814	0.626	0.566	0.516	0.493	0.480	0.472	0.467	0.464	0.462	0.461
1969	0.811	0.598	0.515	0.461	0.437	0.423	0.415	0.411	0.408	0.406	0.405
1970	0.814	0.621	0.552	0.499	0.475	0.461	0.453	0.448	0.445	0.444	0.442
1971	0.812	0.604	0.521	0.468	0.445	0.432	0.424	0.419	0.416	0.414	0.413
1972	0.814	0.621	0.546	0.491	0.468	0.455	0.447	0.442	0.439	0.438	0.436
1973	0.815	0.622	0.544	0.487	0.464	0.451	0.443	0.438	0.435	0.433	0.432
1974	0.814	0.610	0.519	0.461	0.438	0.425	0.417	0.412	0.409	0.407	0.406
1975	0.820	0.663	0.606	0.553	0.531	0.517	0.510	0.505	0.502	0.500	0.499
1976	0.836	0.784	0.822	0.791	0.771	0.758	0.750	0.745	0.742	0.741	0.739
1977	0.848	0.878	0.972	0.936	0.916	0.903	0.895	0.890	0.887	0.885	0.884
1978	0.835	0.761	0.764	0.712	0.690	0.677	0.669	0.664	0.661	0.660	0.658
1979	0.828	0.735	0.722	0.668	0.646	0.633	0.625	0.621	0.618	0.616	0.615
1980	0.860	0.939	1.068	1.029	1.007	0.994	0.987	0.982	0.979	0.977	0.976
1981	0.835	0.773	0.759	0.699	0.676	0.663	0.656	0.651	0.648	0.646	0.645
1982	0.859	0.770	0.732	0.667	0.644	0.631	0.624	0.619	0.616	0.614	0.613
1983	0.883	0.803	0.879	0.851	0.830	0.817	0.809	0.804	0.801	0.800	0.798
1984	0.845	0.860	0.746	0.629	0.603	0.589	0.581	0.577	0.574	0.572	0.571
1985	0.848	0.873	0.923	0.865	0.840	0.827	0.819	0.814	0.811	0.809	0.808
1986	0.846	0.902	0.930	0.858	0.830	0.814	0.806	0.801	0.798	0.796	0.795
1987	0.849	0.833	0.819	0.744	0.712	0.695	0.686	0.681	0.678	0.676	0.675
1988	0.850	0.969	0.843	0.693	0.657	0.639	0.630	0.625	0.622	0.620	0.619
1989	0.861	0.906	0.835	0.715	0.676	0.657	0.647	0.641	0.638	0.636	0.635
1990	0.846	0.913	0.816	0.687	0.648	0.629	0.619	0.613	0.610	0.608	0.607
1991	0.856	0.952	0.906	0.793	0.757	0.739	0.730	0.724	0.721	0.719	0.718
1992	0.849	0.821	0.738	0.636	0.603	0.586	0.577	0.572	0.569	0.567	0.566
1993	0.855	0.913	0.896	0.802	0.770	0.753	0.744	0.739	0.736	0.734	0.733
1994	0.859	0.937	0.886	0.772	0.738	0.721	0.712	0.706	0.703	0.701	0.700
1995	0.850	0.799	0.792	0.737	0.712	0.697	0.687	0.681	0.677	0.675	0.674
1996	0.842	0.813	0.756	0.676	0.647	0.630	0.616	0.606	0.601	0.599	0.598
1997	0.851	0.822	0.760	0.687	0.660	0.642	0.620	0.600	0.593	0.590	0.589
1998	0.835	0.764	0.722	0.660	0.635	0.620	0.608	0.598	0.594	0.592	0.590
1999	0.836	0.762	0.668	0.585	0.557	0.540	0.528	0.518	0.514	0.512	0.511
2000	0.842	0.761	0.671	0.614	0.592	0.573	0.546	0.519	0.510	0.507	0.506
2001	0.832	0.766	0.693	0.665	0.645	0.621	0.569	0.513	0.497	0.493	0.491
2002	0.828	0.753	0.668	0.644	0.626	0.602	0.549	0.492	0.475	0.471	0.470
2003	0.826	0.686	0.668	0.732	0.722	0.689	0.591	0.482	0.450	0.444	0.443
2004	0.816	0.639	0.646	0.744	0.738	0.703	0.596	0.477	0.442	0.436	0.434
2005	0.819	0.663	0.645	0.697	0.687	0.661	0.590	0.512	0.489	0.484	0.483
2006	0.815	0.649	0.643	0.692	0.681	0.656	0.589	0.517	0.495	0.490	0.489
2007	0.817	0.697	0.657	0.672	0.659	0.636	0.581	0.522	0.504	0.500	0.498
2008	0.818	0.684	0.604	0.584	0.567	0.547	0.513	0.478	0.467	0.464	0.463
2009	0.821	0.678	0.623	0.621	0.602	0.580	0.539	0.496	0.482	0.479	0.477
2010	0.821	0.698	0.660	0.693	0.681	0.655	0.590	0.518	0.497	0.492	0.491
2011	0.821	0.663	0.608	0.618	0.604	0.582	0.533	0.480	0.464	0.460	0.459

Table 3.6. Estimated instantaneous female total mortality rate (per yr) at age, including discard mortality

Year	0	1	2	3	4	5	6	7	8	9	10
1950	0.799	0.571	0.553	0.531	0.511	0.498	0.491	0.486	0.483	0.481	0.480
1951	0.797	0.543	0.491	0.467	0.448	0.435	0.427	0.422	0.419	0.418	0.416
1952	0.799	0.567	0.538	0.505	0.483	0.470	0.462	0.457	0.454	0.452	0.451
1953	0.800	0.567	0.539	0.509	0.487	0.474	0.466	0.461	0.458	0.457	0.455
1954	0.799	0.553	0.499	0.460	0.436	0.422	0.414	0.409	0.406	0.404	0.403
1955	0.801	0.576	0.536	0.491	0.469	0.456	0.448	0.444	0.441	0.439	0.438
1956	0.803	0.595	0.579	0.542	0.521	0.508	0.500	0.496	0.493	0.491	0.490
1957	0.803	0.595	0.575	0.530	0.508	0.495	0.487	0.482	0.479	0.477	0.476
1958	0.808	0.640	0.678	0.645	0.625	0.612	0.604	0.600	0.597	0.595	0.594
1959	0.802	0.576	0.528	0.475	0.452	0.439	0.432	0.427	0.424	0.422	0.421
1960	0.803	0.573	0.521	0.467	0.444	0.431	0.423	0.419	0.416	0.414	0.413
1961	0.805	0.590	0.552	0.495	0.471	0.457	0.449	0.444	0.441	0.439	0.438
1962	0.804	0.578	0.528	0.471	0.448	0.435	0.427	0.422	0.419	0.417	0.416
1963	0.804	0.577	0.519	0.457	0.433	0.419	0.411	0.407	0.404	0.402	0.401
1964	0.804	0.573	0.511	0.449	0.425	0.411	0.404	0.399	0.396	0.394	0.393
1965	0.806	0.587	0.539	0.477	0.452	0.439	0.431	0.426	0.423	0.421	0.420
1966	0.806	0.580	0.521	0.456	0.431	0.418	0.410	0.405	0.402	0.400	0.399
1967	0.806	0.573	0.506	0.441	0.417	0.404	0.396	0.391	0.388	0.387	0.385
1968	0.809	0.607	0.579	0.517	0.493	0.480	0.472	0.467	0.464	0.462	0.461
1969	0.808	0.587	0.531	0.462	0.437	0.423	0.415	0.411	0.408	0.406	0.405
1970	0.810	0.605	0.568	0.500	0.475	0.461	0.453	0.448	0.445	0.444	0.442
1971	0.809	0.593	0.539	0.469	0.445	0.432	0.424	0.419	0.416	0.414	0.413
1972	0.811	0.606	0.565	0.492	0.468	0.455	0.447	0.442	0.439	0.438	0.436
1973	0.811	0.608	0.564	0.489	0.464	0.451	0.443	0.438	0.435	0.433	0.432
1974	0.811	0.600	0.542	0.462	0.438	0.425	0.417	0.412	0.409	0.407	0.406
1975	0.815	0.640	0.628	0.554	0.531	0.517	0.510	0.505	0.502	0.500	0.499
1976	0.825	0.732	0.835	0.790	0.771	0.758	0.750	0.745	0.742	0.741	0.739
1977	0.832	0.803	0.985	0.936	0.915	0.903	0.895	0.890	0.887	0.885	0.884
1978	0.825	0.716	0.786	0.713	0.690	0.677	0.669	0.664	0.661	0.660	0.658
1979	0.819	0.696	0.744	0.670	0.646	0.633	0.625	0.621	0.618	0.616	0.615
1980	0.841	0.850	1.081	1.030	1.007	0.994	0.987	0.982	0.979	0.977	0.976
1981	0.825	0.730	0.791	0.701	0.676	0.663	0.656	0.651	0.648	0.646	0.645
1982	0.850	0.732	0.770	0.670	0.645	0.631	0.624	0.619	0.616	0.614	0.613
1983	0.869	0.738	0.874	0.851	0.830	0.817	0.809	0.804	0.801	0.800	0.798
1984	0.834	0.827	0.844	0.636	0.603	0.589	0.581	0.577	0.574	0.572	0.571
1985	0.833	0.805	0.952	0.867	0.840	0.827	0.819	0.814	0.811	0.809	0.808
1986	0.830	0.835	0.974	0.862	0.831	0.815	0.806	0.801	0.798	0.796	0.795
1987	0.835	0.782	0.859	0.748	0.714	0.696	0.686	0.681	0.678	0.676	0.675
1988	0.836	0.924	0.969	0.705	0.658	0.640	0.630	0.625	0.622	0.620	0.619
1989	0.846	0.856	0.914	0.725	0.678	0.658	0.647	0.641	0.638	0.636	0.635
1990	0.831	0.868	0.911	0.697	0.650	0.630	0.619	0.613	0.610	0.608	0.607
1991	0.840	0.894	0.990	0.802	0.759	0.740	0.730	0.724	0.721	0.719	0.718
1992	0.837	0.783	0.804	0.644	0.605	0.587	0.577	0.572	0.569	0.567	0.566
1993	0.840	0.853	0.959	0.809	0.771	0.754	0.744	0.739	0.736	0.734	0.733
1994	0.843	0.881	0.968	0.781	0.739	0.721	0.712	0.706	0.703	0.701	0.700
1995	0.838	0.752	0.823	0.739	0.712	0.697	0.687	0.681	0.677	0.675	0.674
1996	0.831	0.773	0.811	0.681	0.648	0.630	0.618	0.607	0.601	0.599	0.598
1997	0.840	0.784	0.820	0.690	0.661	0.643	0.624	0.602	0.593	0.590	0.589
1998	0.826	0.727	0.761	0.662	0.635	0.620	0.609	0.599	0.594	0.592	0.590
1999	0.827	0.736	0.727	0.590	0.558	0.541	0.529	0.519	0.514	0.512	0.511
2000	0.834	0.738	0.730	0.616	0.592	0.575	0.551	0.522	0.510	0.507	0.506
2001	0.825	0.744	0.748	0.664	0.645	0.624	0.581	0.520	0.498	0.493	0.491
2002	0.821	0.736	0.727	0.642	0.626	0.606	0.561	0.499	0.476	0.471	0.470
2003	0.821	0.669	0.682	0.721	0.722	0.696	0.615	0.496	0.453	0.445	0.443
2004	0.812	0.626	0.640	0.731	0.738	0.711	0.623	0.492	0.445	0.436	0.434
2005	0.815	0.647	0.655	0.687	0.687	0.666	0.607	0.522	0.491	0.485	0.483
2006	0.811	0.631	0.644	0.683	0.681	0.660	0.605	0.525	0.496	0.491	0.489
2007	0.812	0.678	0.685	0.666	0.659	0.640	0.594	0.529	0.505	0.500	0.498
2008	0.813	0.671	0.643	0.582	0.567	0.549	0.520	0.482	0.468	0.464	0.463
2009	0.816	0.662	0.648	0.617	0.603	0.583	0.548	0.501	0.483	0.479	0.477
2010	0.816	0.682	0.687	0.685	0.682	0.660	0.605	0.527	0.498	0.492	0.491
2011	0.817	0.650	0.631	0.613	0.604	0.585	0.544	0.486	0.465	0.460	0.459

Table 3.7. Estimated total landings at age in numbers (1000 fish)

Year	0	1	2	3	4	5	6	7	8	9	10
1950	85.08	344.12	352.75	223.83	128.89	73.92	42.82	24.98	14.63	8.59	12.28
1951	45.34	183.56	216.69	162.36	93.74	53.61	31.02	18.09	10.59	6.22	8.89
1952	83.42	332.23	325.16	201.02	114.84	64.29	37.09	21.62	12.66	7.43	10.63
1953	82.66	330.41	327.12	211.88	130.29	76.18	43.31	25.20	14.76	8.67	12.39
1954	76.24	292.73	255.72	143.51	81.70	49.00	28.62	16.32	9.52	5.59	7.99
1955	82.09	446.22	360.55	204.05	123.93	77.39	48.87	29.18	16.79	9.84	14.07
1956	113.84	577.91	485.57	299.02	187.55	115.53	73.16	46.60	27.94	16.12	23.00
1957	108.84	565.17	443.49	241.19	150.13	94.58	59.10	37.77	24.16	14.54	20.42
1958	170.33	811.04	679.41	392.19	239.40	152.61	97.66	61.55	39.53	25.35	36.77
1959	72.13	435.72	296.02	135.86	79.74	48.84	31.40	20.22	12.79	8.23	12.97
1960	67.92	423.69	298.34	136.15	76.89	46.19	28.65	18.56	12.00	7.61	12.64
1961	105.60	572.09	407.95	195.99	109.03	62.11	37.54	23.42	15.22	9.86	16.68
1962	72.99	463.91	315.46	147.31	91.12	54.30	31.94	19.59	12.30	8.02	14.03
1963	76.20	480.53	311.07	129.35	76.05	47.72	28.62	16.92	10.41	6.55	11.77
1964	64.12	446.46	281.06	114.08	68.07	42.98	27.73	16.85	10.02	6.19	10.92
1965	90.86	557.53	375.26	170.38	103.30	64.52	41.30	26.86	16.39	9.78	16.72
1966	81.50	527.34	331.83	138.26	82.66	52.17	33.17	21.43	14.01	8.58	13.89
1967	59.32	454.74	273.37	104.96	64.42	41.76	27.29	17.62	11.47	7.52	12.10
1968	116.54	683.93	482.06	234.00	144.30	92.82	61.00	40.16	26.05	17.00	29.12
1969	85.40	569.50	346.12	136.75	82.26	52.18	33.99	22.51	14.88	9.68	17.17
1970	113.35	684.46	452.90	197.35	118.35	76.23	49.60	32.70	21.78	14.45	26.12
1971	82.14	590.96	359.14	143.75	86.90	55.64	36.79	24.23	16.07	10.74	20.05
1972	99.25	678.29	428.78	178.14	108.57	68.77	44.69	29.78	19.70	13.10	25.15
1973	102.93	711.72	435.12	176.35	106.15	67.27	43.10	28.20	18.87	12.51	24.34
1974	83.81	660.29	375.72	134.42	81.27	51.54	33.24	21.49	14.13	9.48	18.56
1975	146.02	918.75	609.08	284.90	174.96	111.55	71.74	46.62	30.28	19.95	39.68
1976	278.77	1405.90	1028.13	569.77	359.22	228.13	147.63	95.74	62.50	40.71	80.33
1977	356.65	1669.60	1100.64	521.32	311.40	198.21	127.38	83.06	54.08	35.40	68.69
1978	223.35	1195.37	691.57	253.42	131.75	80.11	51.57	33.37	21.85	14.26	27.51
1979	197.62	1085.05	666.01	243.14	110.18	58.85	36.17	23.44	15.23	9.99	19.14
1980	388.51	1740.27	1144.75	515.92	239.64	111.71	60.30	37.30	24.26	15.80	30.30
1981	216.25	1226.60	638.06	213.38	106.45	50.52	23.80	12.92	8.02	5.23	9.96
1982	112.12	1249.70	689.39	222.82	98.34	50.50	24.22	11.48	6.25	3.89	7.38
1983	111.05	566.50	762.53	365.74	166.08	76.06	39.53	19.08	9.09	4.97	8.98
1984	159.58	784.48	463.70	198.05	91.61	42.12	19.48	10.19	4.94	2.36	3.62
1985	286.50	962.47	346.71	194.60	174.36	87.77	40.97	19.10	10.03	4.87	5.92
1986	531.22	1600.71	578.42	122.71	82.68	76.07	38.68	18.19	8.51	4.48	4.83
1987	189.60	2353.14	718.06	156.42	41.58	28.94	27.08	13.88	6.56	3.08	3.37
1988	358.40	1415.44	1590.44	217.81	58.83	16.66	11.99	11.37	5.87	2.78	2.74
1989	299.61	1880.75	496.60	387.05	101.09	30.57	8.99	6.58	6.28	3.26	3.07
1990	427.03	1632.02	849.46	130.13	159.45	46.84	14.94	4.49	3.32	3.19	3.22
1991	454.15	2348.97	723.87	264.59	72.28	103.50	32.36	10.62	3.24	2.40	4.66
1992	186.15	1773.91	739.96	130.89	70.70	20.91	31.04	9.83	3.25	0.99	2.18
1993	302.38	1214.03	1035.13	312.27	94.37	58.13	18.13	27.54	8.81	2.93	2.86
1994	390.09	1668.77	586.21	288.99	121.62	39.50	25.07	7.93	12.13	3.89	2.56
1995	193.36	1330.17	531.04	148.62	122.55	57.61	19.40	12.45	3.96	6.07	3.26
1996	252.43	1149.89	799.49	181.16	59.62	50.10	23.41	7.74	4.98	1.59	3.75
1997	173.42	1440.85	588.53	280.78	93.15	32.88	27.04	12.00	4.03	2.62	2.82
1998	200.22	816.05	587.14	174.23	118.04	41.24	14.91	13.01	6.43	2.24	3.06
1999	236.48	1339.54	466.25	189.05	70.66	48.45	16.74	6.00	5.38	2.69	2.23
2000	152.39	1478.48	686.94	189.48	129.21	52.46	34.04	10.44	3.70	3.35	3.07
2001	179.91	1175.83	862.70	357.96	136.36	92.28	32.47	17.20	5.60	2.08	3.65
2002	216.19	1290.39	617.04	380.96	183.28	68.04	40.28	12.47	8.42	3.14	3.29
2003	108.85	1278.00	667.00	401.36	292.03	133.73	40.29	16.68	5.70	4.31	3.37
2004	97.35	688.22	919.37	500.79	221.69	147.56	55.53	12.97	7.88	3.62	5.21
2005	95.72	958.52	660.03	643.65	212.80	85.79	50.16	18.50	7.63	6.53	7.87
2006	92.70	684.97	729.64	454.09	324.19	98.15	34.26	17.90	8.97	4.37	8.51
2007	167.48	981.48	700.35	510.75	223.66	147.14	39.47	13.07	9.49	5.62	8.34
2008	169.38	1391.86	603.27	321.57	205.46	83.81	50.40	13.51	6.00	4.98	7.52
2009	115.48	1313.08	901.58	377.32	213.72	129.85	47.62	26.23	8.29	3.99	8.46
2010	133.76	857.66	1033.30	680.34	275.53	150.76	80.63	25.35	16.33	5.64	8.63
2011	66.97	875.36	472.28	500.15	277.22	104.39	50.26	24.67	10.32	7.69	6.93

Table 3.8. Estimated total landings at age in whole weight (1000 lb)

Year	0	1	2	3	4	5	6	7	8	9	10
1950	57.17	540.37	937.78	763.77	528.33	345.51	219.36	136.48	83.70	50.79	74.32
1951	28.46	267.48	517.30	478.23	330.41	215.63	136.83	85.12	52.20	31.67	46.35
1952	54.60	510.41	891.15	754.12	522.87	334.22	211.52	131.58	80.69	48.96	71.65
1953	54.20	508.17	886.49	765.28	573.71	381.07	237.06	147.12	90.22	54.75	80.12
1954	40.50	360.11	583.20	472.02	342.70	241.57	155.27	94.53	57.80	35.07	51.32
1955	49.89	571.61	852.49	685.64	507.24	361.73	251.36	159.21	95.74	57.96	84.83
1956	69.52	757.72	1155.44	975.34	745.43	525.56	364.48	248.34	155.08	92.27	134.74
1957	68.27	754.64	1100.96	850.96	644.54	466.79	320.05	217.68	146.24	90.37	129.51
1958	113.61	1176.97	1794.74	1422.43	1045.69	758.49	534.51	359.38	240.98	160.19	235.84
1959	44.37	547.71	705.22	479.27	342.51	239.21	168.41	116.28	77.05	51.12	82.25
1960	41.50	524.79	698.84	482.97	332.01	227.53	154.47	106.60	72.55	47.57	80.58
1961	60.20	691.43	931.97	684.03	481.20	315.89	210.01	139.65	94.97	63.95	110.50
1962	44.78	573.70	741.75	528.47	400.86	275.40	176.96	115.60	75.84	51.05	91.73
1963	42.79	555.00	680.73	452.12	333.69	242.47	161.62	101.71	65.48	42.50	78.25
1964	37.38	519.90	622.57	409.47	303.89	219.68	156.05	102.15	63.41	40.40	72.86
1965	51.90	656.23	834.92	590.36	446.87	322.16	226.53	157.74	101.78	62.52	109.20
1966	43.62	583.77	685.11	452.32	341.42	250.05	175.58	121.10	83.14	53.09	87.61
1967	33.85	511.69	577.54	361.19	273.72	203.19	145.87	100.71	68.54	46.58	77.13
1968	70.20	849.01	1134.93	840.31	640.19	471.72	340.63	239.71	163.13	109.87	194.00
1969	47.23	642.57	736.77	470.55	356.63	261.62	187.45	132.68	92.04	61.98	112.92
1970	65.22	812.13	1020.77	699.66	522.66	388.24	278.23	195.73	136.64	93.81	174.33
1971	48.20	685.54	790.09	508.20	379.39	276.88	200.93	141.38	98.10	67.78	130.06
1972	59.79	810.41	977.73	648.77	486.15	352.54	250.33	178.10	123.53	84.81	167.21
1973	59.76	824.95	955.45	620.20	463.08	336.08	236.88	164.83	115.58	79.32	158.18
1974	47.57	735.02	783.02	462.06	345.24	250.89	177.36	122.60	84.11	58.36	117.22
1975	87.59	1112.34	1389.44	986.20	741.86	540.85	382.35	264.94	180.53	122.55	250.03
1976	177.91	1896.44	2550.98	1964.38	1499.48	1087.28	771.21	534.54	365.15	246.20	496.56
1977	236.06	2377.54	2926.22	1938.27	1391.56	1010.07	711.68	494.84	338.10	228.53	454.35
1978	145.41	1610.42	1799.95	975.06	607.41	417.08	294.21	203.18	139.26	94.16	185.89
1979	127.75	1435.58	1694.93	942.18	514.95	308.58	205.88	142.31	96.86	65.69	129.12
1980	260.74	2530.45	3103.08	1999.89	1141.83	600.57	349.58	228.50	155.65	104.82	206.06
1981	137.45	1578.51	1596.04	805.39	490.67	268.65	137.32	78.34	50.47	34.02	66.43
1982	69.21	1543.50	1635.31	833.00	443.67	260.44	138.53	69.38	39.01	24.87	48.38
1983	75.57	874.67	2148.12	1408.17	791.04	407.05	232.28	121.09	59.77	33.25	61.04
1984	89.65	859.87	954.44	729.95	418.64	224.50	112.23	62.76	32.25	15.75	24.30
1985	182.12	1287.71	882.29	723.85	823.09	468.59	244.70	119.92	66.10	33.61	40.85
1986	311.77	1977.80	1368.71	440.99	363.62	398.27	220.43	112.82	54.50	29.73	32.82
1987	101.22	2691.22	1558.12	527.05	177.68	141.86	151.43	82.23	41.50	19.84	22.33
1988	179.83	1470.61	3019.17	724.01	256.95	84.94	66.54	69.87	37.45	18.71	18.65
1989	147.69	1977.46	967.81	1227.61	440.18	158.16	51.42	39.65	41.10	21.81	21.35
1990	204.47	1664.76	1576.79	398.43	638.75	231.51	82.28	26.39	20.10	20.64	21.27
1991	234.82	2556.85	1469.46	857.69	301.57	496.92	179.16	62.95	19.97	15.07	30.82
1992	93.57	1880.40	1459.35	423.92	298.62	104.22	168.82	59.91	20.78	6.53	14.66
1993	164.88	1391.23	2244.89	1076.20	407.64	290.70	100.30	160.23	56.17	19.30	19.22
1994	206.93	1847.65	1223.74	983.32	535.38	199.88	139.76	47.41	74.75	25.94	17.45
1995	110.09	1597.23	1203.31	492.48	502.57	274.07	100.47	68.93	23.06	35.99	20.55
1996	131.52	1255.57	1624.29	581.95	239.13	233.91	122.83	43.58	29.46	9.76	23.56
1997	92.75	1582.82	1193.02	872.55	364.81	146.99	136.77	68.31	24.07	16.19	17.90
1998	114.14	952.77	1289.62	578.64	487.77	198.79	78.24	73.84	38.71	13.79	19.21
1999	116.96	1386.69	873.82	563.31	267.55	215.62	84.30	32.31	30.48	15.90	13.29
2000	77.96	1539.89	1265.09	508.96	427.43	199.81	148.26	52.27	19.58	18.35	17.27
2001	88.47	1192.97	1504.20	865.02	402.73	315.75	127.66	80.60	29.26	11.18	20.07
2002	106.00	1293.03	1044.49	883.89	516.09	220.71	149.66	54.20	40.42	15.86	16.83
2003	54.21	1294.06	1103.73	860.60	755.88	396.80	135.67	67.27	26.20	20.95	16.87
2004	47.25	685.83	1461.16	1030.88	550.43	418.94	176.32	47.18	31.86	15.32	22.70
2005	49.95	999.03	1125.71	1414.18	562.20	258.79	170.44	71.74	32.19	28.81	35.65
2006	51.27	754.45	1321.77	1039.61	893.41	309.78	122.36	74.25	40.67	20.67	41.58
2007	88.93	1034.57	1245.40	1194.30	628.64	475.31	144.57	54.75	43.07	26.46	40.50
2008	79.01	1361.95	983.54	714.87	557.17	261.13	176.60	52.64	24.76	21.28	32.95
2009	52.36	1276.14	1469.44	834.56	579.11	406.75	168.08	104.43	35.27	17.51	37.95
2010	64.24	852.13	1689.62	1469.51	719.51	451.54	271.90	96.64	67.33	24.12	37.52
2011	32.86	880.06	786.76	1100.72	737.42	318.09	172.54	96.23	43.39	33.74	30.90

Table 3.9. Estimated time series of landings in number (1000s) for commercial handline (L.HL), commercial pound net (L.PN), commercial gill net (L.GN), commercial cast net (L.CN), recreational (L.Rec), recreational discards (D.Rec) and shrimp bycatch (D.shrimp.B), total landings and total discards.

Year	L.HL	L.PN	L.GN	L.CN	L.Rec	D.Rec	D.shrimp.B	Total.L	Total.D
1950	178.94	23.55	1109.40	0.00	0.00	12.40	11.24	1311.90	23.64
1951	254.99	34.39	540.71	0.00	0.00	1.32	22.48	830.10	23.80
1952	30.12	48.81	1131.46	0.00	0.00	1.09	33.72	1210.39	34.81
1953	87.02	45.17	1130.68	0.00	0.00	5.09	44.96	1262.87	50.05
1954	57.56	171.96	737.42	0.00	0.00	10.78	56.20	966.94	66.98
1955	169.94	52.65	937.56	0.00	252.84	64.44	67.44	1412.98	131.88
1956	304.80	79.10	1315.57	0.00	266.76	11.69	78.68	1966.24	90.37
1957	135.16	50.61	1292.92	0.00	280.69	13.48	89.92	1759.38	103.40
1958	200.36	13.67	2197.20	0.00	294.62	47.57	101.16	2705.85	148.73
1959	79.48	23.25	742.65	0.00	308.54	32.62	112.40	1153.92	145.02
1960	73.53	21.74	710.91	0.00	322.47	76.83	123.64	1128.66	200.47
1961	57.22	120.63	1034.37	0.00	343.29	67.82	134.88	1555.50	202.70
1962	59.46	18.32	789.06	0.00	364.11	49.84	146.12	1230.95	195.96
1963	36.36	73.04	700.87	0.00	384.92	153.80	157.36	1195.20	311.16
1964	30.47	29.06	623.22	0.00	405.74	68.29	168.60	1088.49	236.89
1965	67.53	80.41	898.41	0.00	426.56	80.72	179.84	1472.90	260.56
1966	81.64	100.37	678.68	0.00	444.16	82.90	191.08	1304.84	273.98
1967	60.78	21.07	530.97	0.00	461.75	53.34	202.32	1074.57	255.66
1968	69.62	65.18	1312.83	0.00	479.35	100.11	213.56	1926.97	313.67
1969	47.76	78.45	747.29	0.00	496.94	162.90	224.80	1370.44	387.70
1970	50.98	95.23	1126.52	0.00	514.53	101.85	236.04	1787.28	337.89
1971	63.10	23.38	780.47	0.00	559.47	158.18	247.28	1426.42	405.46
1972	48.96	20.56	1020.32	0.00	604.40	174.45	258.52	1694.23	432.97
1973	71.45	45.85	959.94	0.00	649.33	92.56	269.76	1726.57	362.32
1974	77.93	22.69	689.06	0.00	694.26	124.13	281.00	1483.94	405.13
1975	171.30	55.14	1487.90	0.00	739.19	56.72	292.24	2453.54	348.95
1976	424.84	70.07	3070.23	0.00	731.70	123.18	303.48	4296.84	426.66
1977	163.52	27.07	3611.63	0.00	724.20	186.31	314.72	4526.43	501.03
1978	40.56	2.28	1964.60	0.00	716.71	114.51	325.95	2724.15	440.47
1979	37.93	0.68	1716.98	0.00	709.22	127.79	255.17	2464.81	382.96
1980	47.98	5.55	3553.51	0.00	701.72	85.16	385.43	4308.76	470.59
1981	46.71	5.36	1591.69	0.00	867.44	12.40	296.10	2511.20	308.50
1982	67.32	21.69	1421.17	0.00	965.92	1.32	445.21	2476.11	446.54
1983	29.93	13.79	1955.67	0.00	130.24	1.09	433.19	2129.63	434.28
1984	27.59	21.00	793.67	0.00	937.86	5.09	272.91	1780.13	278.00
1985	14.88	49.20	1574.04	0.00	495.19	10.78	265.05	2133.31	275.83
1986	41.94	226.43	1861.96	0.00	936.16	64.44	291.00	3066.49	355.43
1987	62.58	475.61	1806.16	0.00	1197.37	11.69	245.24	3541.71	256.93
1988	37.38	367.25	1408.78	0.00	1878.93	13.48	292.53	3692.34	306.01
1989	21.43	504.04	1465.23	0.00	1233.14	47.57	345.78	3223.84	393.35
1990	59.33	518.79	1296.19	0.00	1399.79	32.62	268.65	3274.10	301.27
1991	78.46	497.51	1816.39	0.00	1628.28	76.83	333.22	4020.64	410.05
1992	27.53	382.94	1225.67	0.00	1333.68	67.82	252.80	2969.81	320.62
1993	53.89	307.44	1737.83	0.00	977.41	49.84	266.34	3076.57	316.18
1994	30.34	332.04	1543.75	0.00	1240.65	153.80	297.65	3146.78	451.45
1995	111.11	197.19	1359.47	8.10	752.62	68.29	301.25	2428.49	369.54
1996	76.24	283.03	1168.40	36.01	970.48	80.72	245.11	2534.16	325.83
1997	67.81	197.70	1119.13	112.45	1161.05	82.90	280.47	2658.13	363.37
1998	78.44	110.16	1056.90	35.83	695.26	53.34	252.25	1976.58	305.59
1999	98.06	269.99	856.33	34.30	1124.78	100.11	293.72	2383.46	393.83
2000	163.96	154.07	786.78	190.44	1448.29	162.90	265.73	2743.55	428.64
2001	183.38	182.10	708.79	477.30	1314.48	101.85	210.97	2866.06	312.82
2002	222.48	117.81	538.81	497.30	1447.10	158.18	236.33	2823.49	394.51
2003	199.30	86.82	450.52	972.59	1242.08	174.45	177.98	2951.32	352.44
2004	309.93	65.43	290.71	1192.20	801.93	92.56	178.22	2660.21	270.79
2005	437.00	43.28	473.20	831.57	962.14	124.13	132.93	2747.19	257.07
2006	363.35	38.63	595.58	795.56	664.62	56.72	127.82	2457.74	184.54
2007	394.12	47.07	628.23	651.63	1085.82	123.18	121.87	2806.87	245.05
2008	436.58	184.70	478.80	355.25	1402.43	186.31	112.47	2857.76	298.79
2009	493.47	325.38	658.59	495.10	1173.07	114.51	104.38	3145.60	218.89
2010	613.98	124.80	502.13	920.09	1106.92	127.79	122.96	3267.93	250.74
2011	431.32	77.47	390.76	614.57	882.13	85.16	113.86	2396.23	199.02

Table 3.10. Estimated time series of landings in whole weight (1000 lb) for commercial handline (L.HL), commercial pound net (L.PN), commercial gill net (L.GN), commercial cast net (L.CN), recreational (L.Rec), recreational discards (D.Rec) and shrimp bycatch (D.shrimp.B), total landings and total discards.

Year	L.HL	L.PN	L.GN	L.CN	L.Rec	D.Rec	D.shrimp.B	Total.L	Total.D
1950	371.47	26.24	3339.89	0.00	0.00	0.00	5.45	3737.60	5.45
1951	531.02	38.73	1619.95	0.00	0.00	0.00	10.91	2189.70	10.91
1952	63.34	55.42	3493.03	0.00	0.00	0.00	16.36	3611.80	16.36
1953	184.93	51.27	3541.99	0.00	0.00	0.00	21.82	3778.20	21.82
1954	123.37	195.58	2115.15	0.00	0.00	0.00	27.29	2434.10	27.29
1955	367.26	60.08	2981.05	0.00	269.28	0.00	32.72	3677.68	32.72
1956	662.79	89.85	4188.16	0.00	283.14	0.00	38.16	5223.93	38.16
1957	294.20	57.15	4141.24	0.00	297.42	0.00	43.61	4790.01	43.61
1958	434.66	15.32	7081.69	0.00	311.18	0.00	48.99	7842.84	48.99
1959	170.92	25.94	2330.74	0.00	325.81	0.00	54.52	2853.40	54.52
1960	157.72	24.54	2244.53	0.00	342.63	0.00	59.97	2769.43	59.97
1961	123.23	136.87	3158.98	0.00	364.69	0.00	65.40	3783.78	65.40
1962	128.83	20.79	2540.07	0.00	386.45	0.00	70.87	3076.14	70.87
1963	79.23	83.10	2184.86	0.00	409.18	0.00	76.33	2756.37	76.33
1964	66.81	33.15	2016.23	0.00	431.60	0.00	81.80	2547.79	81.80
1965	148.94	91.79	2865.84	0.00	453.63	0.00	87.22	3560.20	87.22
1966	180.87	114.44	2109.48	0.00	472.02	0.00	92.69	2876.80	92.69
1967	135.11	24.07	1749.60	0.00	491.23	0.00	98.16	2400.02	98.16
1968	155.18	74.33	4314.87	0.00	509.33	0.00	103.51	5053.70	103.51
1969	106.45	89.05	2379.95	0.00	527.00	0.00	109.01	3102.45	109.01
1970	113.55	108.09	3619.72	0.00	546.05	0.00	114.40	4387.42	114.40
1971	140.29	26.49	2566.54	0.00	593.22	0.00	119.88	3326.54	119.88
1972	108.69	23.31	3366.22	0.00	641.14	0.00	125.28	4139.37	125.28
1973	158.44	51.89	3115.98	0.00	688.01	0.00	130.70	4014.32	130.70
1974	172.64	25.68	2249.26	0.00	735.86	0.00	136.17	3183.45	136.17
1975	379.20	62.26	4834.98	0.00	782.25	0.00	141.46	6058.68	141.46
1976	933.04	77.48	9812.87	0.00	766.75	0.00	146.54	11590.13	146.54
1977	349.26	28.95	10979.46	0.00	749.54	0.00	151.70	12107.22	151.70
1978	82.92	2.40	5646.25	0.00	740.46	0.00	157.33	6472.04	157.33
1979	75.33	0.73	4849.78	0.00	738.00	0.00	123.08	5663.84	123.08
1980	93.87	5.86	9856.76	0.00	724.70	0.00	185.43	10681.19	185.43
1981	89.16	5.58	4256.99	0.00	891.55	6.35	142.63	5243.29	148.98
1982	128.54	24.06	3935.52	0.00	1017.17	0.74	227.79	5105.31	228.53
1983	58.60	16.44	5991.88	0.00	145.14	0.57	212.92	6212.05	213.49
1984	56.48	23.47	2454.94	0.00	989.45	2.49	127.58	3524.34	130.07
1985	30.99	47.70	4311.99	0.00	482.16	5.29	124.33	4872.83	129.62
1986	79.91	205.43	4119.13	0.00	907.00	31.27	135.48	5311.47	166.76
1987	109.91	485.39	3716.94	0.00	1202.24	6.87	130.40	5514.48	137.27
1988	66.57	412.56	3351.35	0.00	2116.27	6.55	136.20	5946.74	142.75
1989	41.18	528.59	3300.69	0.00	1223.79	24.78	168.40	5094.25	193.17
1990	115.30	525.89	2807.89	0.00	1436.33	15.98	125.80	4885.40	141.78
1991	150.62	488.86	3976.55	0.00	1609.24	38.96	159.45	6225.27	198.41
1992	51.43	405.09	2696.75	0.00	1377.52	37.19	127.58	4530.78	164.77
1993	101.98	337.74	4436.89	0.00	1054.15	24.72	125.67	5930.75	150.39
1994	58.97	333.09	3677.49	0.00	1232.67	76.26	140.42	5302.21	216.69
1995	211.79	201.19	3241.29	15.59	758.91	36.31	148.78	4428.76	185.10
1996	142.17	300.12	2758.58	67.19	1027.50	40.31	116.15	4295.56	156.46
1997	129.55	211.41	2771.79	214.60	1188.83	44.08	138.51	4516.18	182.59
1998	151.46	116.78	2776.98	69.05	731.24	26.29	118.55	3845.51	144.84
1999	191.06	274.67	1939.55	67.14	1127.82	50.63	140.30	3600.24	190.93
2000	317.48	164.10	1926.43	367.77	1499.09	86.61	131.22	4274.86	217.83
2001	357.14	200.03	1761.58	917.09	1402.06	51.46	100.71	4637.91	152.17
2002	441.25	121.68	1333.72	975.04	1469.49	78.21	111.29	4341.19	189.51
2003	391.81	90.83	1094.84	1892.56	1262.20	93.88	88.63	4732.24	182.51
2004	593.40	71.46	719.90	2240.20	862.92	46.64	84.93	4487.87	131.57
2005	847.99	47.30	1266.31	1588.53	998.54	65.51	65.31	4748.67	130.82
2006	712.32	43.08	1666.01	1537.92	710.50	29.25	61.84	4669.83	91.09
2007	782.72	50.31	1733.45	1281.26	1128.76	61.08	57.49	4976.49	118.57
2008	868.99	192.69	1078.54	702.00	1423.68	96.14	54.43	4265.90	150.58
2009	974.09	364.24	1436.44	961.01	1245.80	63.51	53.10	4981.59	116.61
2010	1229.76	144.91	1352.13	1794.94	1222.34	63.95	58.34	5744.08	122.29
2011	895.17	88.13	1092.09	1240.96	916.35	46.71	57.46	4232.69	104.17

Table 3.11. Estimated status indicators, benchmarks, and related quantities from the Beaufort catch-age model, conditional on estimated current selectivities averaged across fisheries. Rate estimates (F) are in units of y^{-1}*; status indicators are dimensionless; and biomass estimates are in units of metric tons or pounds, as indicated. Spawning stock biomass (SSB) and minimum stock size threshold (MSST) are measured by total biomass of mature females. Symbols, abbreviations, and acronyms are listed in Appendix A.*

Quantity	Units	Estimate	SE
F_{MSY}	y^{-1}	0.69	0.295
$85\%F_{\mathrm{MSY}}$	y^{-1}	0.587	0.251
$75\%F_{\mathrm{MSY}}$	y^{-1}	0.518	0.222
$65\%F_{\mathrm{MSY}}$	y^{-1}	0.449	0.192
$F_{30\%}$	y^{-1}	0.659	0.184
$F_{40\%}$	y^{-1}	0.458	0.127
$F_{50\%}$	y^{-1}	0.325	0.088
B_{MSY}	mt	9548	2552
$\mathrm{SSB}_{\mathrm{MSY}}$	mt	3266	1548
MSST	mt	2127	1345
MSY	mt	2750	343
D_{MSY}	1000 fish	509	
R_{MSY}	1000 age-0 fish	23378	9376
$F_{2009-2011}/F_{\mathrm{MSY}}$	—	0.526	
$F_{2011}/F_{\mathrm{MSY}}$	—	0.521	
$\mathrm{SSB}_{2011}/\mathrm{MSST}$	—	2.29	

Table 3.12. Results from sensitivity runs of the Beaufort catch-age model. Current F represented by geometric mean of last three assessment years. Spawning stock was based on total (population) fecundity of mature females, with the exception of S8 which used biomass of mature males and females. See text for full description of sensitivity runs.

Run	Description	F_{MSY}	SSB_{MSY} (mt)	B_{MSY} (mt)	MSY(1000 lb)	$F_{2009-2011}/F_{MSY}$	$SSB_{2011}/MSST$	SSB_{2011}/SSB_{MSY}	steep	R0(1000)
Base	—	0.692	3266	9601	2742	0.52	2.29	1.49	0.75	23621
S1	M low bound	0.623	3645	10045	2681	0.64	1.87	1.22	0.75	20480
S2	M upper bound	0.766	2997	9268	2862	0.43	2.74	1.78	0.75	27486
S3	Gislason M	0.633	3495	10309	2665	0.62	1.93	1.25	0.75	42751
S4	M constant	0.625	3740	9965	2705	0.63	1.88	1.22	0.75	12767
S5	Proportion female = 0.6	0.691	3932	9679	2752	0.52	2.28	1.48	0.75	23618
S6	Proportion female = 0.7	0.69	4591	9818	2753	0.52	2.28	1.48	0.75	23623
S7	Likelihood weights at 1	0.688	3189	9275	2626	0.67	1.81	1.18	0.75	22475
S8	Historical F fixed at 0.1	0.691	3272	9546	2750	0.52	2.29	1.49	0.75	23618
S9	Historical F fixed at 0.3	0.691	3273	9548	2751	0.52	2.29	1.49	0.75	23624
S10	Steepness fixed at 0.6	0.473	4923	13098	2679	0.73	1.6	1.04	0.6	28152
S11	Steepness fixed at 0.9	0.952	2299	7216	2798	0.41	3.04	1.98	0.9	17945
S12	Low shrimp bycatch	0.685	3347	9720	2753	0.53	2.24	1.46	0.75	23918
S13	High shrimp bycatch	0.697	3198	9375	2748	0.51	2.33	1.52	0.75	23325
S14	Retrospective 2010	0.664	3263	9533	2768	0.72	2.25	1.46	0.75	23757
S15	Retrospective 2009	0.649	3245	9494	2763	0.58	2.28	1.48	0.75	23596
S16	Retrospective 2008	0.642	3254	9519	2796	0.61	1.95	1.27	0.75	23753
S17	Retrospective 2007	0.64	3245	9477	2772	0.67	1.99	1.29	0.75	23448
S18	Retrospective 2006	0.666	3275	9596	2788	0.54	2.14	1.39	0.75	23507

Table 3.13. Spanish mackerel: Projection results under scenario R3—fishing mortality rate fixed at F_{MSY}. F = fishing mortality rate (per year), SSB = mid-year spawning stock biomass (mt)*, R = recruits (1000 fish), L = landings (1000* lb *whole weight), Sum L = cumulative landings (1000* lb*), and D = discard mortalities (1000 fish). Horizontal lines give relevant quantities at MSY levels.*

Year	F(per yr)	SSB(mt)	R(1000)	L(1000 lb)	Sum L(1000 lb)	D(1000)
2012	0.393	4811	13,750	4309	4309	4711
2013	0.691	4450	25,349	6478	10,788	12,945
2014	0.691	3552	24,988	5468	16,255	13,653
2015	0.691	3451	23,843	5258	21,513	13,090
2016	0.691	3429	23,686	5307	26,820	12,928
2017	0.691	3399	23,651	5331	32,152	12,899
2018	0.691	3366	23,601	5317	37,469	12,873
2019	0.691	3339	23,547	5290	42,758	12,844
2020	0.691	3321	23,502	5262	48,020	12,819
2021	0.691	3308	23,471	5242	53,262	12,801

Table 3.14. Spanish mackerel: Projection results under scenario 2—fishing mortality rate fixed at $F_{current}$. F = fishing mortality rate (per year), SSB = mid-year spawning stock biomass (mt)*, R = recruits (1000 fish), L = landings (1000* lb *whole weight), Sum L = cumulative landings (1000* lb*), and D = discard mortalities (1000 fish). Horizontal lines give relevant quantities at MSY levels.*

Year	F(per yr)	SSB(mt)	R(1000)	L(1000 lb)	Sum L(1000 lb)	D(1000)
2012	0.393	4811	13,750	4309	4309	4711
2013	0.393	4450	25,349	3983	8293	7458
2014	0.393	4408	24,988	3855	12,147	7911
2015	0.393	4625	24,943	4009	16,157	7881
2016	0.393	4871	25,170	4269	20,426	7940
2017	0.393	5066	25,405	4488	24,915	8014
2018	0.393	5208	25,579	4640	29,555	8072
2019	0.393	5311	25,699	4738	34,293	8113
2020	0.393	5388	25,782	4796	39,089	8141
2021	0.393	5446	25,843	4840	43,928	8161

3.7 Figures

Figure 3.1. Mean length at age (mm) and estimated 95% confidence interval of the males, females and the fished population.

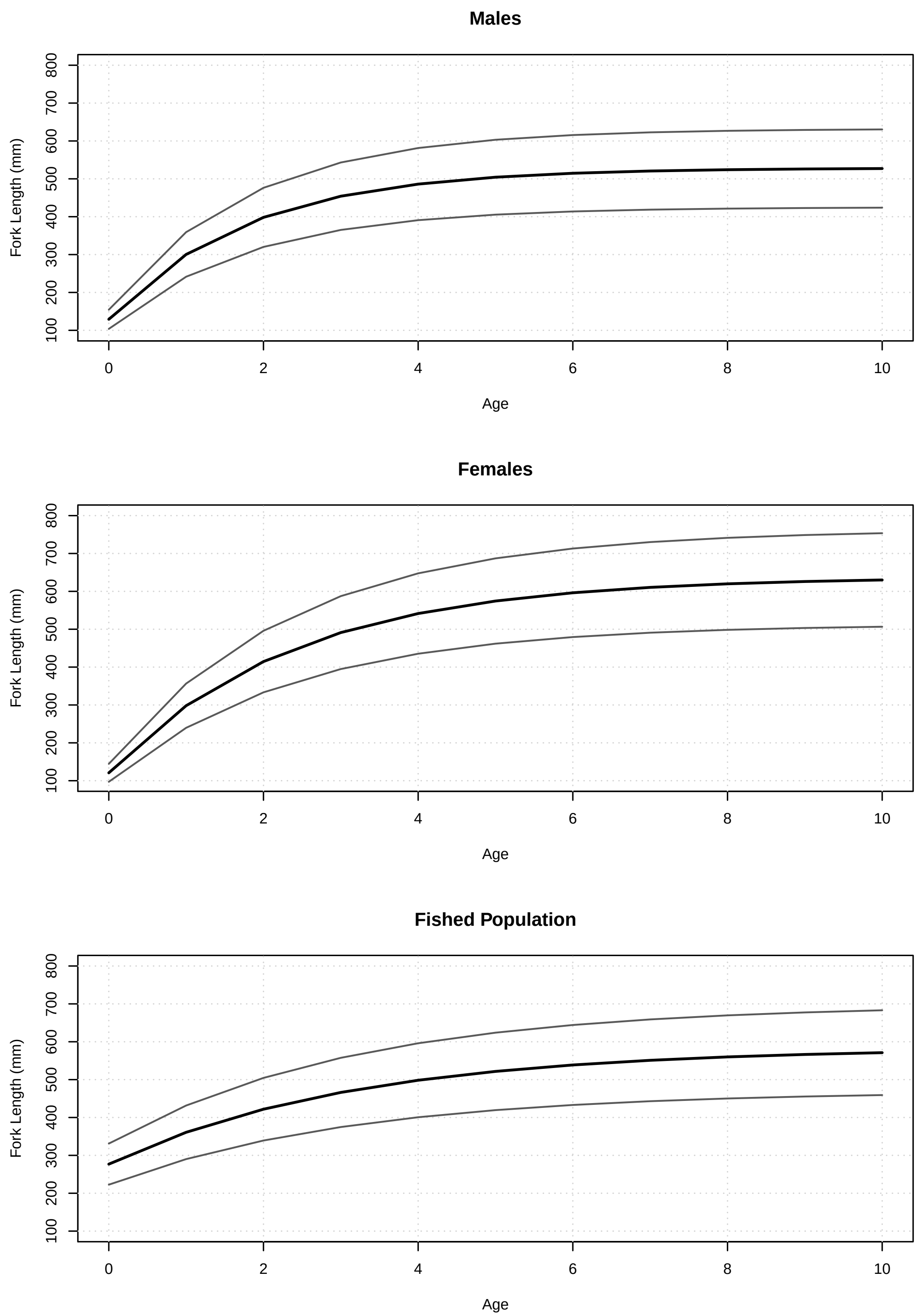


Figure 3.2. Observed (open circles) and estimated (solid line) annual age compositions by fleet or survey. In panel definition of series; acomp refers age compositions, HL to commercial handline, PN to pound nets, GN to gill nets, CN to cast nets, and Rec to recreationl. N indicates the number of fish measured.

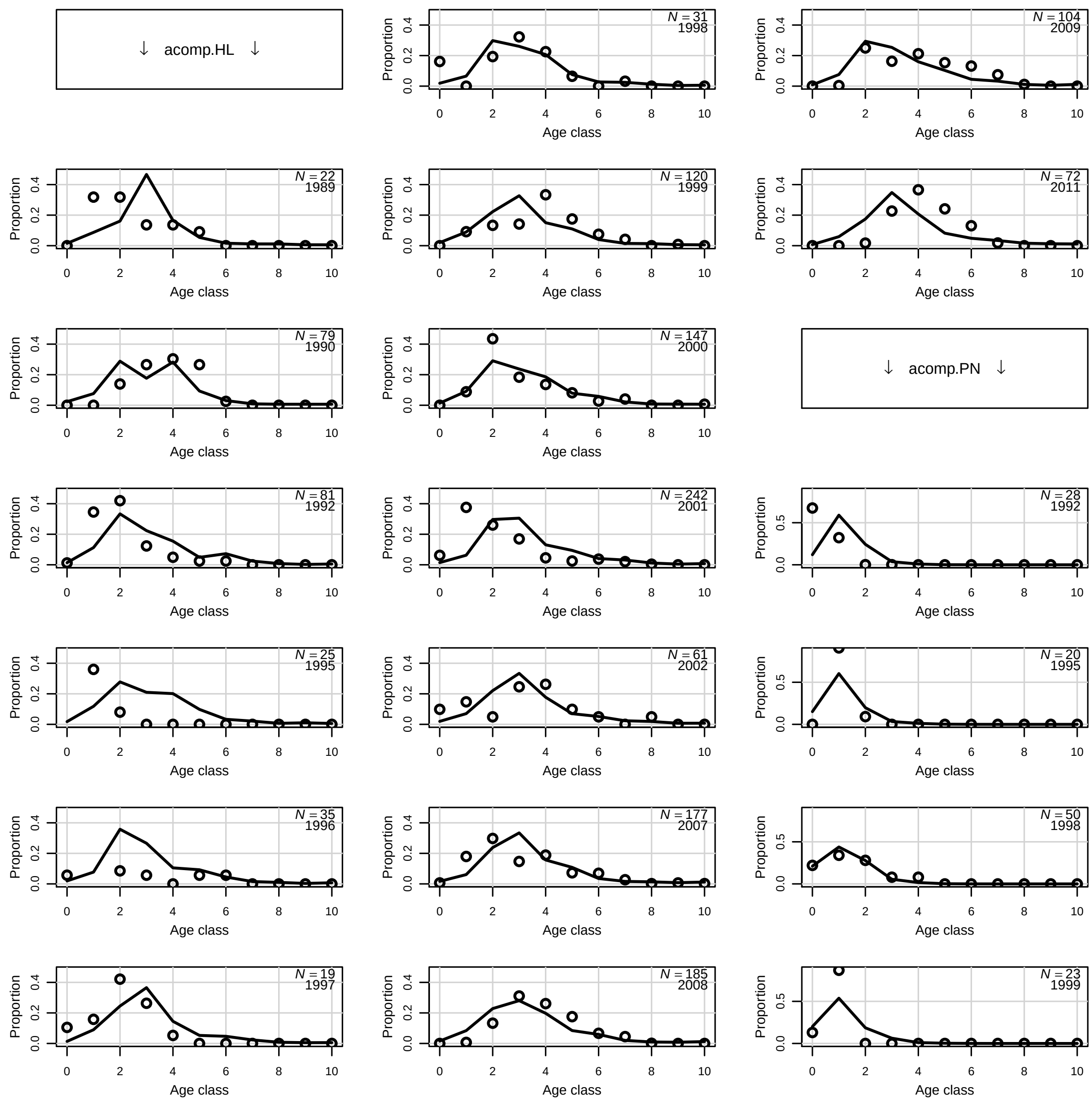


Figure 3.2. (cont.) Observed (open circles) and estimated (solid line) annual age compositions by fleet or survey.

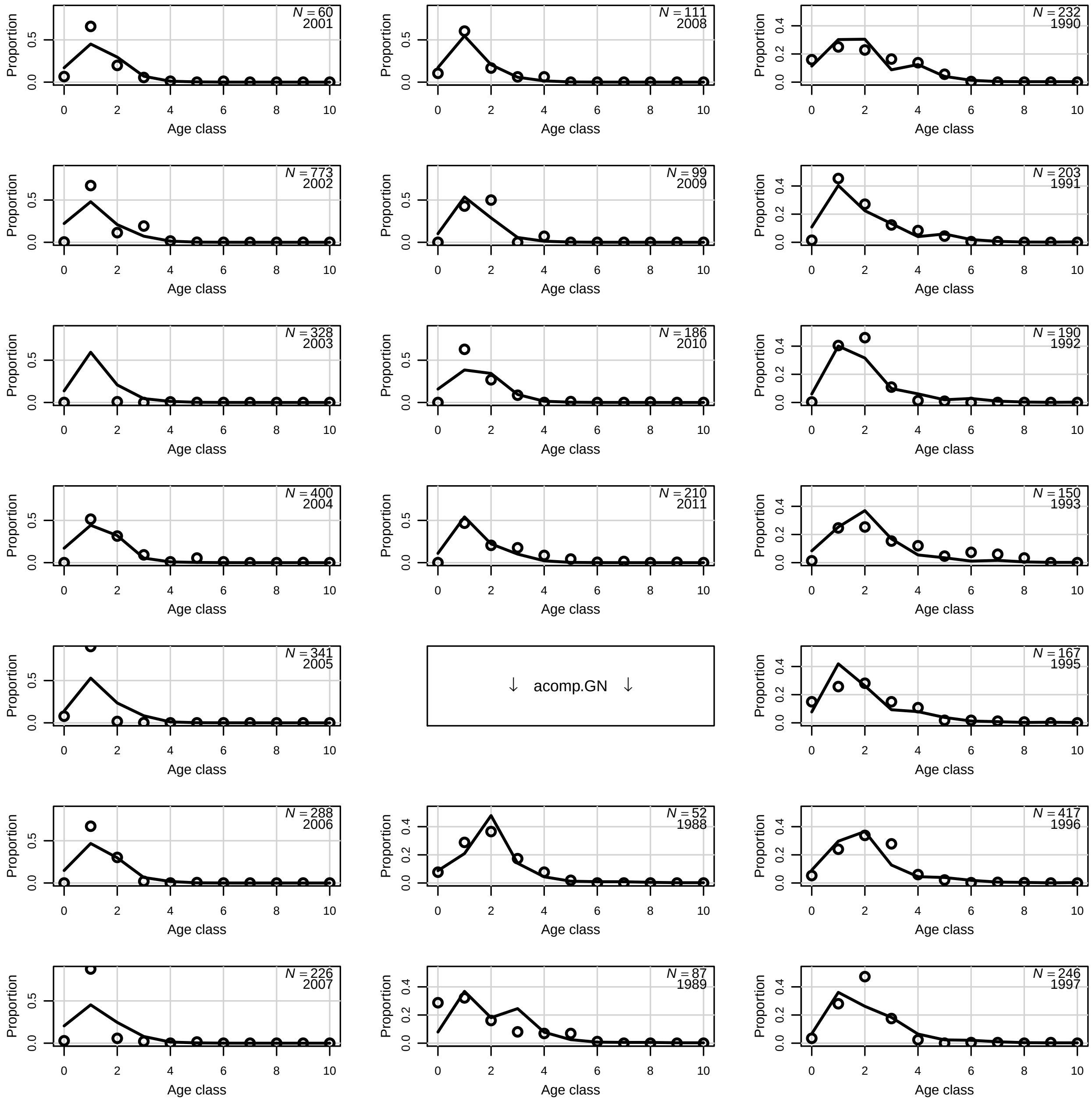


Figure 3.2. (cont.) Observed (open circles) and estimated (solid line) annual age compositions by fleet or survey.

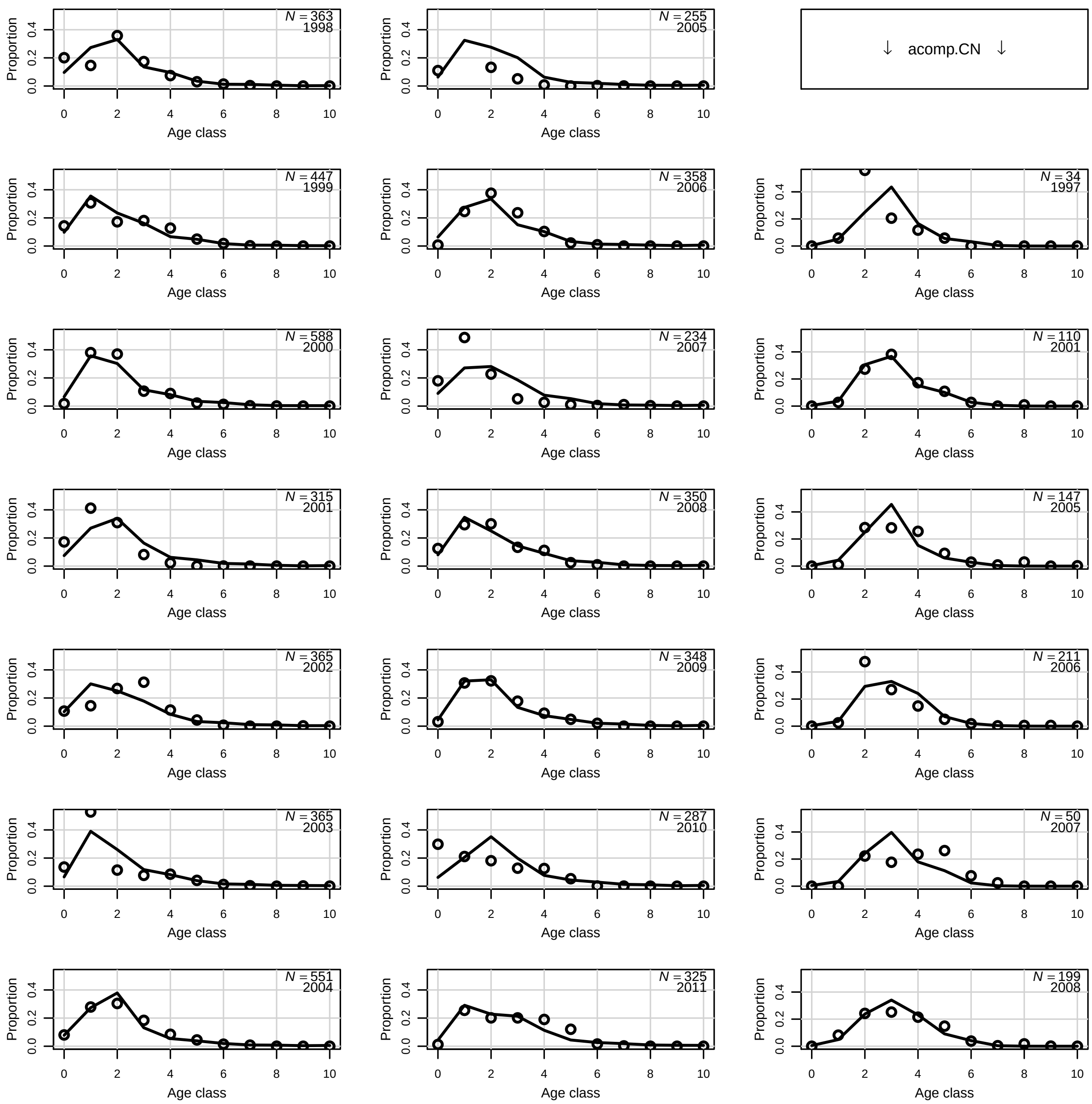


Figure 3.2. (cont.) Observed (open circles) and estimated (solid line) annual age compositions by fleet or survey.

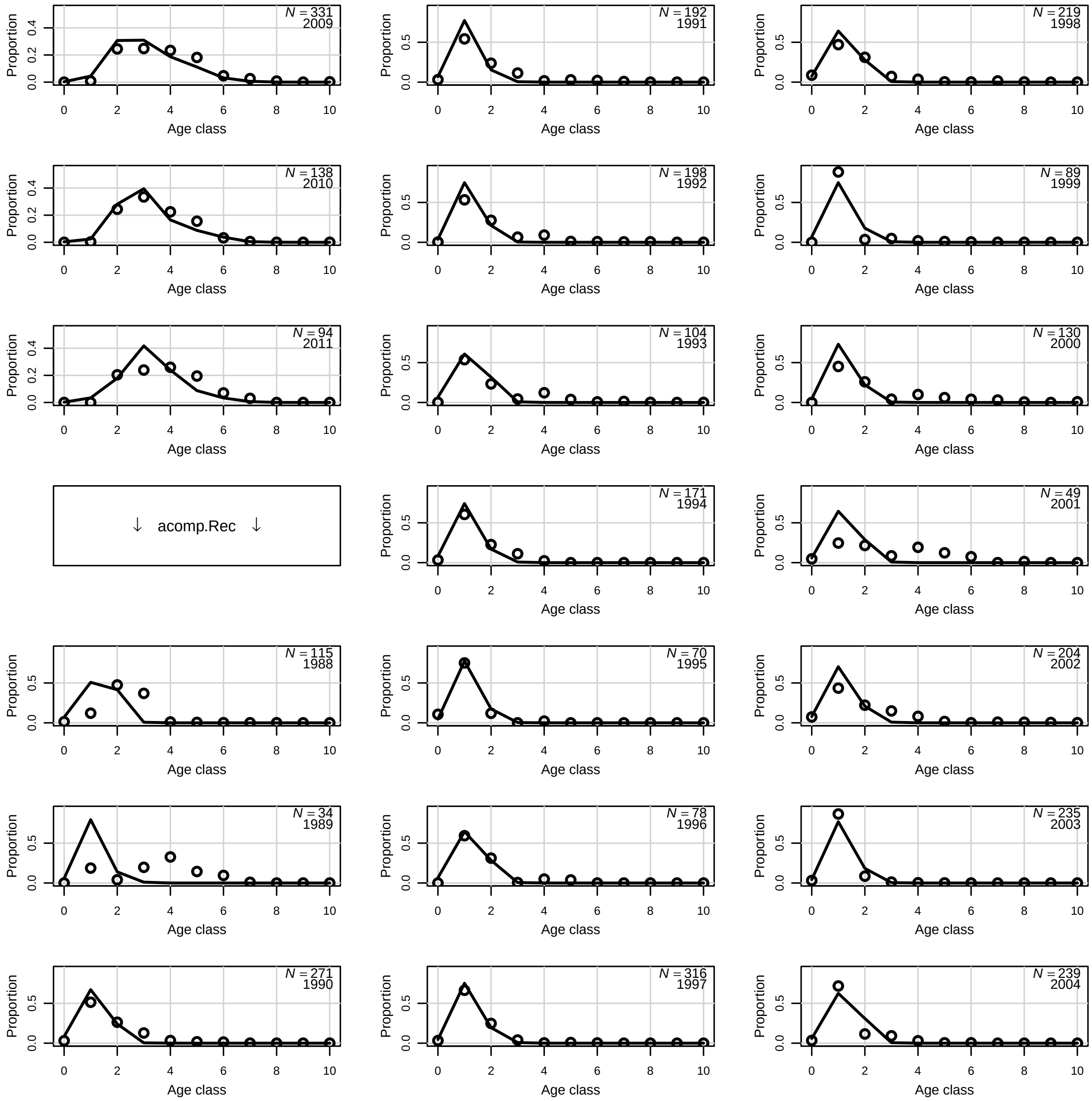


Figure 3.2. (cont.) Observed (open circles) and estimated (solid line) annual age compositions by fleet or survey.

Figure 3.3. Top panel is a bubble plot of age composition residuals from commercial handline landings; Dark represents overestimates and light underestimates. Bottom panel shows the angle (in degrees) between vectors of observations and estimates, with a reference line at 20 degrees. Error is bounded between 0 and 90 degrees, with 0 indicating a perfect fit.

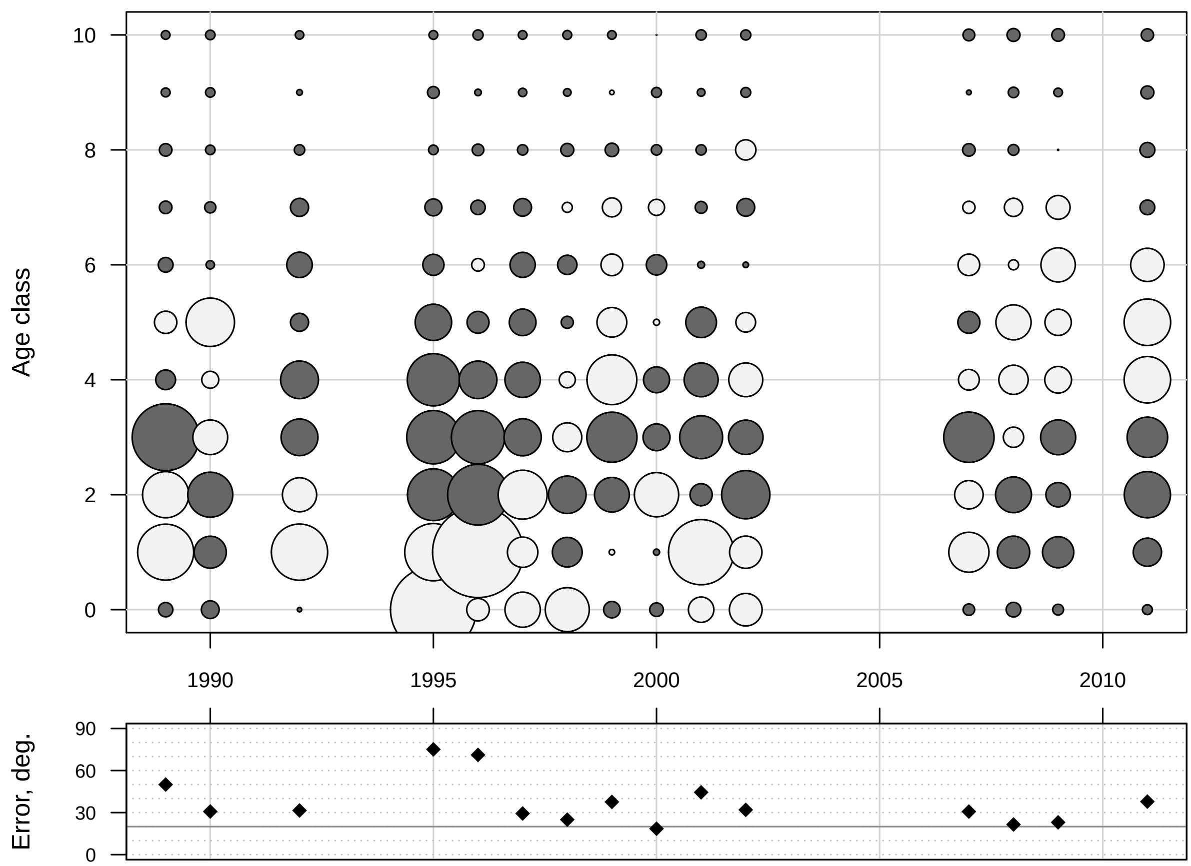


Figure 3.4. Top panel is a bubble plot of age composition residuals from commercial pound net landings; Dark represents overestimates and light underestimates. Bottom panel shows the angle (in degrees) between vectors of observations and estimates, with a reference line at 20 degrees. Error is bounded between 0 and 90 degrees, with 0 indicating a perfect fit.

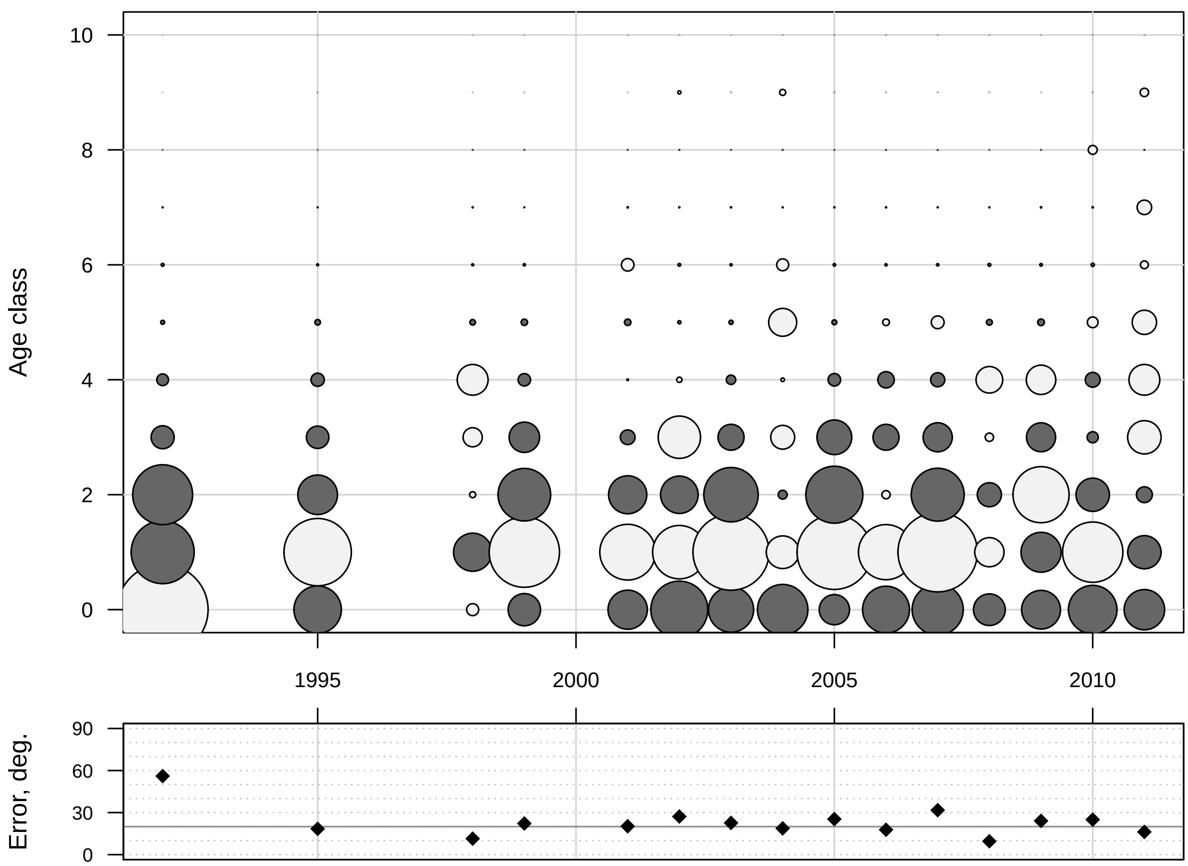


Figure 3.5. Top panel is a bubble plot of age composition residuals from commercial gill net landings; Dark represents overestimates and light underestimates. Bottom panel shows the angle (in degrees) between vectors of observations and estimates, with a reference line at 20 degrees. Error is bounded between 0 and 90 degrees, with 0 indicating a perfect fit.

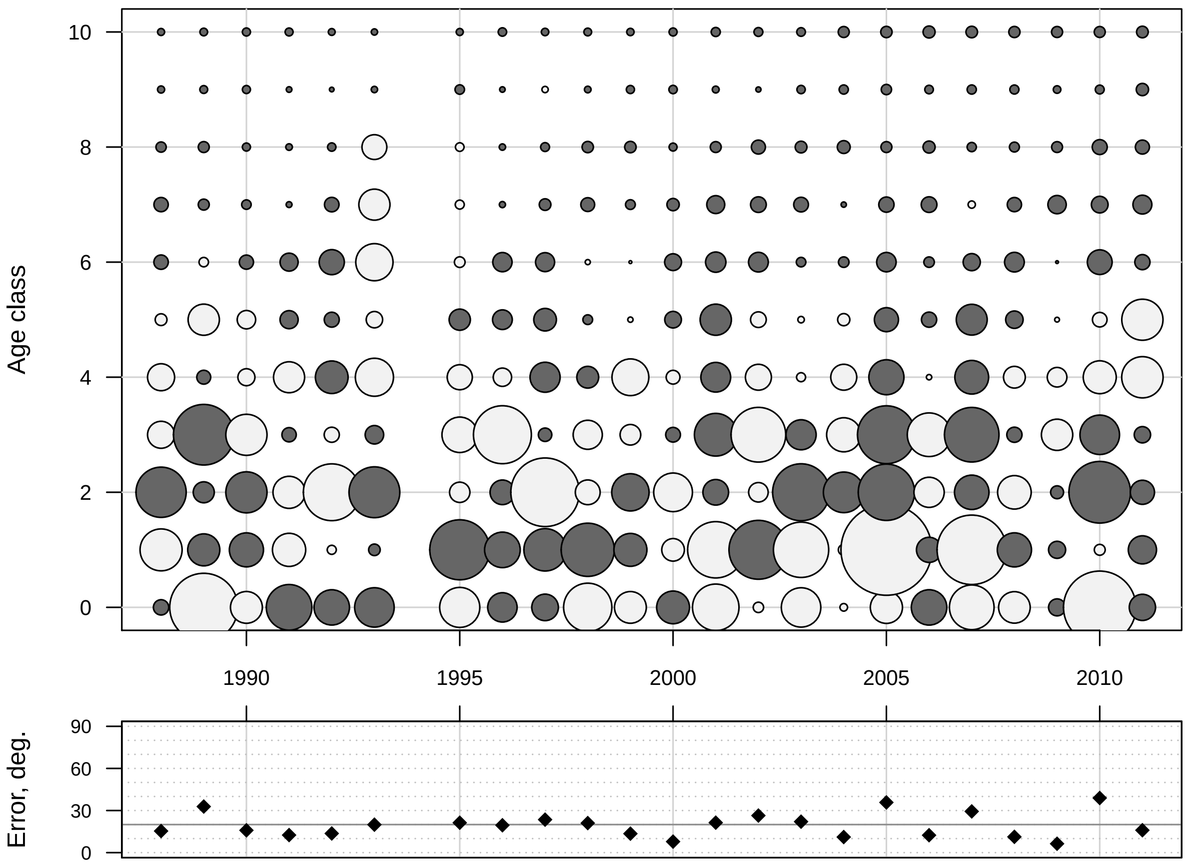


Figure 3.6. Top panel is a bubble plot of age composition residuals from commercial cast net landings; Dark represents overestimates and light underestimates. Bottom panel shows the angle (in degrees) between vectors of observations and estimates, with a reference line at 20 degrees. Error is bounded between 0 and 90 degrees, with 0 indicating a perfect fit.

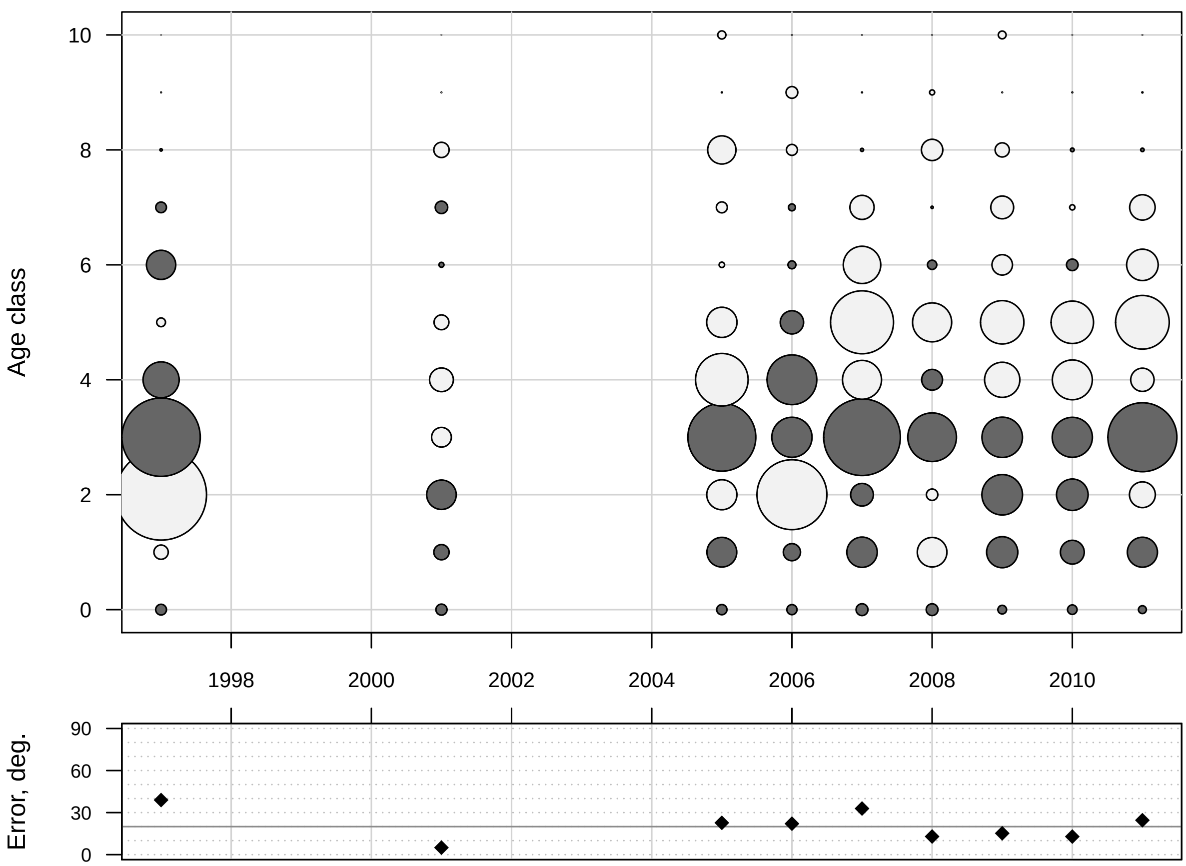


Figure 3.7. Top panel is a bubble plot of age composition residuals from recreational landings; Dark represents overestimates and light underestimates. Bottom panel shows the angle (in degrees) between vectors of observations and estimates, with a reference line at 20 degrees. Error is bounded between 0 and 90 degrees, with 0 indicating a perfect fit.

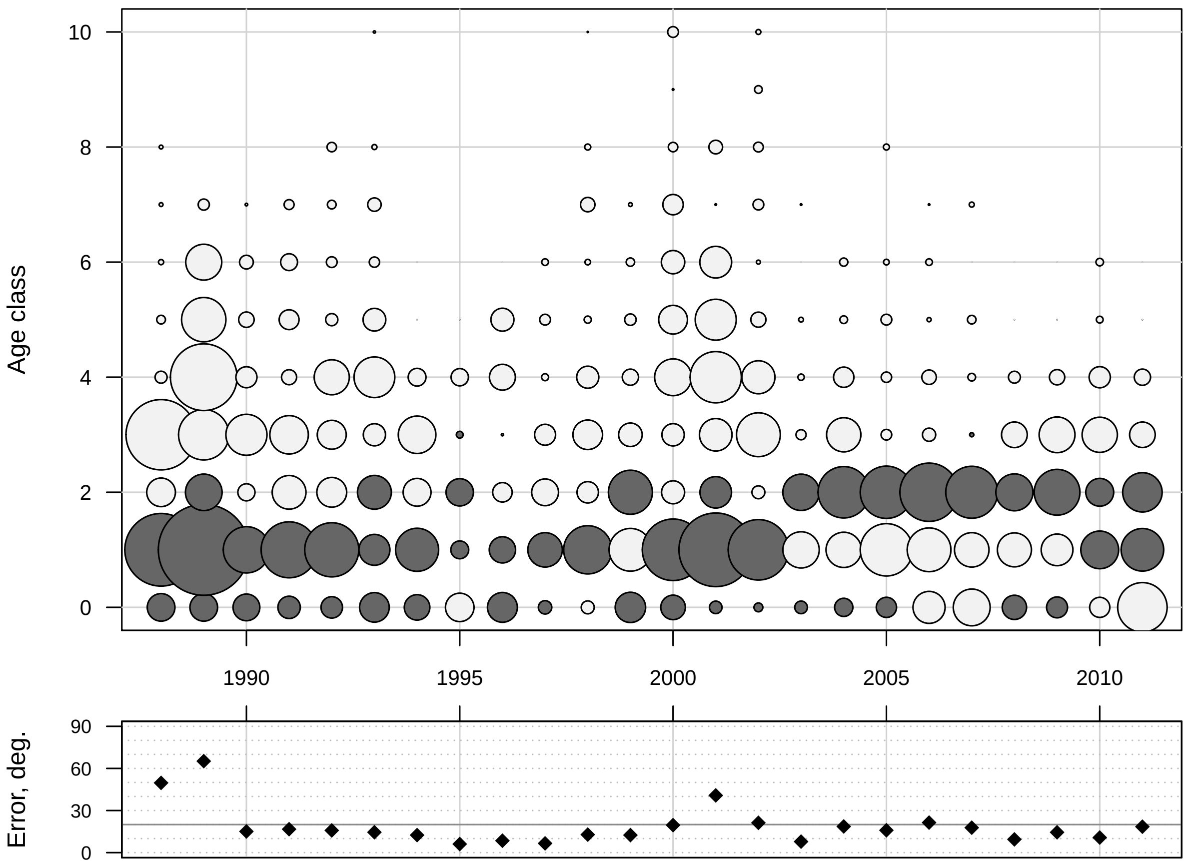


Figure 3.8. Observed (open circles) and estimated (line, solid circles) commercial handline landings (1000 lb whole weight).

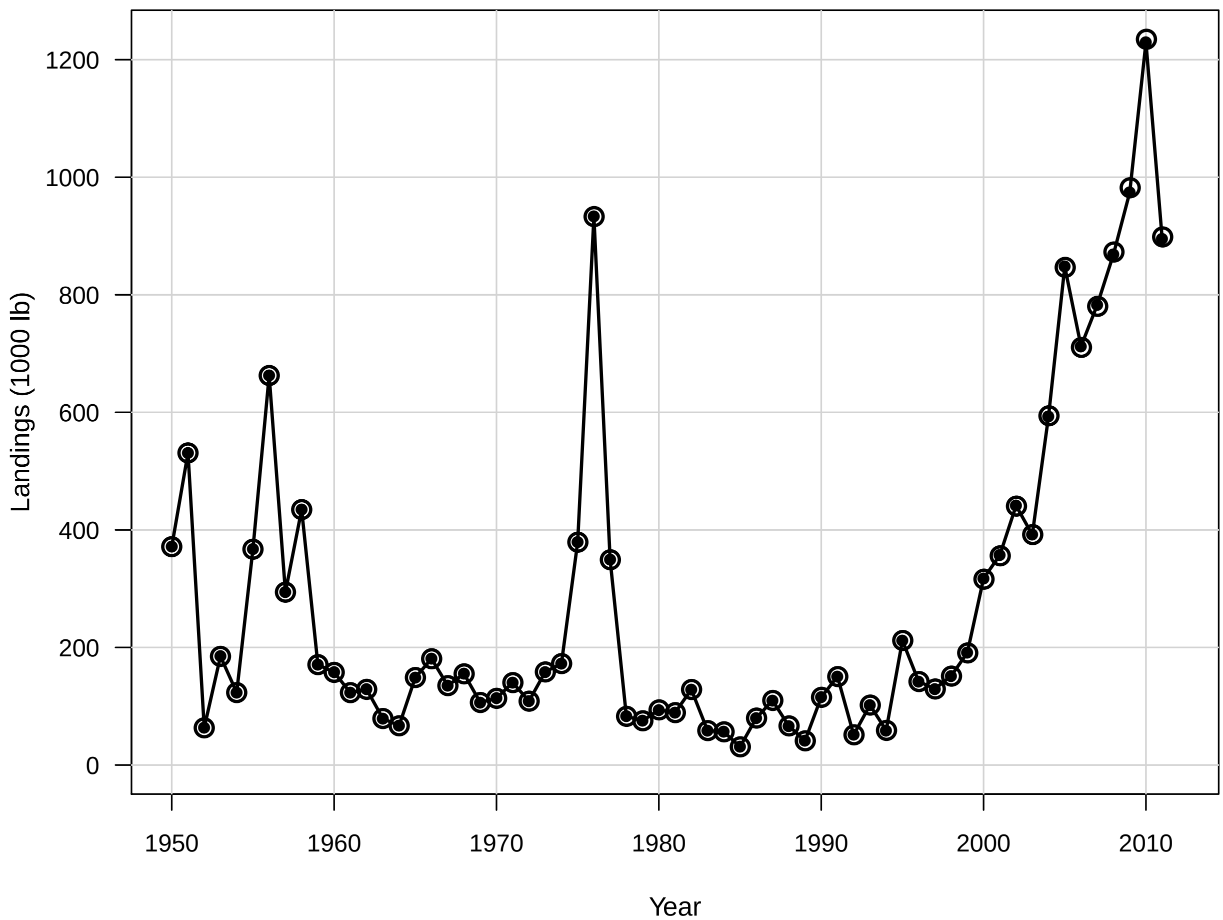


Figure 3.9. Observed (open circles) and estimated (line, solid circles) commercial pound net landings (1000 lb whole weight).

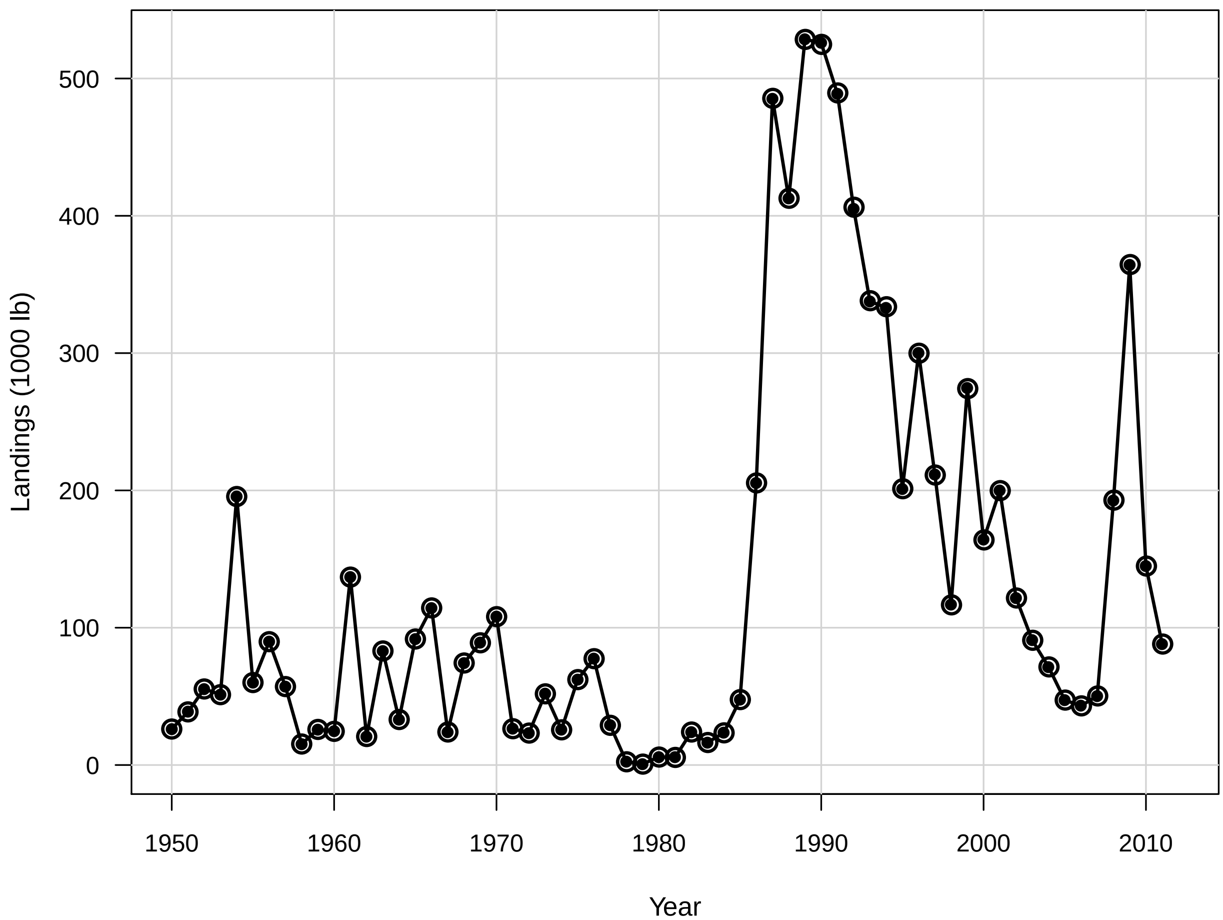


Figure 3.10. Observed (open circles) and estimated (line, solid circles) commercial gill net landings (1000 lb whole weight).

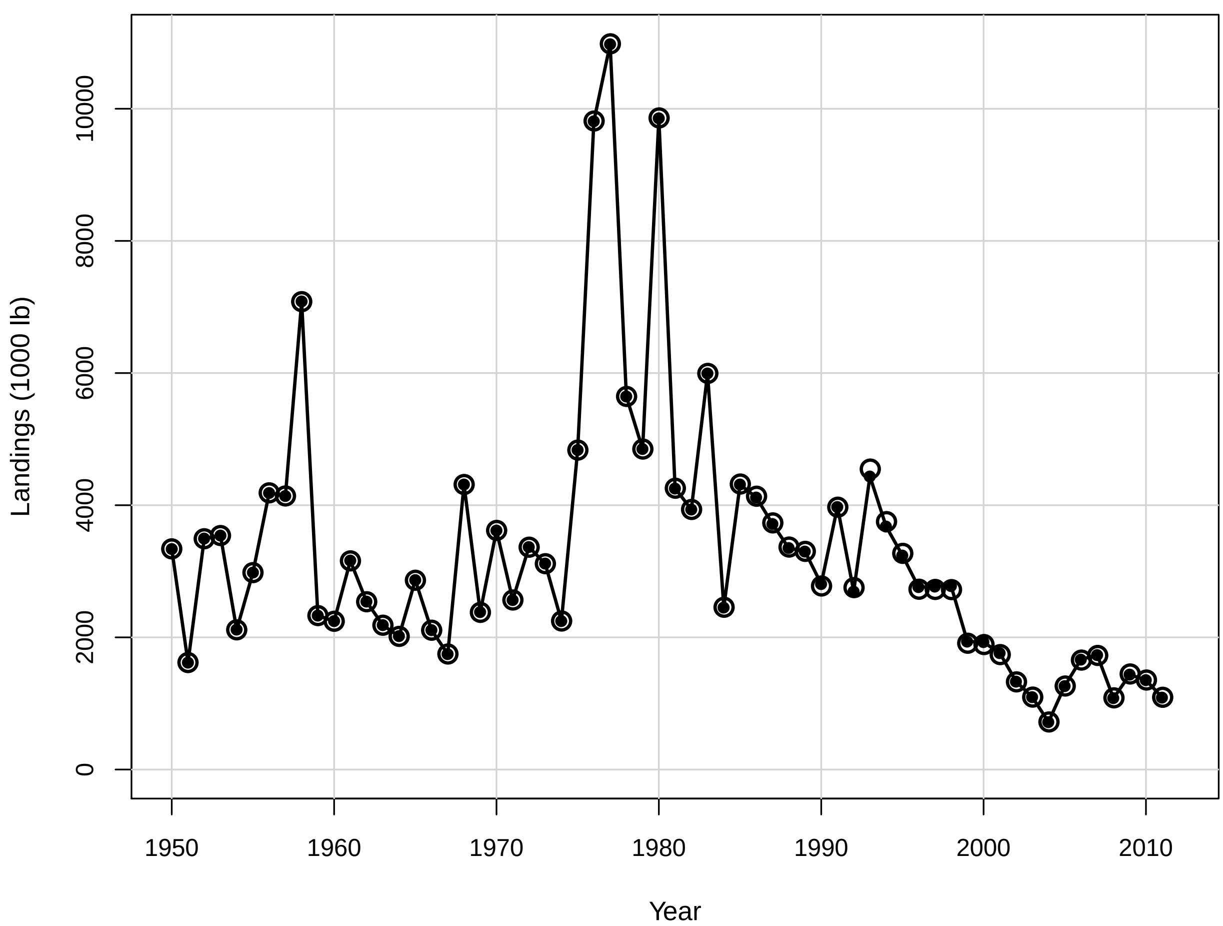


Figure 3.11. Observed (open circles) and estimated (line, solid circles) commercial cast net landings (1000 lb whole weight).

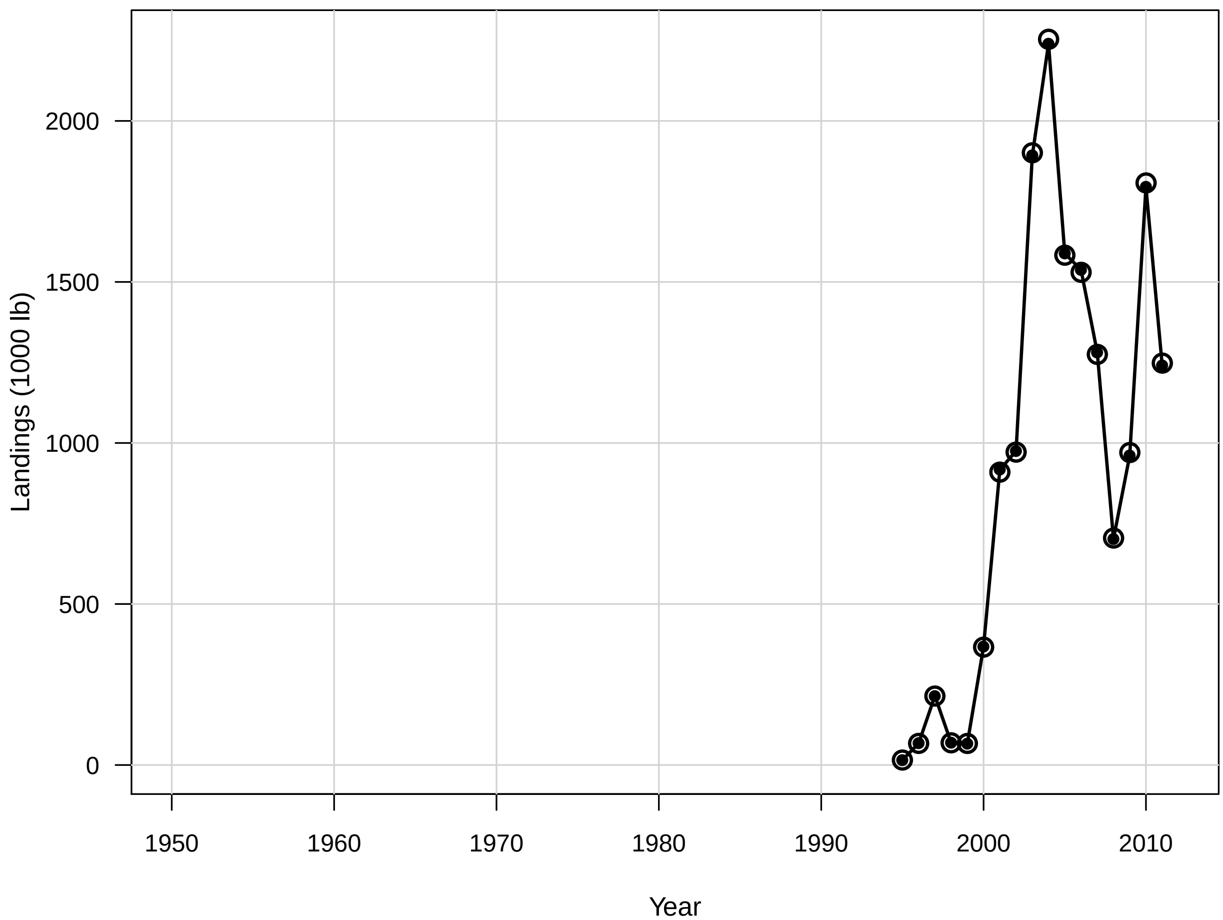


Figure 3.12. Observed (open circles) and estimated (line, solid circles) recreational landings (1000 fish).

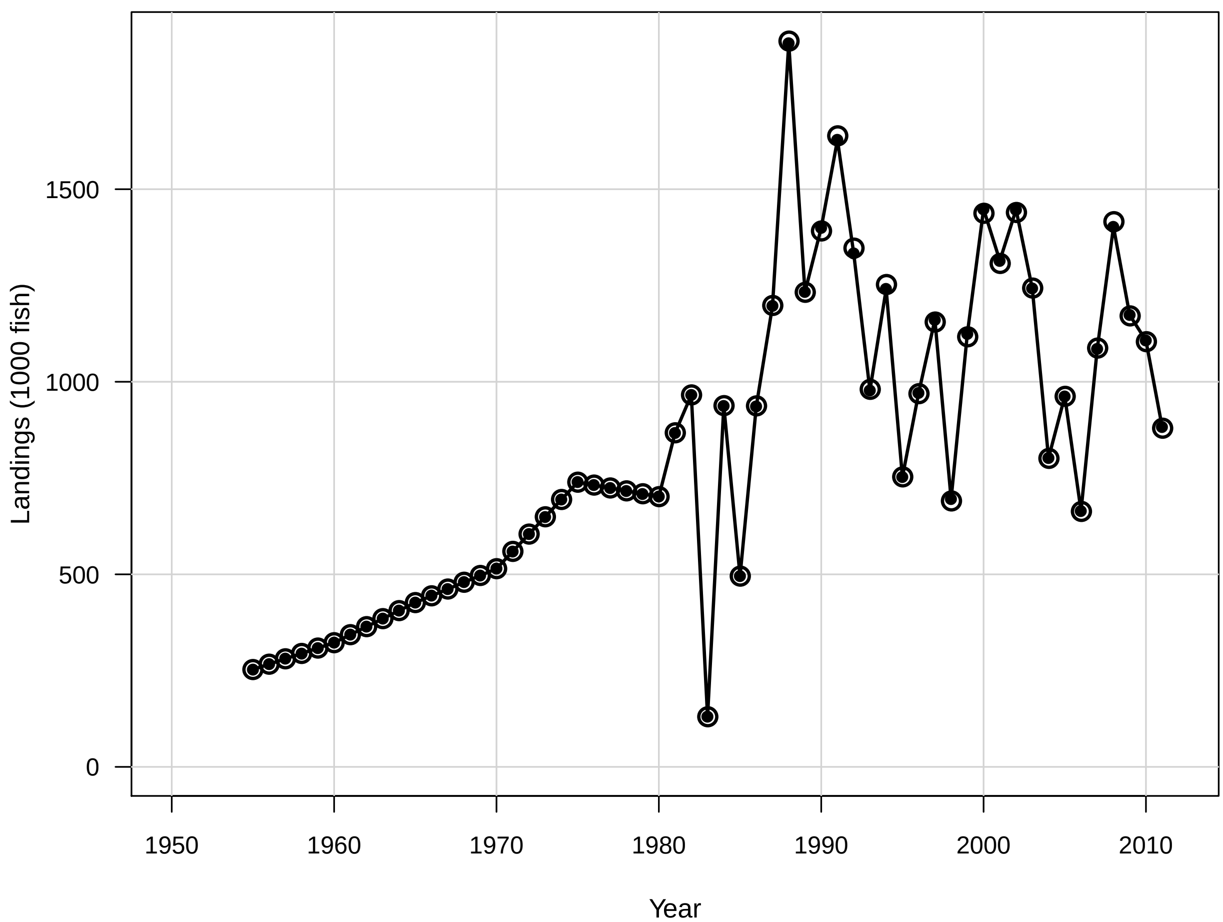


Figure 3.13. Observed (open circles) and estimated (line, solid circles) recreational discards (1000 fish).

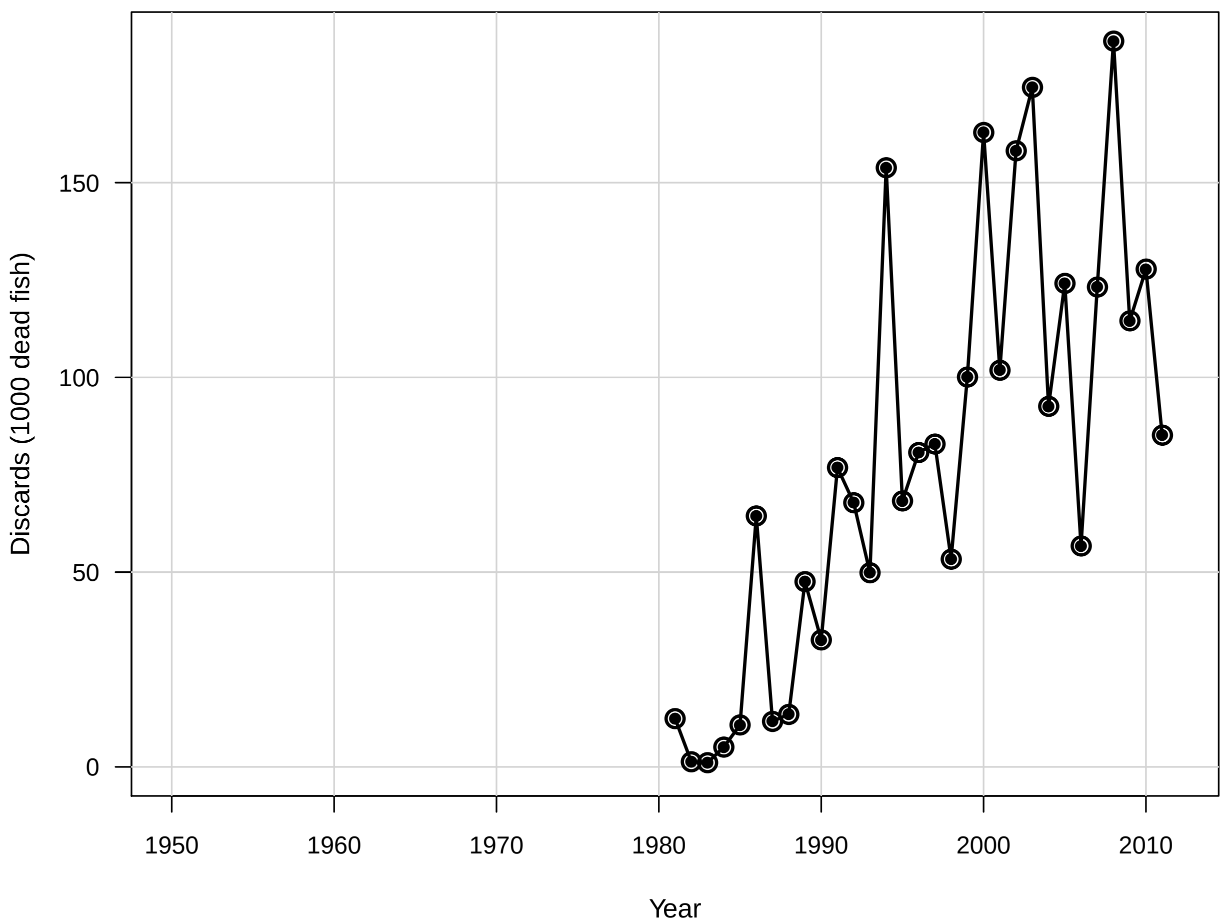


Figure 3.14. Observed (open circles) and estimated (line, solid circles) discards from shrimp bycatch (1000 fish).

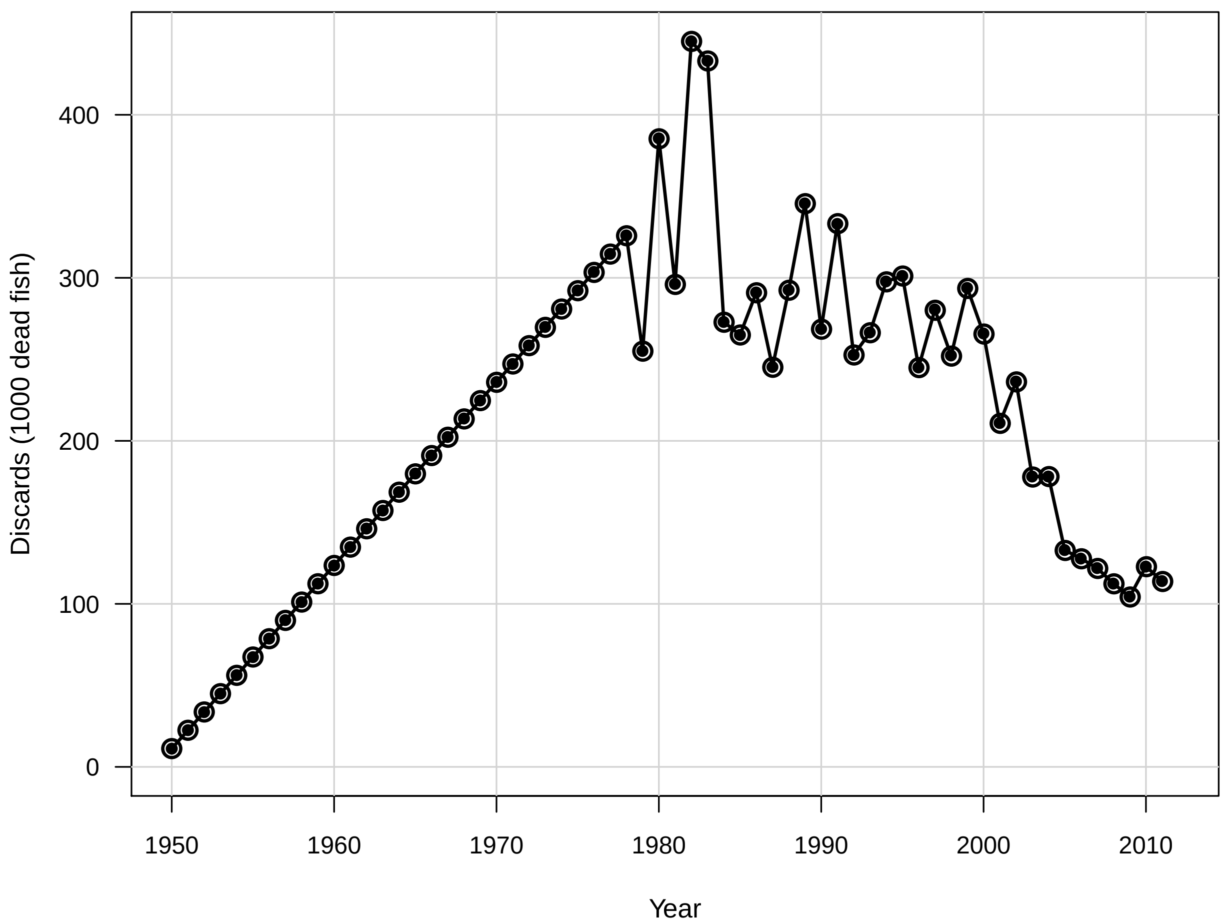


Figure 3.15. Observed (open circles) and estimated (line, solid circles) index of abundance from Florida handline trip tickets.

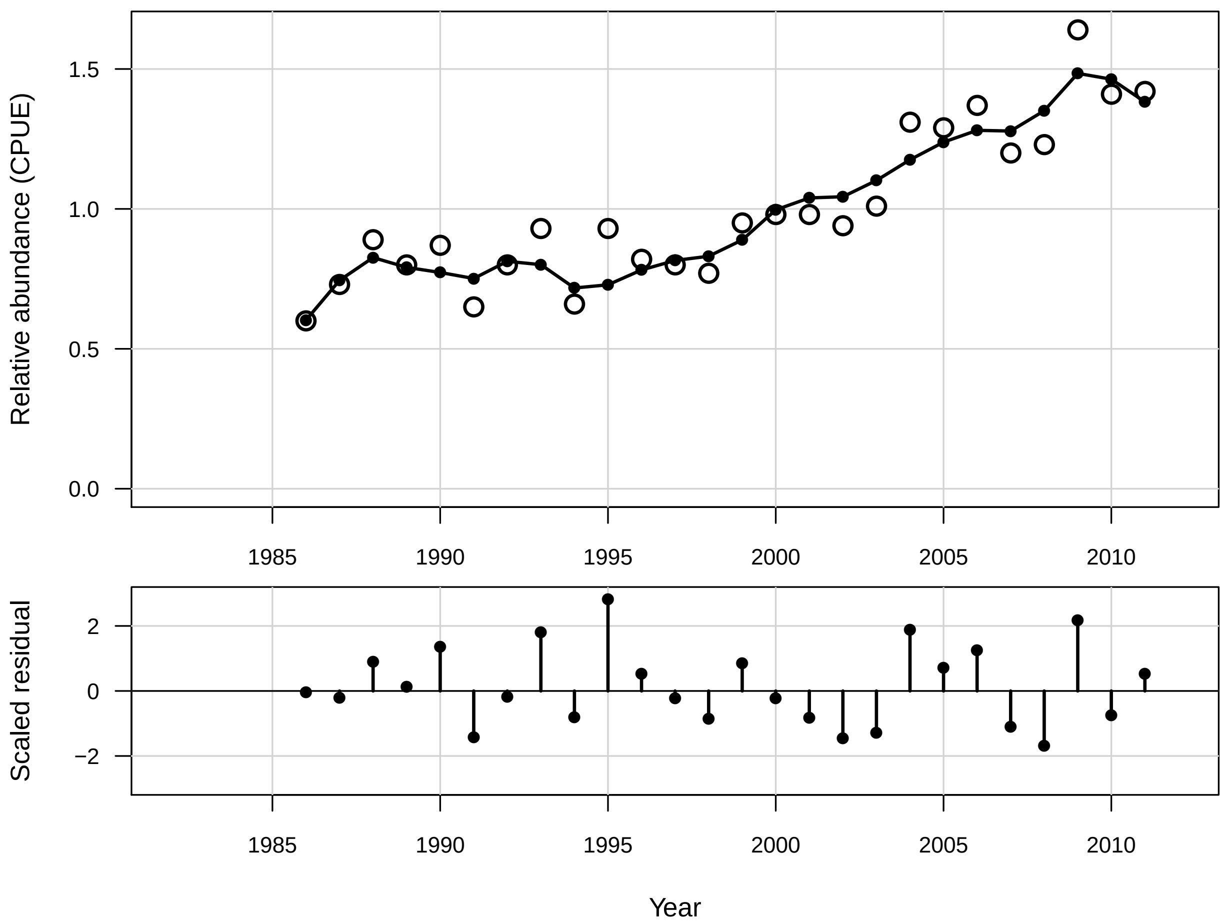


Figure 3.16. Observed (open circles) and estimated (line, solid circles) index of abundance from MRFSS.

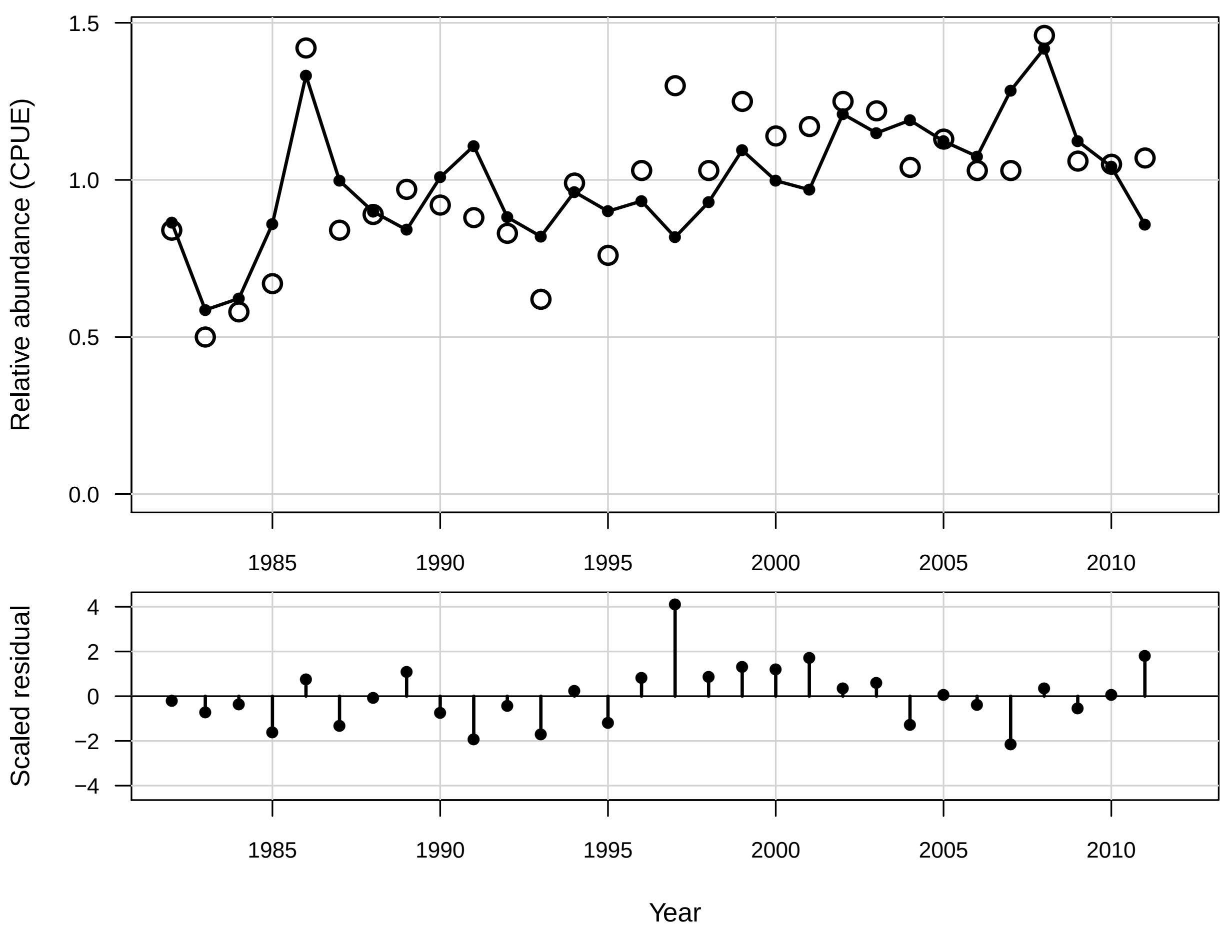


Figure 3.17. Observed (open circles) and estimated (line, solid circles) index of abundance from SEAMAP YOY samples.

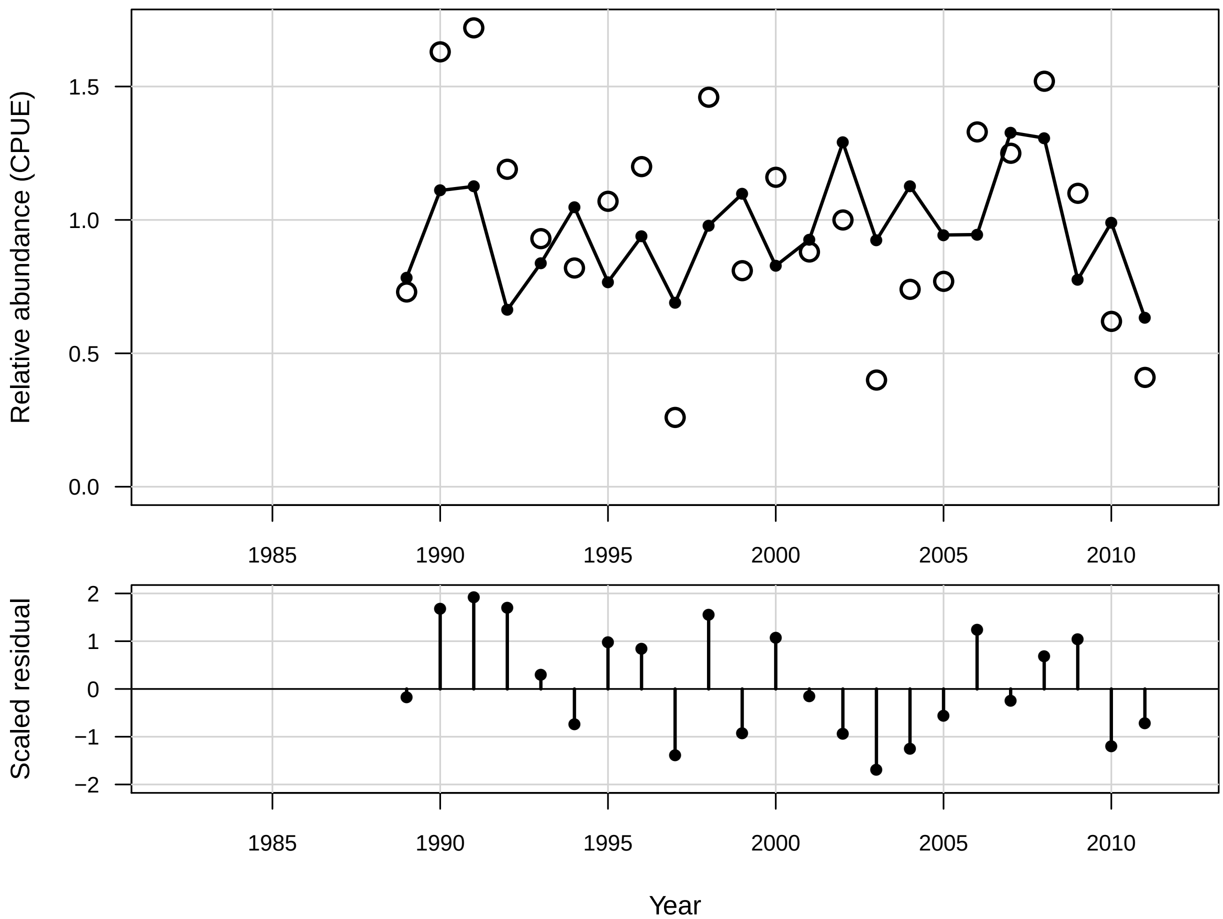


Figure 3.18. Estimated abundance at age at start of year.

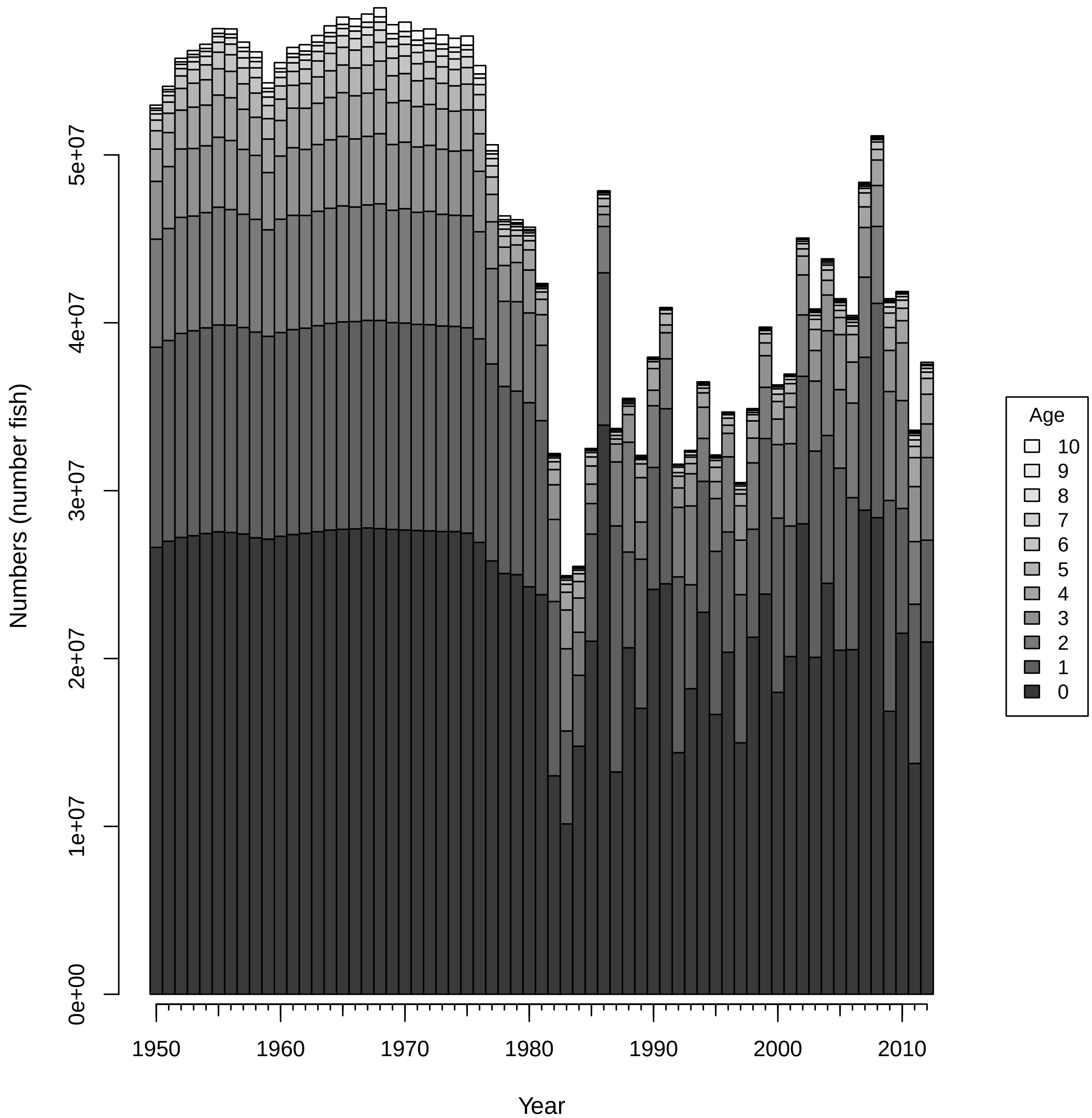


Figure 3.19. Top panel: Estimated recruitment of age-0 fish. Horizontal dashed line indicates R_{MSY}. Bottom panel: log recruitment residuals.

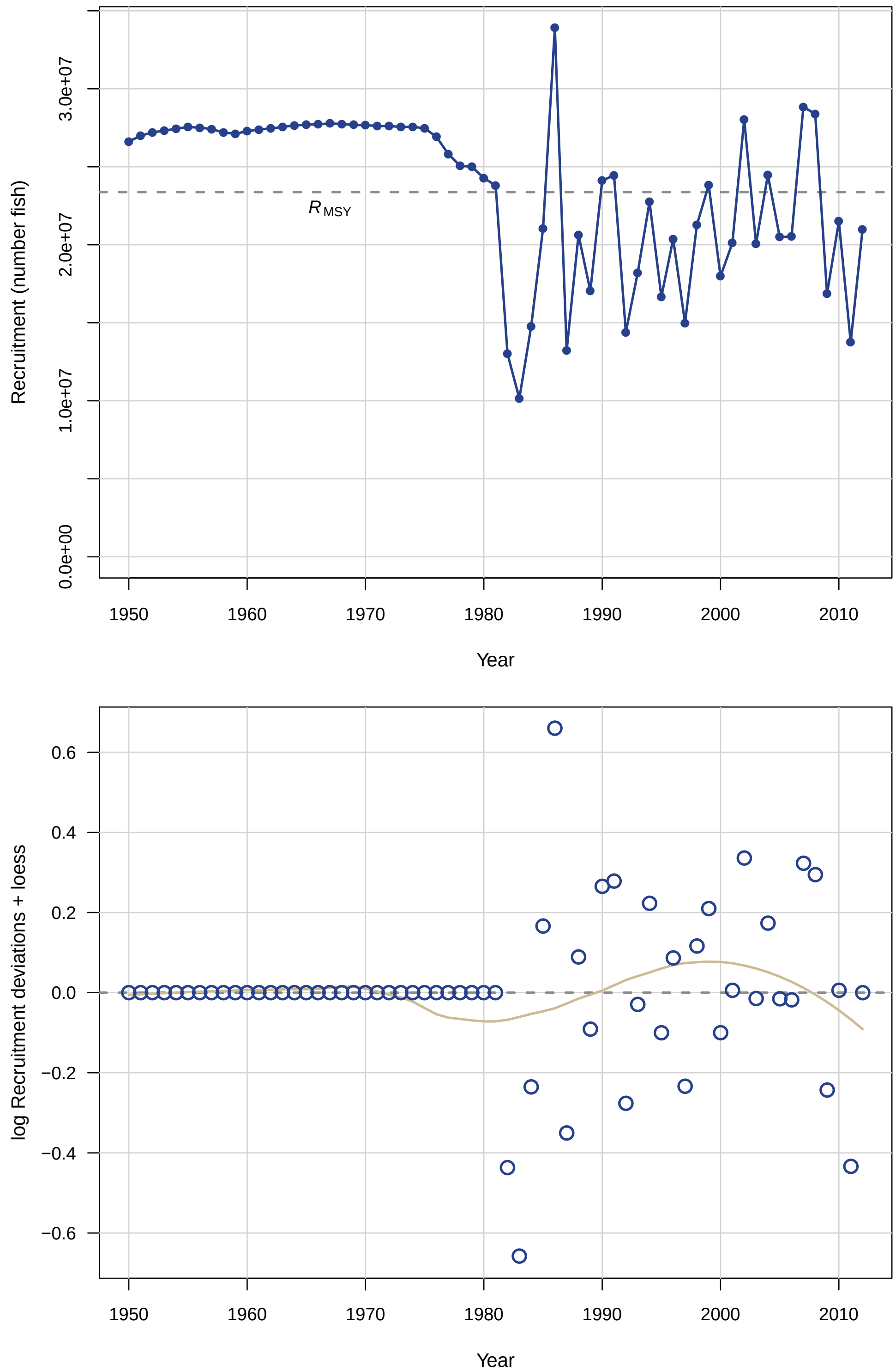


Figure 3.20. Estimated biomass at age at start of year.

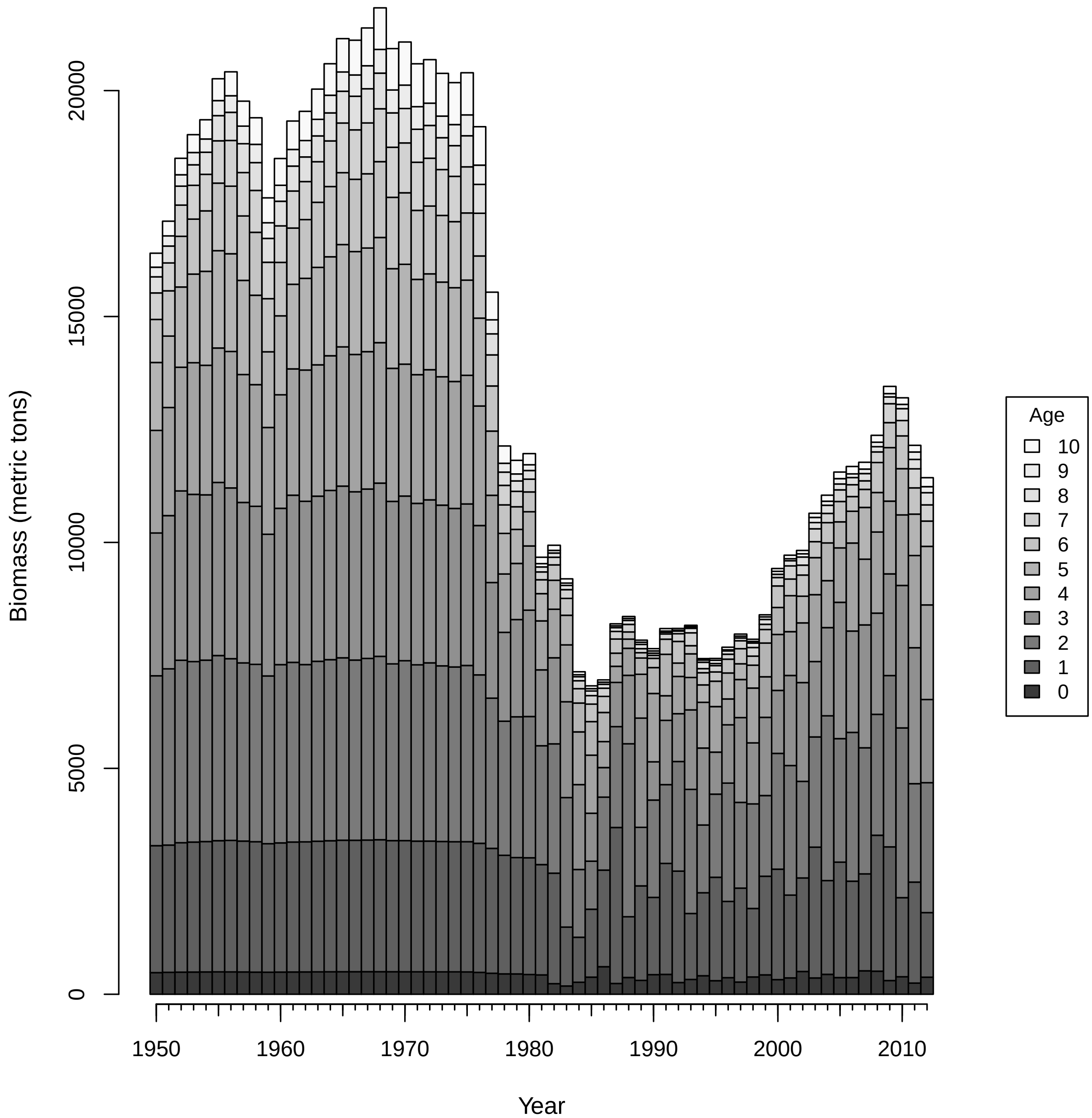


Figure 3.21. Selectivities of fleets. Top panel: commercial handline-female, Bottom panel: commercial handline–male.

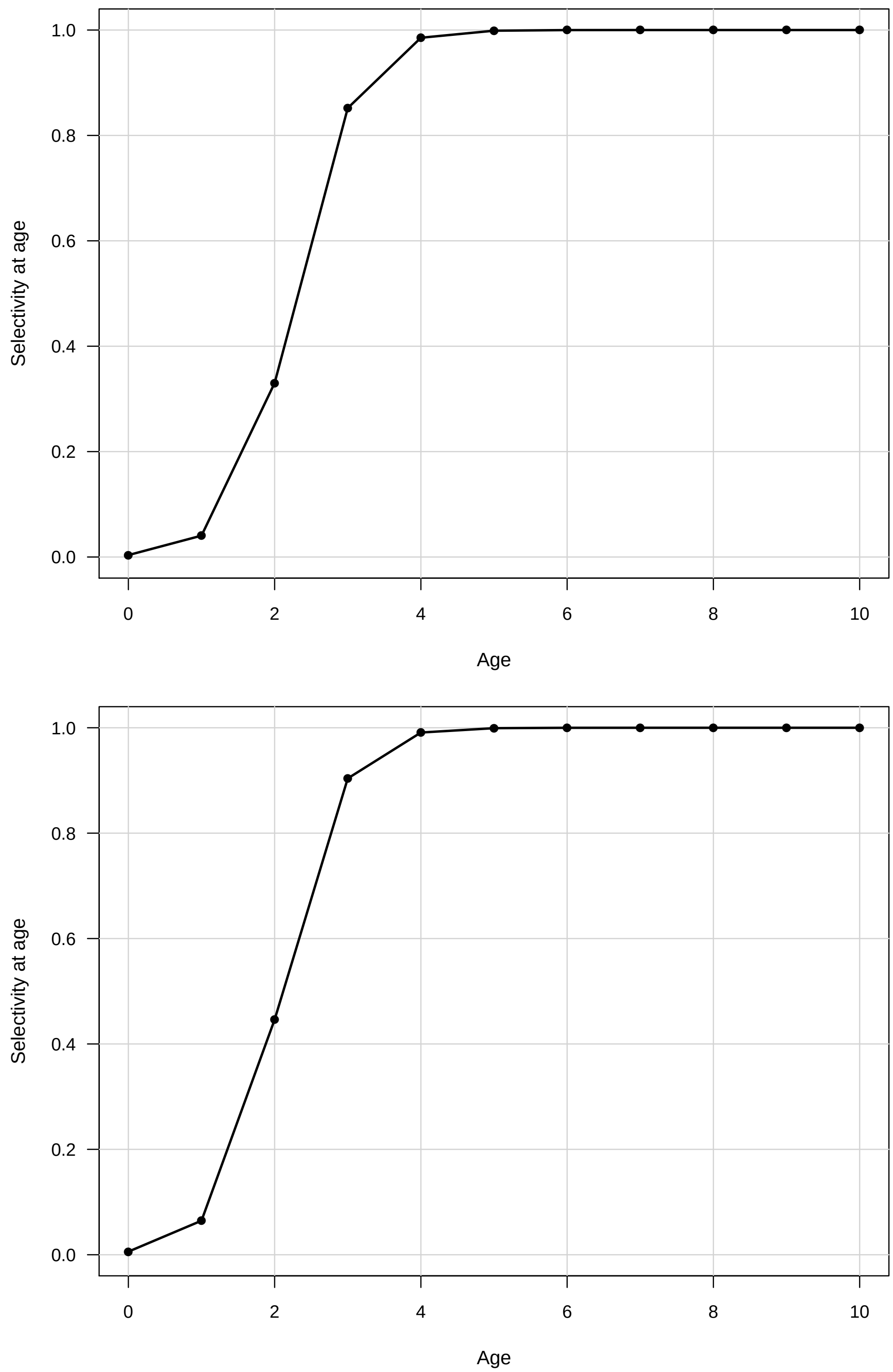


Figure 3.22. Selectivities of fleets. Top panel: commercial pound net–female, Bottom panel: commercial pound net–male.

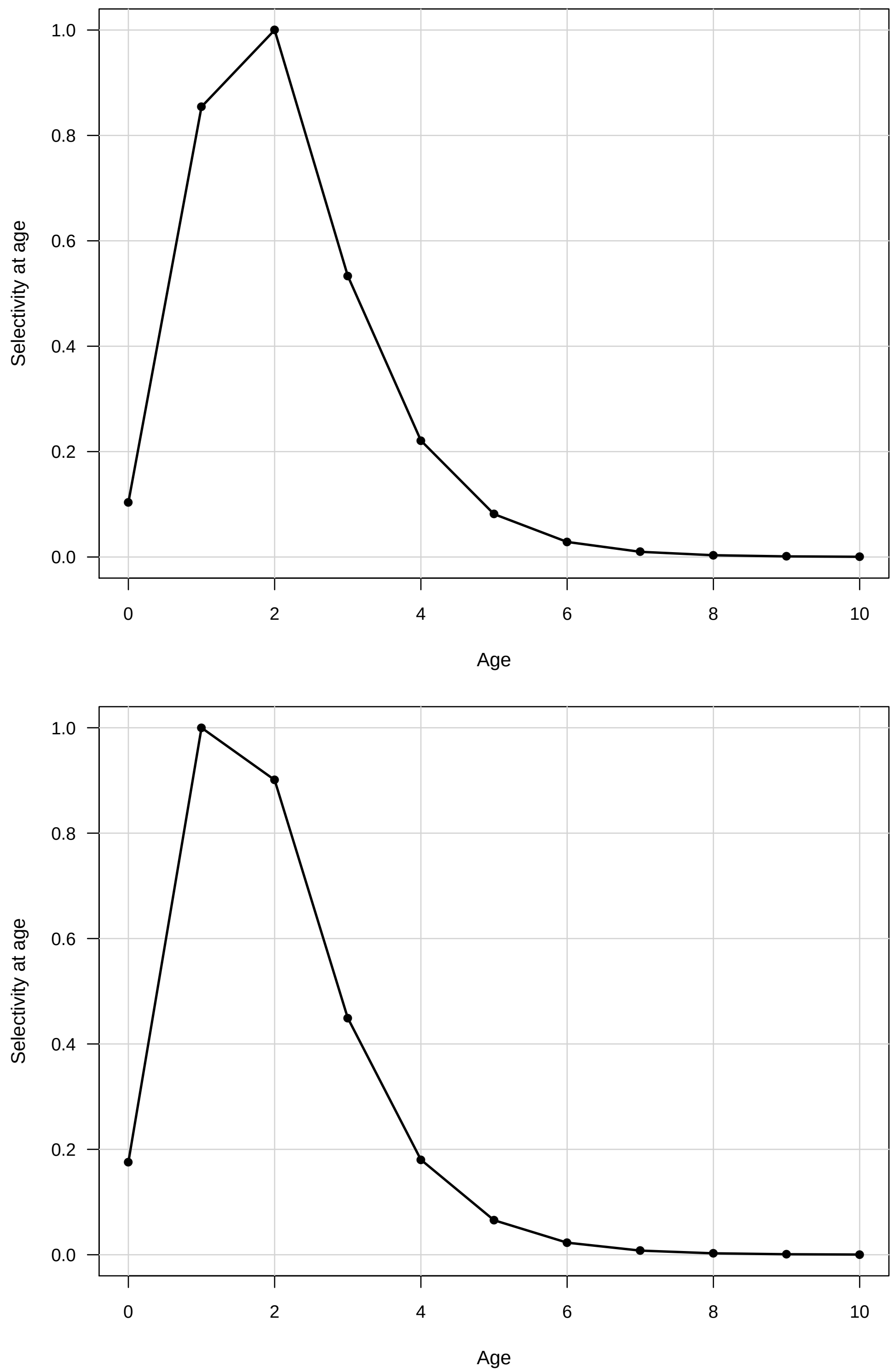


Figure 3.23. Selectivities of fleets. Top panel: commercial gill net-female, Bottom panel: commercial gill net–male.

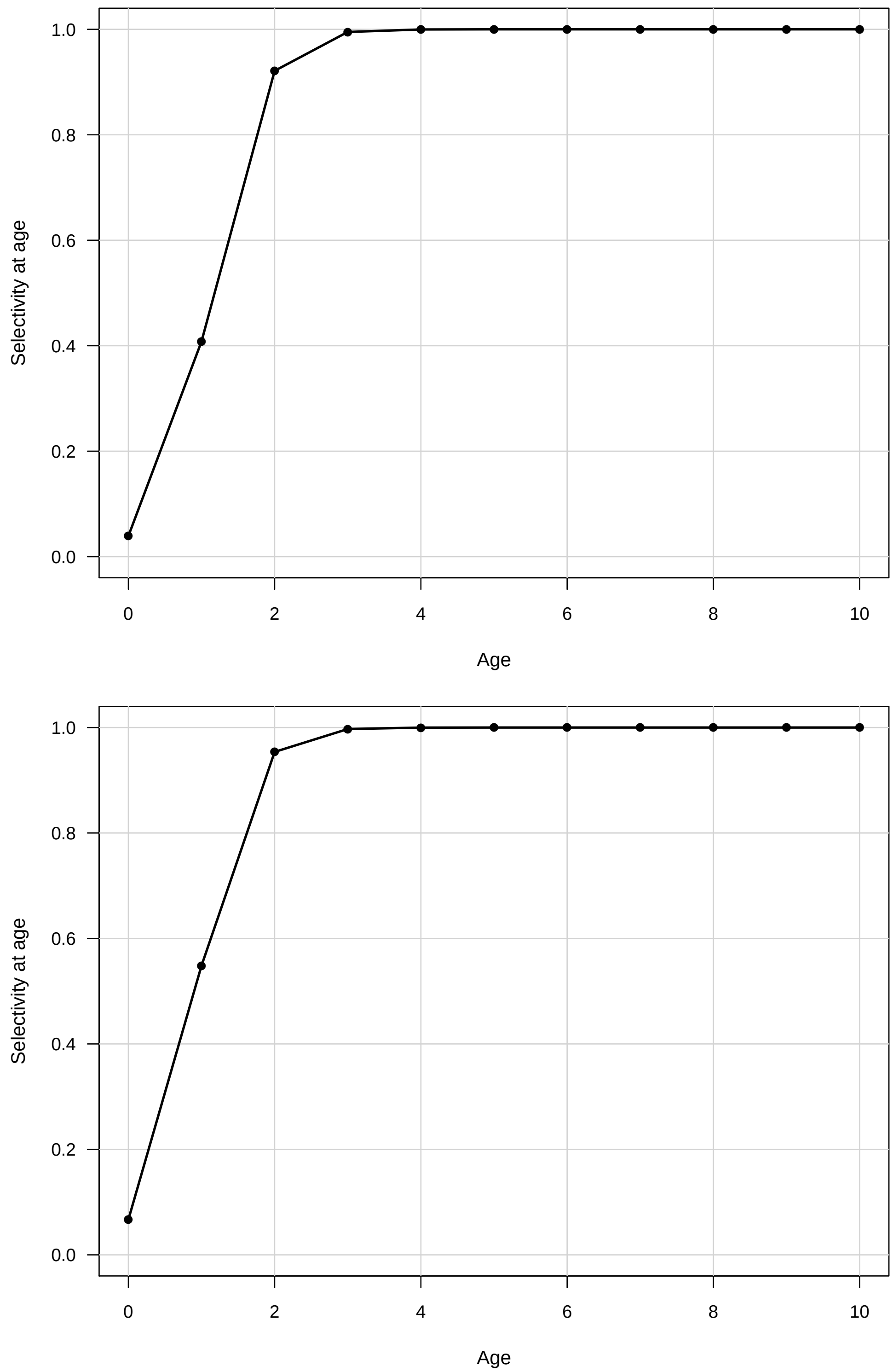


Figure 3.24. Selectivities of fleets. Top panel: commercial cast net–female, Bottom panel: commercial cast net–male.

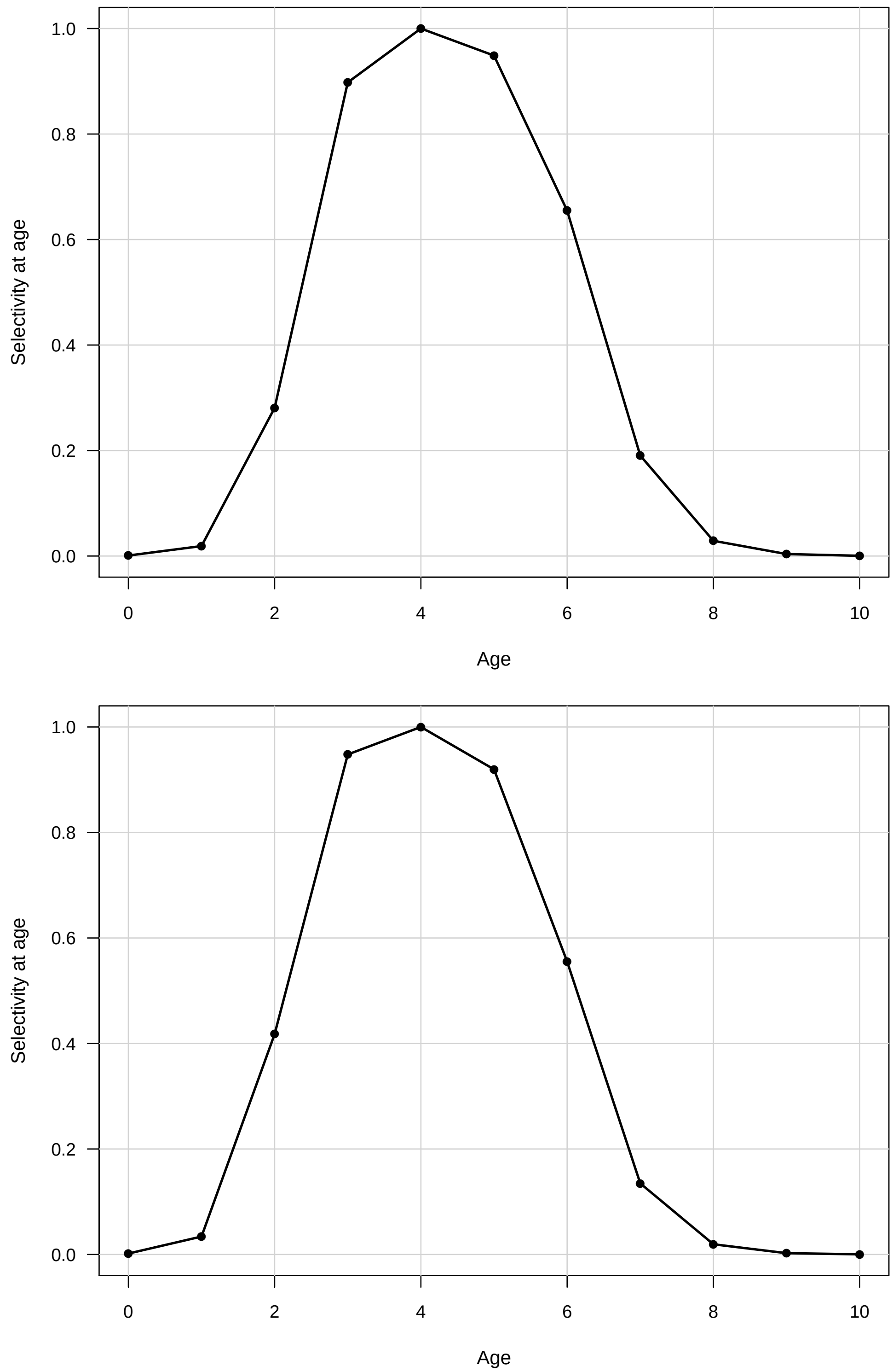


Figure 3.25. Selectivities of fleets. Top panel: recreational-female, Bottom panel: recreational–male.

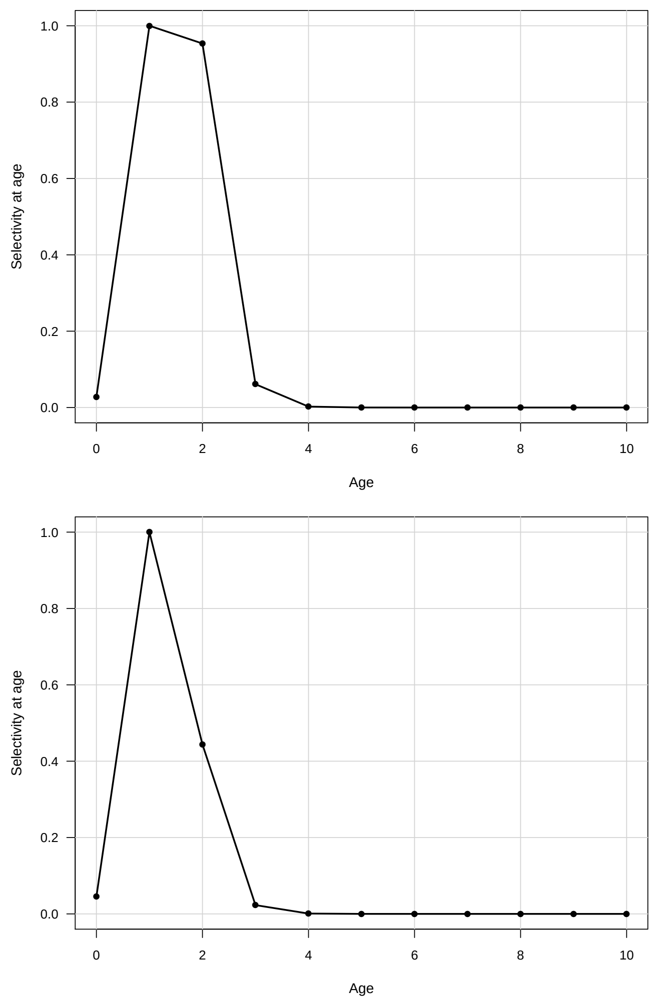


Figure 3.26. Selectivities of fleets. Top panel: recreational discard–female, Bottom panel: recreational discard–male.

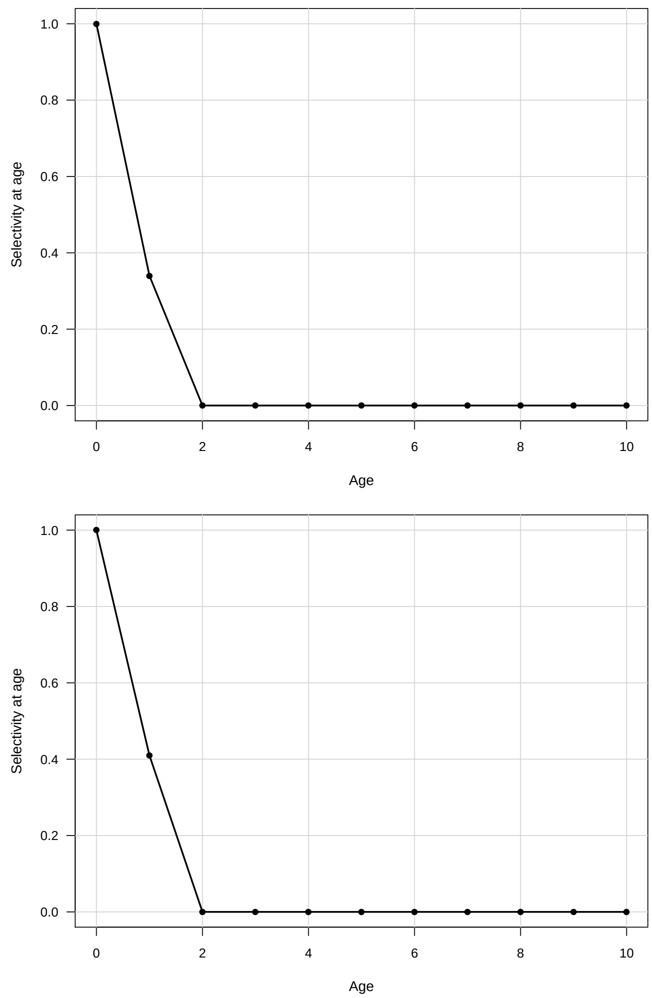


Figure 3.27. Average selectivity from the terminal assessment year weighted by geometric mean Fs from the last three assessment years for females (top panel) and males (bottom panel), and used in computation of benchmarks and central-tendency projections.

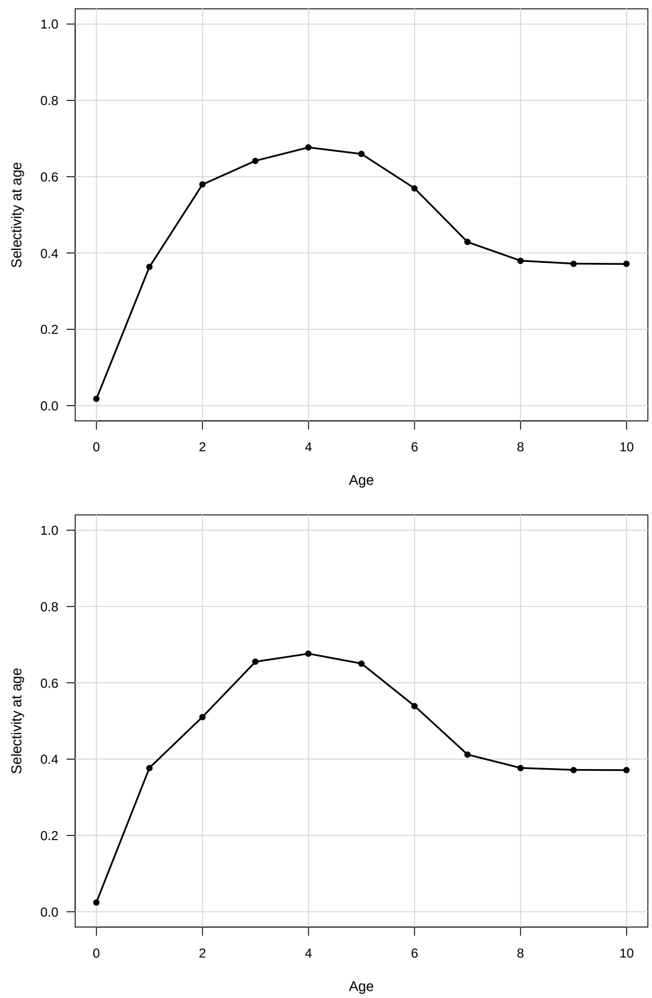


Figure 3.28. Estimated fully selected fishing mortality rate (per year) by fishery. HL refers to commercial handline, PN to commercial pound net, GN to commercial gill net, CN to commercial cast net, Rec for recreational, Rec.D for recreational discards, and shrimp.B for shrimp bycatch.

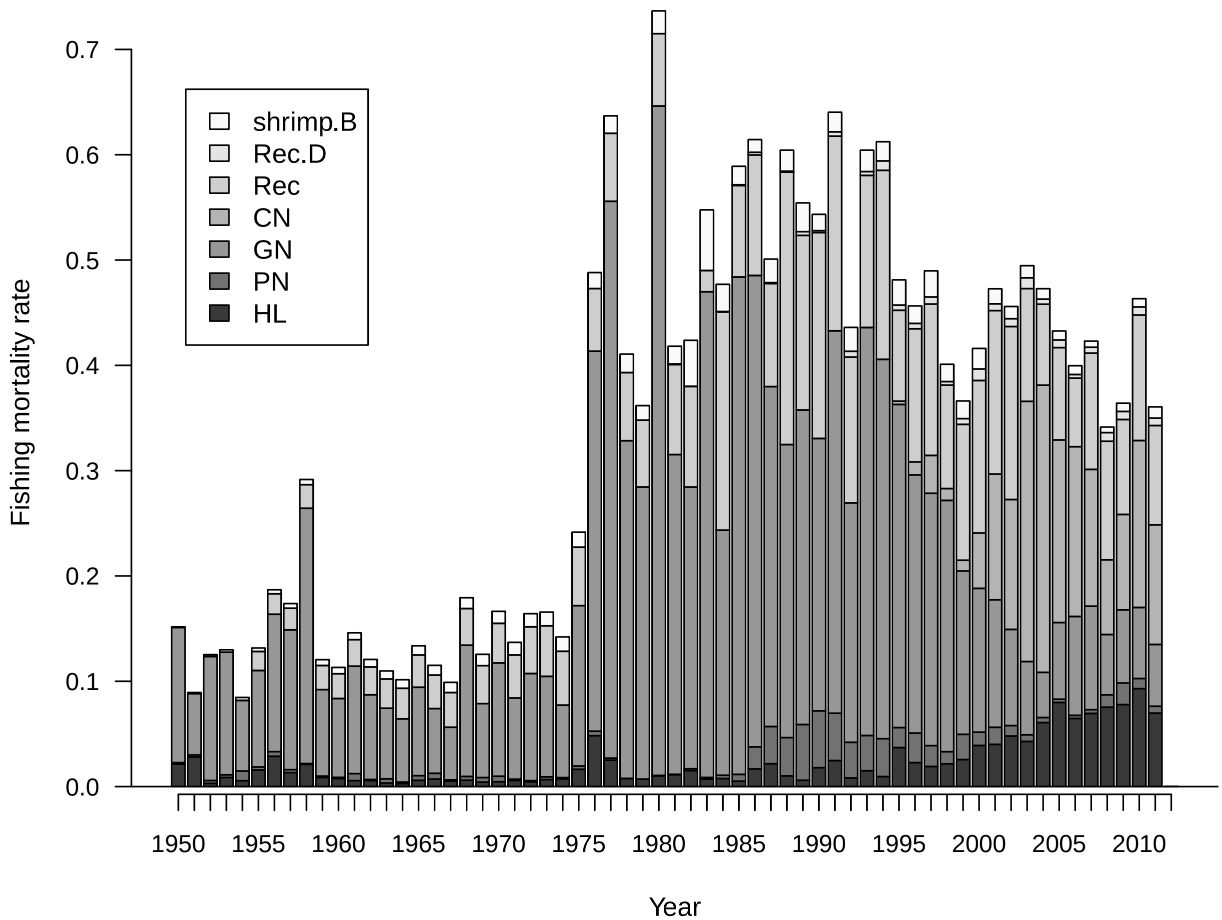


Figure 3.29. Estimated landings in numbers by fishery from the catch-age model. HL refers to commercial handline, PN to commercial pound net, GN to commercial gill net, CN to commercial cast net, and Rec for recreational.

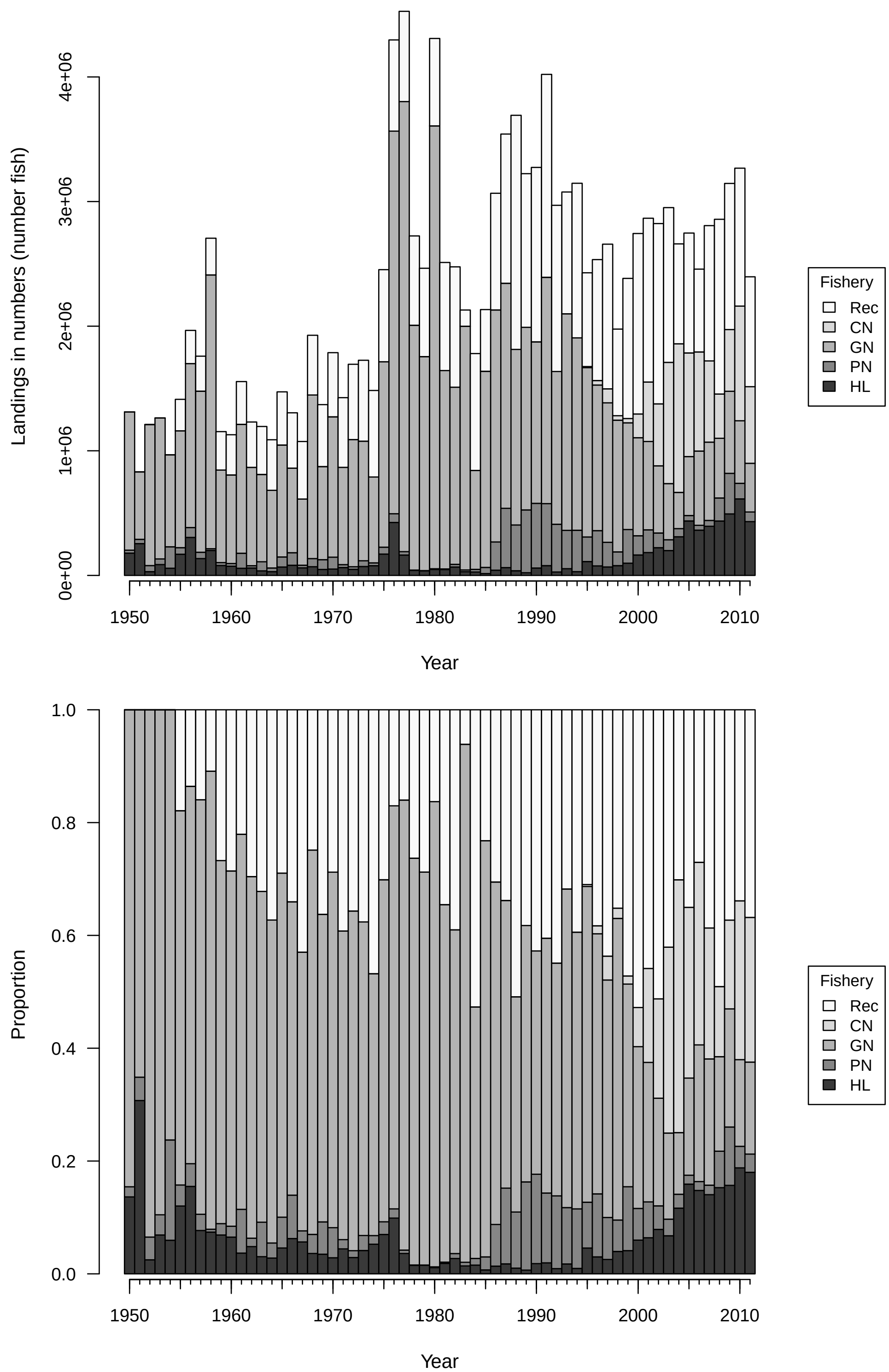


Figure 3.30. Estimated landings in whole weight by fishery from the catch-age model. HL refers to commercial hand-line, PN to commercial pound net, GN to commercial gill net, CN to commercial cast net, and Rec for recreational. Horizontal dashed line in the top panel corresponds to the point estimate of MSY.

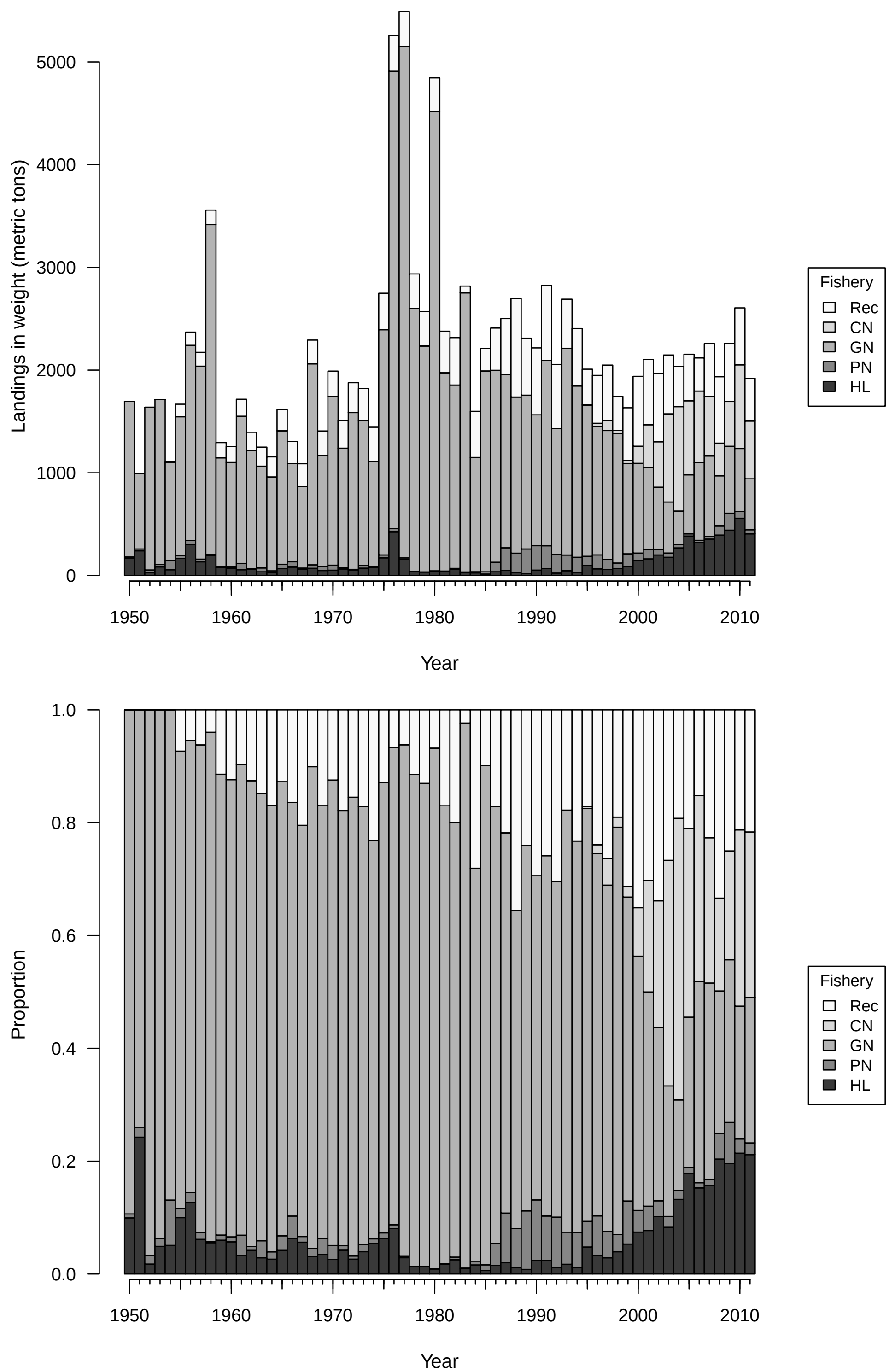
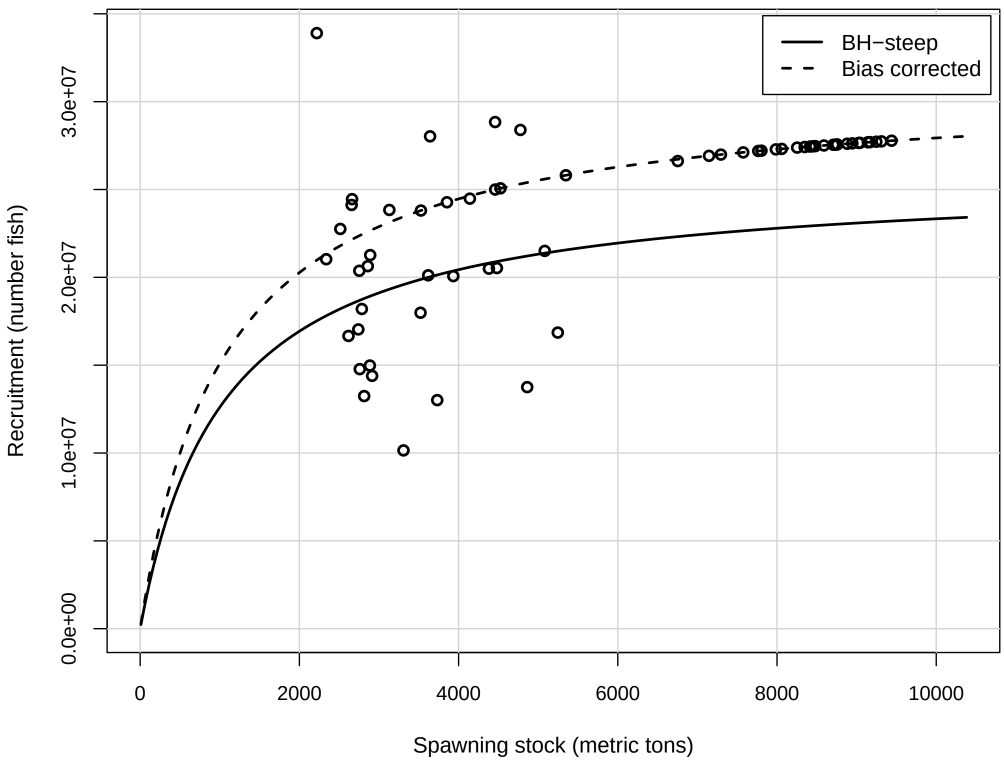


Figure 3.31. Top panel: Beverton–Holt spawner-recruit curves, with and without lognormal bias correction. The expected (upper) curve was used for computing management benchmarks. Years within panel indicate year of recruitment generated from spawning biomass one year prior. Bottom panel: log of recruits (number age-0 fish) per spawner (mature female gonad weight) as a function of spawners.



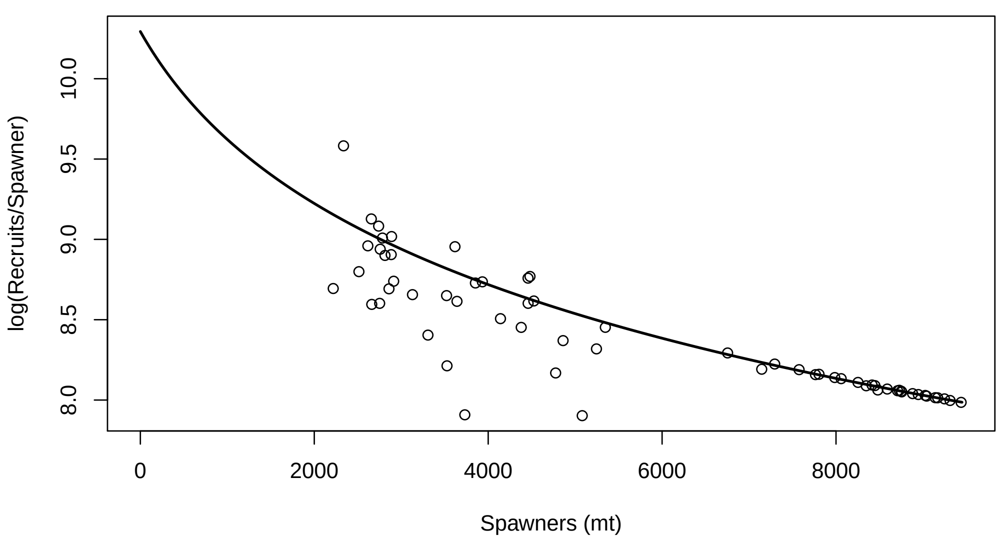


Figure 3.32. Estimated time series of static spawning potential ratio, the annual equilibrium spawners per recruit relative to that at the unfished level. Horizontal dashed line indicates the equilibrium MSY level.

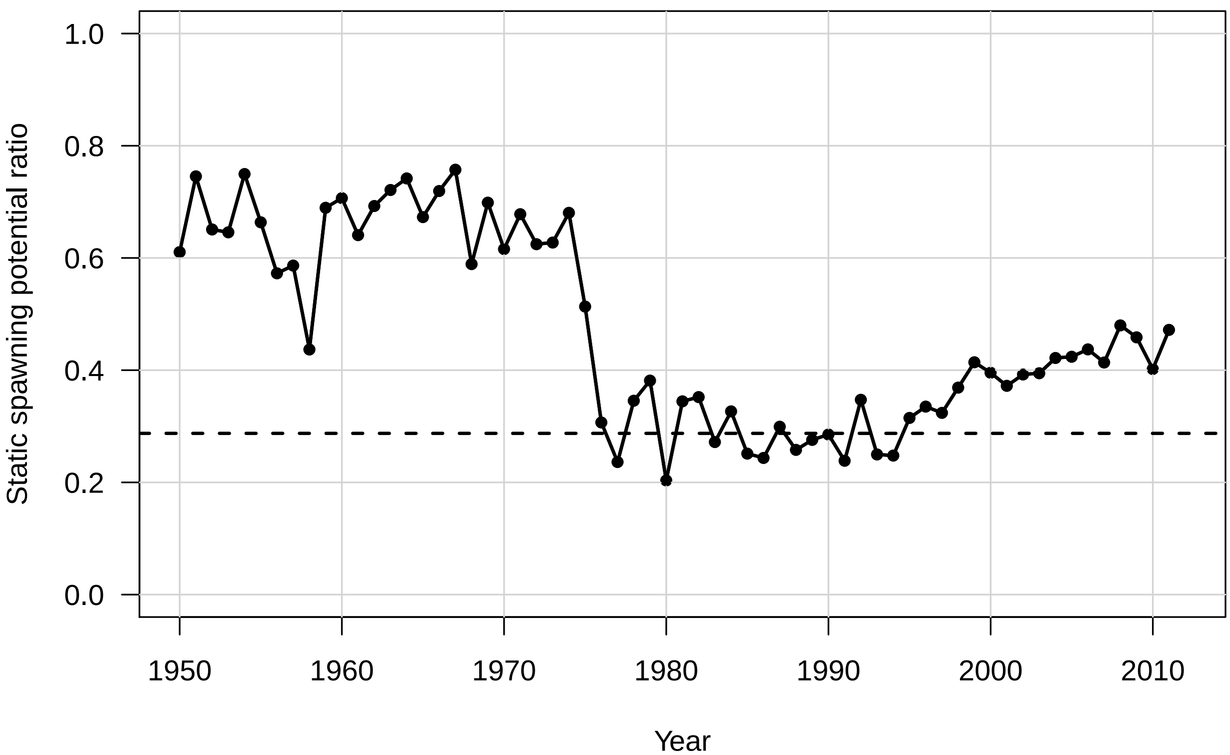


Figure 3.33. Top panel: yield per recruit. Bottom panel: spawning potential ratio (spawning biomass per recruit relative to that at the unfished level), from which the y% levels provide $F_{y\%}$. Both curves are based on average selectivity from the end of the assessment period.

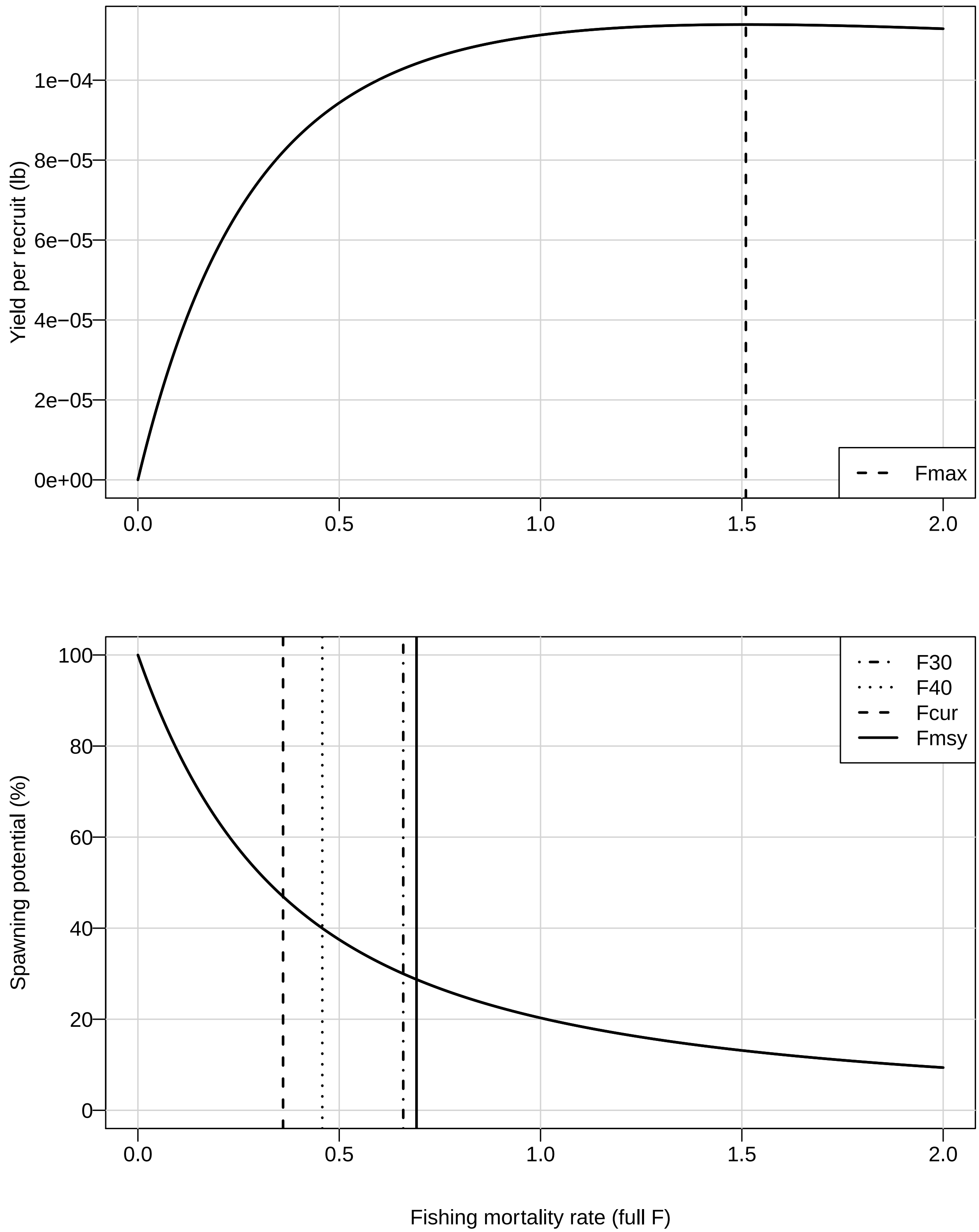


Figure 3.34. Top panel: equilibrium landings. The peak occurs where fishing rate is $F_{\mathrm{MSY}} = 0.69$ *and equilibrium landings are* MSY = 2750 *(1000 lb). Bottom panel: equilibrium spawning biomass. Both curves are based on average selectivity from the end of the assessment period.*

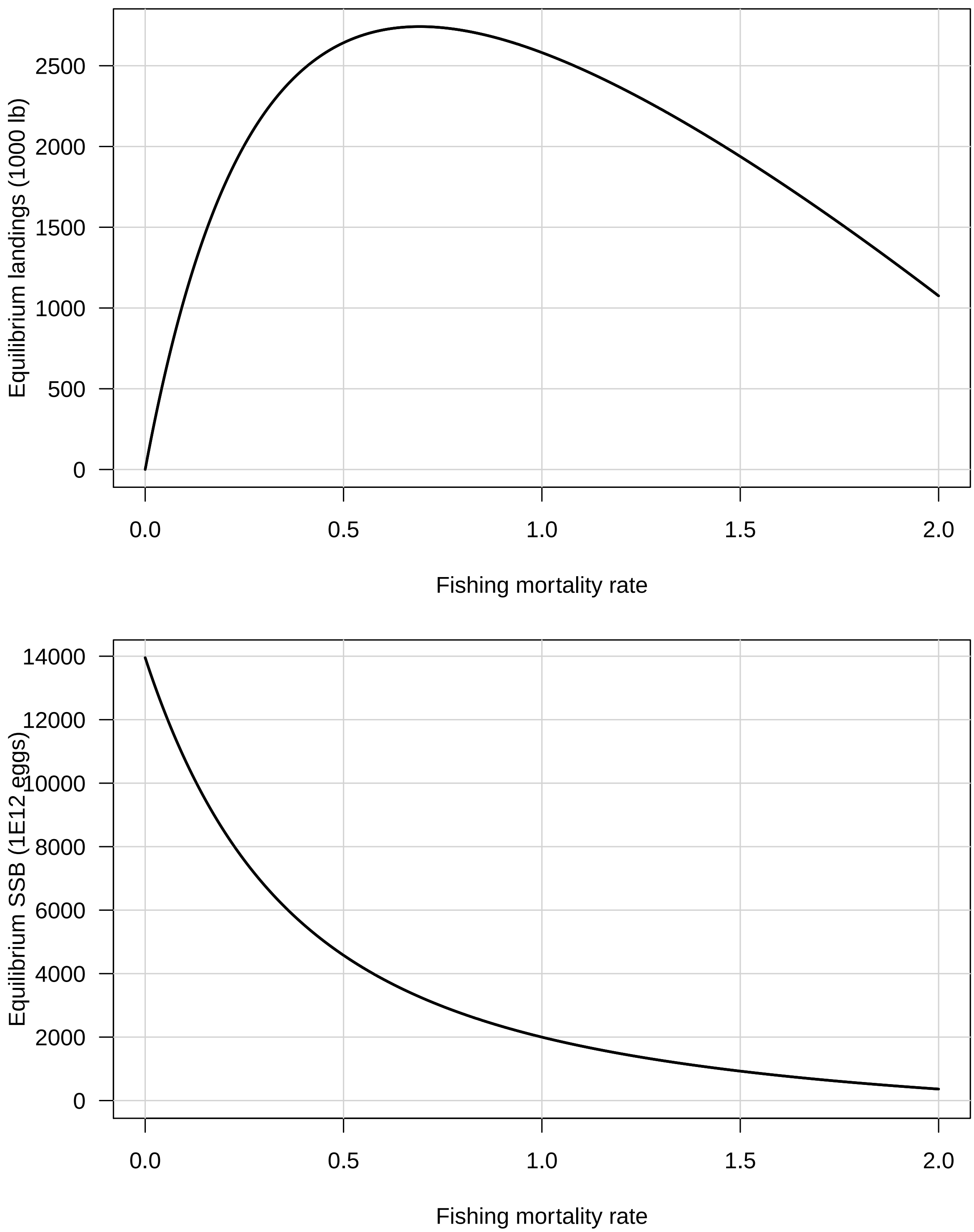


Figure 3.35. Equilibrium landings as a function of equilibrium biomass, which itself is a function of fishing mortality rate. The peak occurs where equilibrium biomass is B_{MSY} = 9548 *mt and equilibrium landings are* MSY = 2750 *(1000 lb).*

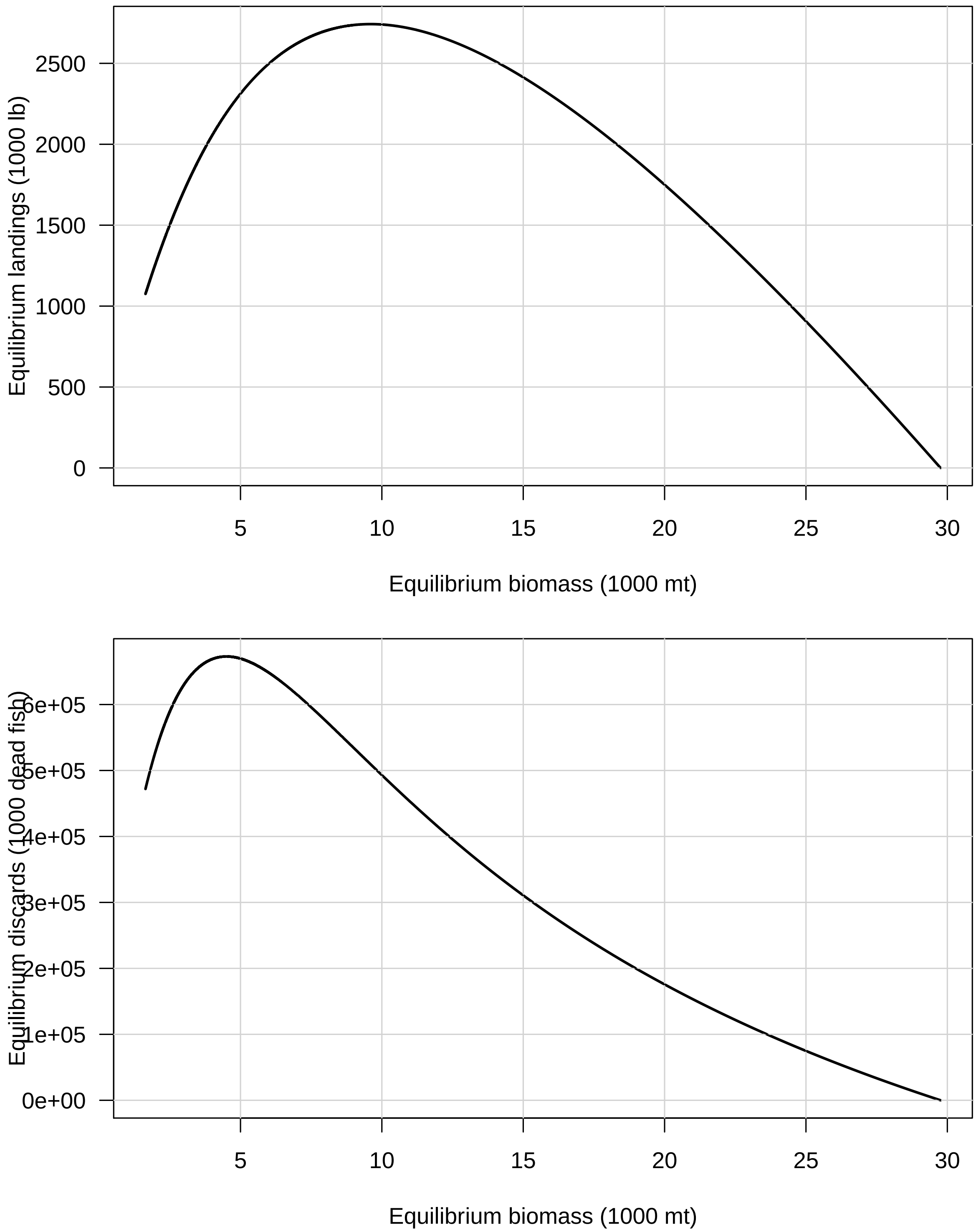


Figure 3.36. Probability densities of MSY*-related benchmarks from MCB analysis of the Beaufort Assessment Model. Vertical lines represent point estimates from the base run.*

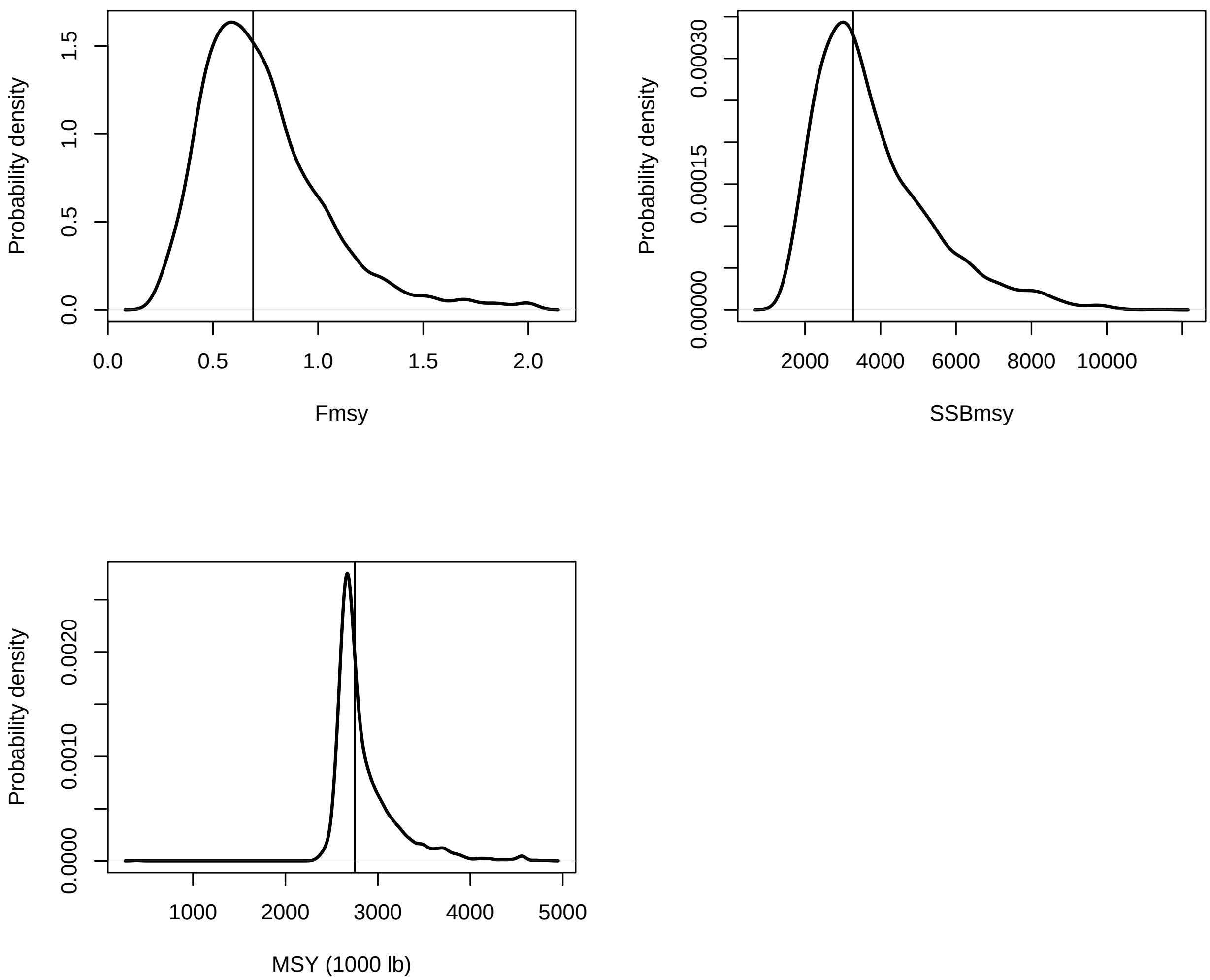


Figure 3.37. Estimated time series relative to benchmarks. Solid line indicates estimates from base run of the Beaufort Assessment Model; gray error bands indicate 5^{th} *and* 95^{th} *percentiles of the MCB trials. Top panel: spawning biomass relative to the spawning stock biomass at* MSY. *Bottom panel: F relative to* F_{MSY}.

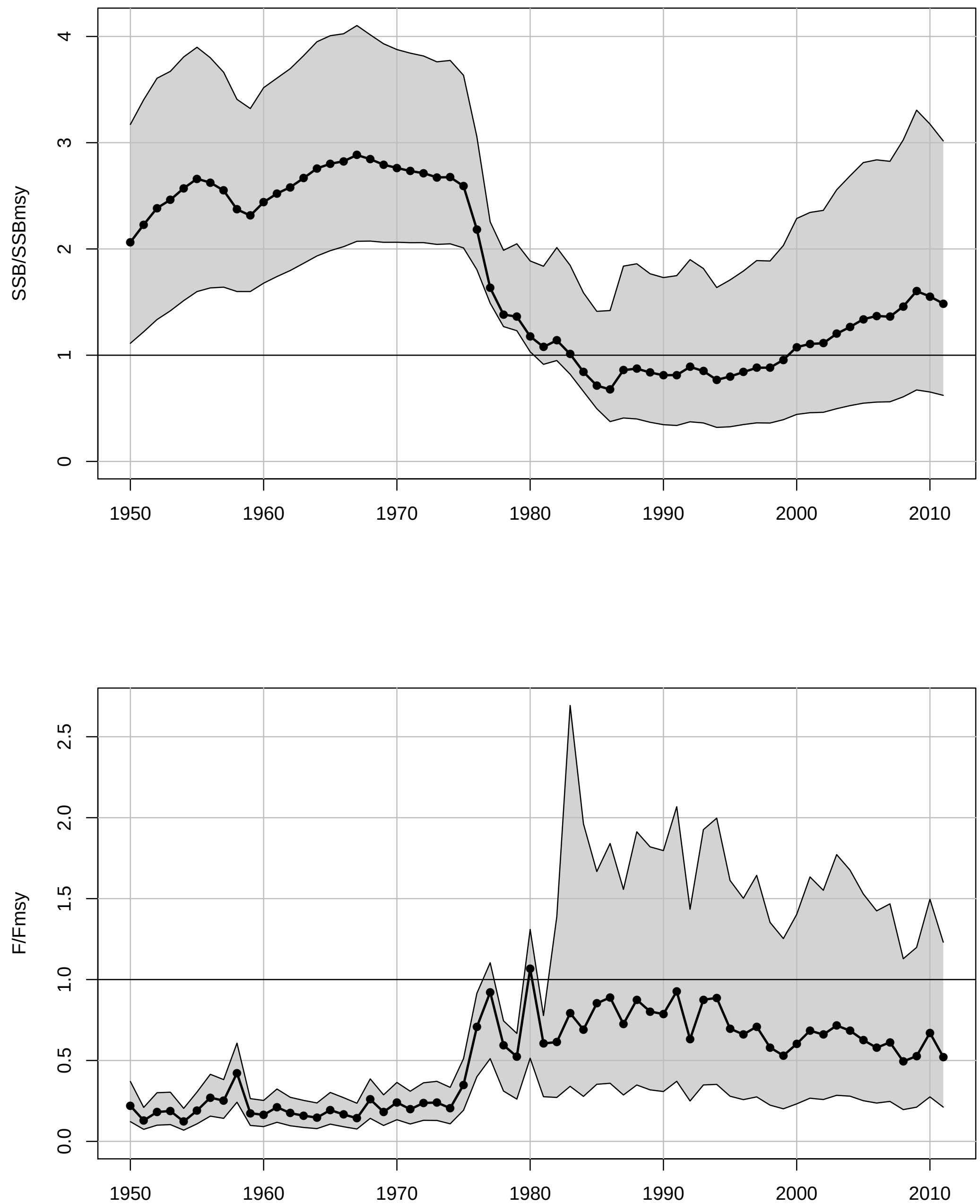
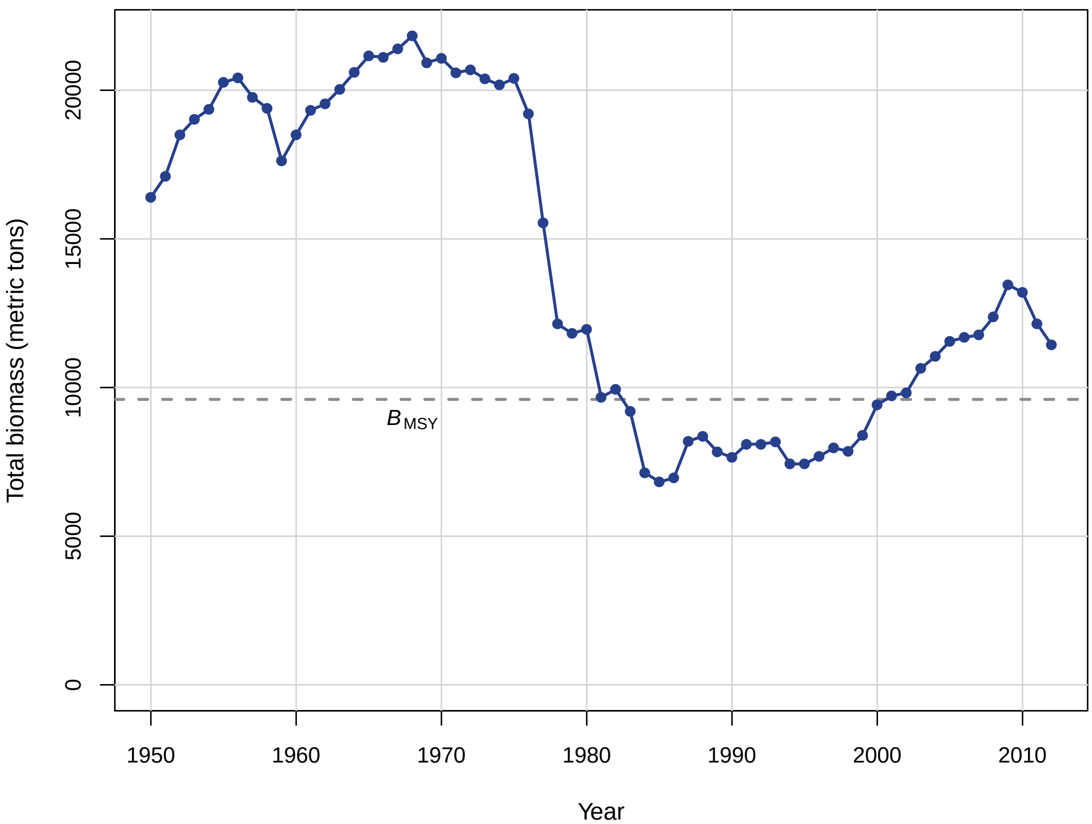


Figure 3.38. Top panel: Estimated total biomass (metric tons) at start of year. Horizontal dashed line indicates B_{MSY}*. Bottom panel: Estimated spawning stock (gonad biomass of mature females) at time of peak spawning.*



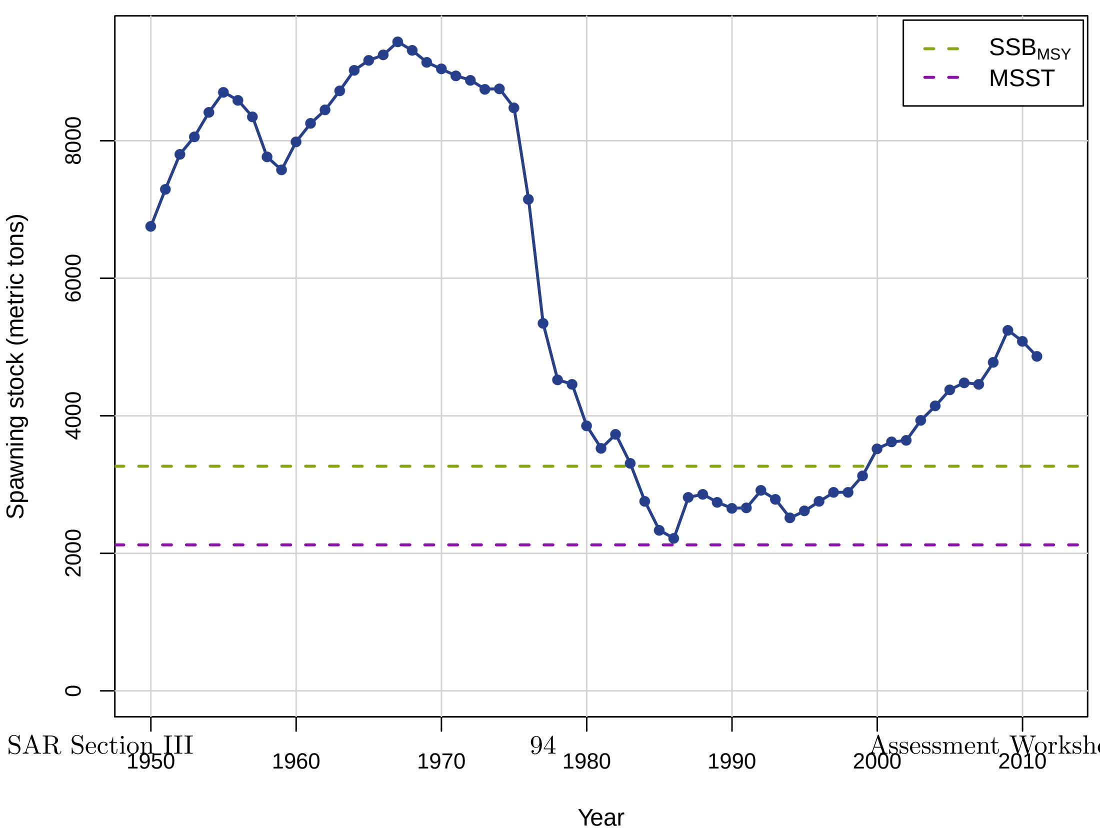


Figure 3.39. Phase plot of terminal status estimates from MCB analysis of the Beaufort Assessment Model. The intersection of crosshairs indicates estimates from the base run; lengths of crosshairs defined by 5^{th} and 95^{th} percentiles.

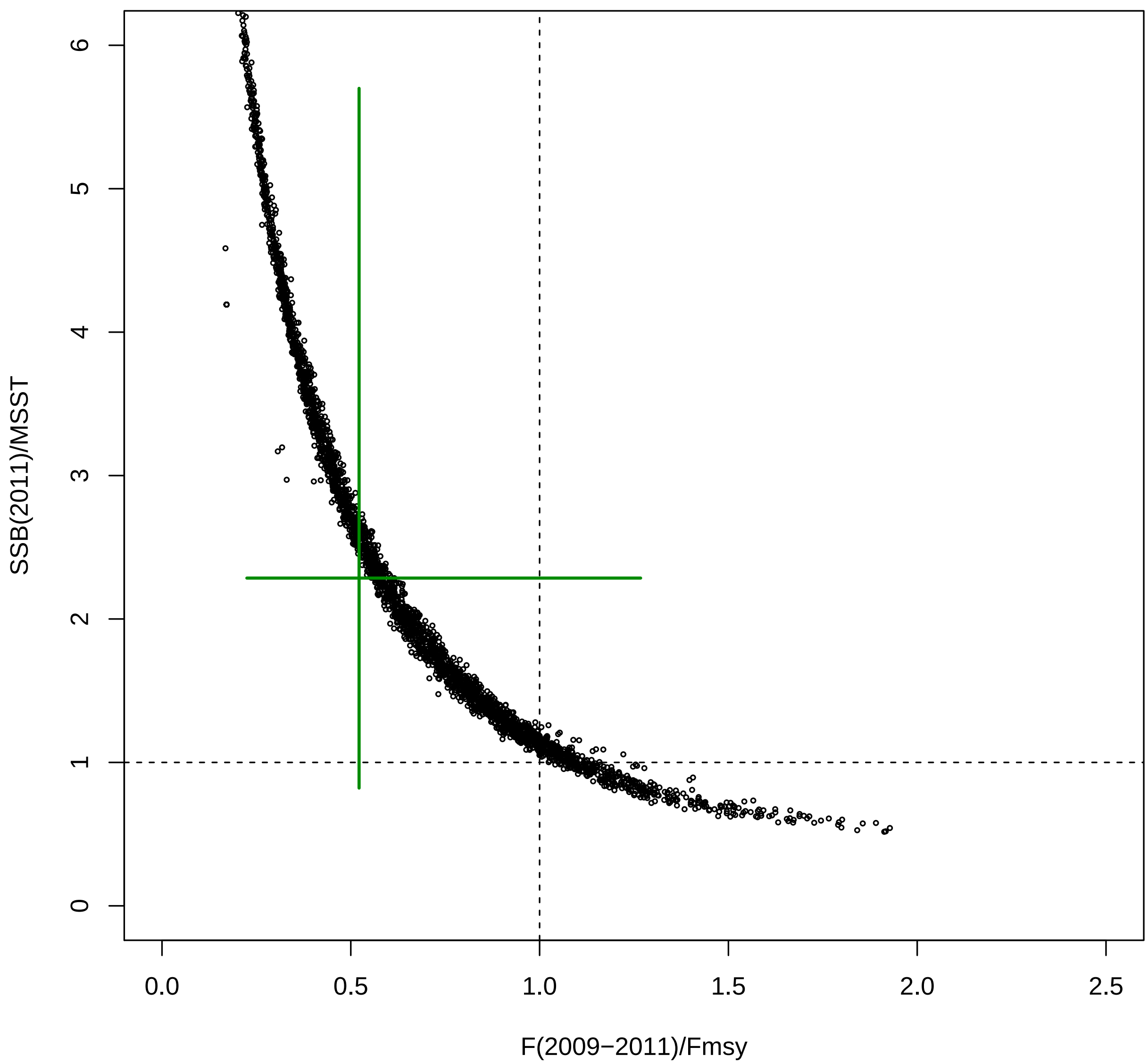


Figure 3.40. Phase plot of terminal status estimates from MCB analysis of the Beaufort Assessment Model. The intersection of crosshairs indicates estimates from the base run; lengths of crosshairs defined by 5^{th} and 95^{th} percentiles.

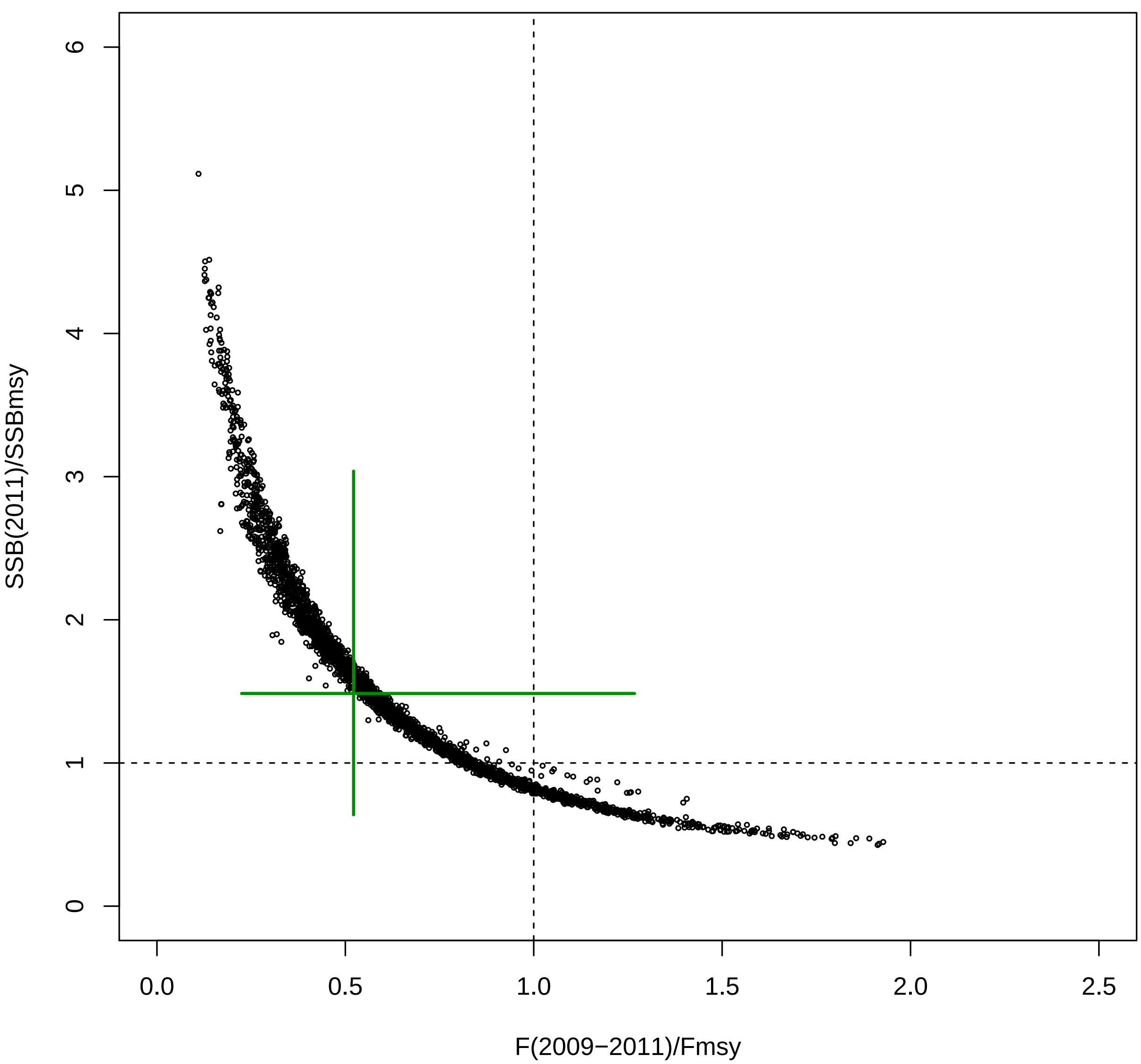
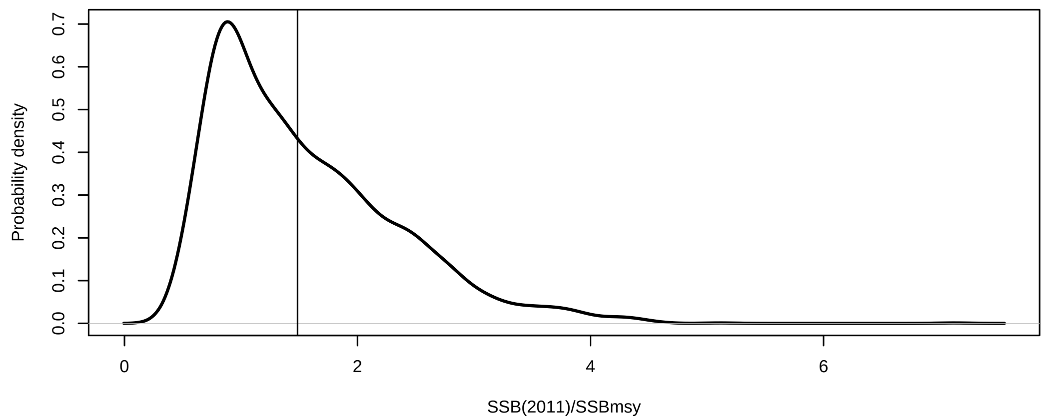
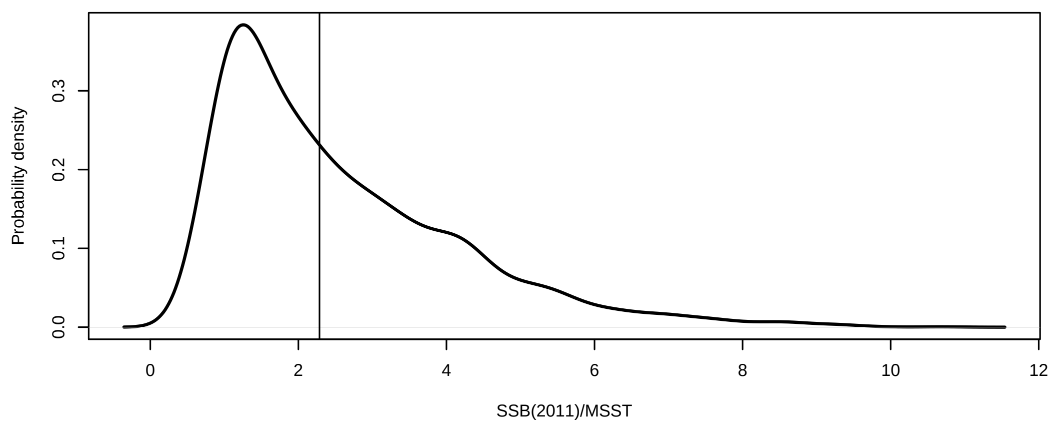


Figure 3.41. Probability densities of terminal status estimates from MCB analysis of the Beaufort Assessment Model. Vertical lines represent point estimates from the base run.





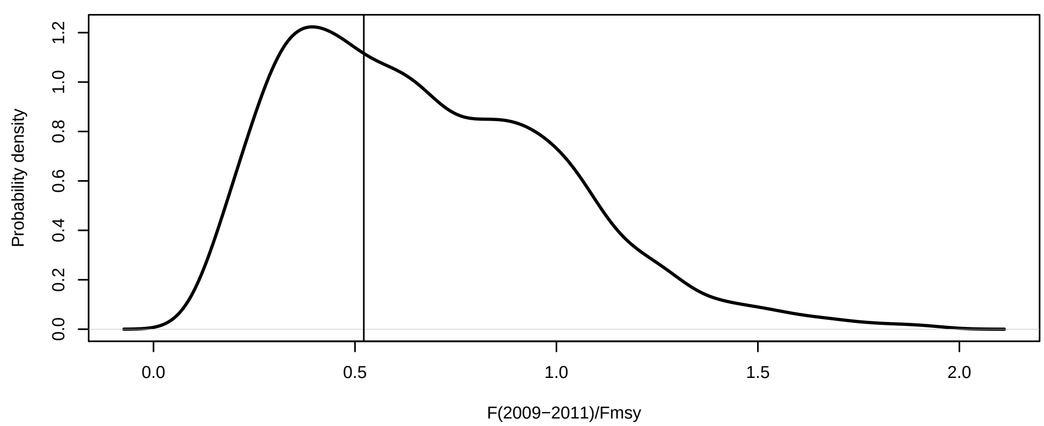


Figure 3.42. Phase plot of terminal status estimates from sensitivity runs of the Beaufort Assessment Model.

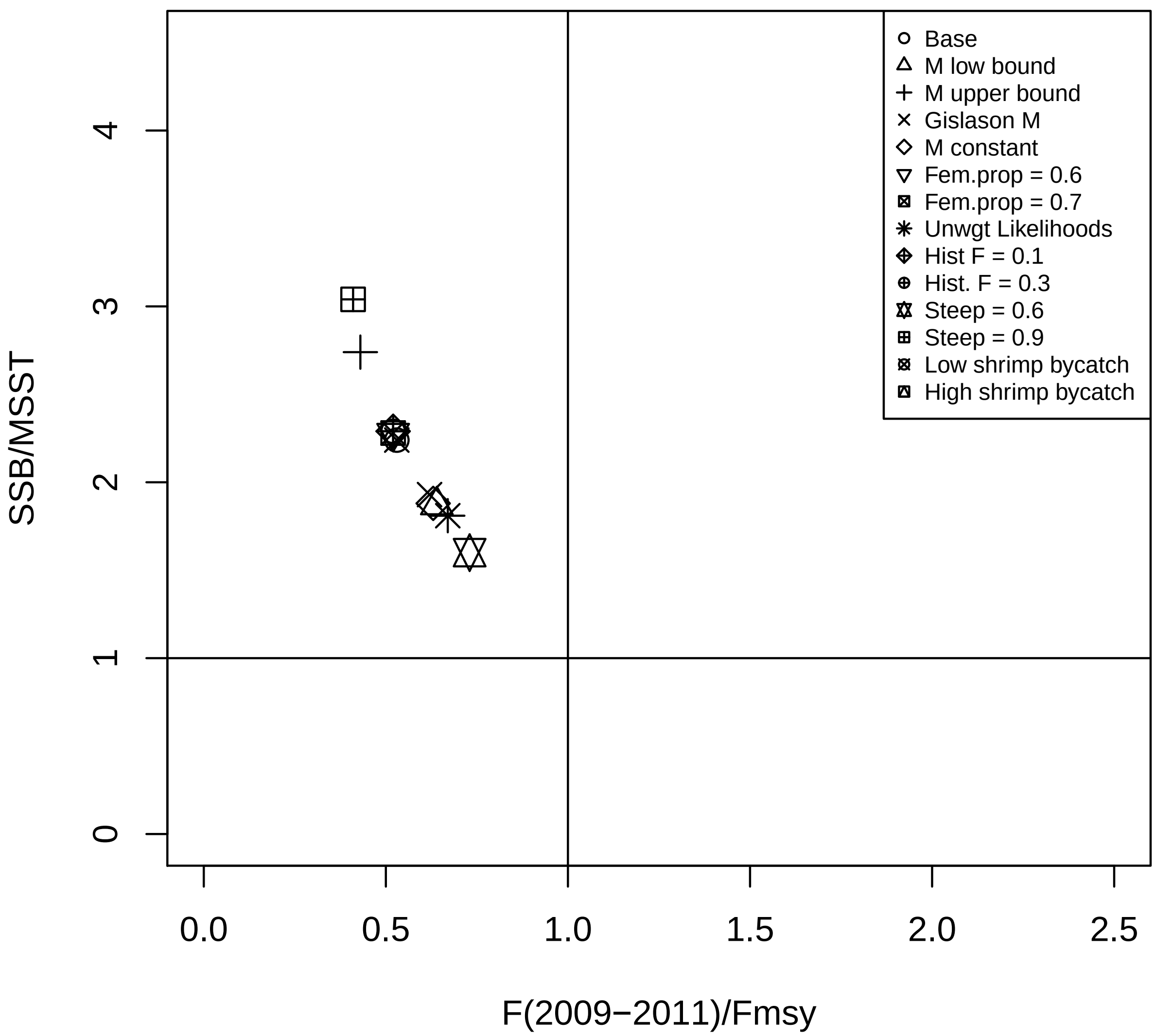
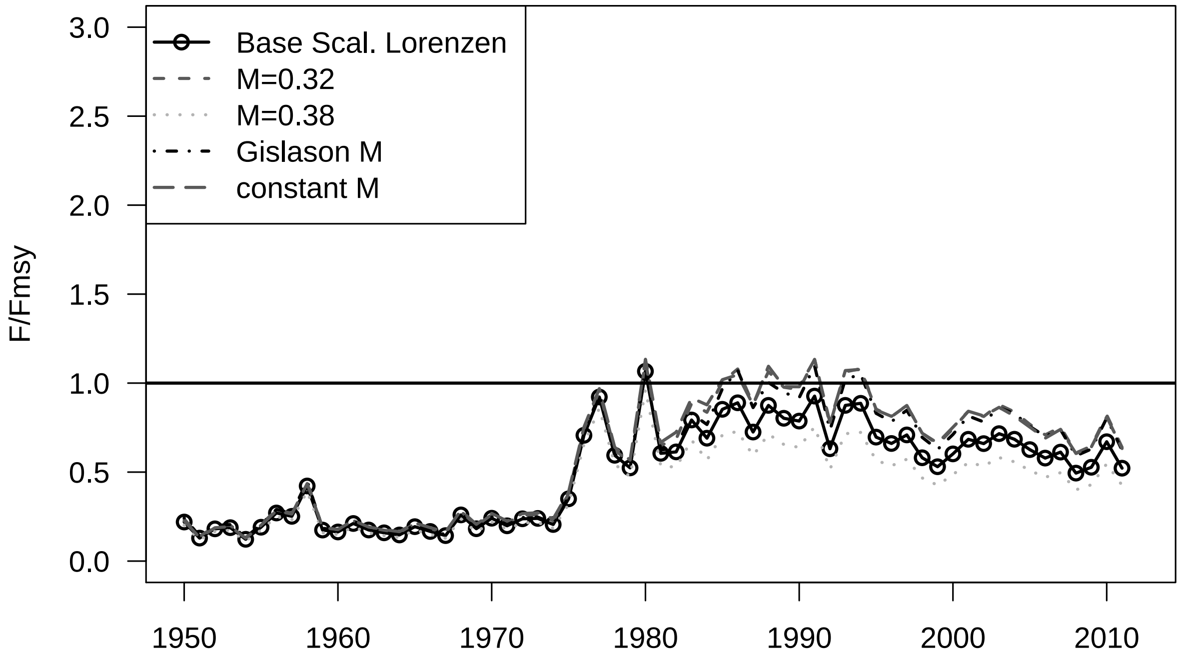


Figure 3.43. Spanish mackerel: Sensitivity of results to estimates of natural mortality M. (sensitivity runs S1 - S3). Top panel – Ratio of F to F_{MSY}. Bottom panel – Ratio of SSB *to* $\mathrm{SSB}_{\mathrm{MSY}}$.



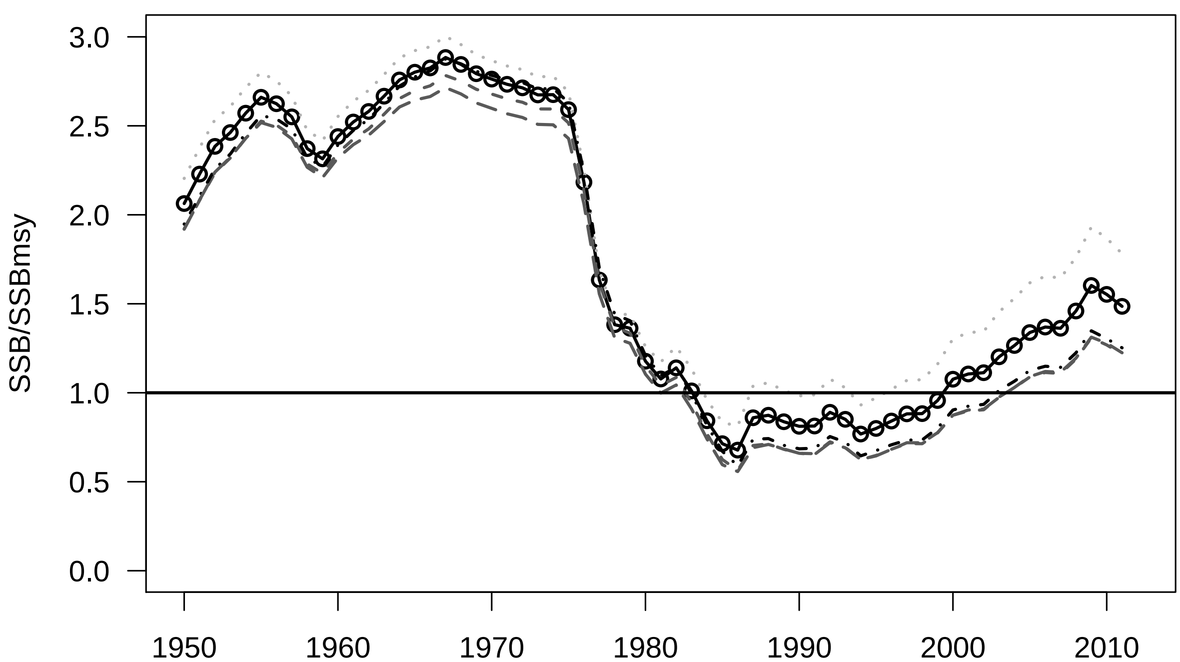
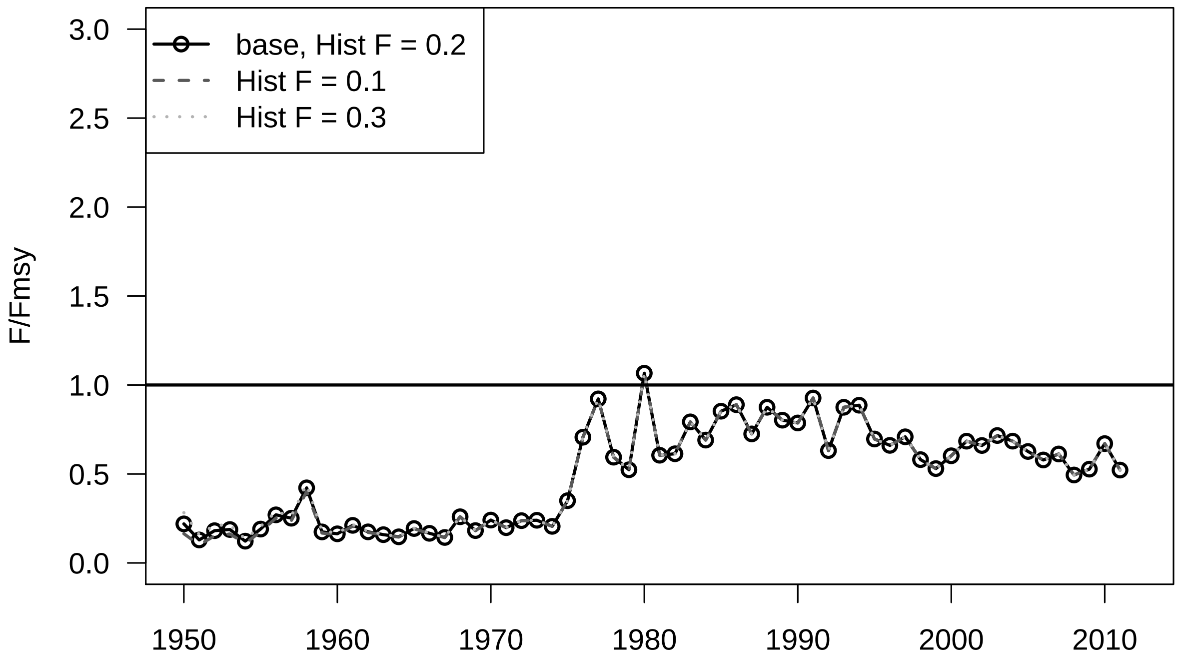


Figure 3.44. Spanish mackerel: Sensitivity of results to the historical fishing effort (sensitivity runs S8 - S9). Top panel – Ratio of F to F_{MSY}. Bottom panel – Ratio of SSB *to* $\mathrm{SSB}_{\mathrm{MSY}}$.



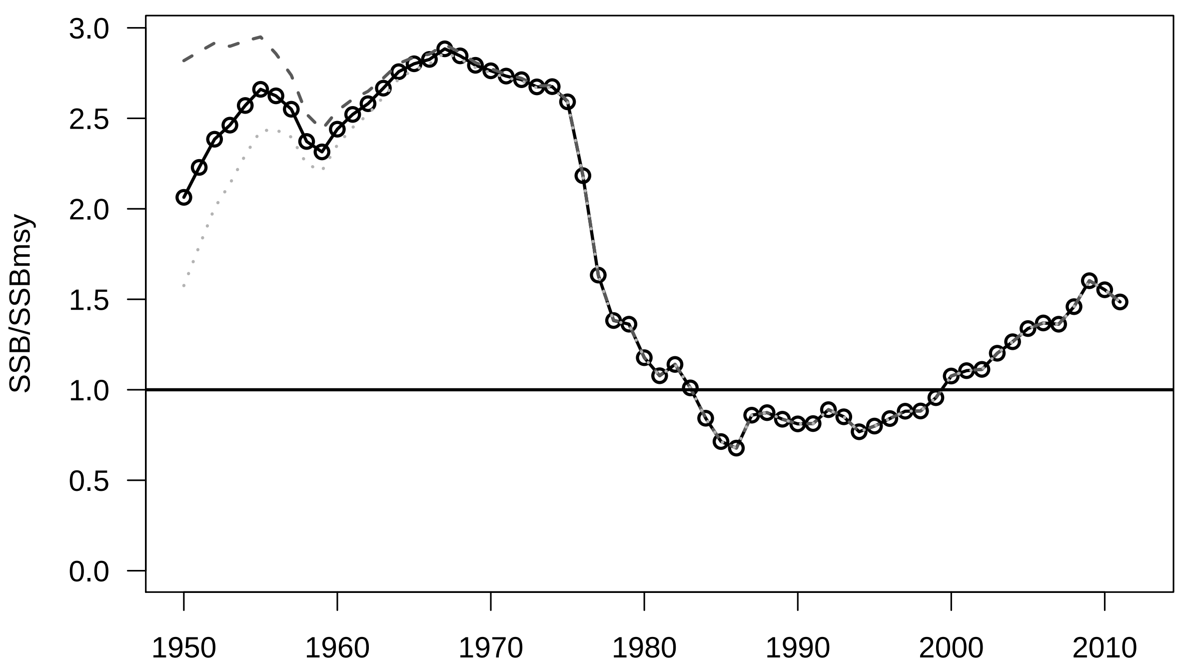


Figure 3.45. Spanish mackerel: Sensitivity of results to the proportion female (sensitivity runs S5 and S6). Top panel – Ratio of F to F_{MSY}. *Bottom panel – Ratio of* SSB *to* $\mathrm{SSB}_{\mathrm{MSY}}$.

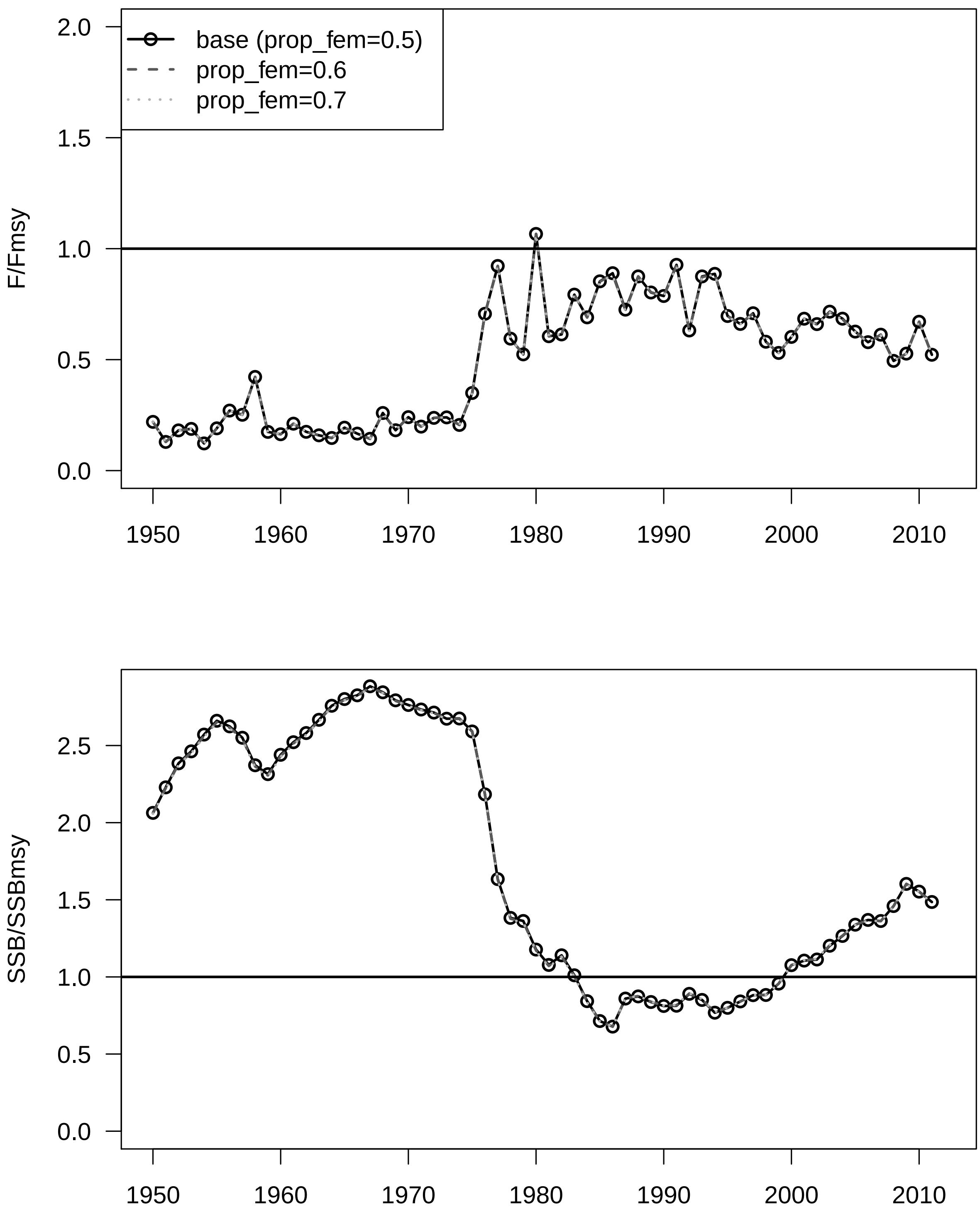


Figure 3.46. Spanish mackerel: Sensitivity of results to fixed values of steepness (sensitivity runs S10 and S11). Top panel – Ratio of F to F_{MSY}. Bottom panel – Ratio of SSB *to* $\mathrm{SSB}_{\mathrm{MSY}}$.

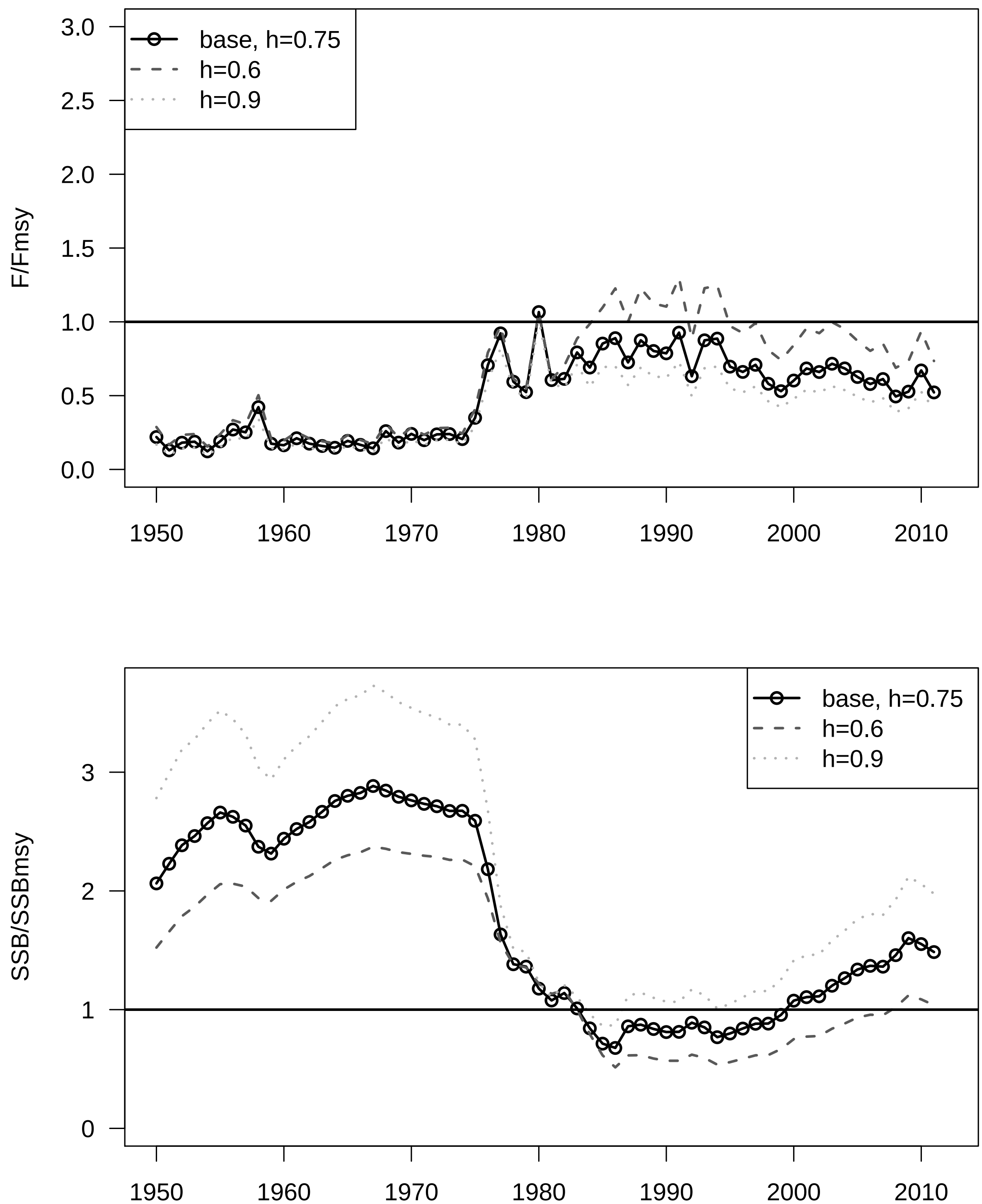


Figure 3.47. Spanish mackerel: Sensitivity of results to likelihood weights (sensitivity run S7). Top panel – Ratio of F to F_{MSY}. Bottom panel – Ratio of SSB *to* $\mathrm{SSB}_{\mathrm{MSY}}$.

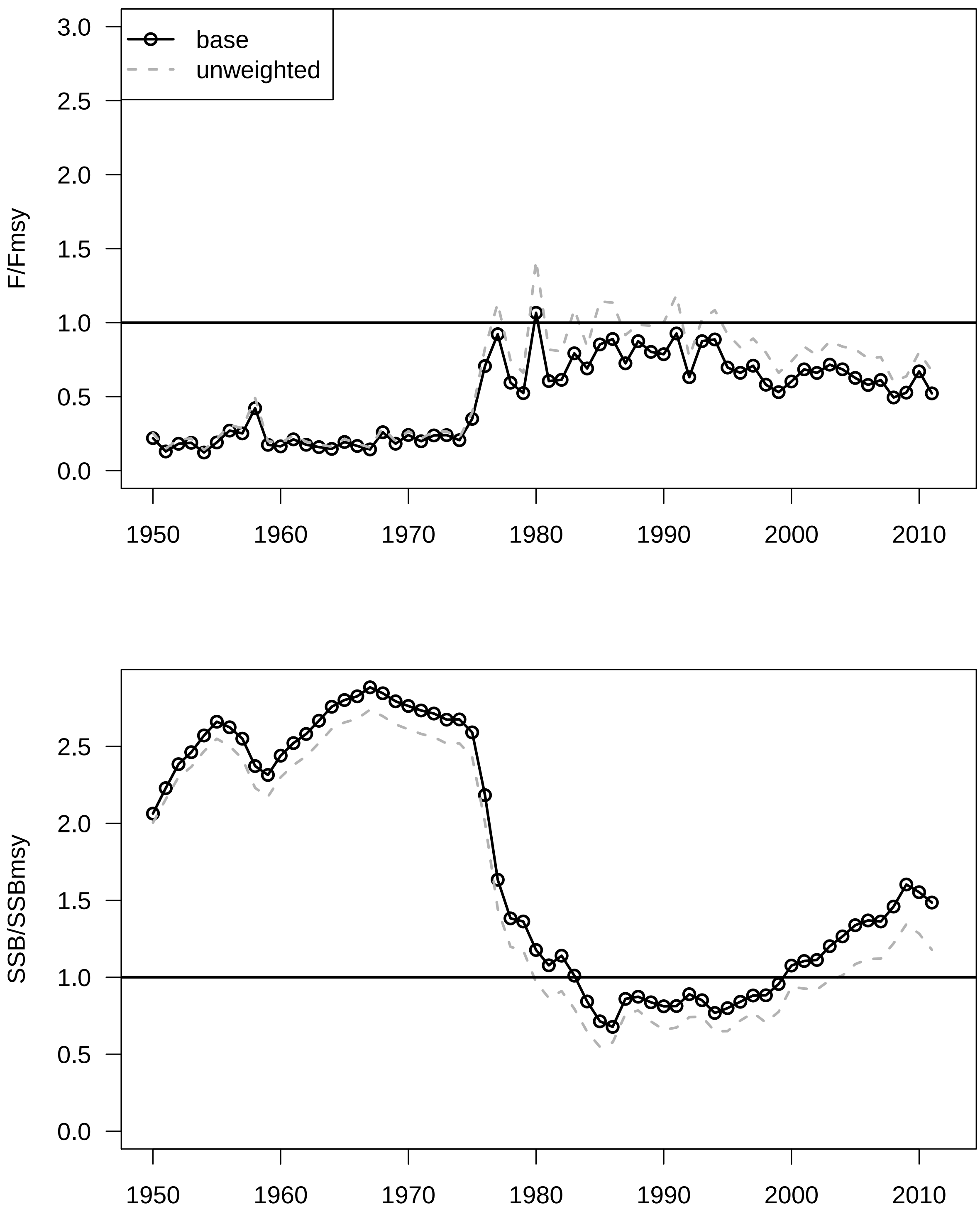


Figure 3.48. Spanish mackerel: Sensitivity of results to shrimp bycatch estimates (sensitivity runs S12 and S13). Top panel – Ratio of F to F_{MSY}. *Bottom panel – Ratio of* SSB *to* $\mathrm{SSB}_{\mathrm{MSY}}$.

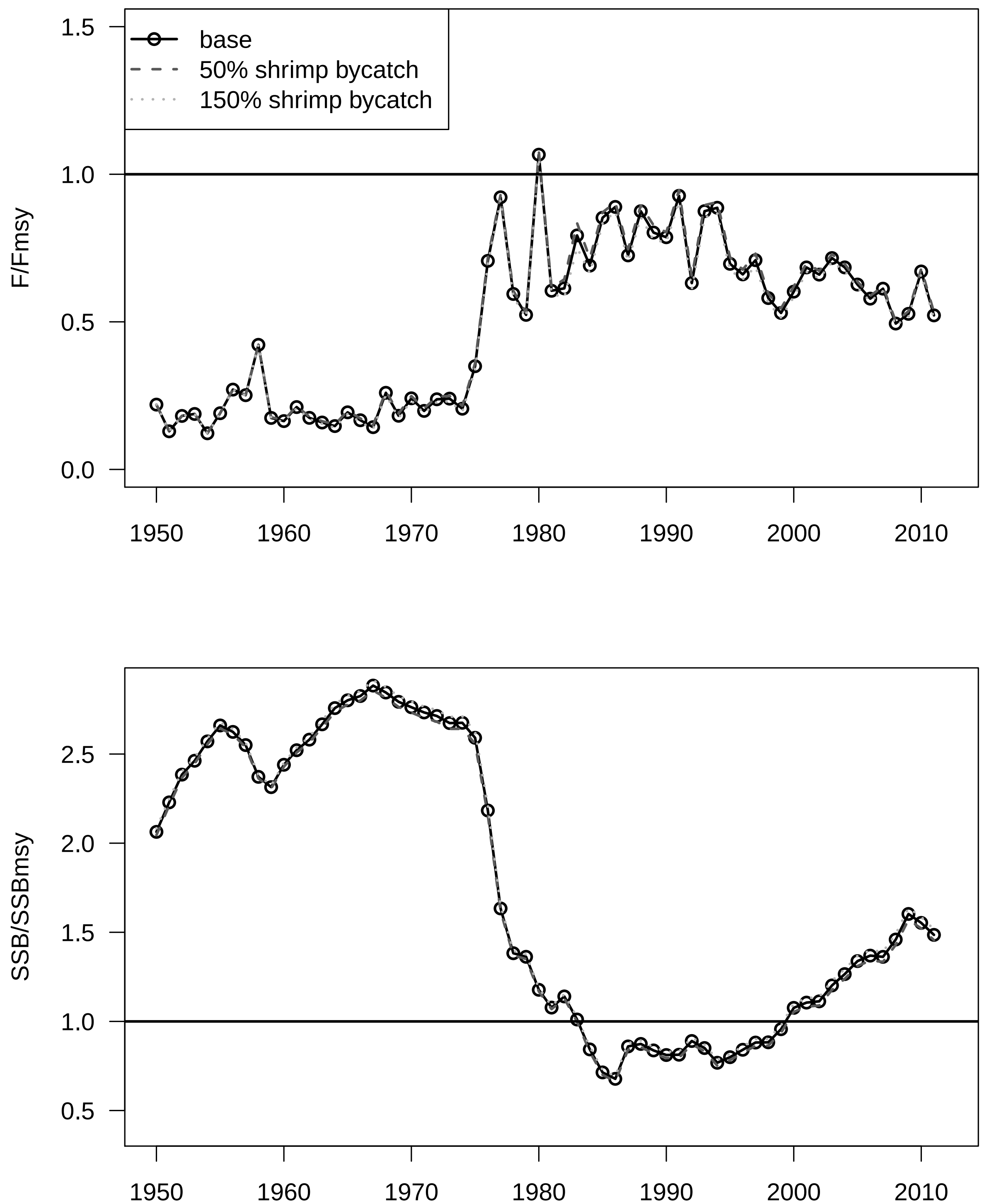


Figure 3.49. Retrospective analyses. Sensitivity to terminal year of data (sensitivity runs S14–S18). Fishing mortality rate, where solid circles show geometric mean of terminal three years, as used to compute fishing status.

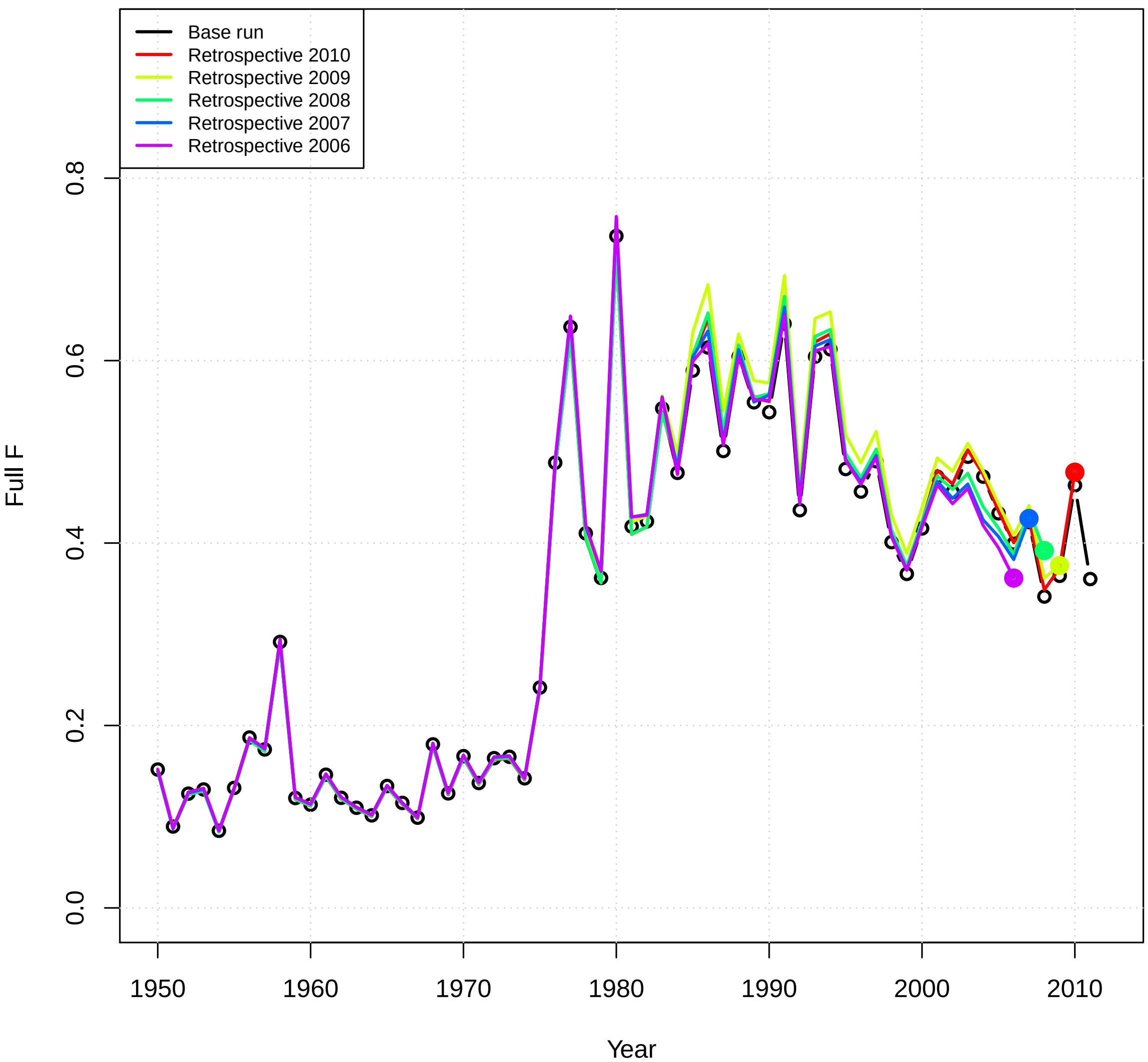


Figure 3.50. Retrospective analyses. Sensitivity to terminal year of data (sensitivity runs S14–S18). Biomass time series.

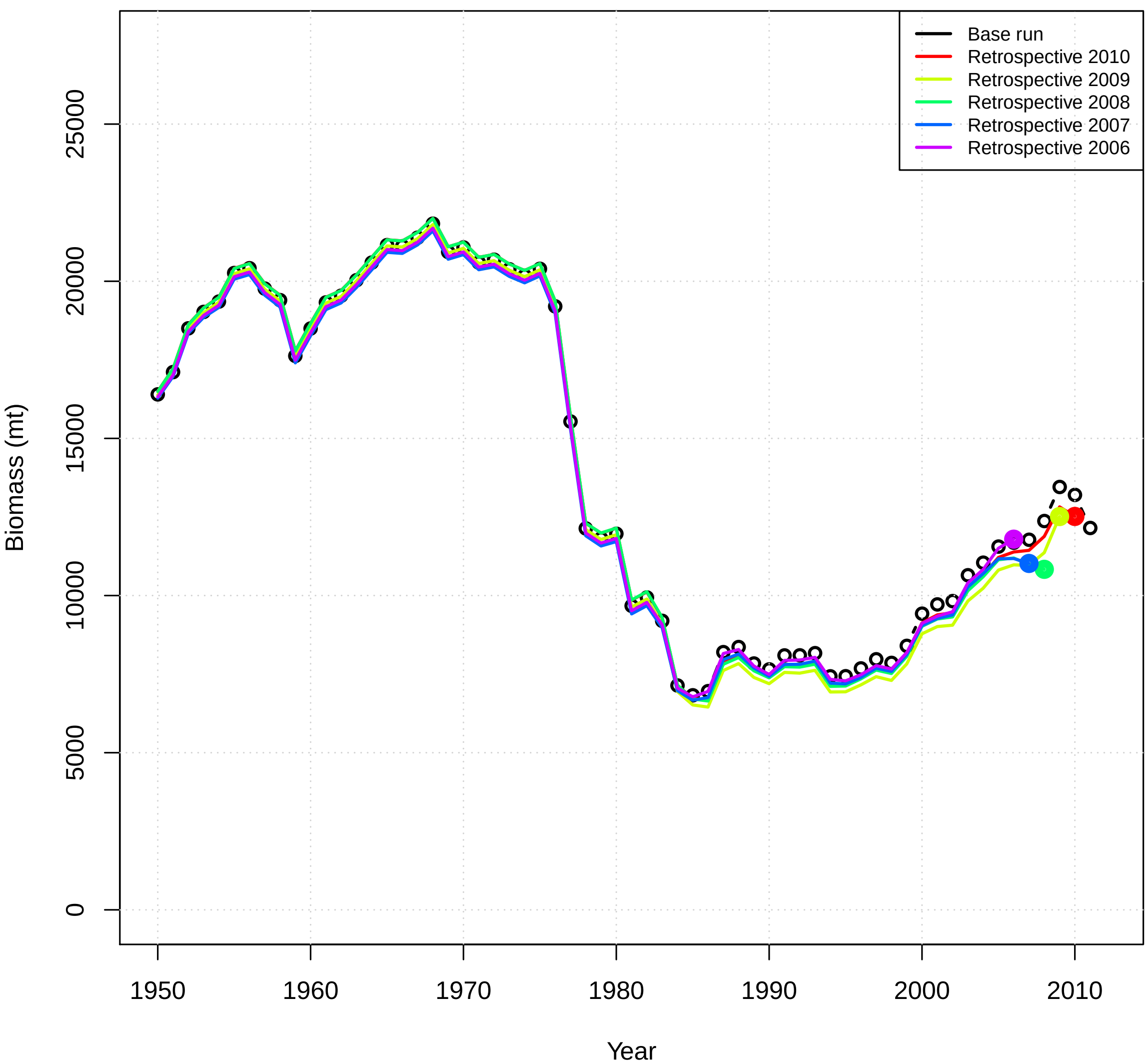


Figure 3.51. Retrospective analyses. Sensitivity to terminal year of data (sensitivity runs S14–S18). Spawning stock biomass time series.

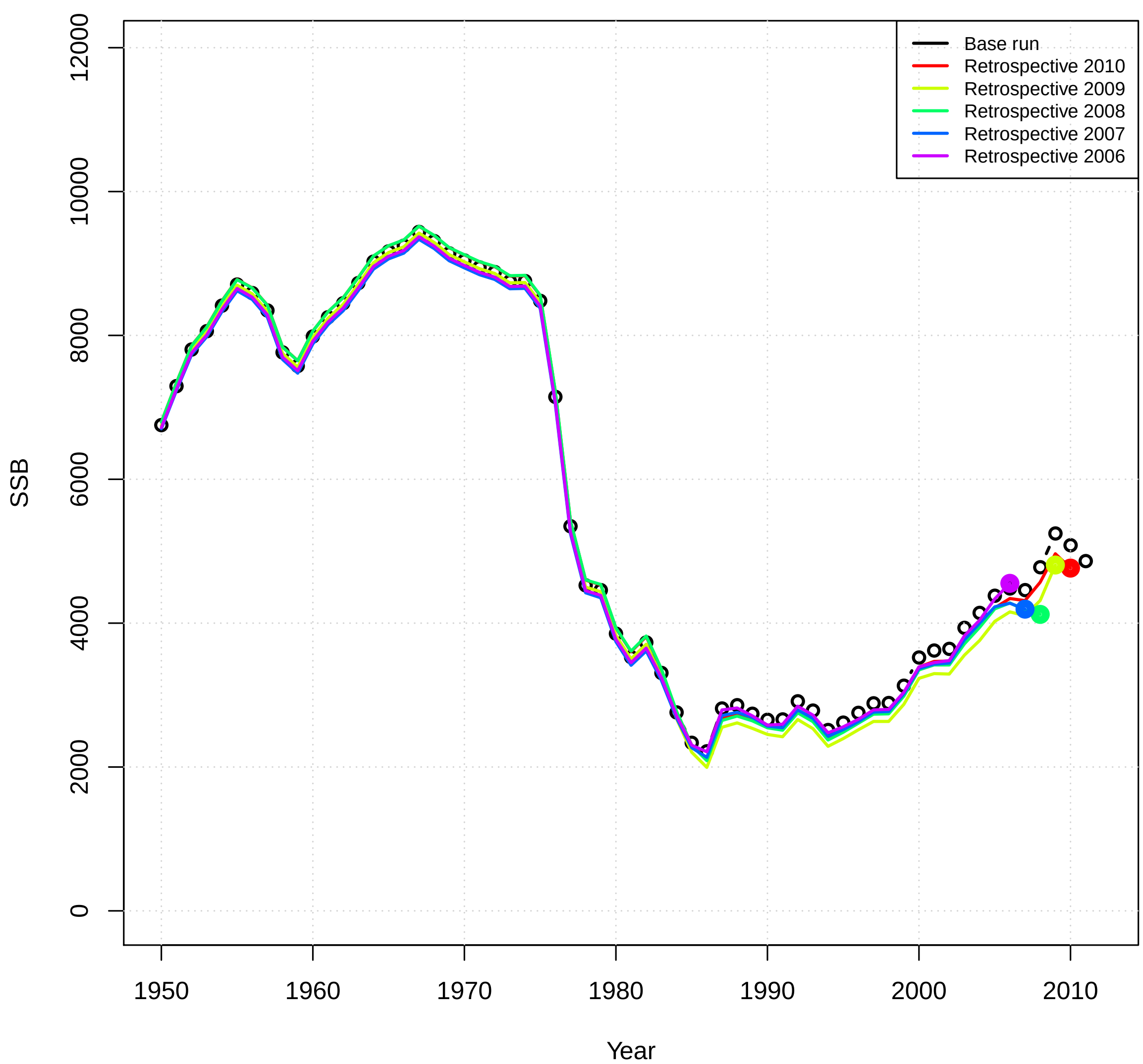


Figure 3.52. Retrospective analyses. Sensitivity to terminal year of data (sensitivity runs S14–S18). Recruitment time series.

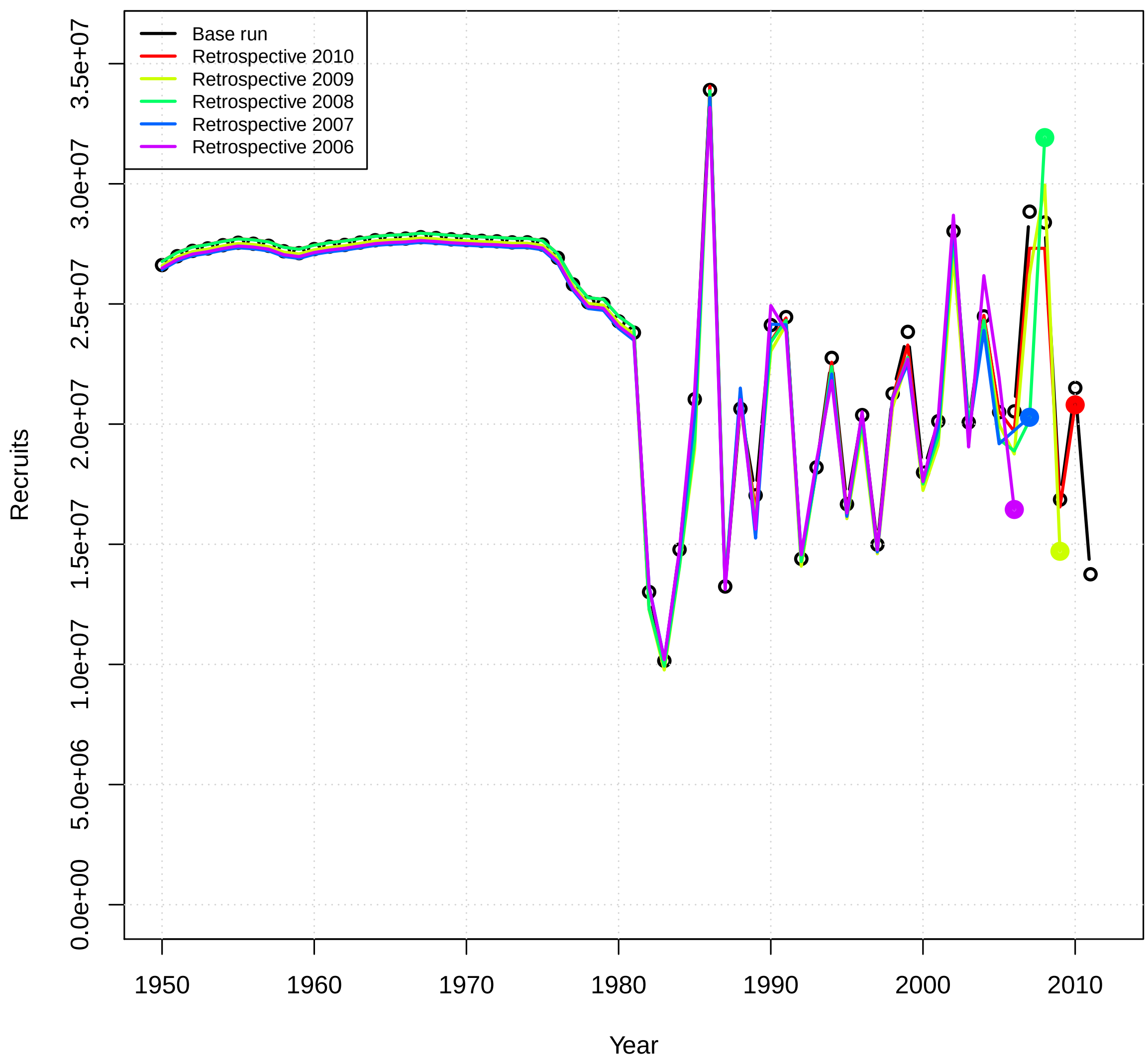


Figure 3.53. Retrospective analyses. Sensitivity to terminal year of data (sensitivity runs S14–S18). Relative spawning stock biomass time series

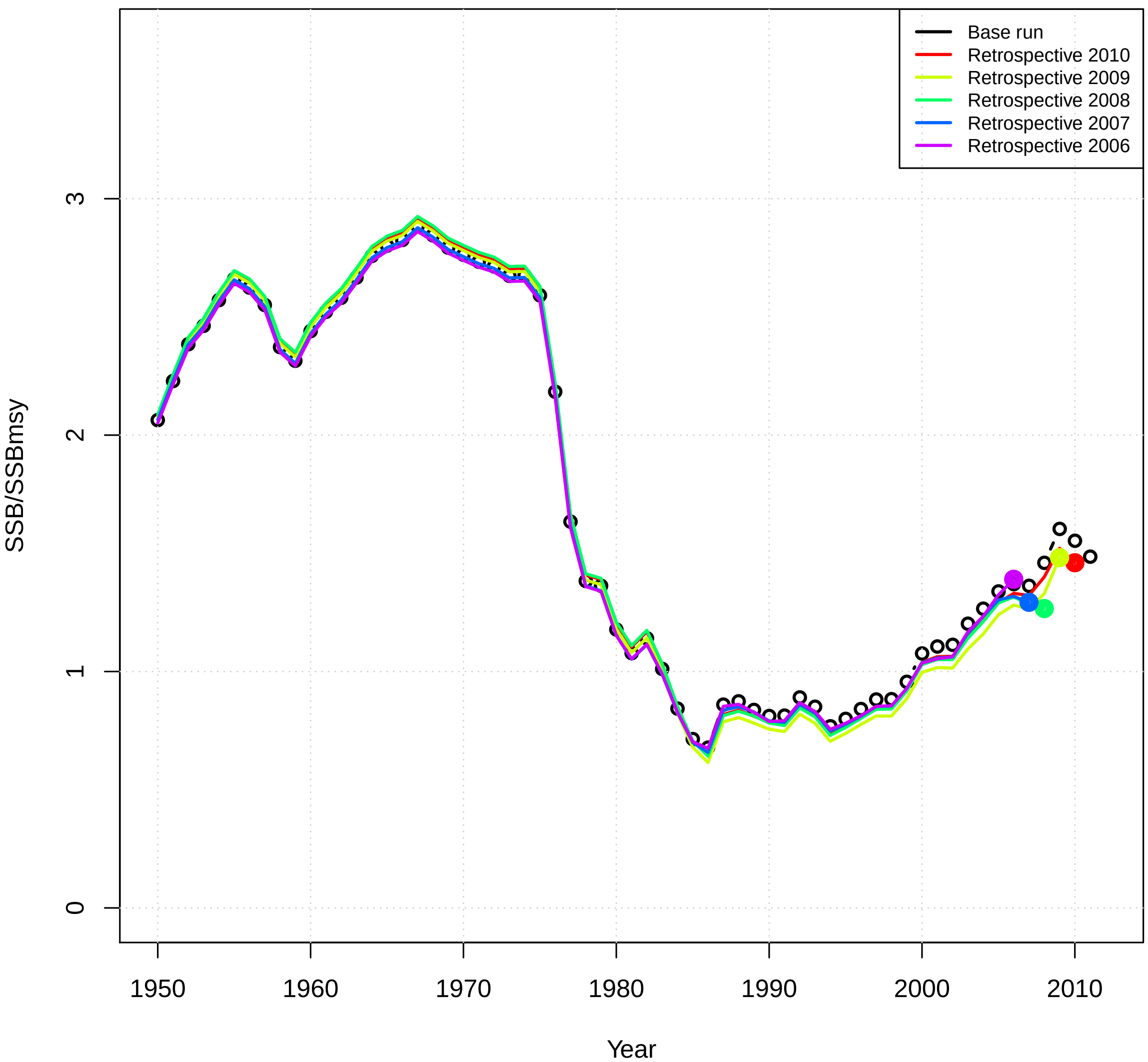


Figure 3.54. Retrospective analyses. Sensitivity to terminal year of data (sensitivity runs S14–S18). Relative fishing mortality rate time series.

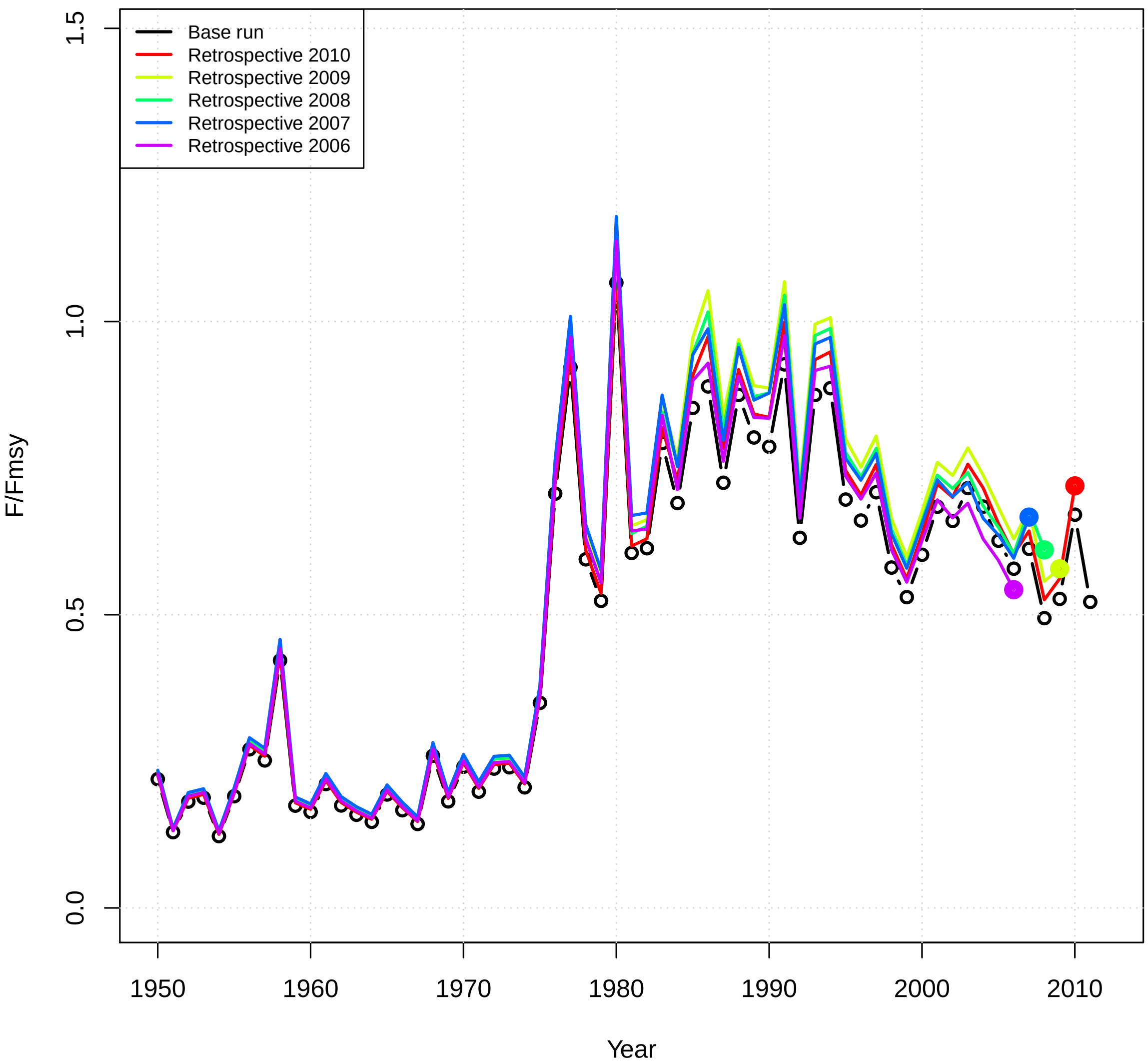


Figure 3.55. Projection results under scenario 1—fishing mortality rate fixed at $F = F_{\mathrm{MSY}}$. Expected values represented by dotted solid lines, and uncertainty represented by thin lines corresponding to 5^{th} and 95^{th} percentiles of replicate projections. Horizontal lines mark MSY*-related quantities. Spawning stock (SSB) is at time of peak spawning.*

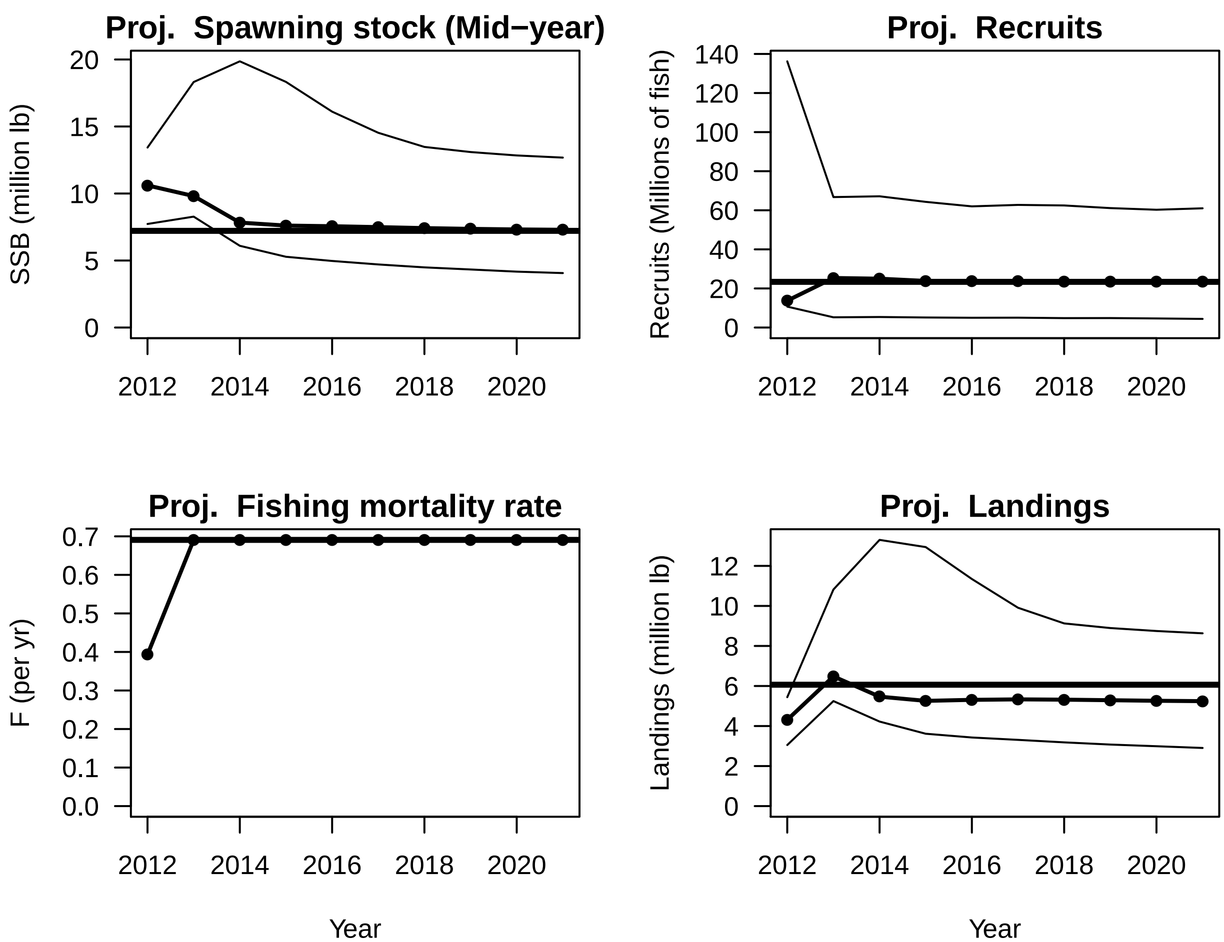


Figure 3.56. Projection results under scenario 2—fishing mortality rate fixed at $F = F_{\text{current}}$. Expected values represented by dotted solid lines, and uncertainty represented by thin lines corresponding to 5^{th} and 95^{th} percentiles of replicate projections. Horizontal lines mark MSY*-related quantities. Spawning stock (SSB) is at time of peak spawning.*

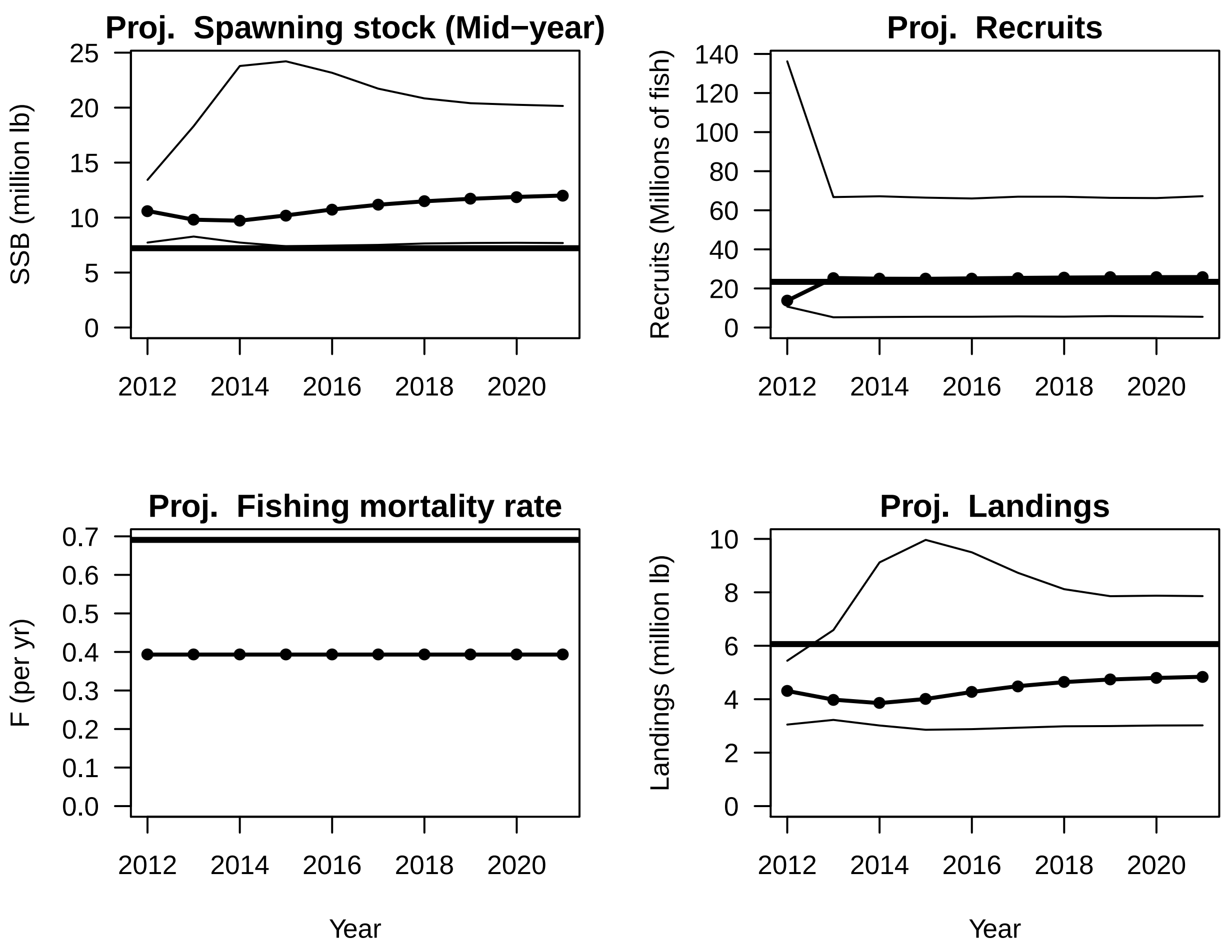


Figure 3.57. P=0.4 Projection results*

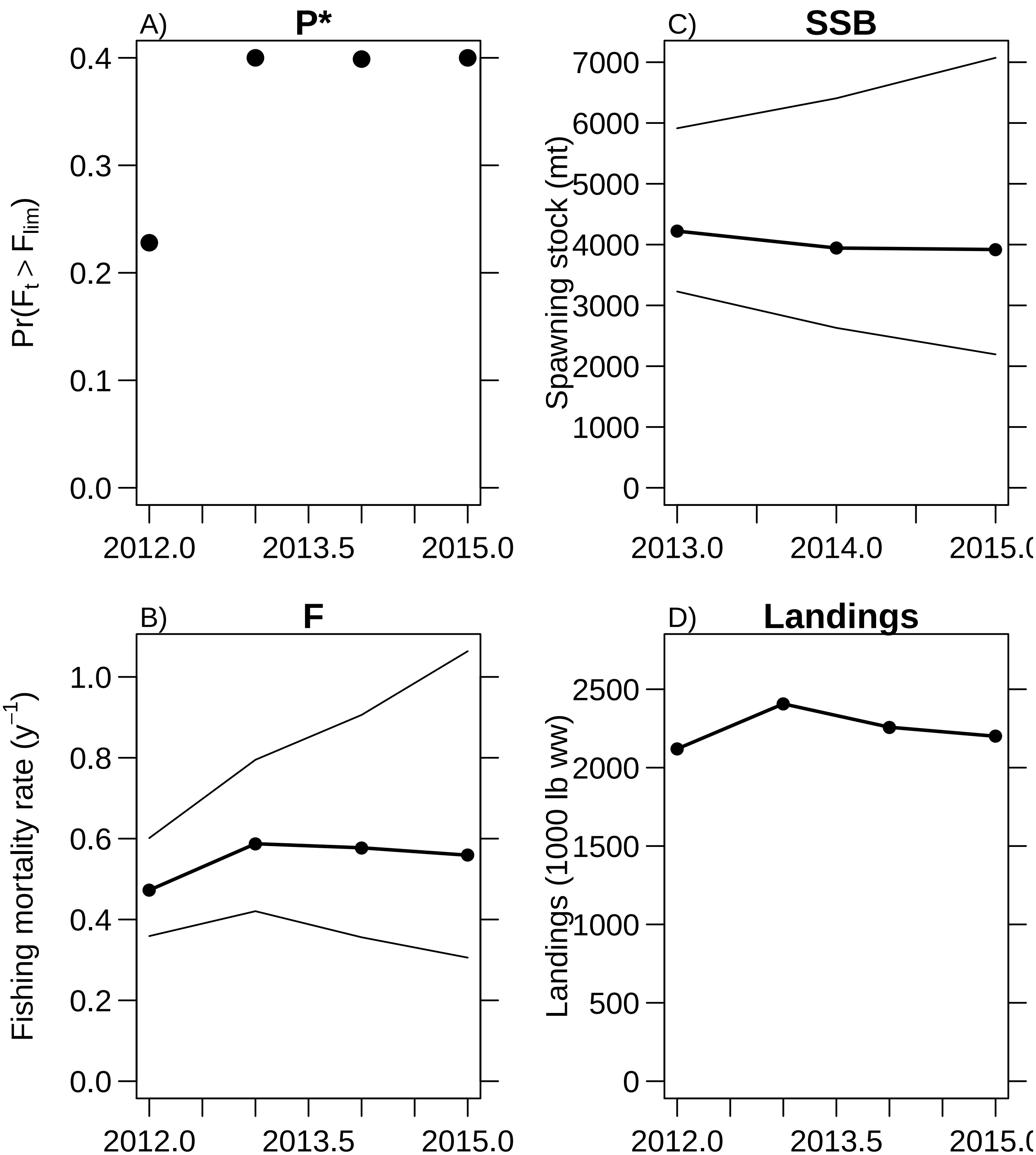


Figure 3.58. P=0.5 Projection results*

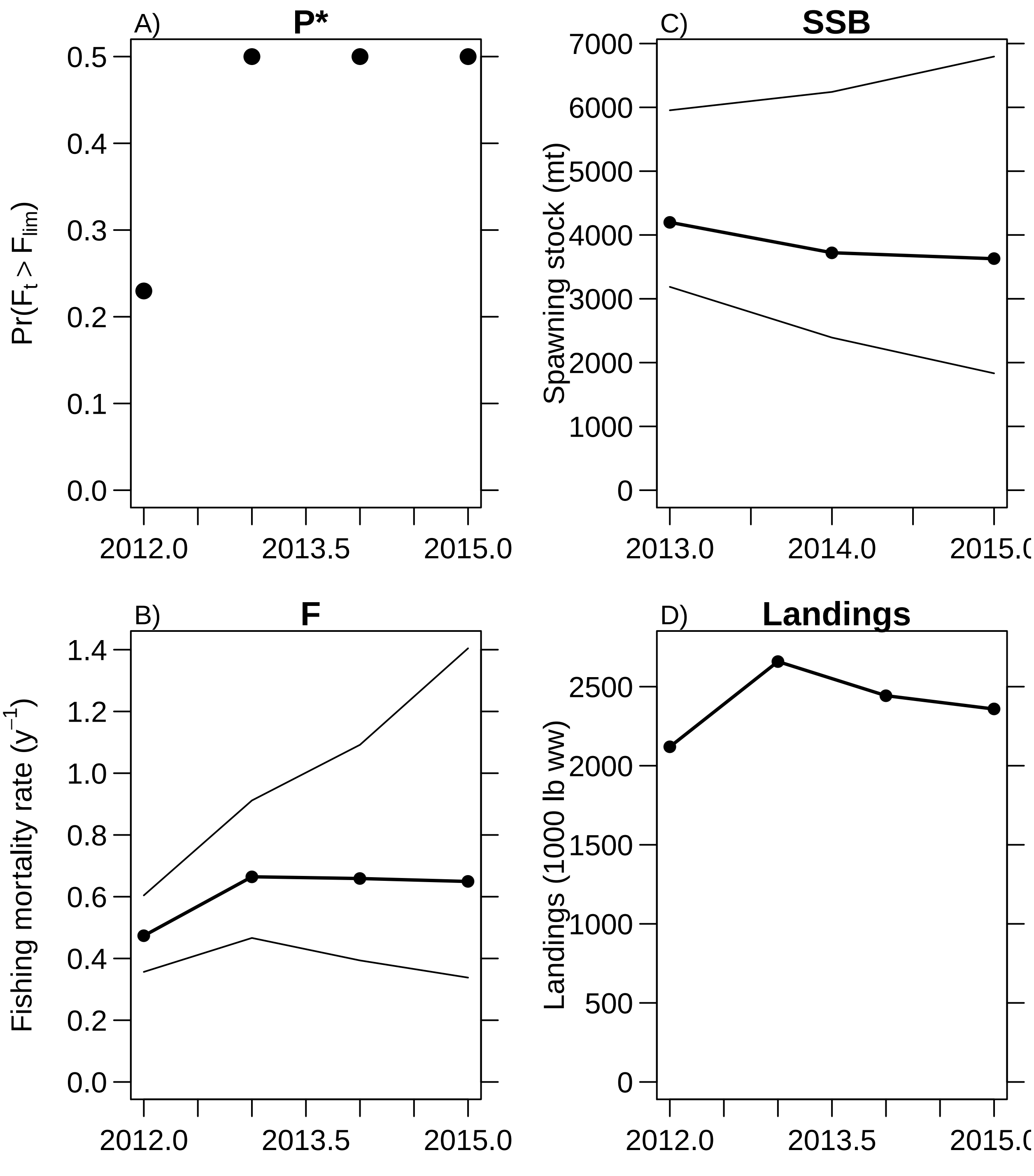


Figure 3.59. Fit of production model to the Florida trip ticket and MRFSS indices.

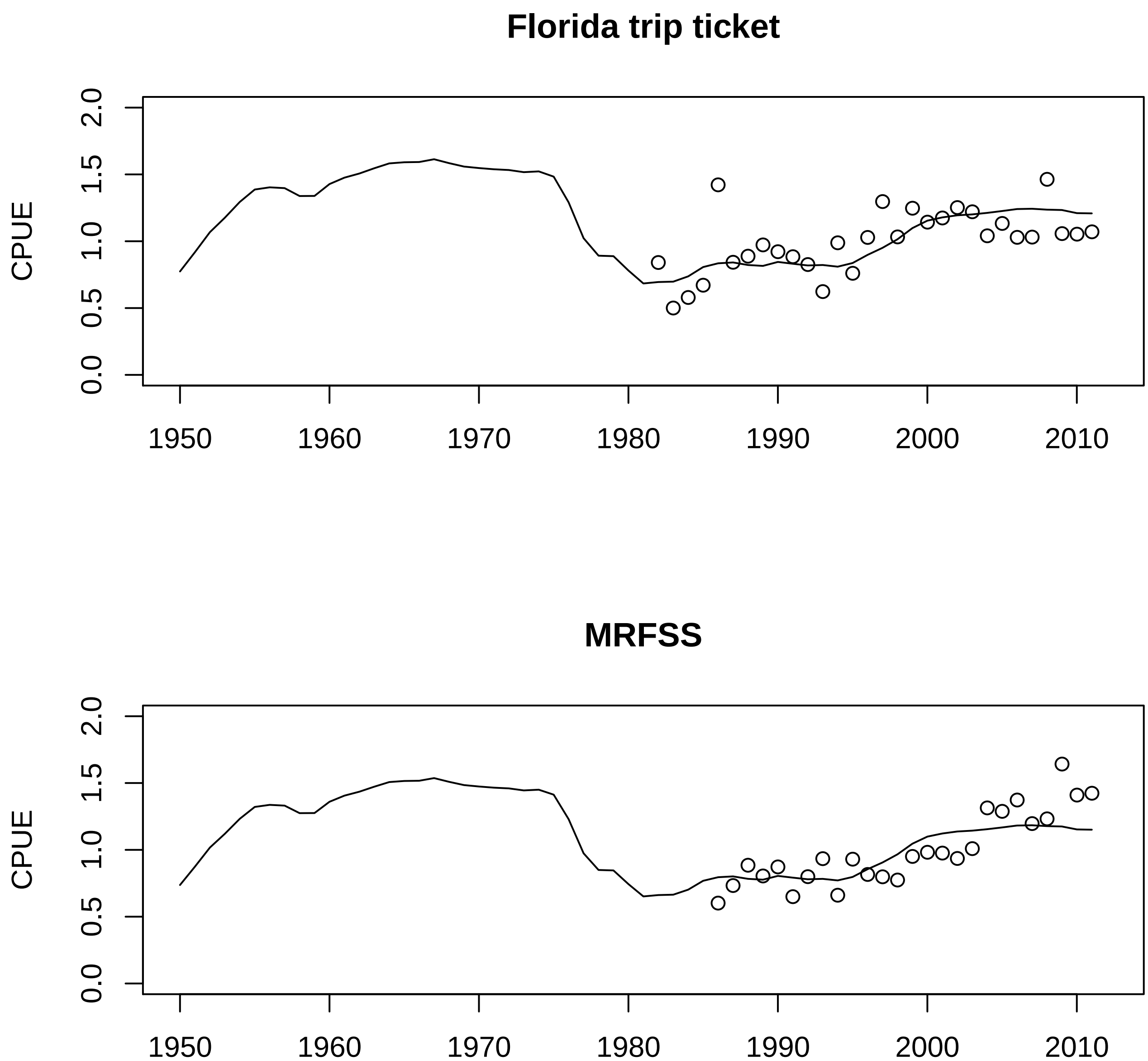
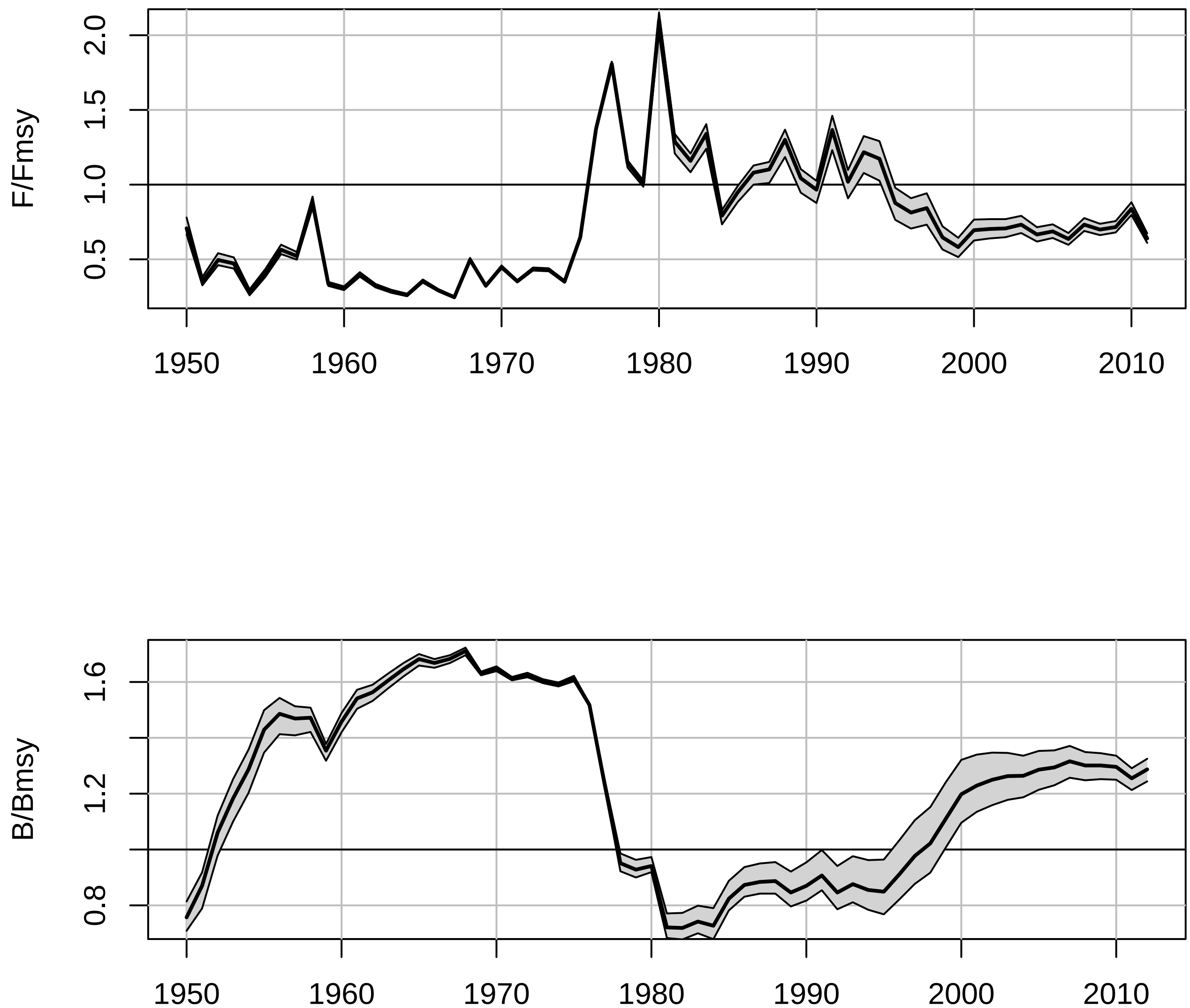


Figure 3.60. Production model estimates of relative fishing rate F/F_{MSY} and biomass, B/B_{MSY} with 80% confidence interval.



Appendix A Abbreviations and symbols

Table A.1. Acronyms and abbreviations used in this report

Symbol	Meaning
ABC	Acceptable Biological Catch
AW	Assessment Workshop (here, for Spanish mackerel)
ASY	Average Sustainable Yield
B	Total biomass of stock, conventionally on January 1r
BAM	Beaufort Assessment Model (a statistical catch-age formulation)
CPUE	Catch per unit effort; used after adjustment as an index of abundance
CV	Coefficient of variation
DW	Data Workshop (here, for Spanish mackerel)
F	Instantaneous rate of fishing mortality
F_{MSY}	Fishing mortality rate at which MSY can be attained
FL	State of Florida
GA	State of Georgia
GLM	Generalized linear model
K	Average size of stock when not exploited by man; carrying capacity
kg	Kilogram(s); 1 kg is about 2.2 lb.
klb	Thousand pounds; thousands of pounds
lb	Pound(s); 1 lb is about 0.454 kg
m	Meter(s); 1 m is about 3.28 feet.
M	Instantaneous rate of natural (non-fishing) mortality
MARMAP	Marine Resources Monitoring, Assessment, and Prediction Program, a fishery-independent data collection program of SCDNR
MCB	Monte Carlo/Boostrap, an approach to quantifying uncertainty in model results
MFMT	Maximum fishing-mortality threshold; a limit reference point used in U.S. fishery management; often based on F_{MSY}
mm	Millimeter(s); 1 inch = 25.4 mm
MRFSS	Marine Recreational Fisheries Statistics Survey, a data-collection program of NMFS, predecessor of MRIP
MRIP	Marine Recreational Information Program, a data-collection program of NMFS, descended from MRFSS
MSST	Minimum stock-size threshold; a limit reference point used in U.S. fishery management. The SAFMC has defined MSST for Spanish mackerel as $(1 - M)\text{SSB}_{\text{MSY}} = 0.7\text{SSB}_{\text{MSY}}$.
MSY	Maximum sustainable yield (per year)
mt	Metric ton(s). One mt is 1000 kg, or about 2205 lb.
N	Number of fish in a stock, conventionally on January 1
NC	State of North Carolina
NMFS	National Marine Fisheries Service, same as "NOAA Fisheries Service"
NOAA	National Oceanic and Atmospheric Administration; parent agency of NMFS
OY	Optimum yield; SFA specifies that OY $\leq$ MSY.
PSE	Proportional standard error
R	Recruitment
SAFMC	South Atlantic Fishery Management Council (also, Council)
SC	State of South Carolina
SCDNR	Department of Natural Resources of SC
SDNR	Standard deviation of normalized residuals
SEDAR	SouthEast Data Assessment and Review process
SFA	Sustainable Fisheries Act; the Magnuson–Stevens Act, as amended
SL	Standard length (of a fish)
SPR	Spawning potential ratio
SSB	Spawning stock biomass; mature biomass of males and females
SSB_{MSY}	Level of SSB at which MSY can be attained
TIP	Trip Interview Program, a fishery-dependent biodata collection program of NMFS
TL	Total length (of a fish), as opposed to FL (fork length) or SL (standard length)
VPA	Virtual population analysis, an age-structured assessment
WW	Whole weight, as opposed to GW (gutted weight)
yr	Year(s)

Appendix B P* analyses

In the $P^{\star}$ projections, the first year of new management is assumed to be 2013, which is the earliest year management could react to this assessment. The initialization in 2012 was projected using the fishing mortality from the terminal year of the assessment.

Values of ABC were computed for 2013–2015 given uncertainties in F_{MSY}, initial abundance at age (2013), natural mortality, discard mortalities, spawner-recruit parameters, and future recruitment deviations. Management implementation error was not considered for these projections. Thus, these ABC values should be considered as possible catch limits, and implementation uncertainty should be considered when setting annual catch targets (ACTs).

The projection method applied here assumed that the catch taken from the stock was the ABC. If the projection had applied a catch level lower than the ABC, say at ACT $<$ ABC, then the corresponding reduction in applied F would have resulted in higher stock sizes, and higher ABCs in subsequent years.

B.1 Uncertainty of projections

To characterize uncertainty in future stock dynamics, stochasticity was included in replicate projections, each an extension of a single MCB assessment model fit. Thus, projections carry forward uncertainties in steepness, natural mortality, and discard mortality, as well as in estimated quantities such as remaining spawner-recruit parameters, selectivity curves, and in initial (start of 2013) abundance at age.

Initial and subsequent recruitment values were generated with stochasticity using a Monte Carlo procedure, in which the estimated Beverton–Holt model of each MCB fit was used to compute mean annual recruitment values ($\bar{R}_y$). Variability was added to the mean values by choosing multiplicative deviations at random from a lognormal distribution,

$$R_y = \bar{R}_y \exp(\epsilon_y). \tag{6}$$

Here ϵ_y is drawn from a normal distribution with mean 0 and standard deviation σ_R, where σ_R is the standard deviation from the relevant MCB fit.

The procedure used 10,000 replicate projections of MCB model fits drawn at random (with replacement) from the MCB runs. In cases where the same MCB run was drawn, projections still differed as a result of stochasticity in projected recruitment streams.

B.2 Results of Projections

The distribution of F_{MSY} in Figure 3.36 was used as input to the P* analysis to compute annual ABC (landings plus discard mortalities in 1000 lb whole weight). In general, the ABC tends to increase with higher acceptable probability of overfishing ($P^{\star}$), whereas stock size tends to decrease. Projected values from this assessment are shown in Tables C.1 and C.2, and Figures 3.57 and 3.58.

Appendix C Results from the P* projections

Table C.1. Acceptable biological catch (ABC) in units of 1000 lb and metric tons whole weight, based on the annual probability of overfishing $P^{\star} = 0.4$. *F = fishing mortality rate (per yr), SSB = total biomass of mature females,* Pr($\text{SSB} > \text{SSB}_{\text{MSY}}$) *= proportion of replicates not overfished (i.e., SSB above the base-run point estimate of* 3266 *mt), and R = recruits (1000 age-0 fish). Annual ABCs are a single quantity of landings and dead discards combined, while other values presented are medians.*

Year	F	$P^{\star}$	SSB	Pr(SSB > SSB_{MSY})	R	ABC(1000lb)	ABC(mt)
2013	0.59	0.4	4222	0.89	18776	4808	2180
2014	0.58	0.4	3943	0.72	18239	4508	2044
2015	0.56	0.4	3919	0.66	17912	4396	1993

Table C.2. Acceptable biological catch (ABC) in units of 1000 lb and metric tons whole weight, based on the annual probability of overfishing $P^{\star} = 0.5$. *F = fishing mortality rate (per yr), SSB = total biomass of mature females,* Pr($\text{SSB} > \text{SSB}_{\text{MSY}}$) *= proportion of replicates not overfished (i.e., SSB above the base-run point estimate of* 3266 *mt), and R = recruits (1000 age-0 fish). Annual ABCs are a single quantity of landings and discards combined while other values presented are medians.*

Year	F	$P^{\star}$	SSB	Pr(SSB > SSB_{MSY})	R	ABC(1000lb)	ABC(mt)
2013	0.66	0.5	4198	0.88	18536	5312	2409
2014	0.66	0.5	3722	0.65	17813	4878	2213
2015	0.65	0.5	3628	0.58	17307	4712	2137

SEDAR

Southeast Data, Assessment, and Review

SEDAR 28

South Atlantic Spanish Mackerel

SECTION IV: Research Recommendations

December 2012

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

Section IV. Research Recommendations

Contents

Data Workshop Research Recommendations

Life History

- 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.

Commercial Statistics

Although under the category of research recommendations, this list is not research per se, but rather suggestions to improve data collection. The first three recommendations were taken verbatim from the SEDAR17 DW report.

- Need observer coverage for the fisheries for Spanish mackerel (gillnets, castnets (FL), handlines, poundnets, and shrimp trawls for bycatch):
    - 5-10% allocated by strata within states.
    - possible to use exemption to bring in everything with no sale.
    - get maximum information from fish.
- Expand TIP sampling to better cover all statistical strata.
    - Predominantly from Florida and by gillnet & castnet gears.
    - In that sense, we have decent coverage for lengths.
- Trade off with lengths versus ages, need for more ages (i.e., hard parts).
- Consider the use of VMS to improve spatial resolution of data.
- During discussions at the data workshop it was noted that the logbook categories for discards (all dead, majority dead, majority alive, all alive) are not useful for informing discard mortality. Consider simplified logbook language in regard to discards (e.g., list them as dead or alive).
- Uniformity between state and federal reporting systems/forms would vastly improve the ease and efficiency of data compilation.
- Establish online reporting and use logbooks as a backup.
- 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.
- 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

- Collect and analyze fishery independent data for adult Spanish mackerel.
- Using simulation analysis, evaluate the utility of including interaction terms in the development of a standardized index and identify the potential effects these interaction terms have on stock assessments.

Assessment Workshop Research Recommendations

The research recommendations from the AW panel were as follows:

- Establish a fishery-independent survey meant to capture the population trends of coastal pelagics in the south Atlantic.
- Examine how schooling or migratory dynamics may influence the catchability of the species. In particular, research the assumption of the hyperstability of indices that sample the schooling portion of the stock.
- Determine whether it is important to model both sexes in the population for assessment purposes.

Review Workshop Research Recommendations

- Stock structure. Following on from the comments in section 2.3 of SEDAR 28, South Atlantic Spanish mackerel Section II, the review recommends that recently developed genetic techniques be utilized to investigate the stock structure of Spanish mackerel. The studies cited are relatively old, and use techniques that could be now considered antiquated and may not have the power to distinguish population structure in highly migratory species. Microsatellite information should be explored to consider both stock identity and internal population structure.
- Investigation of steepness and alternative models for the stock recruit relationship. In particular evaluate if there is newer data available on steepness from other analyses of S-R for pelagic stocks with similar reproductive strategies. However, the RP was uncertain as to how much the analysis would further inform the model or management at present.

SEDAR

Southeast Data, Assessment, and Review

SEDAR 28

South Atlantic Spanish Mackerel

SECTION V: Review Workshop Report
November 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 Review Workshop for South Atlantic Spanish Mackerel (*Scomberomorus maculatus*) and Cobia (*Rachycentron canadum*) was conducted as a workshop held October 29 to November 2, 2012 at the Doubletree Hotel in Atlanta, GA.

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. Evaluate the assessment with respect to the following:
    - Is the stock overfished? What information helps you reach this conclusion?
    - Is the stock undergoing overfishing? What information helps you reach this conclusion?
    - Is there an informative stock recruitment relationship? Is the stock recruitment curve reliable and useful for evaluation of productivity and future stock conditions?
    - Are quantitative estimates of the status determination criteria for this stock reliable? If not, are there other indicators that may be used to inform managers about stock trends and condition?
4. Evaluate the adequacy, appropriateness, and application of the methods used to project future population status with regard to accepted practices and data available for this assessment.
5. 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. Provide justification for the weightings used in producing the combinations of models.
6. Consider how uncertainties in the assessment, and their potential consequences, have been addressed.
    - Comment on the degree to which methods used to evaluate uncertainty reflect and capture the significant sources of uncertainty.
    - Ensure that the implications of uncertainty in technical conclusions are clearly stated.
7. Consider the research recommendations provided by the Data and Assessment workshops and make any additional recommendations or prioritizations warranted.
    - Clearly denote research and monitoring needs that could improve the reliability of, and information provided by, future assessments.
8. Prepare a Peer Review Summary summarizing the Panel's evaluation of the stock assessment and addressing each Term of Reference. Develop a list of tasks to be completed following the

workshop. Complete and submit the Peer Review Summary Report in accordance with the project guidelines.

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 in the assessment, alternative 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

Panelists		
Marcel Reichert	Review Panel Chair	SA SSC
Steve Cadrin	Reviewer	SA SSC
Matt Cieri	Reviewer	CIE
Mark Dickey-Collas	Reviewer	CIE
John Simmonds	Reviewer	CIE
Analytical Team		
Katie Andrews	Lead Analyst SASM	NMFS Beaufort
Kevin Craig	Lead Analyst SAC	NMFS Beaufort
Kyle Shertzer	Analyst	NMFS Beaufort
Erik Williams	Analyst	NMFS Beaufort
Council Members		
Ben Hartig	Council Rep	SAFMC
Anna Beckwith	Council Rep	SAFMC
Observers		
None		
Staff and Agency		
Ryan Rindone	SEDAR 28 RW Coordinator	SEDAR
Julia Byrd	SEDAR Coordinator	SEDAR
Andrea Grabman	Administrative Support	SEDAR
Mike Errigo	Fishery Biologist	SAFMC

1.1.4 List of Review Workshop Working Papers

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

2. Review Panel Report

Executive Summary

The South Atlantic Spanish mackerel stock assessment presented by the SEDAR 28 Assessment Workshop (AW) provided the Review Panel (RP) with outputs and results from two assessments models. The primary model was the Beaufort Assessment Model (BAM), while a secondary, surplus-production model (ASPIC) provided a comparison of model results. The RP concluded that the BAM was the most appropriate model to characterize the stock status for management purposes.

The current stock status in the base run from the BAM was estimated to be $SSB_{2011}/MSST=2.29$. The current level of fishing is $F_{2009\text{-}2011}/F_{MSY} = 0.526$, with $F_{2011}/F_{MSY} = 0.521$. Therefore, the RP concludes that the stock is not overfished and is not undergoing overfishing. The qualitative results on terminal stock status were similar across presented sensitivity runs, indicating that the stock status results were robust given the provided data and can be used for management. The outcomes of sensitivity analyses done with BAM were in general agreement with those of the Monte Carlo Bootstrap analysis in BAM. In general, stock status results from ASPIC were qualitatively similar to those from BAM.

2.2. Statements addressing each Term of Reference

2.2.1. Evaluate the adequacy, quality and applicability of data used in the assessment.

The RP concluded that, overall, the data is the best available and appropriate for the use in the assessment. The data is sufficient to describe the individual fleets. However, the shrimp by-catch data is weak and improvements in monitoring can improve information to the model. Overall, the RP concluded that the data is appropriate for short-term management based on the outcome of the assessment. The RP also indicated that it may be helpful for future assessments to add more detail on how the indices MRFSS and MRIP were dealt with as a single index for use in the assessment.

Shrimp bycatch and lack of monitoring was of concern to the RP. The current shrimp bycatch data were deemed marginally acceptable, in large part because the effect on the assessment outcome was small. In general, the methods to estimate these removals are adequate, but the underlying data need improvement. This can be accomplished by increased on board observer coverage as suggested under "Research Recommendations".

Improve the estimate of the selectivity function. The modeled selectivity at age shows that the change in the fishery following the closure of Florida gill net fishery has resulted in substantial change in selectivity from the 1990s onwards. The selection at age is still changing by year due to changes in proportions of catch among different gear categories. This has two consequences:

- Use of a model that requires separable modeling of the fishery data must allow for multiple fleets or a time varying selection function of some considerable flexibility. This reinforces the need for sufficient age samples to characterize multiple fleets.
- Changing selectivity with time implies changing MSY targets with time which limits the utility of target values into the future. If the changes in the relative contributions of the different gears does continue into the future it is expected the MSY targets will change.

Add strengths and weaknesses of each category of data.

The data strengths included commercial and recreational landings information. Commercial landings were available back to 1950 and a combination of MRFSS and MRIP were used to examine recreational removals to 1983. Commercial discards were of a concern, as these are not well estimated given due low sample sizes. Additionally discards were reconstructed from 1983 to 1993 using a static kept to discard ratio further compounding this uncertainty. However, it was noted that commercial landings represented a small part of the recent catch with discards a fraction of that. This suggests that at least in recent years, overall importance of discards in the assessment were minimal given other catch inputs.

Strengths and weaknesses of length and age composition data:

Length data were not used to inform the model for a number of reasons. The data are more noisy than informative, and lack any information of distinct size classes moving through the population. Since age composition data are available, and are comprised of directly aged samples, the AW decided to not use the length compositions for the assessment. Age data were available from the commercial hand line, pound net, gill net, cast net and recreational sampling programs. The annual age compositions were developed for Spanish mackerel by the SEDAR-28 DW. The AW preferred to weight the age composition by the length composition for years where adequate samples were available. Ages greater than 10 were pooled to age 10 creating a plus group (age 10+; Tables 2.3 & 2.7). The length data is clearly identified as insufficient for population modeling purposes, however, parameters such as selection and maturity are thought to be length dependant rather than age dependant. It seems unlikely that increased sampling for length will solve this issue, except where collected with the dependant variable such as maturity (see other sections). Increased length sampling is not specifically recommended. In contrast collection of age data is identified as critical for the assessment. An examination of the change in overall selection pattern with year (see additional requests for analyses) indicates that selection at age in the fishery has changed considerably in recent years due to changes in catch proportion by fleet following the closure of the gillnet fishery in Florida. This demonstrates the continuing need to obtain good age data by fleet in order to model selectivity in the fishery. The current level of sampling seems barely adequate for this purpose, as for the smaller fisheries, such as pound net, numbers of samples are low. It was noted that by taking such small numbers of samples it is difficult to characterize fisheries except at an annual and global scale. Increased sampling would allow for spatial and seasonal aspects to be documented.

Strengths and weaknesses of the data related to Life History Strategies:

The data strengths were:

- The fact that the stock identity was considered,
- Estimates of age varying natural mortality were considered and provided,
- Discard mortality was considered,
- There was a reasonable coverage of age sampling, and
- The report highlighted and provided information on sexual dimorphism in growth.

The identified data weaknesses of the life history data were:

- That the stock identification considerations used relatively out-of-date techniques,
- The considerations on natural mortality provided an estimate of generic variability in M, however justification for its use for sensitivity analysis for total population was weak,

- Whilst discard mortality was considered, discard selectivity was not assessed,
- If management was to use an alternative reproductive potential proxy than female biomass, the existing information base appears weak, and
- There was no provision of information in the report of time trends in growth, maturity and weight to inform on environmentally driven changes in sustainable exploitation benchmarks.

The strengths and weaknesses of the used indices of abundance:

The strength of the used indices of abundance were:

- One fishery-independent index is used in the Spanish mackerel stock assessment (SEAMAP ages 0) and two fishery-dependent indices are used in the stock assessment (MRFSS and FL trip ticket handline/trolling), with the MRFSS index being available since 1982,
- Indices cover the entire stock area (SEAMAP age-0 and MRFSS) or the central portion of the resource (FL trip ticket handline/trolling),
- All indices are standardized to account for factors not related to relative abundance using conventional statistical analyses (e.g., delta-GLM with bootstrapping), and
- The assessment results (e.g., stock status) are relatively robust to the relative weighting of indices.

The weaknesses of the index information used are:

- The fishery and survey catchability may not be constant or linear, as assumed in the assessment, in particular for the line fisheries,
- The standardization of fishery-dependent indices does not remove the effect of technological improvements in fishing efficiency, and regulatory changes may influence fishery catch rates,
- The MRFSS statistics are not necessarily relevant to fishing effort directed toward Spanish mackerel,
- The MRFSS and MRIP statistics are combined into a single series, but CPUE from the two programs may not be comparable, and
- The correlation among indices is weak.

2.2.2. Evaluate the adequacy, quality and applicability of methods used to assess the stock.

The RP concluded that the model choice (BAM) was appropriate and the preferred model. The ASPIC approach provided supporting information as to the stock status as it was in general agreement both in terms of recent trends and SSB/SSB_{msy}. However, ASPIC was considered to provide an unrealistically narrow estimate of uncertainty relative to BAM, partly because the model only considers rather limited sources of uncertainty (see below).

The main reasons for accepting the model were that it was supported by a good sensitivity analysis covering a reasonable range of other options, and most importantly it had good retrospective performance. The RP noted that the report did not provide a comparison with the previous assessment. Normal practice should be to run the previous assessment with each element of input data updated in turn, and then with any new model being proposed. We understand this was not possible. Without this, the retrospective analysis was used to evaluate changes in the stock assessment over recent year's data.

The RP supported sex specific modeling as presented for the current stock assessment. However, given its treatment and the small impact of sex-specific differences, the RP was not certain that it was a useful addition. As such, the RP suggested that future benchmarks examine the need to model sexes in the stock separately; and if so re-examine the treatment of sex-specific growth and its impact on selectivity.

The RP observed that the confidence and precision of the ASPIC model seemed to be much higher relative to the BAM (Figures 3.37 and 3.58 in the Assessment Report). This increased precision, however, is considered to be false. ASPIC uses a bootstrapped methodology to resample the residuals of predicted vs. fit yield (ASPIC manual) using the variability in the indices. In contrast, BAM uses an MC approach and accounts for uncertainty in many assumed and estimated parameters not explicitly considered as variable by ASPIC. Therefore, the RP concluded that the BAM estimates of uncertainty were more realistic than ASPIC; with the later underestimating the true variable.

2.2.3. Evaluate the assessment with respect to the following:

Is the stock overfished and what information helps you reach this conclusion?

The RP concluded that the probability of the stock being overfished is low. The MC and provided sensitivity runs incorporated and investigated the major sources of uncertainty. The RP concluded that the assessment provides an adequate amount of information for a P* approach (which includes scientific uncertainty) and that this uncertainty was relatively well quantified.

Is the stock undergoing overfishing and what information helps you reach this conclusion?

The RP concluded that the probability of overfishing is low. The MC and provided sensitivity runs incorporated and investigated the major sources of uncertainty.

Is there an informative stock recruitment relationship and is the stock recruitment curve reliable and useful for evaluation of productivity and future stock conditions?

The RP concluded that the stock recruit relationship has information, but steepness was not well estimated. However, there is sufficient information in the context of the parameters needed for management against MSY criteria. In addition, it is informative in the sense that the stock seems in state of reasonable, not impaired recruitment.

Are quantitative estimates of the status determination criteria for this stock reliable?

The RP interpreted this TOR as: How reliable are the reference points? A number of comments were provided above. In addition, RP suggested investigate comparisons with other stock assessments (MSY) and other indicators that may be used to inform managers about stock trends and condition. Although the stock assessment gives relatively reliable indications of status with respect to MSY reference points, the continuing changes in selectivity in the overall fishery due to shifts in effort among fleets can be expected to change the reference values over time. Thus the assessments utility is limited in time not only by consistency of data, but also by the changing fisheries

The RP recommendation for P*'s using SAFMC tiered approach, applying additive penalties to P* = 0.5: Spanish mackerel (P* = 0.425 = 0.5-0.075)

I. Assessment Information – Tier 1: Quantitative assessment provides estimates of exploitation and biomass; includes MSY-derived benchmarks. (P* penalty = 0; steepness was freely estimated)

II. Uncertainty – Tier 2: High. This tier represents those assessments that include re-sampling (e.g. Bootstrap or Monte Carlo techniques) of important or critical inputs such as natural mortality, landings, discard rates, age and growth parameters. Such re-sampling is also carried forward and combined with recruitment uncertainty for projections and reference point calculations, including reference point distributions. The key determinant for this level is that reference point estimates distributions reflect more than just uncertainty in future recruitment. (P* penalty = -0.025)

III. Stock Status – Tier 1: Neither overfished nor overfishing, and stock is at high biomass and low exploitation relative to benchmark values. (P* penalty = 0)

IV. Productivity-Susceptibility Analysis – Tier 2: Moderate Risk. Moderate productivity, vulnerability, susceptibility, score 2.64 - 3.18 (P* penalty = -0.05; PSA score = 2.74, MRAG 2009)

2.2.4. Evaluate the adequacy, appropriateness, and application of the methods used to project future population status with regard to accepted practices and data available for this assessment.

The RP concluded that, since accepted practices were followed, the methods were adequate and appropriate. The RP noted that, management of this stock based on this current assessment be limited temporally. Given the uncertainties associated the RP was not supportive of using this method past 3 to 5 years without further update or review.

2.2.5. 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. Provide justification for the weightings used in producing the combinations of models.

The RP did not propose any changes.

2.2.6. Consider how uncertainties in the assessment, and their potential consequences, have been addressed.

The RP concluded that uncertainty was addressed by the review team by analyzing both MCMC and sensitivity analysis. Some concerns were raised that the natural morality used in the MCMC were drawn from a very wide range, giving the appearance of more uncertainty then appropriate. The RP spent some time establishing the magnitude of the variability in M that was applied following some initial confusion over the actual variance applied in the MC evaluations. However, following some clarification and discussion it was considered that the spread of M used was applicable. In this context, it might be useful to state the CV or variance actually applied as well as the limits, thus reducing the possibility for confusion.

The RP agreed that the methods and sensitivities chosen where appropriate. Further, the RP agreed that the combination of sensitivity and MCMC captured well the possible uncertainty, and as such can be used by the managed process in accounting for scientific uncertainty in setting appropriate ABC's.

The RP supported the attempt to account for uncertainty in natural mortality in estimates of model precision, particularly to support a probabilistic approach to catch limits. A comparison of the assumed distribution in estimates of M (mean of 0.35 with 95% confidence limits of 0.16 to 0.54) is generally consistent with the alternative estimates of M reported in the Data Workshop report.

Comment on the degree to which methods used to evaluate uncertainty reflect and capture the significant sources of uncertainty.

The RP concluded that the degree is sufficient to address scientific uncertainty for management (ABC) recommendations. However, they are conditional to the overall choice of the model dynamics, but this is regarded as acceptable practice. The RP also confirmed that management uncertainty is not included, nor is it expected to form a component of P* analysis.

Ensure that the implications of uncertainty in technical conclusions are clearly stated..

The RP concluded that the implications were clearly stated.

2.2.7. Consider the research recommendations provided by the Data and Assessment workshops and make any additional recommendations or prioritizations warranted.
Clearly denote research and monitoring needs that could improve the reliability of, and information provided by, future assessments.

I. Stock structure. Following on from the comments in section 2.3 of SEDAR 28, South Atlantic Spanish mackerel Section II, the review recommends that recently developed genetic techniques be utilized to investigate the stock structure of Spanish mackerel. The studies cited are relatively old, and use techniques that could be now considered antiquated and may not have the power to distinguish population structure in highly migratory species. Microsatellite information should be explored to consider both stock identity and internal population structure.

II. Investigation of steepness and alternative models for the stock recruit relationship. In particular evaluate if there is newer data available on steepness from other analyses of S-R for pelagic stocks with similar reproductive strategies. However, the RP was uncertain as to how much the analysis would further inform the model or management at present.

2.3. Summary Results of Analytical Requests (sensitivities, corrections, etc.)

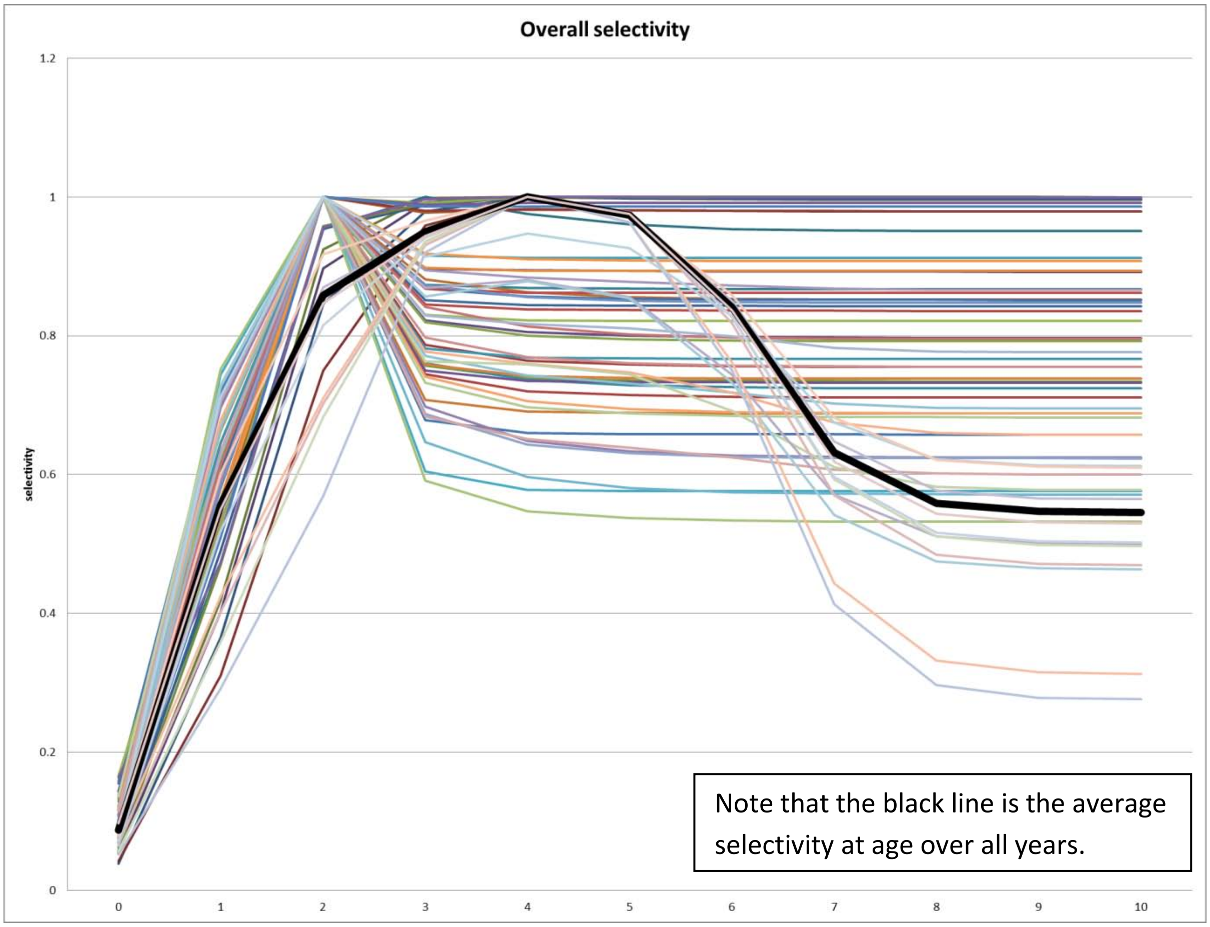
I. Presentation of aggregate selectivity over time.

Rational: It was noted that modeling the fishery required separate selectivity models by fleet and that the age sampling was relatively sparse. The combined catch at age matrix might be more precise than the combined fisheries. Examination of changes with time would inform the decisions on use of separate or combined fleets.

Objective: Present the selectivity at age by year for the aggregate fishery.

Outcome: The modeled selectivity at age (see below) shows that the change in the fishery following the closure has resulted in substantial change in selectivity from the 1990s onwards. The selection at age is still changing by year due to changes in proportions of catch among different gear categories. This has two consequences:

- Use of a model that requires separable modeling of the fishery data must allow for multiple fleets or a time varying selection function of some considerable flexibility. This reinforces the need for sufficient age samples.
- Changing selectivity with time implies changing MSY targets with time which limits the utility of target values into the future. If the changes in the relative contributions of the different gears does continue into the future it is expected the MSY targets will change.

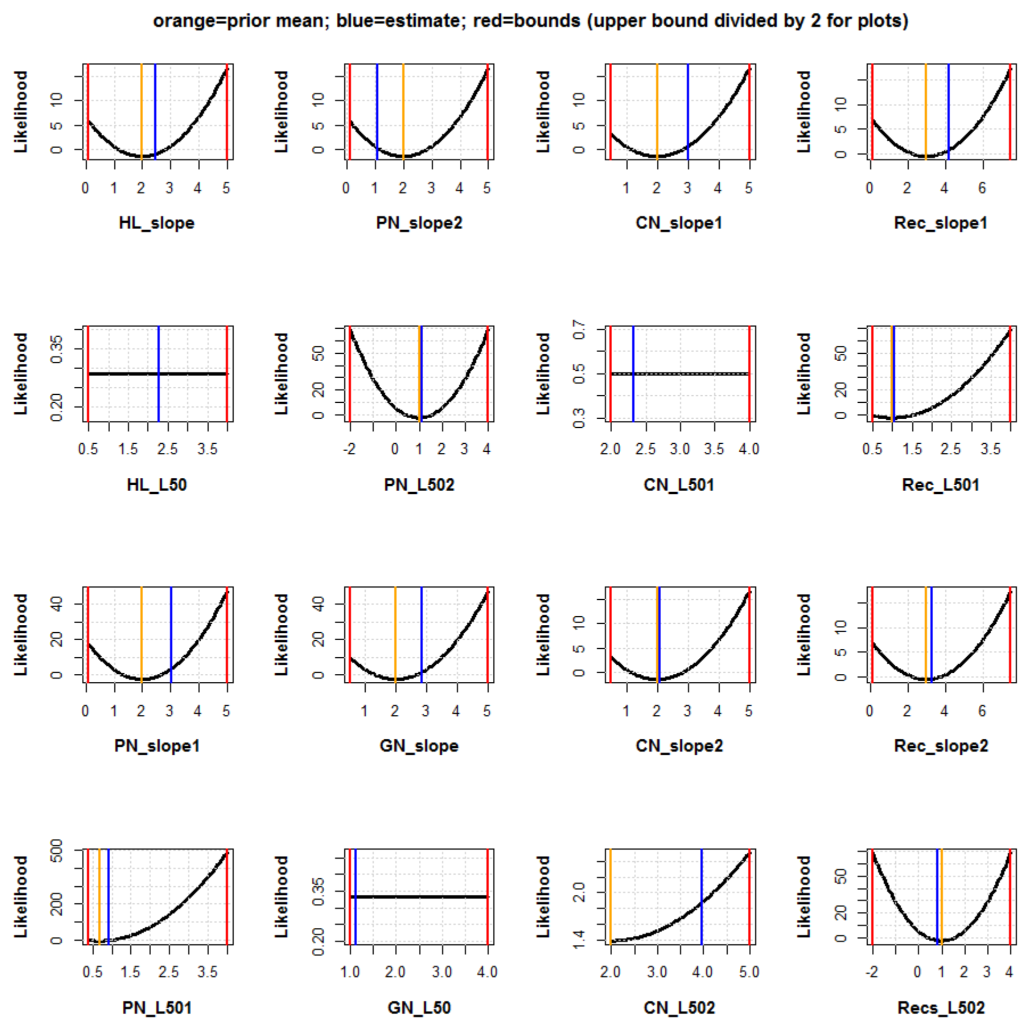


II. Presentation of priors on selectivity functions.

Rational: It was noted that modeling the fishery resulted in some rather rapid change of selection at age particularly for pound-net and recreational fisheries. These steep sided dome shaped functions are thought to be the result of age dependent spatial interactions not gear related technical interactions. The selection patterns also exhibit correlation in the residuals at age among years. In order to better understand the plots of model fit prior probability, parameter bounds and fitted ML values.

Objective: Inspection of greater detail in the modeling of selectivity.

Outcome: The comparison of priors and fitted values shows that none are at the parameter bounds, though gillnet L50 is close to the limit. Pound net L50 and Rec L502 are close to mean of priors and could be checked for sensitivity to priors.


orange=prior mean; blue=estimate; red=bounds (upper bound divided by 2 for plots)
Likelihood
HL_slope
PN_slope2
CN_slope1
Rec_slope1
HL_L50
PN_L502
CN_L501
Rec_L501
PN_slope1
GN_slope
CN_slope2
Rec_slope2
PN_L501
GN_L50
CN_L502
Recs_L502

3. Submitted comments

No additional comments were submitted.