Southeast Data, Assessment, and Review

SEDAR 25

Stock Assessment Report

South Atlantic Black Sea Bass

October 2011

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

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Section I: Introduction

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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

2.1. Fishery Management Plan and Amendments

The following summary describes only those management actions that likely affect black sea bass fisheries and harvest.

Original SAMFC FMP

The Fishery Management Plan (FMP), Regulatory Impact Review, and Final Environmental Impact Statement for the Snapper Grouper Fishery of the South Atlantic Region, approved in 1983 and implemented in August of 1983, established a management regime for the fishery for snappers, groupers and related demersal species of the Continental Shelf of the southeastern United States in the fishery conservation zone (FCZ) under the area of authority of the South Atlantic Fishery Management Council and the territorial seas of the states, extending from the North Carolina/Virginia border through the Atlantic side of the Florida Keys to 83^o W longitude. In the case of the sea basses (black sea bass, bank sea bass, and rock sea bass), the fishery management unit/management regime applies only from Cape Hatteras, North Carolina south. Regulations apply only to federal waters.

Measures in the original FMP (effective 8/31/83) specified an 8" TL minimum size limit and a 4" trawl mesh size.

SAFMC FMP Amendments affecting black sea bass

Description of Action	FMP/Amendment	Effective Date
Prohibit trawls (roller rig trawls) from Cape Hatteras, NC to Cape Canaveral, FL	Amendment 1	1/12/89
BSB 10 year rebuilding program; year 1=1991. Prohibit fish traps, entanglement nets, and longline gear within 50 fathoms; allowed BSB pots north of Cape Canaveral. Prohibit powerheads in SMZs off SC. Black sea bass pot permit, gear, vessel, and identification requirements. Landed with heads & fins attached. Permits - income requirement & required to exceed bag limits.	Amendment 4	1/1/92
Required dealer, charter and headboat federal permits.	Amendment 7	3/1/95
Limited entry program: transferable permits and 225-lb non-transferable permits.	Amendment 8	12/14/98
10" TL minimum size limit recreational & commercial and 20 fish per person per day recreational bag limit; requires escape vents and escape panels with degradable hinges and fasteners in black sea bass pots. The minimum dimensions of an escape vent opening (based on inside measurement) are: (*1*) 11⁄8 by 53⁄4 inches (2.9 by 14.6 cm) for a rectangular vent. (*2*) 1.75 by 1.75 inches (4.5 by 4.5 cm) for a square vent. (*3*) 2.0-inch (5.1-cm) diameter for a round vent.	Amendment 9	2/24/99
1. Specify a **commercial** quota of 477,000 lbs gutted weight		

(563,000 lbs whole weight) in year 1; 423,000 lbs gutted weight (499,000 lbs whole weight) in year 2; and 309,000 lbs gutted weight (364,000 lbs whole weight) in year 3 onwards until modified. 2. The commercial quota & recreational allocation are based on a **Total Allowable Catch (TAC)** of 1,110,000 lbs gutted weight (1,310,000 lbs whole weight) in year 1; 983,000 lbs gutted weight (1,160,000 lbs whole weight) in year 2; and 718,000 lbs gutted weight (847,000 lbs whole weight) in year 3 onwards until modified. 3. After the commercial quota is met, all purchase and sale is prohibited and harvest and/or possession is limited to the bag limit. 4. Require use of at least 2" mesh for the entire back panel of black sea bass pots. This measure was effective 10/23/06. 5. Specify a **recreational** allocation of 633,000 lbs gutted weight (746,000 lbs whole weight) in year 1; 560,000 lbs gutted weight (661,000 lbs whole weight) in year 2; and 409,000 lbs gutted weight (483,000 lbs whole weight) in year 3 onwards until modified. 6. Limit recreational landings to approximate this harvest level by increasing the recreational minimum size limit from 10" total length to 11" total length in year 1 and to 12" total length in year 2 onwards until modified, and reducing the recreational bag limit from 20 to 15 black sea bass per person per day. 7. Change the fishing year from the calendar year to June 1 through May 31. 8. Year 1 = 2006/07.	Amendment 13C	10/23/06
1) Update management reference points for black sea bass. 2) Modify rebuilding strategies for black sea bass. 3) Define rebuilding strategies for black sea bass, None of the measures included in Amendment 15A involve changes to current regulations; therefore, no proposed or final rule is required at this time. 4) Established 10-year rebuilding schedule for black sea bass where 2006 is year 1.	Amendment 15A	3/20/08
1) Prohibit sale the sale of bag-limit caught snapper grouper species. 2) Change the commercial permit renewal period and transferability requirements. 3) Implement a plan to monitor and address bycatch.	Amendment 15B	12/16/09
1) Commercial ACL = 309,000 lbs gw 2) Recreational ACL = 409,000 lbs gw 3) The commercial AM for black sea bass is to prohibit harvest, possession, and retention when the quota is projected to be met. 4) The recreational AM for black sea bass is to compare the recreational ACL with recreational landings over a range of years. For 2010, use only 2010 landings. For 2011, use the average landings of 2010 and 2011. For 2012 and beyond, use the most recent three-year running average. If black sea bass are *overfished* and the ACL is projected to be met, prohibit the harvest and retention of black sea bass. 5) If the recreational or commercial sector ACL is exceeded, independent of stock status, the Regional Administrator shall publish a notice to reduce the sector ACL in the following season by the amount of the overage. 6) Updated the framework procedure.	Amendment 17B	1/31/11

2.2. Emergency and Interim Rules

SAFMC None for black sea bass.

2.3. Secretarial Amendments

SAFMC None for black sea bass.

2.4. Control Date Notices

SAFMC:

1. Notice of Control Date (07/30/91 56 FR 36052) - Anyone entering **federal snapper grouper fishery (other than for wreckfish)** in the EEZ off S. Atlantic States after 07/30/91 was not assured of future access if limited entry program developed.
2. Notice of Control Date (04/23/97 62 FR 22995) - Anyone entering **federal black sea bass pot fishery** off S. Atlantic states after 04/23/97 was not assured of future access if limited entry program developed.
3. Notice of Control Date (10/14/05 70 FR 60058) - Anyone entering **federal snapper grouper fishery** off S. Atlantic states after 10/14/05 was not assured of future access if limited entry program developed.
4. Notice of Control Date (02/20/09 74 FR 7849) - Anyone entering **federal black sea bass pot fishery** off S. Atlantic states after 12/04/08 was not assured of future access if limited entry program developed.
5. Notice of Control Date (01/31/11 76 FR 5325) - Anyone entering **federal snapper grouper fishery** off S. Atlantic states after 09/17/10 was not assured of future access if limited entry program developed.

The net effect of these various control dates is that there are two control dates:

1. Federal Snapper Grouper Fishery – 1/31/2011
2. Federal Black Sea Bass Pot Fishery – 12/4/2008

2.5. Management Program Specifications

Table 2.5.1. General Management Information
South Atlantic

Species	Black Sea Bass
Management Unit	Southeastern US
Management Unit Definition	Cape Hatteras, NC southward to the SAFMC/GMFMC boundary
Management Entity	South Atlantic Fishery Management Council
Management Contacts SERO / Council	SAFMC: Myra Brouwer or Gregg Waugh Jack McGovern/Rick DeVictor
Current stock exploitation status	Overfishing
Current stock biomass status	Overfished

Table 2.5.2. Specific Management Criteria
Values are from Snapper Grouper Amendment 15A (December 2007; available from www.safmc.net) and are based on the SEDAR Update (2005) http://www.sefsc.noaa.gov/sedar/download/bsb-aw-2005_062006.pdf?id=DOCUMENT .

Criteria	South Atlantic - Current		South Atlantic - Proposed	
	Definition	Value	Definition	Value
MSST	MSST = [(1-M) or 0.5 whichever is greater]*B_{MSY}	10,512,613 lbs ww	MSST = [(1-M) or 0.5 whichever is greater]*B_{MSY}	SEDAR 25
MFMT	F_{MSY}	0.43	F_{MSY}	SEDAR 25
MSY	Yield at F_{MSY}	2,777,825 lbs ww	Yield at F_{MSY}	SEDAR 25
F_{MSY}	F_{MSY}	0.429	F_{MSY}	SEDAR 25
OY	Yield at F_{OY}	2,742,551 lbs ww	Yield at F_{OY}	SEDAR 25
F_{OY}	Yield at 75%F_{MSY}*	0.3225	F_{OY} = 65%,75%, 85% F_{MSY}	SEDAR 25
M	n/a	0.30	M	SEDAR 25

**F_{OY} definition from Amendment 15A.*

Table 2.5.3. Stock Rebuilding Information
Black sea bass is in a 10-year rebuilding schedule where 2006 is Year 1 (Amendment 15A).

Table 2.5.4. Stock projection information.
South Atlantic

Requested Information	Value
First Year of Management	2012
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 2.5.5. Quota Calculation Details

If the stock is managed by quota, please provide the following information. Amendment 13C implemented a Total Allowable Catch (TAC) and divided it into a commercial quota and a recreational allocation (effective 10/23/06).

	Commercial	Recreational	Total Allowable Catch
Current Quota Value	309,000 lbs gw	409,000 lbs gw	718,000 lbs gw
Next Scheduled Quota Change	NA	NA	NA
Annual or averaged quota?	NA	NA	NA
If averaged, number of years to average	NA	NA	NA
Does the quota account for bycatch/discard?	Yes	Yes	Yes

How is the quota calculated - conditioned upon exploitation or average landings? Allowable catch from the projection was allocated to recreational and commercial sectors based on average catch during 1999-2003.

Does the quota include bycatch/discard estimates? If so, what is the source of the bycatch/discard values? What are the bycatch/discard allowances? Quota does not require monitoring of discards and is based on landed catch. Assessment takes into consideration bycatch and provides estimate of yield at F_{MSY} and F_{OY} as landed catch rather than landed catch and dead discards.

Are there additional details of which the analysts should be aware to properly determine quotas for this stock? No.

2.6. Management and Regulatory Timeline

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

Table 2.6.1. Annual Commercial Black Sea Bass Regulatory Summary.

	Fishing Year	Size Limit	Possession Limit	Other Regulations
8/31/83	Calendar Year	8 in TL	None	4 in trawl mesh size
1983	Calendar Year	8 in TL	None	4 in trawl mesh size
1984	Calendar Year	8 in TL	None	4 in trawl mesh size
1985	Calendar Year	8 in TL	None	4 in trawl mesh size
1986	Calendar Year	8 in TL	None	4 in trawl mesh size
1987	Calendar Year	8 in TL	None	4 in trawl mesh size
1988	Calendar Year	8 in TL	None	4 in trawl mesh size
1989	Calendar Year	8 in TL	None	Trawls prohibited Cape Hatteras to Cape Canaveral
1990	Calendar Year	8 in TL	None	Trawls prohibited Cape Hatteras to Cape Canaveral
1991	Calendar Year	8 in TL	None	Trawls prohibited Cape Hatteras to Cape Canaveral
1992	Calendar Year	8 in TL	None	Trawls prohibited Cape Hatteras to Cape Canaveral

1993	Calendar Year	8 in TL	None	Trawls prohibited Cape Hatteras to Cape Canaveral
1994	Calendar Year	8 in TL	None	Trawls prohibited Cape Hatteras to Cape Canaveral
1995	Calendar Year	8 in TL	None	Trawls prohibited Cape Hatteras to Cape Canaveral
1996	Calendar Year	8 in TL	None	Trawls prohibited Cape Hatteras to Cape Canaveral
1997	Calendar Year	8 in TL	None	Trawls prohibited Cape Hatteras to Cape Canaveral
1998	Calendar Year	8 in TL	None	Trawls prohibited Cape Hatteras to Cape Canaveral
1999	Calendar Year	10 in TL	None	Trawls prohibited Cape Hatteras to Cape Canaveral; BSB pots allowed north of Cape Canaveral. Prohibited fish traps, entanglement nets, and longline gear within 50 ftms. Require escape vents in pots. The minimum dimensions of an escape vent opening (based on inside measurement) are: (*1*) 11⁄8 by 53⁄4 inches (2.9 by 14.6 cm) for a rectangular vent. (*2*) 1.75 by 1.75 inches (4.5 by 4.5 cm) for a square vent. (*3*) 2.0-inch (5.1-cm) diameter for a round vent.
2000	Calendar Year	10 in TL	None	Trawls prohibited Cape Hatteras to Cape Canaveral; BSB pots allowed north of Cape Canaveral. Prohibited fish traps, entanglement nets, and longline gear within 50 ftms. Require escape vents in pots. The minimum dimensions of an escape vent opening (based on inside measurement) are: (*1*) 11⁄8 by 53⁄4 inches (2.9 by 14.6 cm) for a rectangular vent. (*2*) 1.75 by 1.75 inches (4.5 by 4.5 cm) for a square vent. (*3*) 2.0-inch (5.1-cm) diameter for a round vent.
2001	Calendar Year	10 in TL	None	Trawls prohibited Cape Hatteras to Cape Canaveral; BSB pots allowed north of Cape Canaveral. Prohibited fish traps, entanglement nets, and longline gear within 50 ftms. Require escape vents in pots. The minimum dimensions of an escape vent opening (based on inside measurement) are: (*1*) 11⁄8 by 53⁄4 inches (2.9 by 14.6 cm) for a rectangular vent. (*2*) 1.75 by 1.75 inches (4.5 by 4.5 cm) for a square vent.

				(*3*) 2.0-inch (5.1-cm) diameter for a round vent.
2002	Calendar Year	10 in TL	None	Trawls prohibited Cape Hatteras to Cape Canaveral; BSB pots allowed north of Cape Canaveral. Prohibited fish traps, entanglement nets, and longline gear within 50 ftms. Require escape vents in pots. The minimum dimensions of an escape vent opening (based on inside measurement) are: (*1*) 11⁄8 by 53⁄4 inches (2.9 by 14.6 cm) for a rectangular vent. (*2*) 1.75 by 1.75 inches (4.5 by 4.5 cm) for a square vent. (*3*) 2.0-inch (5.1-cm) diameter for a round vent.
2003	Calendar Year	10 in TL	None	Trawls prohibited Cape Hatteras to Cape Canaveral; BSB pots allowed north of Cape Canaveral. Prohibited fish traps, entanglement nets, and longline gear within 50 ftms. Require escape vents in pots. The minimum dimensions of an escape vent opening (based on inside measurement) are: (*1*) 11⁄8 by 53⁄4 inches (2.9 by 14.6 cm) for a rectangular vent. (*2*) 1.75 by 1.75 inches (4.5 by 4.5 cm) for a square vent. (*3*) 2.0-inch (5.1-cm) diameter for a round vent.
2004	Calendar Year	10 in TL	None	Trawls prohibited Cape Hatteras to Cape Canaveral; BSB pots allowed north of Cape Canaveral. Prohibited fish traps, entanglement nets, and longline gear within 50 ftms. Require escape vents in pots. The minimum dimensions of an escape vent opening (based on inside measurement) are: (*1*) 11⁄8 by 53⁄4 inches (2.9 by 14.6 cm) for a rectangular vent. (*2*) 1.75 by 1.75 inches (4.5 by 4.5 cm) for a square vent. (*3*) 2.0-inch (5.1-cm) diameter for a round vent.
2005	Calendar Year	10 in TL	None	Trawls prohibited Cape Hatteras to Cape Canaveral; BSB pots allowed north of Cape Canaveral. Prohibited fish traps, entanglement nets, and longline gear within 50 ftms. Require escape vents in pots. The minimum dimensions of an escape vent opening (based on inside measurement) are:

				(*1*) 11⁄8 by 53⁄4 inches (2.9 by 14.6 cm) for a rectangular vent. (*2*) 1.75 by 1.75 inches (4.5 by 4.5 cm) for a square vent. (*3*) 2.0-inch (5.1-cm) diameter for a round vent.
2006	Calendar Year	10 in TL	None	Trawls prohibited Cape Hatteras to Cape Canaveral; BSB pots allowed north of Cape Canaveral. Prohibited fish traps, entanglement nets, and longline gear within 50 ftms. Require escape vents in pots. The minimum dimensions of an escape vent opening (based on inside measurement) are: (*1*) 11⁄8 by 53⁄4 inches (2.9 by 14.6 cm) for a rectangular vent. (*2*) 1.75 by 1.75 inches (4.5 by 4.5 cm) for a square vent. (*3*) 2.0-inch (5.1-cm) diameter for a round vent. Require use of at least 2" mesh for the entire back panel of pots; effective 10/23/06
2006/2007 (effective 10/23/06)	June 1 - May 31 Fishing Year	10 in TL	477,000 lbs gutted weight (563,000 lbs whole weight)	Trawls prohibited Cape Hatteras to Cape Canaveral; BSB pots allowed north of Cape Canaveral. Prohibited fish traps, entanglement nets, and longline gear within 50 ftms. Require escape vents in pots. The minimum dimensions of an escape vent opening (based on inside measurement) are: (*1*) 11⁄8 by 53⁄4 inches (2.9 by 14.6 cm) for a rectangular vent. (*2*) 1.75 by 1.75 inches (4.5 by 4.5 cm) for a square vent. (*3*) 2.0-inch (5.1-cm) diameter for a round vent. Require use of at least 2" mesh for the entire back panel of pots; effective 10/23/06
2007/2008	June 1 - May 31 Fishing Year	10in TL	423,000 lbs gutted weight (499,000 lbs whole weight)	Trawls prohibited Cape Hatteras to Cape Canaveral; BSB pots allowed north of Cape Canaveral. Prohibited fish traps, entanglement nets, and longline gear within 50 ftms. Require escape vents in pots. The minimum dimensions of an escape vent opening (based on inside measurement) are: (*1*) 11⁄8 by 53⁄4 inches (2.9 by 14.6 cm) for a rectangular vent. (*2*) 1.75 by 1.75 inches (4.5 by 4.5 cm) for a square vent. (*3*) 2.0-inch (5.1-cm) diameter for a

				round vent. Require use of at least 2" mesh for the entire back panel of pots; effective 10/23/06
2008/2009	June 1 - May 31 Fishing Year	10in TL	309,000 lbs gutted weight (364,000 lbs whole weight)	Trawls prohibited Cape Hatteras to Cape Canaveral; BSB pots allowed north of Cape Canaveral. Prohibited fish traps, entanglement nets, and longline gear within 50 ftms. Require escape vents in pots. The minimum dimensions of an escape vent opening (based on inside measurement) are: (*1*) 11⁄8 by 53⁄4 inches (2.9 by 14.6 cm) for a rectangular vent. (*2*) 1.75 by 1.75 inches (4.5 by 4.5 cm) for a square vent. (*3*) 2.0-inch (5.1-cm) diameter for a round vent. Require use of at least 2" mesh for the entire back panel of pots; effective 10/23/06
2009/2010	June 1 - May 31 Fishing Year	10in TL	309,000 lbs gutted weight (364,000 lbs whole weight)	Trawls prohibited Cape Hatteras to Cape Canaveral; BSB pots allowed north of Cape Canaveral. Prohibited fish traps, entanglement nets, and longline gear within 50 ftms. Require escape vents in pots. The minimum dimensions of an escape vent opening (based on inside measurement) are: (*1*) 11⁄8 by 53⁄4 inches (2.9 by 14.6 cm) for a rectangular vent. (*2*) 1.75 by 1.75 inches (4.5 by 4.5 cm) for a square vent. (*3*) 2.0-inch (5.1-cm) diameter for a round vent. Require use of at least 2" mesh for the entire back panel of pots; effective 10/23/06
2010/2011	June 1 - May 31 Fishing Year	10in TL	309,000 lbs gutted weight (364,000 lbs whole weight)	Trawls prohibited Cape Hatteras to Cape Canaveral; BSB pots allowed north of Cape Canaveral. Prohibited fish traps, entanglement nets, and longline gear within 50 ftms. Require escape vents in pots. The minimum dimensions of an escape vent opening (based on inside measurement) are: (*1*) 11⁄8 by 53⁄4 inches (2.9 by 14.6 cm) for a rectangular vent. (*2*) 1.75 by 1.75 inches (4.5 by 4.5 cm) for a square vent. (*3*) 2.0-inch (5.1-cm) diameter for a round vent. Require use of at least 2" mesh for

				the entire back panel of pots; effective 10/23/06. Commercial ACL (309,000 lbs gw) & AM; overage deducted from next fishing year.

Table 2.6.2. Annual Recreational Black Sea Bass Regulatory Summary

Year	Fishing Year	Size Limit	Bag Limit
8/31/82	Calendar Year	8 in TL	None
1983	Calendar Year	8 in TL	None
1984	Calendar Year	8 in TL	None
1985	Calendar Year	8 in TL	None
1986	Calendar Year	8 in TL	None
1987	Calendar Year	8 in TL	None
1988	Calendar Year	8 in TL	None
1989	Calendar Year	8 in TL	None
1990	Calendar Year	8 in TL	None
1991	Calendar Year	8 in TL	None
1992	Calendar Year	8 in TL	None
1993	Calendar Year	8 in TL	None
1994	Calendar Year	8 in TL	None
1995	Calendar Year	8 in TL	None
1996	Calendar Year	8 in TL	None
1997	Calendar Year	8 in TL	None
1998	Calendar Year	8 in TL	None
1999	Calendar Year	10 in TL	20 fish per person per day
2000	Calendar Year	10 in TL	20 fish per person per day
2001	Calendar Year	10 in TL	20 fish per person per day
2002	Calendar Year	10 in TL	20 fish per person per day
2003	Calendar Year	10 in TL	20 fish per person per day
2004	Calendar Year	10 in TL	20 fish per person per day
2005	Calendar Year	10 in TL	20 fish per person per day
2006	Calendar Year	10 in TL	20 fish per person per day
2006/2007 (effective 10/23/06)	June 1 – May 31 Fishing Year	11 in TL	15 fish per person per day Recreational allocation of 633,000 lbs gw (746,000 lbs ww)
2007/2008	June 1 – May 31 Fishing Year	12 in TL	15 fish per person per day Recreational allocation of 560,000 lbs gw (661,000 lbs ww)
2008/2009	June 1 – May 31 Fishing Year	12 in TL	15 fish per person per day Recreational allocation of 409,000 lbs gw (483,000 lbs ww) Prohibit sale of bag limit caught BSB; effective 12/16/09.
2009/2010	June 1 – May 31 Fishing Year	12 in TL	15 fish per person per day Recreational allocation of 409,000 lbs gw (483,000 lbs ww) Prohibit sale of bag limit caught BSB.
2010/2011	June 1 – May 31 Fishing Year	12 in TL	15 fish per person per day Recreational ACL of 409,000 lbs gw (483,000 lbs ww) Prohibit sale of bag limit caught BSB. Recreational AM to close fishery if ACL is met (if overfished), and deduct overage from following fishing year

2.6. Closures Due to Meeting Commercial Quota or Commercial/Recreational ACL

Commercial:

- 2008/2009 – Commercial closure, May 15, 2009 through May 31, 2009.
- 2009/2010 – Commercial closure, December 9, 2009 through May 31, 2010.
- 2010/2011 – Commercial closure October 7, 2010. Because projected landings estimated the quota would be met by that time. However, it was later determined to not have been met. Therefore, the commercial sector for black sea bass in federal waters was reopened December 1, 2010, through December 15, 2010. The fishery is closed from December 16, 2010 through May 31, 2011. The overage will be deducted from the 2011/2012 fishing year.

Recreational

- 2010/2011 – Recreational closure February 12, 2011 through May 31, 2011. The overage will be deducted from the 2011/2012 fishing year.

Table 7. State Regulatory History

South Carolina:
Black Sea Bass state regulations, Sec. 50-5-2730 of the SC Code states:
'Unless otherwise provided by law, any regulations promulgated by the federal government under the Fishery Conservation and Management Act (PL94-265) or the Atlantic Tuna Conservation Act (PL 94-70) which establishes seasons, fishing periods, gear restrictions, sales restrictions, or bag, catch, size, or possession limits on fish are declared to be the law of this State and apply statewide including in state waters." As such, SC black sea bass regulations are pulled directly from the federal regulations as promulgated under Magnuson. There was a time (prior to a minimum size on Black Sea Bass) where there was a code section in the SC Code of Laws that established a 10" minimum size, and this dates to the mid-1990s. Recall that federal minimum size for the recreational fishery went to 10" (which mirrored the SC regulation) for a while. I believe S-G Amendment 13C stepped the minimum size for the recreational fishery, first to 11" for a year and then to 12". Upon 13C taking effect, we asked the SC General Assembly to repeal the code section that contained the 10" minimum size for black sea bass, which they did several years ago.

Georgia:
Georgia began regulating Black Sea Bass in 1989.

Georgia General Assembly - O.C.G.A. 27-4-130.1 became effective April 18, 1989. It set the parameters around which the Board of Natural Resources could manage Black Sea Bass. those parameters were:
No Closed Season - No Limit on max Daily Creel - 8-15 inches minimum size

GA Board of Natural Resources then adopted Rule 391-2-4-.04 Saltwater Finfishing which became effective on. Sept. 13, 1989 - The original rule stated - No Closed Season - No Creel Limit - 8 inch minimum size

Since then, the following has been amended:
Effective Nov. 17, 1999 - 20 fish creel limit - 10 inch minimum size limit Effective Dec. 8, 2006 - 15 fish creel limit - 11 inches minimum size limit Effective July 1, 2007 - 12 inch minimum size

Commercial limits follow federal permit restrictions.

Florida:
Summary of Florida Black Sea Bass Regulations History

Year	Size Limit	Possession Limit	Other Regulation Changes
1985	8 in TL	None	
1986	8 in TL	None	
1987	8 in TL	None	
1988	8 in TL	None	
1989	8 in TL	None	
1990	8 in TL	None	All commercial harvest of any species of snapper, grouper, and sea bass is prohibited in state waters whenever harvest of that species is prohibited in adjacent federal waters
1991	8 in TL	None	
1992	8 in TL	None	
1993	8 in TL	None	
1994	8 in TL	None	
1995	8 in TL	None	Established degradability requirements for black sea bass traps
1996	8 in TL	None	
1997	8 in TL	None	
1998	10 in TL	20 fish daily recreational aggregate bag limit on black sea bass in Atlantic state waters only	Required escape vents on sea bass pots statewide; black sea bass designated as a "restricted species;" landing in whole condition required
1999	10 in TL	20 fish daily recreational aggregate bag limit on black sea bass in Atlantic state waters only	Allows the use on black sea bass traps of trap lid tie-down straps secured at one end by a loop composed of non-coated steel wire measuring 24 gauge or thinner, 2 X 3/8 inch non-treated pine dowels or squares to replace the hook on tie-down straps, a 3 X 6 inch panel attached to the trap opening with 24 gauge or less wire or single strand jute ▪ Prohibits the use of a 24 gauge hook or tie-down strap on black sea bass traps

2000	10 in TL	20 fish daily recreational aggregate bag limit on black sea bass in Atlantic state waters only	
2001	10 in TL	20 fish daily recreational aggregate bag limit on black sea bass in Atlantic state waters only	Withdraws federal permit requirements for the commercial harvest of sea basses in the Gulf of Mexico
2002	10 in TL	20 fish daily recreational aggregate bag limit on black sea bass in Atlantic state waters only	
2003	10 in TL	20 fish daily recreational aggregate bag limit on black sea bass in Atlantic state waters only	
2004	10 in TL	20 fish daily recreational aggregate bag limit on black sea bass in Atlantic state waters only	Establishes a September 20 through October 4 closure to use of black sea bass traps in all Gulf of Mexico state waters between three and nine miles from shore
2005	10 in TL	20 fish daily recreational aggregate bag limit on black sea bass in Atlantic state waters only	▪ Requires each trap used for harvesting black sea bass to have the trap owner's Saltwater Products License (SPL) number permanently attached ▪ Each buoy attached to these traps shall have the letter "B" and the owner's SPL number affixed to it in legible figures at least 1.5 inches high ▪ Requires a buoy or time-release buoy must be attached to each black sea bass trap or at each end of a weighted trap trotline. The buoy must be constructed of Styrofoam, cork, molded polyvinyl chloride, or molded polystyrene, be of sufficient strength and buoyancy to float, and be either white in color or the same color as the owner's blue crab or stone crab buoy colors. These buoys must be either spherical in shape with a diameter no smaller than six inches, or some other shape that is no shorter than 10 inches in the longest dimension and the width at some point exceeds five inches

2006	10 in TL	20 fish daily recreational aggregate bag limit on black sea bass in Atlantic state waters only	
2007	11 inches TL for the Atlantic; 10 inches TL Gulf	15 fish daily recreational bag limit in Atlantic state waters only	▪ Establishes a June 1 - May 31 harvest season; Requires a minimum 2-inch mesh for the back panel of black sea bass traps in the Atlantic, and requires removal of black sea bass traps in the Atlantic when the commercial quota is reached
2008	12 inches TL for the Atlantic; 10 inches TL Gulf	15 fish daily recreational bag limit in Atlantic state waters only	Allows the use of black sea bass traps to 8 cubic feet in volume
2009	12 inches TL for the Atlantic; 10 inches TL Gulf	15 fish daily recreational bag limit in Atlantic state waters only	
2010	12 inches TL for the Atlantic; 10 inches TL Gulf	15 fish daily recreational bag limit in Atlantic state waters only	

Florida Black Sea Bass Regulation Changes by Year

REEF FISH (formerly SNAPPER, GROUPER, AND SEA BASS), CH 46-14, F.A.C. (Effective July 29, 1985)

Minimum size limits:

- Black and southern sea bass - 8 inches

REEF FISH - BLACK SEA BASS TRAPS, CH 46-14, F.A.C. (Effective October 4, 1995)

Establishes degradability requirements for black sea bass traps. Such traps are considered to have a legal degradable panel if:

- The trap lid tie-down strap is secured to the trap by a single loop of untreated Jute twine, and the trap lid is secured so that when the jute degrades, the lid will no longer be securely closed, or
- The trap lid tie-down strap is secured to one end with a corrodible hook composed of non-coated steel wire measuring 24 gauge or thinner, and the trap lid is secured so that when the hook degrades, the lid will no longer be securely closed, or
- The trap contains at least one sidewall with a vertical rectangular opening no smaller in either dimension than 6 inches high and 3 inches wide, and the opening is laced, sewn, or otherwise obstructed by a single length of untreated jute twine knotted only at each end and not tied or looped more than once around a single mesh bar; the opening in the sidewall of the trap must no longer be obstructed when the jute degrades, or

- The trap contains at least one sidewall with a vertical rectangular opening no smaller in either dimension than 6 inches high by 3 inches wide, and the opening must be obstructed with an untreated pine slat or slats no thicker than 3/8 inch; the opening in the sidewall of the trap must no longer be obstructed when the slat degrades, or
- The trap contains at least one sidewall with a vertical rectangular opening no smaller in either dimension than 6 inches high by 3 inches wide, and the opening must be laced, sewn, or otherwise obstructed by non-coated steel wire measuring 24 gauge or thinner or be obstructed with a panel of ferrous single-dipped galvanized wire mesh made of 24 gauge or thinner wire

REEF FISH, CH 46-14, F.A.C. (Effective December 31, 1998)

- Increases the minimum size limit on black sea bass from 8 to 10 inches total length statewide, establishes a 20 fish daily recreational aggregate bag limit on black sea bass in Atlantic state waters only, and requires escape vents on sea bass pots statewide
- Requires that all reef fish species managed in Florida be landed in a whole condition, and designate all such species as "restricted species"

REEF FISH - BLACK SEA BASS TRAP SPECIFICATIONS, CH 46-14, F.A.C. (Effective June 1, 1999)

- Allows the use on black sea bass traps of trap lid tie-down straps secured at one end by a loop composed of non-coated steel wire measuring 24 gauge or thinner, 2 X 3/8 inch non-treated pine dowels or squares to replace the hook on tie-down straps, a 3 X 6 inch panel attached to the trap opening with 24 gauge or less wire or single strand jute
- Prohibits the use of a 24 gauge hook or tie-down strap on black sea bass traps

REEF FISH - SEA BASSES & RED PORGY, CH 68B-14, F.A.C. (Effective June 1, 2001)

- Withdraws federal permit requirements for the commercial harvest of sea basses and red porgy in the Gulf of Mexico.

REEF FISH - BLACK SEA BASS TRAPS, CH 68B-14, F.A.C. (Effective July 15, 2004)

- Establishes a September 20 through October 4 closure to use of black sea bass traps in all Gulf of Mexico state waters between three and nine miles from shore.

REEF FISH - BLACK SEA BASS TRAPS, CH 68B-14, F.A.C. (Effective July 17, 2005)

- Requires each trap used for harvesting black sea bass to have the trap owner's Saltwater Products License (SPL) number permanently attached
- Each buoy attached to these traps shall have the letter "B" and the owner's SPL number affixed to it in legible figures at least 1.5 inches high
- Requires a buoy or time-release buoy must be attached to each black sea bass trap or at each end of a weighted trap trotline. The buoy must be constructed of Styrofoam, cork, molded polyvinyl chloride, or molded polystyrene, be of sufficient strength and buoyancy to float, and be either white in color or the same color as the owner's blue crab or stone crab buoy colors. These buoys must be either spherical in shape with a diameter no smaller than six inches, or some other shape that is no shorter than 10 inches in the longest dimension and the width at some point exceeds five inches

REEF FISH, CH 68B-14, F.A.C. (Effective July 1, 2007)

- Increases the recreational minimum size limit for Atlantic black sea bass from 10 inches total length to 11 inches total length in 2007, and then to 12 inches total length in 2008, and establishes a June 1 - May 31 harvest season

- Requires a minimum 2-inch mesh for the back panel of black sea bass traps in the Atlantic, and requires removal of black sea bass traps in the Atlantic when the commercial quota is reached

REEF FISH - BLACK SEA BASS TRAPS, CH 68B-14, F.A.C. (Effective March 12, 2008)

- Allows the use of black sea bass traps to 8 cubic feet in volume.

References

None provided.

3. Assessment History & Review

Prior to the inception of SEDAR, this stock of black sea bass was assessed using tuned VPA models (FADAPT). With data through 1990, Vaughan et al. (1995) concluded that overfishing was occurring during the 1980s. Subsequently, with data through 1995, Vaughan et al. (1996) estimated that the rate of overfishing had increased during the 1990s.

This stock was first assessed through the SEDAR process in 2002 (SEDAR-02). The 2002 assessment applied a statistical catch-age formulation as the primary model. It estimated that the rate of overfishing had increased through the 1990s and that the stock was overfished. That assessment was updated in 2005 with data through 2003 (SEDAR Update Process #1). The update assessment estimated that the rate of overfishing continued to increase into the 2000s and that the stock remained overfished.

Several notable improvements in data content have occurred since the 2005 update assessment. Recent studies on black sea bass have provided information on fecundity, as well as total discards and discard mortality rates. Many otoliths have been processed, shedding light on the age compositions of landings and surveys. Natural mortality has been reexamined and revised such that estimates are larger than previously thought and are age-dependent. These improvements were expected to provide SEDAR-25 with the most informative assessment data to date.

Vaughan, DS, MR Collins, and DJ Schmidt. 1995. Population characteristics of the black sea bass *Centropristis striata* from the southeastern U.S. Bulletin of Marine Science 56:250−267.

Vaughan, DS. 1996. Population characteristics of the black sea bass *Centropristis striata* from the U.S. southern Atlantic coast. Report to South Atlantic Fishery Management Council, Charleston, SC, 59 p.

4. Regional Maps

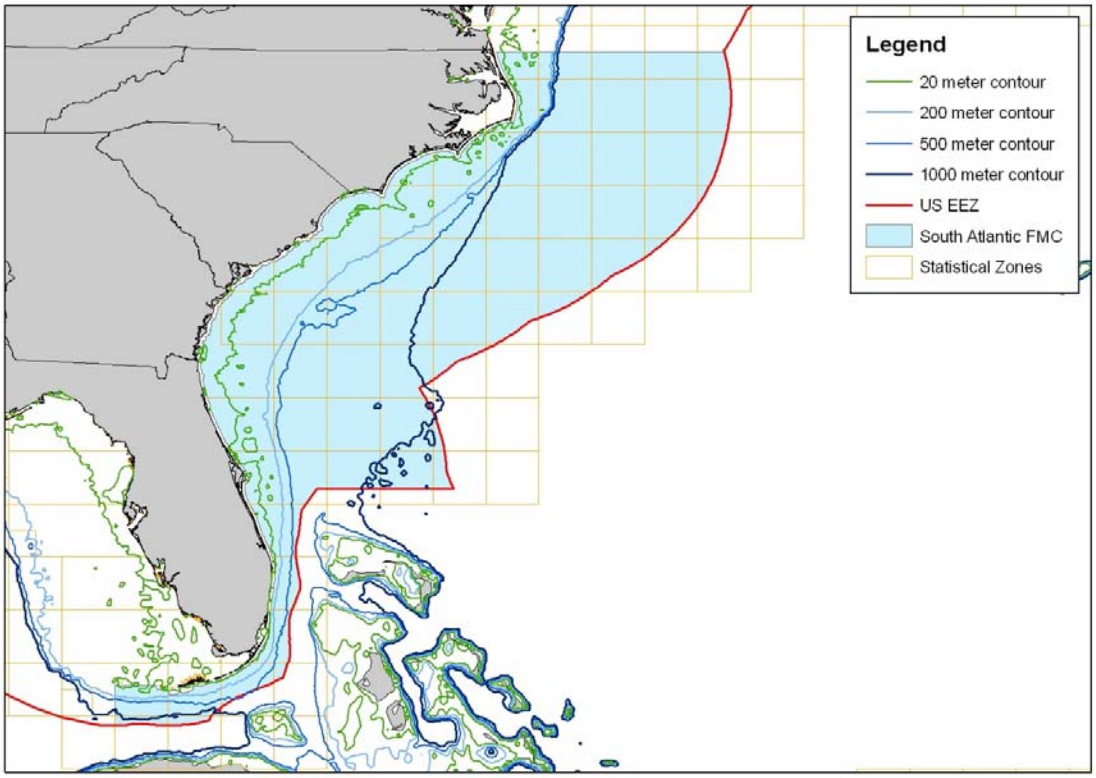

Figure 4.1 South Atlantic Fishery Management Council and EEZ boundaries.

5. Assessment Summary Report

The Summary Report provides a broad but concise view of the salient aspects of the 2011 black sea bass stock assessment (SEDAR 25). 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.

Stock Status and Determination Criteria

Point estimates from the base model indicate that the U.S. southeast stock of black sea bass (*Centropristis striata*) is undergoing overfishing. The stock is under a rebuilding plan and is not yet fully rebuilt.

Estimated time series of stock status (SSB/MSST and SSB/SSB_{MSY}) showed general decline until the mid-1990s and some increase since (Figure 5.8, Table 5.3). The increase in stock status appears to have been initiated by a strong year class in 1994 and perhaps reinforced later by additional recruitment pulses and by management regulations. Base-run estimates of spawning biomass have remained near MSST and below SSB_{MSY} since the early 1990s. Current stock status was estimated in the base run to be $SSB_{2010}/MSST = 1.13$ and $SSB_{2010}/SSB_{MSY} = 0.70$ (Table 5.1), indicating that the stock is not overfished but is also not fully rebuilt. Uncertainty from the MCB analysis suggested that the estimate of SSB relative to SSB_{MSY} is robust, but that the status relative to MSST is less certain. Age structure estimated by the base run showed fewer older fish in the last decade than the (equilibrium) age structure expected at MSY, however with improvement in the terminal year (2010), particularly for ages younger than six.

The estimated time series of F/F_{MSY} suggests that overfishing has been occurring throughout most of the assessment period (Table 5.3), but with much uncertainty demonstrated by the MCB analysis. Current fishery status in the terminal year, with current F represented by the geometric mean from 2009–2010, was estimated by the base run to be $F_{2009–2010}/F_{MSY} = 1.07$ (Table 5.1), but again with much uncertainty in that estimate.

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. Estimates of yield do not include discards. 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) is measured as population fecundity.

Criteria	Recommended Values from SEDAR 25	
	Definition	Value
M (Instantaneous natural mortality; per year)	Average of Lorenzen M (if used)	0.38
$F_{current}$ (per year)	Geometric mean of the apical fishing mortality rates in 2009 – 2010 ($F_{2009-2010}$)	0.747
F_{MSY} (per year)	F_{MSY}	0.698
B_{MSY} (metric tons)	Biomass at MSY	5399
SSB_{2010} (1E10 eggs)	Spawning stock biomass in 2010	173
SSB_{MSY} (1E10 eggs)	SSB_{MSY}	248
MSST (1E10 eggs)	(1-M)*SSB_{MSY}	154
MFMT (per year)	F_{MSY}	0.698
MSY (1000 pounds)	Yield at MSY	1767
OY (1000 pounds)	Yield at F_{OY}	OY (65% F_{MSY})= 1720 OY (75% F_{MSY})= 1746 OY (85% F_{MSY})= 1760
F_{OY} (per year)	F_{OY} = 65%,75%, 85% F_{MSY}	65% F_{MSY}= 0.454 75% F_{MSY}= 0.524 85% F_{MSY}= 0.593
Biomass Status	SSB_{2010}/MSST	1.13
SSB_{2010}/SSB_{msy}		0.70
Exploitation Status	$F_{2009-2010}/F_{MSY}$	1.07

Stock Identification and Management Unit

The current stock definition for the South Atlantic region is south of Cape Hatteras, NC through the east coast of Florida. SEDAR 2, the update to SEDAR 2, and SEDAR 25 used the current SAFMC management unit of black sea bass for consideration in the assessment input data. A recent genetic study of black sea bass off the U.S. east coast supports the separation of a Mid-Atlantic and South Atlantic stocks (SEDAR25- RD42). Preliminary analyses based on otolith microchemistry support this separation as well. Tagging studies also suggest minimal movement of adult black sea bass in the South Atlantic region.

Species Distribution

The black sea bass occurs along the U.S. coast from Cape Cod, Massachusetts, to Cape Canaveral, Florida and in the Gulf of Mexico. The Gulf of Mexico black sea bass are considered a separate subspecies and thus, managed as its own stock. The black sea bass off the east coast of the U.S. has been managed as two separate stocks – Mid-Atlantic and South Atlantic. The stocks have been split at the Cape Hatteras, NC break.

Stock Life History

- Black sea bass are protogynous hermaphrodites (i.e., change sex from female to male).
- Based on the occurrence of hydrated oocytes and/or postovulatory follicles, spawning along the Atlantic coast of the southeastern US occurs in all months of the year except October, though peak spawning appears to occur in the spring from February to May (Figure 7 of DW report, Section 2). The number of annual spawning events per mature female was estimated to be 31 (Danson 2009).
- The assessment used population fecundity as its measure of reproductive potential. To model batch fecundity per female, the DW panel recommended using the relationship between batch fecundity and body weight that was estimated from UNCW and MARMAP data (Figure 11 of the DW report, Section 2).
- The SEDAR 25 data workshop panel recommended using an age-variable M estimated using the Lorenzen method (Lorenzen 2005) assuming a base M = 0.38 calculated from Hoenig (1983).
- The life history workgroup recommended using the von Bertalanffy growth model for size at age. When all data from fishery-independent and fishery-dependent sources were combined, the resulting von Bertalanffy growth curve was

$$TL = 495.9*(1- e^{-0.177*(t+0.92)}).$$

Assessment Methods

Following the Terms of Reference, two models of black sea bass were discussed during the Assessment Workshop (AW): the Beaufort assessment model (BAM) and a surplus-production model (ASPIC). The BAM was selected at the AW to be the primary assessment model.

The primary model in this assessment was the Beaufort assessment model (BAM), which applies a statistical catch-age formulation. The model was implemented with the AD Model Builder software (ADMB Project 2011), and its structure and equations are detailed in SEDAR25-RW03. In essence, the model simulates a population forward in time while including fishing processes (Quinn and Deriso 1999; Shertzer et al. 2008*a*). 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 (Prager 2005), was also used to estimate stock status of black sea bass off the southeastern U.S. While primary assessment of the stock was performed via the age-structured BAM, 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 included data from fishery independent surveys and from five fleets that caught black sea bass in southeast U.S. waters: commercial lines (primarily handlines), commercial pots, commercial trawls, recreational headboats, and general recreational boats. The model was fitted to data on annual landings (in units of 1000 lb whole weight), annual discard mortalities (in units of 1000 fish), annual length compositions of landings, annual age compositions of landings, annual length compositions of discards, two fishery independent indices of abundance (MARMAP blackfish/snapper traps and chevron traps), and three fishery dependent indices (commercial lines, headboat, and headboat discards). Not all of the above data sources were available for all fleets in all years. Data used in the model are tabulated in the DW report and in Section III part 2 of the stock assessment report.

The general recreational fleet was sampled by the Marine Recreational Fishing Statistical Survey (MRFSS) starting in 1981. That sampling program is undergoing modifications, including a change of name to Marine Recreational Information Program (MRIP). In this report, acronyms MRFSS and MRIP are used synonymously to refer to sampling of the general recreational fleet. However, the sampling and estimation methodology for this assessment is that of MRFSS.

Release Mortality

Discards were assumed to have gear-specific mortality probabilities, as suggested by the DW (lines, 0.07; pots with 1.5-inch panels, 0.05; and pots with 2-inch panels, 0.01). Annual discard mortalities, as fitted by the model, were computed by multiplying total discards (tabulated in the DW report) by the gear-specific release mortality probability.

For the commercial fleets, discards from handline and pot gears were combined, and were modeled starting in 1984 with implementation of the 8-inch size limit. Commercial discards prior to 1984 were considered negligible and not modeled. Data on commercial discards were available from the DW starting in 1993. Thus for years 1984–1992, commercial discards were predicted in the assessment model (but not fitted to data), by applying the geometric mean commercial discard F from the years 1993–1998 (the 10-inch limit began in 1999).

For headboat and general recreational fleets, discard time series were assumed to begin in 1978, as observations from MRFSS indicated the occurrence of recreational discards prior to implementation of the 8-inch size limit. Headboat discard estimates were separated from MRFSS beginning in 1986, and were combined for 1978–1985. Because MRFSS began in 1981, the 1978–1980 general recreational (plus headboat) discards were predicted in the assessment model (but not fitted to data), by applying the geometric mean recreational discard F from the years 1981–1983.

For fishery discard length composition data collected under a size limit regulation, the normal distribution of size at age was truncated at the size limit, such that length compositions of discards would include only fish of sublegal size. Mean length at age of discards were computed from these truncated distributions, and thus average weight at age of discards would differ from those in the population at large. Commercial discards in 2009–2010 included a portion of fish that were of legal size as a result of the closed seasons.

Landings Trends

See Figure 5.1 panels *a-e* for detail on landings trends. Commercial line landings peaked in early 1990s then generally declined. Commercial pot landings peaked in the early 1980s and have since remained relatively stable through 2010. Commercial trawl landings were low relative to other gears and variable but generally declining until trawling was banned in 1989. Headboat landings peaked in the early 1980s, declined until the mid-1990s and since have been relatively low but variable. General recreational landings were highly variable in the 1980s, peaked in the late 1980s, and had lower variability 1990-2010.

Fishing Mortality Trends

The estimated fishing mortality rates (F) increased through the mid-1990s, and since then have been quite variable (Figure 5.3, Table 5.3). The general recreational fleet has been the largest contributor to total F (Figure 5.3).

Stock Abundance and Biomass Trends

In general, estimated abundance at age showed truncation of the older ages through the mid-1990s, and more stable or increasing values since (Table 5.4*a*). Total estimated abundance at the end of the assessment period showed some general increase from a low in 2004. Annual number of recruits is shown in Table 5.4*a* (age-0 column). In the most recent decade, a notably strong year class (age-0 fish) was predicted to have occurred in 2001 and better than expected recruitment (i.e., positive residuals) in 2006 and 2007.

Estimated biomass at age followed a similar pattern as abundance at age (Table 5.4*b*). Total biomass and spawning biomass showed similar trends—general decline from early 1980s until the mid-1990s, and general but gradual increase since.

Projections

By design, projections based on F_{rebuild} predicted the stock to rebuild in 2016 with probability of 0.5 (Figures 5.9*a-c*). Lower levels of landings in 2011 allowed for higher levels of F_{rebuild} in subsequent years.

Projections based on the current quota (847,000 lb) predicted the stock to rebuild with probability that exceeded 0.5 (Figures 5.9*d-f*).

Again by design, projections based on L_{rebuild} predicted the stock to rebuild in 2016 with probability of 0.5 (Figures 5.9*g-i*). Lower levels of landings in 2011 allowed for higher levels of L_{rebuild} in subsequent years.

Scientific Uncertainty

Sensitivity runs, described in Section III, part 3.1.1.3, may be useful for evaluating implications of assumptions in the base assessment model, and for interpreting MCB results in terms of expected effects from input parameters. Time series of F/F_{MSY} and SSB/SSB_{MSY} are plotted in the assessment report figures (Section III Figures 3.42-3.47) to demonstrate sensitivity to natural mortality, steepness, model component weights, catchability, continuity assumptions, and the headboat index. The qualitative results on terminal stock status were the same across all sensitivity runs, indicating that the stock is not yet rebuilt ($SSB < SSB_{MSY}$). Most of these runs, but not all, suggested that overfishing is still occurring. In concert, sensitivity analyses were in general agreement with those of the MCB analysis.

Retrospective analyses did not suggest any patterns of substantial over- or underestimation in terminal-year estimates.

Of the sensitivity runs conducted with the BAM, results were least sensitive to the increase in catchability and to the headboat index. They were most sensitive to natural mortality, steepness, and model component weights. Sensitivity to natural mortality and steepness is common in stock assessment. Sensitivity to model component weights occurred here primarily because the alternative weighting schemes gave lower priority to the indices (relative to other data sources) than did the base run. This led to quite different estimates of spawner-recruit parameters (lower steepness, higher *R*0), which in turn led to different estimates of benchmarks. The AW increased the base-run weighting on indices, noting that the strong positive correlations between indices suggested they were tracking the same underlying signal (abundance). This approach was consistent with the principle that indices should be given top priority because they provide direct information about abundance, the stock assessment output of primary interest (Francis 2011).

The continuity run resulted in higher *F* /*F*MSY and lower SSB/SSBMSY than did the base run. These differences in the continuity run occurred for two main reasons: the lower and age-invariant natural mortality rate ($M = 0.3$) and the different measure of spawning biomass (mature biomass rather than fecundity). Model runs with either of these features resulted in status indicators much more similar to the continuity run than to the base run (results not shown).

Significant Assessment Modifications

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

Sources of Information

The contents of this summary report were taken from the data, assessment, and review reports.

Tables

List of tables

- Table 5.4: Stock abundance, biomass, and recruitment

Table 5.2a: Black sea bass landings (1000 lb whole weight) as input into the BAM. Pots includes other and trawl landings post-1990 due to low landings. Horizontal dashed line indicates first year of the assessment model. *(Extracted from Table 9 of the Assessment Report.)*

	GEAR				
	Commercial			Recreational	
Year	Handlines	Pots	Trawl	Headboat	MRFSS
1950	305.0	0.1	0.3		
1951	217.0	0.0	1.5		
1952	158.0	0.1	1.0		
1953	113.3	1.1			
1954	70.8	0.9			
1955	38.9	3.1	0.3		
1956	62.2	5.2	2.6		
1957	59.5	8.9	1.1		
1958	61.8	8.4	1.0		
1959	87.9	9.8	1.4		
1960	95.2	37.4	1.8		
1961	120.9	510.3	38.4		
1962	85.9	518.9	28.3		
1963	126.2	393.8	17.5		
1964	88.4	463.7	18.9		
1965	90.3	467.4	22.5		
1966	78.6	711.9	21.3		
1967	69.3	1361.1	22.8		
1968	97.1	723.6	19.7		
1969	64.4	1275.7	16.0		
1970	51.0	1511.8	12.8		
1971	72.0	1045.4	8.1		
1972	93.8	1145.2	3.6		
1973	58.8	872.2	4.0		
1974	102.5	1292.5	4.5		
1975	93.1	799.4	14.9	965.1	
1976	72.3	367.8	16.2	612.3	
1977	62.4	284.3	42.7	614.8	
1978	118.7	134.4	31.8	532.2	
1979	140.5	676.7	27.3	571.2	
1980	107.9	888.2	25.4	617.8	
1981	163.8	1028.2	32.2	678.3	462.1
1982	150.9	788.2	20.6	701.4	1725.6
1983	145.7	484.3	8.5	690.3	671.9
1984	194.5	410.4	17.8	661.1	1805.9
1985	164.1	395.8	23.8	568.1	1080.9

1986	163.3	502.5	22.3	536.8	541.5
1987	149.3	403.4	7.5	616.5	1037.1
1988	236.6	513.7	21.2	635.2	2890.6
1989	248.5	517.7	13.5	478.0	1269.6
1990	258.7	684.6	13.6	379.6	602.2
1991	267.2	616.6		286.2	841.8
1992	226.6	546.3		215.9	723.0
1993	188.9	508.0		143.0	611.6
1994	213.9	531.0		132.4	625.7
1995	141.5	413.3		127.6	721.3
1996	128.0	511.8		146.5	718.4
1997	162.3	541.0		147.7	577.5
1998	221.1	450.8		142.5	393.6
1999	187.5	501.3		192.6	312.5
2000	92.8	407.6		144.6	287.1
2001	88.7	492.7		172.0	567.5
2002	98.0	419.8		123.3	312.6
2003	91.6	484.2		134.1	415.0
2004	107.1	626.4*		237.6	1026.7
2005	66.9	384.4		179.7	626.4
2006	62.2	483.3*		174.1	624.3
2007	54.9	351.9*		162.1	560.6
2008	57.6	360.0		99.3	398.4
2009	87.7	564.6		163.2	277.3
2010	64.4	408.3		289.2	526.8

*Pots and other combined, excluding trawl due to confidentiality

Table 5.2b: Black sea bass discards (1000 fish) as input into the BAM. *(Extracted from Table 10 of the Assessment Report.)*

	Recreational		Commercial
Year	Headboat	MRFSS	Handline/Pots *
1981**		1126.0**	
1982**		1008.8**	
1983**		418.9**	
1984**		1039.7**	
1985**		1021.9**	
1986	256.4	832.5	
1987	290.3	1200.7	
1988	96.5	1027.2	
1989	70.3	933.5	
1990	4.9	505.9	
1991	160	829.8	
1992	63.1	850.1	
1993	27.2	775.6	153.9
1994	81.8	1347.8	216.5
1995	56.6	931.2	187.7
1996	68.3	782.6	207.8
1997	63.5	1120.7	189.2
1998	46.3	825	191.4
1999	105.5	1190	176.7
2000	94.2	1672.6	132.2
2001	108.9	1809.1	160.6
2002	75.9	1235.5	68.9
2003	68.6	1397.7	170.8
2004	105.4	2688	118.2
2005	125.8	2147.2	185.5
2006	123.2	2549	242.6
2007	109	3224.8	64.5
2008	69.9	2382.4	67.1
2009	104.1	2096.9	119.2***
2010	165.1	2888.1	56.7***

* Commercial gears combined due to confidentiality
** Combination of headboat and MRFSS
*** Combined discards from open and closed seasons

Table 5.3: Estimated time series and status indicators. Fishing mortality rate is apical *F*, which includes discard mortalities. Total biomass (*B*, mt) is at the start of the year, and spawning biomass (SSB, population fecundity, 1E10 eggs) at the time of peak spawning (end of March). The MSST is defined by MSST = (1 − M)SSB_{MSY}, with constant M = 0.38. SPR is static spawning potential ratio. *(Extracted from Table 3.4 of the Assessment Report.)*

year	F	F/Fmsy	B	SSB	SSB/SSBmsy	SSB/msst	SPR
1978	0.291	0.417	6133	249	1.004	1.619	0.699
1979	0.411	0.589	7035	273	1.103	1.779	0.623
1980	0.447	0.640	7705	325	1.311	2.114	0.601
1981	0.406	0.582	7439	367	1.480	2.388	0.628
1982	0.538	0.771	7884	327	1.321	2.131	0.569
1983	0.352	0.504	6978	337	1.363	2.198	0.660
1984	0.615	0.881	6556	313	1.265	2.040	0.579
1985	0.454	0.651	6343	254	1.025	1.654	0.635
1986	0.400	0.573	6533	281	1.134	1.829	0.651
1987	0.505	0.724	6877	311	1.256	2.026	0.614
1988	1.049	1.502	6474	294	1.186	1.913	0.485
1989	0.772	1.106	5053	228	0.919	1.482	0.543
1990	0.654	0.937	4279	202	0.815	1.315	0.570
1991	0.802	1.149	3834	171	0.689	1.111	0.531
1992	0.858	1.229	3176	144	0.582	0.938	0.519
1993	0.892	1.278	2868	118	0.478	0.771	0.511
1994	1.182	1.693	3119	112	0.451	0.727	0.463
1995	1.375	1.970	3279	137	0.553	0.893	0.446
1996	1.180	1.690	3299	152	0.615	0.992	0.478
1997	0.903	1.294	3173	146	0.591	0.954	0.520
1998	0.727	1.042	3055	138	0.557	0.898	0.565
1999	1.046	1.499	2925	136	0.550	0.887	0.591
2000	0.765	1.097	2994	132	0.533	0.859	0.626
2001	1.042	1.492	3480	138	0.559	0.901	0.574
2002	0.857	1.228	3531	166	0.671	1.081	0.613
2003	0.764	1.094	3803	181	0.729	1.176	0.630
2004	1.100	1.576	3752	177	0.713	1.151	0.567
2005	0.833	1.193	3268	151	0.608	0.980	0.604
2006	0.896	1.284	3259	140	0.564	0.910	0.587
2007	1.091	1.562	3282	141	0.570	0.919	0.589
2008	0.839	1.201	3395	157	0.634	1.022	0.630
2009	0.733	1.050	3608	170	0.688	1.110	0.648
2010	0.762	1.091	3796	173	0.700	1.129	0.643

Table 5.4a: Estimated total abundance at age (1000 fish) at start of year. Age-0 estimated abundance is estimated recruitment. *(Extracted from Table 3.2 of the Assessment Report.)*

Year	0	1	2	3	4	5	6	7	8	9	10	11	Total
1978	52118.70	11789.83	7155.89	3226.75	1682.90	923.20	502.19	278.51	157.04	89.35	51.29	70.28	78045.92
1979	66710.04	20555.53	6150.31	3742.69	1602.61	856.55	481.71	267.25	151.21	86.11	49.49	68.01	100721.51
1980	59977.59	26303.38	10647.18	2991.77	1664.90	724.56	396.42	227.36	128.68	73.54	42.30	58.30	103235.99
1981	24029.91	23646.59	13589.98	5043.82	1279.40	725.66	323.53	180.53	105.63	60.39	34.86	48.16	69068.46
1982	71886.14	9474.78	12244.13	6642.28	2279.51	582.53	337.41	153.39	87.32	51.60	29.80	41.38	103810.28
1983	24294.11	28339.95	4887.65	5611.88	2624.75	908.64	237.43	140.24	65.04	37.40	22.32	31.10	67200.52
1984	23994.64	9580.35	14735.72	2472.22	2648.02	1258.46	446.00	118.85	71.62	33.55	19.48	28.11	55407.03
1985	63678.31	9458.28	4960.89	7220.79	949.18	982.22	475.20	171.69	46.68	28.41	13.44	19.26	88004.34
1986	47161.26	25106.86	4915.47	2544.86	3184.56	412.74	435.42	214.78	79.17	21.74	13.36	15.54	84105.75
1987	42653.83	18595.27	13042.49	2524.85	1165.80	1459.86	193.19	207.81	104.57	38.93	10.80	14.50	80011.90
1988	23633.00	16815.97	9649.38	6575.15	1061.44	481.71	614.93	82.97	91.05	46.28	17.40	11.42	59080.69
1989	31480.77	9309.95	8609.61	4147.47	1779.81	258.01	117.94	153.39	21.11	23.40	12.01	7.56	55921.05
1990	18582.69	12407.09	4799.68	4035.54	1456.80	571.34	83.29	38.78	51.46	7.15	8.01	6.77	42048.60
1991	22729.87	7324.76	6402.09	2290.42	1577.06	526.33	207.61	30.83	14.65	19.63	2.76	5.75	41131.75
1992	14591.36	8957.56	3763.75	2918.99	791.73	493.36	164.93	66.26	10.04	4.82	6.52	2.85	31772.17
1993	24508.07	5749.82	4593.16	1680.90	971.03	235.11	146.30	49.81	20.41	3.12	1.51	2.98	37962.22
1994	38660.23	9656.99	2943.81	2019.62	544.68	278.96	67.35	42.68	14.82	6.13	0.95	1.38	54237.58
1995	27230.56	15227.74	4897.41	1178.49	535.68	119.27	59.88	14.71	9.51	3.33	1.39	0.53	49278.51
1996	21273.57	10723.49	7715.44	1905.72	269.69	96.97	21.11	10.78	2.70	1.76	0.62	0.36	42022.22
1997	20961.55	8380.60	5472.26	3246.54	526.53	59.37	20.86	4.62	2.41	0.61	0.40	0.23	38675.97
1998	22529.50	8260.39	4299.18	2459.33	1092.63	151.13	16.83	6.02	1.36	0.72	0.18	0.19	38817.46
1999	16231.38	8880.71	4261.23	2054.67	956.84	372.27	51.07	5.79	2.11	0.48	0.26	0.14	32816.94
2000	26053.87	6403.63	4665.30	2412.81	716.75	254.91	92.33	12.78	1.48	0.54	0.13	0.10	40614.64
2001	36493.08	10278.83	3362.81	2654.21	947.66	239.74	83.20	30.58	4.32	0.50	0.19	0.08	54095.19
2002	21390.18	14397.02	5392.15	1876.61	851.28	240.23	59.33	20.90	7.83	1.12	0.13	0.07	44236.84
2003	25828.62	8439.04	7568.98	3078.78	700.07	261.56	71.61	17.93	6.44	2.44	0.35	0.06	45975.89
2004	16520.09	10190.19	4437.71	4341.97	1217.42	233.85	85.49	23.75	6.07	2.20	0.84	0.14	37059.72
2005	21274.54	6517.34	5343.59	2464.18	1347.02	291.38	54.61	20.26	5.74	1.48	0.54	0.25	37320.93
2006	25957.35	8393.14	3419.49	3006.37	896.15	411.43	88.64	16.90	6.40	1.83	0.48	0.26	42198.43
2007	26828.58	10240.34	4397.10	1900.06	1025.20	256.50	117.43	25.75	5.01	1.92	0.55	0.22	44798.66
2008	24121.93	10584.16	5365.46	2477.57	690.31	243.98	60.13	28.12	6.30	1.24	0.48	0.20	43579.89
2009	23465.98	9516.73	5558.77	3082.80	1026.17	211.56	73.67	18.50	8.84	2.00	0.40	0.22	42965.65
2010	26923.73	9258.04	5001.44	3209.07	1324.74	350.62	71.08	25.19	6.46	3.12	0.71	0.22	46174.43

Table 5.4b: Estimated biomass at age (1000 lb) at start of year. Age-0 estimated biomass is estimated recruitment biomass. *(Extracted from Table 3.3 of the Assessment Report.)*

Year	0	1	2	3	4	5	6	7	8	9	10	11	Total
1978	2618.0	2057.8	2601.9	1921.8	1429.5	1022.9	682.8	444.7	284.8	179.7	112.0	164.2	13520.1
1979	3351.0	3587.6	2236.1	2229.1	1361.1	949.1	655.0	426.6	274.3	173.1	108.0	159.0	15510.4
1980	3012.8	4590.7	3871.3	1781.8	1414.0	802.9	539.0	363.1	233.5	147.9	92.4	136.2	16985.5
1981	1207.0	4127.1	4941.2	3004.0	1086.7	804.0	439.8	288.1	191.6	121.5	76.1	112.7	16400.0
1982	3611.0	1653.7	4452.0	3956.0	1936.1	645.5	458.8	244.9	158.3	103.6	65.0	96.8	17381.7
1983	1220.3	4946.3	1777.1	3342.2	2229.3	1006.9	322.8	224.0	117.9	75.2	48.7	72.8	15383.4
1984	1205.3	1672.0	5357.9	1472.5	2249.2	1394.4	606.5	189.8	129.9	67.5	42.5	65.7	14453.1
1985	3198.7	1650.8	1803.8	4300.6	806.2	1088.4	646.2	274.0	84.7	57.1	29.3	45.0	13984.8
1986	2369.1	4381.9	1787.3	1515.7	2704.9	457.5	592.2	342.8	143.5	43.7	29.1	36.4	14403.7
1987	2142.7	3245.4	4742.1	1503.8	990.1	1617.8	262.8	331.8	189.6	78.3	23.6	34.0	15161.6
1988	1187.2	2934.8	3508.4	3916.1	901.5	533.7	836.2	132.5	165.1	93.0	37.9	26.7	14273.4
1989	1581.4	1624.8	3130.3	2470.1	1511.7	285.9	160.3	244.9	38.4	47.0	26.2	17.6	11138.9
1990	933.4	2165.4	1745.2	2403.5	1237.2	633.2	113.3	61.9	93.3	14.3	17.4	15.9	9434.0
1991	1141.8	1278.5	2327.9	1364.0	1339.5	583.1	282.2	49.2	26.7	39.5	6.0	13.4	8451.9
1992	733.0	1563.3	1368.4	1738.6	672.4	546.7	224.2	105.8	18.3	9.7	14.3	6.6	7001.2
1993	1231.1	1003.5	1670.0	1001.1	824.7	260.6	198.9	79.6	37.0	6.2	3.3	7.1	6323.1
1994	1942.1	1685.4	1070.3	1202.8	462.5	309.1	91.5	68.1	26.9	12.3	2.0	3.3	6876.7
1995	1368.0	2657.7	1780.7	702.0	455.0	132.1	81.4	23.6	17.2	6.6	3.1	1.3	7228.5
1996	1068.6	1871.5	2805.4	1134.9	229.1	107.4	28.7	17.2	4.9	3.5	1.3	0.9	7273.5
1997	1052.9	1462.8	1989.7	1933.5	447.3	65.7	28.4	7.3	4.4	1.3	0.9	0.4	6994.6
1998	1131.6	1441.6	1563.1	1464.8	927.9	167.6	22.9	9.7	2.4	1.5	0.4	0.4	6734.0
1999	815.3	1549.8	1549.4	1223.8	812.6	412.5	69.4	9.3	3.7	0.9	0.7	0.2	6447.9
2000	1308.7	1117.5	1696.2	1437.0	608.7	282.4	125.4	20.5	2.6	1.1	0.2	0.2	6601.1
2001	1833.1	1793.9	1222.7	1580.7	804.9	265.7	113.1	48.7	7.9	1.1	0.4	0.2	7672.5
2002	1074.5	2512.8	1960.6	1117.7	723.1	266.1	80.7	33.3	14.1	2.2	0.2	0.2	7785.6
2003	1297.4	1472.9	2752.0	1833.6	594.6	289.9	97.4	28.7	11.7	4.9	0.7	0.2	8384.0
2004	829.8	1778.5	1613.6	2586.0	1034.0	259.0	116.2	37.9	11.0	4.4	1.8	0.4	8272.8
2005	1068.6	1137.4	1942.9	1467.6	1144.2	323.0	74.3	32.4	10.4	3.1	1.1	0.7	7205.4
2006	1303.8	1464.8	1243.4	1790.6	761.0	455.9	120.6	26.9	11.7	3.7	1.1	0.7	7184.0
2007	1347.7	1787.3	1598.8	1131.6	870.8	284.2	159.6	41.0	9.0	3.7	1.1	0.4	7235.8
2008	1211.7	1847.3	1950.9	1475.6	586.2	270.3	81.8	45.0	11.5	2.4	1.1	0.4	7484.3
2009	1178.8	1661.0	2021.2	1836.0	871.5	234.4	100.1	29.5	16.1	4.0	0.9	0.4	7954.1
2010	1352.5	1615.8	1818.6	1911.2	1125.2	388.5	96.6	40.1	11.7	6.2	1.5	0.4	8368.5

Figures

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Figure 5.1a: Observed (open circles) and estimated (line, solid circles) commercial lines landings (1000 lb whole weight). *(Extracted from Figure 3.3 of the Assessment Report.)*

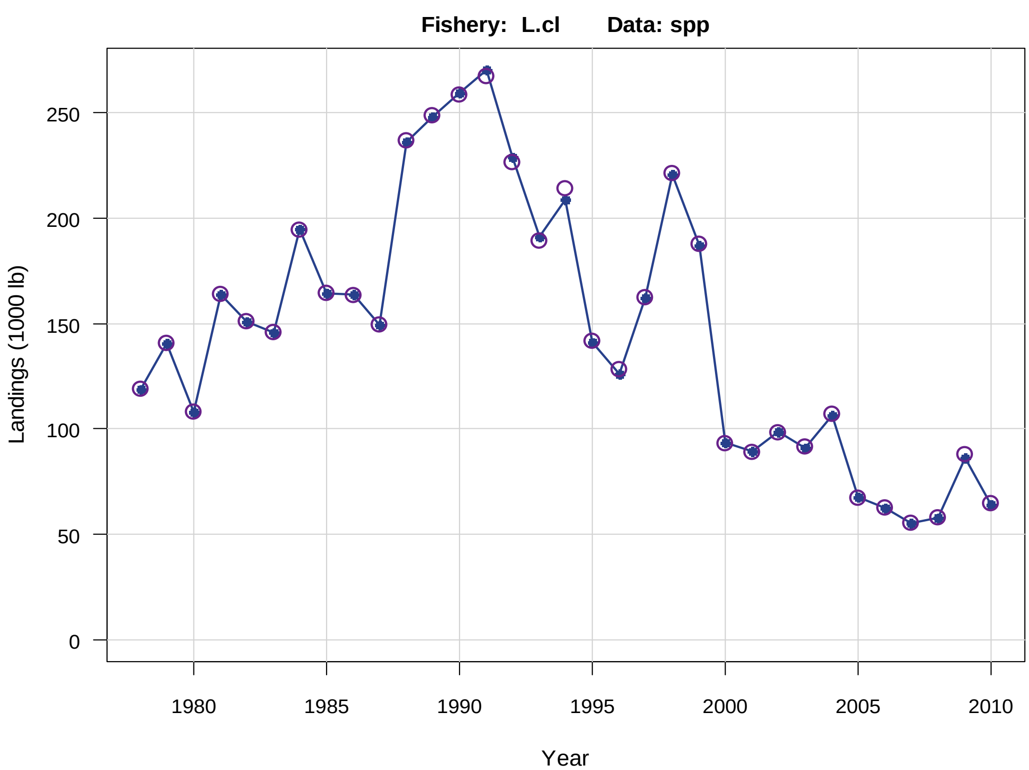


Figure 5.1b: Observed (open circles) and estimated (line, solid circles) commercial pot landings (1000 lb whole weight). *(Extracted from Figure 3.4 of the Assessment Report.)*

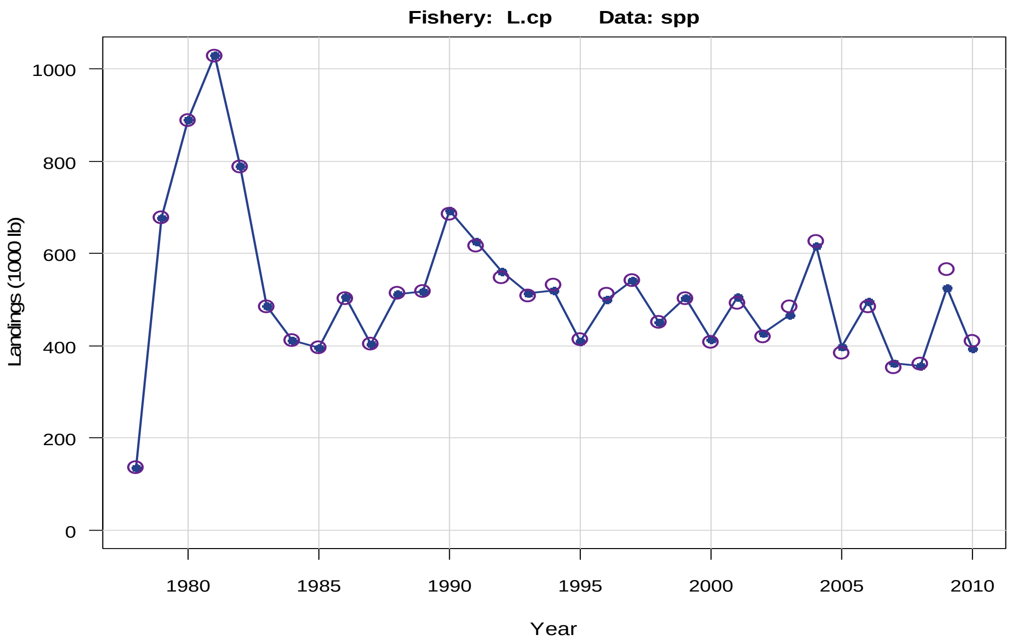


Figure 5.1c: Observed (open circles) and estimated (line, solid circles) commercial trawl landings (1000 lb whole weight). *(Extracted from Figure 3.5 of the Assessment Report.)*

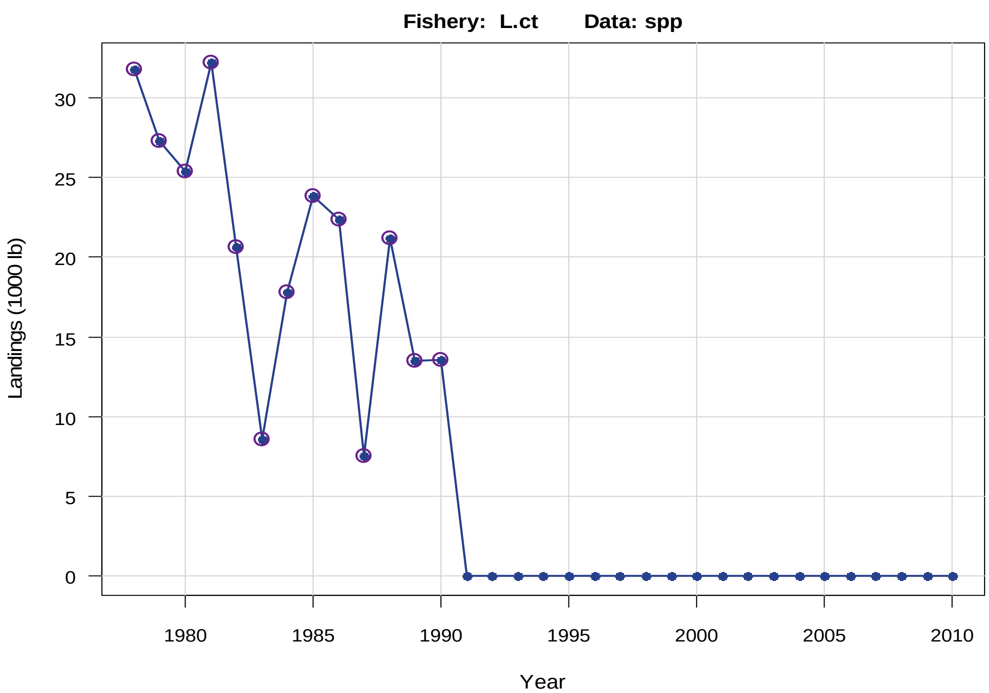


Figure 5.1d: Observed (open circles) and estimated (line, solid circles) headboat landings (1000 lb whole weight). *(Extracted from Figure 3.6 of the Assessment Report.)*

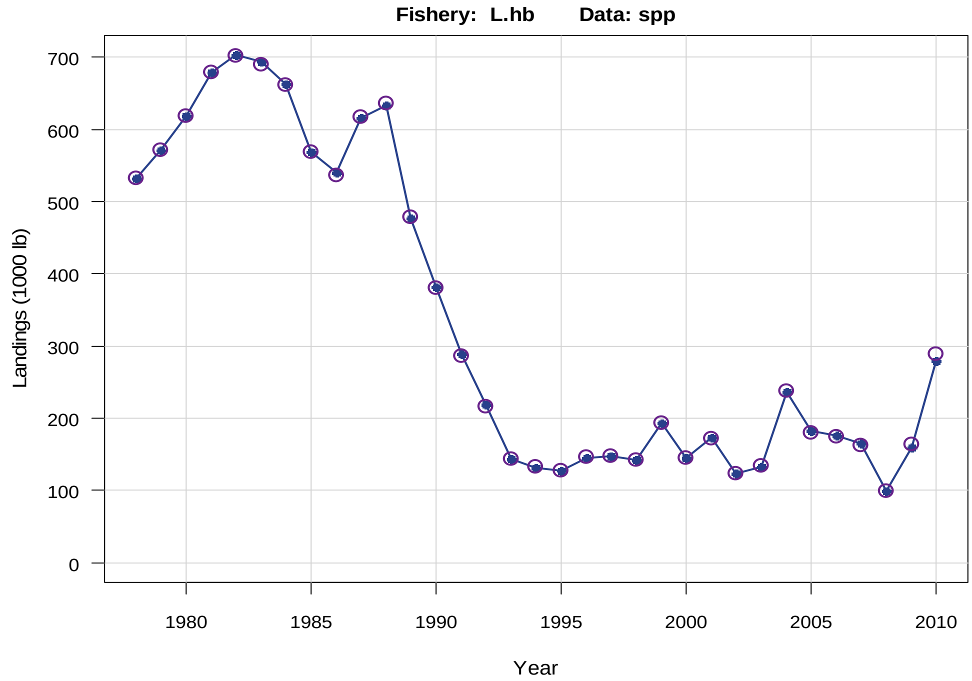


Figure 5.1e: Observed (open circles) and estimated (line, solid circles) general recreational landings (1000 lb whole weight). In years without observations (1978–1980), values were predicted using average F (see §3.1.1.3 for details). *(Extracted from Figure 3.7 of the Assessment Report.)*

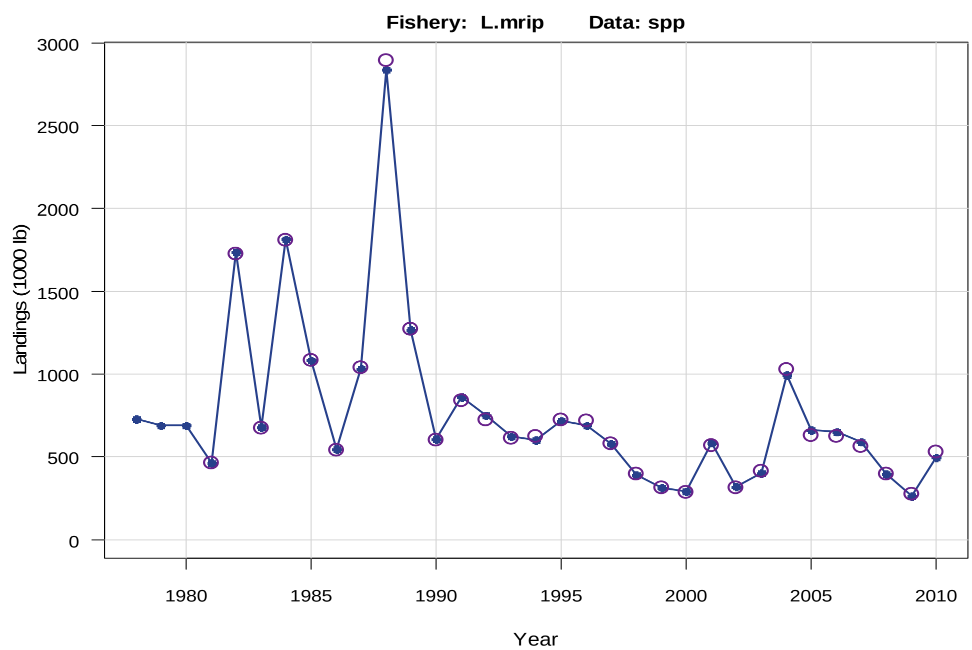


Figure 5.2a: Observed (open circles) and estimated (line, solid circles) commercial (lines + pots) discard mortalities (1000 dead fish). In years without observations (1984–1992), values were predicted using average F (see §3.1.1.3 for details). Commercial discards were modeled starting in 1984 with implementation of the 8-inch size limit. *(Extracted from Figure 3.8 of the Assessment Report.)*

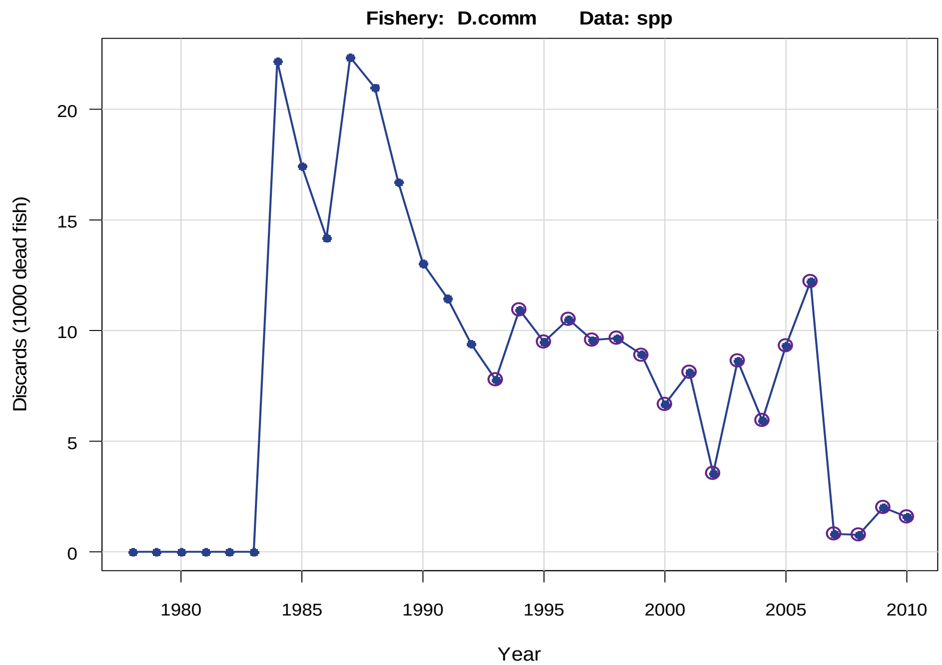


Figure 5.2b: Observed (open circles) and estimated (line, solid circles) headboat discard mortalities (1000 dead fish). Estimates prior to 1986 were combined with the general recreational discards. *(Extracted from Figure 3.9 of the Assessment Report.)*

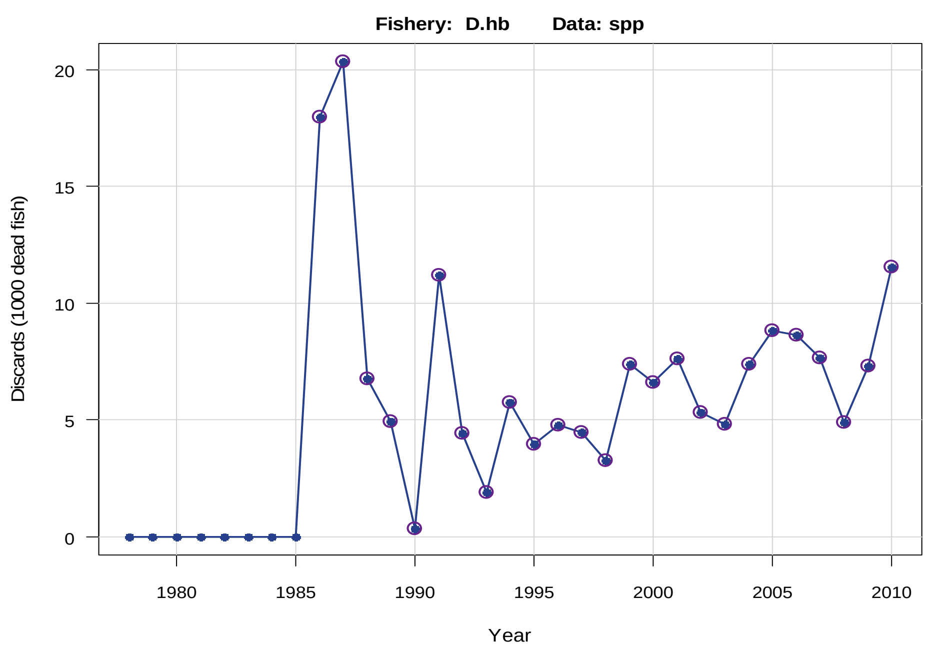


Figure 5.2c: Observed (open circles) and estimated (line, solid circles) general recreational discard mortalities (1000 dead fish). Estimates prior to 1986 include headboat discard mortalities. In years without observations (1978–1980), values were predicted using average F (see §3.1.1.3 for details). *(Extracted from Figure 3.10 of the Assessment Report.)*

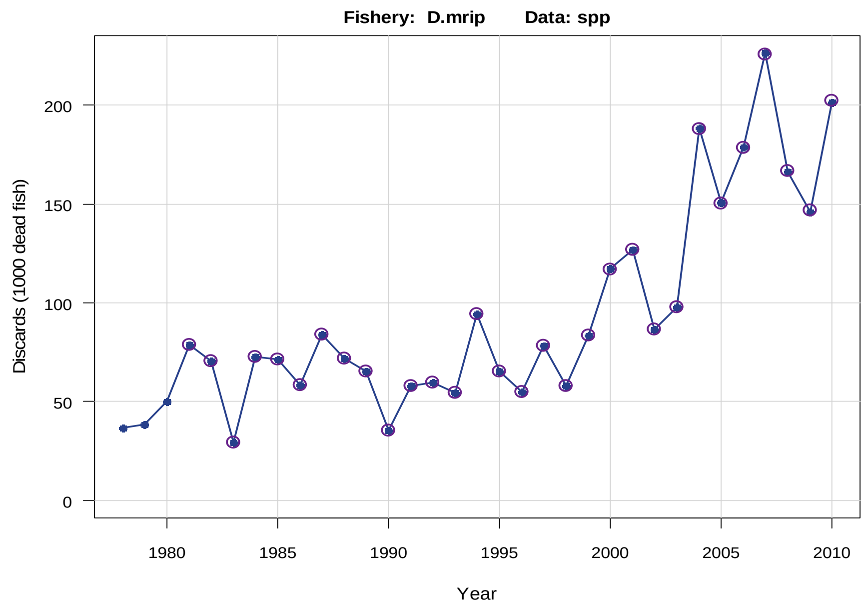


Figure 5.3: Estimated fully selected fishing mortality rate (per year) by fishery. *cl* refers to commercial lines, *cp* to commercial pots, *ct* to commercial trawl, *hb* to headboat, *mrip* to general recreational, *comm.D* to commercial discard mortalities, *hb.D* to headboat discard mortalities, and *mrip.D* to general recreational discard mortalities. *(Extracted from Figure 3.27 of the Assessment Report.)*

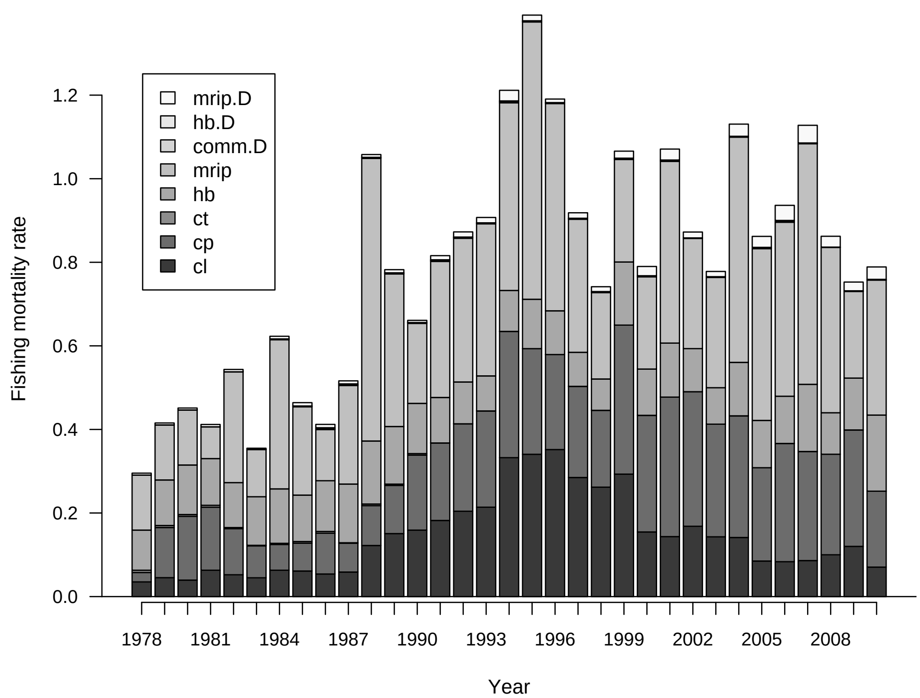


Figure 5.4: Top panel: Estimated total biomass (metric tons) at start of year. Horizontal dashed line indicates B_{MSY}. Bottom panel: Estimated spawning stock (population fecundity) at time of peak spawning. *(Extracted from Figure 3.19 of the Assessment Report.)*

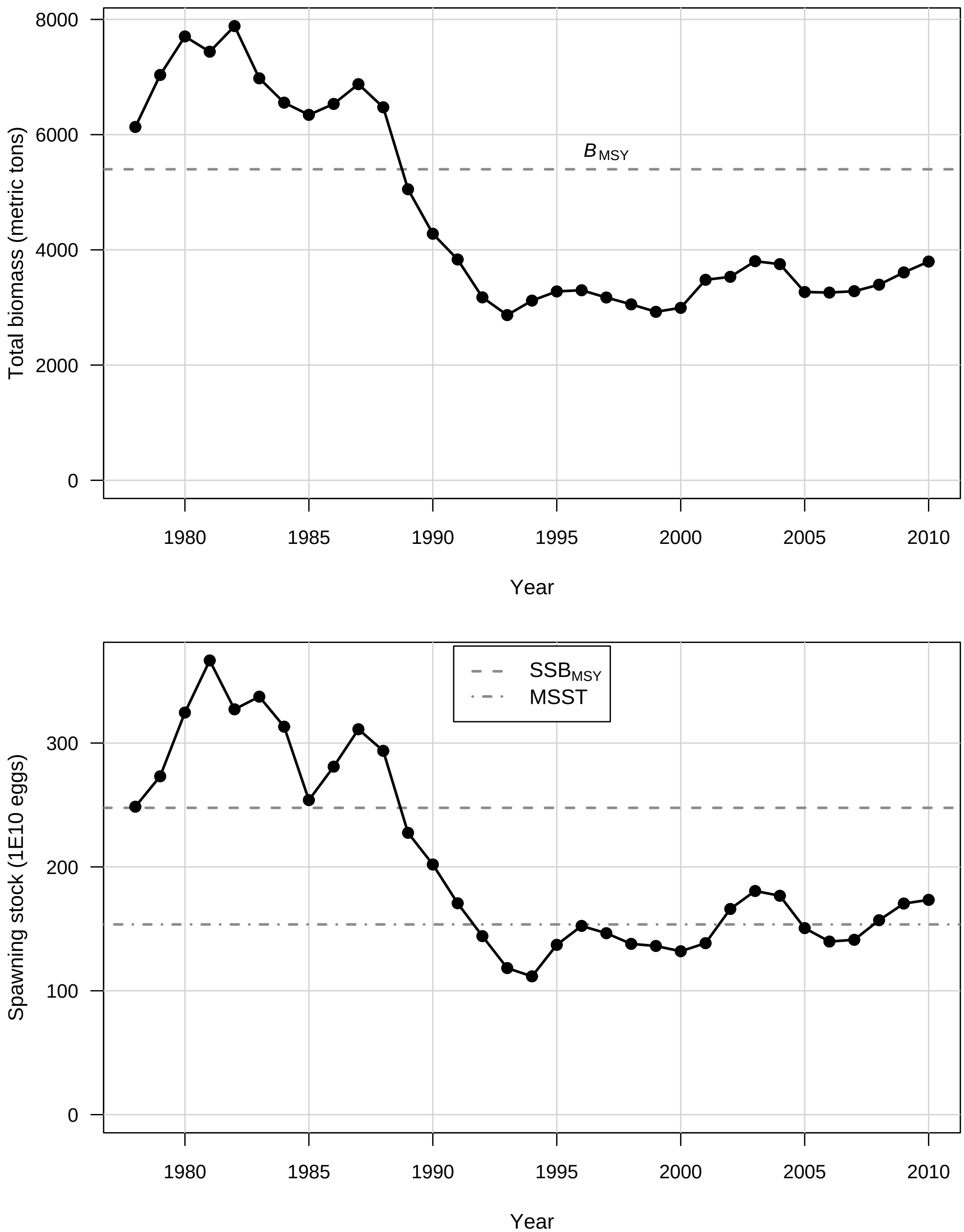


Figure 5.5: Abundance Indices

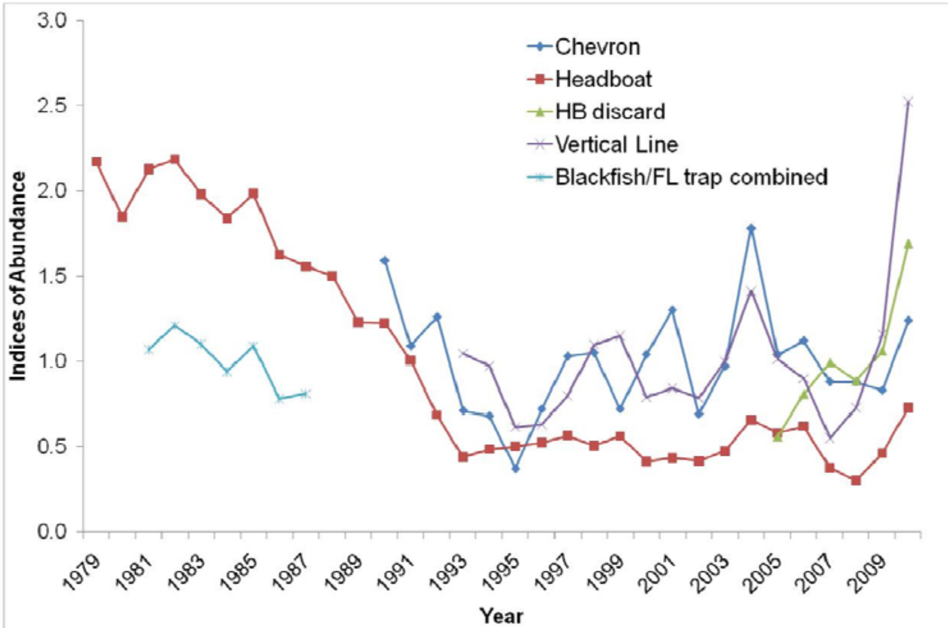


Figure 5.6: Beverton–Holt spawner-recruit curves, with and without lognormal bias correction. The expected (upper) curve was used for computing management benchmarks. Years within panel indicate year of recruitment generated from spawning biomass. Diagonal line indicates MSY-level replacement. *(Extracted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

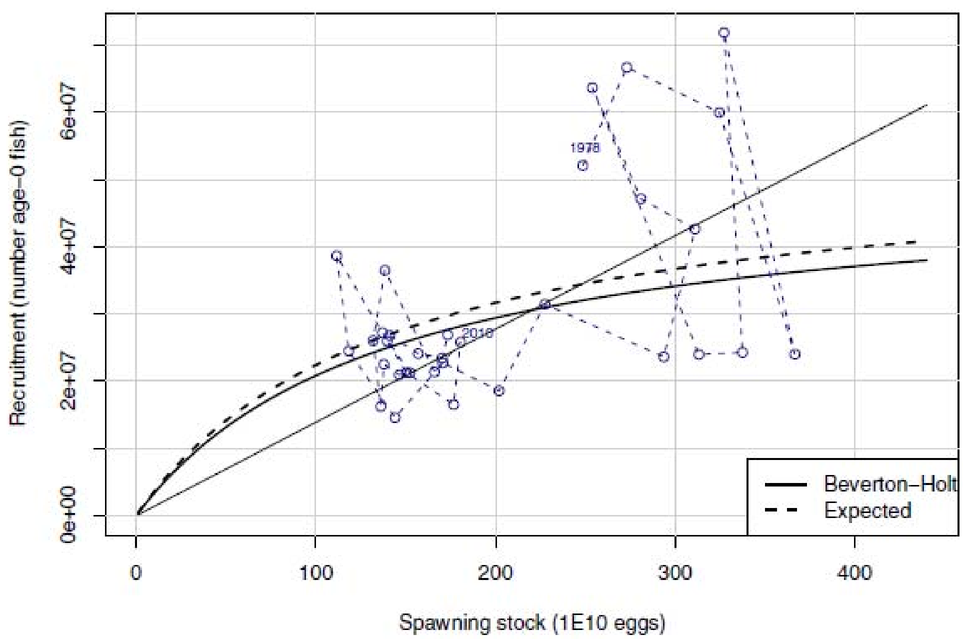


Figure 5.7: Top panel: yield per recruit. Bottom panel: spawning potential ratio (spawning biomass per recruit relative to that at the unfished level), from which the X% level of SPR provides FX%. Both curves are based on average selectivity from the end of the assessment period. *(Extracted from Figure 3.34 of the Assessment Report.)*

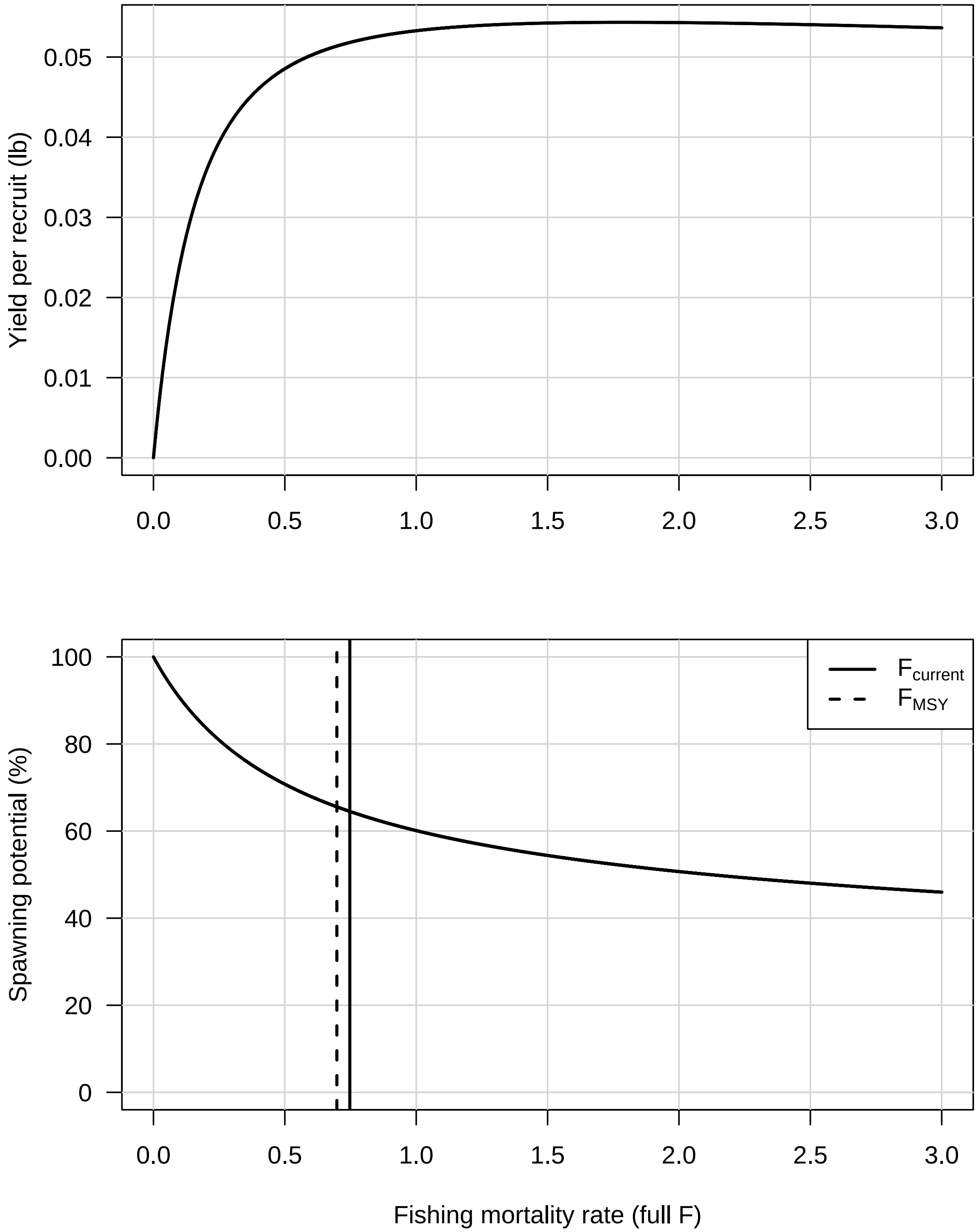


Figure 5.8: Estimated time series relative to benchmarks. Solid line indicates estimates from base run of the Beaufort Assessment Model; gray error bands indicate 5th and 95th percentiles of the MCB trials. Top panel: spawning biomass relative to the minimum stock size threshold (MSST). Middle panel: spawning biomass relative to SSB_{MSY}. Bottom panel: F relative to F_{MSY}. *(Extracted from Figure 3.38 of the Assessment Report.)*

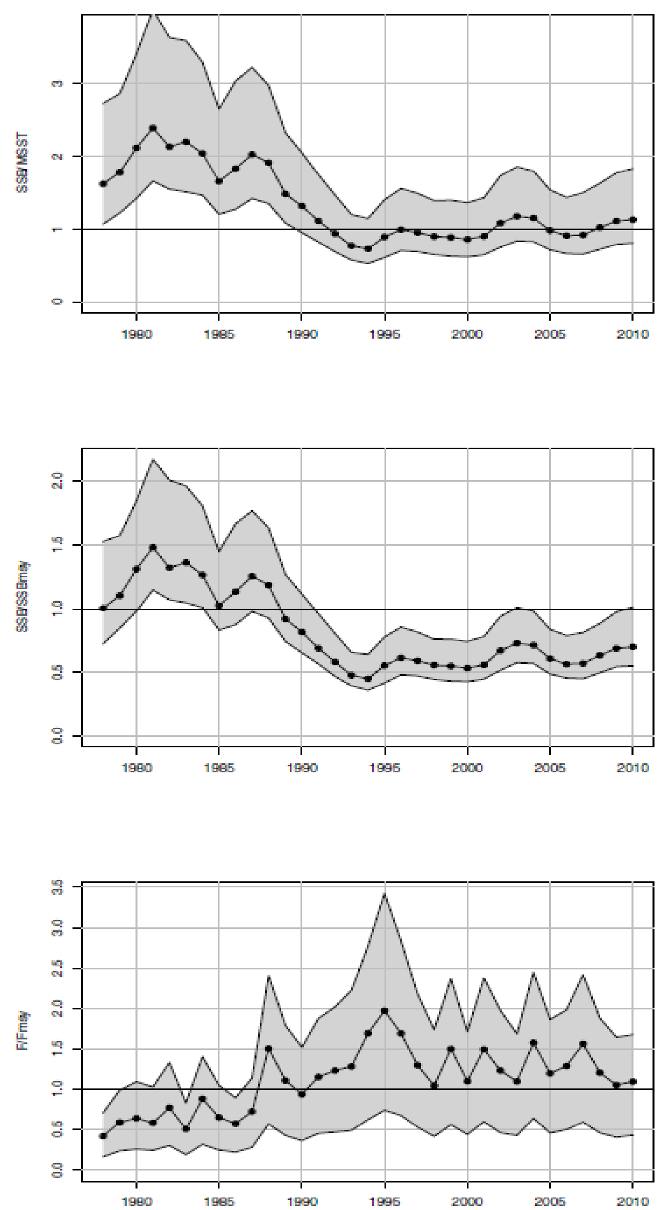


Figure 5.9a: Projection results under scenario 1—fishing mortality rate fixed at $F = F_{rebuild}$, with 2011 landings at 100% of the current quota. In top four panels, expected values represented by dotted solid lines, and uncertainty represented by thin lines corresponding to 5^{th} and 95^{th} percentiles of replicate projections. Horizontal lines mark MSY-related quantities. Spawning stock (SSB) is at time of peak spawning. In bottom panel, the curve represents the proportion of projection replicates for which SSB has reached at least SSB_{MSY} = 248. *(Extracted from Figure 3.50 of the Assessment Report.)*

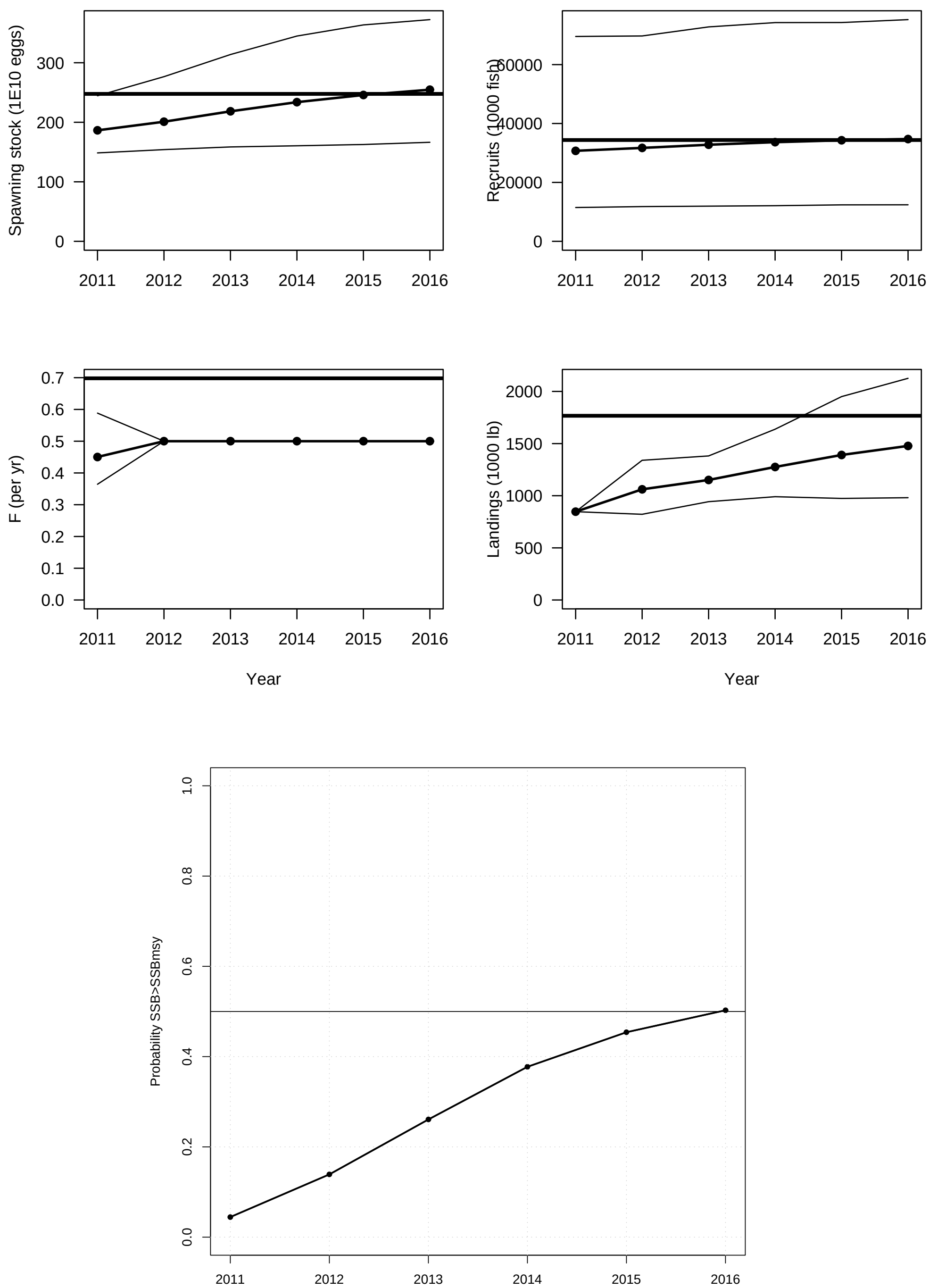


Figure 5.9b: Projection results under scenario 2—fishing mortality rate fixed at $F = F_{rebuild}$, with 2011 landings at 150% of the current quota. In top four panels, expected values represented by dotted solid lines, and uncertainty represented by thin lines corresponding to 5^{th} and 95^{th} percentiles of replicate projections. Horizontal lines mark MSY-related quantities. Spawning stock (SSB) is at time of peak spawning. In bottom panel, the curve represents the proportion of projection replicates for which SSB has reached at least $SSB_{MSY} = 248$. *(Extracted from Figure 3.51 of the Assessment Report.)*

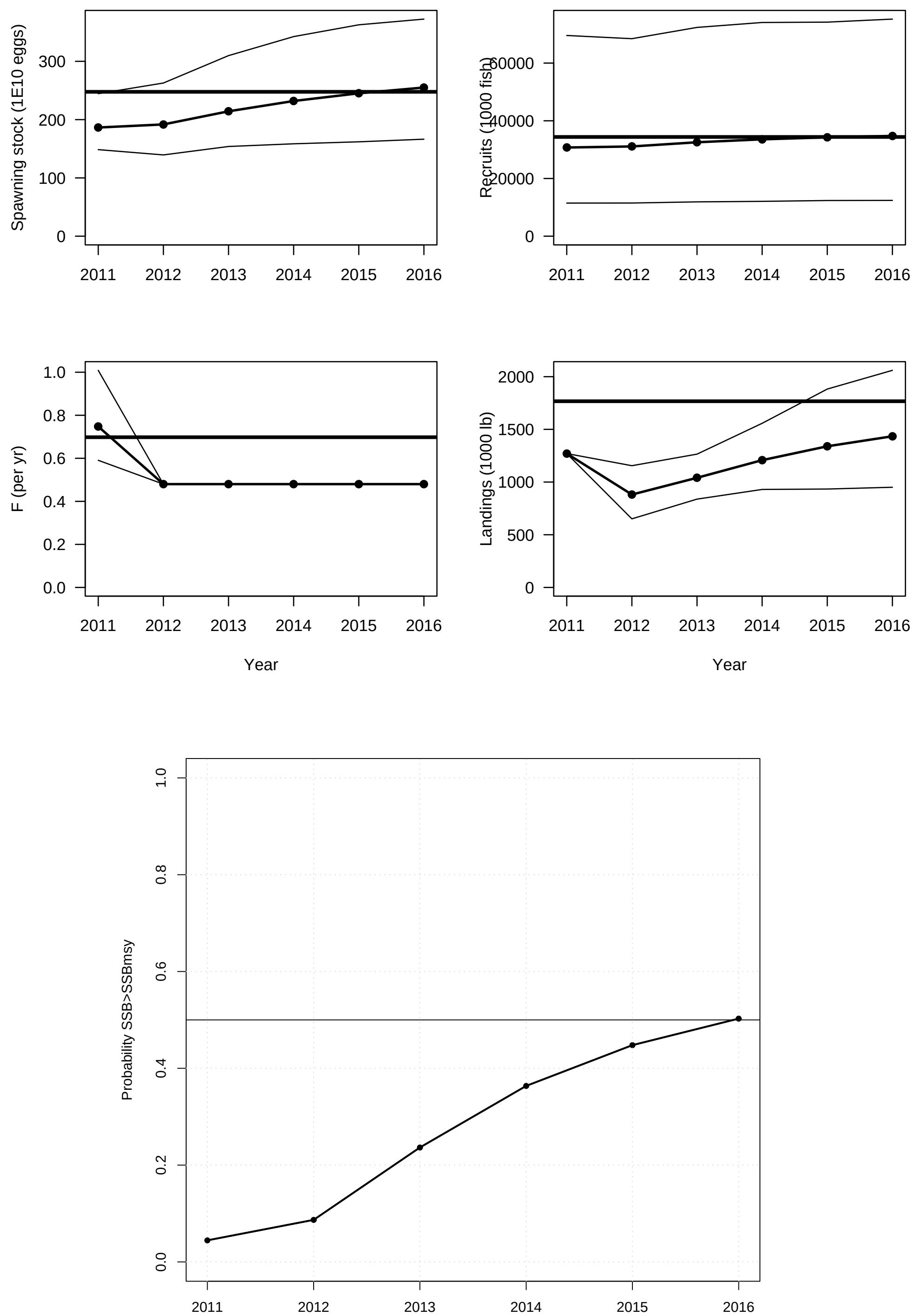


Figure 5.9c: Projection results under scenario 3—fishing mortality rate fixed at $F = F_{rebuild}$, with 2011 landings at 200% of the current quota. In top four panels, expected values represented by dotted solid lines, and uncertainty represented by thin lines corresponding to 5th and 95th percentiles of replicate projections. Horizontal lines mark MSY-related quantities. Spawning stock (SSB) is at time of peak spawning. In bottom panel, the curve represents the proportion of projection replicates for which SSB has reached at least $SSB_{MSY} = 248$. *(Extracted from Figure 3.52 of the Assessment Report.)*

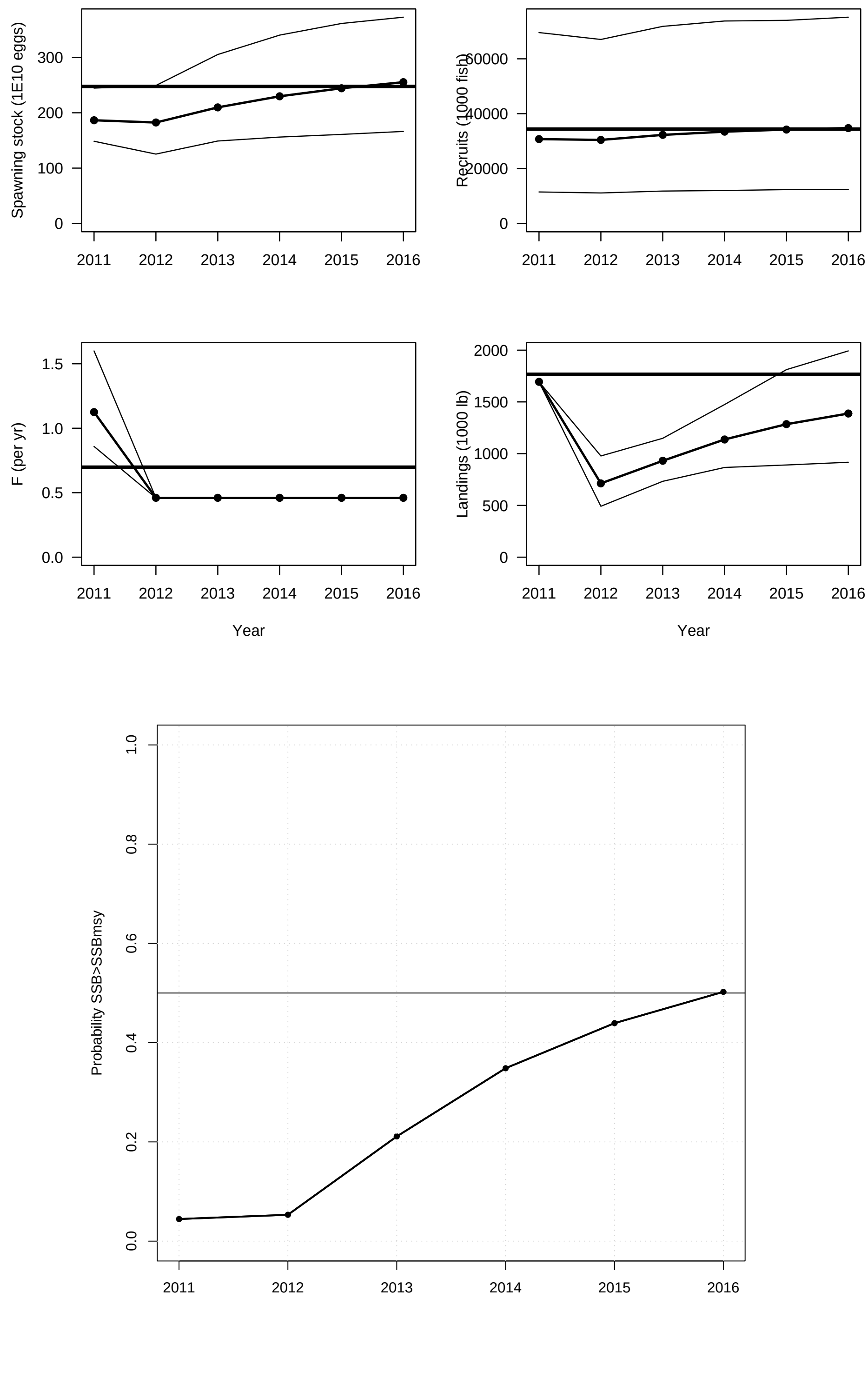


Figure 5.9d: Projection results under scenario 4—landings fixed at the current quota (847,000 lb), with 2011 landings at 100% of the current quota. In top four panels, expected values represented by dotted solid lines, and uncertainty represented by thin lines corresponding to 5th and 95th percentiles of replicate projections. Horizontal lines mark MSY-related quantities. Spawning stock (SSB) is at time of peak spawning. In bottom panel, the curve represents the proportion of projection replicates for which SSB has reached at least SSB_{MSY} = 248. *(Extracted from Figure 3.53 of the Assessment Report.)*

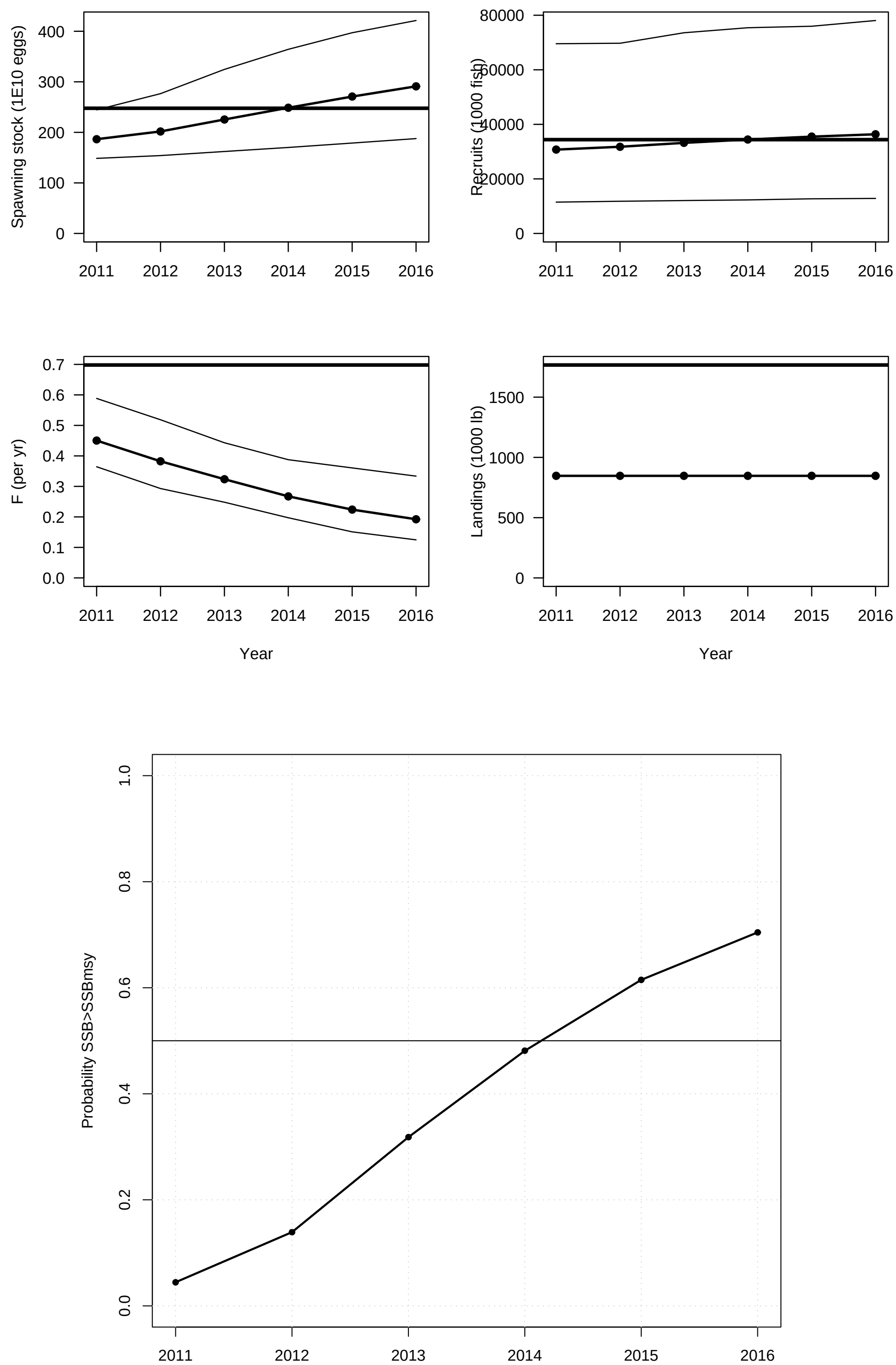


Figure 5.9e: Projection results under scenario 5—landings fixed at the current quota (847,000 lb), with 2011 landings at 150% of the current quota. In top four panels, expected values represented by dotted solid lines, and uncertainty represented by thin lines corresponding to 5th and 95th percentiles of replicate projections. Horizontal lines mark MSY-related quantities. Spawning stock (SSB) is at time of peak spawning. In bottom panel, the curve represents the proportion of projection replicates for which SSB has reached at least SSB_{MSY} = 248. *(Extracted from Figure 3.54 of the Assessment Report.)*

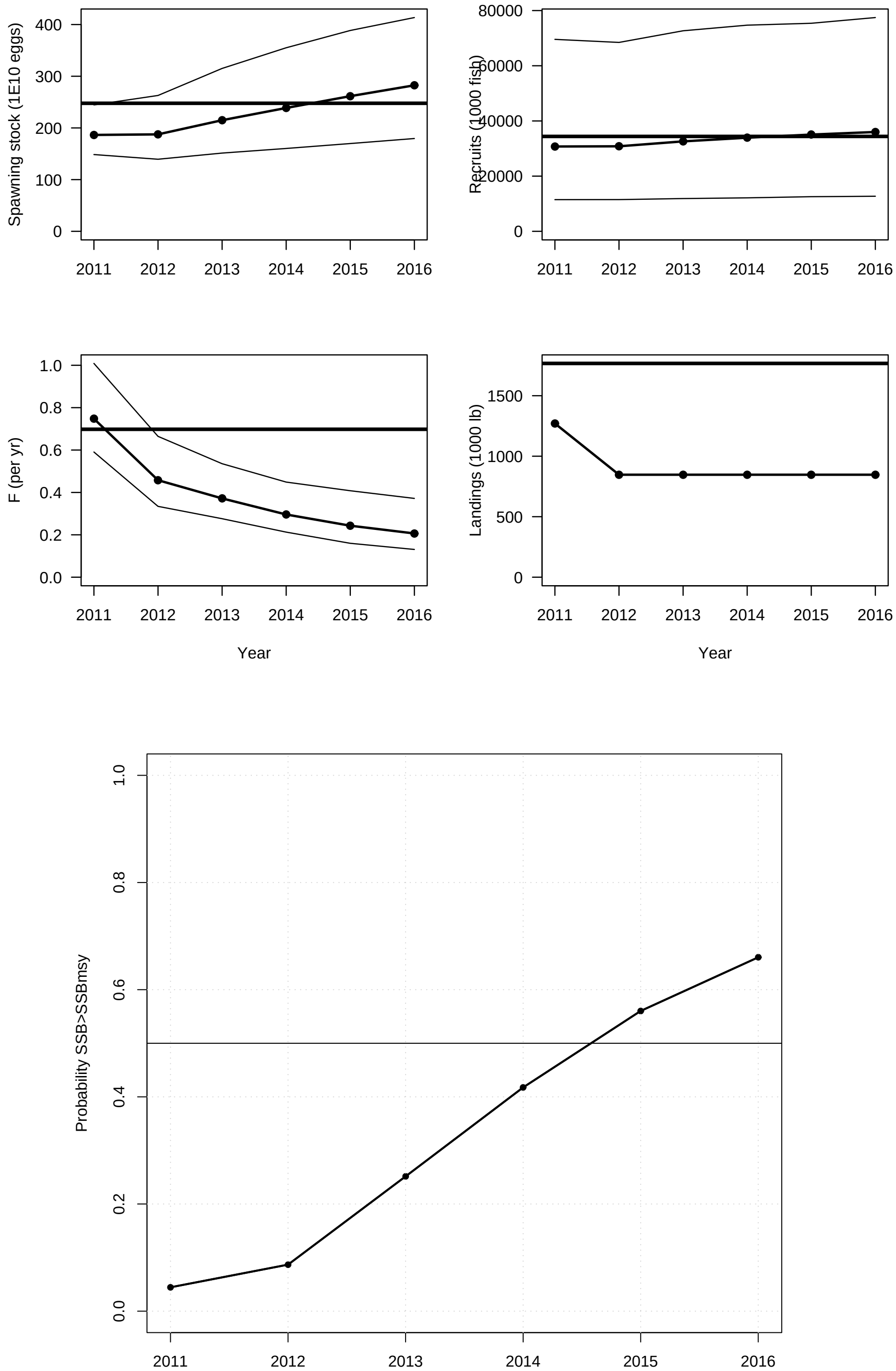


Figure 5.9f: Projection results under scenario 6—landings fixed at the current quota (847,000 lb), with 2011 landings at 200% of the current quota. In top four panels, expected values represented by dotted solid lines, and uncertainty represented by thin lines corresponding to 5th and 95th percentiles of replicate projections. Horizontal lines mark MSY-related quantities. Spawning stock (SSB) is at time of peak spawning. In bottom panel, the curve represents the proportion of projection replicates for which SSB has reached at least SSB_{MSY} = 248. *(Extracted from Figure 3.55 of the Assessment Report.)*

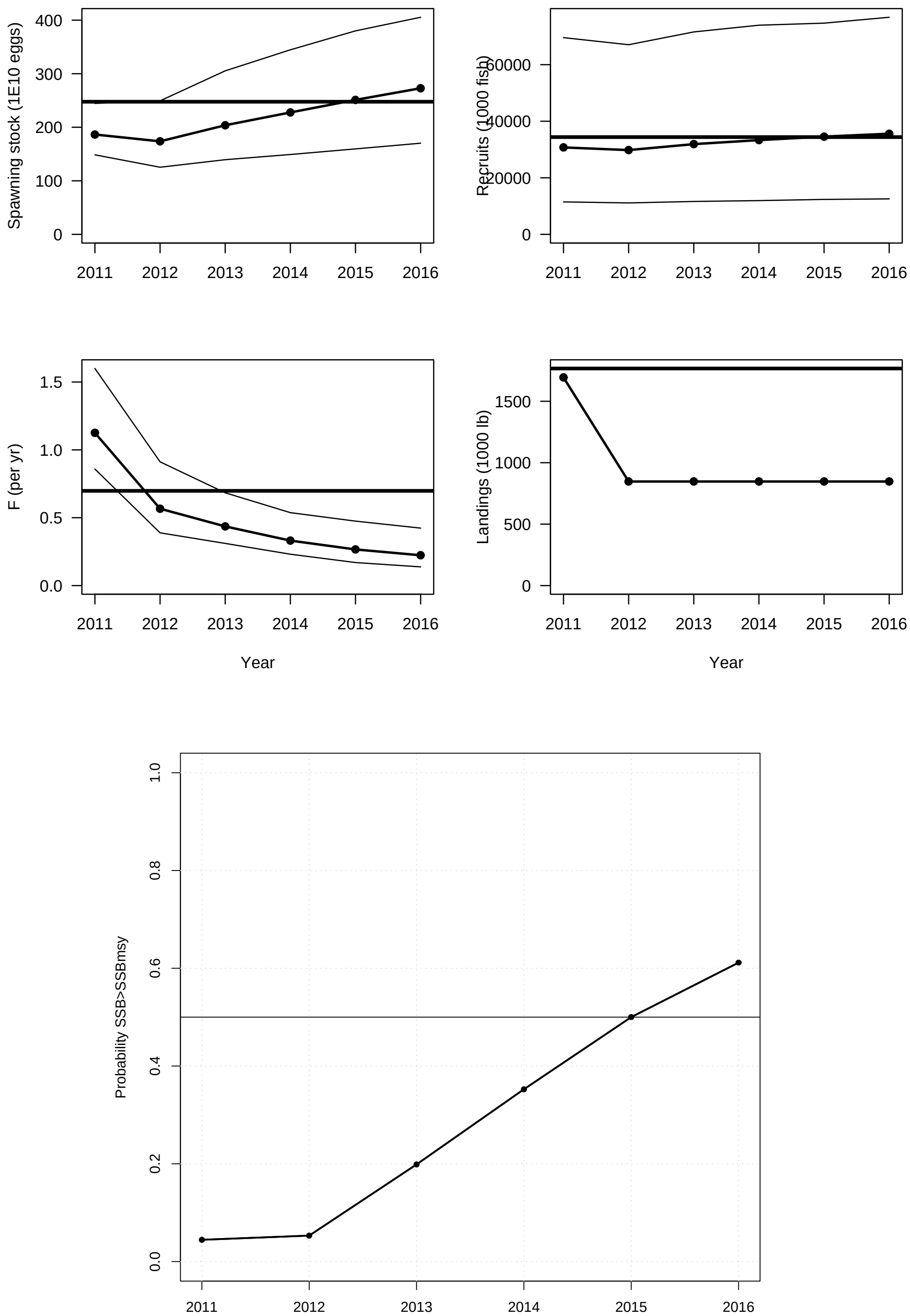


Figure 5.9g: Projection results under scenario 7—landings fixed at L = $L_{rebuild}$, with 2011 landings at 100% of the current quota. In top four panels, expected values represented by dotted solid lines, and uncertainty represented by thin lines corresponding to 5^{th} and 95^{th} percentiles of replicate projections. Horizontal lines mark MSY-related quantities. Spawning stock (SSB) is at time of peak spawning. In bottom panel, the curve represents the proportion of projection replicates for which SSB has reached at least SSB_{MSY} = 248. *(Extracted from Figure 3.56of the Assessment Report.)*

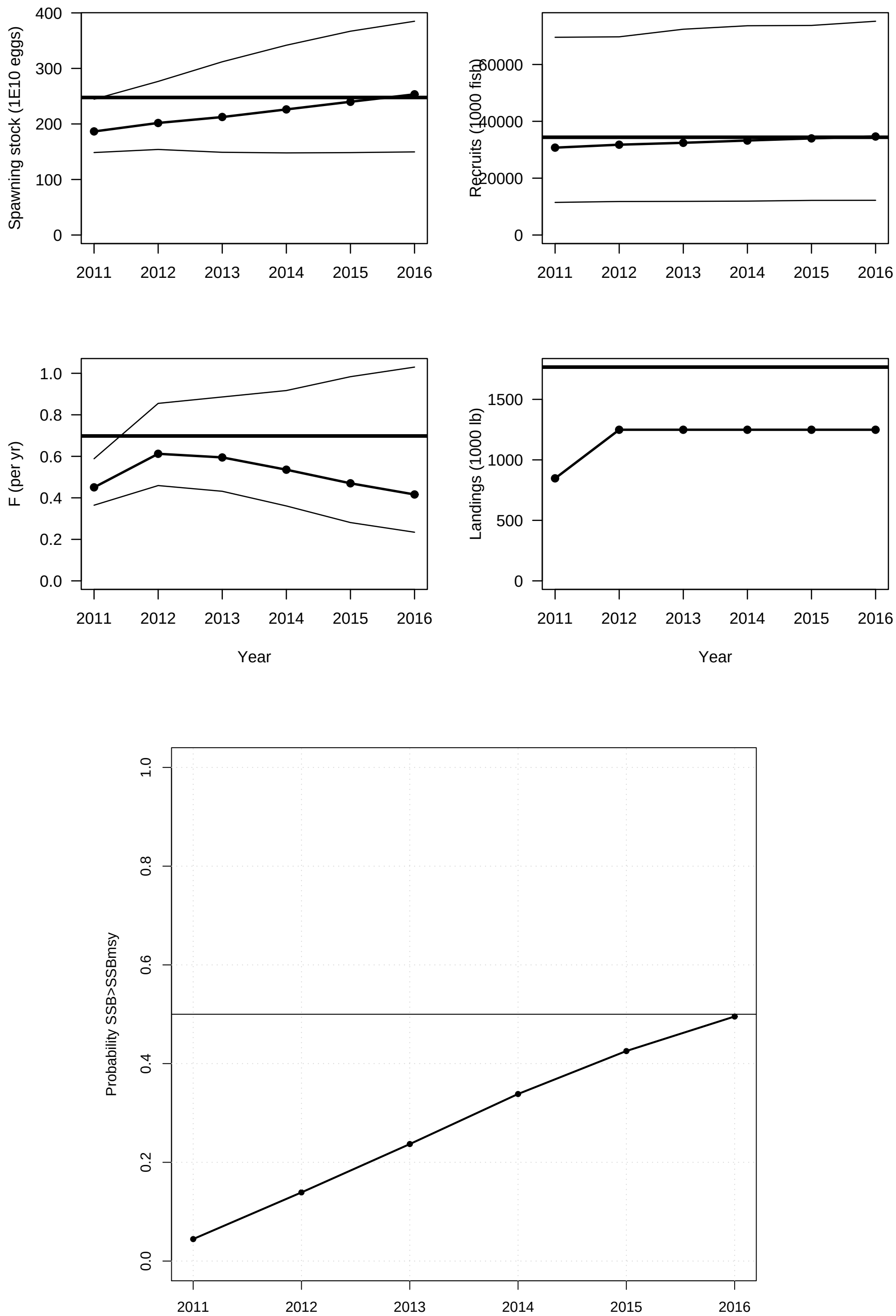


Figure 5.9h: Projection results under scenario 8—landings fixed at L = $L_{rebuild}$, with 2011 landings at 150% of the current quota. In top four panels, expected values represented by dotted solid lines, and uncertainty represented by thin lines corresponding to 5^{th} and 95^{th} percentiles of replicate projections. Horizontal lines mark MSY-related quantities. Spawning stock (SSB) is at time of peak spawning. In bottom panel, the curve represents the proportion of projection replicates for which SSB has reached at least SSB_{MSY} = 248. *(Extracted from Figure 3.57 of the Assessment Report.)*

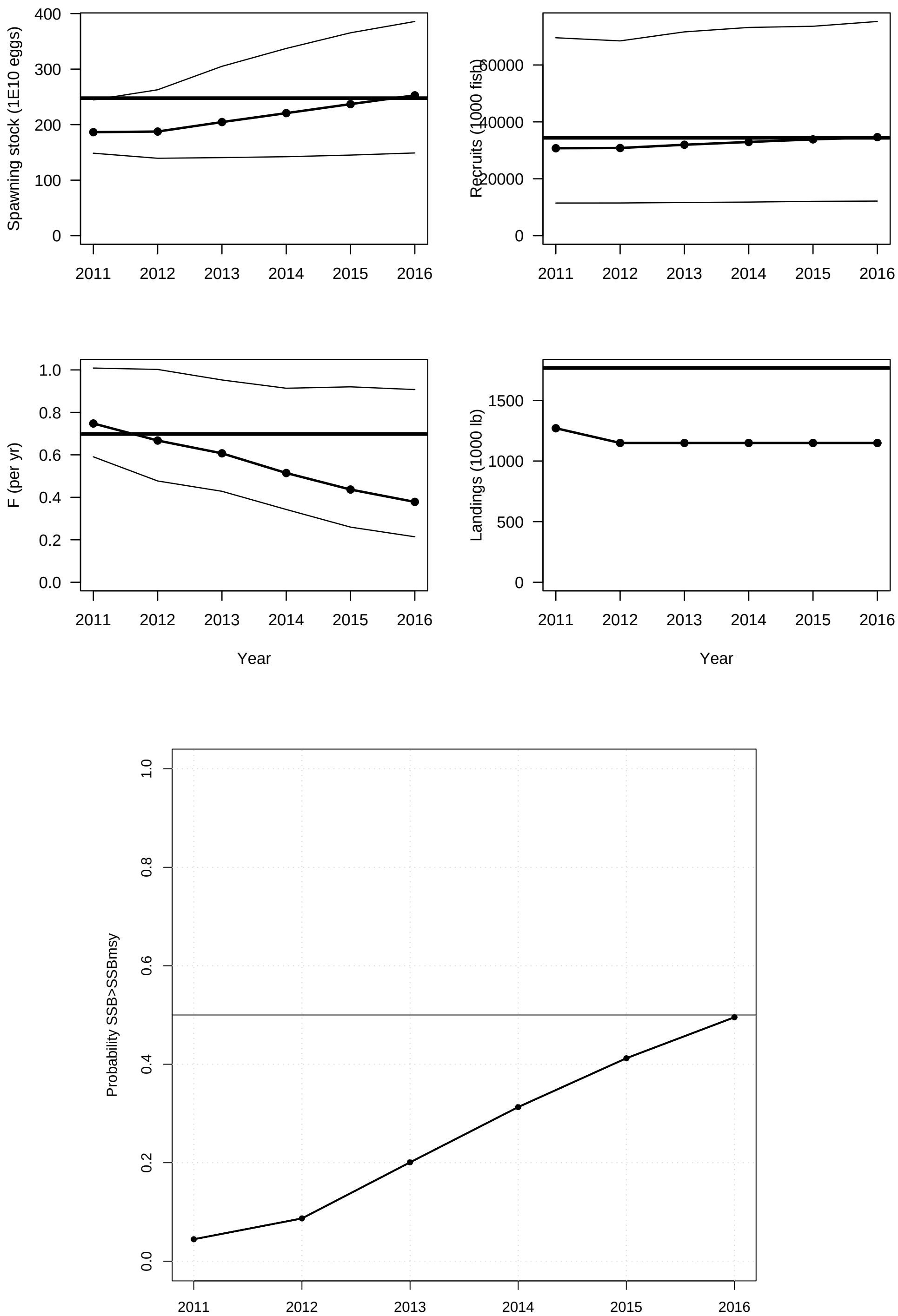
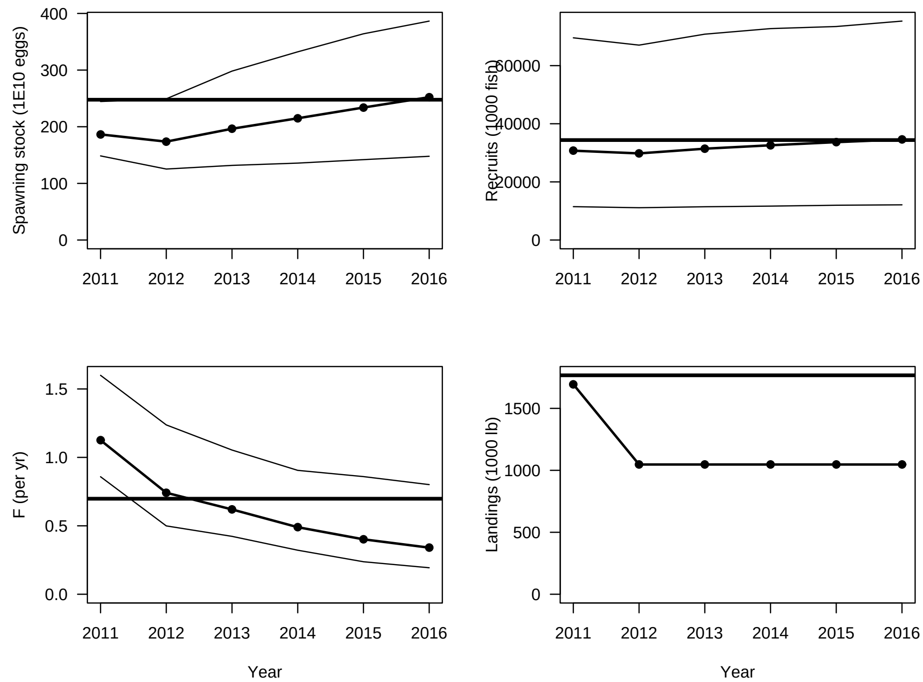
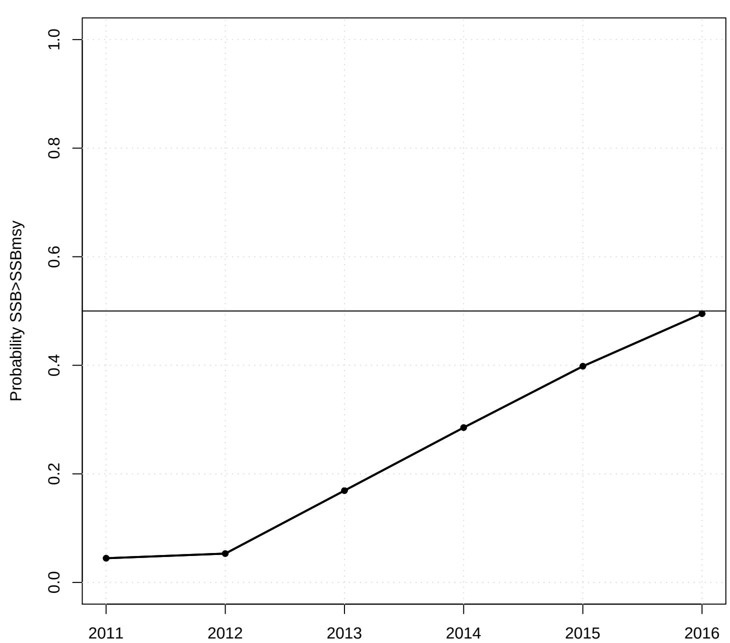


Figure 5.9i: Projection results under scenario 9—landings fixed at L = $L_{rebuild}$, with 2011 landings at 200% of the current quota. In top four panels, expected values represented by dotted solid lines, and uncertainty represented by thin lines corresponding to 5^{th} and 95^{th} percentiles of replicate projections. Horizontal lines mark MSY-related quantities. Spawning stock (SSB) is at time of peak spawning. In bottom panel, the curve represents the proportion of projection replicates for which SSB has reached at least SSB_{MSY} = 248. *(Extracted from Figure 3.58 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
B	stock biomass level
BMSY	value of B capable of producing MSY on a continuing basis
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
GA DNR	Georgia Department of Natural Resources
GLM	general linear model
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
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 25

South Atlantic Black Sea Bass

SECTION II: Data Workshop Report

June 2011

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

Table of Contents

1 Introduction

1.1 Workshop Time and Place

The SEDAR 25 Data Workshop was held April 26-28, 2011 in Charleston, South Carolina.

1.2 Terms of Reference

1. Review stock structure and unit stock definitions and consider whether changes are required.
2. Review, discuss, and tabulate available life history information if new information is available.
   - 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
   - Consider research directed at black sea bass as well as similar species from the Atlantic 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 the last benchmark and update (SEDAR2, 2005 Update).
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 survey coverage.
   - Develop CPUE and index values 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.
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 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 if feasible.
   - Provide maps of fishery effort and harvest.
7. 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.
8. Develop a spreadsheet of assessment model input data that reflects the decisions and recommendations of the Data Workshop. Review and approve the contents of the input spreadsheet by TBD.
9. Develop a list of tasks to be completed following the workshop.
10. No later than May 25, 2011, prepare the Data Workshop report providing complete documentation of workshop actions and decisions (Section II. of the SEDAR assessment report).

1.3 List of Participants

Data Workshop Panel

Kate Andrews....................................NMFS/SEFSC
Tony Austin...................................NC Commercial
Nate Bacheler...................................NMFS/SEFSC
Joey Ballenger..SC DNR
Alan Bianchi...NC DMF
Zach Bowen.................................GA Recreational
Ken Brennan.....................................NMFS/SEFSC
Steve Brown...FL FWC
Julia Byrd...SC DNR
Julie Califf...GA DNR
Bobby Cardin.................................FL Commercial
Dan Carr...NMFS/SEFSC
Rob Cheshire....................................NMFS/SEFSC
Chip Collier..NC DMF
Kevin Craig.......................................NMFS/SEFSC
Julie Defilippi..ACCSP
Laurie DiJoy..SC DNR
Kenny Fex......................................NC Commercial
Eric Fitzpatrick.................................NMFS/SEFSC
Kelly Fitzpatrick................................NMFS/SEFSC
David Gloeckner................................NMFS/SEFSC
Rusty Hudson ....FL Recreational
Jimmy Hull......................................FL Commercial
Walter Ingram...................................NMFS/SEFSC
Nikolai Klibanski .... UNCW
Joe Klosterman..............................FL Commercial
Kathy Knowlton...GA DNR
Chad Lee...FL Commercial
Linda Lombardi.................................NMFS/SEFSC
Vivian Matter...MRIP
Kevin McCarthy.................................NMFS/SEFSC
Ron McPherson...........................NC Recreational
Paulette Mikell..SC DNR
Michelle Pate..SC DNR
David Player...SC DNR
Jennifer Potts ....NMFS/SEFSC
Marcel Reichert...SC DNR
Paul Rudershausen.......................................NCSU
Beverly Sauls...FL FWC
Kyle Shertzer.....................................NMFS/SEFSC
Tom Sminkey..MRIP
Jessica Stephen ....NMFS/SERO
Erik Williams ....NMFS/SEFSC
Chris Wilson...NC DMF
Dave Wyanski..SC DNR

Council Representatives

Tom Burgess……..SAFMC

Council & Agency Staff

Kari Fenske……SEDAR
Gregg Waugh………..SAFMC
Mike Errigo……..SAMFC
Tyree Davis……………………………………………………………………………………………………..NMFS/SEFSC
Rachael Silvas……SEDAR
Myra Brouwer………..SAFMC
John Carmichael……SEDAR
Julie Neer……SEDAR
Amy Dukes……NMFS
Claudia Dennis……………………………………………………………………………………………………NMFS/SEFSC

Data workshop observers

Eric Hiltz
Kevin Kolmos
Rodolfo Serra
Renzo Tascheri
Max Zilleruelo
Frank Hester
Peter Barile
Mark Brown

Data webinar observers

Betsy Laban
Gregg Davis
Byron White
Eric Hiltz
Kevin Kolmos
Tracy McCulloch
Frank Hester
Peter Barile
Jim Busse
David Nelson

1.4 List of Data Workshop Working Papers

Document #	Title	Authors
Documents Prepared for the Data Workshop		
SEDAR25-DW01	Black sea bass length frequencies and condition of released fish from at-sea headboat observer surveys, 2004-2010	Sauls, Wilson, and Brennan 2011
SEDAR25-DW02	Standardized CPUE of black sea bass (*Centripristis striata*) caught in blackfish and Florida snapper traps deployed by MARMAP	Bacheler, Shertzer, Reichert, Stephen, and Pate 2011
SEDAR25-DW03	Standardized CPUE of black sea bass (*Centropristis striata*) from chevron trapping by MARMAP	Bacheler, Shertzer, Reichert, Stephen, and Pate 2011
SEDAR25-DW04	Catch-per-unit-effort of golden tilefish from MARMAP bottom longlining	Bacheler, Reichert, Stephen, and Pate 2011
SEDAR25-DW05	Klibansky and Scharf batch fecundity methods	Klibansky and Scharf 2011
SEDAR25-DW06	The Regulations that have already affected the Black Sea Bass rebuilding	Fex 2011
SEDAR25-DW07	Commercial Longline Vessel Standardized Catch Rates of Tilefish in the US South Atlantic, 1993-2010	McCarthy 2011
SEDAR25-DW08	The potential for using the sea bass pot fishery to assess changes in abundance of black sea bass (Centropristis striata) in the South Atlantic region	Hull and Hester 2011
SEDAR25-DW09	Fisheries-dependent landings data for the east Florida golden tilefish (L*opholatilus chamaeleonticeps*) fishery	Hull and Barile 2011
SEDAR25-DW10	Black sea bass and tilefish discard mortality working paper	Collier, Fex, Rudershausen, and Sauls 2011
SEDAR25-DW11	Bottom longline fishery bycatch of golden tilefish from observer data	Hale 2011
SEDAR25-DW12	Abundance indices of black sea bass collected during SEAMAP shallow water trawl surveys in the South Atlantic Bight (1990-2010)	Ingram 2011
SEDAR25-DW13	Standardized discard rates of US black sea bass (*Centropristis striata*) from headboat at-sea observer data	Sustainable Fisheries Branch, NMFS 2011
SEDAR25-DW14	Preliminary standardized catch rates of Southeast	Sustainable

	US Atlantic black sea bass (*Centropristis striata*) from headboat data	Fisheries Branch, NMFS 2011
SEDAR25-DW15	South Carolina Department of Natural Resources State Finfish survey (SFS)	Hiltz and Byrd 2011
SEDAR25-DW16	SCDNR Charterboat Logbook Program Data, 1993-2010	Errigo et al. 2011
SEDAR25-DW17	A note on the occurrence of bank sea bass (*Centropristis ocyurus*) in the Florida hook and line and black sea bass pot fisheries	Nelson 2011
SEDAR25-DW18	Commercial vertical line vessel standardized catch rates of black sea bass in the US South Atlantic, 1993-2010	McCarthy 2011
SEDAR25-DW19	Calculated discards of black sea bass and tilefish from commercial fishing vessels in the US South Atlantic	McCarthy
SEDAR25-DW20	Summary of black sea bass (*Centropristis striata*) length composition sampling from the Gulf and South Atlantic Fisheries Foundation observer program, 2007-2009	Gloeckner 2011
SEDAR25-DW21	Summary of black sea bass (*Centropristis striata*) length composition sampling from the Trip Interview Program (TIP) 1981-2010	Gloeckner 2011
SEDAR25-DW22	Summary of golden tilefish (*Lopholatilus chamaeleonticeps*) length composition sampling from the Trip Interview Program (TIP) 1981-2010	Gloeckner 2011
SEDAR25-DW23	Revised working paper: SCDNR Charterboat logbook program data, 1993-2010 (replaces SEDAR25-DW16)	Errigo et al 2011
SEDAR25-DW24	Standardized catch rates of black sea bass from commercial fish traps in the US South Atlantic, 1993-2010	McCarthy 2011

Reference Documents		
SEDAR25-RD01	Tilefish off South Carolina and Georgia	Low et al. 1983
SEDAR25-RD02	Temporal and spatial variation in habitat characteristics of tilefish (*Lopholatilus chamaeleonticeps*) off the east coast of Florida	Able et al. 1993
SEDAR25-RD03	The fishery for tilefish, *Lopholatilus chamaeleonticeps*, off South Carolina and Georgia	Low et al. 1982
SEDAR25-RD04	The complex life history of tilefish *Lopholatilus chamaeleonticeps* and vulnerability to exploitation	Grimes and Turner 1999
SEDAR25-RD05	South Carolina Sea Grant Project: To investigate and document legal and undersized fish (Black	D. Lombardi 2008

	Sea Bass) and injuries to released fish.	
SEDAR25-RD06	The 1882 tilefish kill – a cold event in shelf waters off north-eastern United States?	March et al. 1999
SEDAR25-RD07	Contributions to the life history of black sea bass, *Centropristis striata*, off the Southeastern United States	Wenner et al. 1986
SEDAR25-RD08	Population characteristics of the black sea bass *Centropristis striata* from the Southeastern US	Vaughan et al. 1995
SEDAR25-RD09	The summer flounder, scup, and black sea bass fishery of the Middle Atlantic Bight and southern New England waters	Shepherd and Terceiro 1994
SEDAR25-RD10	Estimating discard mortality of black sea bass (*Centropristis striata*) and other reef fish in North Carolina using a tag-return approach	Rudershausen et al. 2010
SEDAR25-RD11	List of working papers for SEDAR 4 (Atlantic and Caribbean deepwater snapper and grouper) – all documents are available on the SEDAR website	SEDAR 4
SEDAR25-RD12	List of reference documents for SEDAR 4 (Atlantic and Caribbean deepwater snapper and grouper) – all documents are available on the SEDAR website	SEDAR 4
SEDAR25-RD13	Evaluation of multiple survey indices in assessment of black sea bass from the US South Atlantic Coast	Vaughan et al. 1997
SEDAR25-RD14	Seasonal distribution and movement of black sea bass (*Centropristis striata*) in the northwest Atlantic as determined from a mark-recapture experiment	Moser and Shepherd 2009
SEDAR25-RD15	Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (South Atlantic) – Black sea bass	Mercer et al. 1989
SEDAR25-RD16	Black sea bass	Shepherd 2006
SEDAR25-RD17	Seafood Watch – Black Sea Bass (*Centropristis striata*), northeast region	Kerkering 2004
SEDAR25-RD18	Dispersal of black sea bass (*Centropristis striata*) larvae on the southeast US continental shelf: results of a coupled vertical larval behavior – 3D circulation model	Edwards et al. 2008
SEDAR25-RD19	List of working paper for SEDAR 2 (SA Black sea bass) – all documents are available on the SEDAR website	SEDAR 2
SEDAR25-RD20	Catch rates and selectivity among three trap types in the US South Atlantic black sea bass commercial trap fishery	Rudershausen et al. 2008

SEDAR25-RD21	Lead-radium dating of golden tilefish (*Lopholatilus chamaeleonticeps*)	Andrews 2009
SEDAR25-RD22	Black sea bass, *Centropristis striata*, life history and habitat characteristics (second edition)	Drohan et al. 2007
SEDAR25-RD23	Spawning locations for Atlantic reef fishes off the Southeastern US	Sedberry et al. 2006
SEDAR25-RD24	Growth of black sea bass (*Centropristis striata*) in recirculating aquaculture systems	Perry et al. 2007
SEDAR25-RD25	American food and game fishes. A popular account of all the species found in America north of the equator, with keys for ready identification, life histories and methods of capture – *Tilefish excerpt*	Jordan and Evermann 1908
SEDAR25-RD26	American fishes: A popular treatise upon the game and food fishes of North America with especial reference to habits and methods of capture – *Sea basses excerpt*	Goode and Gill 1903
SEDAR25-RD27	American food and game fishes. A popular account of all the species found in America north of the equator, with keys for ready identification, life histories and methods of capture – *Centropristes excerpt*	Jordan and Evermann 1908
SEDAR25-RD28	Returns from the 1965 Schlitz tagging program including a cumulative analysis of previous results	Beaumariage 1969
SEDAR25-RD29	Source Document for the Snapper-Grouper Fishery of the South Atlantic region	SAFMC 1983
SEDAR25-RD30	FMP, Regulatory Impact Review, and final Environmental Impact Statement for the SG fishery of the South Atlantic region	SAFMC 1983
SEDAR25-RD31	Biological-statistical census of the species entering fisheries in the Cape Canaveral area	Anderson and Gehringer 1965
SEDAR25-RD32	Survey of offshore fishing in Florida	Moe 1963
SEDAR25-RD33	Southeastern US Deepwater reef fish assemblages, habitat characteristics, catches, and life history summaries	Parker and Mays 1998
SEDAR25-RD34	Sea bass pots: bigger mesh may yield larger fish	Lee 2007
SEDAR25-RD35	Migration and standing stock of fishes associated with artificial and natural reefs on Georgia's outer continental shelf	Ansley and Harris 1981
SEDAR25-RD36	The South Carolina fishery for black sea bass (*Centropristis striata*), 1977-1981	Low 1982
SEDAR25-RD37	Age sampling of the commercial snapper grouper fishery and age description of the black sea bass	Collier and Stewart, 2010

	fishery in North Carolina	
SEDAR25-RD38	Black sea bass 2009 stock assessment update (Northeast Fisheries Science Center Reference Document 09-16)	Shepherd 2009
SEDAR25-RD39	The recreational fishery in South Carolina: The Little River story	Burrell
SEDAR25-RD40	Otolith and histology interpretation workshop for golden tilefish and snowy grouper	Joint agency report 2009
SEDAR25-RD41	Age workshop for black sea bass (*Centropristis striata*)	Joint agency report 2009
SEDAR25-RD42	Population genetic structure of black seabass (*Centropristis striata*) on the eastern US coast, with an analysis of mixing between stocks north and south of Cape Hatteras, North Carolina	McCartney and Burton 2011
SEDAR25-RD43	Delineation of tilefish, *Lopholatilus chamaeleonticpes*, stocks along the United States east coast and in the Gulf of Mexico	Katz et al 1982
SEDAR25-RD44	Foreign fishing off the southeastern United States under the currently accepted contiguous sea limitation	Fuss
SEDAR25-RD45	Black sea bass, managing a fishery. A case study. *website document*	Camblos et al. 2005
SEDAR25-RD46	SAFMC Science and Statistics Committee, Bio-Assessment sub-committee	SA SSC 2003

2 Life History

2.1 Overview

State and federal biologists, academic representatives and industry representatives comprised the Life History Work Group (LHWG)

Jennifer Potts – NMFS, Beaufort, NC, Co-leader of LHWG
Joseph Ballenger – SCDNR, Charleston, SC, Co-leader of LHWG
Peter Barile – Industry Scientist, Florida
Tom Burgess – Industry Representative
Daniel Carr – NMFS, Beaufort, NC, Rapporteur
Chip Collier – NCDMF, Wilmington, NC
Kevin Craig – NMFS, Beaufort, NC
Laurie DiJoy – SCDNR, Charleston, SC
Nikolai Klibanski – UNC-Wilmington, Wilmington, NC
Kevin Kolmos – SCDNR, Charleston, SC
Linda Lombardi – NMFS, Panama City, FL
Paulette Mikell – SCDNR, Charleston, SC
Marcel Reichert – SCDNR, Charleston, SC
Rodolfo Serra – Instituto de Fomento Pesquero, Valparaiso, Chile
David Wyanski – SCDNR, Charleston, SC

The LHWG was tasked with combining life history data from SEDAR 2-SAR1 and SEDAR 2-SAR3 Update Report with updated and new life history data from three sources: National Marine Fisheries Service Beaufort Laboratory (NMFS), South Carolina Department of Natural Resources (SCDNR), and North Carolina Division of Marine Fisheries (NCDMF).

In order to combine age data from all sources, the LHWG needed to be sure that aging methodology between agencies was consistent. The three laboratories involved in aging US South Atlantic black sea bass participated in an age workshop, followed by an exchange of whole otoliths and otolith sections, to determine consistency in aging within this species. A document was prepared (SEDAR25-RD41) and all three laboratories were consistently aging the fish using the agreed upon aging methodology.

The LHWG was also tasked with reviewing the stock structure and unit stock definitions (SEDAR25-DW-TOR #1), reviewing, discussing and tabulating life history information where new information was available (SEDAR25-DW-TOR #2), and recommend discard mortality rates (SEDAR25-DW-TOR #3) to be applied to the various fisheries. These discussions will be addressed in their appropriate sections.

Finally, the LHWG was also tasked with providing recommendations for future research (SEDAR25-DW-TOR #7). Research recommendations stemming from discussions within the LHWG are tabulated and can be found in Section 7.1 of this Data Workshop Report.

2.2 Review of Working Papers

2.2.1 Black sea bass length frequencies and condition of released fish from at-sea headboat observer surveys, 2004-2010 (SEDAR25-DW01).

Abstract
The working paper submitted by Sauls et al. contains information on size frequencies and lower limits for headboat discard mortality relevant to the 2011 standard SEDAR for black sea bass. There are no apparent issues with discard mortality data (Table 4) which should represent a valuable estimate of the lower limit of discard mortality caught on headboats using hook and line. These estimates are regarded as lower limits because they represent immediate apparent mortality and do not take into account delayed mortality. It is important to note that these data were collected in Florida only. As water temperature is likely to be positively correlated with hooking mortality in this species, these estimates may be somewhat higher than if headboats in Georgia, South Carolina, and North Carolina were included. Given the potential effect of temperature, the authors should report what time of year discard data were collected. Any data or even basic estimates of water temperature and depth would also be valuable.

2.2.2 Klibansky and Scharf batch fecundity methods (SEDAR25-DW05).

Abstract
All black sea bass fecundity samples were collected in Onslow Bay off the coast of North Carolina during a cooperative study that involved scientists at the University of North Carolina and a commercial trap fisherman. Sampling with black sea bass traps was conducted in 2008 and 2009 on three main ledges with 0.3-1.2 m relief in three depth ranges. Size-based sub-sampling was used to select specimens from the entire size range of the catch. Only females that were confirmed histologically to be ripe (presence of hydrated but unovulated oocytes) were used to estimate batch fecundity (size); specimens with new postovulatory follicles were not utilized. Batch fecundity was determined by counting the hydrated oocytes in two 200-mg subsamples of preserved ovarian tissue with image analysis software (Image J). Oocyte density (# hydrated oocytes/subsample weight) was calculated for each sample. If the coefficient of variation for the two subsamples was > 10, then the data were omitted from analyses. Batch fecundity was calculated as the product of oocyte density and preserved gonad weight for 74 specimens and then simple linear regression analyses were performed with total length and whole fish weight as independent variables.

2.2.3 Black sea bass and tilefish discard mortality working paper (SEDAR25-DW10)

Abstract
Determining appropriate discard mortality rates for species of concern continues to present challenges for fishery modelers/managers, leading to a Discard Mortality Ad Hoc Working Group that was formed prior to the SEDAR 25 data workshop for black sea bass and golden tilefish. Members include Chip Collier, Kenny Fex, Paul Rudershausen, and Beverly Sauls. The result, SEDAR25-DW10 provides a thorough compilation of many studies reporting a variety of methods of determining discard mortality estimates as well as providing a wide range of discard mortality rates for black sea bass. This report (SEDAR25-DW10) summarizes many studies that have attempted to define factors affecting the discard mortality rates for fishes of the south Atlantic snapper-grouper fishery. Primary factors include injury from hook and line and barotrauma injury. The data workshop participants recommended a 4-15% discard mortality

rate. This rate is the same as the previous review of black sea bass (SEDAR 2). It is considerably lower than the highest rate reported by Stephen and Harris (66%). However, that rate was calculated from fish that were captured in deeper water by hook and line. Because larger fish are captured in deeper water, fewer fish were discarded resulting in a skewed estimate of discard mortality on sublegal fish. The managed fishery is predominately fished in shallower water with less impact on mortality due to barotrauma on sublegal fish. In light of the differences in discard mortality rates between traps and hook and line gear, separate rates for different gear types may be worth considering in future assessments. This comprehensive review of literature regarding discard mortality rates for black sea bass will allow for improved discard mortality estimate recommendations by the workshop panelists.

As tilefish habitat is so deep, coupled with the low number of discarded fish by the fishery, as well as a lack of information regarding discard mortality estimates for golden tilefish, all interested parties (from previous assessments in regions where tilefish are managed as well as SEDAR 25 panelists) concur that a discard mortality rate of 100% is appropriate for this species.

Critique
SEDAR 25 DW Working Document 10 was reviewed and deemed pertinent for the SEDAR process. This document provides a summary of literature reporting discard mortality rates for both black sea bass and tilefish that served as a reference for the LHWG when determining appropriate discard mortality rate estimates for black sea bass and golden tilefish.

2.3 Stock Definition and Description

The black sea bass occurs along the U.S. coast from Cape Cod, Massachusetts, to Cape Canaveral, Florida and in the Gulf of Mexico. The Gulf of Mexico black sea bass are considered a separate subspecies (Bowen and Avis, 1990) and thus, managed as its own stock. The black sea bass off the east coast of the U.S. has been managed as two separate stocks – Mid-Atlantic and South Atlantic. The stocks have been split at the Cape Hatteras, NC break. SEDAR 2 and update to SEDAR 2 used the current SAFMC management unit of black sea bass for consideration in the assessment input data. A recent genetic study of black sea bass off the U.S. east coast supports the separation of a Mid-Atlantic and South Atlantic stocks (SEDAR25-RD42). Preliminary analyses based on otolith microchemistry support this separation as well (see Section 2.3.3 for full description of otolith microchemistry). Tagging studies also suggest minimal movement of adult black sea bass in the South Atlantic region (see Section 2.9 for full description of tagging studies).

The LHWG recommended maintaining the current stock definition for the South Atlantic region – south of Cape Hatteras, NC through the east coast of Florida. Consensus was reached during the SEDAR 25 webinar, March 24, 2011.

2.3.1 Population genetics

Because questions arose in regards to the stock definition of black sea bass in the U.S. South Atlantic jurisdiction, a genetic study was undertaken (McCartney and Burton, SEDAR25-RD42). Black sea bass tissue samples were collected from Cape Cod, MA through the east coast of

Florida and the northern Gulf of Mexico. Fish were collected between the months of June and October (summer/fall) for stock delineation. They also collected samples from February to April (winter), which coincides with the spawning season, to address the hypothesis of winter migration of Mid-Atlantic fish into Onslow Bay, NC.

The results of this study showed three major regional stocks: the Gulf of Mexico, Mid-Atlantic and South Atlantic. The population residing in offshore waters between Cape Hatteras, NC and the Virginia line was transitional with approximately half of the fish from each of the Atlantic regions. In the winter samples, there was slightly elevated frequency of the Mid-Atlantic haplotype in Onslow Bay. This result may support the anecdotal information from commercial fishermen in the area, who suggest that there is a slight winter, southward migration of the Mid-Atlantic fish. Management implications from this study are that the black sea bass Mid-Atlantic and South Atlantic stocks, as currently managed, are well separated and have a long history of limited interbreeding.

Research Recommendation: The LHWG recommends further study of the possible southward, winter migration of Mid-Atlantic black sea bass into Onslow Bay, NC. A genetic study should focus on samples from the November –April and of the larger fish in the population.

2.3.2 Demographic patterns

Though the recent genetic study of black sea bass indicates one genetic stock in the U.S. South Atlantic, concern was raised that the fish off North Carolina and South Carolina may have different growth rates or other life history characteristics from those fish off Florida. The data presented in this section is only from the age data set available to SEDAR25. The oldest fish in the data set were caught off the Carolinas, but the largest fish was caught off Georgia. In the 2007 - 2010 commercial and recreational fishery, the modal age was 4 years for the Carolinas and 3 years for Florida (Figure 1). The length frequencies of black sea bass in the age data set were similar, but more, larger fish were landed in the Carolinas than in Florida (Figure 2), which helps explain the difference in modal age.

Based on the age data set available for SEDAR 25, no discernable difference in length-at-age of black sea bass caught in the commercial and recreational fisheries from the Carolinas and Florida was found. To eliminate confounding effects due to year, changing management regulations, and fishery and gear selectivity, a simple analysis of the mean length-at-age (± 1 SD) by region was done on the 2009-2010 commercial trap fishery and on the 2007-2010 recreational hook and line fishery (Figure 3). In the 2009-2010 commercial trap fishery, 99% of the fish landed were aged 2-6. There was no significant difference in mean length-at-age for any of the ages and all of the means differened by only 2 – 14 mm. In the 2007-2010 recreational fishery, 99% of the fish landed were aged 2-6 years. The biggest difference in length-at-age was seen in the 6 year olds, but they were not significantly different and sample sizes were low ($n_{Carolinas}$ = 26 and $n_{Florida}$ = 42).

2.3.3 Otolith microchemistry

Dr. Jason Schaffler (pers. comm., Old Dominion University's Center for Quantitative Fish Ecology) conducted a pilot analysis of black sea bass otolith microchemistry to determine if signatures were substantially different from different regions. His study included fish collected through MARMAP surveys off of the northern South Carolina and southern North Carolina coasts, samples collected off Virginia, and samples off Delaware. Preliminary analysis suggests there was no mixing between black sea bass collected from south of Cape Hatteras and those collected north of Cape Hatteras. When analyzed, all specimens were correctly classified to their true origin using their otolith chemistry.

2.4 Natural Mortality

The WG reviewed estimates of total and natural mortality (M) from various equations (Table 1). Using these equations, the panel developed a table of estimated M values (Table 2).

Several life history parameters (L_∞, k, age at maturity, maximum age) were needed to calculate point estimates of natural mortality (Table 3). Refer to other sections of this life history section report for the methodologies used to calculate each of the life history parameters. Average water temperatures were obtained from SCDNR MARMAP cruise data where black sea bass were collected.

Fourteen estimates of natural mortality (M) were derived using different functions for all data combined (Table 2 and Figure 4). The highest M (M = 2.7) was calculated using Beverton and Holt (1956), which uses the von Bertalanffy growth model parameters and the age that 50% of the population is mature (based on females). The Jensen (1996) method calcuated the lowest M of 0.27 that assumes M = 1.5* k. The LHWG recommends the $\text{Hoenig}_{\text{fish}}$ point estimate of M = 0.38, a value near the average value of M estimates from 11 of the 12 equations (excluding the Beverton and Holt (1956) outlier). The LHWG also recommends modeling the uncertainty in natural mortality through sensitivity runs with M ranging from 0.27 (corresponding to Jensen(1996)) to 0.53 (using $\text{Hoenig}_{\text{fish}}$ method with a maximum age of 8).

The 2003 SEDAR 2 used a point estimate of 0.30 with a range of 0.20-0.40 (Table 4). These values were chosen given the natural mortality estimates published by Low (1981) and Vaughan et al. (1995). Further investigation revealed that a natural mortality estimate of 0.30 was based on an assumption that black sea bass south of Cape Hatteras should have a shorter life span and a higher natural mortality than black sea bass north of Cape Hatteras (M=0.27; Low 1981). The Vaughan et al. (1995) value for natural mortality (M = 0.30) was calculated using a regression from Pauly (1980) with growth parameters L_∞ = 315 TL mm and k = 0.08yr^{-1} and an average water temperature of 20^{o}C. The range of sensitivities was based on MARMAP data maximum aged fish of 10 years (M = 0.40) and reports of black sea bass being as old as 20 yrs (M = 0.20; Vaughan et al. 1995).

The 2003 SEDAR 2 assumed the natural mortality rate was constant over all ages and times. During more recent SEDAR workshops, constant natural mortality rates across all sizes and ages have been considered unlikely, and, thus, an age-variable approach has been advocated (e.g., SEDAR 4, 10, 12, 15A, 19, and 22). A method for estimating mortality rates by age was developed by Lorenzen (2005). Based upon LHWG recommendations, Lorenzen estimates were computed for ages 0+ based on $\text{Hoenig}_{\textit{fish}}$ estimates of M for all available records (Figure 5). Results from the Gislason et al. (2010) age-specific mortality approach was also presented to the data workshop panel ,but the LHWG decided further investigation of this newly published approach should be completed before its use in SEDAR.

LHWG Recommendation:

Natural Mortality: The DW panel recommends using an age-variable M estimated using the Lorenzen method (Lorenzen 2005) assuming a base M = 0.38 calculated from $Hoenig_{fish}$ (1983). Sensitivity runs using a Lorenzen age-variable M with a base M ranging from 0.27-0.53 are also recommended.

2.5 Discard Mortality

A review of the literature found published discard mortality rates to range between 0.7% and 66.3%. Commonly referenced factors for estimating black sea bass discard mortality were hooking injury, barotrauma, gear type, and venting. Based on high tag returns (22.5% to 37.3% return rate) and a recent study conducted by Rudershausen et al. (2010, SEDAR25-RD10), it appears the overall discard mortality rate is low for this species; potentially lower than the 15% used in SEDAR 2. Rudershausen et al. (2010) estimated a discard mortality rate of 4.3% for hook and line and 0.7% for traps using the tag return approach of Heuter et al. (2006). These estimates of discard mortality are low when compared to other studies. There was some concern that the tagging study did not account for all sources of mortality. Assumptions of the model included: tagged and untagged fish had the same survival rate, fish in the best surviving category had 100% survivorship, and all fish were classified into the correct release categories. Some aspects of these assumptions were tested; however, more work is continuing to refine the estimate of discard mortality.

Other studies have reported discard mortality rates much higher than the Rudershausen et al. (2010) study including rates up to 67% (Stephen and Harris 2010). The depth fished in the Stephen and Harris (2010) study was much deeper than the depths that black sea bass are typically fished. Rudershausen et al. (2007, SEDAR25-RD20) also reported a discard mortality rate greater than 60% based on a random sampling of the depth distribution of depths where fish were caught. The depth range was 60 to 470 feet. Most of the depths samples in both of these studies extended beyond the normal depth range for commercial and recreational fisheries catching black sea bass (<120 feet).

Additionally tagging studies of black sea bass had high recovery rates which ranged between 22.5% and 37.3% (Moe 1966; Beaumariage 1969; Ansley and Harris 1981; Rudershausen et al. 2010). The recovery rates in many of the studies did not account for tag loss or reporting rates. Tag loss and reporting rates were included in the discard mortality estimate by Rudershausen et al. (2010). Ansley and Harris (1981) did note the potential for tag loss through time but did not estimate the rate. Since tag loss and reporting rates were not included in the estimated recovery rates, the recovery rates are a minimum for Moe (1966), Beaumariage (1969), and Ansley and Harris (1981).

Fish traps (all-panel and back-panel traps) had a lower discard mortality rate than hook and line gear (Rudershausen et al. 2008). Fish captured in traps appear less stressed than hook and line caught fish. This behavioral response potentially causes a difference in the synergistic response between the swim bladder inflation caused by decompression and lactic acid build up or stress response during capture.

There was discussion for different discard mortality rates due to different trap panel sizes. Rudershausen et al. (2008) estimated a higher discard mortality rate for traps with a 1 ½ inch panel compared to traps with 2 inch panels. Traps with smaller panel size would have a higher number of fish to release leading to a higher discard mortality due to increased deck and handling time (Rudershausen et al. 2008; supported by commercial fishermen at the workshop). A regulatory change from 1 ½ inch panel to a 2 inch panel went into effect in October 2006.

Discard mortality for trawls was considered; however, there were no estimates of discards from trawl gear. Since no estimate of discards was available, discard mortality will not be included in the assessment for trawl gear. Few estimates were available estimating black sea bass discard mortality in South Atlantic trawl fisheries.

Although depth was an important consideration for discard mortality, most of the effort and discard of black sea bass occurs in shallow water where barotraumas are expected to be lower. Currently there is no logistic regression of discard mortality regressed on depth, which was used for red snapper in SEDAR 24. Therefore, point estimates were developed for each gear type. The recommended discard mortality for black sea bass was 7% for hook and line, 5% for 1½ inch panel pots, and 1% for 2 inch panel pots. The 7% discard mortality rate for hook and line is slightly higher than the estimated value from Ruderhausen et al. (2010) due to assumptions in the tagging model. The lower bound for the estimate of discard mortality was 4% which was the estimated value from Rudershausen et al. (2010). An upper bound for hook and line discard mortality was 15% which was used in the previous assessment (SEDAR 2). The 5% discard mortality in traps with 1½ inch panels had a higher discard mortality than the 2 inch panel (1%) but lower than the hook and line. The value for 1½ inch panel also corresponds to discard mortality estimated in Rudershausen et al. (2008). The estimate for the 2 inch panel matches the discard mortality estimated using a tagging model (Rudershausen et al. 2010). The upper bound for both trap types was 15% to match SEDAR 2. No estimate of trawl discard mortality rate was developed.

Research Recommendations Discard Mortality

Further develop the tagging model described by Rudershausen et al. (2010) to address the assumptions of the model.

Depth appears to have an effect on the discard mortality rate. Currently depth specific discard rates and estimates of discard numbers are not available. There is very little depth specific information on the private recreational fleet.

Temperature and seasonality of discard mortality should be investigated.

Circle hooks are now required by the SAFMC for fishermen operating in the snapper grouper fishery. The impact of this regulation cannot currently be incorporated into the discard mortality rate.

Venting is not required in the South Atlantic but it is required in the Gulf of Mexico for snapper grouper fishermen. Research should be conducted on a variety of recompression techniques to determine the most effective method for reducing discard mortality.

2.6 Age

The NMFS, the SCDNR, and the NCDMF contributed both fishery-dependent and fishery-independent age data for this assessment. The final age data set included age dated collected from 1978 to 2010, with a total sample size of 67,355 aged fish. Of the total sample, the majority (n = 45,389) are from fishery-independent studies, with the primary source (n = 43,105) being samples collected by the Marine Resources Monitoring, Assessment and Prediction (MARMAP) program conducted by the SCDNR (Table 5) and the remaining samples (n = 2,284) collected by several smaller fishery-independent studies conducted by the SCDNR, the NMFS, and the NCDMF (Table 6). The remaining age samples are from fishery-dependent collections from both commercial (n = 15,704, Table 7) and recreational (n = 6,260, Table 8) fisheries. All age data included an increment count. Based on the timing of annulus formation and an estimate of the amount of translucent edge present, all increment counts were converted to calendar age (SEDAR25-RD41). Calendar ages were converted to fractional age using a March 1 birth day.

2.7 Growth

In SEDAR 2, black sea bass growth in the US South Atlantic was modeled using the von Bertalanffy growth equation presented in McGovern et al. (2002), which expressed length (standard length (SL) in mm) as a function of age a in years, based on a sample of 3,494 fish captured during 1987-1998 using blackfish and chevron traps. For the SEDAR-SAR3 Update Report on black sea bass, J. McGovern re-estimated the von Bertalanffy growth equation using the same data, except using total length (TL) in mm.

In both of these model formulations, the ages used in calculation of the von Bertalanffy growth equation were based on raw increment counts, without a conversion to calendar age based on timing of annulus formation and an estimate of the amount of translucent edge present. For the current assessment, the MARMAP program re-analyzed the McGovern et al. (2002) data and assigned an estimate of the amount of translucent edge present so that all increment counts could be converted to calendar ages.

In addition, the updated age data set used for this assessment includes 63,861 newly processed samples from fishery-dependent and fishery-independent sources for which increment counts, an estimate of translucent edge present, and month of capture were available (Tables 5-8). This large increase in sample sizes warranted the LHWG revisiting the growth of US South Atlantic black sea bass. Given these new samples, for this assessment we had age data for fish captured from 1978 to 2010 and from 27.3 to 34.6^{o}N.

Being a hermaphroditic fish species, any analysis looking for dimorphic growth between the sexes was not warranted, as reproductive analyses (see Section 2.8) indicate that females transition to males as they age. Thus, the LHWG did not develop sex specific growth curves for black sea bass.

A preliminary analysis of spatial and temporal variation in growth curves for black sea bass in the South Atlantic region was conducted using data from the MARMAP program. Exploratory analyses suggested similar growth curves across depth, latitude, and time periods. Though no formal statistical analysis was conducted, the slight apparent differences in growth with depth, latitude and time period occurred primarily for older ages (> age 6-8) where the model fit was not particularly good. This similarity in growth patterns within the South Atlantic region is consistent with the genetic data indicating no genetic differences from Cape Hatteras to Florida (section 2.3.1) and the similar mean size at age of black sea bass captured in Florida and in the Carolinas in both the commercial (Fig. 3a) and recreational (Fig. 3b) fishery.

Based on this increase in sample size, the LHWG recommended developing a modified von Bertalanffy growth model correcting for size limited data for all data combined to represent the growth of black sea bass in the US South Atlantic (Diaz et al. 2004). This is because growth models can be influenced by the use of size-biased samples, for example, due to minimum size limits affecting fishery-dependent sampling (Diaz et al. 2004). When all data (both fishery-independent and fishery-dependent sources) are combined, the resulting von Bertalanffy growth curve correcting for size-selective data is (Figure 6 and Table 9):

$$TL = 495.9 * \left(1 - e^{-0.177*(t+0.92)}\right) \qquad (1)$$

This model had an overall coefficient of variation (CV) of 0.18 with a standard error of 0.04. The model was fit using temporal-specific size limits for both the commercial and recreational fisheries (Table 10), with the assumption of a constant CV with age. In addition, the data in the model was weighted by inverse sample size at age, with the sample size for ages 9+ pooled. The model was fit to fractional ages as calculated in Section 2.7. The LHWG recommended the use of this model in the assessment to describe the growth of US South Atlantic black sea bass. This type of model was previously used to estimate growth curves for Atlantic and Gulf of Mexico gag grouper (SEDAR 10) as well as Gulf of Mexico (SEDAR 7) and Atlantic red snapper (SEDAR 15 and SEDAR 24).

2.8 Reproduction

Black sea bass are protogynous hermaphrodites (i.e., change sex from female to male). Iindividuals undergoing transition have been observed throughout the year, though the percentage of those in transition is low during the spawning season and highest when spent and resting individuals are collected (McGovern et al. 2003). The MARMAP program provided sex and maturity data (n = 43,711) on US South Atlantic black sea bass for this assessment. The data were collected over the period 1973-2010, with the majority (n = 40,744, >93% of total) of the samples collected via fishery-independent surveys. Of the total sample for which sex and maturity data were available, age data were also available for 39,171 individuals. All age-related results presented in this section were based on either calendar age or fractional age as calculated in Section 2.6. Information below on spawning seasonality, sexual maturity and transition, sex ratio, and spawning frequency is based on the most accurate technique (histology) used to assess reproductive condition in fishes.

2.8.1 Spawning seasonality

Based on the occurrence of hydrated oocytes and/or postovulatory follicles, spawning along the Atlantic coast of the southeastern US occurs in all months of the year except October, though peak spawning appears to occur in the spring from February to May (Figure 7). McGovern et al. (2002) also reported the greatest percentage of females in spawning condition during March-May. The greatest percentage of spawning individuals was seen during the month of March, thus when converting to fractional age for age-based analysis March was considered the month of peak spawning. In both the updated analysis and the McGovern et al. (2002) original paper, there is some indication of a potential small fall spawn in November, though McGovern et al. (2002) suggests that fall spawning does not occur every year.

2.8.2 Sexual maturity

In the SEDAR 2 SAR3 update, age at female maturity was estimated using the MARMAP sex, age and maturity data available for the original benchmark assessment of US South Atlantic black sea bass (SEDAR 2). In these reports, the authors provide age-specific estimates of female maturity, with the data separated into three time periods (1978-1983, 1984-1989, and 1990-2003) in the SEDAR2-SAR3 update report. Since the SEDAR2-SAR3 update report, the MARMAP program has been able to determine the age, sex, and maturity of numerous additional samples, thus the LHWG recommended an update to the age at female maturity relationship used in SEDAR2-SAR3.

As an initial analysis, the LHWG constructed period-specific age at female maturity ogives using logistic regression with multiple potential link functions. Given the long time series of data available, three periods were used in this analysis: early period (1978-1989), mid period (1990-1999), and late period (2000-2010). Results of these initial analyses revealed there was little difference in the age at 50% maturity estimated for the different periods, with the age at 50% female maturity less than 1 year of age (Table 11). For the early, mid, and late period the age at 50% female maturity was estimated at 0.89, 0.42, and 0.69 years, respectively. Thus the LHWG recommended an age at female maturity ogive be developed for all time periods combined.

In addition, the LHWG discussed the possibility of modeling the female age at maturity relationship on a depth- or latitude-specific basis similar to that considered for growth curves (see Section 2.7). Arguments against this type of analysis for the age at female maturity analysis were similar to those given against modeling US South Atlantic black sea bass growth on a latitude or depth specific basis. Primarily due to the lack of genetic studies (or other data sources) confirming separate black sea bass stocks in the US South Atlantic region, the LHWG came to a consensus that based on our stock definition (see Section 2.3) black sea bass female age at maturity should not be modeled on a depth or latitude specific basis. In addition there were concerns regarding possible confounding effects (i.e., gear effects) making it more difficult to correctly assess the possibility of depth- or latitudinal variation in age at female maturity patterns. Thus the LHWG recommended an age at female maturity ogive be developed for all time periods combined.

To estimate maturity of females at age, logistic regressions with a logit, probit, and clog-log link function were fit to all maturity data for females (n = 26,731) collected by the MARMAP program on US South Atlantic black sea bass from 1978 to 2010. The logistic regressions modeled the relationship between the percent of females mature at age versus fractional age. Akaike's (1974) information criteria suggested that the logistic regression with the logit link function best fit the data (Table 12 and Figure 8). Region-wide observed and predicted (based on logistic regression with logit link) maturity ogives for female maturity at fractional age are available in tabular format in Table 13.

The logistic regression growth curve predicts that a small percentage (Table 13) of US South Atlantic black sea bass would mature, and potentially spawn, during their first year of life. This is not biologically realistic, thus the LHWG and data panelists recommended that maturity during the first year of life (< 1 years old) be set to 0. In addition, panelists discussed the possibility that the maturity ogive may need to be shifted to account for the timing of reproduction relative to the time that samples were collected (e.g., sampled age-1 maturity applies to 'next' year's age-2 spawners).

Recommendation

The LHWG recommended the use of the logistic regression with logit link maturity ogives for female black sea bass generated for specimens collected throughout the US South Atlantic region be used in the assessment, with the caveat that maturity during the first year of life (<1 years old) be set to 0. Recommendation was accepted at the plenary session of the Data Workshop.

2.8.3 Sexual Transition

In the SEDAR 2 SAR3 Update Report on US South Atlantic black sea bass, there does not appear to be an attempt to model age at sexual transition from male to female; only the observed proportion of males at age based on the available MARMAP maturity and sex data were provided. Given this, the LHWG felt the need to model the age-at-transition from female to male in this assessment explicitly.

As an initial analysis, the LHWG constructed period-specific age at transition ogives using logistic regression with the same link functions and period definitions used in the age at female maturity analysis. Results of these initial analyses revealed there was little difference in the predicted % male at age estimated for the different periods (Table 14), with the age at 50% transition from female to male estimated as 3.64, 3.32 and 3.59 years for the early, mid, and late period, respectively. Thus the LHWG recommended an age at female maturity ogive be developed for all time periods combined.

In addition, the LHWG discussed the possibility of modeling the age at transition from female to male relationship on a depth- or latitude-specific basis. Arguments against this type of analysis for the age at transition analysis were similar to those given against modeling US South Atlantic black sea bass growth and age at female maturity on a latitude or depth specific basis. Primarily, due to a lack of genetic (or other data sources) studies confirming separate black sea bass stocks in the US South Atlantic region, the LHWG came to a consensus that based on our stock definition (see Section 2.3) we should not model black sea bass age at transition on a depth or latitude specific basis. There were additional concerns regarding possible confounding effects (i.e., gear effects) making it more difficult to correctly assess the possibility of depth or latitude specific age at transition patterns. Thus the LHWG recommended an age at transition ogive be developed for all time periods combined.

To estimate age at transition, logistic regressions with a logit, probit, and clog-log link function were fit to all maturity data for males and females (n = 36,231) collected by the MARMAP program on US South Atlantic black sea bass from 1978 to 2010. The logistic regressions modeled the relationship between the percentage of males at age versus fractional age. Akaike's (1974) information criteria suggested that the logistic regression with the logit link function best fit the data (Table 15 and Figure 9). This information suggests that 50% of US South Atlantic black sea bass transition to male on average by their fourth year of life. Region-wide observed and predicted (based on logistic regression with logit link) percent male at fractional age ogives are available in tabular format in Table 16. In addition, panelists discussed the possibility that the maturity ogive may need to be shifted to account for the timing of reproduction relative to the time that samples were collected (e.g., sampled age-1 maturity applies to 'next' year's age-2 spawners).

Recommendation

The LHWG recommended the use of the logistic regression with logit link to model the age at transition from female to male for specimens collected throughout the US South Atlantic region be used in the assessment. Recommendation was accepted at the plenary session of the Data Workshop.

2.8.3 Sex ratio

Being a hermaphroditic species and that the LHWG estimated a logistic regression to predict the percent male at fractional age relationship for the US South Atlantic region (Section 2.8.2), the LHWG did not feel calculating age-specific ratios would provide any additional information. This information is contained within the age at transition analysis. This recommendation was presented to the plenary session of the Data Workshop and accepted by panelists.

2.8.4 Batch fecundity (BF)

Wenner et al. (1986) produced equations relating fecundity to body weight, total length, and age, but those equations yield a point estimate of fecundity (i.e., number of vitellogenic oocytes in ovary), not an estimate of batch size that can then be used to estimate annual fecundity.

Equations that describe the relationship between batch fecundity and age, total length, and whole fish weight were generated after combining datasets from the MARMAP program and an on-going study at the University of North Carolina at Wilmington (UNCW). The MARMAP fecundity samples were collected during 2000-2009 off South Carolina and the UNCW samples were collected during 2008-2009 off North Carolina. The methodologies of these two studies were very similar, as migratory- nucleus and/or hydrated oocytes were counted in two samples per specimen. The primary difference between the studies was the size of sub-samples (75 mg for MARMAP, 200 mg for UNCW). A plot of the natural log of batch fecundity versus total length revealed that the data from the studies shared a similar slope and elevation (Figure 10). Equations that related batch fecundity to total length or whole fish weight exhibited the strongest relationship, with an adjusted $r^2 = 0.29$ and 0.38, respectively (Table 17). The equation relating batch fecundity to age was also reasonably strong ($r^2 = 0.20$) compared to other published studies. The adjusted r^2 value this equation is typically < 0.1 in reef fishes owing to the high variability in size at age. Though the assessment is age based, the LHWG recommended using the natural log of batch fecundity versus whole fish weight (Figure 11) in the assessment. This equation showed the strongest correlation and included data from both the UNCW study and the MARMAP study.

2.9 Movements & Migrations

Larval black sea bass settle in coastal and estuarine waters often near structure (Steimle et al. 1999). Black sea bass migrate to offshore reefs as they get larger. Once the fish migrate to offshore reefs, site fidelity is very high (Moe 1966; Beaumariage 1969; Parker et al. 1977; Ansley and Harris 1981; Rudershausen et al. 2010). However, fishermen in the South Atlantic and north of Cape Hatteras describe large scale migrations of black sea bass (Steimle et al. 1999; fishermen comments at SEDAR 25). Fishermen report large black sea bass migrating from either offshore or from northern areas during the winter. Black sea bass north of Cape Hatteras migrate south and to deeper water during the fall and migrate back inshore in the spring (Steimle et al. 1999). The five tagging studies described below have observed limited movements with the exception of one fish that migrated 259 km (Ansley and Harris 1981).

Moe (1966) tagged 89 black sea bass with a variety of tags and recaptured 22 (25% recapture rate) off the east coast of Florida. All of the fish were recaptured in the release location. They also reviewed other tagging studies and did not report movement or migrations of black sea bass.

Beaumariage (1969) tagged 788 black sea bass and recaptured 294 (37.3% recapture rate) on the east coast of Florida as part of the Schlitz Tagging Program. No significant movements were reported for black sea bass. Additionally, he noted the few fish that were recaptured during the winter were caught near their release location.

Parker et al. (1977) tagged 145 black sea bass and recaptured 34 (23% recapture rate) off South Carolina. All fish were recaptured within 250 feet of the capture and release location. Eighty-nine percent of the black sea bass were observed by divers within 100 feet of the release location.

Ansley and Harris (1981) tagged 4,343 black sea bass and recaptured 1,442 (33% recapture rate) off Georgia. The majority of the fish (98%) were recaptured within one km of the release site. One fish migrated 259 km in 31 days.

Rudershausen et al. (2010) tagged 4,555 black sea bass and recaptured 1,025 (22.5% recapture rate). All of the fish were released and recaptured in Onslow Bay off North Carolina. The fish ranged in size from 6 inches to 18 inches total length and were tagged throughout the year for three years.

Based on the tagging research conducted on adult black sea bass, site fidelity on offshore reefs appears high for black sea bass in the South Atlantic. More research is needed to address the observation by fishermen that a migrating stock exists for black sea bass. The movements of eggs and larvae and the migration of juvenile black sea bass are also important considerations for defining stock structure. Some local retention (within state) of black sea bass eggs and larvae as well as dispersal from spawning areas off Florida, Georgia, and South Carolina to reefs off each state was predicted by a 3D circulation model. Predicted larval dispersal and success for North Carolina spawning and recruitment locations was not considered in the model (Edwards et al. 2008, SEDAR25-RD18). The migration of juvenile black sea bass to offshore spawning locations is unclear. Research is needed to determine the timing of the migration to offshore habitats, the age at which fish migrate offshore, and the relative contribution of recruitment locations to the offshore spawning stock biomass.

2.10 Meristics & Conversion Factors

Black sea bass are measured for length and weight in fishery-dependent and fishery-independent surveys. Due to the rounded caudal fin (no fork), black sea bass lengths are based on total length (TL). Some fishery surveys have coded the length type as fork length (FL), which are measured as the center line of the tail and are treated as TL measurements without conversion. Often a fishery survey will include data on standard length (SL), which can be used if the caudal fin is damaged and total length cannot be measured. Table 18 includes the parameters for TL-SL conversions as used in SEDAR 2.

In the commercial fishery, fish are often gutted at sea to preserve the flesh for market. A whole weight to length conversion is needed to estimate the weight of the landed fish. New data were available to update the weight – length regression from SEDAR 2. The data used were from the SCDNR MARMAP survey and the Headboat Survey from 1972 – 2010. The data were linearized by the ln-ln transformation and then converted to the power equation $W = a TL^{b}$. The parameters from the regression are included in Table 18.

Recommendation: Treat FL as equivalent to TL. Use the TL-SL conversion from SEDAR 2. Update the W - TL relation with additional data.

2.11 Comments on Adequacy of Data for Assessment Analyses

The life history working group did not discuss the relative merits of specific data sources, but generally agreed the data were collected and analyzed in an appropriate and defensible manner for assessment purposes.

2.12 Itemized List of Tasks for Completion Following Workshop

None provided.

2.13 Literature Cited

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2.14 Tables

Table 1. List of age based natural mortality (M) point estimate methods in order of year of publication. Parameters: k – von Bertalanffy growth coefficient (yr^{-1}), age mat – age at 50% maturity, tmax – maximum age (yr), L_∞ - asymptotic length (mm) determined from on Bertalanffy growth model, temp – average water temperature (^oC), S – survivorship. Equations provided in Microsoft Excel notation.

Method	Parameters	Equation
Alverson & Carney (1975)	k, tmax	M = 3*k/[exp(0.38*tmax*k)-1]
Beverton & Holt (1956)	k, age mat	M = 3*k/[exp(age mat*k)-1])
Hoenig fish (1983)	tmax	M=exp(1.46 - 1.01*ln(tmax))
Hoenig all taxa (1983)	tmax	M=exp(1.44-0.982*ln(tmax))
Pauly I (1980)	k, L_∞, temp	M=exp[-0.0152+0.6543*ln(k)-0.279*ln(L_∞) +0.4634*ln(temp)]
Pauly II (Pauly & Binohlan 1996)	k, L_∞, temp	M=exp[-0.1464+0.6543*ln(k)-0.279*ln(L_∞) +0.4634*ln(temp)]
Ralston I (1987)	k	M=0.0189 + 2.06*k
Ralston II (Pauly & Binohlan 1996)	k	M=-0.1778+3.1687*k
Jensen (1996)	k	M = 1.5*k
Hewitt & Hoenig (2005)	tmax	M = 4/tmax
Alagaraja (1984)	S, tmax	M=-(lnS)/tmax

Table 2. Point estimates of natural morality (M) using multiple regressions (see Table 1 for equations and citations).

Method	All data combined
Alverson & Carney	0.4846
Beverton & Holt	2.7423
Hoenig $_{fish}$	0.3822
Hoenig $_{all\ taxa}$	0.4006
Pauly	0.4583
Pauly Method II	
(snappers and groupers)	0.4020
Ralston	0.3835
Ralston	
(geometric mean)	0.3794
Ralston Method II	0.3831
Jensen	0.2655
Hewitt & Hoenig	0.3636
Alagaraja (S = 0.01)	0.4187
Alagaraja (S = 0.03)	0.3556
Alagaraja (S = 0.05)	0.2723

Table 3. Life history parameters used in natural mortality regressions.

Life History Parameter	All data combined
Sample Size	65,535
L_∞ (mm)	495.90
k (yr^{-1})	0.18
Maximum Age (yr)	11
Age (yr) at 50% maturity	1
Water temperature ^oC	23.21
Survivorship (S)	0.01, 0.02, 0.05

Table 4. Published estimates of natural mortality (M) used in previous assessments.

Citation	M	Rational
Mercer 1978	0.27	Original citation not recovered M based on fish North of Cape Hatteras
Low 1981	0.30	Black sea bass south of Cape Hatteras appear to have shorter life spans, M probably higher than Mercer 1978
NEFSC 1991	0.30	No rational
SEFSC 1992	0.30	No rational
Vaughan et al. 1995	0.30	Based on Pauly 1980; Parameters used: L_∞ = 315 TL mm, k = 0.08 yr^{-1}, average water temperature 20^{o}C, data 1978-1990, n = 15,992
Vaughan 1996	0.30	Based on Pauly 1980; Parameters used: L_∞ = 325 TL mm, k = 0.08 yr^{-1}, average water temperature 20^{o}C, data 1978-1995, n = 17,729
SEDAR 2003	0.30	Based on Low 1981 and Vaughan 1995

Table 5. Number of fishery-independent age samples collected by the MARMAP program in the US South Atlantic by year and gear.

Year	Chevron Trap	Blackfish Trap	Florida "Antillean" Trap	Rod and Reel combined	Yankee Trawl	Misc. Traps	Vertical Longline	Fly Net	Kali Pole
1978		285			323	395			
1979		1035		550	728	53			
1980		1034	40	976		123		190	
1981		684	288	1072				8	
1982		458	444	957					
1983		3826	1642	1128					6
1984		1250	305	551					
1985		701	1	503					
1986		420	14	290					
1987		279	33	250					
1988	267	197	195	271					
1989	249	156	125	203					
1990	1013			141					
1991	913			45		76			
1992	849			38					

1993	974	66
1994	858	34
1995	628	17
1996	1171	1
1997	1110	9
1998	1078	
1999	835	
2000	1039	113
2001	886	8
2002	841	
2003	721	
2004	841	

Table 5. continued.

Year	Chevron Trap	Blackfish Trap	Florida "Antillean" Trap	Rod and Reel combined	Yankee Trawl	Misc. Traps	Vertical Longline	Fly Net	Kali Pole
2005	1312								
2006	996			18		11	1		
2007	1101			2					
2008	710					2			
2009	740					1			
2010	1385					16			

Table 6. Number of black sea bass fishery-independent age samples collected by the MARMAP program in the US South Atlantic by fishery-independent study (excluding MARMAP), gear and year.

	FI Trap Comparison			FI SRFAC	SEAMAP		NMFS SEFIS		NMFS Research	NCDMF Research	
Year	**Blackfish Trap**	**Florida 'Antillean' Trap**	**Chevron Trap**	**mini-Antillean Trap**	**Rod & Reel**	**Chevron Trap**	**Chevron Trap**	**Chevron Trap w/camera**	**Hook & Line**	**Gill Net**	**Hook & Line**
2002									**5**		
2003											
2004	171	186	199								
2005	62	76	68						73		24
2006	83	86	93						129		
2007											
2008										6	
2009				80					1		
2010					27	190	74	637	14		

Table 7. Number of black sea bass age samples (# of trips sampled) collected via fishery-dependent surveys of commercial fisheries in the US South Atlantic by year, state, and gear.

	Florida			North Carolina			South Carolina					
Year	**Vertical Hook & Line**	**Bottom Longline**	**Trap**	**Vertical Hook & Line**	**Trap**	**Unk**	**Diver**	**Vertical Hook & Line**	**Bottom Longline**	**Trap**	**Trawl**	**Unk**
1979										19 (1)	29 (4)	
1980												
1981								190 (1)				
1982								200 (1)		26 (1)		
1983								50 (2)				
1984								2 (2)				
1985								2 (2)				
1986												
1987												
1988												
1989												
1990												
1991								4 (1)		7 (1)		

1992					49 (6)			
1993								
1994					77 (5)			
1995								
1996								
1997	22 (4)							
1998	23 (3)	6 (1)						
1999							120 (1)	
2000								
2001								
2002	5 (1)				76 (3)			9 (1)
2003	8 (2)		26 (2)	41 (3)	388 (17)	21 (2)		

Table 7. continued.

	Florida			North Carolina			South Carolina					
Year	**Vertical Hook & Line**	**Bottom Longline**	**Trap**	**Vertical Hook & Line**	**Trap**	**Unk**	**Diver**	**Vertical Hook & Line**	**Bottom Longline**	**Trap**	**Trawl**	**Unk**
2004	4 (2)			216 (29)	127 (6)	45 (2)		389 (11)				
2005	1 (1)			530 (55)	423 (22)			305 (22)				
2006				488 (41)	739 (25)			321 (68)		46 (4)		
2007				571 (46)	2004 (68)		5 (1)	208 (68)		120 (14)		
2008	3 (1)		13 (1)	314 (38)	1944 (87)			236 (75)		141 (12)		
2009	80 (7)		388 (14)	495 (52)	1757 (81)		2 (2)	118 (44)		107 (13)		
2010			733 (23)	338 (44)	771 (33)		6 (1)	248 (42)		68 (3)		

Table 8. Number of black sea bass age samples (# of trips sampled) collected via fishery-dependent surveys of recreational fisheries in the US South Atlantic by year, sector, and state.

	Headboat				Charter Boat				Private Recreational Boat				Shore
Year	**FL**	**GA**	**NC**	**SC**	**FL**	**GA**	**NC**	**SC**	**FL**	**GA**	**NC**	**SC**	**GA**
1988	3 (1)			4 (2)									
1989	1 (1)			4 (2)									
1990	17 (6)		8 (5)										
1991	18 (7)		41 (18)	26 (18)									
1992	18 (8)		20 (8)	22 (15)									
1993	3 (2)		3 (2)	1 (1)									
1994	3 (1)		2 (1)										
1995			2 (1)										
1996	16 (6)		8 (5)	3 (1)									
1997	1 (1)		3 (1)			8 (1)							
1998		17 (2)		58 (7)	1 (1)	155 (16)	44 (3)	23 (5)		102 (21)	30 (3)	19 (7)	5 (1)
1999													
2000	1 (1)												
2001					9 (4)								

2002			7 (4)	16 (11)	82 (28)	2 (1)		
2003	42 (19)		54 (8)	9 (4)	75 (20)	2 (1)		
2004	173 (36)		56 (15)	5 (2)	565 (45)	2 (1)		
2005	347 (48)		133 (56)		131 (33)	8 (3)		
2006	796 (91)		105 (22)	165 (134)	171 (16)	2 (1)		
2007	384 (71)		138 (71)	149 (129)	27 (3)		10 (1)	
2008	176 (58)		34 (8)	99 (95)			2 (1)	
2009	255 (78)	3 (3)	135 (24)	124 (113)			19 (2)	
2010	673 (192)	2 (2)	252 (47)	102 (100)			29 (4)	

Table 9. von Bertalanffy growth model parameter estimates for all data combined, corrected for minimum size limit bias (Diaz et al. 2004).

Parameter	Estimate	Standard Error
Linf	495.9	154.5
K	0.177	0.118
t_0	-0.92	0.61
CV	0.18	0.04

Table 10. Size limit regulations and effective dates for the US South Atlantic commercial and recreational black sea bass fisheries. These size limits were accounted for when estimating the growth curve by using a Diaz correction (Diaz et al. 2004).

Fishery	**No MLL**	**8 in MLL**	**10 in MLL**	**11 in MLL**	**12 in MLL**
Commercial	< 8/31/82	8/31/82 - 1998	Since 1999	–	–
Recreational	< 8/31/82	8/31/82 - 1998	1999 - 10/22/2006	10/23/2006 - 6/1/2007	Since 6/1/2007

Table 11. Percentage of observed and predicted mature female black sea bass by calendar age in each period. Percent mature predicted was calculated using logistic regression with a probit, a clog-log, and a logit link for the early, mid, and late period, respectively. These regressions were selected as the most appropriate for the period in question based on AIC analysis.

Age	# Immature	# Mature	# Total	Obs. % Mature	Pred. % Mat
Early Period (1978-1989)					
0	41	3	44	0.07	0.12
1	285	353	638	0.55	0.56
2	235	3273	3508	0.93	0.93
3	16	5586	5602	1.00	1.00
4	1	2442	2443	1.00	1.00
5	0	592	592	1.00	1.00
6	0	128	128	1.00	1.00
7	0	24	24	1.00	1.00
8	0	8	8	1.00	1.00
Mid Period (1990-1999)					
1	132	522	654	0.80	0.79
2	81	2149	2230	0.96	0.97
3	0	2071	2071	1.00	1.00
4	0	858	858	1.00	1.00
5	0	189	189	1.00	1.00
6	0	41	41	1.00	1.00
7	0	15	15	1.00	1.00
Late Period (2000-2010)					
1	205	324	529	0.61	0.63
2	178	2119	2297	0.92	0.91

3	46	2676	2722	0.98	0.98
4	6	1445	1451	1.00	1.00
5	1	537	538	1.00	1.00
6	0	101	101	1.00	1.00
7	0	29	29	1.00	1.00
8	0	6	6	1.00	1.00

Table 12. Logistic regression parameter estimates for female age at maturity for US South Atlantic black sea bass. Also included is the predicted age at 50% female maturity and AIC for each different link function.

Link	n	a	SE	b	SE	Age at 50% maturity	AIC
Logit	26731	-1.988	0.1009	2.064	0.0488	0.96	7195.88
Probit	26731	-0.801	0.0552	0.999	0.0246	0.80	7220.98
clog-log	26731	-0.592	0.0447	0.670	0.0182	0.88	7324.87

Table 13. Percentage of observed and predicted mature female black sea bass by fractional age. Percent mature predicted was calculated using a logistic regression with a logit link function. This model was selected most appropriate based on AIC analysis (Table 2.8.2).

Age (yrs)	# Immature	# Mature	# Total	Obs. % Mature	Pred % Mature
0.17	0	2	2	1.00	0.16
0.25	0	1	1	1.00	0.19
0.33	1	1	2	0.50	0.21
0.50	41	1	42	0.02	0.28
0.58	1	0	1	0.00	0.31
0.83	0	2	2	1.00	0.43
1.00	1	3	4	0.75	0.52
1.08	15	53	68	0.78	0.56
1.17	46	274	320	0.86	0.60
1.25	90	259	349	0.74	0.64
1.33	176	274	450	0.61	0.68
1.42	118	169	287	0.59	0.72
1.50	155	136	291	0.47	0.75
1.58	19	25	44	0.57	0.78
1.67	1	4	5	0.80	0.81
1.83	0	25	25	1.00	0.86
1.83	1	0	1	0.00	0.86
1.92	0	7	7	1.00	0.88
2.00	0	143	143	1.00	0.89
2.08	86	616	702	0.88	0.91
2.17	31	1377	1408	0.98	0.92

2.25	168	1877	2045	0.92	0.93
2.33	81	1556	1637	0.95	0.94
2.42	83	1063	1146	0.93	0.95
2.50	39	688	727	0.95	0.96
2.58	1	58	59	0.98	0.97
2.67	3	82	85	0.96	0.97
2.75	0	1	1	1.00	0.98
2.83	2	95	97	0.98	0.98
2.92	0	53	53	1.00	0.98
3.00	0	157	157	1.00	0.99
3.08	0	1370	1370	1.00	0.99
3.17	8	1900	1908	1.00	0.99
3.25	11	2504	2515	1.00	0.99
3.33	18	1838	1856	0.99	0.99
3.42	13	1467	1480	0.99	0.99
3.50	9	714	723	0.99	0.99
3.58	1	44	45	0.98	1.00
3.67	2	67	69	0.97	1.00

Table 13. Continued

3.75	0	4	4	1.00	1.00
3.83	0	232	232	1.00	1.00
3.92	0	113	113	1.00	1.00
4.00	0	63	63	1.00	1.00
4.08	0	651	651	1.00	1.00
4.17	0	809	809	1.00	1.00

4.25	0	1256	1256	1.00	1.00
4.33	2	823	825	1.00	1.00
4.42	3	538	541	0.99	1.00
4.50	1	275	276	1.00	1.00
4.58	0	5	5	1.00	1.00
4.67	0	29	29	1.00	1.00
4.75	0	3	3	1.00	1.00
4.83	1	147	148	0.99	1.00
4.92	0	48	48	1.00	1.00
5.00	0	25	25	1.00	1.00
5.08	0	211	211	1.00	1.00
5.17	0	219	219	1.00	1.00
5.25	0	313	313	1.00	1.00
5.33	0	191	191	1.00	1.00
5.42	1	151	152	0.99	1.00
5.50	0	43	43	1.00	1.00
5.58	0	1	1	1.00	1.00
5.67	0	17	17	1.00	1.00
5.83	0	79	79	1.00	1.00
5.92	0	9	9	1.00	1.00
6.00	0	4	4	1.00	1.00
6.08	0	56	56	1.00	1.00
6.17	0	31	31	1.00	1.00
6.25	0	43	43	1.00	1.00
6.33	0	30	30	1.00	1.00

6.42	0	33	33	1.00	1.00
6.50	0	15	15	1.00	1.00
6.67	0	2	2	1.00	1.00
6.83	0	37	37	1.00	1.00
6.92	0	2	2	1.00	1.00
7.00	0	1	1	1.00	1.00
7.08	0	8	8	1.00	1.00
7.17	0	7	7	1.00	1.00
7.25	0	17	17	1.00	1.00
7.33	0	5	5	1.00	1.00

Table 13. Continued

7.42	0	12	12	1.00	1.00
7.50	0	5	5	1.00	1.00
7.75	0	1	1	1.00	1.00
7.83	0	9	9	1.00	1.00
8.08	0	1	1	1.00	1.00
8.17	0	2	2	1.00	1.00
8.25	0	2	2	1.00	1.00
8.33	0	4	4	1.00	1.00
8.42	0	3	3	1.00	1.00
8.83	0	6	6	1.00	1.00
9.25	0	1	1	1.00	1.00
9.33	0	2	2	1.00	1.00
9.83	0	1	1	1.00	1.00

10.33	0	1	1	1.00	1.00

*In assessment, fixed % maturity of females at 0 for females less than 1 years of age

Table 14. Percentage of observed and predicted male black sea bass by calendar age in each period. The percent of mature males was predicted using logistic regression with a logit link for the early, mid, and late period, respectively. These regressions were selected as the most appropriate for the period in question based on AIC analysis.

Age	# Female	# Male	# Total	Obs. % Male	Pred. % Male
Early Period (1978-1989)					
1	320	68	388	0.18	0.10
2	2876	894	3770	0.24	0.20
3	4665	2354	7019	0.34	0.37
4	1856	2475	4331	0.57	0.57
5	383	1650	2033	0.81	0.75
6	94	663	757	0.88	0.88
7	18	226	244	0.93	0.94
8	6	67	73	0.92	0.97
9	1	11	12	0.92	0.99
Mid Period (1990-1999)					
1	457	69	526	0.13	0.10
2	1751	414	2165	0.19	0.22
3	1574	1217	2791	0.44	0.42
4	561	1135	1696	0.67	0.66
5	116	572	688	0.83	0.84
6	19	197	216	0.91	0.93
7	5	90	95	0.95	0.97
8	2	20	22	0.91	0.99
9	0	6	6	1.00	1.00
Late Period (2000-2010)					

1	257	50	307	0.16	0.10
2	1688	347	2035	0.17	0.21
3	1876	1222	3098	0.39	0.38
4	891	1384	2275	0.61	0.58
5	282	871	1153	0.76	0.76
6	50	276	326	0.85	0.88
7	15	137	152	0.90	0.94
8	6	27	33	0.82	0.97
9	0	9	9	1.00	0.99

Table 15. Logistic regression parameter estimates for age at transition from female to male for US South Atlantic black sea bass. Also included is the predicted age at 50% transition to male and AIC for each different link function.

Link	n	a	SE	b	SE	Age at 50% maturity	AIC
Logit	36231	-3.272	0.0435	0.853	0.0117	3.83	42600.5
Probit	36231	-1.946	0.0247	0.506	0.0066	3.85	42723.9
clog-log	36231	-2.481	0.0294	0.532	0.0072	4.66	43011.2

Table 16. Percentage of observed and predicted male black sea bass by fractional age. Percent mature predicted was calculated using a logistic regression with a logit link function. This model was selected most appropriate based on AIC analysis (Table 2.8.5).

Age	# Female	# Male	# Total	Obs. % Male	Pred. % Male
0.17	2	0	2	0.00	0.04
0.25	1	0	1	0.00	0.04
0.33	1	0	1	0.00	0.05
0.50	1	1	2	0.50	0.05
0.83	2	0	2	0.00	0.07
1.00	0	1	1	1.00	0.08
1.08	52	12	64	0.19	0.09
1.17	206	37	243	0.15	0.09
1.25	222	46	268	0.17	0.10
1.33	256	31	287	0.11	0.11
1.42	155	19	174	0.11	0.11
1.50	118	33	151	0.22	0.12
1.58	20	7	27	0.26	0.13
1.67	3	0	3	0.00	0.14
1.83	24	2	26	0.08	0.15
1.83	0	1	1	1.00	0.15
1.92	3	1	4	0.25	0.16
2.00	57	20	77	0.26	0.17
2.08	535	142	677	0.21	0.18
2.17	1080	261	1341	0.19	0.19
2.25	1634	365	1999	0.18	0.21
2.33	1342	354	1696	0.21	0.22

2.42	934	172	1106	0.16	0.23
2.50	546	281	827	0.34	0.24
2.58	49	24	73	0.33	0.26
2.67	64	24	88	0.27	0.27
2.75	0	1	1	1.00	0.28
2.83	84	25	109	0.23	0.30
2.92	28	12	40	0.30	0.31
3.00	60	79	139	0.57	0.33

Table 16. Continued

3.08	1221	476	1697	0.28	0.35
3.17	1505	919	2424	0.38	0.36
3.25	1944	1027	2971	0.35	0.38
3.33	1394	972	2366	0.41	0.39
3.42	1201	671	1872	0.36	0.41
3.50	532	469	1001	0.47	0.43
3.58	22	50	72	0.69	0.45
3.67	40	41	81	0.51	0.46
3.75	1	3	4	0.75	0.48
3.83	175	99	274	0.36	0.50
3.92	61	52	113	0.46	0.52
4.00	20	37	57	0.65	0.54
4.08	546	543	1089	0.50	0.55
4.17	556	1036	1592	0.65	0.57
4.25	840	1227	2067	0.59	0.59
4.33	575	909	1484	0.61	0.60

4.42	375	669	1044	0.64	0.62
4.50	194	349	543	0.64	0.64
4.58	5	7	12	0.58	0.65
4.67	17	35	52	0.67	0.67
4.75	3	0	3	0.00	0.69
4.83	91	113	204	0.55	0.70
4.92	21	62	83	0.75	0.72
5.00	3	24	27	0.89	0.73
5.08	154	508	662	0.77	0.74
5.17	125	615	740	0.83	0.76
5.25	171	624	795	0.78	0.77
5.33	119	487	606	0.80	0.78
5.42	98	432	530	0.82	0.79
5.50	28	143	171	0.84	0.81
5.58	0	5	5	1.00	0.82
5.67	8	21	29	0.72	0.83
5.75	0	2	2	1.00	0.84
5.83	41	161	202	0.80	0.85
5.92	3	22	25	0.88	0.86
6.00	3	8	11	0.73	0.86
6.08	42	245	287	0.85	0.87
6.17	17	175	192	0.91	0.88
6.25	22	193	215	0.90	0.89
6.33	16	139	155	0.90	0.89
6.42	17	135	152	0.89	0.90

Table 16. Continued

6.50	11	105	116	0.91	0.91
6.58	0	2	2	1.00	0.91
6.67	0	2	2	1.00	0.92
6.83	26	96	122	0.79	0.93
6.92	0	9	9	1.00	0.93
7.00	0	2	2	1.00	0.94
7.08	6	70	76	0.92	0.94
7.17	5	81	86	0.94	0.95
7.25	8	101	109	0.93	0.95
7.33	2	56	58	0.97	0.95
7.42	7	54	61	0.89	0.96
7.50	2	39	41	0.95	0.96
7.67	0	1	1	1.00	0.96
7.75	1	0	1	0.00	0.97
7.83	6	38	44	0.86	0.97
8.08	1	21	22	0.95	0.97
8.17	2	15	17	0.88	0.98
8.25	1	27	28	0.96	0.98
8.33	3	13	16	0.81	0.98
8.42	3	10	13	0.77	0.98
8.50	0	10	10	1.00	0.98
8.83	4	20	24	0.83	0.99
8.92	0	2	2	1.00	0.99
9.08	0	4	4	1.00	0.99

9.17	0	2	2	1.00	0.99
9.25	0	5	5	1.00	0.99
9.33	0	3	3	1.00	0.99
9.42	0	3	3	1.00	0.99
9.50	0	1	1	1.00	0.99
9.83	1	4	5	0.80	0.99
10.25	0	2	2	1.00	1.00
10.33	0	2	2	1.00	1.00
11.33	0	1	1	1.00	1.00

Table 17. Equations describing the relationship between the natural log of batch fecundity and total length, whole fish weight, and calendar age in black sea bass collected off the Carolinas during 2000-2009. Data from the MARMAP program (Danson 2009) and an on-going study at the University of North Carolina at Wilmington (UNCW; Klibansky, Unpubl. data) were combined.

Independent variable (x)	a	SE of a	B	SE of b	adj. r^2	P	Range of x
Total length (mm)	5.49		0.0143		0.29		182-342
Whole fish weight (g)	7.69		0.0053		0.38		101-616
Age (yr)	7.80		0.42		0.20		2-6

Table 18. Meristic conversions for black sea bass caught off the U. S. South Atlantic.

Source	Equation	n	a	b	r^2	Range of data
SCDNR MARMAP Survey (SEDAR2)	TL = SL	34,382	-10.83	1.35	0.98	
SCDNR MARMAP Survey and Headboat Survey	Whole weight (g) = Total Length (mm): $W = aL^b$	174,214	5.02×10^{-5}	2.77	0.93	W:1 – 3370 L: 7 - 643

2.15 Figures

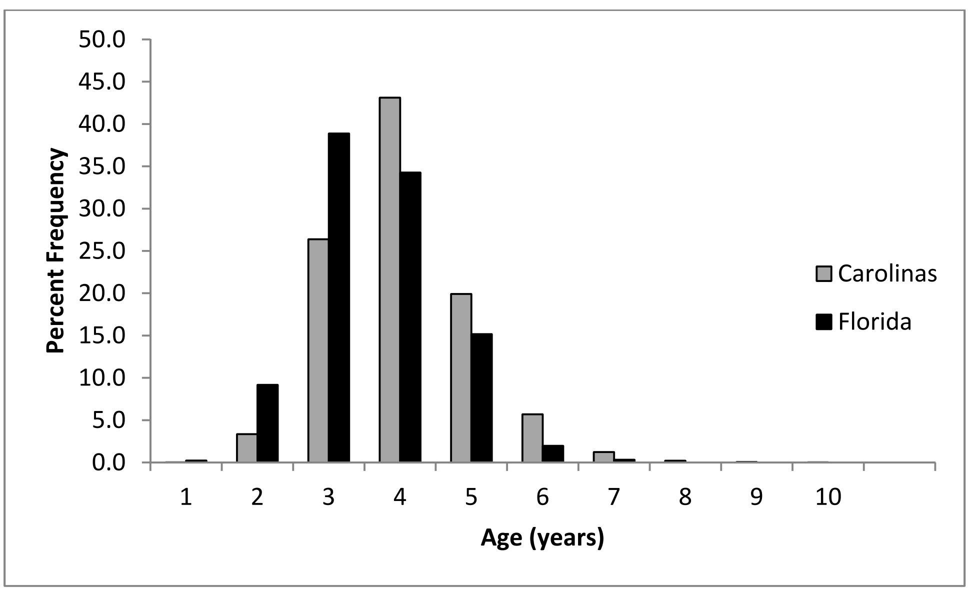

Figure 1. Age frequency of black sea bass landed in the 2007 – 2010 commercial and recreational fisheries off North Carolina and South Carolina and off Florida.

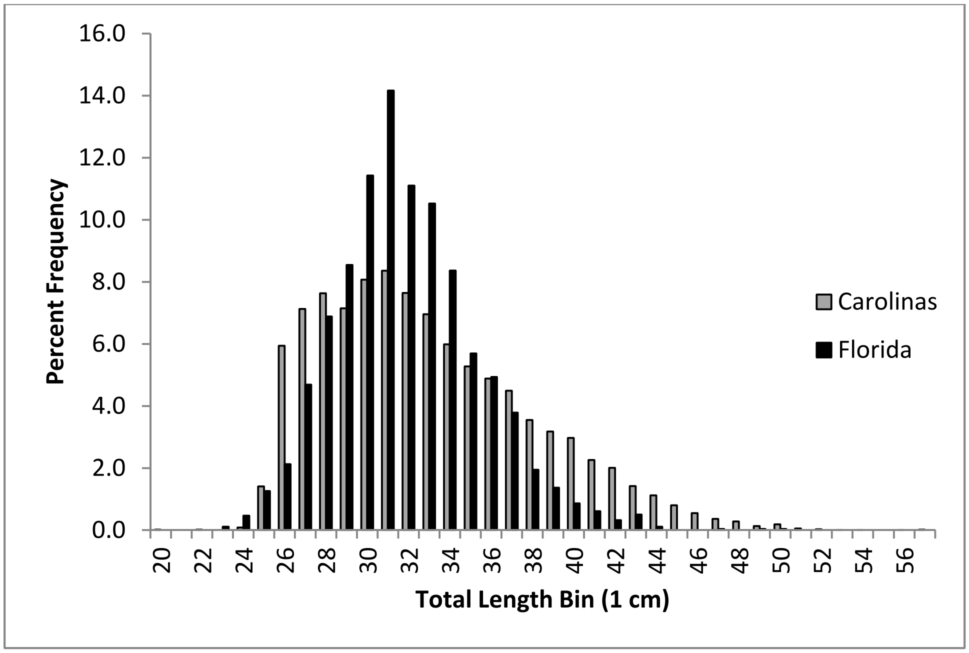

Figure 2. Total length frequency of black sea bass landed in the 2007 – 2010 commercial and recreational fisheries off North Carolina and South Carolina and off Florida.

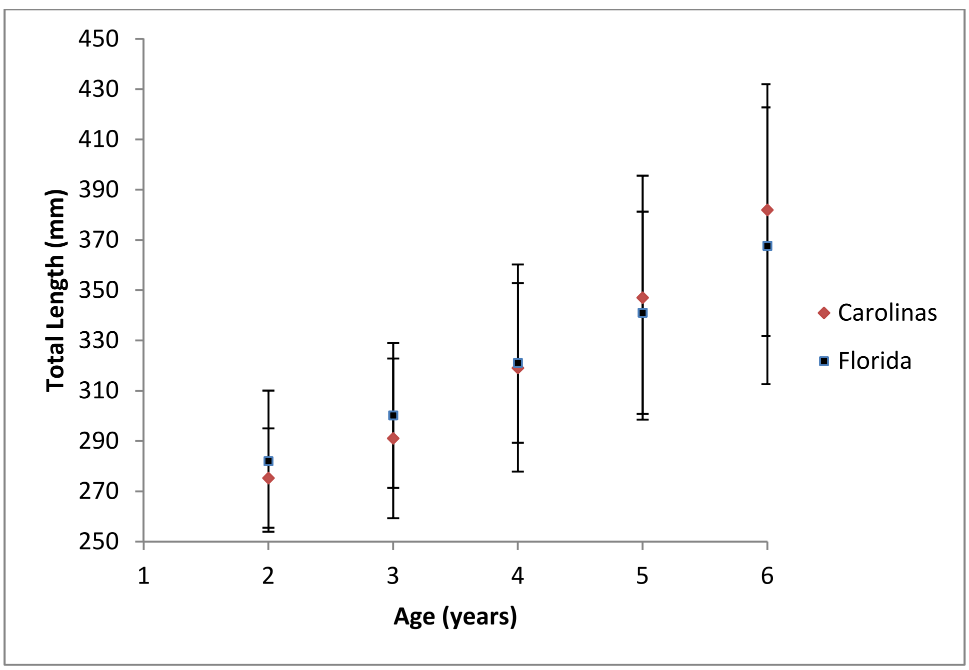

Figure 3a. Mean length-at-age (± 1 SD) of black sea landed in the 2009-2010 commercial trap fishery operating off North Carolina and South Carolina versus Florida.

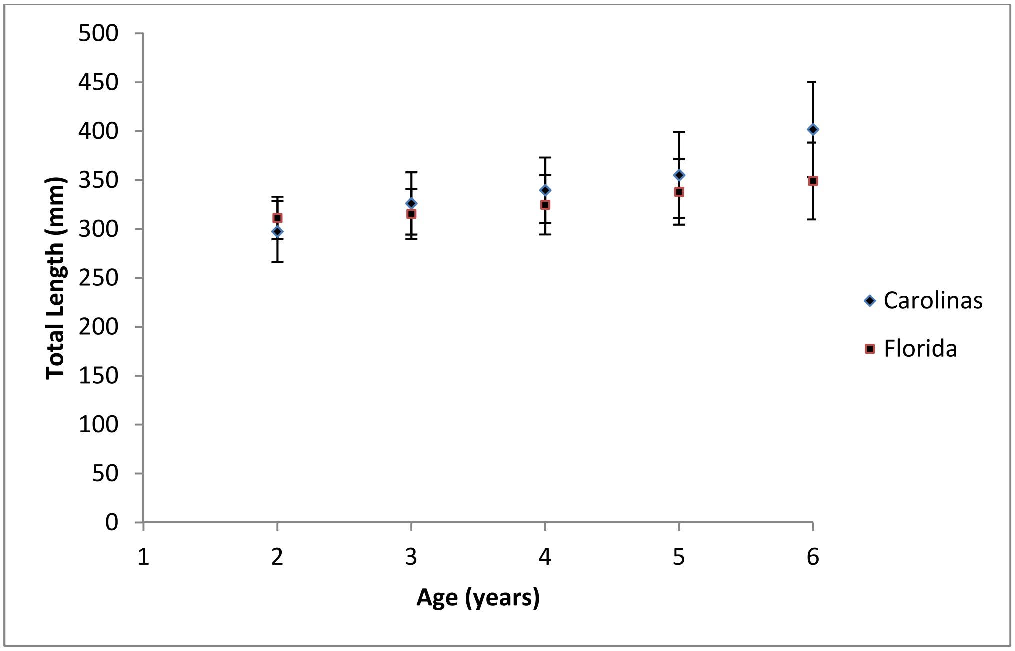

Figure 3b. Mean length-at-age (± 1 SD) of black sea landed in the 2007-2010 recreational hook and line fishery operating off North Carolina and South Carolina versus Florida.

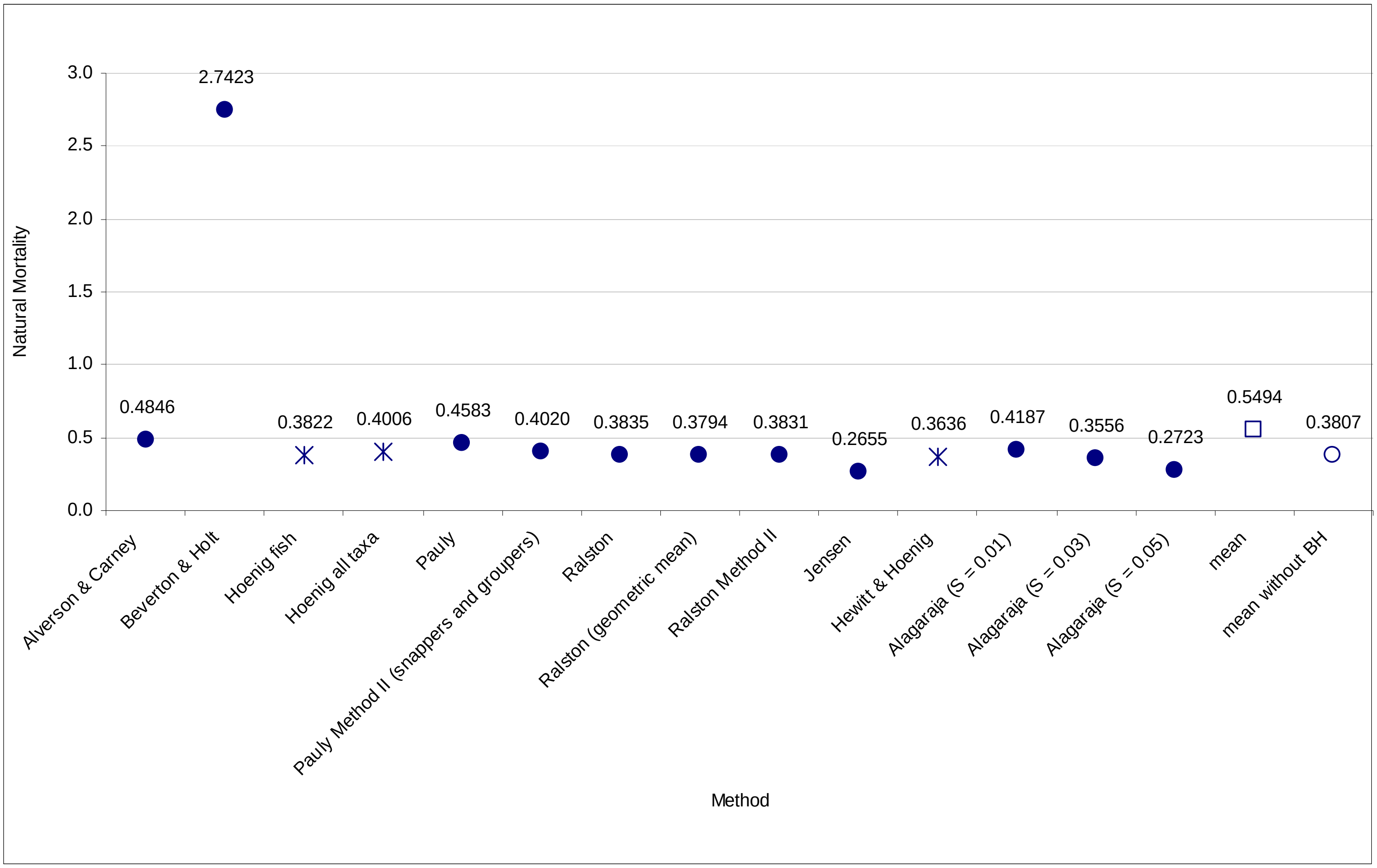

Figure 4. Point estimates of natural mortality (M) for black sea bass from the South Atlantic for all data combined. Mean with (open square) and without (open circle) the outlier Beverton and Holt method is provided. The WG recommends using the Hoenig$_{fish}$ point estimate methods (stars).

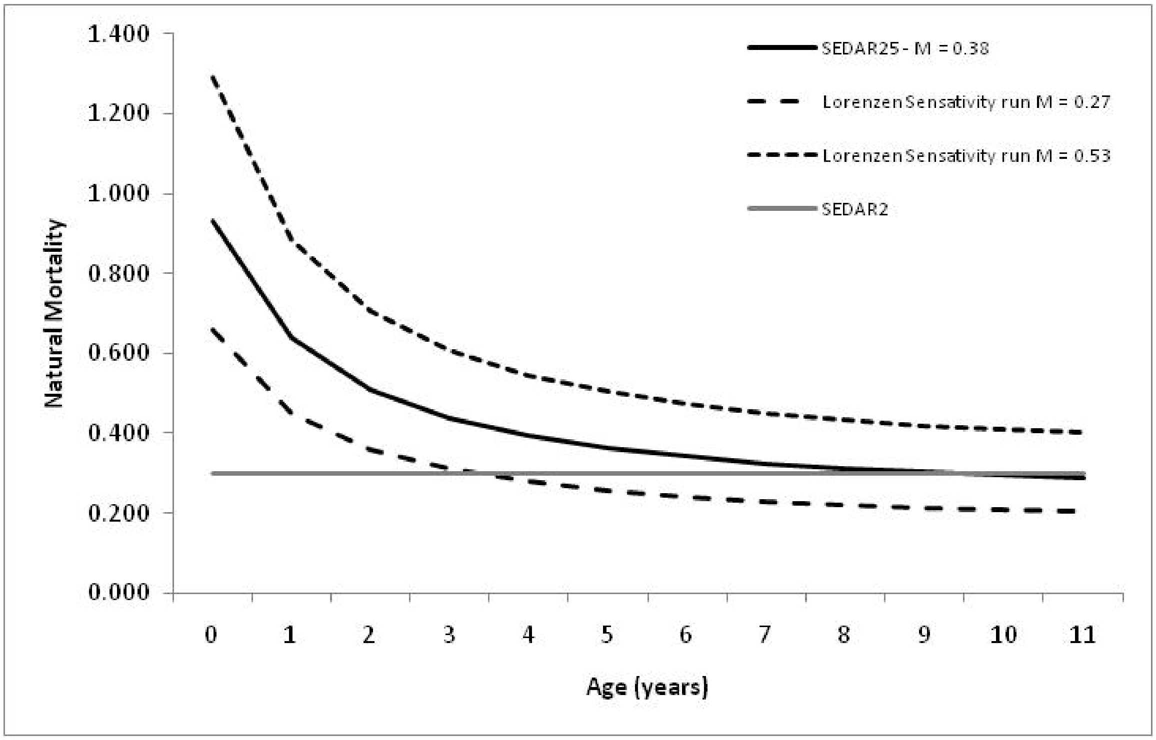

Figure 5. Age-specific natural mortality for black sea bass from the South Atlantic using Lorenzen (2005) method for all data combined, scaled to Hoenig$_{fish}$ estimate of 0.38. Lorenzen mortality curve sensitivity runs scaled to a range of M from 0.27 to 0.53. SEDAR 2 used a point estimate of M = 0.3.

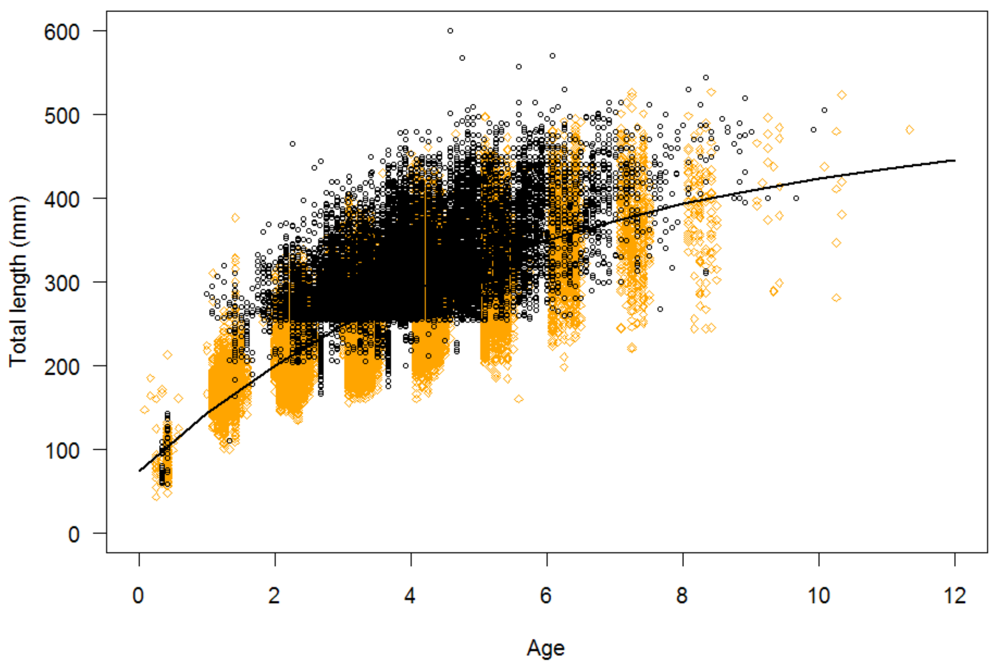

Figure 6. von Bertalanffy growth model for all data combined, corrected for minimum size limit bias (Diaz et al. 2004). Black circles represent fishery-dependent age samples. Orange circles represent fishery-independent age samples.

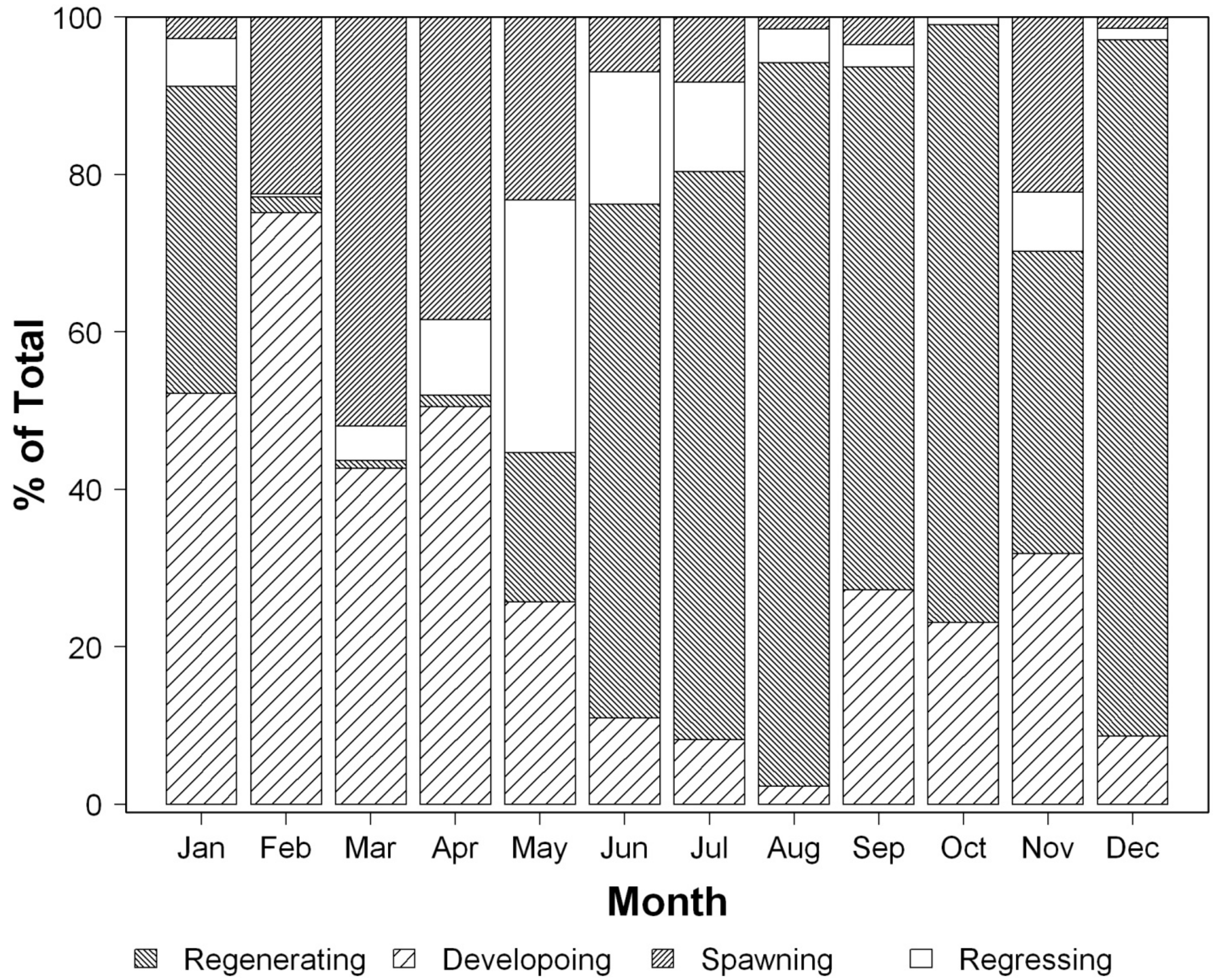

Figure 7. Distribution of maturity stages (% of total) by month for US South Atlantic black sea bass collected and analyzed by the MARMAP program over the period 1973-2010.

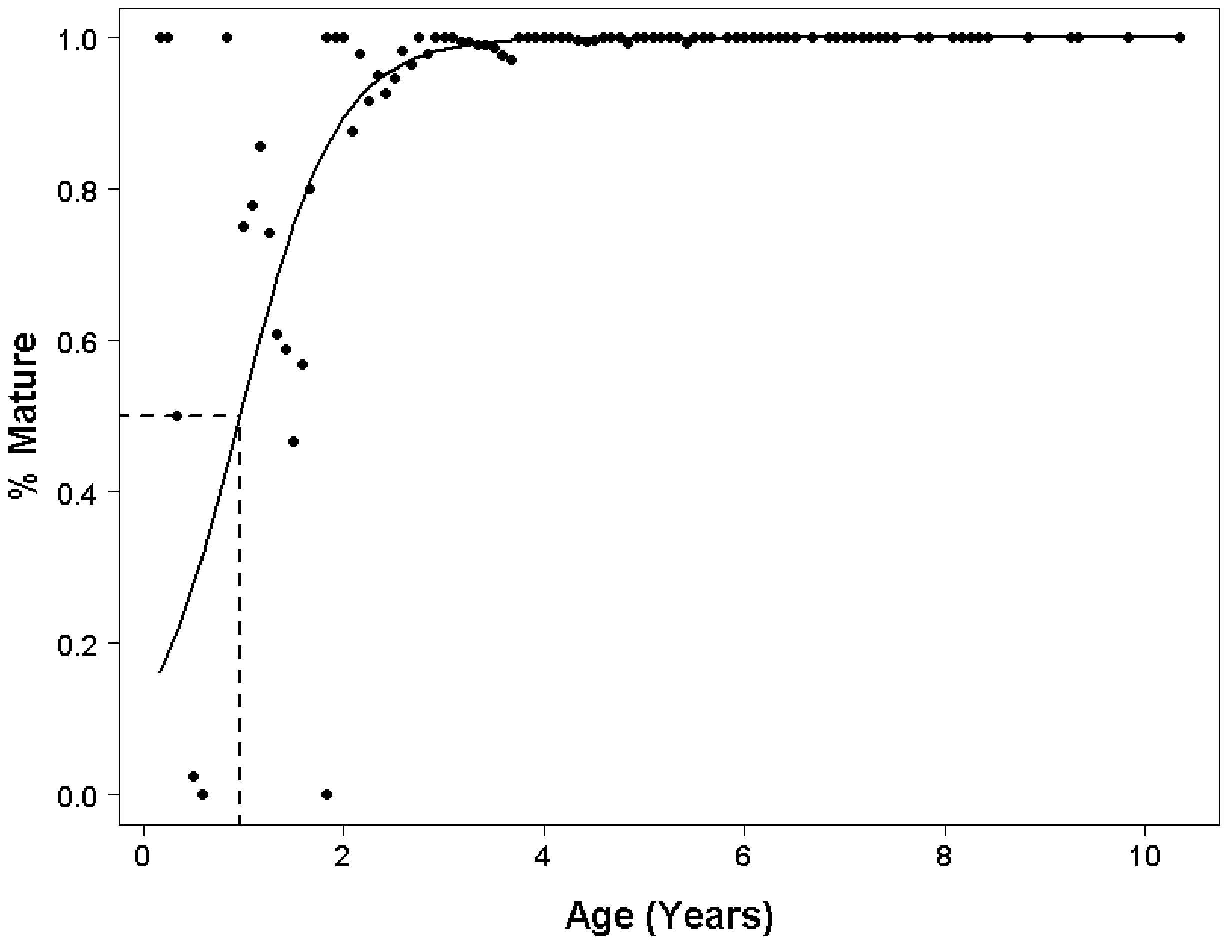

Figure 8. Observed and predicted percent female maturity at fractional age for US South Atlantic black sea bass. Predicted female maturity ogive (solid black line) is from a logistic regression with a logit link function. Dashed line represents the age at 50% maturity for female black sea bass (0.96 years).

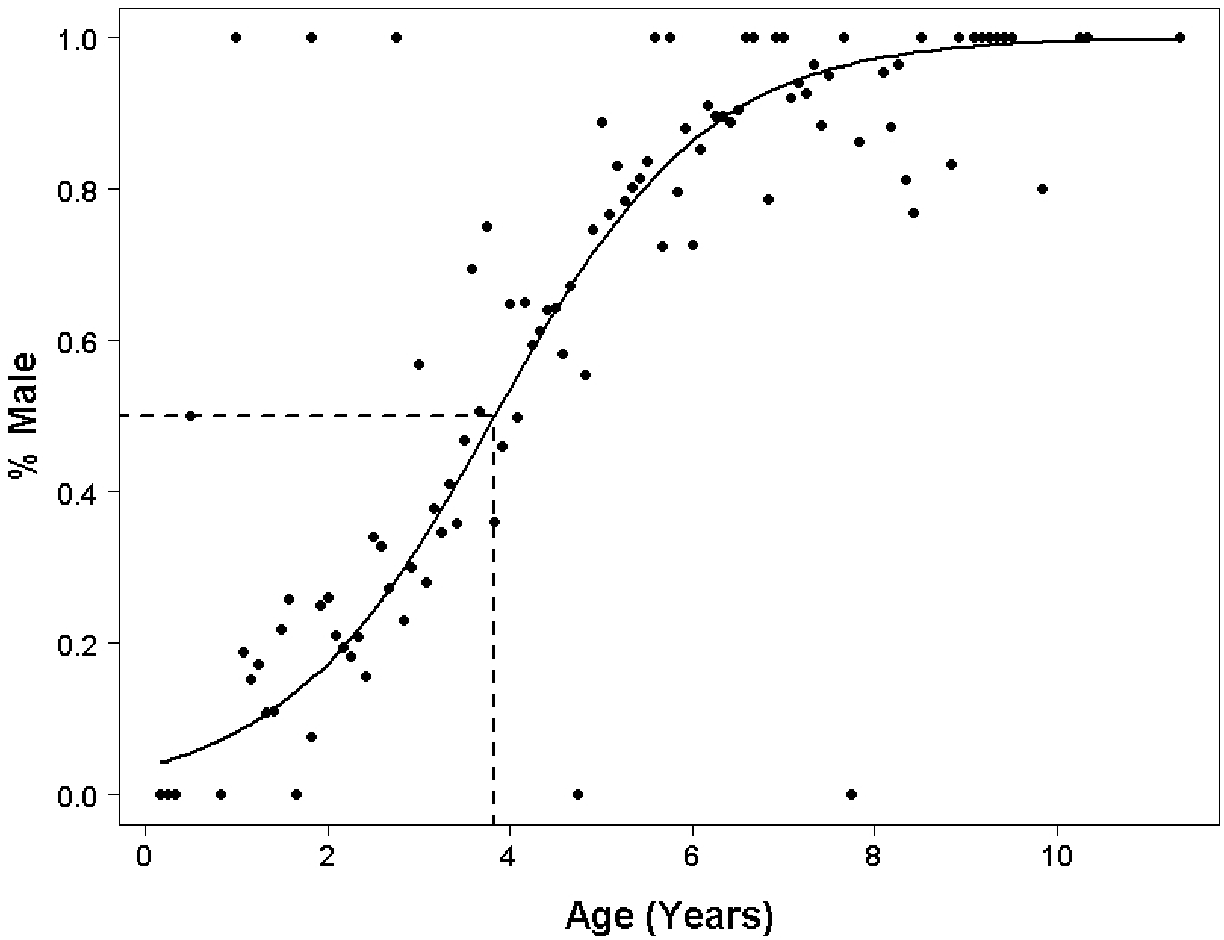

Figure 9. Observed and predicted percent male at fractional age for US South Atlantic black sea bass. Predicted percent male ogive (solid black line) is from a logistic regression with a logit link function. Dashed line represents the age at 50% transition from female to male for black sea bass (3.83 years).

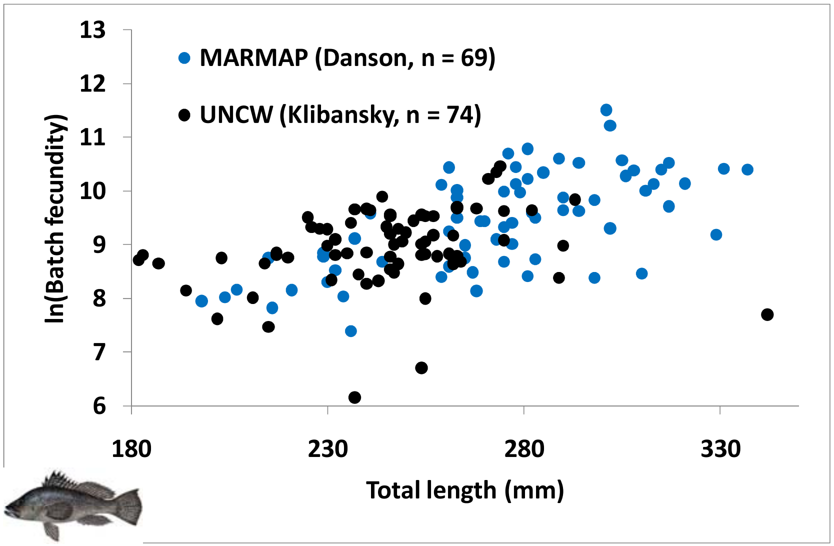

Figure 10. Batch fecundity versus total length (mm) in black sea bass collected off the Carolinas during 2000-2009. Data from two studies (Danson 2009; Klibansky, Unpubl. data) were combined. MARMAP = Marine Resources Monitoring Assessment and Prediction program; UNCW = University of North Carolina – Wilmington.

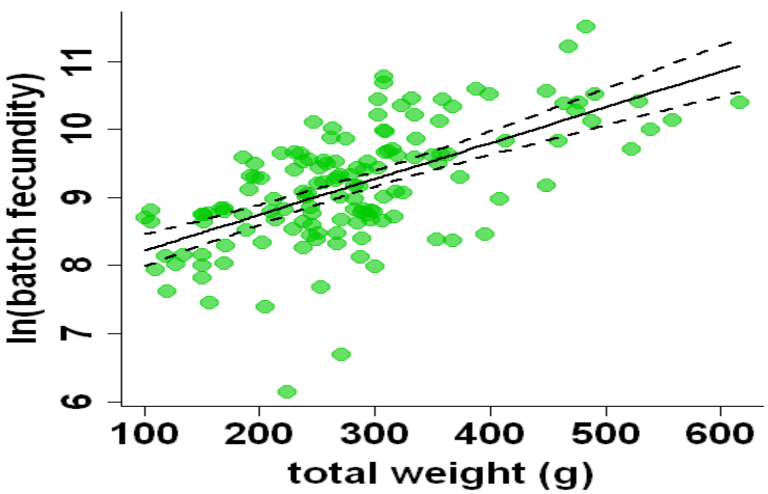

Figure 11. Batch fecundity versus whole weight (g) in black sea bass collected off the Carolinas during 2000-2009. Data from two studies (Danson 2009; Klibansky, Unpubl. data) were combined. MARMAP = Marine Resources Monitoring Assessment and Prediction program; UNCW = University of North Carolina – Wilmington.

3 Commercial Fishery Statistics

3.1 Overview

Topics discussed by the Commercial Workgroup began with a discussion of stock boundaries, both the southern boundary with the Gulf of Mexico and the northern boundary (Cape Hatteras, NC).

To develop annual landings by gear and state, adjustments were deemed necessary for misreporting of black sea bass in FL as the early trip ticket coding only allowed for sea bass, mixed. Commercial landings for the U.S. South Atlantic black sea bass stock were developed by gear (pots/traps, lines, trawls and other) in whole weight for the period 1950 through 2010 based on federal and state databases. Corresponding landings in numbers were estimated from mean weights estimated from TIP by gear, state and year for 1950-2010.

Commercial discards were calculated for vessels fishing vertical line gear (handline and electric reel) and fish traps (fish pots) in the US South Atlantic.

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

3.1.1 Participants in SEDAR 25 Data Workshop Commercial Workgroup:

Erik Williams, NMFS, Beaufort, NC (co-leader)
Alan Bianchi, NC DMF, Morehead City, NC (co-leader)
David Gloeckner, NMFS, Miami, FL (co-leader – not present)
Julie Defilippi, ACCSP, Arlington, VA (rapporteur)
Tony Austin, Commercial Fisher, NC, BSB
Steve Brown, FL MRRI, St. Petersburg, FL
Claudia Dennis, NMFS, FL
Kenny Fex, Commercial Fisher, NC, BSB
Jimmy Hull, Commercial Fisher, FL, BSB
Max Zilleruelo, IFOP, Chile
Joe Klosterman, Commercial Fisher, FL, GT
Chad Lee, Commercial Fisher, FL, GT
Kevin McCarthy, NMFS, Miami, FL
Dave Player, SC DMF, Charleston, SC

3.1.2 Commercial Gears Considered

The group discussed the gear groups used in SEDAR 2 (pots/traps, lines and other) and noted that trawls fish differently than lines or pots. The trawls were a very small portion of landings based on the table from the previous assessment; however, trawls were more prominent prior to 1972. Based on the extension of the time series of presented data (see Decision 5), the group suggested adding trawl into the list of gear categories and allowing for it to be grouped with other gear later if necessary or appropriate. During this discussion, the impact of the foreign fleets in the South Atlantic was broached. The Workgroup acknowledged the likely existence of such fleets in South Atlantic waters, but had little information to provide estimates of their landings. One reference document suggested that foreign-fleet landings in the South Atlantic waters might have been relatively small (SEDAR25-RD44). Further investigation of the impact of South Atlantic foreign fleets is part of the research recommendations for the group.

> **Decision 1:** The group decided to break down landings into four gear categories (pots/traps, lines, trawls, and other), while recognizing that the "other" category is relatively small and might be combined with another gear for the assessment.
>
> *This decision was approved by the plenary.*

3.1.3 Stock Boundaries

DW ToR #1: Review stock structure and unit stock definitions and consider whether changes are required (Decisions 2 & 3).

Initial discussion and decisions concerned setting the geographic boundaries for the South Atlantic black sea bass stock. The group reviewed the existing boundaries of Cape Hatteras, NC to Monroe County, FL inclusive and determined that these lines were appropriate and there was no existing evidence for a change.

In SEDAR 2, gear/area data were not available in North Carolina and data were categorized as north or south of Cape Hatteras based solely on gear information. For this assessment, we used gear/area information available from 1996 to 2010 to determine the proportion of landings for each gear that are north or south of Cape Hatteras and applied that proportion backward to all landings prior to 1996.

> **Decision 2:** Because no evidence exists to change the existing line, the Workgroup recommends using the Cape Hatteras, NC line as the northern boundary for the South Atlantic black sea bass stock. North Carolina data will be proportioned by gear/area and that proportion will be applied backward to all data prior to 1996.
>
> *This decision was approved by the plenary.*

The Commercial Workgroup considered the southern boundary and determined that Monroe County, FL would be used as the dividing line between the South Atlantic and Gulf Stocks. The landings in Monroe County are relatively insignificant. Prior to 1996, landings would include all of Monroe County. From 1996 to 2010, only South Atlantic landings from Monroe Country would be included. This decision is based on the granularity of data available. The trip ticket data provide more detailed information and were not required until 1995. The data are considered reliable for this purpose from 1996.

> **Decision 3:** The Workgroup recommends using Monroe County, FL inclusive as the southern boundary for the South Atlantic black sea bass stock.

This decision was approved by the plenary.

Maps of the entire fishing area and specific areas in Florida can be found in Figures 3.1 and 3.2.

3.2 Review of Data Workshop Reports Assigned to Commercial Workgroup:

SEDAR25DW19: This report presents a description of commercial discards for both golden tilefish and black sea bass. There were two potential data sets. The first was hook and line and only volunteer boats. This is a limited data set that has only been going on for the last couple of years. This dataset was rejected.

The other is the self-reported coastal logbook. It is meant to be a 20% random subsample of all permit holders and includes vertical line and trap fishers. The vertical line data are very straight forward. For trap data, the instructions have changed and have been very confusing. The data are less reliable through no fault of the fishers. We should have number of traps, number of hauls and some measure of soak. Due to lack of quality data, only number of traps was used. The group reviewed the analysis and results. It was discussed that the confusion in reporting has resulted in having to use the number of traps which is not the ideal. Also, it means that the data may not be accurate. The fishers agreed that the rates were close to what they were seeing especially with those that are only using the escape panel.

Effort data are available back to 1993. The size change was in 1999, but the escape panel was not put into effect until 2006. The fishers commented that the larger mesh size allowed smaller fish to escape. Based on the assumption that the mesh size and size change cancel each other out, the mean discard rate can be applied to the effort data back to 1993.

The group discussed making a recommendation that management require a 2 inch mesh. Kevin McCarthy would like to work with the fishers on clarifying the language for the logbook reporting forms.

The Commercial Workgroup recommended the use of this analysis.

SEDAR25DW20: This report presents a description of the length composition sampling from the Gulf & South Atlantic Fisheries Foundation Observer Program from 2007 to 2009. The group discussed concerns with the inclusion of these data including the short time series, the inability to link samples to trips and methodological issues such as voluntary participation, and the practice of paying fishers to take observers. There is recognition that these data may be useful in the future for providing length compositions for discards. The Commercial Workgroup did not recommend the use of these data.

SEDAR25DW21: This report presents a description of the length composition sampling from the Trip Interview Program from 1981 to 2010. Specific methodologies are described in Section 3.4. The Commercial Workgroup recommended the use of these data and determined that they are representative for the species.

3.3 Characterizing Commercial Landings

DW ToR #8: 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 if feasible. Provide maps of fishery effort and harvest. (Decisions 4-7)

3.3.1 Misidentification and Unclassified Black Sea Bass

The next topic of discussion included whether misidentification of black sea bass with other species was a concern. This was an issue for Florida as the trip ticket program originally had a single code for sea bass, mixed. It was decided that unclassified sea bass categories were factored for percent of black sea bass based on Florida commercial trip ticket data from 1995-2001 reported by species (black, bank, rock).

Decision 4. The Workgroup concurs with prior SEDAR 2 decision to factor unclassified landings from Florida for 1995-2001.

This decision was approved by the plenary.

3.3.2 Time Series for Commercial Landings

Next, the time series for commercial landings was discussed. Landings for SEDAR 2 were presented back to 1972 because that was when gear data were first available. The Workgroup made the decision to examine landings back to 1950 because looking at the longer time period will allow for better examination of stock potential. This had to be weighed against the quality of the data. The group determined that the data available back to 1950 were reliable and useful to the extent that their inclusion in the assessment would enhance results rather than hinder.

Decision 5: The Commercial Workgroup decided to provide all available data from 1950 to 2010.

This decision was approved by the plenary.

3.3.3 Development of Commercial Landings by Gear and State

Historical 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 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 April 2011 for all black sea bass landings (annual summaries by state and gear category) from 1950 to present for Florida (east coast including Monroe County), Georgia, South Carolina and North Carolina (ACCSP, 2011). Data are presented using the gear categories as determined at the workshop. 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 Working Group 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. The first full year of available data from Florida trip tickets is 1986.

A data set was provided to the commercial workgroup of summarized black sea bass landings by year and gear with pounds (whole weight) from Florida South Atlantic waters (Monroe county landings in total if before 1996; landings from Atlantic fishing zones for Monroe county thereafter). Gear categories include pots/traps, lines, trawls and other/unknown. Gear from 1986 to 1991 landings proportioned from 1992 to 2001 averages by gear; later data not used because of increase in use of pot/trap gear in late 2000's. Unclassified sea bass categories were factored for percent of black sea bass based on Florida commercial trip ticket data from 1995 to 2001 reported by species (black, bank, rock). Data from 1995 to 2001 were factored by year and gear. Pre-1995 data were factored by the annual average (98%) of 1995-2001 data.

NMFS logbook data were evaluated and it was decided to use Florida trip ticket data from 1986 forward for landings, area, and gear distributions, and NMFS ALS landings data prior to 1986. Logbook data did not start until 1992, and while gear distributions were similar to Florida trip ticket landings data, logbook did not account for inshore landings of black sea bass, and total landings of black sea bass were significantly less than trip ticket landings from 1992 to 2010.

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 comes 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; 2004-present is the ACCSP Trip Ticket System. This 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.

Three datasets were provided to the commercial group for the SEDAR 25 Data Workshop. North Carolina commercial landings of black sea bass were provided for 1972-2010 by year and gear type. Gears were grouped into the following categories: Hand lines, Pots, Trawls, and Others. Commercial landings for black sea bass from the NC trip ticket program were also provided by fishing year from 1994 to 2010.

Combined State Results –Landings by gear category are presented in Table 3.2 and Figure 3.4. Pots/traps are the dominant gear over the time period and account for 78.6% of landings with lines making up 19.4%, trawls 1.6% and other gears accounting for only 0.5%. Landings by gear are presented by fishing year from 1997/1998 to 2009-2010 in Table 3.3 and Figure 3.5.

Decision 6: The Workgroup made the following decisions for reporting of commercial landings:

- Landings should be reported as whole weight (rather than gutted)
- Landings by state should be separated into Florida (South Atlantic)/Georgia, South Carolina and North Carolina, if necessary, to maintain confidentiality for Georgia landings.

- Landings would be presented by fishing year/gear and fishing year/state as far back as monthly data are available across all states.
- Final landings data would come from the following sources:
  - NC:
  - 1950-1971 (ACCSP)
  - 1972-2010 (NC DMF)
  - SC:
  - 1950-1979 (ACCSP)
  - 1980-2010 (SC DNR)
  - GA:
  - 1950-2010 (ACCSP)
  - FL:
  - 1950-1985 (ACCSP)
  - 1986-2010 (FL trip ticket)

Whole vs Gutted Weight – The Commercial Workgroup discussed the topic of what units to use to report commercial landings. Black sea bass are typically landed whole. For this analysis, landings were provided in whole weight.

This decision was approved by the plenary.

Confidentiality Issues – The Commercial Workgroup agreed that if it was necessary to pool Georgia commercial landings with one or more of the other states because of confidentiality issues, this would be done. The Workgroup recommended that Georgia landings be pooled with Florida to meet the rule of 3.

This decision was approved by the plenary.

3.2.4 Converting Landings in Weight to Landings in Numbers

Length was converted to weight (whole weight in pounds) using conversions provided by the life history group. This differs from the preliminary report data workshop report, which used the formula from SEDAR 2. This lead to differences in the mean weights and landings in numbers in each report. The mean weights by gear and year (weighted by weight of fish in the sample at length in pounds whole weight, trip weight in pounds whole weight and landing weight in pounds whole weight) were calculated. To fill in mean weights where the sample size was less than 20 fish, the mean weight before 1999 (change in minimum size) and after 1998 was calculated by gear. Where the sample size was less than 20 fish, the mean for that gear and period (before or after 1999) was used. If there was no mean weight for the gear and period, then the mean weight across all years for the gear was used (Table 3.4). The landings in pounds whole weight were then divided by the mean weight for that stratum to derive landings in numbers (Table 3.5).

3.3 Commercial Discards

Commercial discards were calculated for vessels fishing vertical line gear (hand line and electric reel) and fish traps (fish pots) in the US South Atlantic using methods described in SEDAR25-DW19. Other gears reported fewer than 20 trips (per gear) with black sea bass discards during the period 2002-2010 and were not included in the discard calculations.

Total discards were calculated separately for traps and vertical line gear during both open and closed fishing seasons. Discard rates were calculated from data reported during open fishing seasons using delta-lognormal model generated least squares means of year-specific discard rates for the period 2002-2010 (when discard data were reported). Discard rate for the period 1993-2001 (prior to discard reporting) was assumed to be the mean discard rate over the years 2002-2010, weighted by sample size. Calculated discard rates were used along with the appropriate yearly total effort (fish trap or vertical line) reported to the coastal logbook program as ratio estimators of yearly total discards. Discards were reported in numbers of black sea bass.

Landings of black sea bass were prohibited for portions of 2009 and 2010. Sample sizes were too small for delta-lognormal analyses of the closed season discard rates. However, nominal discard rates for vertical line and trap vessels were calculated using data reported during closed seasons. As with the open season calculations, closed season discard rates were used along with the effort reported by vertical line and trap vessels during the closed seasons to calculate total discards.

The working group discussed use of the number of traps fished as the effort measure for calculating discards from trap vessels. Fishing effort data available for fish traps included number of traps fished, number of hauls, and trap soak time. Changes in logbook reporting forms and apparent confusion regarding how fishing effort was to be reported have resulted in inconsistencies within the data set. Number of hauls and trap soak time cannot be reliably included in calculations of fishing effort of fish traps. Of concern were reports of up to 200 traps fished per trip. Commercial fishers in the working group commented that 150-200 traps fished on a trip was not unreasonable, although uncommon, for some fishers and the group accepted the use of traps fished as an appropriate effort measure.

The working group noted that a minimum size change increasing the commercial minimum black sea bass size from eight to ten inches was effected in 1999. In addition, the group noted that escape panels on fish traps were required beginning in 1999 and that changes in mesh size and design of escape panels occurred in 2006. Total discards were calculated for all years for which there were effort data (1993-2010).

The working group recommended using the calculated discards as presented, but requested that some measure of variability of those estimates be calculated. Following the data workshop coefficients of variation were calculated for the gear/season-specific discard rates. Effort was assumed to be fully reported because all vessels with federal fishing permits were required to report to the coastal logbook program. Total calculated discards (gears and seasons combined) are included in Table 3.10.

Decision 7: The Commercial Workgroup supports the methodology of calculating discards and recommends the use of these data.

This decision was approved by the plenary.

3.4 Biological Sampling

Biological sample data were obtained from the TIP sample data at NMFS/SEFSC. Data were filtered to eliminate those records that included a size or effort bias, non-random collection of length data, were not from commercial trips, fish were selected by quota sampling or the data were not collected by the TIP program. Codes are embedded in TIP to allow the identification of these records.

- IF SAMPLE_METHOD_TYPE = 'QUOTA SAMPLING' THEN DELETE
- IF IS_RANDOM = 'NO' THEN DELETE;
- IF SUB_SAMPLE_IS_RANDOM = 'NO' THEN DELETE IF TRIP WAS SUB SAMPLED
- IF FISHING_MODE NOT EQUAL TO 'COMMERCIAL' THEN DELETE
- IF INTERVIEW_TYPE = 'OBSERVER' THEN DELETE (NOT PART OF TIP PROGRAM)
- IF BIAS_TYPE = 'SIZE BIAS' OR 'SIZE AND EFFORT BIAS' THEN DELETE

These data were further limited to those that could be assigned a year, gear, and state. Data that had an unknown sampling year, gear, or sampling state were deleted from the file. These data must be weighted by trip, so where no trip landings data were available, the sample was excluded. TIP data must also be weighted spatially by the landings for the particular year, state and gear stratum. TIP data were joined with landings data by year, gear, and state. Landings data were also limited to only those data that could be assigned a year, gear, and state. Landings and biological data were assigned a state based on landing location or sample location if there was no landing location assigned. Records were the length was greater than 3 standard deviations from the mean length for the year, gear and state were eliminated as outliers.

3.4.1 Sampling Intensity for Lengths

The number of trips sampled ranged from a high of 116 for hand line gear in 2005 to a low of zero for many strata (Table 3.6). The number of trips sampled was consistently greater than 10 trips for hand line gear from 1984 to 2010, and pots and traps for 2005 to 2010. Trips using trawl and other gear were rarely sampled. Table 3.4 displays number of trip that caught black sea bass, number of trips targeting black sea bass, number of valid samples and number of samples used (trip weights available).

The number of fish sampled had a high of 2,218 for pot and trap gear in 2009 to lows of zero for many of the strata (Tables 3.7a-d). The number of lengths sampled was consistently greater than 100 for hand line gear for 1984-2010. Pot and trap lengths sampled were well above 100 lengths per year for most years, excluding 1985, 1986, 1995-1997, and 1999. For trawl and other gears, the numbers of length samples available were below 100 for most years. Tables 3.7a-d displays the number of lengths used and the number and reason for those not used by year for each gear. An improvement to the number of useable lengths could be accomplished by ensuring that samplers enter the trip landing weights for fish that are sampled.

Length compositions presented in SEDAR 2 may differ based on any filtering done in SEDAR 2. The methodology used to filter lengths in SEDAR 2 was not well documented, so any differences may not be readily explained.

3.4.2 Length/Age Distribution

All lengths were converted to TL in mm using the formula provided in the Black Sea Bass SEDAR Update #1 (SEDAR, 2006) and binned into one centimeter groups with a floor of 0.6 cm and a ceiling of 0.5 cm. The length data and landings data (trip and annual, state and gear) were divided into hand line, traps, trawl, and other gears. Length compositions were weighted by the trip landings in numbers and the landings in numbers by strata (state, year, gear). Annual length compositions of black sea bass are summarized in Figures 3.6-3.9.

Sample size of black sea bass ages are summarized by gear from commercial landings in the U.S. South Atlantic for 1979-2010 (Table 3.8). Age compositions were developed for hand line (1983-2010 with exceptions in Figure 3.10) and pots/traps (2004-2010, Figure 3.11) gear types. Weighting is by length compositions shown in Figures 3.6 and 3.7, respectively. This corrects for a potential sampling bias of age samples relative to length samples (see Section 3 in SEDAR 10 for South Atlantic gag).

3.4.3 Adequacy for characterizing lengths

Length sampling has been inadequate for gears other than hand line and pots and traps. Sampling fractions are less than 0.05 for many years in the hand line and long line gear categories. Sample size needs to be paid particular attention when using the length compositions. Length sampling fractions are displayed in Table 3.9. The number of samples for trawl and other gears may indicate that length compositions for these gear categories should be supplemented with hand line and pot and trap length compositions to obtain a reasonable sample size.

3.6 Research Recommendations for Black Sea Bass

DW ToR #10: 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.

> **Decision 10.** The Workgroup determined the following recommendations be added to any pending recommendations issued in SEDAR 2 that have not been addressed.

The Commercial Workgroup recommends study of migration patterns, focusing on fish movements around the Cape Hatteras, NC area. Additionally, the group would suggest determining the impact/landings of the historical foreign fleet in the South Atlantic. Finally, collection of better spatial information in the fishery to determine potential localized depletion effects is recommended.

These recommendations were approved by the plenary.

3.7 References

Atlantic Coastal Cooperative Statistics Program. 2011. (1950-2010) Annual landings by state and custom gear category; generated by Julie Defilippi; using ACCSP Data Warehouse, Arlington, VA: accessed April, 2011.

SEDAR. 2006. SEDAR 10 South Atlantic Gag Grouper Stock Assessment Report 1. (http://www.sefsc.noaa.gov/sedar/download/S10_SAR1_SA_Gag_updated_ALL.pdf?id=DOCUMENT).

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Addendum to Commercial Landings (Section 3.2):

NMFS SEFIN Accumulated Landings (ALS)

Information on the quantity and value of seafood products caught by fishermen in the U.S. has been collected as early as the late1890s. 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
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The National Marine Fisheries Service prior to 1978 collected commercial landings data for North Carolina. Port agents would conduct monthly surveys of the state's major commercial seafood dealers to determine the commercial landings for the state. Starting in 1978, the North Carolina Division of Marine Fisheries entered into a cooperative program with the National Marine Fisheries Service to maintain the monthly surveys of North Carolina's major commercial seafood dealers and to obtain data from more dealers.

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

NMFS 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.

Table 3.1. Specific ACCSP gears in each gear category for black sea bass commercial landings.

ACCSP_GEAR_CODE	ACCSP_GEAR_NAME	ACCSP_TYPE_NAME	SEDAR25_GEAR_CATEGORY
000	NOT CODED	NOT CODED	OTHER
010	HAUL SEINES	HAUL SEINES	OTHER
020	OTHER SEINES	HAUL SEINES	OTHER
092	OTTER TRAWL BOTTOM, FISH	TRAWLS	TRAWLS
093	OTTER TRAWL BOTTOM, LOBSTER	TRAWLS	TRAWLS
094	OTTER TRAWL BOTTOM, SCALLOP	TRAWLS	TRAWLS
095	OTTER TRAWL BOTTOM, SHRIMP	TRAWLS	TRAWLS
110	OTHER TRAWLS	TRAWLS	TRAWLS
130	POTS AND TRAPS	POTS AND TRAPS	POTS AND TRAPS
139	POTS AND TRAPS, FISH	POTS AND TRAPS	POTS AND TRAPS
180	POTS AND TRAPS, OTHER	POTS AND TRAPS	POTS AND TRAPS
205	GILL NETS, RUNAROUND	GILL NETS	OTHER
207	GILL NETS, OTHER	GILL NETS	OTHER
300	HOOK AND LINE	HOOK AND LINE	LINES
301	HOOK AND LINE, MANUAL	HOOK AND LINE	LINES
303	ELECTRIC/HYDRAULIC, BANDIT REELS	HOOK AND LINE	LINES
403	LONG LINES, BOTTOM	LONG LINES	LINES
404	LONG LINES, SURFACE, MIDWATER	LONG LINES	LINES
660	SPEARS	SPEARS AND GIGS	OTHER
661	SPEARS, DIVING	SPEARS AND GIGS	OTHER
700	HAND LINE	HAND LINE	LINES
701	TROLL AND HAND LINES CMB	HAND LINE	LINES
801	UNSPECIFIED GEAR	OTHER GEARS	OTHER
802	COMBINED GEARS	OTHER GEARS	OTHER

Table 3.2. Black sea bass landings (pounds whole weight) by gear (pots/traps, lines, trawls and other) from the U.S. South Atlantic, 1950-2010. Nulls indicate that no data were found when the various databases were queried. Landings by state and year are not presented due to confidentiality constraints.

(* indicates confidential data)

Year	Whole Weight	Lines	Other	Pot/Trap	Trawl
1950	305,288	304,951	54		284
1951	218,482	216,952	31		1,500
1952	159,072	158,016	61		995
1953	114,399	113,293			1,106
1954	71,649	70,793			856
1955	42,284	38,912	719	2,369	284
1956	70,028	62,236	4,282	928	2,583
1957	69,465	59,462	2,078	6,842	1,084
1958	71,265	61,809	1,962	6,461	1,033
1959	99,115	87,858	2,289	7,538	1,431
1960	134,428	95,168	1,414	36,035	1,811
1961	669,677	120,883	1,152	509,195	38,446
1962	633,032	85,887	2,340	516,535	28,270
1963	537,519	126,236	3,190	390,591	17,502
1964	570,974	88,356	2,460	461,210	18,947
1965	580,202	90,342	2,395	465,002	22,463
1966	811,773	78,566	3,162	708,710	21,334
1967	1,453,238	69,306	3,925	1,357,216	22,791
1968	840,406	97,145	3,462	720,098	19,701

1969	1,356,165	64,431	3,542	1,272,194	15,998
1970	1,575,561	50,954	3,145	1,508,647	12,816
1971	1,125,498	72,047	4,679	1,040,692	8,080
1972	1,242,587	93,824	6,056	1,139,094	3,613
1973	934,929	58,787	3,680	868,511	3,951
1974	1,399,489	102,494	4,785	1,287,757	4,454
1975	907,415	93,122	5,016	794,404	14,873
1976	456,328	72,332	3,758	363,998	16,240
1977	389,412	62,357	3,869	280,438	42,748
1978	284,842	118,675	3,285	131,065	31,817
1979	844,562	140,539	3,120	673,576	27,327
1980	1,021,495	107,927	2,706	885,469	25,393
1981	1,224,239	163,821	2,435	1,025,762	32,221
1982	959,675	150,879	3,329	784,844	20,623
1983	638,557	145,746	2,788	481,496	8,527
1984	622,729	194,532	3,729	406,690	17,778
1985	583,698	164,100	2,090	393,682	23,826
1986	688,110	163,256	2,137	500,370	22,346
1987	560,178	149,296	2,399	401,007	7,474
1988	771,537	236,629	2,006	511,725	21,177
1989	779,760	248,538	2,086	515,652	13,484
1990	956,899	258,736	3,660	680,927	13,576
1991	883,731	267,179	2,709	609,435	4,407
1992	772,893	226,570	4,839	534,546	6,938
1993	696,950	188,927	3,185	499,697	5,141

1994	744,910	213,869	9,076	519,570	2,395
1995	554,739	141,466	3,681	407,593	1,999
1996	639,798	128,008	2,369	507,763	1,658
1997	703,284	162,325	8,859	531,876	225
1998	671,945	221,095	11,012	436,890	2,948
1999	688,888	187,538	2,286	497,005	2,059
2000	500,499	92,849	1,459	405,588	602
2001	581,408	88,663	2,870	489,687	190
2002	517,797	97,985	3,120	416,638	54
2003	575,830	91,588	1,759	482,439	45
2004	733,618	107,121	996	625,501	*
2005	451,295	66,911	274	384,084	27
2006	545,441	62,169	1,098	482,174	*
2007	406,823	54,915	744	351,165	*
2008	417,609	57,594	2,610	357,406	
2009	652,321	87,707	731	563,784	99
2010	472,641	64,371	1,021	406,289	959

Table 3.3. Black sea bass landings (pounds whole weight) by gear (pots/traps, lines, trawls and other) from the U.S. South Atlantic, fishing year 1977/1978 – 2009/2010. Nulls indicate that no data were found when the various databases were queried. Landings by state and year are not presented due to confidentiality constraints.

(* indicates confidential data withheld)

Fishing Year	Whole Weight	Lines	Other	Pot/Trap	Trawl
1977/1978	197,771	42,460	1,954	121,283	32,073
1978/1979	567,994	138,553	3,175	399,422	26,843
1979/1980	1,179,219	135,688	3,124	1,014,344	26,062
1980/1981	984,843	121,445	2,571	831,959	28,868
1981/1982	1,270,029	171,358	2,868	1,071,408	24,395
1982/1983	586,525	137,174	2,888	437,901	8,562
1983/1984	609,233	176,354	3,623	411,523	17,734
1984/1985	634,688	186,285	2,518	422,063	23,821
1985/1986	618,051	134,628	1,049	460,496	21,879
1986/1987	644,073	174,570	2,342	459,329	7,831
1987/1988	653,958	192,113	1,325	439,763	20,756
1988/1989	758,527	239,085	1,523	504,085	13,833
1989/1990	974,000	264,411	2,105	693,782	13,702
1990/1991	832,293	252,078	2,694	573,000	4,521
1991/1992	818,624	246,326	1,390	564,186	6,721
1992/1993	700,085	213,610	4,253	476,407	5,815
1993/1994	783,205	213,057	7,989	560,078	2,080
1994/1995	614,046	174,763	2,872	434,031	2,381
1995/1996	460,891	99,507	3,394	356,458	1,533

1996/1997	773,252	142,169	7,937	622,828	318
1997/1998	680,192	226,727	12,105	438,449	2,910
1998/1999	813,206	219,419	2,817	590,596	375
1999/2000	444,094	111,378	906	329,369	2,440
2000/2001	567,959	97,189	2,954	467,616	199
2001/2002	575,961	93,532	1,997	480,387	45
2002/2003	410,004	77,597	3,211	329,138	58
2003/2004	803,103	109,510	1,228	692,365	*
2004/2005	641,829	99,344	376	542,081	*
2005/2006	404,378	51,809	277	352,293	*
2006/2007	541,869	65,932	1,534	474,401	*
2007/2008	353,403	53,842	1,009	298,549	*
2008/2009	494,143	56,290	2,102	435,751	
2009/2010	459,207	71,341	559	386,299	1,008
2010/2011	294,355	35,169	155	258,982	50

Table 3.4. Mean weights in pounds whole weight used to derive landings in numbers by year and gear.

	GEAR			
YEAR	HAND LINES	POTS AND TRAPS	TRAWL	OTHER
1983	1.095	0.803	1.553	1.006
1984	1.230	0.941	1.553	1.006
1985	1.319	1.110	1.553	1.006
1986	1.338	1.110	1.553	1.006
1987	1.484	1.173	1.553	1.006
1988	1.151	1.075	1.553	1.006
1989	1.335	1.116	1.553	1.006
1990	1.014	0.993	1.553	1.006
1991	1.190	1.009	1.553	1.860
1992	1.108	0.836	1.553	1.006
1993	1.207	0.842	1.553	1.006
1994	1.435	1.296	1.553	1.006
1995	1.779	1.110	1.553	1.006
1996	1.480	1.110	1.553	1.006
1997	1.321	1.110	1.553	0.937
1998	1.359	0.854	1.553	1.006
1999	1.307	1.110	1.553	1.006
2000	1.364	1.090	1.553	1.122
2001	1.307	1.063	1.553	1.065
2002	1.444	1.090	1.553	1.006

2003	1.338	0.902	1.553	1.006
2004	1.288	0.931	1.553	1.006
2005	1.444	1.120	1.553	1.006
2006	1.565	1.246	1.553	0.752
2007	1.563	1.246	1.553	1.006
2008	1.349	1.194	1.553	1.006
2009	1.545	1.182	1.553	0.843
2010	1.636	1.214	1.553	0.901

Table 3.5. Commercial landings by gear and year in numbers (thousands).

YEAR	GEAR			
	HAND LINES	POTS AND TRAPS	TRAWL	OTHER
1983	132.851	597.228	5.504	2.959
1984	158.061	431.203	11.475	3.958
1985	124.386	385.510	15.379	2.218
1986	121.972	489.983	14.423	2.268
1987	100.703	341.649	4.824	2.546
1988	205.361	474.930	13.669	2.129
1989	186.095	461.337	8.703	2.214
1990	254.441	684.248	8.763	3.884
1991	224.597	603.259	2.845	1.459
1992	204.337	636.213	4.478	5.136
1993	156.167	590.479	3.318	3.380
1994	149.058	400.589	1.546	9.632
1995	79.777	399.132	1.290	3.907
1996	86.457	497.222	1.070	2.514
1997	122.827	520.835	0.145	9.409
1998	162.715	510.141	1.903	11.687
1999	143.488	440.448	1.329	2.137
2000	68.063	370.884	0.389	1.298
2001	67.787	459.427	0.123	2.691
2002	67.848	381.173	0.035	2.917

2003	68.400	532.675	0.029	1.644
2004	83.078	668.863	**	0.931
2005	46.349	342.205	0.017	0.256
2006	39.742	386.456	**	1.400
2007	35.125	281.468	**	0.696
2008	42.663	298.835	0.000	2.440
2009	56.772	478.178	0.064	0.857
2010	39.397	339.791	0.619	1.128

** = confidential data

Table 3.6. Number of trips from logbooks landing any amount of black sea bass, where sea bass was targeted (black sea bass was at least 30% of catch) and the number of trips with valid samples (no biases) and number of trips with samples usable for analysis (trip weights available) by year and gear. No data are available specific to trawl gear from the Coastal Logbook Program.

	HAND LINES				POTS				TRAWL				OTHER			
YEAR	ALL LOGBOOK	LOGBOOK TARGET	TRIPS WITH VALID SAMPLES	TRIPS WITH SAMPLES FOR ANALYSIS	ALL LOGBOOK	LOGBOOK TARGET	TRIPS WITH VALID SAMPLES	TRIPS WITH SAMPLES FOR ANALYSIS	ALL LOGBOOK	LOGBOOK TARGET	TRIPS WITH VALID SAMPLES	TRIPS WITH SAMPLES FOR ANALYSIS	ALL LOGBOOK	LOGBOOK TARGET	TRIPS WITH VALID SAMPLES	TRIPS WITH SAMPLES FOR ANALYSIS
1983			6	6			7	7			0	0			0	0
1984			66	66			9	9			1	1			1	1
1985			56	56			0	0			0	0			3	2
1986			45	45			0	0			0	0			1	1
1987			50	50			5	5			1	0			2	2
1988			52	52			12	12			1	1			1	1
1989			30	30			3	3			0	0			1	1
1990			43	43			9	9			0	0			1	1
1991			46	46			8	7			0	0			5	3
1992	1,089	147	26	26	532	519	5	5			0	0	55	**	1	1
1993	2,220	257	32	32	929	905	2	2			0	0	92	**	0	0
1994	2,776	353	41	41	1,104	1,085	3	3			0	0	105	**	1	1
1995	2,233	279	39	39	898	880	0	0			0	0	107	**	0	0

YEAR	HAND LINES				POTS				TRAWL				OTHER			
	ALL LOGBOOK	LOGBOOK TARGET	TRIPS WITH VALID SAMPLES	TRIPS WITH SAMPLES FOR ANALYSIS	ALL LOGBOOK	LOGBOOK TARGET	TRIPS WITH VALID SAMPLES	TRIPS WITH SAMPLES FOR ANALYSIS	ALL LOGBOOK	LOGBOOK TARGET	TRIPS WITH VALID SAMPLES	TRIPS WITH SAMPLES FOR ANALYSIS	ALL LOGBOOK	LOGBOOK TARGET	TRIPS WITH VALID SAMPLES	TRIPS WITH SAMPLES FOR ANALYSIS
1996	2,092	251	23	23	1,099	1,083	0	0			0	0	118	6	0	0
1997	2,429	360	17	17	1,267	1,240	0	0			1	1	152	10	2	2
1998	2,435	256	20	20	1,145	1,140	1	1			0	0	204	16	1	1
1999	1,891	254	42	42	1,020	1,005	0	0			0	0	149	14	1	1
2000	1,535	182	47	47	807	784	3	3			0	0	143	22	3	3
2001	1,772	155	73	73	1,076	1,063	2	2			0	0	108	**	4	4
2002	1,714	160	61	61	778	757	6	6			0	0	105	7	1	1
2003	1,379	146	53	53	762	756	7	7			0	0	93	10	3	3
2004	1,446	158	98	98	804	803	8	8			0	0	115	13	4	4
2005	1,378	108	116	116	571	566	16	16			0	0	106	7	0	0
2006	1,344	114	98	98	738	726	26	26			0	0	93	6	5	5
2007	1,245	95	93	93	583	567	47	47			0	0	134	8	2	2
2008	1,341	95	90	90	513	504	79	79			0	0	106	7	3	3
2009	1,541	145	71	71	721	717	89	89			0	0	133	7	15	15
2010	847	89	91	91	342	342	74	74			0	0	93	**	14	14

**=data deemed confidential have been removed

Table 3.7a. Number of length samples (fish measured) retained for length composition and number of length samples deleted and reason for deletion by year and state for hand line gear.

YEAR	NO TRIP WEIGHTS				NON-COMMERCIAL				OUTLIER LENGTH				QUOTA SAMPLING				TOTAL	RETAINED				
	FL	GA	NC	SC	FL	GA	NC	SC	FL	GA	NC	SC	FL	GA	NC	SC	EXCLUDED	FL	GA	NC	SC	TOTAL
1983	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	54	0	54
1984	0	0	320	0	0	0	0	0	0	0	1	0	0	0	0	0	321	0	425	1,016	87	1,528
1985	0	6	252	8	0	0	1	0	5	0	1	0	0	0	0	0	273	133	142	613	360	1,248
1986	0	30	620	75	0	0	22	0	1	0	0	0	0	0	0	0	748	5	113	536	41	695
1987	0	0	583	0	0	0	0	0	0	0	0	0	0	0	0	0	583	0	205	468	131	804
1988	0	0	197	18	0	0	0	0	0	0	0	0	0	0	0	0	215	4	141	499	170	814
1989	0	0	10	10	0	0	0	0	0	0	1	0	0	0	0	0	21	0	47	393	255	695
1990	1	0	139	97	0	0	0	16	2	0	0	1	0	0	0	0	256	36	0	625	479	1,140
1991	7	21	328	557	0	0	0	0	0	0	1	0	0	0	0	0	914	3	59	439	311	812
1992	30	0	511	463	0	148	0	0	0	0	1	0	0	0	0	0	1,153	2	46	336	20	404
1993	13	0	291	486	0	0	0	0	2	0	1	0	0	0	0	0	793	170	22	145	61	398
1994	0	0	161	379	0	0	0	0	1	0	3	0	0	0	0	0	544	54	0	298	218	570
1995	11	7	66	393	0	0	4	0	2	0	0	0	0	0	0	0	483	31	0	186	18	235

1996	0	8	62	511	0	0	0	0	3	0	0	0	0	0	0	0	584	24	0	63	152	239
1997	36	6	200	743	0	0	0	0	0	0	0	0	0	0	0	0	985	51	0	21	77	149
1998	23	1	347	1,134	27	0	0	0	0	0	0	0	0	0	0	0	1,532	45	0	120	19	184
1999	28	32	224	660	0	0	0	0	1	0	2	0	0	0	0	0	947	222	0	472	108	802
2000	10	27	85	515	0	0	0	0	0	0	0	0	0	0	0	0	637	41	0	347	22	410
2001	10	20	107	832	0	0	17	0	0	0	0	0	0	0	0	0	986	37	6	622	272	937
2002	100	59	6	465	0	0	0	0	0	0	0	0	0	0	0	0	630	33	37	673	296	1,039
2003	70	69	0	508	0	0	0	0	1	0	0	0	0	0	0	0	648	4	4	159	227	394
2004	0	399	42	347	249	0	0	0	0	0	2	0	0	0	4	0	1,043	1	27	1,392	107	1,527
2005	0	0	61	203	82	0	0	0	0	0	0	0	0	0	0	0	346	2	32	1,178	127	1,339
2006	0	0	44	380	0	0	0	0	0	0	3	0	0	0	0	0	427	34	0	1,074	106	1,214
2007	0	0	25	154	0	0	0	0	1	0	0	0	0	0	0	0	180	56	0	645	159	860
2008	0	0	6	160	0	0	0	0	0	0	0	0	0	0	0	0	166	9	0	442	178	629
2009	0	0	11	289	0	0	0	0	0	0	3	0	0	0	0	0	303	20	0	514	88	622
2010	0	0	38	0	0	0	0	0	0	0	3	0	0	0	0	0	41	0	0	435	196	631

Table 3.7b. Number of length samples (fish measured) retained for length composition and number of length samples deleted and reason for deletion by year and state for trap gear.

	NO LANDINGS				NO TRIP WEIGHTS				NON-COMMERCIAL				NONRANDOM SAMPLE				NONSENSE WEIGHT UNITS				OUTLIER LENGTH				TOTAL	RETAINED				
YEAR	FL	GA	NC	SC	FL	GA	NC	SC	FL	GA	NC	SC	FL	GA	NC	SC	FL	GA	NC	SC	FL	GA	NC	SC	EXCLUDED	FL	GA	NC	SC	TOTAL
1983	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	258	0	258
1984	0	0	0	0	0	0	62	38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0	548	209	757
1985	0	0	0	0	0	0	0	305	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	305	0	0	0	0	0
1986	0	0	0	0	0	0	0	893	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	893	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	195	499	694
1988	0	0	0	0	0	0	153	265	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	418	0	0	1,080	0	1,080
1989	0	0	0	0	0	0	104	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	104	0	0	265	0	265
1990	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	410	360	770
1991	0	3	0	0	0	0	147	585	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	735	0	0	331	139	470
1992	0	0	0	0	0	0	239	840	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,079	0	0	477	0	477
1993	0	0	0	0	0	0	92	460	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	553	0	0	79	36	115
1994	0	0	0	0	0	0	0	1,213	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,213	0	0	83	167	250
1995	0	0	0	0	0	0	0	352	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	352	0	0	0	0	0

1996	0	0	0	0	0	0	0	506	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	506	0	0	0	0	0
1997	0	0	0	0	0	0	0	873	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	873	0	0	0	0	0
1998	0	0	0	0	0	0	0	109	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	109	0	0	319	0	319
1999	0	0	0	0	0	0	0	868	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	868	0	0	0	0	0
2000	0	0	0	0	0	0	0	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32	0	0	416	0	416
2001	0	0	0	0	0	0	0	167	0	0	152	0	0	0	0	0	0	0	0	0	0	0	0	0	319	0	0	268	0	268
2002	0	0	0	0	0	0	3,357	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3,357	0	0	916	0	916
2003	0	0	0	0	0	0	6,515	28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6,543	0	0	1,238	0	1,238
2004	0	0	0	0	0	0	76	158	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	234	0	0	972	43	1,015
2005	0	0	0	0	0	0	0	42	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	42	0	0	670	0	670
2006	0	0	0	0	0	0	323	135	0	0	0	0	0	0	0	0	0	0	9	0	0	0	4	0	471	0	0	1,115	0	1,115
2007	0	0	0	0	0	0	670	289	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	960	0	0	1,958	0	1,958
2008	0	0	0	0	0	0	20	316	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	336	21	0	1,924	0	1,945
2009	0	0	0	0	0	0	25	772	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	797	410	0	1,808	0	2,218
2010	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	3	0	5	824	0	930	129	1,883

Table 3.7c. Number of length samples (fish measured) retained for length composition and number of length samples deleted and reason for deletion by year and state for trawl gear.

YEAR	NO LANDINGS				TOTAL	RETAINED				
	FL	GA	NC	SC	EXCLUDED	FL	GA	NC	SC	TOTAL
1983	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	29	29
1985	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	0
1987	0	19	0	0	19	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	6	6
1989	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0

1996	0	0	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	1	0	0	0	1
1998	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0
2006	0	0	0	0	0	0	0	0	0	0
2007	0	0	0	0	0	0	0	0	0	0
2008	0	0	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0	0	0

Table 3.7d. Number of length samples (fish measured) retained for length composition and number of length samples deleted and reason for deletion by year and state for other gear.

	NO LANDINGS				NO TRIP WEIGHTS				NON-COMMERCIAL				NONRANDOM SAMPLE				OUTLIER LENGTH				SIZE BIAS				TOTAL	RETAINED				
YEAR	FL	GA	NC	SC	FL	GA	NC	SC	FL	GA	NC	SC	FL	GA	NC	SC	FL	GA	NC	SC	FL	GA	NC	SC	EXCLUDED	FL	GA	NC	SC	TOTAL
1983	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	0	13
1985	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	13	2	0	1	0	3
1986	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23	0	23
1987	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	20	0	20
1988	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	12
1989	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	5
1990	0	0	0	0	0	0	71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	71	0	0	6	0	6
1991	0	0	0	42	0	0	14	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	62	0	0	59	0	59
1992	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	0	0	12	0	12
1993	0	0	0	0	0	0	235	136	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	371	0	0	0	0	0
1994	0	0	0	0	1	0	115	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	116	4	0	0	0	4
1995	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2	0	0	0	0	0

1996	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	78	0	78	0	0	261	0	261
1998	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	3
1999	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	1
2000	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	207	0	208
2001	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	16	0	388	0	404
2002	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4	0	0	0	4
2003	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	22	0	6	0	28
2004	0	0	0	0	5	0	0	0	0	0	0	0	16	0	0	0	0	0	0	0	0	0	0	0	21	6	0	1	7	14
2005	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
2006	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	45	0	0	12	57
2007	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	2	0	0	0	2
2008	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	3	2	0	7	0	9
2009	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	100	0	0	0	0	0	101	181	0	40	1	222
2010	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	233	0	21	30	284

Table 3.8. U.S. South Atlantic commercial black sea bass number of fish aged by gear and year.

YEAR	HAND LINES	POTS AND TRAPS
1979	19	-
1980	-	-
1981	-	190
1982	26	200
1983	-	50
1984	-	2
1985	-	2
1986	-	-
1987	-	-
1988	-	-
1989	-	-
1990	-	-
1991	7	4
1992	-	49
1993	-	-
1994	-	77
1995	-	-
1996	-	-
1997	-	22
1998	-	29
1999	120	-

2000	-	-
2001	-	-
2002	-	81
2003	-	443
2004	127	609
2005	423	836
2006	785	809
2007	2124	779
2008	2098	553
2009	2252	693
2010	1572	586

Table 3.9. Commercial length sampling fractions (number of fish lengths used for length composition/landings in numbers) by gear and year.

	GEAR			
YEAR	HAND LINES	POTS AND TRAPS	TRAWL	OTHER
1983	0.000	0.000	0.000	0.000
1984	0.010	0.002	0.003	0.003
1985	0.010	0.000	0.000	0.001
1986	0.006	0.000	0.000	0.010
1987	0.008	0.002	0.000	0.008
1988	0.004	0.002	0.000	0.006
1989	0.004	0.001	0.000	0.002
1990	0.004	0.001	0.000	0.002
1991	0.004	0.001	0.000	0.040
1992	0.002	0.001	0.000	0.002
1993	0.003	0.000	0.000	0.000
1994	0.004	0.001	0.000	0.000
1995	0.003	0.000	0.000	0.000
1996	0.003	0.000	0.000	0.000
1997	0.001	0.000	0.007	0.028
1998	0.001	0.001	0.000	0.000
1999	0.006	0.000	0.000	0.000
2000	0.006	0.001	0.000	0.160
2001	0.014	0.001	0.000	0.150

2002	0.015	0.002	0.000	0.001
2003	0.006	0.002	0.000	0.017
2004	0.018	0.002	**	0.015
2005	0.029	0.002	0.000	0.000
2006	0.031	0.003	**	0.041
2007	0.024	0.007	**	0.003
2008	0.015	0.007	0.000	0.004
2009	0.011	0.005	0.000	0.259
2010	0.016	0.006	0.000	0.252

**=data deemed confidential have been removed

Table 3.10. Black sea bass yearly total calculated discards from vertical line (hand line, electric and hydraulic reels) and fish trap (fish pot) commercial vessels in the US South Atlantic.

Year	Calculated discards
1993	153,920
1994	216,509
1995	187,736
1996	207,810
1997	189,224
1998	191,408
1999	176,749
2000	132,153
2001	160,580
2002	68,929
2003	170,848
2004	118,246
2005	185,460
2006	242,582
2007	64,535
2008	67,076
2009	119,248
2010	56,709

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

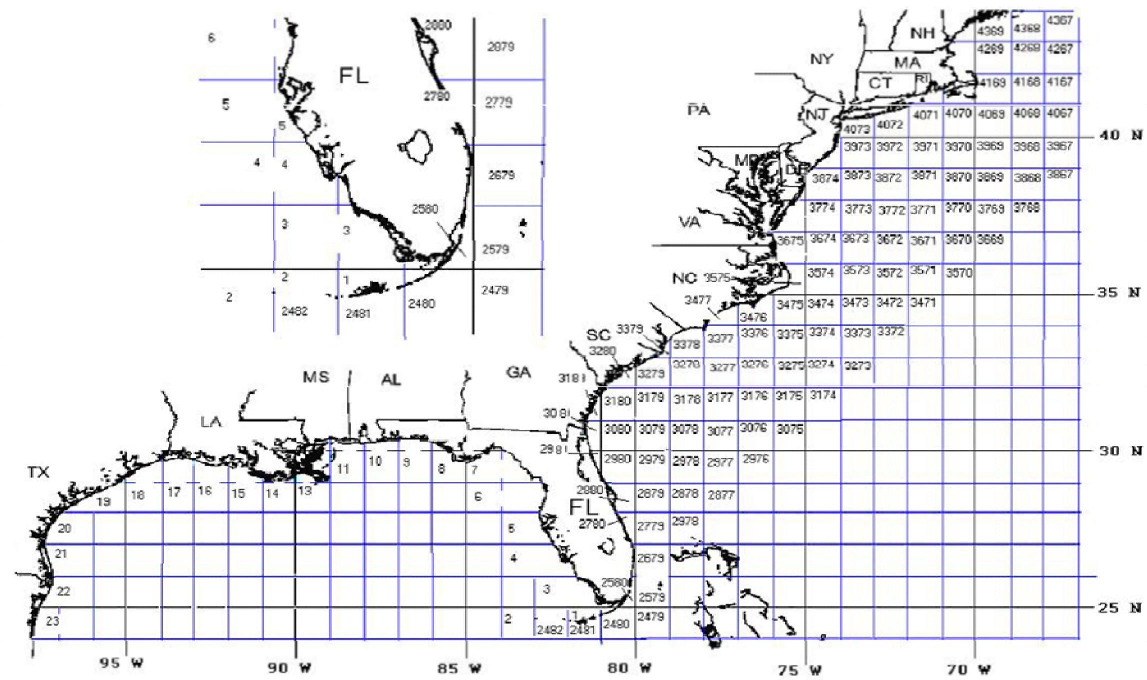


Figure 3.2. Map showing marine fisheries trip ticket fishing area code map for Florida.

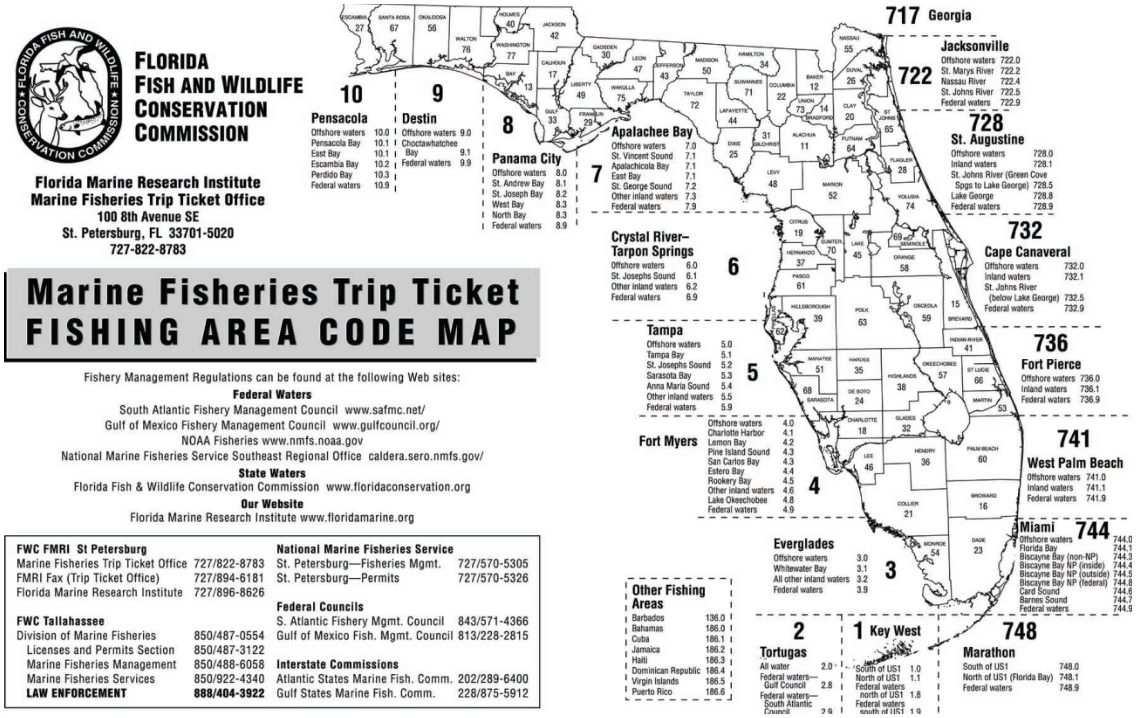


Figure 3.3. Atlantic Coastal Cooperative Statistics Program (ACCSP) Data Warehouse - data sources and collection methods by state. Early summaries provided by NMFS.

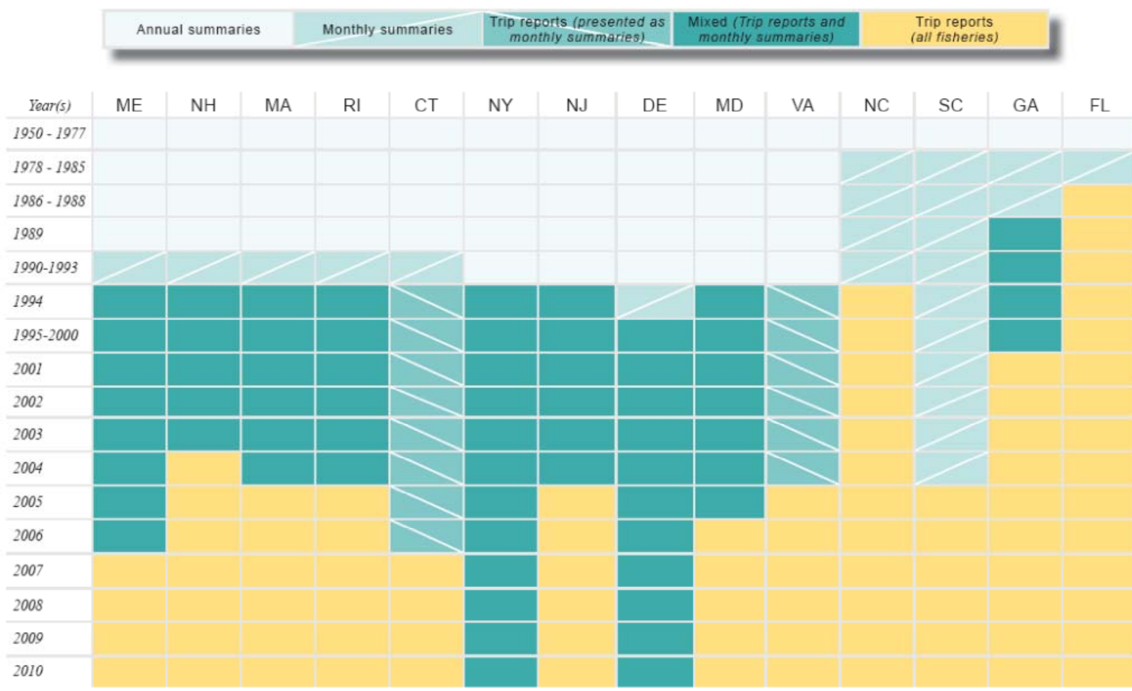


Figure 3.4. Black sea bass landings in millions of pounds (whole weight) by gear (pots/traps, lines, trawls and other) from the U.S. South Atlantic, 1958-2010.

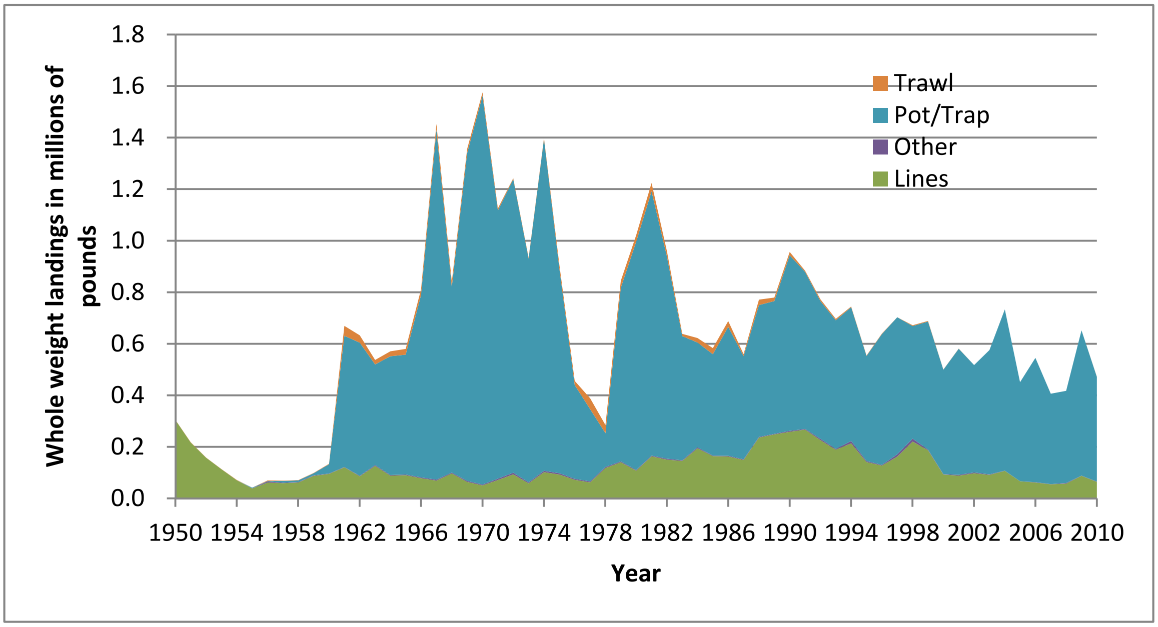
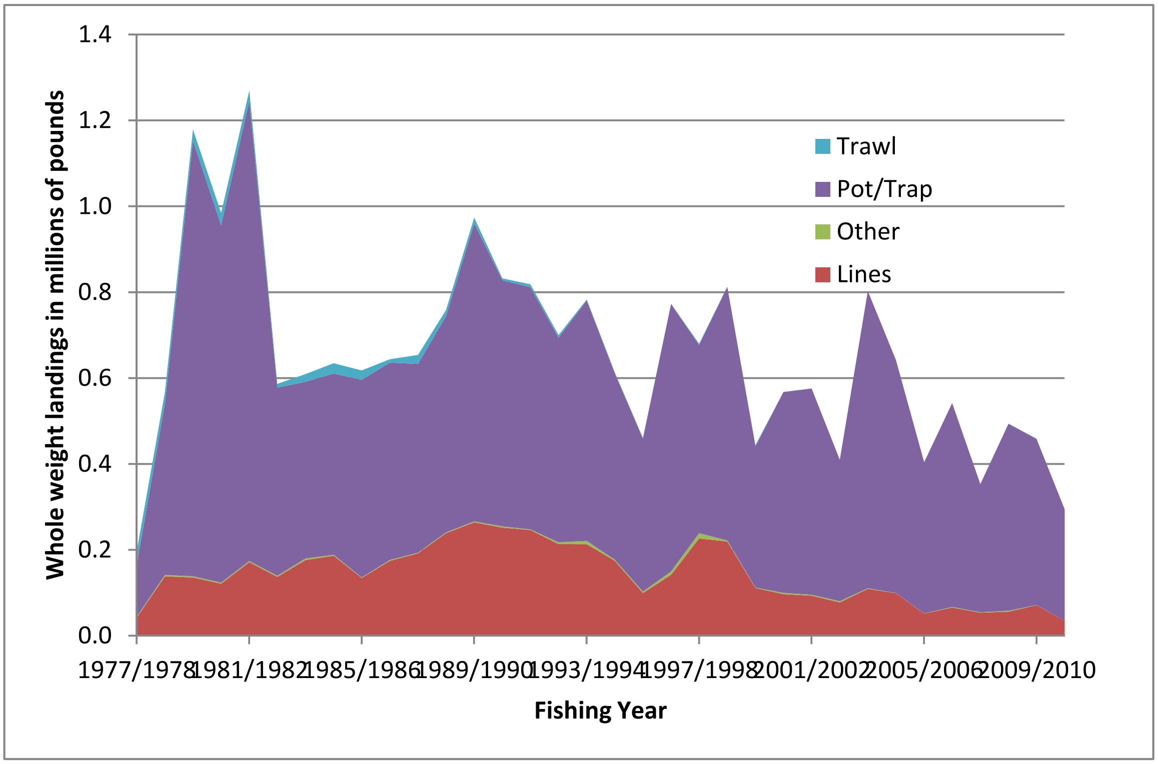


Figure 3.5. Black sea bass landings in millions of pounds (whole weight) by gear (pots/traps, lines, trawls and other) from the U.S. South Atlantic, fishing year 1977/1978-2009/2010.



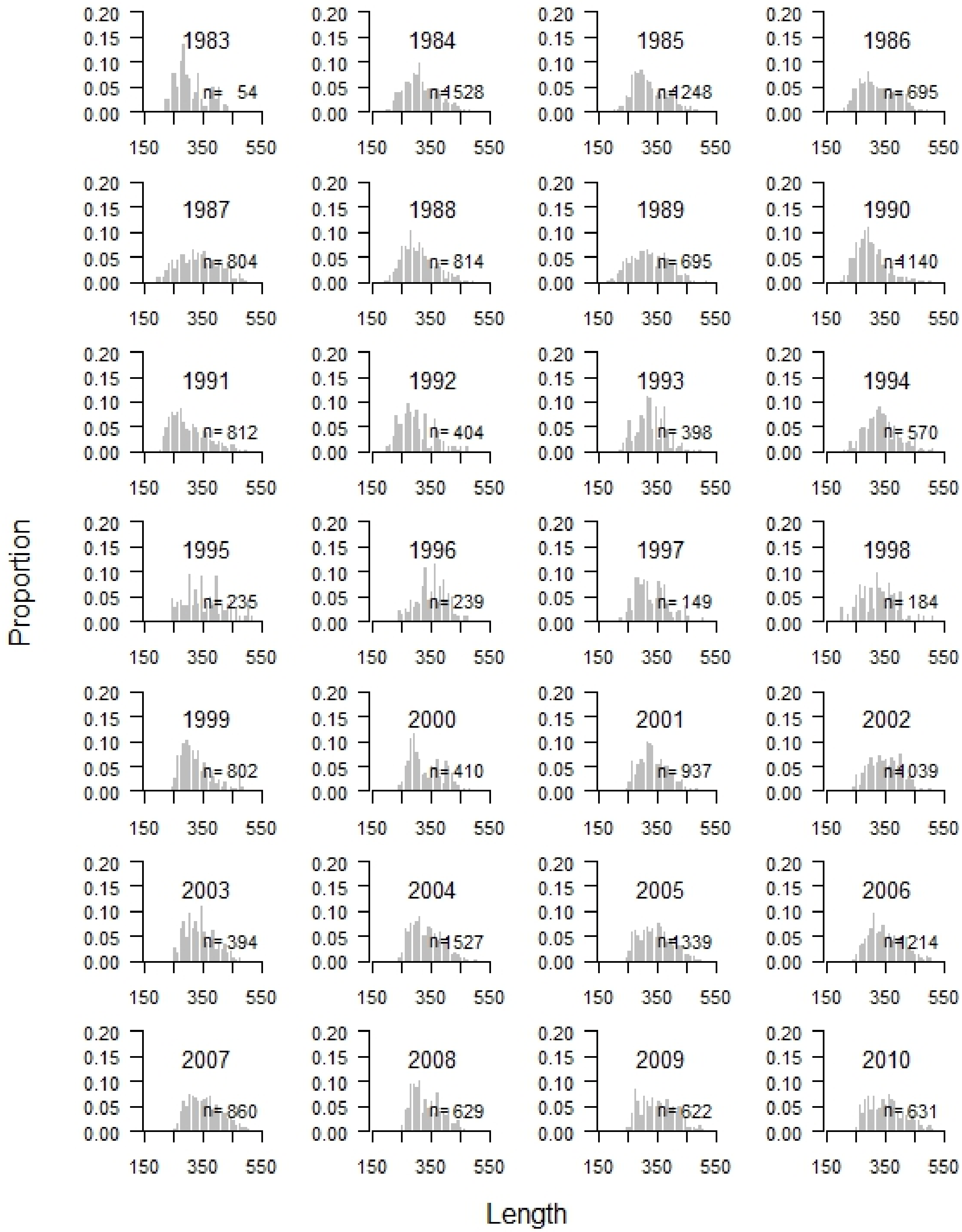


Figure 3.6. Relative length composition of commercial length (TL in mm) samples by year for hand line. N = number of fish.

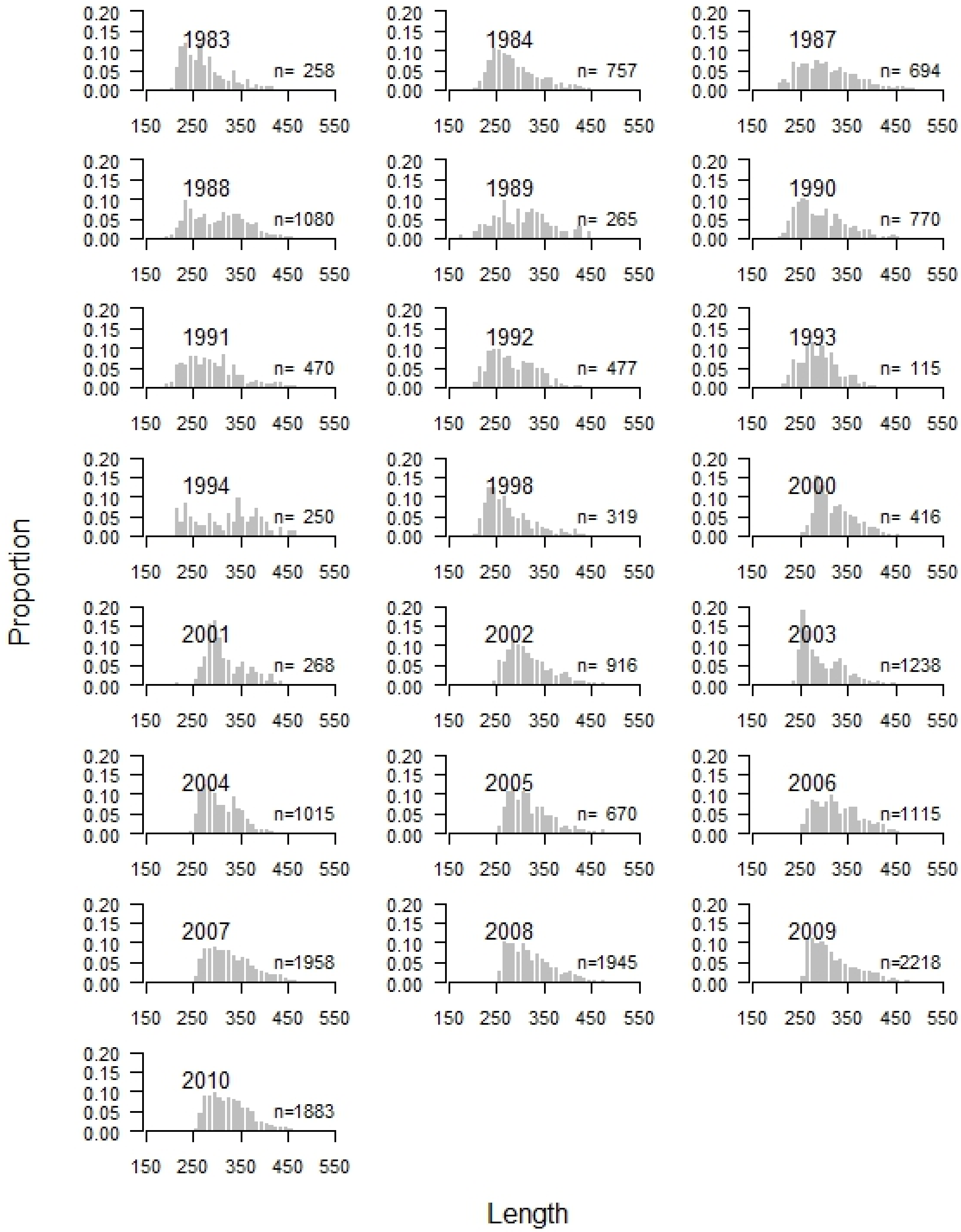


Figure 3.7. Relative length composition of commercial length (TL in mm) samples by year for pot and trap gear. N = number of fish.

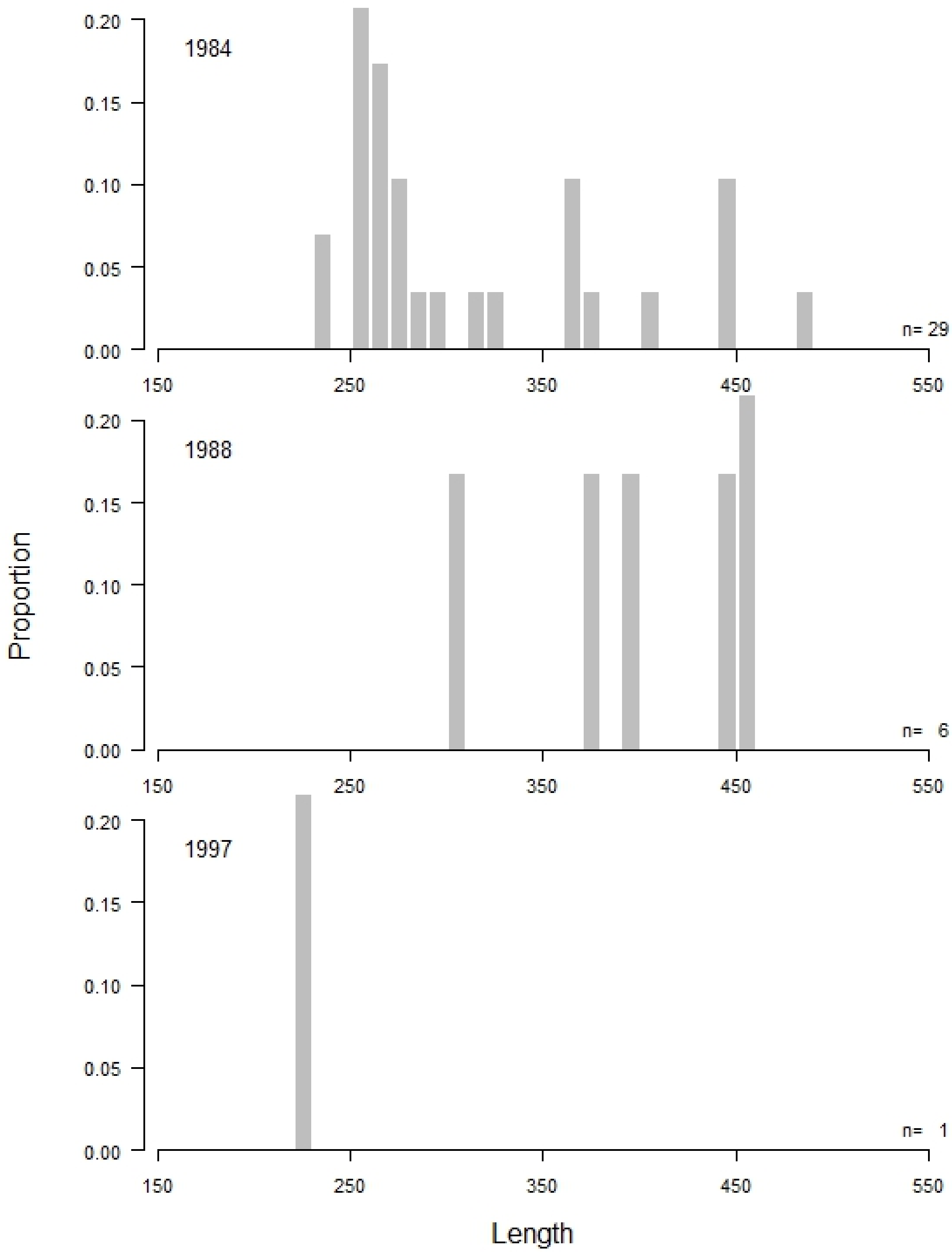


Figure 3.8. Relative length composition of commercial length (TL in mm) samples by year for trawl gear. N = number of fish.

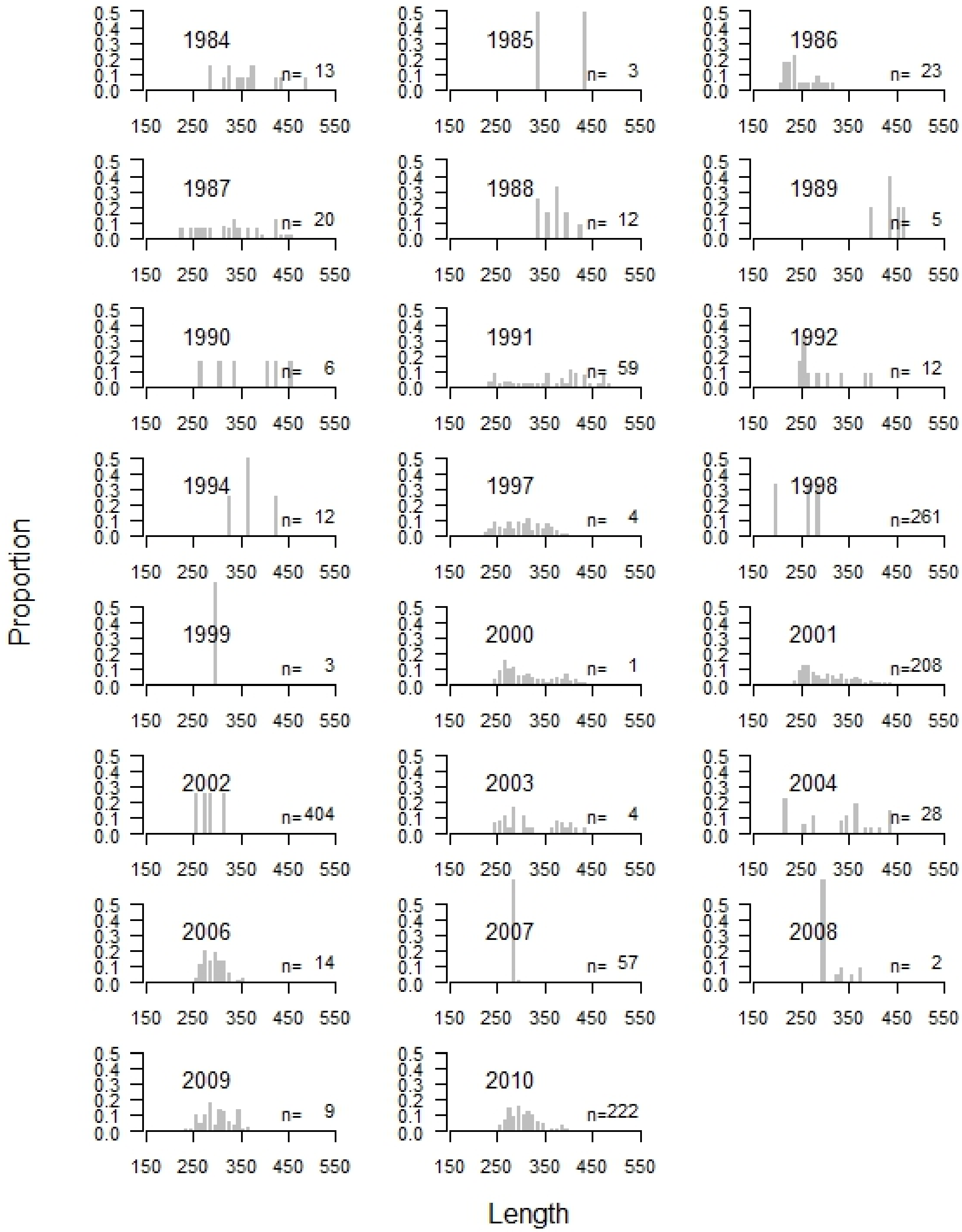


Figure 3.9. Relative length composition of commercial length (TL in mm) samples by year for other gear. N = number of fish.

Figure 3.10a. Relative age composition of commercial black sea bass age samples by year for hand line gear.

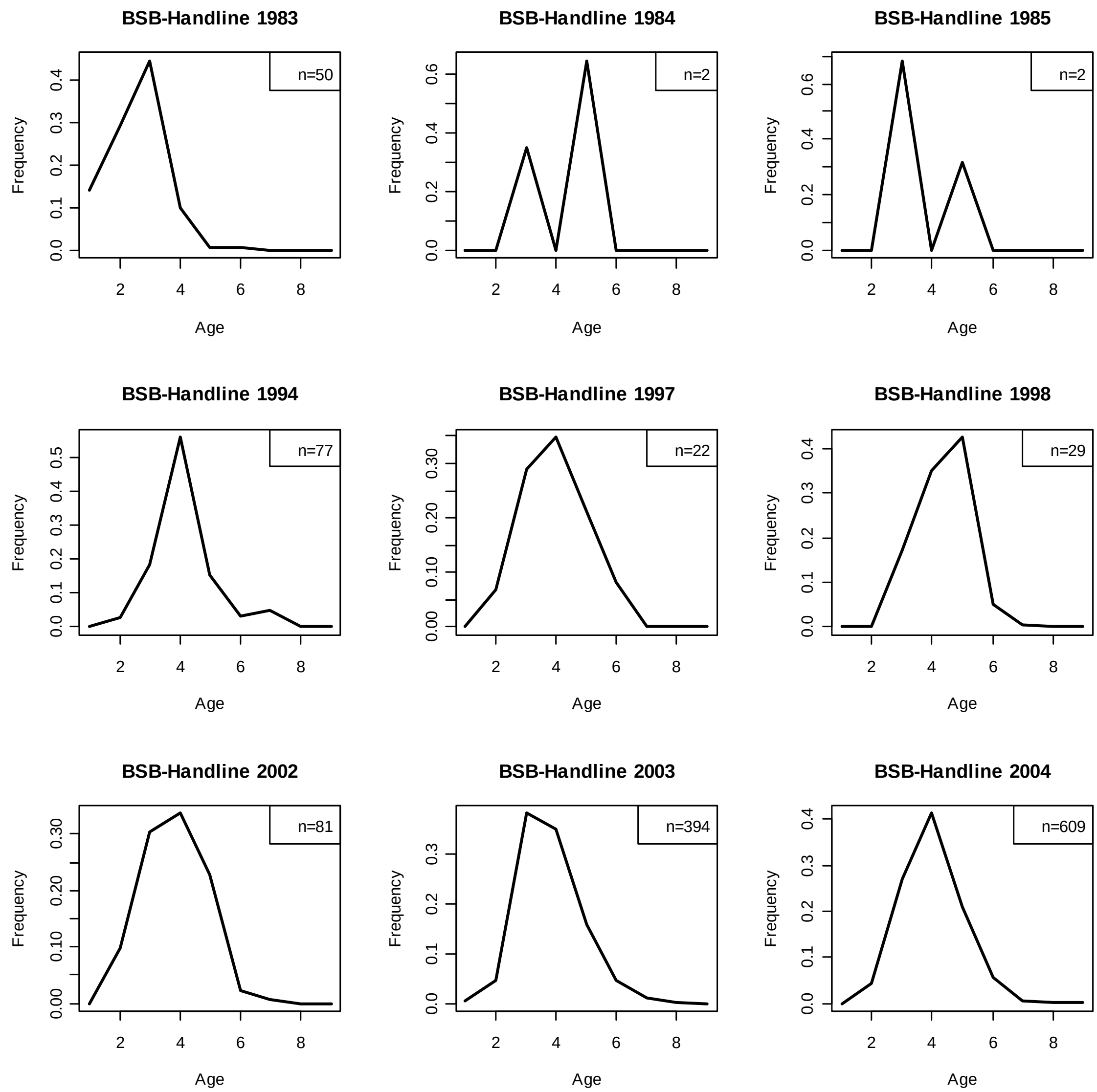


Figure 3.10b. Relative age composition of commercial black sea bass age samples by year for hand line gear.

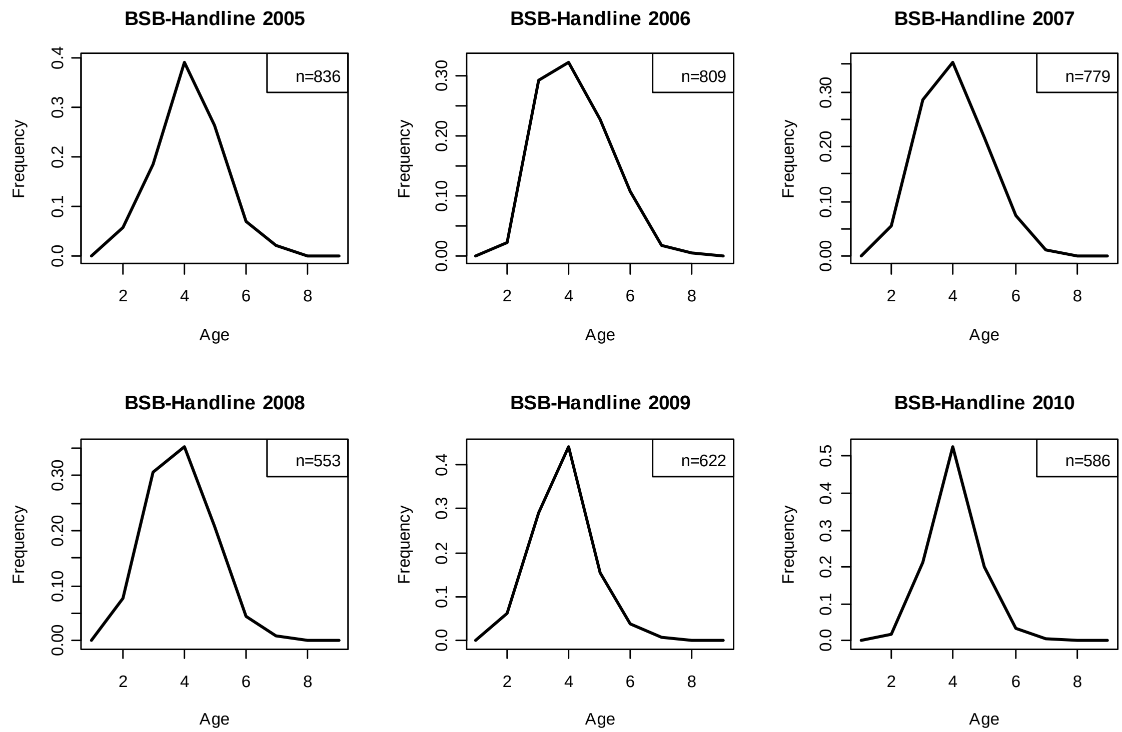
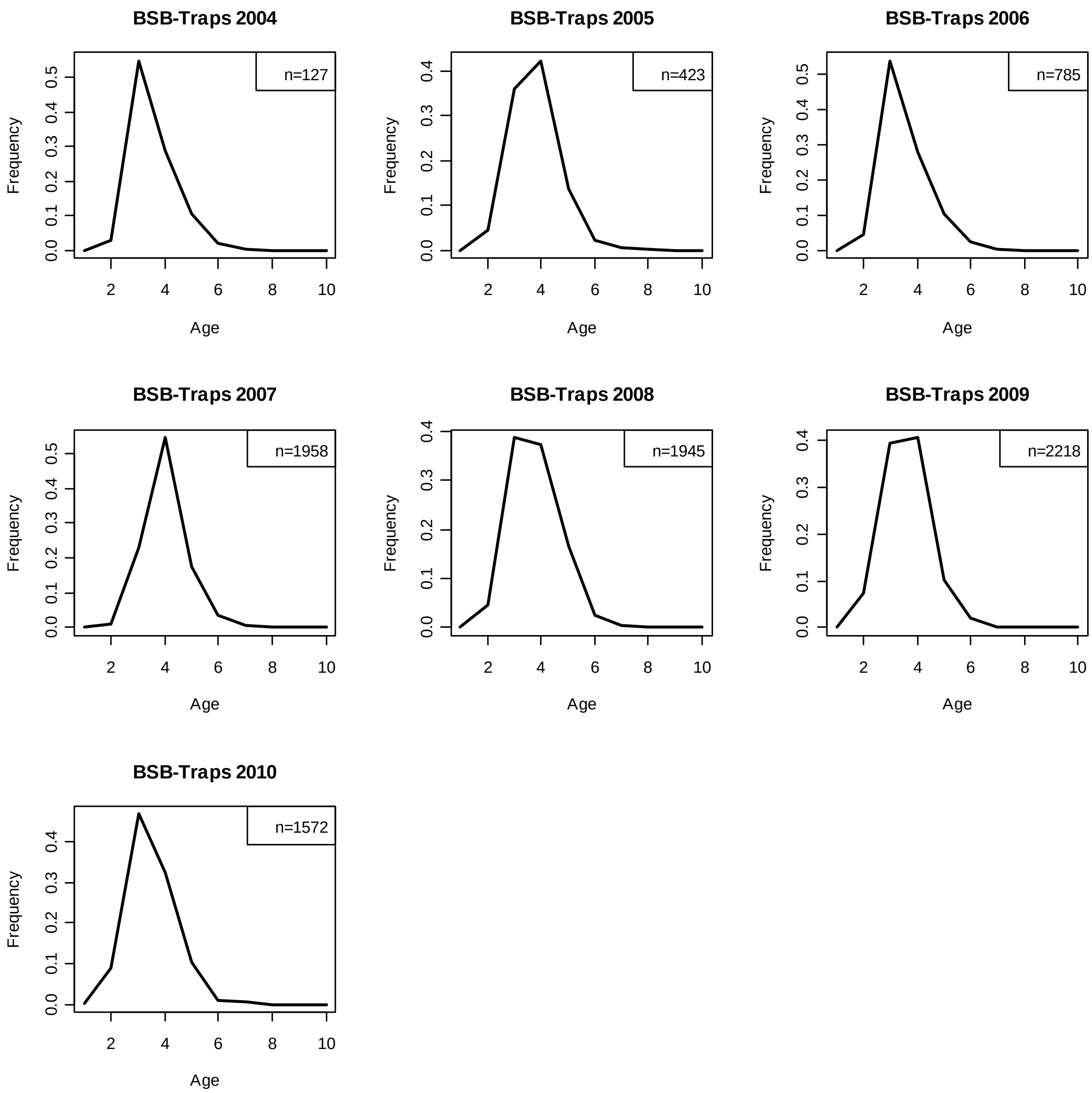


Figure 3.11. Relative age composition of commercial black sea bass age samples by year for pot/trap gear.



4 Recreational Fishery Statistics

4.1 Overview

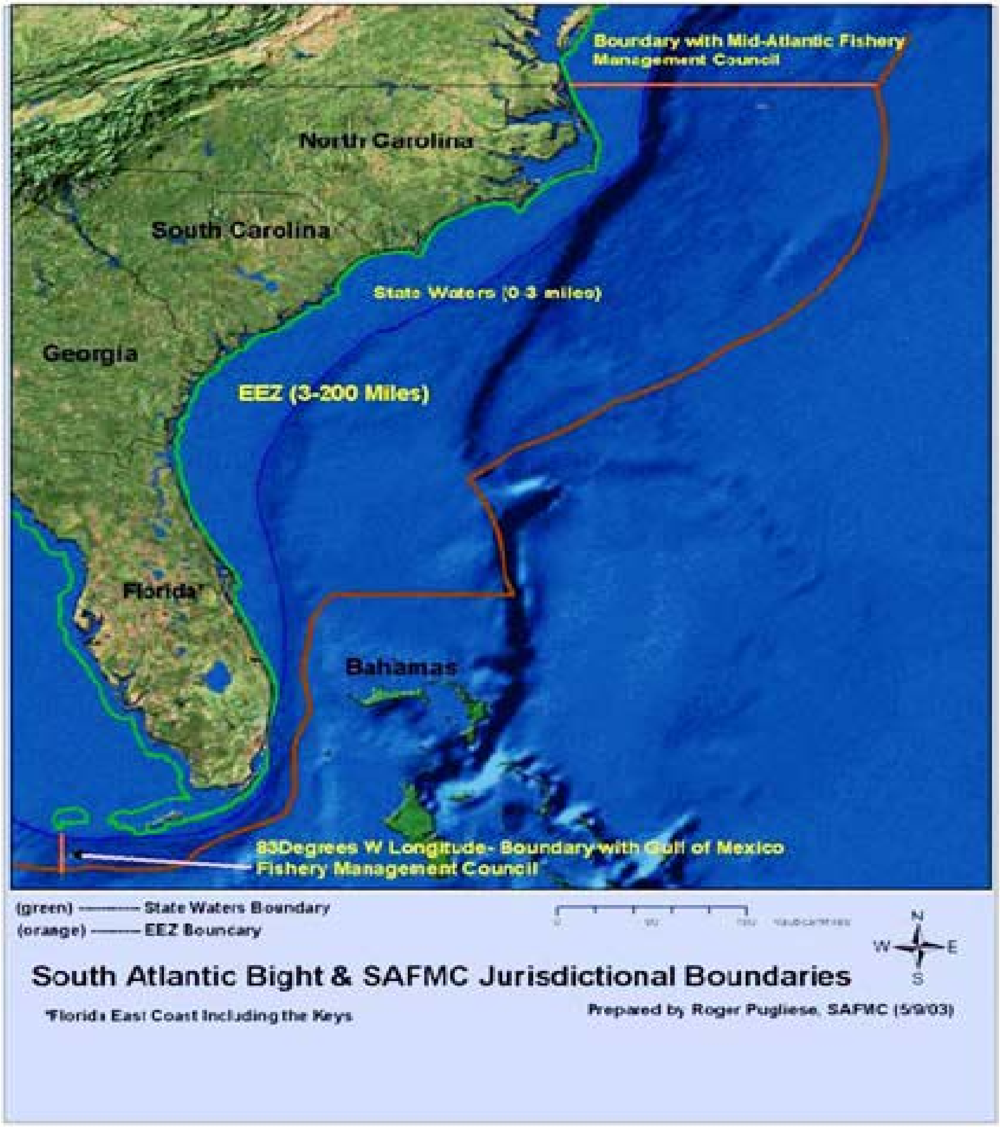
4.1.1 Group membership

Members- Ken Brennan (Leader\NMFS Beaufort), Kathy Knowlton (Rapporteur\GADNR), Zach Bowen (SAFMC Appointee/Industry rep GA), Julia Byrd (SCDNR), Kelly Fitzpatrick (NMFS Beaufort), Eric Hiltz (SCDNR), Rusty Hudson (SAFMC Appointee/Industry rep FL), Vivian Matter (NMFS Miami), Robert McPherson (SAFMC Appointee/Industry rep FL), Beverly Sauls (FWRI), Tom Sminkey (NMFS Silver Spring), Chris Wilson (NCDNR).

4.1.2 Issues

1) Catch within Monroe County, FL: Determine whether there is significant catch, and if so, whether it can be parsed out between Gulf and Atlantic and added to rest of South Atlantic catch.
2) Start date for recreational landings: 1981 typically used for MRFSS data, but 2006 update indicate data for 1978-1980.
3) Missing weight estimates for some recreational "cells" (i.e., specific year, state, fishing mode, wave combinations).
4) Headboat landings data available for SEDAR 25 from 1976-1977 for GA/NEFL and 1975-1977 for NC and SC that were not available for SEDAR 2.
5) Estimating headboat landings from 1975 (GA/NEFL) or 1975-1977 (SEFL) for periods of partial geographic coverage in the Southeast Region Headboat Survey (SRHS).
6) 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.
7) Uncertainty estimates for headboat landings and discards.
8) Charter Boat Landings: 1986-2003 & 2004-2009, MRFSS survey methods changed.
9) Party/Charter Landings: 1981-1985; Headboat landings, obtained from the SRHS, must be parsed out from combined MRFSS party/charter landings during the 1981-1985 time periods during which MRFSS did not stratify.
10) 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 1975. Review whether other data sources also available.

4.1.3 South Atlantic Fishery Management Council Jurisdictional Boundaries



4.2 Review of Working Papers

SEDAR25-DW*1 Black Sea Bass Length Frequencies and Condition of Released Fish from At-Sea Headboat Observer Surveys, 2004 to 2009. B. Sauls and C. Wilson 2010.*

The headboat at-sea observer program is conducted in North Carolina, South Carolina, Georgia and the east coast of Florida. The Recreational Workgroup reviewed available data for recreational discards from the headboat at-sea observer program. Methods for data collection and sample sizes are provided in working paper SEDAR-DW-1 titled, "Black sea bass Length Frequencies and Condition of Released Fish from At-Sea Headboat Observer Surveys, 2004 to

2010." Vital statistics, including species composition, size distribution, and released portion of total catch for recreational hook-and-line caught fish are collected in this survey and are summarized in SEDAR25-DW01.

SEDAR25-DW15, *South Carolina Department of Natural Resources (SCDNR) State Finfish Survey. Eric Hiltz and Julia Byrd*

This working paper presents a summary of the black sea bass catch, disposition, and size information collected through the South Carolina Department of Natural Resources (SCDNR) State Finfish Survey (SFS) from 1988 to 2010. 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 2010, 3,414 fishing parties were interviewed where black sea bass were caught, representing between 3.9% and 13.8% of the total number of interviews in each year. Fishing parties interviewed through the SFS caught 37,329 black sea bass from 1988 to 2010. Of those fish, a total of 8,323 were harvested (plus 43 harvested for use as bait) and 3,372 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 in combination with the MRFSS data for length compositions.

SEDAR25-DW16 & DW23 *South Carolina Department of Natural Resources (SCDNR) Charter boat Logbook Program. Mike Errigo, Eric Hiltz and Julia Byrd.*

These working papers present an index of abundance that was developed from the South Carolina Department of Natural Resources (SCDNR) charter boat logbook program for 1993-2010. SEDAR25-DW23 replaces and reflects substantial changes made to the original working paper SEDAR25-DW16. These changes were made based on discussions at the SEDAR 25 data workshop. The index of abundance developed is standardized catch per unit effort (CPUE; catch per angler hour) of black sea bass (BSB) using a delta-GLM model. Three explanatory variables were used in the delta-GLM model (year, locale, and season). 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. Combined these data represent ~20,661 fishing trips where anglers caught ~545,586 and harvested ~250,076 black sea bass. 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.

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, head boats 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. North of Florida sampling is not conducted in Wave 1 (Jan/Feb) because fishing effort is very low or non-existent, with the exception of NC 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 percent 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 data were improved through increased sample quotas and state add-ons 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. The FHS sub-regions include three distinct regions bordering the Atlantic coast: Monroe County (sub-region 3), southeast Florida from Dade through Indian River Counties (sub-region 4), and northeast 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.

The recreational statistics workgroup of SEDAR 15 recommended a comparison of the two methods of estimation of charter boat effort be conducted so that CHTS estimates from earlier years could be adjusted and the new FHS estimates used for later years. This comparison was made at SEDAR 16 (DW-15, Sminkey, 2008) and applied to South Atlantic charter boat effort and king mackerel catches. The same conversion ratios were used for black sea bass at the SEDAR 25 data workshop to produce a time series of adjusted charter boat landings and live discards (similar to that used for red snapper in SEDAR24- DW13, Sminkey, 2010). For this data workshop similar methods were employed to the extended overlapping survey years of 2004-2010 to produce more robust ratios for adjusting the earlier time series, and the adjusted effort was used to produce the adjusted landings and discards of black sea bass in NC to East Florida.

The MRFSS did not sample charter boats and headboats independently in 1981-1985. Head Boats were pooled with charter boats for sampling and estimation into a Party-Charter, or PC, mode. However, because the Southeast Region Headboat Survey (SRHS) logbooks provide more complete and accurate landings statistics, the PC mode estimates of black sea bass landings from 1981-1985 in the South Atlantic sub-region were adjusted by a ratio to extract the estimated portion from headboats. The SRHS did not collect information about discards during that time period so the MRFSS discard estimates for the PC mode are included in the total discard estimates for 1981-1985. In all subsequent years, the black sea bass statistics only include the charter boats from the For-Hire fishing sector and the headboat statistics are provided by the SRHS.

Missing cells in MRFSS estimates

MRFSS weight estimates must be treated with caution due to the occurrence of missing 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 black sea bass 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 (SEDAR22-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. Average weights are then multiplied by the landings estimates in number to obtain estimates of landings in weight. These estimates are provided in pounds whole weight.

Monroe County

Monroe County landings can be post-stratified to separate them from the MRFSS West Florida estimates. Black sea bass are less common on the extreme south Atlantic coast of Florida and this is evident from the sparse Monroe county post-stratified landings shown in Table 4.11.1. In addition, Monroe county landings cannot be partitioned into those from the Atlantic Ocean and those from the Gulf of Mexico. For these reasons, the recreational workgroup decided not to include Monroe County MRFSS estimates. Headboat landings from Monroe County are separated by area fished, and trips that occurred on the Atlantic side of Keys and Dry Tortugas were included in headboat landings.

North Carolina

Cape Hatteras on the North Carolina coast represents the faunal break between northern and southern stocks of black sea bass along the Atlantic Coast. The landings, discards and related data products for this black sea bass SEDAR include only the stock that occurs south of Cape Hatteras. For the MRFSS landings, discards, and length frequencies this division of NC statistics was done using a post-stratification technique that proportionally distributes effort and catch rates based on the county of origin of the angler's fishing trip (or access point) as sampled by the Angler Intercept Survey. For the charter boat mode, the landings estimates were first post-stratified and only the southern portion of NC retained, then the FHS adjustment ratios were applied (Table 4.11.2; Figure 4.12.1). Landings estimates for private/rental boat and shore modes are summarized in Table 4.11.3 and 4.11.4, respectively.

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. Black sea bass landings estimates in the South Atlantic are only available for those years when coverage occurred.

Headboat data prior to 1978 not available for SEDAR 2 was considered for inclusion for SEDAR 25. Based on data tabulated on paper copies and recently key-entered, these 1972-1980 time period data included estimated black sea bass landings from 1975 to 1977 for NC and SC and 1976-1977 for GA/NEFL. These data were verified with previous Headboat Survey personnel as having been collected during those time periods. NC and SC landings already key-entered and used in SEDAR 2 were compared and matched to the hard copies of the recovered tabulated data for the time period 1978-1980 to check for accuracy. These updated estimates are highlighted in Table 4.11.5. Based on the SEDAR 2, landings were adjusted for the mixing of sea basses (principally black and bank sea basses) in the headboat logbook database. In years 1975-1980, there was no separation, but during 1981-1987 these species were increasingly separated in the data base. To correct for this mixture, the proportion of black sea bass to total sea bass was calculated for 1988-1990 (0.9536) and applied to total (black + bank) sea bass landings for 1975 to 1987 (Table 4.11.6; Figure 4.12.2).

Issue 1: Headboat landings data available for SEDAR 25 from 1975-1977 for NC and SC and 1976-1977 for GA/NEFL were not available for SEDAR 2.

Option 1: Include the new data in the assessment prior to 1978.

Option 2: Do not include the new data in the assessment, start headboat landings in 1978 similar to SEDAR 2.

Decision: Option 1 to include the newly key-entered data for 1975-1977 NC and SC, 1976-1977 for GA/NEFL. These data were verified and deemed reliable for use in SEDAR 25 to extend headboat landings back to 1975.

Issue 2: The Headboat Survey had partial geographic coverage prior to 1978. Reported data are not available for GA/NEFL from 1975 or SEFL from 1975-1977.

Estimates for these area/time periods can be calculated using a 3 year average ratio of NC, SC and GA landings from 1975 to 1977 for periods of partial coverage, to produce estimates for GA\\NEFL in 1975 and SEFL in 1975-1977 (Table 4.11.5).

Option 1: Include these estimates using the 3 year average ratio of landings in the assessment for 1975-1977 for years of partial coverage.

Option 2: Do not include 3 year average ratio for landings in areas of partial coverage.

Decision: Option 1 to use the 3 year average ratio for estimating both number and weight to predict landings for GA/EFL 1975 and SEFL for 1975-1977. This statistical method was recommended and approved in SEDAR 24 and SEDAR 25.

Based on this decision the 3 year average ratio was applied to the areas and periods when partial coverage occurred. The complete time series for black sea bass estimated headboat landings from 1975 to 2010 are summarized in Table 4.11.6.

4.3.3 Historic Recreational Landings

Introduction

The historic recreational catch time period will be defined as pre-1981 for the charter and private boat sectors, which represents the start of the Marine Recreational Fisheries Statistics Survey (MRFSS). The SEDAR 2 2003 update included identical annual recreational landings estimates for 1978-1980. However, the source of these data could not be determined, and thus were not included in this new assessment SEDAR 25. The headboat data in the South Atlantic for black sea bass has been extended back in time to 1975, which represents the earliest year estimated landings, are available from Southeast Region Headboat Survey. Therefore the historic period for the headboat sector is pre-1975.

The Recreational Working Group was tasked to explore potential historical recreational landings of black sea bass in order to compile landings prior to the available time series of MRFSS and headboat estimated landings. The sources of historical landings that were reviewed for potential use are as follows:

- Salt Water Angler Surveys (SWAS).1960, 1965 &1970.
- Anderson, 1965, DW Reference Document 31.
- Schlitz tagging survey 1961-1965.

When considering the SWAS as a potential source of historical recreational landings the RWG reviewed SEDAR 19 data workshop working paper (SEDAR19DW-05), "Evaluation of the 1960, 1965, and 1970 U.S. Fish and Wildlife Service salt-water angling survey data for use in the stock assessment of red grouper (Southeast US Atlantic) and black grouper (Southeast US Atlantic and Gulf of Mexico)," for description of survey methodologies (including changes between years) and issues of undetermined species grouping. From SEDAR19-DW05 document; "Confounding the problem of identification is the grouping of species." Only twenty categories were allowed for each region. Species-level identification was allowed for a few species while many of the species were grouped into general categories. Three lines were available at the end of the survey to write in species not listed in the 20 categories. The grouper category is listed on the data sheet as "Grouper: sea bass, hinds, jewfish" (see Appendix 1). It is not clear where black sea bass would have been classified. Estimates of black sea bass were generated presumably from those who added black sea bass as a write-in at the end of the form. It is likely that many black sea bass were included in the grouper category in the saltwater angling surveys. This brings into question the estimates for species that were not on the form for a given region (possibly underestimated) and those that are on the form (other species grouped instead of written in at the bottom which would lead to overestimates). Estimates were generated for 37, 31, and 40 species or species groups in 1960, 1965, and 1970 respectively from the 20 categories in the South Atlantic plus the write-in values. The Saltwater Angling Survey reports provided examples of the data collection forms for the Southeast US in 1960 and 1965 and for the Northeast in 1970 (Appendix 1). Grouper estimates are even more problematic than other species groupings because of the description as sea basses on the form with no other space provided for black sea bass values."

1960 Cape Hatteras, NC-Florida Keys species grouping: "Grouper: sea bass, hinds, and jewfish"
1965 Cape Hatteras, NC-Florida Keys species grouping: "Grouper (sea bass, hind, etc.)
1970 Cape Hatteras, NC-Florida Keys species grouping not available in document

Year	Estimated # Black Sea Bass	# Anglers with Catch	CPUE	Average Weight per Black Sea Bass (in pounds) *
1960	433,000	22,000	19.68	1.5
1965	1,043,000	40,000	26.08	1.6
1970	7,218,000	278,000	25.96	1.7

* = weight of fish in 1960 was calculated after the interview using regional advice from state agency staff, scientists, sportsmen, etc. Anglers estimated the average weight for each species or species grouping in 1965 and 1970.

See SEDAR 24 data workshop reference documents (SEDAR24-RD04, SEDAR24-RD05, and SEDAR24-RD06) for 1960, 1965, and 1970 salt water angling survey publications. See SEDAR 24 data workshop working paper (SEDAR24-DW11) for issues of overestimation and recall bias.

Though estimates of total number and pounds of black sea bass caught in 1960, 1965 and 1970 are available from the salt water angling surveys, based on the myriad of issues with changes in methodologies, biases and species groupings, the recreational workgroup does not recommend they be used to derive historical landings for inclusion in the SEDAR 25 assessment.

Based on the review of SEDAR25-RD31and the Schlitz Tagging Survey (Beaumariage, D.S. 1963) neither was recommended for use in SEDAR 25 due to the limited geographic scope and information that was available.

4.3.4 Additional Potential Data Sources

4.3.4.1 SCDNR Charter boat Logbook Program Data, 1983 – 2010

The Recreational Fisheries Working Group discussed the possibility of replacing the MRFSS charter mode estimates for South Carolina from 1993 to 2010 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 charter mode estimates (Figure 4.12.3). Large scale differences were seen in total catch, with the SCDNR charter boat logbook catch being orders of magnitude smaller than MRFSS estimates. The Recreational Fisheries Working Group recommended not replacing the MRFSS charter boat estimates with the SCDNR Charter boat Logbook Program estimates for 1993 – 2010. The MRFSS estimates represent a longer time series and switching from the MRFSS dataset (1981 – 1992) to the SCDNR Charter boat logbook dataset (1993 – 2010) would artificially reduce the total catch due to the change in methodology that would not necessarily be indicative of a change in the black sea bass population which could affect the stock assessment model.

4.3.4.2 SCDNR State Finfish Survey (SFS)

Black sea bass lengths were collected through the SCDNR State Finfish Survey (SFS) from 1988 to 2010. 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 2010 total lengths were measured. From 1988 to 2010 3,372 black sea bass lengths were collected by SFS personnel. The Recreational Fisheries Working Group recommended the SCDNR SFS supplemental length data for private boat mode be incorporated into the MRFSS length frequency data. A conversion from total length to mid-line length was not available at the SEDAR 25 data workshop, so SFS supplemental length data from private boat mode was provided from 1988 to 2008. Summarized length data for private boat mode from 1988 – 2008 can be found in Table 4.11.7.

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 in the South Atlantic sub-region. At-sea sampling of head boat discards was initiated as part of the improved for-hire surveys to characterize the size distribution of live discarded fishes in the head boat fishery, however, the Beaufort, NC Logbook program (SRHS) produces estimates of total discards in the head boat fishery since that class of caught fish was added to their logbook (2004). All live released fish statistics (B2 fish) in charter or party/charter mode fishing were adjusted in the same manner as the landings (described above; SEDAR24-DW13). Size or weight of discarded fishes is not estimated by the MRFSS. Estimates of black sea bass discards in the early 1980s were relatively large (> 100,000 live discards), and may be an artifact of the combined charter boat and party boat sampling and estimation (PC mode) during the period of 1981-1985. Live discards in both the charter and private boat recreational fisheries were considerably lower in the 5-year period after 1985 but have steadily increased since then (Table 4.11.8).

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. The RWG evaluated the results reported in SEDAR25-DW1 and additional analyzes comparing black sea bass discard data from the MRFSS At-Sea Observer Headboat program to the Southeast Region Headboat Survey (SRHS) logbook. Based on the results of these comparisons, it was determined that the logbook discard data were underreported from 2005-2010. The RWG further concluded that a proxy should be used to estimate the headboat black sea bass discards for this time period. Combined charter boat and headboat discard data are available for 1981-1985; therefore no proxy is needed for those years. The RWG considered the following three possible data sources to be used as a proxy for estimated headboat discards for 1986-2010 (Figure 4.12.4).

- MRFSS At-sea Observer – Not recommended for use since it is a short time series (2003-2010 in NC and SC; 2005-2010 in GA and FL) and is not expanded by angler effort.

- MRFSS charter boat discard estimates (corrected for FHS adjustment) – Extend back to 1986 and follows the pattern exhibited in the Southeast Region Headboat Survey, SC Charter Logbook Survey, and MRFSS At-Sea Observer program in later years.
- SC logbook – Extends back to 1993 and follows the pattern exhibited in the Southeast Region Headboat Survey, MRFSS charter boat, and MRFSS At-Sea Observer program. It is limited to one state that does not contribute a large portion of the black sea bass landings, therefore it is not recommended for use.

Issue 1: Proxy for estimated headboat discards from 1986-2010.

Option 1: Apply the MRFSS charter boat discard:landings ratio to estimated headboat landings in order to estimate headboat discards from 1986-2010.
Option 2: Use MRFSS charter boat (corrected for FHS adjustment) discards as a proxy for headboat discards from 1986-2005. Apply at-sea observer discard proportion to headboat landings to estimate discards 2005-2010.
Option 3: Do not attempt to estimate discards for the headboat sector from 1986-2010. Allow the assessment model to account for discards during this time period.

Decision: Option 1 Apply the MRFSS charter boat discard:landings ratio to estimated headboat landings in order to estimate headboat discards from 1986-2010. The MRFSS charter boat discard estimates followed the pattern exhibited in the Southeast Region Headboat Survey, SC Charter Logbook Survey, and MRFSS At-Sea Observer program in later years. The resulting discard estimates for headboats from 1986 to 2010 are represented in Table 4.11.8.

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) (Table 4.11.9, 4.11.10). 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. This data set provides valuable quantitative information on the ratio of harvested to discarded fish, depths fished, and the size distribution and release condition of fish discarded in the recreational headboat fishery and provides the only available time series on the size distribution of discards (Table 4.11.10). Survey methods, sample sizes and size distributions of discarded fish are described in detail in SEDAR25-DW1.

4.5 Biological Sampling

4.5.1 MRFSS Charter and Private

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, 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, e.g., the black sea bass. 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.

Headboat Survey Biological Sampling
Lengths were collected from 1972 to 2010 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, food analyzes and maturity studies.

At-Sea Observer Program
Headboats in South Carolina and North Carolina have participated in the At-Sea Observer Survey from 2004 to present, while headboats along the Atlantic coast of Florida and Georgia have participated since 2005. The purpose of the Headboat At-Sea Survey is to collect detailed information on both harvested and discarded fish during recreational fishing. For each fish, biologists recorded the species, disposition, size (fork length in mm), and the condition of fish that were released (Florida only). Biological samples such as scales, otoliths, spines, stomachs and gonads, are not typically collected as part of this protocol.

4.5.2 Sampling Intensity Length/Age/Weight

Dockside Surveys - Annual numbers of black sea bass measured for lengths and the number of trips from which black sea bass were measured in MRFSS charter fleet intercepts are summarized in Table 4.11.11. Annual numbers of black sea bass measured for length in the MRFSS private-rental mode and the number of trips from which black sea bass were measured are summarized in Table 4.11.12. Annual numbers of black sea bass measured for length in the shore mode and the number of trips from which black sea bass were measured are summarized in Table 4.11.13. Annual numbers of black sea bass measured for length in the headboat fleet and the number of trips from which black sea bass were measured are summarized in Table 4.11.14. The number of black sea bass aged and the number of trips from which black sea bass were aged from the headboat fleet by year and state are summarized in Table 4.11.15. The number of black sea bass and the number of trips from which black sea bass were aged from the charter boat fleet by year and state is summarized in Table 4.11.16. The number of black sea bass and the number of trips from which black sea bass were aged from the private fleet by year and state is summarized in Table 4.11.17. The number of black sea bass and the number of trips from which black sea bass were aged from shore mode by year and state is summarized in Table 4.11.18. Tables 4.11.19, 4.11.20, and 4.11.21 provide details on the numbers of MRFSS intercept in charter boat, private/rental boat, and shore mode, respectively, by year in each state and the percentage of intercepts that encountered black sea bass.

Charter mode, private mode and shore mode dockside mean weights are tabulated for 1981-2010 in Table 4.11.22, 4.11.23, 4.11.24. Dockside mean weights for the headboat fishery are tabulated for 1973-2010 in Table 4.11.25.

At-Sea Observer Program

Lengths of harvested and discard black sea bass were collected during headboat at-sea observer trips starting in 2004 in the South Atlantic. The number black sea bass positive trips and numbers of black sea bass lengths by state and year are found in Table 4.11.9 and Table 4.11.10.

4.5.3 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/area/wave strata,
2) Output a distribution of estimated catch among state/mode/area/wave strata,
3) Calculate and output relative length-class frequencies for each state/mode/area/wave stratum,
4) Calculate appropriate relative weighting factors to be applied to the length-class frequencies for each state/mode/area/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 4.12.5).

Lengths were taken from the MRFSS (charter boat, private/rental boat, and shore modes) during 1981 to 2010. Lengths were taken from the SCDNR SFS during 1988 to 2008. 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 black sea bass length measurements taken is an amalgam of vessel and angler trips during 1988 to 2008.

Southeast Region Headboat Survey Length Frequency Analysis Protocol
Headboat landings (1975 to 2010) were pooled across five time intervals (Jan-May, Jun, July, Aug, Sep-Dec) because landings were not estimated by month until 1996. The headboat landings were only estimated annually prior to 1981 so, no intra-annual weightings were developed for 1975-1980. Spatial weighting was developed by region for the headboat survey by pooling landings by region; NC, SC, NF (GA and North FL), and SF (South FL). 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 4.12.6).

MRFSS Age Frequency
The calendar age for each black sea bass was matched to the corresponding annual proportion at length in the length composition for the private fleet that matched the length of the aged fish. The annual proportion at age (age frequency) was developed as the sum of the length bin proportion assigned to each fish by year and age normalized to sum to 1 annually (Figure 4.12.7, see SEDAR 24 data summary workbook for data). Ages 1-7 were plotted, although one fish aged 8 was observed. This weighting adjusts for any bias in sampling otoliths from a distribution of different sized fish.

The number of vessel trips with aged black sea bass is required for the assessment model. In some cases it was not possible to determine whether the age samples were taken from one or multiple vessel trips. Therefore the number of trips reported is an amalgam of vessel trips and angler trips.

Headboat Fleet Age Frequency
The calendar age for each black sea bass was matched to the corresponding annual proportion at length in the length composition for headboat fleet that matched the length of the aged fish and year captured. The annual proportion at age (age frequency) was developed as the sum of the length bin proportion assigned to each fish by year and age normalized to sum to 1 annually (Figure 4.12.8, see SEDAR 25 data summary workbook for data). Ages 1-9 were plotted although few ages greater than 8 years were observed. This weighting adjusts for any bias in sampling otoliths from a distribution of different sized fish.

4.5.4 Adequacy for characterizing catch

Regarding the adequacy for characterizing recreational catch for this assessment, the RWG discussed the following:

- Landings, as adjusted, appear to be adequate for the time period covered.

4.5.5 Alternatives for characterizing discards

Based on the comparison of logbook data to the At-Sea Observer data, it was concluded that the headboat logbook discard estimates were under reported and should not be used for the available years back to 2004 for the South Atlantic headboat fishery. Further, the group decided to use the charter mode as a proxy to calculate headboat discards for 1986-2010, 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 black sea bass over time.

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

The RWG discussed and had no input on this issue.

4.7 Recreational Effort

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). The adjusted charter boat, private/rental boat, and shore mode angler estimates are tabulated in Table 4.11.26, 4.11.27, and 4.11.28, respectively. An angler-trip is a single day of fishing in the specified mode, not to exceed 24 hours.

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.

Estimated headboat angler days have decreased in the South Atlantic in recent years (Table 4.11.29). 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 Itemized list of tasks for completion following workshop

No tasks to be completed.

4.10 Literature Cited

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4.11 Tables

Table 4.11.1 Black sea bass MRFSS landings (numbers of fish) from Monroe County 1981-2010.

Year	Harvested (A+B1)	Discards (B2)
1987	974	12,396
1990	5,962	0
1991	0	34,912
1993	784	0
1999	0	803

Table 4.11.2 South Atlantic black sea bass landings (numbers of fish and whole weight in pounds) for charter boat mode (MRFSS, NMFS, 1981-2010). CH mode adjusted for FHS conversion.

	Estimated MRFSS CH Landings		
Year	Number	CV	Pounds
1981	469,265	0.94	221,770
1982	129,721	0.77	72,460
1983	463,266	1.12	227,891
1984	309,485	0.47	198,964
1985	313,627	0.63	180,878
1986	158,594	0.35	87,441
1987	202,613	0.24	112,217
1988	1,821,587	0.57	2,383,950
1989	524,847	0.32	618,490
1990	212,462	0.25	246,919
1991	137,182	0.27	113,854
1992	344,633	0.23	321,632
1993	252,099	0.26	330,863
1994	178,202	0.24	215,948
1995	395,143	0.24	485,457
1996	285,856	0.18	322,844
1997	223,328	0.23	235,848
1998	121,903	0.21	135,152
1999	88,909	0.18	95,274
2000	31,120	0.20	25,926
2001	82,959	0.19	83,850
2002	48,351	0.31	62,425

2003	100,928	0.17	107,374
2004	207,456	0.23	237,120
2005	108,321	0.14	94,898
2006	83,607	0.24	82,105
2007	81,452	0.16	83,613
2008	35,243	0.19	44,400
2009	66,434	0.13	78,313
2010	92,606	0.15	118,673

Table 4.11.3 South Atlantic black sea bass landings (numbers of fish and whole weight in pounds) for private/rental boat mode (MRFSS, NMFS, 1981-2010).

	Estimated MRFSS PR Landings		
Year	Number	CV	Pounds
1981	312,314	0.18	152,634
1982	2,098,845	0.17	1,638,476
1983	912,932	0.21	396,404
1984	1,802,618	0.18	1,593,090
1985	1,535,142	0.20	847,181
1986	879,415	0.18	446,720
1987	1,317,622	0.11	917,896
1988	794,312	0.13	490,287
1989	827,564	0.10	649,654
1990	570,577	0.20	354,051
1991	843,801	0.16	714,260
1992	575,285	0.11	397,466
1993	389,571	0.10	266,055
1994	488,334	0.12	394,637
1995	282,683	0.17	234,617
1996	358,075	0.21	391,078
1997	368,584	0.16	335,242
1998	237,612	0.18	249,699
1999	199,466	0.17	213,801
2000	320,557	0.14	255,166
2001	448,570	0.12	474,521
2002	277,991	0.14	245,531

2003	311,480	0.13	304,782
2004	762,739	0.12	786,800
2005	573,200	0.12	528,238
2006	572,651	0.14	540,104
2007	465,566	0.13	472,346
2008	296,274	0.16	351,558
2009	177,785	0.14	196,840
2010	358,142	0.13	402,416

Table 4.11.4 South Atlantic black sea bass landings (numbers of fish and whole weight in pounds) for shore mode (MRFSS, NMFS, 1981-2010).

	Estimated MRFSS SH Landings		
Year	Number	CV	Pounds
1981	203,452	0.52	87,658
1982	28,704	0.34	14,639
1983	102,732	0.37	47,565
1984	32,476	0.26	13,819
1985	92,679	0.33	52,890
1986	13,284	0.75	7,383
1987	14,208	0.51	7,010
1988	20,794	0.68	16,338
1989	2,607	0.45	1,449
1990	2,641	0.63	1,192
1991	20,069	0.31	13,711
1992	5,354	0.42	3,866
1993	14,995	0.32	14,678
1994	19,157	0.57	15,109
1995	1,658	0.58	1,212
1996	5,213	0.47	4,451
1997	6,963	0.72	6,448
1998	8,179	0.48	8,762
1999	4,073	0.38	3,422
2000	6,741	0.43	5,993
2001	11,488	0.48	9,137
2002	4,643	0.55	4,674

2003	2,977	0.58	2,886
2004	3,257	0.77	2,819
2005	3,582	0.50	3,223
2006	3,079	1.00	2,135
2007	5,841	0.51	4,637
2008	2,471	0.71	2,403
2009	2,594	0.71	2,133
2010	6,481	0.51	5,736

Table 4.11.5 Black sea bass estimated headboat landings in pounds 1975-1980.

Year	NC	SC	GA/NEFL	SEFL
1975	233,684	496,211	222,954	12,249
1976	160,996	316,375	127,479	7,423
1977	72,022	405,400	127,304	10,065
1978	98,162	250,184	174,230	9,631
1979	104,259	326,519	128,654	11,806
1980	78,516	409,533	125,677	4,072

Years/areas not covered by the Headboat Survey, estimated landings calculated using 3 year average ratio of available estimated landings.

Estimated landings not available for SEDAR2

Table 4.11.6 Estimated headboat landings of black sea bass in the South Atlantic 1975-2010.*

	North Carolina		South Carolina		GA/NE Florida		SE Florida	
Year	Number	Weight (lbs)	Number	Weight (lbs)	Number	Weight (lbs)	Number	Weight (lbs)
1975	174,119	233,684	676,707	496,211	287,401	222,954	18,922	12,249
1976	132,023	160,996	354,982	316,375	192,657	127,479	11,467	7,423
1977	73,728	72,022	695,449	405,400	152,449	127,304	15,549	10,065
1978	80,558	98,162	419,424	250,184	209,781	174,230	16,122	9,631
1979	138,526	104,259	544,271	326,519	166,851	128,654	19,427	11,806
1980	106,374	78,516	811,172	409,533	180,239	125,677	5,526	4,072
1981	181,151	122,144	850,365	395,454	204,726	156,642	4,777	4,016
1982	145,299	117,365	763,500	361,368	324,301	222,109	928	523
1983	120,873	94,522	757,031	341,510	397,645	253,198	1,449	1,097
1984	98,231	90,739	632,873	326,626	348,202	233,790	12,873	9,915
1985	112,670	75,896	669,346	322,765	228,880	151,601	31,121	17,838
1986	113,908	67,786	635,860	299,706	290,920	161,417	16,552	7,889
1987	80,708	49,657	675,995	347,014	326,549	204,963	21,474	14,884
1988	77,012	49,805	600,169	350,727	326,093	221,106	26,738	13,585
1989	47,026	30,222	484,320	241,760	178,456	177,438	55,272	28,611
1990	69,384	45,814	319,172	162,164	259,201	165,546	10,828	6,049
1991	39,234	33,074	319,002	165,902	142,346	84,671	5,766	2,593
1992	32,564	23,660	258,076	135,890	91,427	54,154	3,943	2,173
1993	33,537	27,751	137,899	90,860	38,980	22,496	3,336	1,920
1994	27,155	23,468	144,750	88,445	33,328	19,222	2,840	1,306
1995	22,639	23,081	120,867	71,090	42,614	31,149	4,167	2,306
1996	48,446	45,821	127,695	76,002	35,942	24,707	19	14
1997	41,394	33,918	124,206	87,613	40,678	25,297	1,459	913
1998	54,297	46,316	110,243	79,128	30,016	15,610	2,571	1,450
1999	68,500	64,255	104,514	91,361	52,427	36,768	329	185
2000	67,552	62,491	81,337	58,884	27,294	21,032	1,889	2,182
2001	58,472	54,782	102,377	91,342	28,930	20,404	9,655	5,497
2002	48,124	43,901	76,654	59,367	23,145	17,721	4,096	2,286
2003	45,716	42,764	76,929	64,914	27,921	23,288	4,278	3,144
2004	52,154	55,061	106,962	97,904	65,718	65,584	25,826	19,038
2005	62,725	60,539	79,691	56,525	45,245	38,879	32,806	23,717
2006	38,353	35,647	122,548	84,809	50,881	40,146	19,661	13,464
2007	35,155	39,605	76,570	74,462	47,476	43,587	5,119	4,416
2008	25,426	31,565	33,583	36,120	29,816	28,380	3,961	3,246
2009	20,392	26,068	44,718	48,996	67,257	69,709	21,413	18,398
2010	45,814	57,777	82,527	86,444	110,387	117,053	31,549	27,961

* Adjusted to exclude bank sea bass 1975-1987.

Table 4.11.7 SCDNR State Finfish Survey number of black sea bass measured in private boat mode, mean mid-line length, standard deviation of length, and minimum and maximum size range, 1988 - 2008.

Year	Number of fish measured	Mean Length (ML, mm)	St Dev. (mm)	Minimum Length (ML, mm)	Maximum Length (ML, mm)
1988	25	276.5	51.7	220	450
1989	2	292.0	53.7	254	330
1990	23	298.0	64.5	190	410
1991	111	250.9	50.7	179	432
1992	43	264.1	55.0	196	441
1993	145	258.6	51.7	161	445
1994	26	250.9	54.7	169	364
1995	49	291.3	68.4	173	420
1996	177	272.3	31.5	206	386
1997	-	-	-	-	-
1998	95	299.2	60.6	165	481
1999	300	295.9	47.4	164	455
2000	106	296.0	44.1	239	422
2001	207	314.5	48.0	203	492
2002	237	299.6	36.0	195	405
2003	254	320.1	55.2	200	496
2004	450	332.0	49.3	130	571
2005	223	314.3	43.6	178	485
2006	149	316.7	44.5	255	460
2007	125	320.8	38.3	257	430
2008	76	331.3	30.1	290	458

Table 4.11.8 Estimated black sea bass discards for the recreational sectors by year and fishing mode.

	MRFSS CH Discards*		MRFSS PR Discards		MRFSS SH Discards		SRHS Discards†
Year	Number	PSE	Number	PSE	Number	PSE	Number
1981	479,857	0.40	557,817	0.28	88,321	0.41	
1982	90,832	0.42	850,439	0.27	67,555	0.41	
1983	104,524	0.19	210,799	0.39	103,597	0.32	
1984	246,731	0.22	685,260	0.22	107,668	0.28	
1985	180,745	0.32	723,039	0.17	118,164	0.26	
1986	65,621	0.54	533,963	0.15	232,935	0.34	256,429
1987	59,329	0.38	1,016,411	0.13	124,993	0.34	290,282
1988	85,903	0.26	873,593	0.15	67,702	0.62	96,499
1989	39,703	0.51	846,055	0.12	47,747	0.65	70,259
1990	1,716	0.44	480,118	0.16	24,092	0.40	4,944
1991	44,736	0.32	745,813	0.14	39,252	0.30	159,999
1992	70,427	0.29	757,856	0.10	21,769	0.43	63,101
1993	44,332	0.51	697,439	0.14	33,811	0.27	27,249
1994	97,702	0.28	1,162,519	0.09	87,554	0.18	81,777
1995	181,859	0.22	730,900	0.11	18,423	0.25	56,631
1996	136,684	0.22	594,982	0.13	50,916	0.24	68,272
1997	87,106	0.25	974,091	0.08	59,486	0.20	63,499
1998	25,790	0.41	733,231	0.09	65,962	0.20	46,332
1999	70,425	0.17	1,025,060	0.09	94,496	0.26	105,502
2000	36,862	0.17	1,568,514	0.10	67,191	0.20	94,202
2001	101,946	0.22	1,629,753	0.08	77,449	0.23	108,949
2002	35,959	0.39	1,111,826	0.09	87,687	0.21	75,899

2003	101,231	0.17	1,187,345	0.08	109,092	0.31	68,594
2004	170,247	0.22	2,388,236	0.08	129,564	0.17	105,362
2005	149,797	0.14	1,827,969	0.07	169,415	0.23	125,804
2006	99,737	0.18	2,349,462	0.07	99,765	0.21	123,187
2007	152,820	0.15	2,961,600	0.09	110,369	0.21	109,045
2008	127,235	0.17	2,120,089	0.08	135,038	0.25	69,912
2009	132,340	0.19	1,879,143	0.07	85,460	0.19	104,077
2010	172,499	0.12	2,573,379	0.07	142,213	0.19	165,075

*1981-1985 CH and HB mode discards are combined; 1986-2010 CH mode only.
†1986-2010 HB mode uses MRFSS CH discard ratio

Table 4.11.9 Numbers of harvested black sea bass measured during headboat at-sea observer trips in the South Atlantic.

State	Year	Number measured	Minimum (mm FL)	Maximum (mm FL)	Mean (mm FL)
North Carolina	2004	457	240	535	296
	2005	989	239	482	291
	2006	498	201	510	298
	2007	354	243	439	309
	2008	207	234	461	335
	2009	143	208	400	322
	2010	811	222	503	335
South Carolina	2004	186	190	435	296
	2005	216	225	415	288
	2006	231	165	441	283
	2007	100	264	415	315
	2008	42	258	372	319
	2009	77	301	380	325
	2010	51	301	405	333
Georgia	2004	-	-	-	-
	2005	-	-	-	-
	2006	103	258	413	297
	2007	19	290	385	325
	2008	14	315	424	344
	2009	242	223	556	331
	2010	45	280	427	336
Florida	2004	-	-	-	-
	2005	472	123	452	290
	2006	746	103	420	288
	2007	453	166	432	309
	2008	245	104	497	314
	2009	395	218	483	321
	2010	1,600	208	555	325

Table 4.11.10 Numbers of discarded black sea bass measured during headboat at-sea observer trips in the South Atlantic.

State	Year	Number measured	Minimum (mm FL)	Maximum (mm FL)	Mean (mm FL)
North Carolina	2004	510	60	347	203
	2005	1,343	81	328	195
	2006	1,927	88	326	210
	2007	2,866	101	393	220
	2008	2,290	101	324	217
	2009	2,568	95	336	225
	2010	4,105	112	355	237
South Carolina	2004	264	112	340	210
	2005	563	117	291	205
	2006	785	99	296	210
	2007	1,080	113	331	219
	2008	956	102	311	217
	2009	1,404	102	323	230
	2010	924	92	531	230
Georgia	2004	-	-	-	-
	2005	45	170	268	243
	2006	242	164	305	226
	2007	100	180	305	253
	2008	50	169	301	262
	2009	143	197	372	271
	2010	30	184	300	278
Florida	2004	-	-	-	-
	2005	829	55	392	218
	2006	961	135	372	228
	2007	1,362	106	374	235
	2008	1,742	109	401	242
	2009	2,274	102	363	247
	2010	5,998	104	395	250

Table 4.11.11 Number of black sea bass measured and number of trips with measured black sea bass in the MRFSS charter fleet by year and state.

	Fish(N)					Trips(N)				
Year	NC	SC	GA/NEFL	SEFL	Total	NC	SC	GA/NEFL	SEFL	Total
1981	39	7	-	3	49	8	1	-	1	10
1982	1	2	-	-	3	1	1	-	-	2
1983	29	4	-	-	33	4	2	-	-	6
1984	20	43	1	10	74	2	9	1	1	13
1985	20	-	26	-	46	2	-	5	-	7
1986	-	11	10	122	143	-	2	1	54	57
1987	73	43	14	-	130	9	8	4	-	21
1988	167	86	3	-	256	29	16	1	-	46
1989	93	54	-	-	147	25	14	-	-	39
1990	140	13	6	-	159	39	3	2	-	44
1991	28	-	-	-	28	10	-	-	-	10
1992	182	49	54	-	285	34	12	8	-	54
1993	95	21	13	-	129	21	4	9	-	34
1994	78	4	19	1	102	21	2	9	1	33
1995	78	5	51	-	134	16	3	8	-	27
1996	95	29	20	-	144	18	3	6	-	27
1997	67	37	6	3	113	12	5	6	3	26
1998	85	92	34	-	211	11	12	11	-	34
1999	96	83	16	20	215	11	15	3	4	33
2000	62	72	93	14	241	8	13	13	5	39
2001	116	76	53	86	331	19	16	14	15	64
2002	15	48	32	23	118	6	7	5	12	30

2003	52	34	410	94	590	12	7	25	17	61
2004	47	154	325	70	596	9	27	29	16	81
2005	16	79	558	27	680	6	11	32	7	56
2006	42	267	183	76	568	8	25	17	11	61
2007	31	143	372	41	587	6	17	20	4	47
2008	47	141	159	5	352	7	30	21	4	62
2009	110	81	295	31	517	12	17	22	5	56
2010	195	181	356	118	850	25	32	21	8	86
Total	2,119	1,859	3,109	744	7,831	391	314	293	168	1,166

Table 4.11.12 Number of black sea bass measured and number of trips with measured black sea bass in the MRFSS private fleet by year and state.

	Fish(N)					Trips(N)				
Year	NC	SC	GA/NEFL	SEFL	Total	NC	SC	GA/NEFL	SEFL	Total
1981	48	33	24	26	131	8	8	4	7	27
1982	39	111	52	196	398	7	29	12	35	83
1983	35	27	2	50	114	6	8	2	10	26
1984	19	17	18	131	185	7	6	6	25	44
1985	50	72	178	110	410	10	11	32	24	77
1986	11	47	100	75	233	2	17	22	21	62
1987	183	86	180	81	530	41	24	37	17	119
1988	175	72	47	41	335	55	16	11	14	96
1989	224	64	102	44	434	66	20	24	13	123
1990	205	8	20	-	233	63	7	5	-	75
1991	74	46	1	36	157	27	14	1	6	48
1992	116	115	46	42	319	27	29	13	9	78
1993	93	77	2	31	203	23	17	2	12	54
1994	64	22	25	37	148	29	5	6	22	62
1995	76	70	8	6	160	28	13	4	4	49
1996	32	66	9	12	119	14	20	4	4	42
1997	100	50	7	27	184	29	23	7	13	72
1998	47	28	1	25	101	17	12	1	11	41
1999	27	34	-	111	172	8	5	-	46	59
2000	37	27	34	24	122	14	11	5	14	44
2001	93	20	48	64	225	25	6	10	32	73
2002	20	26	23	68	137	9	9	5	22	45

2003	23	2	58	71	154	8	2	13	24	47
2004	78	41	14	102	235	26	14	6	22	68
2005	74	24	16	22	136	24	9	3	16	52
2006	47	135	35	108	325	20	20	7	25	72
2007	20	41	17	104	182	6	9	5	29	49
2008	25	27	76	59	187	12	5	10	21	48
2009	44	12	4	71	131	18	5	2	29	54
2010	98	16	6	150	270	25	7	2	35	69
Total	2,177	1,416	1,153	1,924	6,670	654	381	261	562	1,858

Table 4.11.13 Number of black sea bass measured and number of trips with measured black sea bass in the MRFSS shore mode by year and state.

	Fish(N)					Trips(N)				
Year	NC	SC	GA/NEFL	SEFL	Total	NC	SC	GA/NEFL	SEFL	Total
1981	6	5	-	3	14	1	3	-	1	5
1982	2	9	1	4	16	2	6	1	4	13
1983	10	6	8	3	27	1	5	6	3	15
1984	-	14	4	8	26	-	7	2	6	15
1985	-	2	18	12	32	-	2	11	6	19
1986	-	1	3	-	4	-	1	3	-	4
1987	2	2	4	-	8	2	2	4	-	8
1988	2	-	2	-	4	2	-	2	-	4
1989	19	1	5	-	25	9	1	5	-	15
1990	19	-	3	-	22	6	-	2	-	8
1991	7	3	-	-	10	7	3	-	-	10
1992	1	3	2	-	6	1	2	2	-	5
1993	1	2	2	1	6	1	1	2	1	5
1994	5	-	4	-	9	3	-	4	-	7
1995	2	1	-	-	3	1	1	-	-	2
1996	4	2	-	-	6	2	1	-	-	3
1997	1	1	-	-	2	1	1	-	-	2
1998	2	1	1	2	6	1	1	1	1	4
1999	4	-	-	3	7	3	-	-	3	6
2000	3	-	1	-	4	3	-	1	-	4
2001	10	-	2	-	12	1	-	2	-	3
2002	1	-	-	1	2	1	-	-	1	2
2003	-	-	-	-	-	-	-	-	-	-
2004	-	2	-	-	2	-	1	-	-	1

2005	-	-	-	-	-	-	-	-	-	-
2006	-	-	-	-	-	-	-	-	-	-
2007	-	2	1	-	3	-	2	1	-	3
2008	-	-	-	1	1	-	-	-	1	1
2009	-	-	-	1	1	-	-	-	1	1
2010	-	-	-	2	2	-	-	-	1	1
Total	101	57	61	41	260	48	40	49	29	166

Table 4.11.14 Number of black sea bass measured and positive trips in the SRHS by year and area.

	Fish (N)					Trips (N)				
Year	NC	SC	GA/NEFL	SEFL	Total	NC	SC	GA/NEFL	SEFL	Total
1972	-	-	-	-	-	-	-	-	-	-
1973	-	1	-	-	1	-	1	-	-	1
1974	506	663	-	-	1,169	79	72	-	-	151
1975	238	823	-	-	1,061	68	82	-	-	150
1976	325	323	294	-	942	70	58	48	-	176
1977	446	2,234	540	-	3,220	81	149	100	-	330
1978	439	965	903	49	2,356	73	73	175	11	332
1979	190	921	507	36	1,654	35	56	100	9	200
1980	788	1,144	452	34	2,418	81	92	89	15	277
1981	534	1,721	767	13	3,035	70	136	177	5	388
1982	870	1,372	1,431	13	3,686	116	133	185	5	439
1983	1,098	2,011	2,233	390	5,732	155	161	246	63	625
1984	848	2,582	2,222	434	6,086	164	215	248	67	694
1985	998	2,152	2,070	622	5,842	155	150	249	84	638
1986	1,395	2,704	2,178	272	6,549	187	188	256	53	684
1987	1,782	2,624	1,940	96	6,442	284	237	233	33	787
1988	1,160	1,748	1,246	99	4,253	213	156	155	22	546
1989	768	1,367	1,416	285	3,836	126	109	159	31	425
1990	465	3,026	2,253	28	5,772	77	200	198	6	481
1991	467	3,219	1,668	26	5,380	93	161	136	1	391
1992	465	3,377	1,335	-	5,177	90	184	126	-	400
1993	586	2,584	766	12	3,948	106	149	130	2	387
1994	302	3,048	508	357	4,215	72	154	108	17	351
1995	208	2,569	517	31	3,325	62	123	92	6	283
1996	475	2,360	370	7	3,212	93	124	66	2	285
1997	699	1,925	980	74	3,678	103	126	136	14	379
1998	862	1,892	1,479	131	4,364	119	123	192	28	462
1999	1,284	1,220	1,603	7	4,114	127	82	190	4	403
2000	1,285	778	1,345	11	3,419	110	60	156	6	332
2001	1,466	-	1,449	67	2,982	138	-	172	19	329
2002	529	473	923	32	1,957	58	61	177	9	305
2003	771	1,212	1,104	179	3,266	70	132	170	34	406
2004	1,328	655	1,744	486	4,213	124	64	161	51	400
2005	1,131	171	1,620	532	3,454	113	21	158	50	342
2006	690	1,465	1,525	433	4,113	71	153	157	62	443
2007	299	1,160	936	179	2,574	48	142	80	58	328
2008	503	622	629	77	1,831	68	97	83	33	281
2009	625	726	723	328	2,402	85	121	152	39	397

2010	1,035	836	1,863	895	4,629	114	103	228	42	487
Total	27,860	58,673	43,539	6,235	136,307	3,898	4,448	5,488	881	14,71

Table 4.11.15 Number of black sea bass aged and number of trips with age samples from the SRHS by year and state.

	Fish (N)					Trips (N)				
Year	NC	SC	GA	FL	Total	NC	SC	GA	FL	Total
1988	-	4	-	3	7	-	2	-	1	3
1989	-	4	-	1	5	-	2	-	1	3
1990	8	-	-	17	25	5	-	-	6	11
1991	41	26	-	18	85	18	18	-	7	43
1992	20	22	-	18	60	8	15	-	8	31
1993	3	1	-	3	7	2	1	-	2	5
1994	2	-	-	3	5	1	-	-	1	2
1995	2	-	-	-	2	1	-	-	-	1
1996	8	3	-	16	27	5	1	-	6	12
1997	3	-	-	1	4	1	-	-	1	2
1998	-	58	17	-	75	-	7	2	-	9
1999	-	-	-	-	-	-	-	-	-	-
2000	-	-	-	1	1	-	-	-	1	1
2001	-	-	-	-	-	-	-	-	-	-
2002	7	16	-	-	23	4	11	-	-	15
2003	54	9	-	42	105	8	4	-	19	31
2004	56	5	-	173	234	15	2	-	36	53
2005	133	-	-	347	480	56	-	-	48	104
2006	105	165	-	796	1,066	22	134	-	91	247
2007	138	149	-	384	671	71	129	-	71	271
2008	34	99	-	176	309	8	95	-	58	161
2009	135	124	3	255	517	24	113	3	78	218
2010	252	102	2	673	1,029	47	100	2	192	341
Total	1,001	787	22	2,927	4,737	296	634	7	627	1,564

Table 4.11.16 Number of black sea bass aged and number of trips with age samples from the MRFSS charter boat fleet by year and state.

	Fish (N)					Trips (N)				
Year	NC	SC	GA	FL	Total	NC	SC	GA	FL	Total
1988	-	-	-	-	-	-	-	-	-	-
1989	-	-	-	-	-	-	-	-	-	-
1990	-	-	-	-	-	-	-	-	-	-
1991	-	-	-	-	-	-	-	-	-	-
1992	-	-	-	-	-	-	-	-	-	-
1993	-	-	-	-	-	-	-	-	-	-
1994	-	-	-	-	-	-	-	-	-	-
1995	-	-	-	-	-	-	-	-	-	-
1996	-	-	-	-	-	-	-	-	-	-
1997	-	-	8	-	8	-	-	1	-	1
1998	44	23	155	1	223	3	5	16	1	25
1999	-	-	-	-	-	-	-	-	-	-
2000	-	-	-	-	-	-	-	-	-	-
2001	-	-	-	9	9	-	-	-	4	4
2002	-	-	-	82	82	-	-	-	28	28
2003	-	-	-	75	75	-	-	-	20	20
2004	-	-	-	565	565	-	-	-	45	45
2005	-	-	-	131	131	-	-	-	33	33
2006	-	-	-	171	171	-	-	-	16	16
2007	-	-	-	27	27	-	-	-	3	3
2008	-	-	-	-	-	-	-	-	-	-
2009	-	-	-	-	-	-	-	-	-	-
2010	-	-	-	-	-	-	-	-	-	-
Total	44	23	163	1,061	1,291	3	5	17	150	175

Table 4.11.17 Number of black sea bass aged and number of trips with age samples from the MRFSS private/rental fleet by year and state.

	Fish (N)					Trips (N)				
Year	NC	SC	GA	FL	Total	NC	SC	GA	FL	Total
1988	-	-	-	-	-	-	-	-	-	-
1989	-	-	-	-	-	-	-	-	-	-
1990	-	-	-	-	-	-	-	-	-	-
1991	-	-	-	-	-	-	-	-	-	-
1992	-	-	-	-	-	-	-	-	-	-
1993	-	-	-	-	-	-	-	-	-	-
1994	-	-	-	-	-	-	-	-	-	-
1995	-	-	-	-	-	-	-	-	-	-
1996	-	-	-	-	-	-	-	-	-	-
1997	-	-	-	-	-	-	-	-	-	-
1998	30	19	102	-	151	3	7	21	-	31
1999	-	-	-	-	-	-	-	-	-	-
2000	-	-	-	-	-	-	-	-	-	-
2001	-	-	-	-	-	-	-	-	-	-
2002	-	-	-	2	2	-	-	-	1	1
2003	-	-	-	2	2	-	-	-	1	1
2004	-	-	-	2	2	-	-	-	1	1
2005	-	-	-	8	8	-	-	-	3	3
2006	-	-	-	2	2	-	-	-	1	1
2007	10	-	-	-	10	1	-	-	-	1
2008	2	-	-	-	2	1	-	-	-	1
2009	19	-	-	-	19	2	-	-	-	2
2010	29	-	-	-	29	4	-	-	-	4
Total	90	19	102	16	227	11	7	21	7	46

Table 4.11.18 Number of black sea bass aged and number of trips with age samples from the MRFSS shore mode by year and state.

	Fish (N)					Trips (N)				
Year	NC	SC	GA	FL	Total	NC	SC	GA	FL	Total
1988	-	-	-	-	-	-	-	-	-	-
1989	-	-	-	-	-	-	-	-	-	-
1990	-	-	-	-	-	-	-	-	-	-
1991	-	-	-	-	-	-	-	-	-	-
1992	-	-	-	-	-	-	-	-	-	-
1993	-	-	-	-	-	-	-	-	-	-
1994	-	-	-	-	-	-	-	-	-	-
1995	-	-	-	-	-	-	-	-	-	-
1996	-	-	-	-	-	-	-	-	-	-
1997	-	-	-	-	-	-	-	-	-	-
1998	-	-	5	-	5	-	-	1	-	1
1999	-	-	-	-	-	-	-	-	-	-
2000	-	-	-	-	-	-	-	-	-	-
2001	-	-	-	-	-	-	-	-	-	-
2002	-	-	-	-	-	-	-	-	-	-
2003	-	-	-	-	-	-	-	-	-	-
2004	-	-	-	-	-	-	-	-	-	-
2005	-	-	-	-	-	-	-	-	-	-
2006	-	-	-	-	-	-	-	-	-	-
2007	-	-	-	-	-	-	-	-	-	-
2008	-	-	-	-	-	-	-	-	-	-
2009	-	-	-	-	-	-	-	-	-	-
2010	-	-	-	-	-	-	-	-	-	-
Total	-	-	5	-	5	-	-	1	-	1

Table 4.11.19 Number of MRFSS intercept surveys conducted in charter boat mode by year and state with the percentage of intercepts that encountered black sea bass.

	NC			SC			GA			EFL		
Year	Total Int	BSB Int	% BSB	Total Int	BSB Int	% BSB	Total Int	BSB Int	% BSB	Total Int	BSB Int	% BSB
1981	8	8	100.00	33	11	33.33	5	-	-	55	1	1.82
1982	31	4	12.90	14	2	14.29	8	3	37.50	43	-	-
1983	30	16	53.33	41	11	26.83	122	3	2.46	328	5	1.52
1984	47	29	61.70	134	40	29.85	101	11	10.89	406	9	2.22
1985	23	19	82.61	187	1	0.53	257	17	6.61	182	-	-
1986	42	12	28.57	466	28	6.01	373	11	2.95	741	54	7.29
1987	682	193	28.30	671	73	10.88	549	17	3.10	341	-	-
1988	759	276	36.36	809	146	18.05	262	2	0.76	626	10	1.60
1989	933	339	36.33	753	162	21.51	209	-	-	699	1	0.14
1990	1,082	312	28.84	370	68	18.38	162	17	10.49	610	-	-
1991	898	191	21.27	316	39	12.34	225	11	4.89	641	5	0.78
1992	1,110	503	45.32	459	71	15.47	542	169	31.18	1,154	23	1.99
1993	564	209	37.06	272	26	9.56	263	101	38.40	672	-	-
1994	643	264	41.06	279	45	16.13	316	76	24.05	667	5	0.75
1995	813	160	19.68	273	42	15.38	235	99	42.13	666	-	-
1996	908	200	22.03	397	68	17.13	262	114	43.51	729	-	-
1997	674	73	10.83	480	81	16.88	292	97	33.22	984	8	0.81
1998	597	91	15.24	449	85	18.93	347	82	23.63	1,298	1	0.08
1999	548	83	15.15	449	102	22.72	290	28	9.66	1,827	39	2.13
2000	323	38	11.76	881	201	22.81	339	56	16.52	1,944	37	1.90
2001	744	132	17.74	367	106	28.88	272	60	22.06	2,833	107	3.78
2002	871	130	14.93	316	40	12.66	280	31	11.07	3,311	99	2.99

2003	759	110	14.49	285	78	27.37	556	217	39.03	2,810	93	3.31
2004	668	104	15.57	581	219	37.69	629	313	49.76	2,056	95	4.62
2005	452	45	9.96	520	158	30.38	550	202	36.73	2,201	96	4.36
2006	424	63	14.86	449	226	50.33	676	291	43.05	1,878	96	5.11
2007	367	78	21.25	610	196	32.13	618	164	26.54	1,760	41	2.33
2008	480	56	11.67	615	145	23.58	579	122	21.07	1,338	28	2.09
2009	438	78	17.81	523	55	10.52	535	52	9.72	1,041	18	1.73
2010	611	205	33.55	644	180	27.95	581	125	21.51	1,249	49	3.92

Table 4.11.20 Number of MRFSS intercept surveys conducted in private boat mode by year and state with the percentage of intercepts that encountered black sea bass.

	NC			SC			GA			EFL		
Year	Total Int	BSB Int	% BSB	Total Int	BSB Int	% BSB	Total Int	BSB Int	% BSB	Total Int	BSB Int	% BSB
1981	202	50	24.75	238	30	12.61	138	8	5.80	739	23	3.11
1982	361	38	10.53	497	85	17.10	485	49	10.10	1,958	104	5.31
1983	185	24	12.97	159	26	16.35	287	15	5.23	1,351	28	2.07
1984	187	26	13.90	251	17	6.77	288	38	13.19	1,718	95	5.53
1985	404	46	11.39	424	74	17.45	1,569	110	7.01	1,441	64	4.44
1986	500	29	5.80	787	89	11.31	1,780	69	3.88	3,356	106	3.16
1987	2,986	240	8.04	1,239	162	13.08	2,465	158	6.41	3,668	60	1.64
1988	2,797	250	8.94	1,483	180	12.14	1,217	32	2.63	3,674	47	1.28
1989	3,657	404	11.05	1,551	243	15.67	1,200	54	4.50	3,260	107	3.28
1990	3,911	294	7.52	997	71	7.12	440	24	5.45	2,995	52	1.74
1991	3,098	242	7.81	539	35	6.49	631	35	5.55	3,684	111	3.01
1992	2,704	230	8.51	1,393	91	6.53	1,122	64	5.70	6,595	111	1.68
1993	2,625	183	6.97	963	65	6.75	649	18	2.77	5,777	90	1.56
1994	3,821	425	11.12	840	80	9.52	600	23	3.83	6,683	157	2.35
1995	4,765	356	7.47	987	84	8.51	598	16	2.68	6,158	63	1.02
1996	3,018	197	6.53	1,685	89	5.28	780	28	3.59	7,073	105	1.48
1997	3,055	289	9.46	1,993	215	10.79	925	28	3.03	7,026	109	1.55
1998	2,702	266	9.84	1,911	129	6.75	759	8	1.05	8,091	115	1.42
1999	2,002	157	7.84	1,301	63	4.84	665	4	0.60	11,556	378	3.27
2000	2,546	242	9.51	1,334	133	9.97	902	55	6.10	11,109	304	2.74
2001	4,082	398	9.75	1,269	82	6.46	1,023	51	4.99	12,176	393	3.23
2002	2,968	213	7.18	1,134	91	8.02	928	27	2.91	12,472	357	2.86

2003	3,124	228	7.30	530	33	6.23	1,072	49	4.57	11,402	291	2.55
2004	3,579	359	10.03	1,109	129	11.63	1,046	45	4.30	9,789	262	2.68
2005	3,406	363	10.66	1,173	130	11.08	847	37	4.37	9,745	234	2.40
2006	4,747	498	10.49	1,227	150	12.22	815	40	4.91	12,144	359	2.96
2007	4,077	297	7.28	1,205	150	12.45	971	46	4.74	11,062	307	2.78
2008	4,198	226	5.38	1,350	156	11.56	841	90	10.70	9,822	265	2.70
2009	4,039	150	3.71	1,366	74	5.42	841	31	3.69	9,067	111	1.22
2010	6,734	698	10.37	1,522	120	7.88	868	42	4.84	9,563	313	3.27

Table 4.11.21 Number of MRFSS intercept surveys conducted in shore mode by year and state with the percentage of intercepts that encountered black sea bass.

	NC			SC			GA			EFL		
Year	Total Int	BSB Int	% BSB	Total Int	BSB Int	% BSB	Total Int	BSB Int	% BSB	Total Int	BSB Int	% BSB
1981	334	6	1.80	335	18	5.37	121	3	2.48	884	11	1.24
1982	733	10	1.36	574	14	2.44	312	2	0.64	2,427	12	0.49
1983	271	5	1.85	386	11	2.85	615	14	2.28	2,578	20	0.78
1984	328	10	3.05	551	32	5.81	521	10	1.92	2,734	36	1.32
1985	380	11	2.89	610	19	3.11	1,199	25	2.09	2,568	30	1.17
1986	150	-	-	259	4	1.54	829	15	1.81	823	9	1.09
1987	1,063	14	1.32	439	16	3.64	1,077	17	1.58	752	4	0.53
1988	1,239	9	0.73	663	4	0.60	578	10	1.73	1,858	2	0.11
1989	2,089	24	1.15	673	8	1.19	571	12	2.10	1,477	2	0.14
1990	1,300	28	2.15	267	1	0.37	270	12	4.44	1,491	-	-
1991	4,408	34	0.77	264	4	1.52	458	7	1.53	1,765	7	0.40
1992	2,499	8	0.32	678	3	0.44	683	17	2.49	3,751	2	0.05
1993	2,167	16	0.74	733	7	0.95	470	7	1.49	6,970	8	0.11
1994	2,576	75	2.91	720	4	0.56	542	17	3.14	7,850	11	0.14
1995	3,153	27	0.86	766	3	0.39	518	5	0.97	7,287	-	-
1996	2,686	21	0.78	1,027	16	1.56	433	10	2.31	4,051	2	0.05
1997	2,424	36	1.49	895	19	2.12	455	1	0.22	4,282	9	0.21
1998	2,300	39	1.70	889	11	1.24	466	5	1.07	4,461	8	0.18
1999	2,177	28	1.29	910	5	0.55	379	2	0.53	5,796	28	0.48
2000	1,629	24	1.47	783	7	0.89	351	5	1.42	4,710	20	0.42
2001	2,057	24	1.17	768	6	0.78	306	9	2.94	5,294	14	0.26
2002	2,143	19	0.89	657	6	0.91	333	8	2.40	6,804	24	0.35

2003	2,430	21	0.86	510	5	0.98	345	-	-	6,010	34	0.57
2004	2,357	44	1.87	578	6	1.04	364	1	0.27	4,608	15	0.33
2005	2,045	51	2.49	767	5	0.65	374	2	0.53	4,944	22	0.44
2006	1,307	25	1.91	649	4	0.62	370	2	0.54	5,035	20	0.40
2007	1,938	11	0.57	802	6	0.75	377	5	1.33	5,127	26	0.51
2008	3,015	11	0.36	680	6	0.88	373	24	6.43	4,064	17	0.42
2009	1,791	6	0.34	657	2	0.30	399	6	1.50	4,618	11	0.24
2010	3,417	41	1.20	752	1	0.13	389	19	4.88	4,272	23	0.54

Table 4.11.22 Mean weight (kg) of black sea bass measured in the charter boat fleet by year and state, 1981-2010.

	NC				SC				GA				EFL			
Year	N	Mean (kg)	Min (kg)	Max (kg)	N	Mean (kg)	Min (kg)	Max (kg)	N	Mean (kg)	Min (kg)	Max (kg)	N	Mean (kg)	Min (kg)	Max (kg)
1981	39	0.15	0.10	0.30	7	0.19	0.10	0.30	-	-	-	-	3	0.20	0.20	0.20
1982	1	0.30	0.30	0.30	2	0.40	0.40	0.40	-	-	-	-	-	-	-	-
1983	29	0.23	0.10	1.00	4	0.30	0.20	0.40	-	-	-	-	-	-	-	-
1984	39	0.40	0.10	1.10	43	0.21	0.10	0.60	1	0.20	0.20	0.20	10	0.76	0.60	0.90
1985	21	0.26	0.10	0.70	-	-	-	-	26	0.57	0.10	1.20	-	-	-	-
1986	4	0.27	0.20	0.40	16	0.31	0.10	0.90	10	0.42	0.20	1.10	122	0.12	0.10	0.30
1987	75	0.42	0.10	1.30	40	0.27	0.20	1.00	14	0.19	0.10	0.30	-	-	-	-
1988	126	0.43	0.10	2.60	39	0.32	0.10	1.00	3	0.20	0.20	0.20	20	0.56	0.40	0.70
1989	64	0.42	0.10	2.10	14	0.61	0.20	1.50	-	-	-	-	-	-	-	-
1990	146	0.50	0.10	2.30	4	0.50	0.20	0.90	2	0.70	0.50	0.90	-	-	-	-
1991	8	0.39	0.20	0.70	20	0.75	0.30	1.40	-	-	-	-	-	-	-	-
1992	188	0.44	0.10	2.30	51	0.44	0.20	1.00	57	0.38	0.10	1.20	-	-	-	-
1993	91	0.44	0.20	1.50	21	0.49	0.10	2.00	13	0.76	0.40	1.60	-	-	-	-
1994	88	0.34	0.15	1.30	4	0.34	0.10	0.50	17	0.49	0.10	1.30	1	0.70	0.70	0.70
1995	75	0.49	0.10	1.20	5	0.58	0.30	0.80	69	0.43	0.10	1.20	-	-	-	-
1996	62	0.40	0.15	1.30	41	0.73	0.25	1.90	47	0.60	0.20	1.90	-	-	-	-
1997	51	0.48	0.10	1.35	57	0.40	0.15	3.00	6	0.60	0.20	0.90	4	0.39	0.20	0.75
1998	85	0.57	0.20	1.50	95	0.52	0.20	1.75	29	0.36	0.15	1.20	-	-	-	-
1999	96	0.47	0.05	0.90	82	0.47	0.20	1.15	18	0.60	0.20	4.00	20	0.41	0.20	0.99
2000	62	0.37	0.10	0.90	73	0.40	0.15	1.20	83	0.28	0.15	0.60	14	0.49	0.27	0.99
2001	116	0.45	0.20	1.55	76	0.49	0.15	1.20	53	0.58	0.10	1.15	86	0.44	0.21	0.95
2002	15	0.64	0.30	1.20	48	0.38	0.20	1.15	32	0.40	0.20	1.00	23	0.46	0.20	0.82
2003	52	0.49	0.20	1.40	27	0.39	0.20	0.95	410	0.44	0.20	1.55	93	0.42	0.22	0.94

2004	47	0.57	0.22	1.46	159	0.49	0.20	1.70	324	0.46	0.20	1.30	68	0.46	0.19	1.08
2005	16	0.56	0.20	1.20	76	0.45	0.20	1.50	551	0.38	0.20	1.30	25	0.36	0.20	0.66
2006	42	0.64	0.26	1.19	267	0.40	0.20	1.20	176	0.49	0.15	1.50	45	0.44	0.20	0.90
2007	31	0.70	0.35	1.10	144	0.46	0.30	0.90	371	0.49	0.25	1.45	41	0.42	0.24	0.72
2008	47	0.69	0.40	1.25	143	0.54	0.30	1.50	159	0.59	0.35	1.50	5	0.52	0.40	0.65
2009	108	0.60	0.30	1.55	76	0.55	0.35	2.20	296	0.56	0.30	1.25	22	0.44	0.30	0.80
2010	142	0.60	0.35	1.70	181	0.56	0.35	1.25	355	0.63	0.35	1.65	118	0.46	0.28	0.74

Table 4.11.23 Mean weight (kg) of black sea bass measured in the private/rental boat fleet by year and state, 1981-2010.

	NC				SC				GA				EFL			
Year	N	Mean (kg)	Min (kg)	Max (kg)	N	Mean (kg)	Min (kg)	Max (kg)	N	Mean (kg)	Min (kg)	Max (kg)	N	Mean (kg)	Min (kg)	Max (kg)
1981	48	0.14	0.10	0.30	51	0.18	0.10	0.70	23	0.26	0.10	0.60	24	0.25	0.10	0.50
1982	42	0.28	0.10	1.00	109	0.17	0.10	0.60	52	0.34	0.10	1.20	202	0.35	0.10	1.00
1983	35	0.14	0.10	0.50	25	0.15	0.10	0.40	9	0.62	0.10	1.50	50	0.27	0.10	0.80
1984	17	0.24	0.10	0.80	15	0.21	0.10	0.50	18	0.17	0.10	0.60	131	0.40	0.10	1.20
1985	44	0.22	0.10	0.50	69	0.22	0.10	0.90	178	0.36	0.10	2.00	111	0.27	0.10	1.20
1986	14	0.44	0.20	0.70	60	0.26	0.10	0.70	100	0.35	0.10	1.30	73	0.23	0.10	0.80
1987	177	0.23	0.10	1.10	50	0.22	0.10	0.50	163	0.21	0.10	0.70	97	0.36	0.20	1.10
1988	181	0.27	0.10	1.00	24	0.29	0.20	0.50	47	0.20	0.10	1.00	43	0.40	0.10	0.80
1989	210	0.27	0.10	1.40	25	0.39	0.10	1.40	102	0.21	0.10	0.90	46	0.38	0.10	0.90
1990	188	0.27	0.10	1.30	3	0.20	0.10	0.30	20	0.18	0.10	0.30	10	0.39	0.30	0.60
1991	58	0.28	0.10	0.70	84	0.48	0.10	1.30	-	-	-	-	36	0.41	0.10	1.10
1992	119	0.28	0.10	1.00	111	0.28	0.10	0.60	42	0.36	0.10	1.30	42	0.30	0.20	1.70
1993	73	0.26	0.10	0.50	77	0.33	0.10	0.80	2	0.30	0.20	0.40	35	0.34	0.20	1.20
1994	72	0.27	0.05	1.15	23	0.65	0.15	3.10	25	0.28	0.05	0.70	34	0.26	0.10	0.80
1995	63	0.24	0.10	1.10	66	0.36	0.10	0.80	9	0.19	0.05	0.40	6	0.51	0.30	0.65
1996	12	0.37	0.10	0.95	61	0.31	0.10	1.15	12	0.38	0.15	1.20	13	0.42	0.20	1.30
1997	71	0.38	0.10	0.85	58	0.32	0.05	0.70	9	0.41	0.20	0.75	27	0.41	0.15	1.35
1998	47	0.26	0.10	0.70	29	0.31	0.15	0.70	1	0.60	0.60	0.60	32	0.39	0.20	1.50
1999	27	0.23	0.10	0.80	32	0.71	0.25	1.30	-	-	-	-	110	0.38	0.17	0.96
2000	47	0.34	0.10	0.95	30	0.36	0.15	0.90	33	0.31	0.10	0.80	23	0.37	0.15	0.88
2001	94	0.50	0.15	1.00	21	0.50	0.25	0.90	28	0.47	0.25	1.10	64	0.38	0.13	0.95
2002	20	0.37	0.20	0.65	26	0.34	0.20	0.65	22	0.29	0.20	0.50	62	0.41	0.17	0.90
2003	23	0.45	0.25	0.85	2	0.60	0.35	0.85	58	0.47	0.15	1.15	70	0.44	0.18	1.36

2004	78	0.42	0.20	1.25	33	0.43	0.25	0.75	14	0.41	0.30	0.55	96	0.44	0.16	1.02
2005	74	0.42	0.20	1.20	24	0.40	0.20	0.65	16	0.39	0.20	0.85	20	0.40	0.26	0.72
2006	43	0.38	0.15	1.30	138	0.49	0.25	1.35	35	0.39	0.20	1.05	107	0.38	0.12	0.90
2007	20	0.72	0.40	2.00	42	0.48	0.30	1.10	17	0.32	0.05	0.60	87	0.42	0.20	0.88
2008	24	0.62	0.15	1.55	28	0.59	0.30	1.00	76	0.41	0.10	0.80	59	0.44	0.20	1.22
2009	38	0.50	0.35	1.15	11	0.49	0.40	0.85	4	0.47	0.40	0.50	71	0.48	0.28	0.98
2010	86	0.53	0.10	1.05	16	0.52	0.35	0.80	6	0.42	0.35	0.55	145	0.48	0.21	1.20

Table 4.11.24 Mean weight (kg) of black sea bass measured in shore mode by year and state, 1981-2010.

	NC				SC				GA				EFL			
Year	N	Mean (kg)	Min (kg)	Max (kg)	N	Mean (kg)	Min (kg)	Max (kg)	N	Mean (kg)	Min (kg)	Max (kg)	N	Mean (kg)	Min (kg)	Max (kg)
1981	6	0.40	0.30	0.50	4	0.10	0.10	0.10	-	-	-	-	9	0.18	0.10	0.30
1982	2	0.15	0.10	0.20	9	0.21	0.10	0.50	1	0.10	0.10	0.10	4	0.10	0.10	0.10
1983	10	0.22	0.10	0.30	6	0.13	0.10	0.20	2	0.10	0.10	0.10	3	0.17	0.10	0.30
1984	-	-	-	-	9	0.12	0.10	0.20	5	0.12	0.10	0.20	7	0.16	0.10	0.30
1985	-	-	-	-	2	0.15	0.10	0.20	18	0.11	0.10	0.20	10	0.19	0.10	0.40
1986	-	-	-	-	2	0.15	0.10	0.20	2	0.10	0.10	0.10	-	-	-	-
1987	3	0.20	0.10	0.30	3	0.20	0.20	0.20	4	0.12	0.10	0.20	-	-	-	-
1988	2	0.20	0.10	0.30	-	-	-	-	2	0.15	0.10	0.20	-	-	-	-
1989	19	0.29	0.10	0.80	2	0.15	0.10	0.20	5	0.10	0.10	0.10	-	-	-	-
1990	19	0.34	0.10	0.60	-	-	-	-	3	0.10	0.10	0.10	-	-	-	-
1991	6	0.15	0.10	0.30	2	0.20	0.20	0.20	-	-	-	-	-	-	-	-
1992	1	0.10	0.10	0.10	3	0.27	0.10	0.40	1	0.20	0.20	0.20	-	-	-	-
1993	2	0.20	0.10	0.30	2	0.10	0.10	0.10	2	0.50	0.10	0.90	1	0.20	0.20	0.20
1994	5	0.16	0.10	0.20	-	-	-	-	3	0.07	0.05	0.10	-	-	-	-
1995	1	0.10	0.10	0.10	1	0.20	0.20	0.20	-	-	-	-	-	-	-	-
1996	-	-	-	-	2	0.07	0.05	0.10	-	-	-	-	-	-	-	-
1997	-	-	-	-	1	0.15	0.15	0.15	-	-	-	-	-	-	-	-
1998	2	0.17	0.10	0.25	1	0.10	0.10	0.10	1	0.10	0.10	0.10	2	0.35	0.35	0.35
1999	4	0.10	0.05	0.20	-	-	-	-	-	-	-	-	3	0.29	0.15	0.50
2000	3	0.28	0.10	0.40	-	-	-	-	-	-	-	-	-	-	-	-
2001	10	0.23	0.20	0.35	-	-	-	-	2	0.10	0.10	0.10	-	-	-	-
2002	1	0.20	0.20	0.20	-	-	-	-	-	-	-	-	1	0.26	0.26	0.26
2004	-	-	-	-	2	0.10	0.10	0.10	-	-	-	-	-	-	-	-

2007	-	-	-	-	2	0.30	0.20	0.40	1	0.10	0.10	0.10	-	-	-	-
2008	-	-	-	-	-	-	-	-	-	-	-	-	1	0.66	0.66	0.66
2009	-	-	-	-	-	-	-	-	-	-	-	-	1	0.20	0.20	0.20
2010	-	-	-	-	-	-	-	-	-	-	-	-	2	0.14	0.12	0.16

Table 4.11.25 Mean weight (kg) of black sea bass measured in the SRHS by year and area, 1973-2010. No black sea bass were measured in 1972.

	NC				SC				GA/NEFL				SEFL			
Year	N	Mean (kg)	Min (kg)	Max (kg)	N	Mean (kg)	Min (kg)	Max (kg)	N	Mean (kg)	Min (kg)	Max (kg)	N	Mean (kg)	Min (kg)	Max (kg)
1973	-	-	-	-	1	0.27	0.27	0.27	-	-	-	-	-	-	-	-
1974	504	0.45	0.05	2.13	647	0.43	0.05	1.68	-	-	-	-	-	-	-	-
1975	227	0.53	0.05	2.18	802	0.35	0.05	1.82	-	-	-	-	-	-	-	-
1976	325	0.39	0.05	1.27	323	0.44	0.09	1.63	292	0.31	0.05	0.95	-	-	-	-
1977	446	0.41	0.09	4.54	2,195	0.29	0.05	1.82	538	0.38	0.05	1.50	-	-	-	-
1978	431	0.50	0.06	2.50	955	0.30	0.05	1.70	879	0.39	0.04	1.61	49	0.27	0.12	0.76
1979	190	0.34	0.08	1.30	921	0.28	0.04	3.55	507	0.37	0.07	2.70	36	0.28	0.13	0.77
1980	782	0.28	0.04	1.75	1,144	0.24	0.04	1.65	451	0.32	0.08	1.10	34	0.33	0.15	0.61
1981	534	0.33	0.06	1.56	1,720	0.22	0.03	1.50	765	0.36	0.07	1.80	13	0.38	0.18	1.20
1982	870	0.37	0.02	2.10	1,374	0.23	0.04	2.05	1,411	0.31	0.07	2.22	13	0.26	0.14	0.45
1983	1,101	0.35	0.02	1.60	2,011	0.22	0.04	2.10	2,233	0.30	0.06	2.00	388	0.30	0.10	3.00
1984	850	0.43	0.08	4.54	2,584	0.25	0.04	1.80	2,221	0.31	0.05	3.02	433	0.34	0.10	1.30
1985	993	0.30	0.05	1.72	2,152	0.22	0.03	1.60	2,071	0.30	0.06	3.10	622	0.26	0.05	1.72
1986	1,394	0.28	0.04	1.80	2,703	0.22	0.04	1.60	2,177	0.27	0.06	1.90	258	0.29	0.10	1.65
1987	1,724	0.28	0.01	1.40	2,624	0.24	0.04	1.60	1,939	0.30	0.04	1.51	97	0.34	0.03	4.14
1988	1,157	0.34	0.01	1.98	1,747	0.27	0.02	3.69	1,248	0.34	0.04	3.37	100	0.22	0.04	0.67
1989	707	0.31	0.08	1.31	1,352	0.24	0.05	1.63	1,410	0.34	0.01	3.02	205	0.23	0.06	2.48
1990	409	0.33	0.08	1.44	2,950	0.22	0.04	1.59	2,013	0.29	0.07	2.16	26	0.25	0.09	0.47
1991	438	0.34	0.01	2.09	2,847	0.22	0.04	1.86	1,392	0.26	0.07	1.32	26	0.20	0.11	0.47
1992	409	0.34	0.05	1.59	2,969	0.24	0.02	2.70	1,116	0.27	0.01	3.10	-	-	-	-
1993	565	0.34	0.08	1.49	2,572	0.29	0.08	1.55	634	0.26	0.08	1.21	12	0.26	0.11	0.71
1994	236	0.38	0.09	1.51	3,011	0.26	0.03	1.51	472	0.26	0.10	1.30	348	0.26	0.08	1.12
1995	208	0.45	0.07	1.51	2,121	0.26	0.05	1.43	498	0.30	0.10	1.42	27	0.25	0.12	0.42
1996	459	0.40	0.04	3.55	2,348	0.26	0.01	1.71	363	0.29	0.11	1.79	7	0.28	0.15	0.62
1997	697	0.33	0.08	1.73	1,878	0.30	0.08	1.85	919	0.26	0.01	1.64	71	0.28	0.10	0.70
1998	778	0.36	0.03	2.50	1,848	0.33	0.07	2.10	1,314	0.24	0.09	1.12	130	0.27	0.09	0.80
1999	1,282	0.40	0.11	1.72	1,189	0.38	0.13	1.48	1,524	0.28	0.02	1.17	8	0.44	0.25	0.90
2000	1,290	0.37	0.06	1.54	739	0.34	0.15	1.46	1,185	0.26	0.02	1.28	11	0.50	0.19	1.94
2001	1,464	0.38	0.12	1.47	-	-	-	-	1,136	0.28	0.12	0.98	67	0.24	0.06	0.45
2002	529	0.36	0.18	1.19	476	0.37	0.12	1.42	762	0.33	0.16	1.52	34	0.26	0.17	0.43
2003	746	0.38	0.05	1.89	1,213	0.38	0.11	3.14	956	0.35	0.07	1.48	182	0.33	0.18	0.88
2004	1,234	0.47	0.10	3.57	654	0.37	0.16	1.95	1,498	0.36	0.17	1.51	465	0.34	0.16	0.92
2005	1,042	0.37	0.02	1.75	171	0.34	0.19	1.10	1,417	0.36	0.17	1.29	635	0.33	0.16	0.73
2006	600	0.36	0.18	1.53	1,466	0.32	0.03	2.38	1,256	0.35	0.15	1.02	1,170	0.31	0.15	1.23
2007	242	0.48	0.24	1.72	1,159	0.43	0.14	1.59	757	0.42	0.20	1.15	578	0.31	0.17	0.99
2008	460	0.51	0.18	1.50	622	0.49	0.20	1.72	518	0.41	0.17	0.85	245	0.35	0.20	0.58
2009	614	0.50	0.16	1.56	726	0.52	0.22	1.76	620	0.47	0.03	1.64	686	0.38	0.16	0.85
2010	1,013	0.53	0.06	1.99	836	0.50	0.21	1.36	1,853	0.47	0.25	1.54	783	0.40	0.26	0.76

Table 4.11.26 For-Hire recreational angler effort in the South Atlantic sub-region. Charter boat mode (1981-85 = Party/Charter boat mode; 1986-2003 adjusted FHS-ratios).

	NC		SC		GA		EFL		South Atlantic	
Year	Trips	PSE	Trips	PSE	Trips	PSE	Trips	PSE	Trips	PSE
1981	119,545	32.3	19,182	35.3	218	101.3	184,293	12.9	323,238	14.2
1982	58,836	30.8	76,877	40.6	26,037	32.1	433,888	11.1	595,638	10.2
1983	155,971	49.3	45,513	23.3	23,528	27.2	321,582	11.3	546,594	15.7
1984	60,946	20.5	123,433	23.3	30,312	22.7	402,050	12.3	616,741	9.6
1985	53,719	24.7	105,658	24.9	30,330	25.2	477,455	10.8	667,162	9.0
1986	43,468	16.4	72,051	15.6	26,198	24.0	295,693	38.0	437,411	25.9
1987	85,480	9.5	77,575	17.4	26,512	39.1	332,514	29.6	522,082	19.2
1988	135,211	12.6	230,049	23.8	40,925	39.0	444,313	30.6	850,499	17.4
1989	69,155	9.6	210,832	21.4	31,145	28.3	314,261	32.4	625,394	17.9
1990	86,118	8.2	103,326	17.9	10,056	21.8	195,687	18.0	395,187	10.3
1991	63,248	5.7	113,238	13.6	27,353	47.9	188,383	13.7	392,222	8.4
1992	76,667	5.7	152,262	20.5	26,139	14.4	169,238	10.3	424,306	8.5
1993	63,051	4.4	183,422	10.5	34,984	14.2	224,116	6.3	505,572	4.8
1994	88,942	3.1	200,725	9.5	51,394	14.1	324,640	4.7	665,701	3.9
1995	115,443	3.7	239,234	11.1	66,723	12.7	357,617	4.5	779,017	4.2
1996	101,555	3.7	291,853	8.8	55,910	11.6	395,043	3.9	844,360	3.6
1997	86,099	3.1	177,252	8.0	39,859	11.5	384,522	4.1	687,732	3.2
1998	69,518	3.0	115,146	10.5	23,904	12.2	324,374	4.6	532,941	3.7
1999	60,280	3.5	77,512	10.3	14,793	11.8	277,296	7.1	429,881	5.0
2000	26,674	4.1	54,396	9.5	9,019	9.9	201,378	5.4	291,466	4.2
2001	55,357	3.7	49,862	9.4	9,348	10.7	177,111	5.6	291,677	3.8
2002	70,186	3.2	45,543	9.0	13,064	9.6	150,874	4.7	279,666	3.1
2003	51,416	4.2	54,805	9.7	17,390	11.8	152,287	4.9	275,898	3.5
2004	32,155	10.8	122,473	22.9	29,502	12.6	198,004	8.3	382,134	8.6
2005	30,937	12.0	28,889	15.9	25,081	10.8	200,910	6.0	285,817	4.8
2006	16,488	10.6	28,592	23.7	28,003	9.0	173,465	4.8	246,548	4.6
2007	17,760	10.8	84,307	15.1	26,302	10.6	177,725	5.2	306,094	5.3
2008	19,481	11.1	71,712	13.2	17,005	10.0	160,530	5.8	268,728	5.1
2009	22,319	8.8	79,561	13.2	16,193	10.1	179,654	5.9	297,727	5.1
2010	27,584	6.6	71,221	10.0	8,417	12.4	135,826	6.2	243,048	4.6

Table 4.11.27 Private / Rental boat recreational angler effort in the South Atlantic sub-region.

	NC		SC		GA		EFL		South Atlantic	
Year	Trips	PSE	Trips	PSE	Trips	PSE	Trips	PSE	Trips	PSE
1981	323,568	10.9	332,825	15.7	119,379	25.0	1,973,018	8.4	2,748,790	6.5
1982	683,854	11.1	455,386	14.0	283,532	13.9	2,974,778	8.1	4,397,550	6.0
1983	880,701	9.8	619,188	17.4	185,863	25.1	3,482,077	7.6	5,167,829	5.9
1984	925,864	11.3	479,536	13.5	194,959	17.3	4,336,598	6.5	5,936,957	5.2
1985	780,364	9.5	548,617	12.7	199,197	17.3	4,356,877	8.2	5,885,055	6.3
1986	431,906	10.0	719,438	12.4	372,494	12.1	4,380,415	6.7	5,904,253	5.3
1987	1,187,849	3.4	886,502	10.5	449,256	11.6	5,044,634	4.8	7,568,241	3.6
1988	1,082,928	3.6	962,733	8.9	415,860	10.4	5,086,710	4.0	7,548,231	3.0
1989	923,499	3.8	506,772	14.0	409,934	13.7	4,883,028	5.0	6,723,233	3.9
1990	1,029,579	3.6	550,496	12.3	399,931	14.9	3,976,094	4.1	5,956,100	3.2
1991	749,618	3.8	977,119	11.4	355,832	17.5	4,738,486	3.7	6,821,055	3.2
1992	874,501	2.8	745,871	8.6	334,761	8.9	4,719,286	2.3	6,674,419	2.0
1993	876,259	3.2	807,638	7.9	439,918	9.2	4,162,425	2.3	6,286,240	2.0
1994	985,411	2.6	966,955	8.6	479,172	10.0	5,336,003	2.0	7,767,541	1.9
1995	1,053,539	2.4	677,163	7.8	432,017	8.3	5,242,230	2.1	7,404,949	1.8
1996	798,271	3.1	648,453	6.9	296,255	9.8	5,057,284	2.5	6,800,263	2.0
1997	898,759	2.8	731,897	5.3	352,097	9.8	5,622,174	2.5	7,604,927	2.0
1998	918,714	3.4	661,423	5.9	345,219	9.9	4,890,020	2.9	6,815,376	2.2
1999	881,752	3.5	586,501	7.3	292,109	11.1	4,196,050	3.0	5,956,412	2.3
2000	1,235,251	3.5	707,203	8.6	435,250	10.5	5,752,689	3.0	8,130,393	2.4
2001	1,283,732	3.2	953,558	8.2	448,507	14.9	5,994,125	3.0	8,679,922	2.5
2002	1,156,461	3.7	557,165	7.4	338,104	10.2	5,429,728	2.9	7,481,458	2.3
2003	1,425,803	3.5	1,020,784	8.3	549,099	11.0	6,212,067	3.0	9,207,753	2.4
2004	1,598,595	3.3	1,070,368	8.7	442,083	11.9	5,313,366	3.5	8,424,412	2.6
2005	1,637,317	3.2	988,887	7.8	500,607	10.5	6,230,328	3.5	9,357,139	2.6
2006	1,704,244	3.3	1,118,469	6.7	471,562	9.5	6,502,930	2.9	9,797,205	2.2
2007	1,954,431	3.2	1,483,233	6.3	552,638	7.9	8,317,491	2.9	12,307,793	2.2
2008	1,879,036	3.6	1,260,154	7.6	747,311	8.2	6,451,381	3.0	10,337,882	2.3
2009	1,629,005	3.5	1,051,366	6.2	503,246	9.0	5,401,059	3.2	8,584,676	2.3
2010	1,800,635	3.5	1,044,558	7.6	556,325	8.4	5,674,994	3.4	9,076,512	2.4

Table 4.11.28 Shore mode recreational angler effort in the South Atlantic sub-region.

	NC		SC		GA		EFL		South Atlantic	
Year	Trips	PSE	Trips	PSE	Trips	PSE	Trips	PSE	Trips	PSE
1981	554,105	15.8	254,444	30.4	207,071	28.7	3,386,373	11.0	4,401,993	9.0
1982	1,403,162	8.3	926,496	22.2	183,189	39.4	4,830,927	16.1	7,343,774	11.1
1983	808,799	12.9	518,635	17.8	270,418	22.5	4,430,493	9.2	6,028,345	7.2
1984	881,692	14.4	1,131,449	38.7	303,260	22.5	4,277,549	6.9	6,593,950	8.3
1985	687,407	9.5	917,599	32.1	209,336	18.2	5,092,375	8.4	6,906,717	7.6
1986	829,508	15.1	674,142	15.0	252,045	14.0	4,997,888	7.3	6,753,583	5.9
1987	1,105,443	7.2	701,589	11.7	280,365	18.7	5,184,084	7.3	7,271,481	5.5
1988	1,418,686	6.7	756,253	9.4	223,354	16.7	5,748,181	5.2	8,146,474	4.0
1989	987,115	7.0	408,989	13.7	194,597	32.8	5,461,204	6.6	7,051,905	5.3
1990	996,819	6.6	308,444	14.2	301,369	19.6	3,825,367	5.2	5,431,999	4.1
1991	1,367,097	6.4	745,386	12.4	361,081	21.3	6,097,792	4.7	8,571,356	3.8
1992	1,250,328	4.5	587,454	10.6	221,005	14.5	5,332,514	3.2	7,391,301	2.6
1993	1,371,148	4.7	842,316	8.0	207,468	13.2	5,079,957	2.7	7,500,889	2.2
1994	1,387,957	4.2	871,679	8.0	433,617	15.1	6,051,345	2.4	8,744,598	2.1
1995	1,363,112	4.5	663,649	8.8	294,493	20.0	5,897,410	2.6	8,218,664	2.3
1996	823,704	4.7	594,719	9.1	277,874	16.5	4,988,209	3.3	6,684,506	2.7
1997	763,205	4.7	752,066	9.6	193,525	13.4	5,196,555	3.2	6,905,351	2.7
1998	695,189	5.0	962,928	11.9	209,871	12.1	4,769,746	3.6	6,637,734	3.2
1999	633,001	5.8	565,102	10.0	169,817	14.7	3,626,664	4.1	4,994,584	3.3
2000	824,092	5.9	590,286	11.3	354,840	15.4	5,447,628	3.9	7,216,846	3.2
2001	1,094,096	5.2	683,609	13.3	351,889	13.9	6,219,479	3.5	8,349,073	3.0
2002	874,811	4.9	665,182	12.7	272,372	15.0	4,657,212	4.0	6,469,577	3.3
2003	1,402,013	4.7	1,037,739	13.1	409,920	14.3	5,045,039	4.0	7,894,711	3.3
2004	1,392,255	6.7	1,129,827	12.3	475,110	14.8	5,148,689	4.5	8,145,881	3.6
2005	1,503,211	5.8	1,065,629	14.7	325,800	17.3	5,618,042	4.3	8,512,682	3.6
2006	1,179,621	6.5	1,481,468	13.4	290,733	11.9	6,438,592	3.6	9,390,414	3.4
2007	1,322,463	6.8	961,417	13.9	347,544	11.6	6,673,892	3.9	9,305,316	3.3
2008	1,706,843	5.3	1,196,215	12.3	517,422	10.8	4,603,458	4.1	8,023,938	3.3
2009	1,028,685	6.6	1,192,003	12.4	332,024	12.9	4,560,955	4.3	7,113,667	3.6
2010	1,354,657	6.0	1,027,122	14.7	395,131	11.9	4,369,403	4.4	7,146,313	3.7

Table 4.11.29 South Atlantic headboat estimated angler days 1981-2010.

Year	NC	SC	GA/NEFL	SEFL	South Atlantic
1981	19,372	59,030	72,069	226,456	376,927
1982	26,939	67,539	66,961	226,172	387,611
1983	23,830	65,713	83,499	194,364	367,406
1984	28,865	67,313	95,234	193,760	385,172
1985	31,346	66,001	94,446	186,398	378,191
1986	31,187	67,227	113,101	203,960	415,475
1987	35,261	78,806	114,144	218,897	447,108
1988	42,421	76,468	109,156	192,618	420,663
1989	38,678	62,708	102,920	213,944	418,250
1990	43,240	57,151	98,234	224,661	423,286
1991	40,936	67,982	85,111	194,911	388,940
1992	41,177	61,790	90,810	173,714	367,491
1993	42,785	64,457	74,494	162,478	344,214
1994	36,693	63,231	65,745	177,035	342,704
1995	40,294	61,739	59,104	142,507	303,644
1996	35,142	54,929	47,236	152,617	289,924
1997	37,189	60,147	52,756	120,510	270,602
1998	37,399	61,342	51,790	103,551	254,082
1999	31,596	55,499	56,770	107,042	250,907
2000	31,323	40,291	59,771	122,478	253,863
2001	31,779	49,263	55,795	107,592	244,429
2002	27,601	42,467	48,911	102,635	221,614
2003	22,998	36,556	52,795	92,216	204,565
2004	27,255	50,461	50,544	123,157	251,417
2005	31,573	34,036	47,778	123,300	236,687
2006	25,730	56,070	48,943	126,607	257,350
2007	28,997	60,725	53,759	103,386	246,867
2008	17,156	47,285	52,338	71,593	188,372
2009	19,463	40,916	66,442	66,971	196,792
2010	21,066	44,947	53,672	69,983	189,668

4.12 Figures

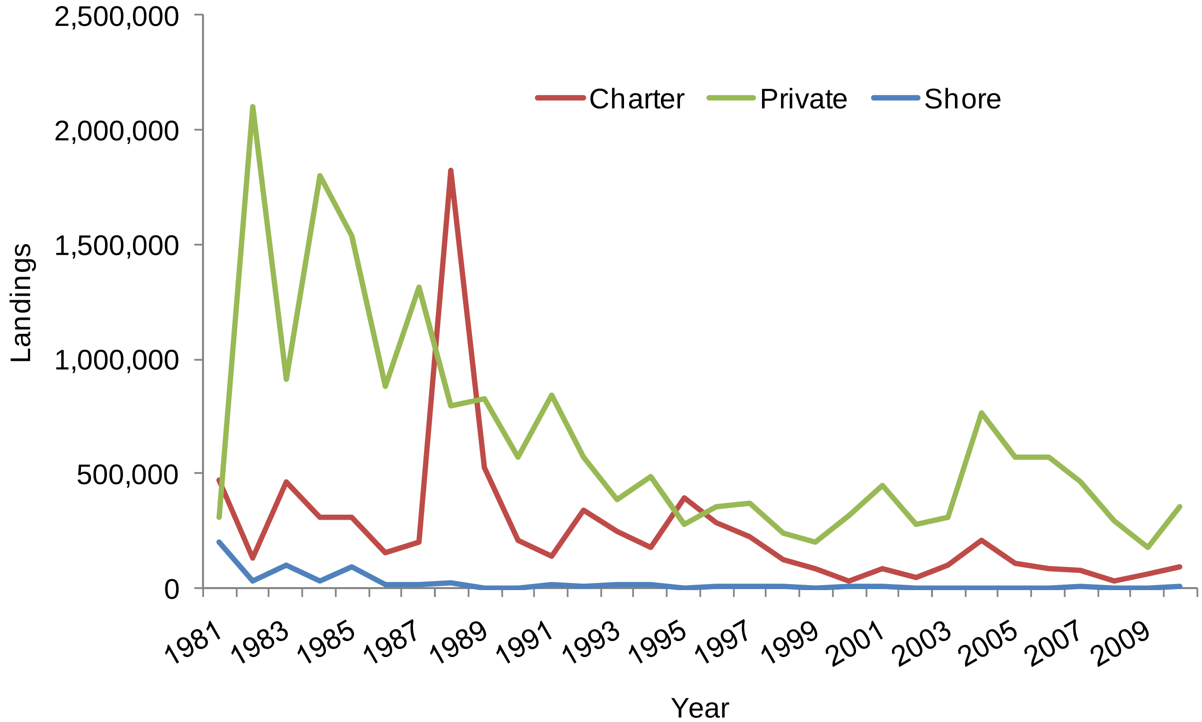

Figure 4.12.1 Estimated black sea bass landings (numbers of fish) for recreational charter boat, private/rental boat, and shore fisheries, 1981-2010.

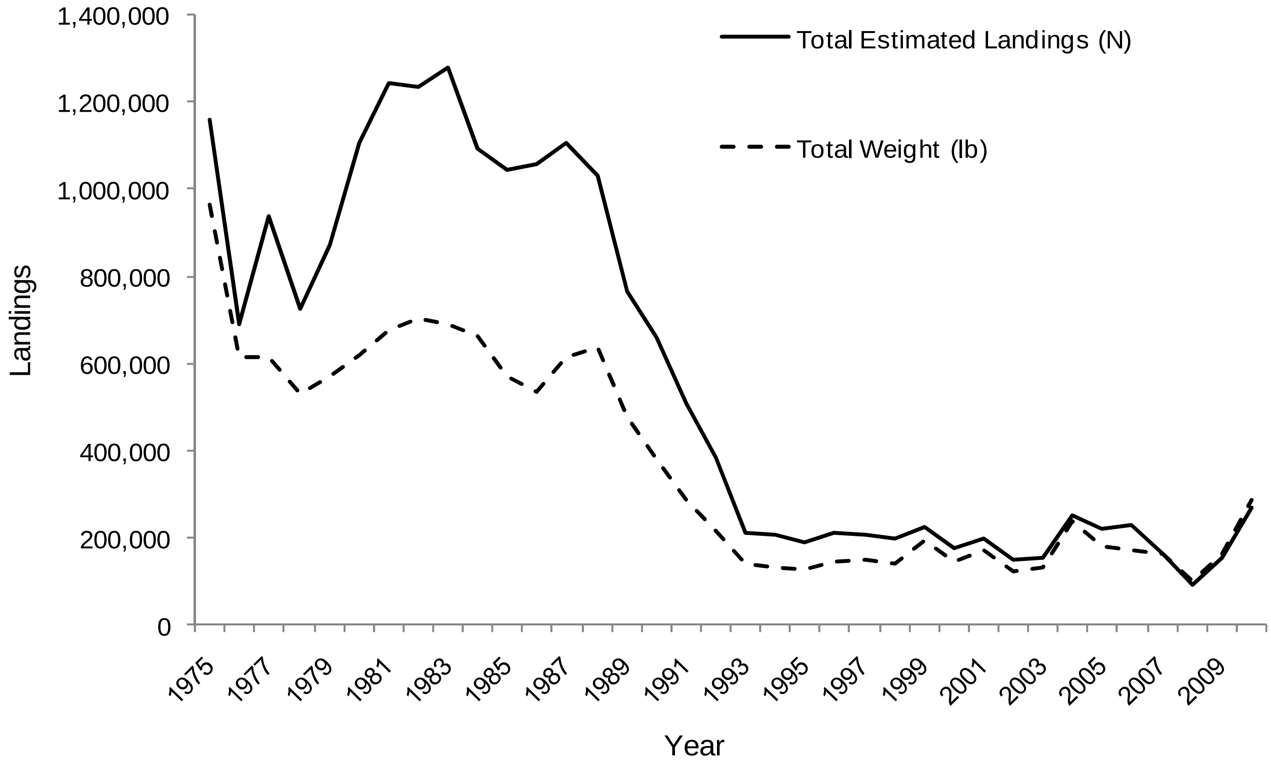

Figure 4.12.2 Estimated landings black sea bass landings (number and pounds) for the headboat fishery, 1975-2010.

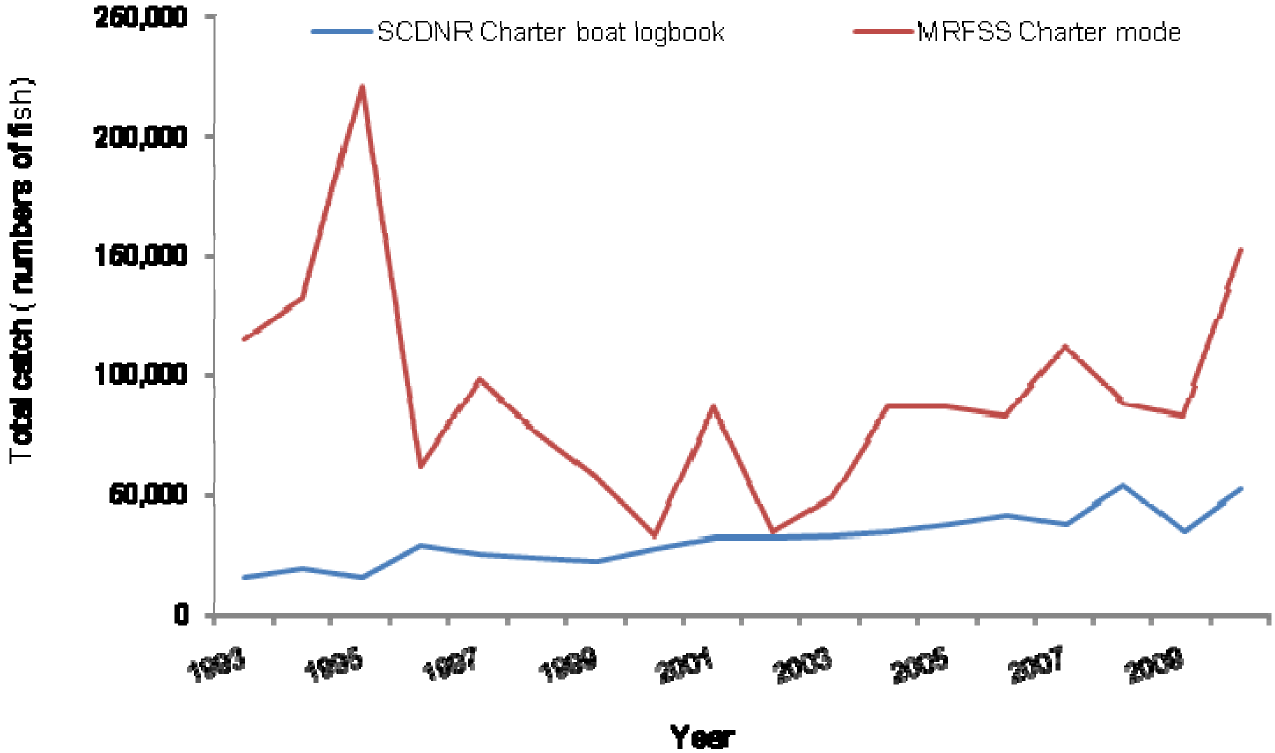

Figure 4.12.3 Comparison of total catch from MRFSS charter mode and SCDNR charter boat logbook program, 1993-2010.

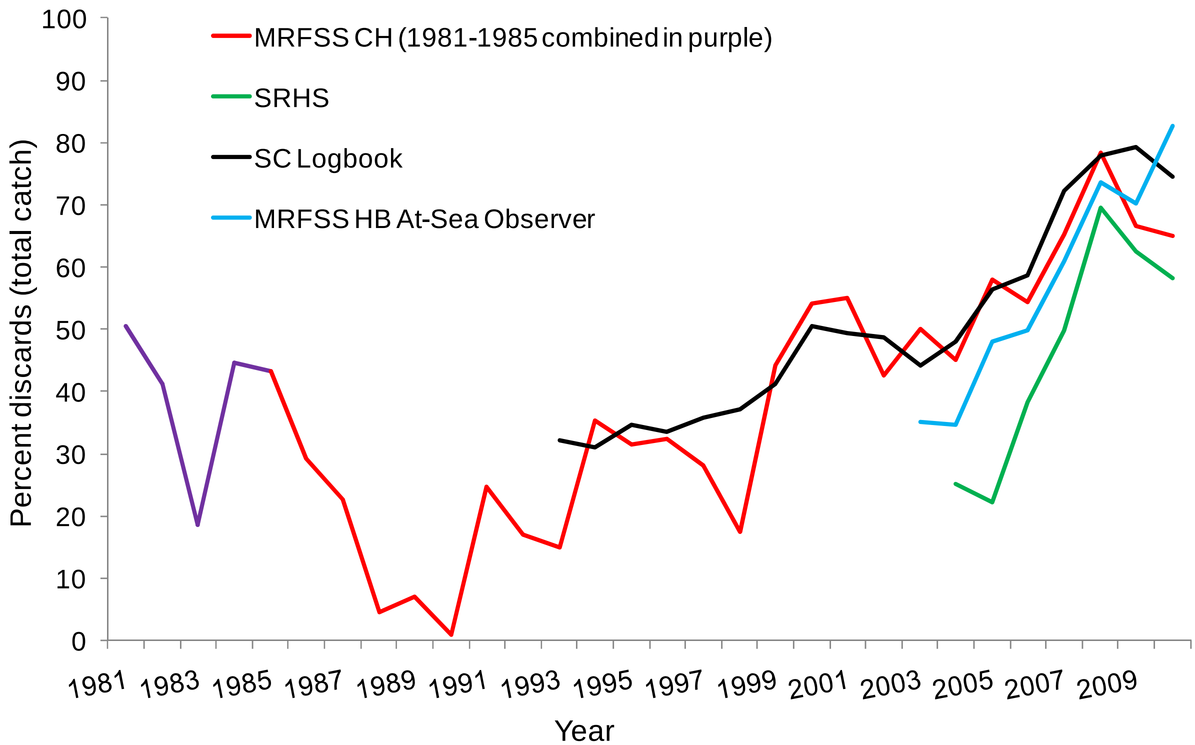

Figure 4.12.4 Percentage of black sea bass discards in the recreational fishery, 1981-2010.

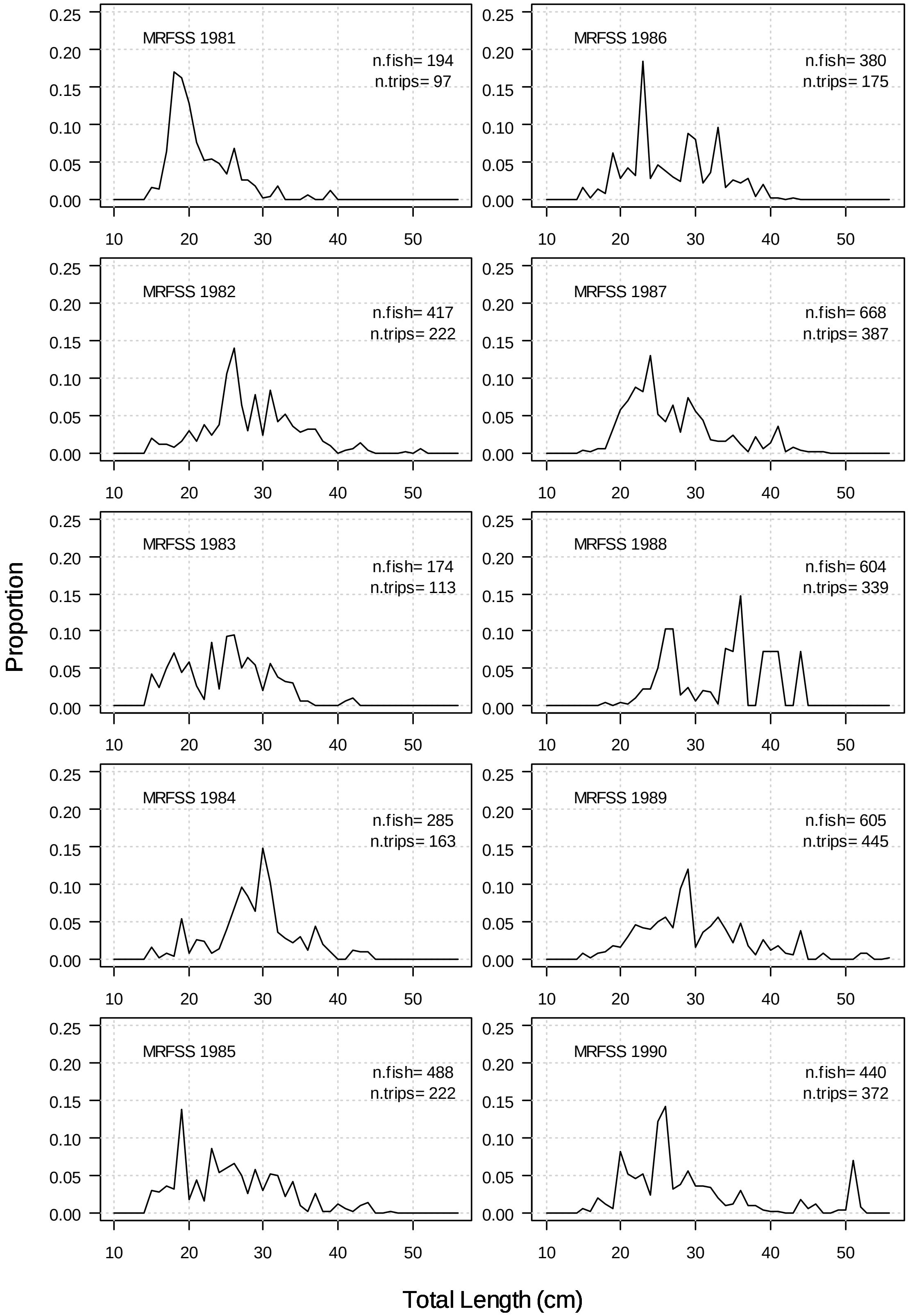

Figure 4.12.5 Length composition from the MRFSS (1981-2010) and SCDNR SFS (1988-2008). The number of trips reported includes both angler and vessel trips for years 1988-2008.

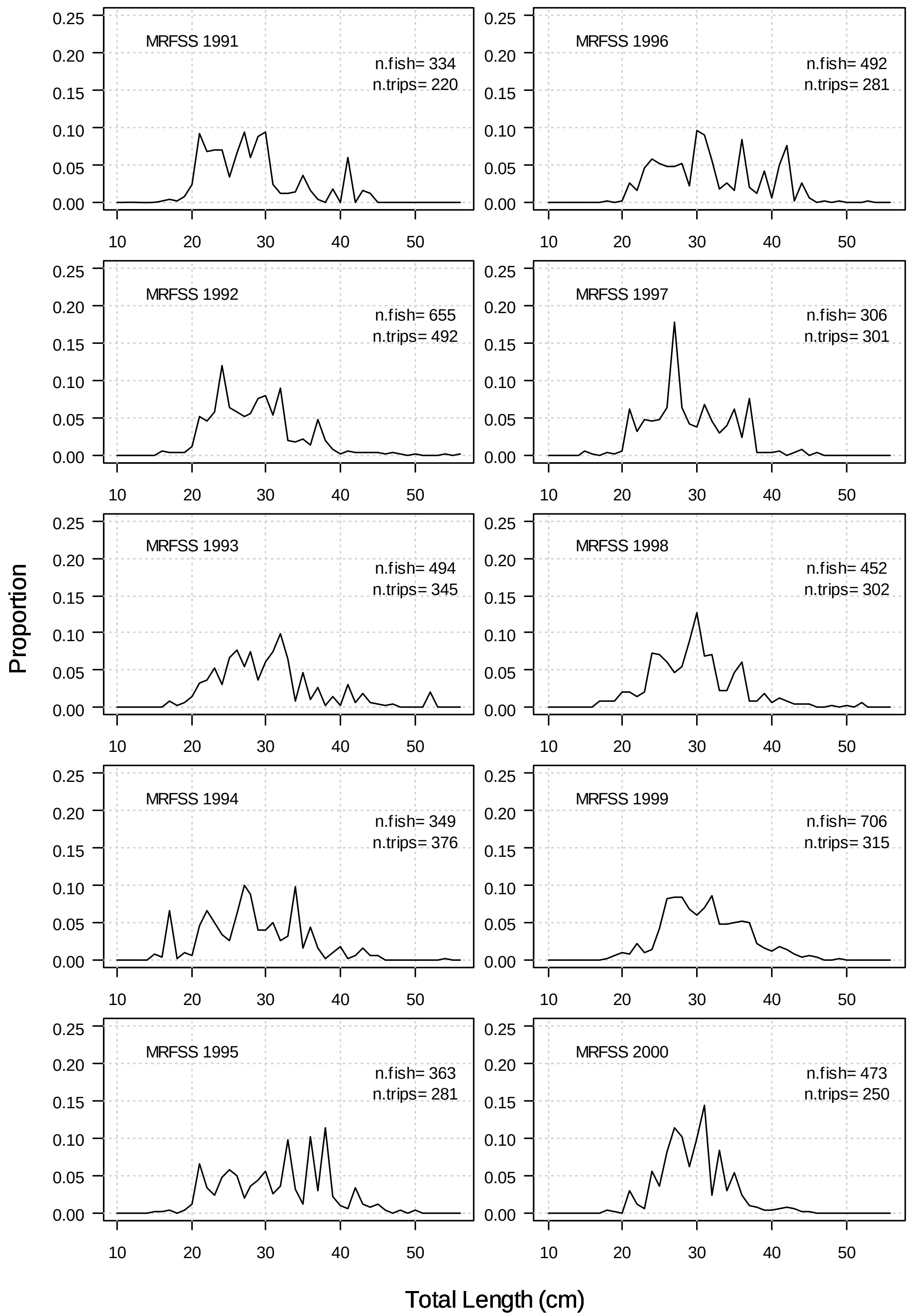

Figure 4.12.5 Length composition from the MRFSS (1981-2010) and SCDNR SFS (1988-2008) (continued). The number of trips reported includes both angler and vessel trips for years 1988-2008.

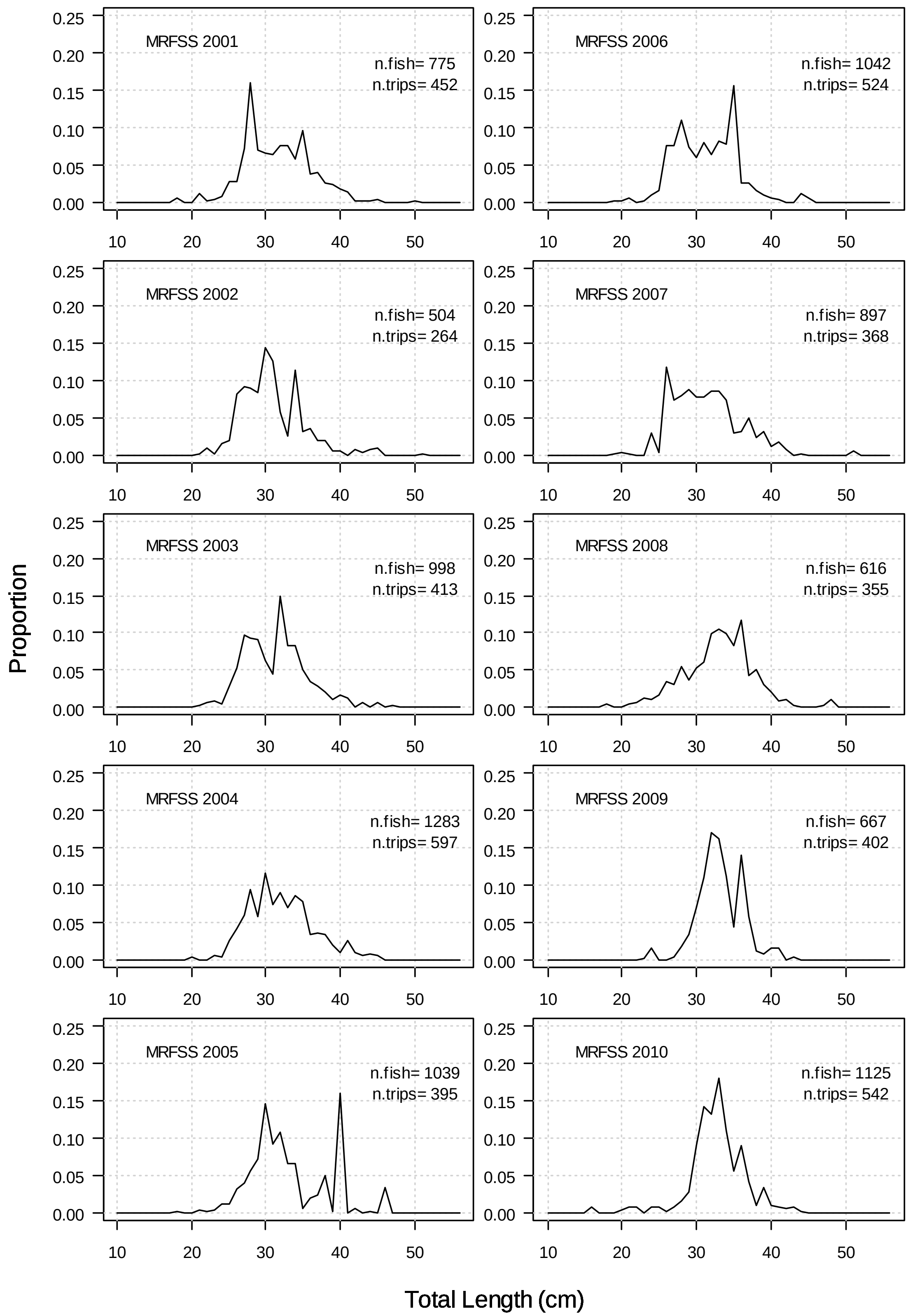

Figure 4.12.5 Length composition from the MRFSS (1981-2010) and SCDNR SFS (1988-2008) (continued). The number of trips reported includes both angler and vessel trips for years 1988-2008.

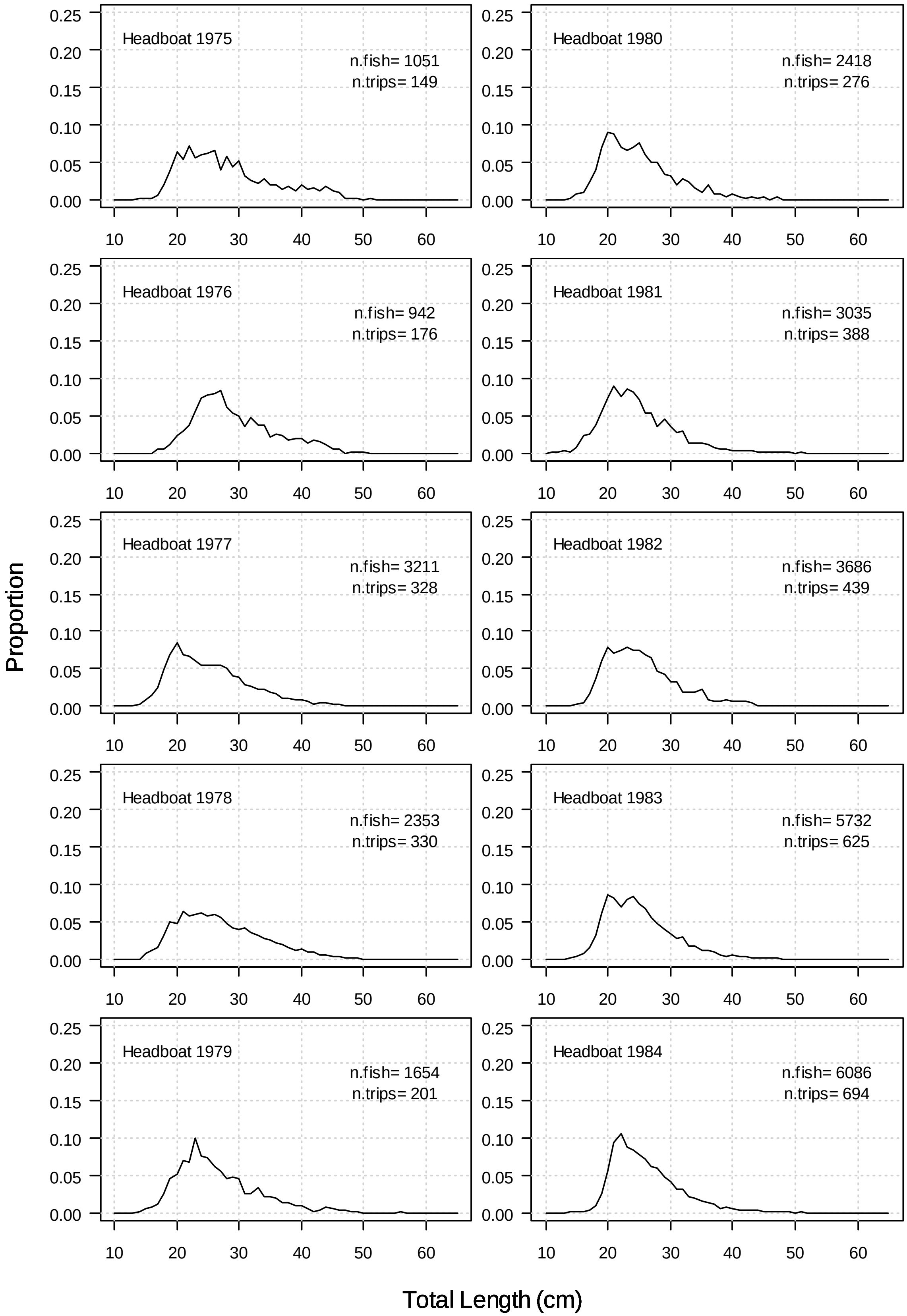

Figure 4.12.6 Headboat length composition 1975-2010.

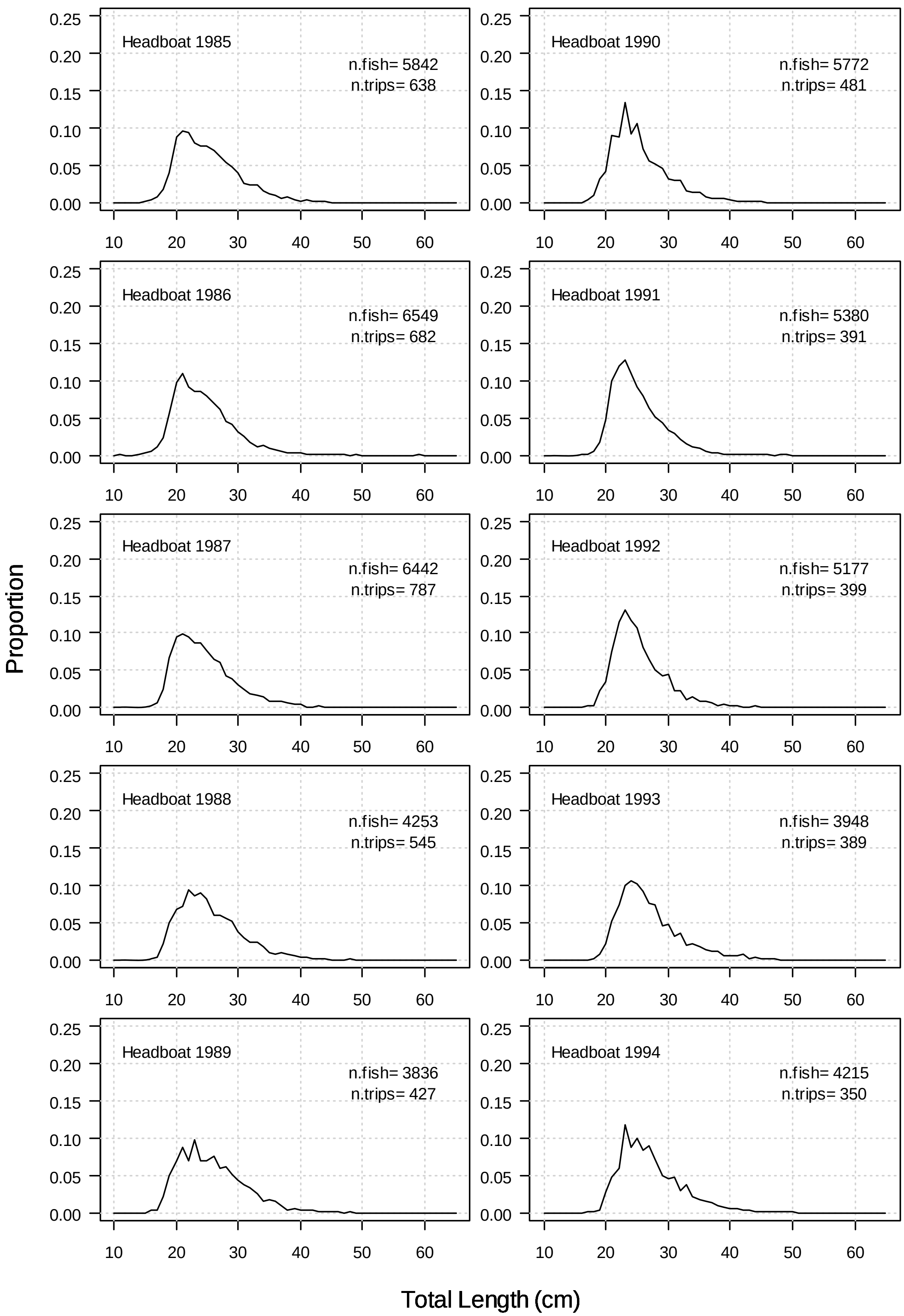

Figure 4.12.6 Headboat length composition 1975-2010 (Continued).

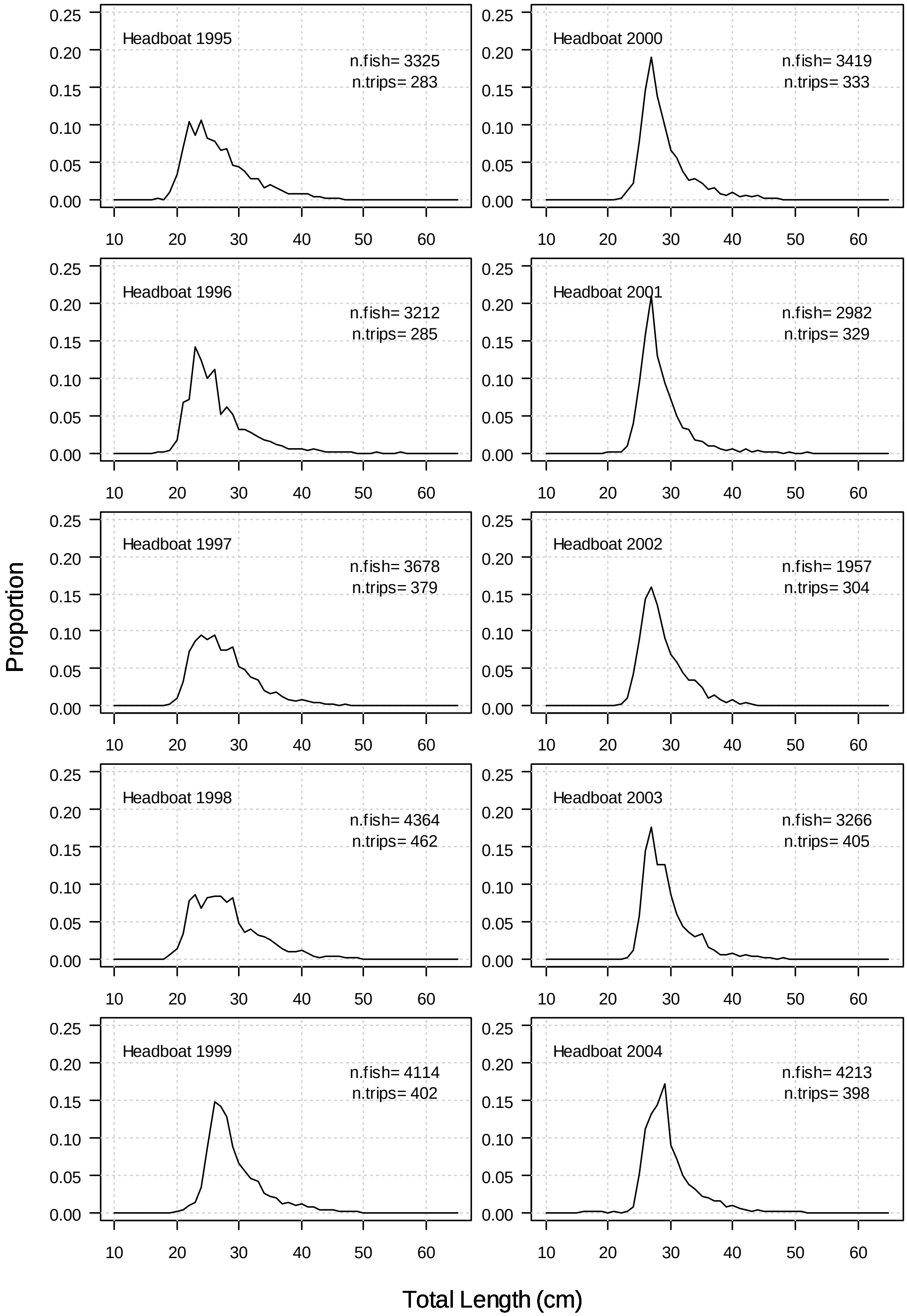

Figure 4.12.6 Headboat length composition 1975-2010 (Continued).

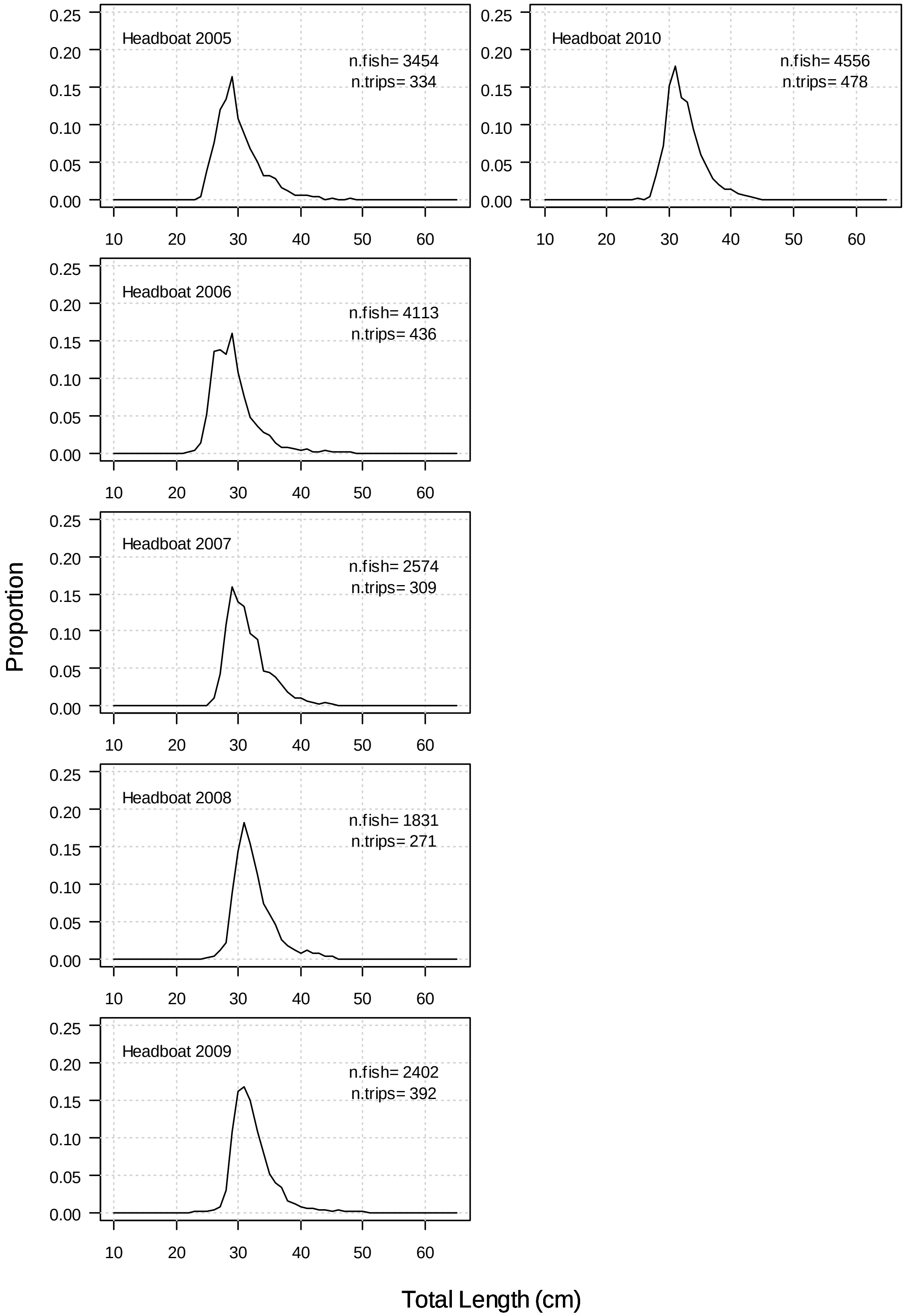

Figure 4.12.6 Headboat length composition 1975-2010 (Continued).

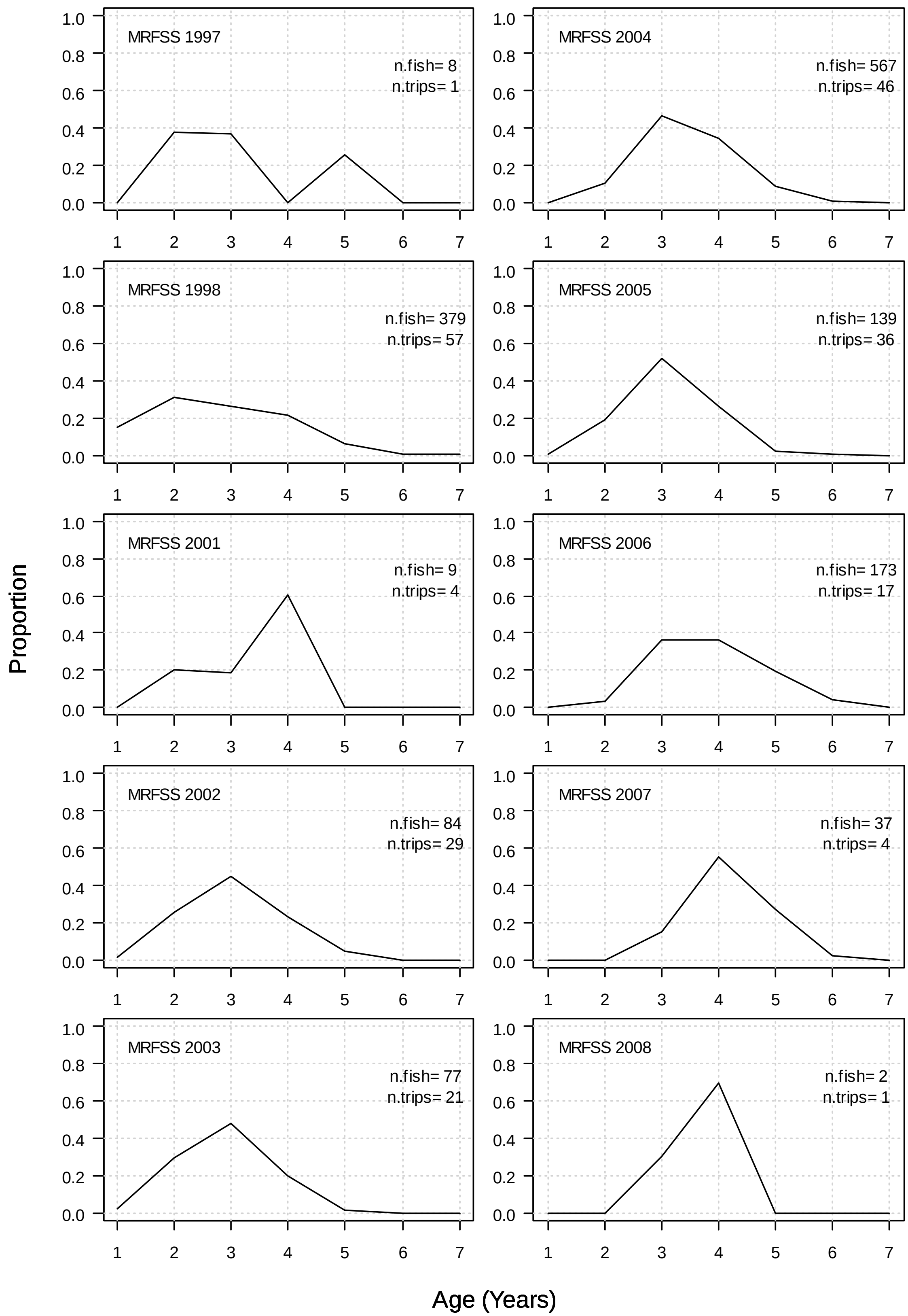

Figure 4.12.7 Age composition of black sea bass from the charter boat, private/rental boat, and shore modes (1997-1998, 2001-2010).

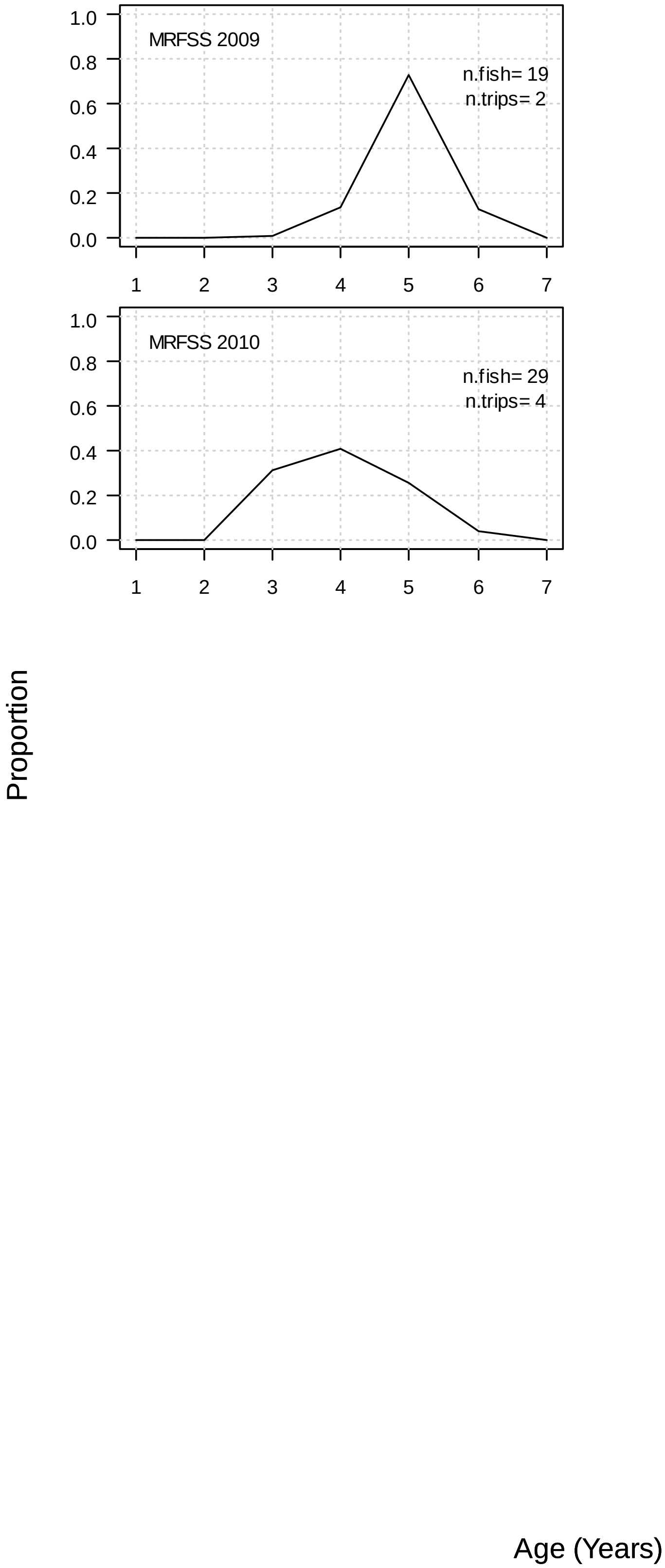

Figure 4.12.7 Age composition of black sea bass from the charter boat, private/rental boat, and shore modes (1997-1998, 2001-2010) (continued).

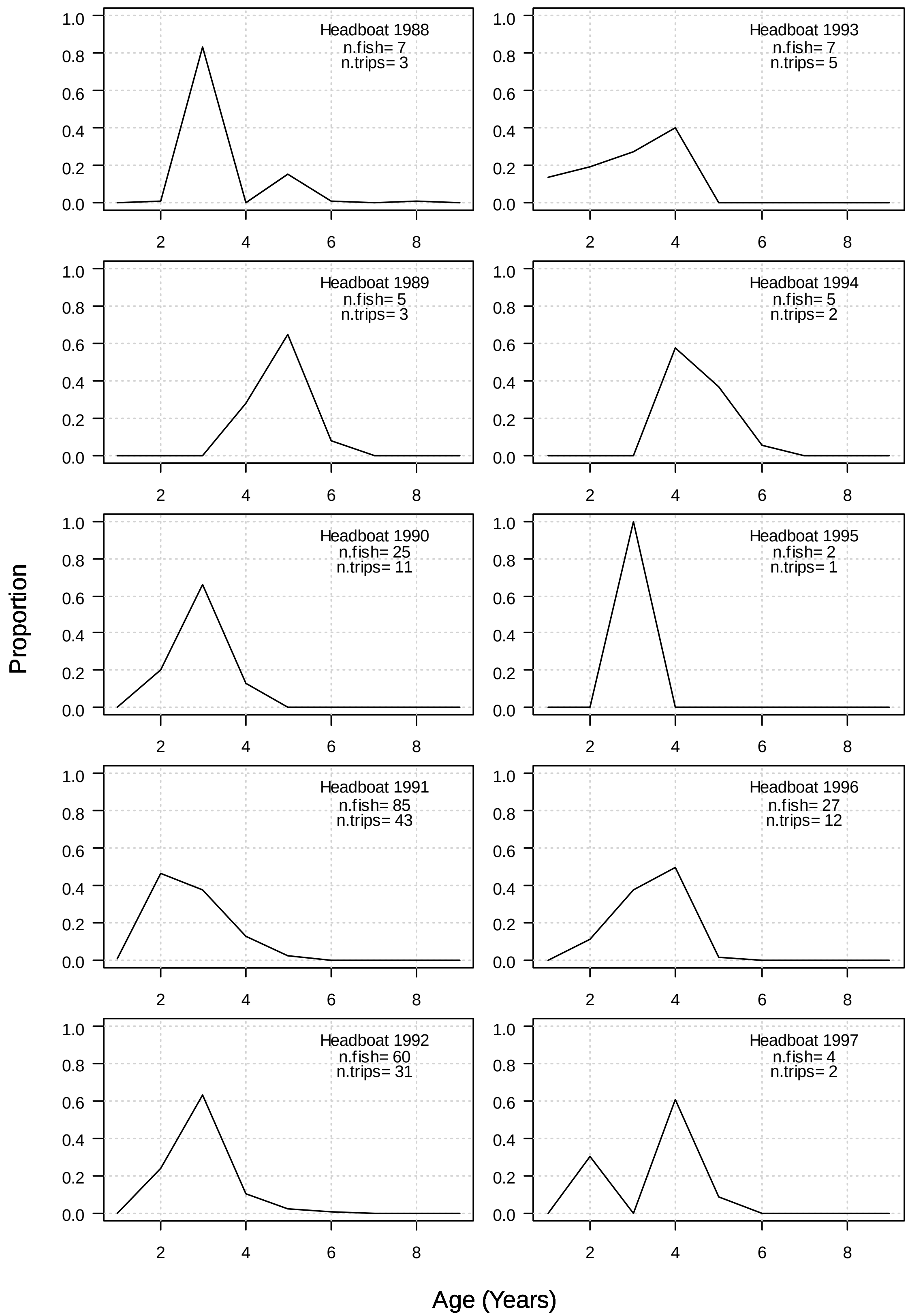

Figure 4.12.8 Age composition of black sea bass from the headboat fleet during 1988-2010, no fish were aged in the headboat fleet during 1999 and 2001.

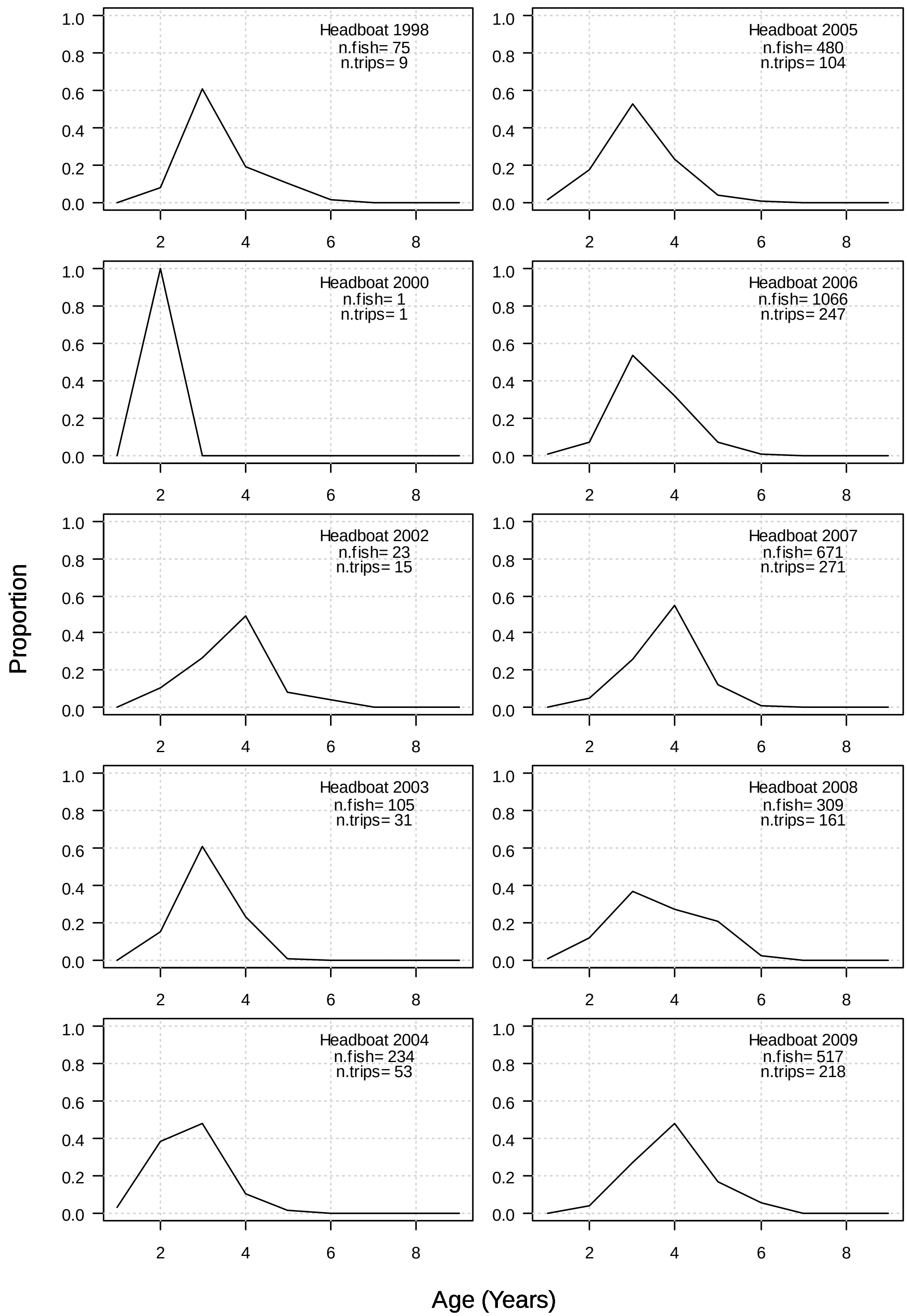

Figure 4.12.8 Age composition of black sea bass from the headboat fleet during 1988-2010, no fish were aged in the headboat fleet during 1999 and 2001 (continued).

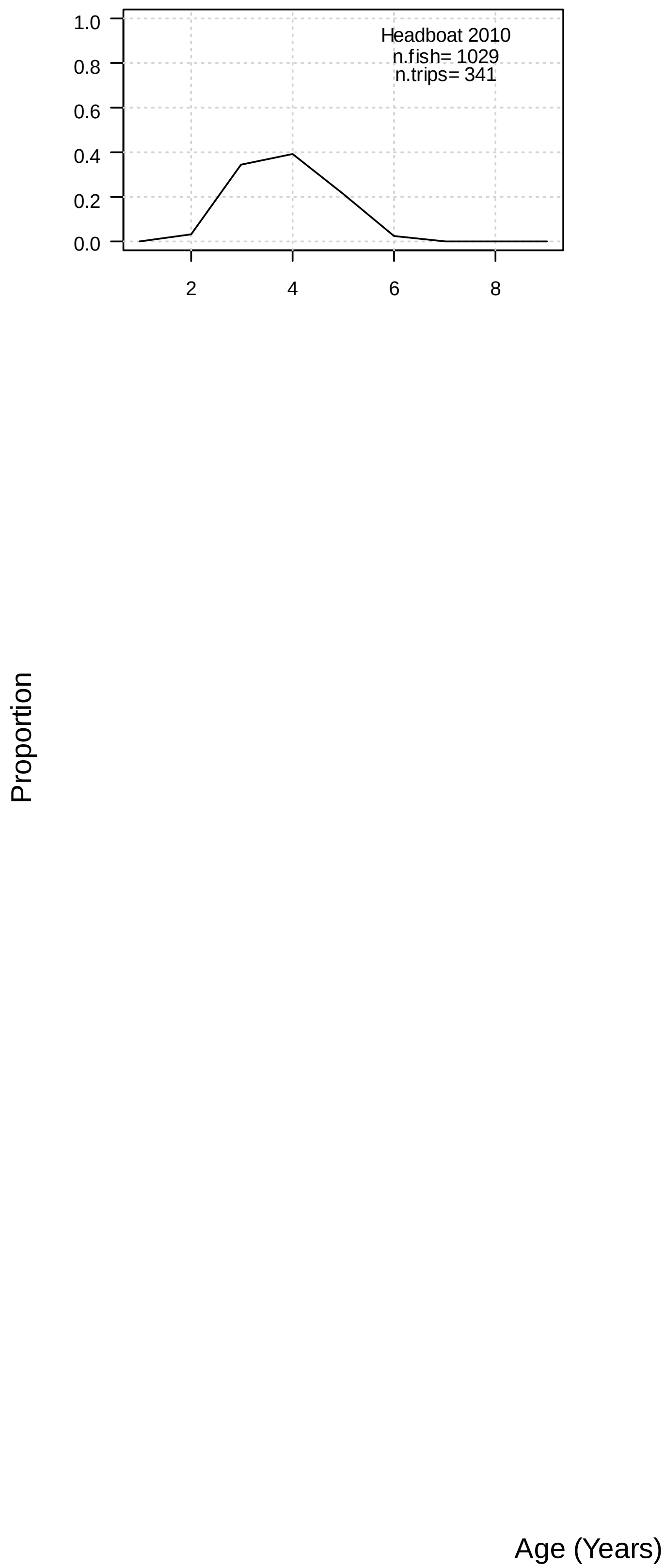

Figure 4.12.8 Age composition of black sea bass from the headboat fleet during 1988-2010, no fish were aged in the headboat fleet during 1999 and 2001 (continued).

5 Measures of Population Abundance

5.1 Overview

Several indices of abundance were considered for use in the South Atlantic black sea bass assessment model. These indices are listed in Table 5.1.1, with pros and cons of each in Table 5.1.2. The nine indices came from fishery independent and fishery dependent data. The DW recommended the use of two fishery independent indices (MARMAP chevron trap, MARMAP blackfish/Florida snapper trap combined) and three fishery dependent indices (recreational headboat index, commercial logbook index, and headboat observer discards index).

Group membership
Membership of this DW Index Working Group (IWG) included Kevin McCarthy (work group leader), Kate Andrews (Rapporteur), Nate Bacheler, Walter Ingram, Michelle Pate, Jessica Stephen, Rob Cheshire, Kyle Shertzer, Eric Fitzpatrick, Mike Errigo, Julia Byrd and Jimmy Hull. 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 nine working papers describing index construction, including: SEDAR25-DW02; SEDAR25-DW03; SEDAR25-DW8; SEDAR25-DW12; SEDAR25-DW13; SEDAR25-DW14; SEDAR25-DW16; SEDAR25-DW18; and SEDAR25-DW24. SEDAR25-DW02 described the computation of a fishery independent index from the MARMAP chevron trap data. SEDAR25-DW03 described the computation of a fishery independent index from the MARMAP blackfish/FL snapper trap data. SEDAR25-DW08 described the computation of fishery dependent data from one vessel in the black sea bass pot fishery in Florida. SEDAR25-DW12 described the computation of a fishery independent index from the SCDNR shallow water trawl data. SEDAR25-DW13 described the computation of a fishery dependent discard index from the headboat at-sea observer data. SEDAR25-DW14 described the computation of a fishery dependent index from recreational headboat data. SEDAR25-DW16 described the computation of a fishery dependent index from the SCDNR charterboat data. SEDAR25-DW18 described the computation of a fishery dependent index from the commercial logbook vertical line data. SEDAR25-DW24 described the computation of a fishery dependent index from the commercial logbook trap 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 both fishery independent and fishery dependent data considered at the data workshop can be found in Appendix 5.

5.3 Fishery Independent Indices

5.3.1 MARMAP Chevron trap

5.3.1.1 Methods, Gears, and Coverage

Chevron traps were baited with cut clupeids and deployed at stations randomly selected by computer from a database of approximately 1,800 live bottom and shelf edge locations and soaked for approximately 90 minutes. Sampling occurred from North Carolina to Florida, but most effort was concentrated off of South Carolina. An index of abundance that standardized catch-per-unit-effort (CPUE; number of fish caught per hour of soak time) of black sea bass was developed using a delta-GLM model.

5.3.1.2 Sampling intensity and time series

Chevron traps were deployed from 1990 through 2010. Between 109 and 416 traps were deployed each year.

5.3.1.3 Size/Age data

The ages of black sea bass collected by MARMAP chevron traps (1990–2010) ranged from 0 to 10 years (median = 2, N = 71,989 individual ages).

5.3.1.4 Catch Rates

Index results are listed in Table 5.3.1 and shown graphically in Figure 5.3.1.

5.3.1.5 Uncertainty and Measures of Precision

Coefficients of variation (CV) were in the range of 0.08-0.15 over the entire time series.

5.3.1.6 Comments on Adequacy for assessment

Traps were typically deployed in clusters of up to six traps at one time no closer than 200 m to another trap. A question posed during the data workshop was whether results depended on the assumption of independence among individual trap deployments. To test this, nominal CPUE was calculated two ways, the first using individual trap deployments as the experimental unit and the second using the cluster of trap deployments as the experimental unit. The nominal CPUE values for each method were nearly identical, so final analyses considered the trap sample to be the experimental unit. Indices results are listed in Table 5.3.1 and shown graphically in Figure 5.3.1.

5.3.2 MARMAP Blackfish trap & Florida Antillean trap combined

5.3.2.1 Methods, Gears, and Coverage

Blackfish and Florida snapper traps were baited with cut clupeids and deployed at stations randomly selected by computer from a database of live bottom and shelf edge locations and soaked for approximately 90 minutes. Sampling occurred from North Carolina to Georgia, but most effort was concentrated off of South Carolina. An index of abundance that standardized catch-per-unit-effort (CPUE; number of fish caught per hour of soak time) of black sea bass was developed using a delta-GLM model. To estimate fewer parameters in the assessment model, these two trap gears were combined into a single index of abundance, and a 'gear' variable was included in the model to account for differences in CPUE between trap types.

5.3.2.2 Sampling intensity and time series

Blackfish and Florida snapper traps were deployed from 1981 through 1987. Between 238 and 641 total traps were deployed each year.

5.3.2.3 Size/Age data

See Figure 1 in SEDAR25-DW02 for age and length comps.

5.3.2.4 Catch Rates – Number and Biomass

Index results are listed in Table 5.3.2 and shown graphically in Figure 5.3.2.

5.3.2.5 Uncertainty and Measures of Precision

Coefficients of variation (CV) were in the range of 0.05-0.09 over the entire time series.

5.3.2.6 Comments on Adequacy for assessment

The data workshop accepted this index to be included in the stock assessment. Two series, one with each trap type, were generated and used in the last assessment. The IWG found the combination of trap types to be an improvement upon the series previously used. Index results are listed in Table 5.3.2 and shown graphically in Figure 5.3.2.

5.4 Fishery Dependent Indices

5.4.1 Recreational Headboat

The headboat fishery in the south Atlantic includes for-hire vessels that typically accommodate 11-70 passengers and charge a fee per angler. The fishery uses hook and line gear, generally targets hard bottom reefs as the fishing grounds, and generally targets species in the snapper-grouper complex. This fishery is sampled separately from other fisheries, and the available data were used to generate a fishery dependent index.

Headboats in the south Atlantic are sampled from North Carolina to the Florida Keys (Figure 5.4.1.1). Data have been collected since 1972, but logbook reporting did not start until 1973. In addition, only North Carolina and South Carolina were included in the earlier years of the data set. In 1976, data were collected from North Carolina, South Carolina, Georgia, and northern Florida, and starting in 1978, data were collected from southern Florida (areas 11, 12, and 17).

Variables reported in the data set include year, month, day, area, location, trip type, number of anglers, species, catch, and vessel id. Biological data and discard data were recorded for some trips in some years.

Until 1986, when bank sea bass were added to the logbook form, headboat personnel were instructed to include landed bank sea bass in the estimate of landed black sea bass. The combined landings of these species were reduced by the proportion of black sea bass to combined sea bass determined headboat landings estimates from years where bank sea bass were fully reported (1988-90). Bank sea bass were collected in numbers and were converted to weight using a mean weight of 0.441 lb/fish. Relatively few bank sea bass were considered landed during this time period and thus the proportion of black to bank sea bass is large (0.95).

The development of the WPUE index is described in more detail in SEDAR25-DW14. The appendix to the working paper describes decisions made by the SEDAR 25 DW panel with updated tables and figures. The SEDAR 25 DW index working group decisions summarized in SEDAR25-DW14 (Appendix 1) include;

- Exclude 1973-78, because in those years black sea bass were reported in units of 100 lb boxes, as described below
- Retain general rule (0.5%) to remove outliers (potentially erroneous reporting) for the number of anglers, landings, and landings/hour
- Retain all trip types for full- and half-day trips, remove 3/4-day trips for consistency with the SEDAR-2 update and because there were relatively few 3/4-day trips compared to the other trip types
- Regional differences in WPUE were plotted and discussed within the index working group. The index working group panel acknowledged some regional differences, but attempted to account for such differences by including region as a factor in the model. A plot of WPUE for each region scaled to their respective means was developed after the workshop (SEDAR25-DW14, Appendix 1). The regional WPUEs show similar overall trends.
- The index working group and the DW panel discussed the relatively small error associated with the fit of the headboat index. Options were discussed including scaling the CVs to some maximum value. The group recommended that the assessment panel consider a method to increase the error to reflect the uncertainty in the data as well as the model fit. An example of scaling the CVs to a maximum of 0.3 was developed after the workshop (Table 5.4.1.1, Figure 5.4.1.2).
- Bag limits were rarely met or exceeded for all anglers on a trip; bag limits were not believed to affect this index. The effect of size limits on WPUE were discussed and the index working group concluded the assessment model should be set up to use size composition data to account for changes in the size of landed fish as is usually done in the Beaufort Assessment Model.

5.4.1.1 Methods of Estimation

Subsetting trips

Years
The time series used for construction of the index spanned 1979−2010 because the units of landings (pounds) requested on the logbook form was consistent during this entire time series. Prior to 1979, logbook forms requested black sea bass landings as the number of 100-pound boxes. Some database errors were identified for black sea bass landings in 1973-76. These errors were likely due to confusion over the reporting units. Attempts were made to correct for or remove these errors but were unsuccessful.

Areas
Data from area 1 (Figure 5.4.1.1) were excluded as this area had few vessels and were not recorded during most of the time series. Areas 11, 12, and 17 representing South Florida, the Florida Keys and the Tortugas were excluded due to very low catches of black sea bass. Georgia was combined with North Florida.
Vessels
Vessels that did not have at least 250 trips recorded in the entire time series (from 1973-2010) were removed from the analysis. These vessels either did not operate for more than a few years or participated minimally each year. There was concern that CPUE from short term vessels were confounded by business startup, learning locations and developing their niche within the fleet. Vessels that participate minimally may also be operating as commercial or private fishing vessels. These trips were excluded because they likely don't reflect the behavior of headboats in general. This step removed a major percentage of the vessels but a small portion of the trips (SEDAR25-DW14).

Habitat
Trips to be included in the computation of the index need to be determined based on effort directed at black sea bass. Black sea bass are typically caught closer to shore than other species in the snapper-grouper complex in the Southeast US. Vessels are likely to fish multiple locations within a trip and many vessels will fish both the nearshore and offshore areas in a single trip. Trips that caught any deepwater species (defined by Shertzer and Williams 2009) were excluded from the analysis to remove trips where effort was obviously split between nearshore and offshore habitat. The deepwater species complex was defined as warsaw grouper, cubera snapper, yellowedge grouper, speckled hind, snowy grouper and blueline tilefish (Shertzer and Williams 2008).

Outliers
Finally, trips defined by the upper 0.5% of black sea bass catch, anglers, and catch per trip hour were dropped as they likely represent misreporting or data entry errors (SEDAR25-DW14).

Black sea bass were landed on 88% of the trips in South Carolina and in 71% and 75% of the trips in North Carolina and Georgia/Florida respectively. The high encounter rate suggests that it is appropriate to determine WPUE on the positive trips only.

Standardization method
Weight per unit effort (WPUE) has units of pounds/hour and was calculated as the weight of black sea bass landed divided by the number of trip hours (5 for half-day trips, 10 for full-day trips). WPUE was modeled using the glm approach (Dick 2004; Maunder and Punt 2004). Factors included in the GLM were year, region, season, trip type, number of anglers as a categorical variable, and the maximum number of anglers observed for each vessel by year as a categorical variable. The maximum number of anglers by vessel and year was used as a proxy for vessel size. The effort, number of trips, landings and average nominal WPUE by factor are shown in Table 5.4.1.3. In particular, fits of lognormal and gamma models were compared for the full model of positive WPUE, and the predictor variables described above were examined to determine which best explained WPUE patterns. Bootstrap estimates of variance were computed based on 1000 fits of the model, in which data (trips) were resampled with replacement for each fit (Efron and Tibshirani 1994).

The model was fit using GLM code developed by E.J. Dick modified for positive trips and implemented in the R software environment (R Development Core Team 2010). All main effects were considered for both the lognormal and gamma distributions. The AIC values were compared to choose the most appropriate distribution. The lognormal preformed slightly better than the gamma model. Stepwise AIC (Venables and Ripley1997) with a backwards selection algorithm was then used to eliminate those factors that did not improve model fit. Backwards model selection did not eliminate any of the predictor variables for the lognormal.

5.4.1.2 Sampling Intensity

The resulting data set contained 88,166 trips with black sea bass landings. A summary of the total number of trips with black sea bass landings by year and region is provided in Table 5.4.1.2. Table 5.4.1.3 summarizes the number of trips by each factor.

5.4.1.3 Size/Age data

The sizes/ages represented in this index should be the same as those of landings from the corresponding fleet (See section 4 of this report).

5.4.1.4 Catch Rates

Standardized catch rates and associated error bars are shown in Figure 5.4.1.2. and are tabulated in Table 5.4.1.1.

5.4.1.5 Uncertainty and Measures of Precision

Measures of precision were computed using a bootstrap procedure with 1000 iterations of the model using randomly sampled trips with replacement. The samples were drawn from the entire data set with the sample size matching the size of the initial data set. Annual CVs of catch rates are tabulated in Table 5.4.1.1 and applied to the estimated index to develop error estimates. The CVs were also scaled to a maximum of 0.3 as an example of how the assessment panel may choose to adjust the CVs to reflect more realistic uncertainty in how this index tracks relative abundance.

5.4.1.6 Comments on Adequacy for Assessment

The index of abundance from the headboat data was considered by the indices working group to be adequate for use in this assessment. Its importance was ranked second behind the MARMAP chevron trap index. The data cover the full range of the stock for the South Atlantic and is a complete census of the headboats. The data set has an adequately large sample size and has a long enough time series to provide potentially meaningful information for the assessment. The sampling was consistent over time, and some of the data were verified by port samplers and observers. Headboat effort generally targets snapper-grouper species and not necessarily the focal species, which should minimize changes in catchability relative to fishery dependent indices that target specific species. The primary caveat concerning this index was that it was derived from fishery dependent data. Another caveat is that black sea bass are commonly caught in large numbers and the reported landings may be coarse estimates of the true landings.

5.4.2 Index of Abundance from commercial logbook data –vertical line

Self-reported commercial vertical line (handline, electric and hydraulic reel) logbook catch per unit effort (CPUE) data were used to construct a standardized abundance index for black sea bass in the US South Atlantic. Black sea bass data were sufficient to construct an index including the years 1993-2010. Methods and results of the analyses are described in SEDAR25-DW18. Due to a change in the minimum size of black sea bass for commercial harvest, three indices of abundance were constructed. The indices included data from 1) only those years of available data prior to the size change (1993-1998), 2) those years following the size change (1999-2010), and 3) spanning the size change by including all years of available data (1993-2010). The split index was computed as an option for assessment, but the non-split version was recommended for use, with the understanding that size-limits could be accounted for in the assessment model through change in selectivity.

5.4.2.1Methods of Estimation

Black sea bass trips were identified for each analysis using a data subsetting technique (modified from Stephens and MacCall, 2004) intended to restrict the data set to trips with fishing effort in black sea bass habitat. The delta lognormal model approach (Lo et al. 1992) was used to separately construct the three standardized indices of abundance. Parameterization of each model was accomplished using a GLM procedure (GENMOD; Version 8.02 of the SAS System for Windows © 2000. SAS Institute Inc., Cary, NC, USA). The final delta-lognormal models were fit using a SAS macro, GLIMMIX (Russ Wolfinger, SAS Institute). To facilitate visual comparison, each relative standardized index and relative nominal CPUE series was calculated by dividing each value in the series by the mean value of the series.

The final model of the 1993-2010 time series for the binomial on proportion positive trips (PPT) and the lognormal on CPUE of successful trips for each species were:

PPT = Subregion + Year + Days at Sea

LOG(CPUE) = Days at Sea + Subregion + Season + Year + Number of Crew + Days at Sea*Season + Subregion*Year

Relative nominal CPUE, number of trips, proportion positive trips, and relative abundance indices are provided in Tables 5.4.2.1, Table 5.4.2.2 and Table 5.4.2.3 for each of the black sea bass analyses. The delta-lognormal abundance indices constructed for each time series are shown in Figure 5.4.2.1.

Black sea bass standardized catch rates for vertical line vessels appear to have periodic increases in cpue for one to two years on an approximately five year cycle. During the final two years of the time series (2009-10), CPUE was particularly high. Given the variability around those mean cpues, however, it is unclear if that pattern is statistically significant. CPUE may have been constant during the period 1993-2009 with a higher cpue in 2010 only. Caution should be used when making conclusions, based upon a single data source, about black sea bass abundance or possible trends in recruitment.

5.4.2.2 Sampling Intensity

Number of trips sampled is reported in Table 5.4.2.1.

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 (commercial vertical line).

5.4.2.4 Catch Rates

Nominal and standardized catch rates are shown in Figure 5.4.2.1 and are tabulated in Table 5.4.2.1.

5.4.2.5 Uncertainty and Measures of Precision

Coefficients of variation (CV) were in the range 0.20-0.23 over the entire time series.

5.4.2.5 Comments on Adequacy for Assessment

The full time series index was recommended for use by the IWG because changes in minimum size may be accounted for in the assessment model(s). The full time series was recommended for use in plenary session with the caveat that if the index was found to be in conflict with other data sources, the Assessment Panel might consider removing this index from the analysis.

5.4.3 Headboat at-sea observer discard data

Standardized discard rates were generated from the Southeast headboat at-sea observer data for 2005-2010. The analysis included areas from North Carolina through central Florida. The index describes trends in black sea bass discard rates for headboat vessels.

The data used for this index were all trips in the headboat at-sea observer database which discarded black sea bass during 2005-2010. The at-sea observer program occurred during 2004-2010 in North and South Carolina, but did not occur in Florida and Georgia in 2004. In addition, after 2007 the Florida Keys were no longer included in the at-sea observer program.

Trip-level information included state, county, Florida region, year, month, day, dock to dock hours (total trip hours), the number of hours fished (to the nearest half hour), the total number of anglers on the boat, the number of anglers observed on a trip, the number of black sea bass discarded, minimum depth of the fishing trip, and maximum depth of the fishing trip. Depth information was not collected for South Carolina, North Carolina, and Georgia; therefore, it was not used in this analysis.

5.4.3.1Methods of Estimation

Trips to be included in the computation of the index were based on effort directed at black sea bass, assumed here to be all trips with black sea bass discards. The resulting data set, given the methods described above, contained 871 trips with black sea bass discards.

DPUE – Discards per unit effort (DPUE) has units of fish/ angler-hour and was calculated as the number black sea bass discarded divided by the product of the number of observed anglers and the number of hours fished. Changes in the minimum size or bag limit did not result in changes in the computation of the discard index. Changes in these limits can be accounted for with selectivity estimation within the assessment model.

YEAR – A summary of the total number of trips with black sea bass effort per year and distribution of total effort (angler-hr) and discards by factor is provided in Table 5.4.3.1 and Table 5.4.3.2.

STATE –State was defined as Florida/Georgia, North Carolina and South Carolina.

SEASON – The seasons were defined as winter (January, February, March), spring (April, May, June), summer (July, August, September) and fall (October, November, December).

PARTY – Four categories for the number of anglers on a boat were considered in the standardization process. The categories included: ≤20 anglers, 21-30 anglers, 31-50 anglers, and >50 anglers.

DTD – The number of dock to dock hours was included as a factor with ≤8.75 hours representing few hours and >8.75 hours representing many hours. This factor indicates hours fished.

Standardization
A generalized linear model (GLM) approach was used to model DPUE (Lo et al. 1992). Because black sea bass are ubiquitous and headboats tend to target reef fishes in general (i.e., not just the focal species), the index was based only on trips successful for black sea bass. Fits of lognormal and gamma models for positive DPUE including all main factors were compared using AIC values. With DPUE as the dependent variable, the gamma distribution outperformed the lognormal distribution. Thus, the gamma model with all factors was used for computing the index. The positive portion of the model was fitted with all main effects using both the lognormal and gamma distributions. Stepwise AIC with a backwards selection algorithm was then used to eliminate those that did not improve model fit for the chosen model. All predictor variables were modeled as fixed effects (and as factors rather than continuous variables) (Dick 2004; Maunder and Punt 2004).

5.4.3.2 Sampling Intensity

A summary of the total number of trips with black sea bass effort per year and distribution of total effort (angler-hr) and discards is provided in Table 5.4.3.1 and Table 5.4.3.2.

5.4.4.3 Size/Age Data

Length data were collected and available in working paper SEDAR25-DW01.

5.4.3.4 Catch Rates – Number and Biomass

Index results are listed in Table 5.4.3.3 and shown graphically in Figure 5.4.3.1.

5.4.3.5 Uncertainty and Measures of Precision

Coefficients of variation (CV) were in the range 0.10-0.12 over the entire time series and are listed in Table 5.4.3.3.

5.4.3.6 Comments on Adequacy for Assessment

The data workshop accepted this index to be included in the stock assessment. Although the headboat index was already included, the discards modeled in this index represent a different portion (smaller fish) of the population. Because this index represents undersized fish, it may give indications of recruitment patterns prior to when those patterns could be observed in landings data.

5.4.5 Other Data Sources Considered

Several datasets were introduced at the SEDAR 25 data workshop that were considered but not recommended by the IWG or at the plenary session.

5.4.5.1 SCDNR Shallow Water Trawl

The purpose of SEDAR 25 DW-12 was to provide an abundance index of black sea bass to the SEDAR 25 Data Workshop for possible use in stock assessment. Data were collected during SEAMAP (Southeast Area Monitoring and Assessment Program) Shallow Water Trawl Surveys (hereafter referred to as trawl surveys) conducted by SCDNR in the U.S. South Atlantic Bight (SAB) from 1990-2010.

A delta-lognormal (DL) modeling approach was used to develop the index. The submodels of the DL model were built using a backward selection procedure based on type 3 analyses with an inclusion level of significance of $\alpha = 0.05$. Variables that were used in each submodel included year, sampling area (associated with each state, see Anonymous 2007, SEDAR13-DW1), season (Spring: months 4 and 5; Summer: months 6, 7, and 8; and Fall: months 10 and 11; other months were not sampled or due to limited sampling were dropped), bottom temperature, bottom salinity, depth, and the interactions between sampling area and season, and sampling area and year. The variables that were retained in the binomial submodel were year, sampling area, and bottom salinity. For the lognormal submodel for both numbers and biomass, the year, season and sampling area, depth variables were retained as well as the interaction effect of season*sampling area. The interaction effect between sampling area and season on the modeled non-zero CPUE of black sea bass in both numbers and biomass indicated during the summer sampling season both the FL and NC sampling areas have higher non-zero CPUE in both numbers and biomass. QQ plots of the residuals of the lognormal submodels for non-zero CPUE in both numbers and biomass indicated that the lognormal submodel for non-zero CPUE in biomass performed better than that of non-zero CPUE in numbers.

There was an overall decreasing trend over time in the index. The length frequency histogram of black sea bass collected and measured (2,238 individuals measured with a mean total length of 15.85 cm) in this survey indicated that black seabass sampled were generally of three years in age or less.

Discussions surrounding this survey focused on the habitat sampled by the trawl surveys; and even though the index was correctly constructed, the habitat sampled by the trawl surveys (sandy bottom) was considered not that of black sea bass. It was requested in plenary session to further investigate length distribution by year and determine changes in proportion positive trips through time. Results indicated that length distribution were the same through time, suggesting that this survey did not represent a snapshot of a transient use of the habitat from year to year. Questions remained regarding why black sea bass might be sampled outside of their preferred habitat. Sampled abundance might correlate with actual abundance, but might also be dominated by other factors such as predator avoidance, prey movement, or timing of ontogenetic migration from estuaries to the deeper habitat of adults. Because of these uncertainties, the group recommended not using this index. Refer to working paper SEDAR 25 DW-12 for full description of this index.

5.4.5.2SCDNR Charterboat Logbook Program

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.

SCDNR charterboat logbook vessel trips included in this analysis represent fishing trips in nearshore (0-3 miles) and offshore (3+ miles) waters where at least one of a suite of bottom fishes (likely, or even possibly, to occur in association with black sea bass) were caught using hook and line. Data were standardized with delta-GLM standardization method. The predictors included were year, season, and locale. Variance was estimated using a jackknife procedure.

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 fishing trips in nearshore (0-3 miles) and offshore (3+ miles) waters where at least one of a suite of bottom fishes (likely, or even possibly, to occur in association with black seabass) were caught using hook and line. The SCDNR charterboat logbook data represent 20,661 fishing trips in which anglers caught 554,586 black sea bass and harvested 250,076 black sea bass.

The IWG was prepared to recommend this index for use contingent on whether the Recreational Data Working Group felt that 6-pack charter vessels were representative of all general recreational anglers, since charter and private modes were combined into a single fleet for the assessment. During plenary, there was some doubt that 6-pack charter vessels were appropriate to use as a representative of all recreational anglers. Also, there was concern that this index was limited only to waters and vessels out of South Carolina and that it was not representative of the fishery as a whole. Some panel members felt that the population being sampled here was also being sampled by other indices and that this index was redundant. Therefore, the index was dropped from the list of recommended indices. Refer to working paper SEDAR25 DW16 for full description.

5.4.5.3 Commercial Logbook – Trap

Self-reported commercial fish trap (fish pot) logbook catch per unit effort (CPUE) data were used to construct standardized abundance indices for black sea bass in the US South Atlantic. Black sea bass data were sufficient to construct indices including the years 1993-2010. Methods and results of the analyses are described in SEDAR25-DW24. Due to the very high proportion of positive trap trips (98.4%) a lognormal model of positive trips only was used to construct an index of abundance. Number of traps fished was used as the effort measure because the number of trap hauls and trap soak time had been reported inconsistently among fishers to the coastal logbook program.

Parameterization of the 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 final lognormal model was fit using a mixed model (PROC MIXED; Version 9.1 of the SAS System for Windows © 2002-03. SAS Institute Inc., Cary, NC, USA). To facilitate visual comparison, each relative standardized index and relative nominal CPUE series was calculated by dividing each value in the series by the mean value of the series.

The final model of the lognormal on CPUE of successful trips for each species were:

LOG(CPUE) = Vessel ID + Number of traps fished + Days at Sea + Quarter + Year

No long term trend was found in black sea bass standardized catch rates for fish trap vessels. There were occasional increases in CPUE (1996, 2004, 2010, perhaps 1993) over the time series. For much of the index period (1994-2002), however, there was no apparent trend in CPUE (except for the slight increase in 1996). Over the final eight years of the index, mean yearly CPUE increased during 2003-04 and 2009-10, but declined during the period 2005-07. Variability around those yearly means was low (CVs were <0.1), perhaps due to including only positive trips in the model. In addition, only main effects were modeled which tends to decrease the confidence intervals around the mean CPUE.

The IWG was prepared to recommend the commercial trap index for use because of the large spatial and temporal extent of the index (Cape Canaveral to Cape Hatteras; 1993-2010). The various changes in black sea bass minimum size and trap mesh size may be accounted for in the assessment model(s). This index was not recommended for use in plenary session, however, because it was not used in the previous assessments, may be redundant with the fishery independent trap indices, and because of concerns that an index constructed from a directed fishery may not track population trends. Refer to working paper SEDAR25 DW24 for full description of this index.

5.4.5.4 Logbook pot fisherman (FL)

A nominal catch rate analysis developed from one Florida boat shows year to year fluctuations in catch-per pot-hour over the period from 1992 to 2011. There is an increasing trend of apparent abundance over time from 1992 through 2006 when a 2-inch mesh size requirement for the pots was mandated. The regulation change resulted in new gear selectivity and a marked drop in nominal catch rate followed by four years with no apparent trend.

The Indices Workgroup was concerned with the limited geographic coverage and the limited sample size. Thus, the index work group did not recommend these data for inclusion as an index, and this recommendation was accepted by the data workshop panel. For full description refer to working paper SEDAR25 DW 08.

5.5 Consensus Recommendations and Survey Evaluations

Two fishery independent indices were recommended for use in the assessment, and three fishery dependent indices were recommended: MARMAP Chevron trap index, MARMAP Blackfish/FL snapper trap index, recreational headboat index; headboat at sea observer discards index; commercial vertical line logbook index. The last two indices (at-sea-observer and commercial logbook) were not included in the previous assessment, but the working group found compelling reason to include them here. The bar for inclusion was relatively high for this assessment because it is not a benchmark assessment and because a strong fishery independent index (MARMAP chevron trap) is available. Indices sampling coverage are presented in Figure 5.5.1. All the indices that have been computed are compared graphically in Figure 5.5.2. Pearson correlations and significance values (p-value) among indices are presented in Table 5.5.1.

The relative ranking of the reliability of the recommended indices were discussed. Based on these discussions, the indices recommended for the assessment were ranked as follows with discussed issues:

1. MARMAP Chevron Trap
    - Fishery independent, large sample size, long time series, in species' range
2. Headboat index
    - Longest time series
    - Operates in a manner more similar to fishery independent data collection because the fishery targets the snapper-grouper complex in general rather than the focal species specifically
3. Headboat at sea observer discard index
    - Shortest time series
4. Commercial Logbook – Vertical Line
    - Recommended with caveat that it might be discarded at the discretion of the assessment panel
5. MARMAP Blackfish/FL snapper trap
    - Accepted during plenary session but ranking not addressed
    - Combination of two static time series in 1980s
    - Improved single index by combining data from both

5.6 Itemized List of Tasks for Completion following Workshop

- Fill out report card for each index
- Paragraphs of the index including the changes or work done at meeting.

5.7 Literature Cited

Dick, E.J. 2004. Beyond 'lognormal versus gamma': discrimination among error distributions for generalized linear models. Fish. Res. 70:351−366.

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5.8 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	MARMAP Chevron Trap	NC – FL	1990-2010	Number fish / trap hour	Delta glm	Statistical independence of trap samples	Yes
Independent	MARMAP Blackfish/ Antillian	NC-FL	1981-1987	Number fish / trap hour	Delta glm	Combined two gears into one index	Yes
Recreational	Headboat	NC-FL	1979-2010	Weight/hour	glm	Fishery dependent	Yes
Recreational	Headboat at-sea Observer Discard Data	NC-FL	2005-2010	Number fish/ angler-hour	glm	Using discards fishery dependent	Yes
Commercial	SC Charter Boat	SC	1993-2010	Number fish kept/angler hrs	Delta glm	SC only. Fishery dependent. Self-reported.	No
Commercial	Commercial Logbook Vertical Line	NC-FL	1993-2010	Lb kept/hook hour	Delta glm	Fishery dependent. Self reported.	Yes
Commercial	Commercial Logbook Trap	NC-FL	1993-2010	Lb kept/hook hour	Delta glm	Fishery dependent. Effort may not be reported consistently across vessels. Self reported.	No
Independent	SCDNR Shallow Water Trawl	SC	1990-2010	Number fish /tow	Delta glm	Does not sample black sea bass habitat.	No
Commercial	FL Pot fishery	FL	1992-2010	Pounds/Pot Hour	none	One Vessel	No

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

<u>Fishery independent indices</u>

MARMAP
Chevron Trap Index (*Recommended for use*)
Pros:
- Fishery independent random hard bottom survey
- Adequate regional coverage
- Consistent sampling techniques

Blackfish/Florida trap combined (*Recommended for use*)
Pros:
- Fishery independent random hard bottom survey
- Standardized sampling techniques
- Improvement to combine trap type and use as gear factor

Cons:
- Relatively short time series (1981-1987)

SCDNR Shallow Water Trawl (*Not recommended for use*)
Pros:
- Fishery independent random survey
- Juvenile index
- Consistent sampling techniques
- Long time series

Cons:
- Does not sample black sea bass habitat
- Fluctuations in abundance outside of preferred habitat may occur for many reasons not related to overall population abundance (e.g., prey availability, predator avoidance, timing of ontogenetic migrations).

Issues Discussed;
- In plenary session, Industry says they don't catch black sea bass on sandy bottom, where these trawls take place.
- Stated that the length of the series and consistent age comps is an indicator of a successful series.
- Too much uncertainty about whether this index reflects black sea bass juvenile abundance

<u>Fishery dependent indices</u>

Recreational Headboat (*Recommended for use*)
Pros:
- Complete census
- Covers entire management area
- Longest time series available

- Some data are verified by port samplers and observers
- Large sample size
- Non-targeted for focal species, which should minimize changes in catchability relative to fishery dependent indices that target specific species

Cons:

- Fishery dependent
- Little information on discard rates
- Catchability may vary over time or with abundance

Headboat at-sea observer index (*Recommended for use*)
Pros:

- Observer program
- Good discard data (provides amount of discards and length frequency)
- Random sampling design
- More reliable depth recordings in FL
- Broad spatial coverage

Cons:

- Short time series

Commercial Logbook – Vertical Line (*Recommended for use*)
Pros:

- Complete census
- Covers entire management area
- Continuous, 17-year time series
- Large sample size

Cons:

- Fishery dependent
- Data are self-reported and largely unverified
- Catchability may vary over time or with abundance

Issues discussed:

- CIE recommendation to develop logbook index for black sea bass
- Vertical line index recommended for use with the caveat that it could be removed by the AW if it conflicts with other information in the assessment model.

Commercial Logbook - Trap (*Not recommended for use*)
Pros:

- Complete census
- Covers entire management area
- Continuous, 17-year time series
- Large sample size

Cons:

- Fishery dependent
- Effort information may not be reported consistently
- Commercial pot fishermen are able to target black sea bass, which can make time-varying catchability more of a problem than with multispecies fisheries.

Issues discussed:

- Recommended by IWG but not in plenary session
- Industry input: 200 pots is not an unreasonable number of traps but very few fisherman use that many traps

SCDNR Charterboat *(Not recommended for use)*

Pros:

- In the center of the range
- Census
- Standarized index

Cons:

- Just South Carolina
- Fishery dependent

Issues discussed:

- Recommended by IWG conditioned on the recreational group agreeing that the charterboat represents the recreational fleet as a whole. In plenary, there was disagreement that charterboat was representative.

FL pot fishery *(Not recommended for use)*

Pros:

- Explores FL logbook data
- Comparative use regarding additional indices

Cons:

- Duplicative data
- One vessel
- Small spatial coverage

Table 5.3.1 Relative nominal CPUE and relative standardized index of black sea bass abundance from MARMAP chevron trapping data, 1990–2010.

Year	Number of trap sets	Proportion *N* Positive	Relative nominal CPUE	Relative standardized index	CV (index)
1990	274	0.80	1.37	1.59	0.08
1991	222	0.73	1.18	1.09	0.10
1992	253	0.76	1.07	1.26	0.09
1993	285	0.70	0.65	0.71	0.09
1994	292	0.58	0.70	0.68	0.10
1995	416	0.42	0.48	0.37	0.10
1996	331	0.49	0.59	0.72	0.12
1997	264	0.61	0.90	1.03	0.10
1998	290	0.59	0.92	1.05	0.09
1999	218	0.48	1.16	0.72	0.13
2000	217	0.52	1.17	1.04	0.11
2001	163	0.53	1.37	1.30	0.15
2002	183	0.48	0.80	0.69	0.13
2003	109	0.60	0.95	0.97	0.13
2004	167	0.58	1.62	1.78	0.12
2005	182	0.60	1.05	1.04	0.11
2006	196	0.62	1.30	1.12	0.11
2007	203	0.57	0.94	0.88	0.11
2008	186	0.59	0.85	0.88	0.11
2009	272	0.59	0.79	0.83	0.11
2010	252	0.73	1.14	1.24	0.08

Table 5.3.2 Relative nominal CPUE and relative standardized index of black sea bass abundance from MARMAP blackfish and Florida snapper trapping data, 1981–1987.

Year	Number of trap sets	Proportion *N* Positive	Relative nominal CPUE	Relative standardized index	CV (index)
1981	462	0.79	0.99	1.07	0.06
1982	375	0.84	1.42	1.21	0.08
1983	511	0.90	0.97	1.10	0.06
1984	641	0.86	0.91	0.94	0.05
1985	473	0.81	1.08	1.09	0.06
1986	337	0.77	0.80	0.78	0.07
1987	238	0.82	0.84	0.81	0.09

Table 5.4.1.1 The relative nominal WPUE, number of positive black sea bass trips, standardized index, CV and CV scaled to a maximum of 0.3 (as an example) for black sea bass in the headboat fishery in the South Atlantic.

Year	Trips	Relative nominal WPUE	Standardized index	CV (index)	CV (index) Scaled to 0.3 max
1979	2186	1.827	2.170	0.02	0.229
1980	2828	1.690	1.848	0.02	0.225
1981	2228	2.029	2.128	0.021	0.244
1982	2693	2.058	2.186	0.021	0.239
1983	2624	1.988	1.980	0.022	0.251
1984	2652	1.765	1.839	0.02	0.232
1985	2650	1.813	1.986	0.018	0.211
1986	3519	1.460	1.627	0.017	0.198
1987	3626	1.428	1.557	0.017	0.198
1988	3472	1.284	1.501	0.016	0.181
1989	2951	1.190	1.231	0.019	0.218
1990	2803	1.043	1.224	0.017	0.2
1991	2667	0.982	1.006	0.019	0.222
1992	3489	0.698	0.685	0.019	0.212
1993	3279	0.474	0.438	0.018	0.209
1994	2696	0.589	0.485	0.021	0.241
1995	2448	0.620	0.500	0.021	0.238
1996	2221	0.693	0.522	0.023	0.263
1997	1674	0.770	0.565	0.026	0.3
1998	2723	0.590	0.504	0.021	0.239
1999	2830	0.608	0.561	0.019	0.216
2000	2888	0.536	0.413	0.02	0.225
2001	2606	0.564	0.433	0.02	0.233
2002	2347	0.558	0.415	0.023	0.258
2003	2645	0.566	0.475	0.021	0.241
2004	3144	0.688	0.656	0.019	0.216
2005	2489	0.603	0.579	0.021	0.236
2006	2737	0.660	0.618	0.021	0.241
2007	2490	0.521	0.376	0.026	0.293
2008	2242	0.444	0.300	0.025	0.286
2009	2876	0.475	0.462	0.022	0.249
2010	3443	0.786	0.728	0.021	0.239

Table 5.4.1.2 Number of headboat trips reporting black sea bass landings by region.

Year	NC	SC	GA-N. FL	Total
1979	140	1141	905	2186
1980	222	1216	1390	2828
1981	198	1140	890	2228
1982	287	1361	1045	2693
1983	243	1176	1205	2624
1984	214	1300	1138	2652
1985	216	1366	1068	2650
1986	206	1633	1680	3519
1987	239	1818	1569	3626
1988	281	1566	1625	3472
1989	131	1386	1434	2951
1990	151	1342	1310	2803
1991	239	1352	1076	2667
1992	276	1433	1780	3489
1993	212	1515	1552	3279
1994	272	1385	1039	2696
1995	250	1262	936	2448
1996	249	1133	839	2221
1997	133	947	594	1674
1998	214	1267	1242	2723
1999	234	1167	1429	2830
2000	378	1355	1155	2888
2001	288	1175	1143	2606
2002	277	1120	950	2347
2003	352	1137	1156	2645
2004	419	1217	1508	3144
2005	287	970	1232	2489
2006	259	1190	1288	2737
2007	152	1241	1097	2490
2008	233	1108	901	2242
2009	238	1325	1313	2876
2010	384	1362	1697	3443
Total	7874	41106	39186	88166

Table 5.4.1.3 Distribution of total effort (hours), number of trips, landings, and average nominal WPUE for all factor from the headboat logbook survey.

Year	Trips	Hours	Landings (pounds)	Average Nominal WPUE
1979	2186	16230	278037	17.13
1980	2828	21275	337032	15.84
1981	2228	16100	306186	19.02
1982	2693	19180	370034	19.29
1983	2624	18340	341796	18.64
1984	2652	19065	315418	16.54
1985	2650	18710	318061	17.00
1986	3519	24720	338324	13.69
1987	3626	26250	351513	13.39
1988	3472	25750	309833	12.03
1989	2951	20925	233517	11.16
1990	2803	20465	200071	9.78
1991	2667	20145	185383	9.20
1992	3489	27250	178403	6.55
1993	3279	25450	113080	4.44
1994	2696	20670	114174	5.52
1995	2448	18255	106035	5.81
1996	2221	17230	111870	6.49
1997	1674	12440	89768	7.22
1998	2723	21355	118063	5.53
1999	2830	22400	127637	5.70
2000	2888	21980	110512	5.03
2001	2606	20055	106117	5.29
2002	2347	18035	94370	5.23
2003	2645	19920	105622	5.30
2004	3144	23915	154235	6.45
2005	2489	18745	105911	5.65
2006	2737	20505	126912	6.19
2007	2490	18475	90212	4.88
2008	2242	16685	69400	4.16
2009	2876	22030	98092	4.45
2010	3443	26210	193242	7.37

Region	Trips	Hours	Landings (pounds)	Average Nominal WPUE
NC	7874	66170	841936	12.72
SC	41106	258165	3511623	13.60
GA-FL	39186	334425	1745300	5.22

Table 5.4.1.3. (continued).

Trip type	Trips	Hours	Landings (pounds)	Average Nominal WPUE
full	43586	435860	3309279	7.59
half	44580	222900	2789580	12.51
Num. Anglers	**Trips**	**Hours**	**Landings (pounds)**	**Average Nominal WPUE**
Less than 20	19972	157115	1100728	7.01
20-32	23427	178210	1484999	8.33
33-49	21804	165495	1559289	9.42
Greater than 49	22963	157940	1953844	12.37
Max. Num Anglers	**Trips**	**Hours**	**Landings (pounds)**	**Average Nominal WPUE**
Less than 25	6287	54590	459442	8.42
25-49	17250	136120	1105750	8.12
50-74	21175	170380	1399674	8.22
75-99	24134	177970	1698459	9.54
100 or more	19320	119700	1435534	11.99
Season	**Trips**	**Hours**	**Landings (pounds)**	**Average Nominal WPUE**
fall	9983	81620	573987	7.03
spring	31997	238945	2323645	9.72
summer	36469	260290	2637958	10.13
winter	9717	77905	563269	7.23

Table 5.4.2.1. Full time series (1993-2010) of commercial vertical line relative nominal CPUE, number of trips, proportion positive trips, and standardized abundance index for black sea bass in the South Atlantic.

YEAR	Normalized Nominal CPUE	Trips	Proportion Successful Trips	Standardized Index	Lower 95% CI (Index)	Upper 95% CI (Index)	CV (Index)
1993	0.720563	1,071	0.68	1.04566	0.682611	1.601799	0.215687
1994	0.95139	1,967	0.69	0.971267	0.645773	1.460822	0.20622
1995	0.939677	1,950	0.53	0.613684	0.400022	0.941467	0.216453
1996	0.820392	1,477	0.54	0.630099	0.408621	0.971622	0.219108
1997	0.748086	1,776	0.62	0.797507	0.52474	1.212061	0.211606
1998	0.964602	1,801	0.68	1.098211	0.725438	1.662539	0.20958
1999	1.405986	1,238	0.64	1.149422	0.745998	1.771009	0.218695
2000	1.119476	1,007	0.57	0.788	0.498677	1.245181	0.231795
2001	0.729371	1,478	0.60	0.842406	0.548661	1.293418	0.216878
2002	0.845932	1,524	0.56	0.784195	0.507315	1.212189	0.22037
2003	1.389748	1,176	0.57	0.998496	0.63979	1.558317	0.22534
2004	1.326806	1,110	0.59	1.412633	0.905688	2.203331	0.225031
2005	1.01238	1,044	0.58	1.010472	0.644155	1.585106	0.227999
2006	1.144549	1,014	0.59	0.899179	0.569793	1.418976	0.231104
2007	0.704136	1,167	0.45	0.550369	0.344111	0.880258	0.238087
2008	0.633502	1,147	0.50	0.726998	0.459564	1.15006	0.232371
2009	0.997483	875	0.60	1.157559	0.734961	1.82315	0.230087
2010	1.545919	480	0.73	2.523842	1.585367	4.017858	0.23566

Table 5.4.2.2 The 1993-1998 (8 inch minimum size) series of commercial vertical line relative nominal CPUE, number of trips, proportion positive trips, and standardized abundance index for black sea bass in the South Atlantic.

YEAR	Normalized Nominal CPUE	Trips	Proportion Successful Trips	Standardized Index	Lower 95% CI (Index)	Upper 95% CI (Index)	CV (Index)
1993	0.809855	1,050	0.70	1.123760	0.944643	1.336840	0.086978
1994	1.101898	1,865	0.72	1.134838	0.993594	1.296162	0.066532
1995	1.127417	1,792	0.56	0.784639	0.661587	0.930578	0.085446
1996	1.019019	1,393	0.57	0.836254	0.697161	1.003097	0.091146
1997	0.8634	1,709	0.64	0.911352	0.781742	1.062451	0.076815
1998	1.078411	1,740	0.70	1.209157	1.043892	1.400586	0.073583

Table 5.4.2.3 The 1999-2010 (10 inch minimum size) series of commercial vertical line relative nominal CPUE, number of trips, proportion positive trips, and standardized abundance index for black sea bass in the South Atlantic.

YEAR	Normalized Nominal CPUE	Trips	Proportion Successful Trips	Standardized Index	Lower 95% CI (Index)	Upper 95% CI (Index)	CV (Index)
1999	1.324897	1,240	0.63	1.058996	0.876078	1.280104	0.512835
2000	0.984528	1,064	0.55	0.757392	0.604526	0.948912	0.381087
2001	0.699951	1,519	0.60	0.820021	0.685394	0.981092	0.270934
2002	0.817559	1,589	0.55	0.721388	0.598287	0.869819	0.316457
2003	1.275184	1,186	0.56	0.970097	0.785921	1.197433	0.493593
2004	1.301483	1,152	0.59	1.363917	1.109416	1.676802	0.503772
2005	0.916099	1,088	0.58	0.973739	0.785042	1.207792	0.3546
2006	1.014016	1,039	0.57	0.784301	0.626139	0.982413	0.392501
2007	0.669036	1,189	0.44	0.504814	0.392013	0.650072	0.258967
2008	0.614621	1,178	0.48	0.649809	0.513088	0.82296	0.237905
2009	0.903952	909	0.60	1.060857	0.845848	1.330519	0.349898
2010	1.478674	478	0.73	2.33467	1.790356	3.04447	0.572359

Table 5.4.3.1 The number of trips by state across years that were observed at sea by the headboat observer program. Florida and Georgia (FL/GA) were combined due to low sample sizes for GA.

Year	FL/GA	NC	SC	Total
2005	39	70	42	151
2006	33	66	34	133
2007	39	72	41	152
2008	58	64	31	153
2009	47	57	32	136
2010	52	69	25	146
Total	268	398	205	871

Table 5.4.3.2 Distribution of total effort (angler-hr) and discards by factor in the headboat at sea observer data set used to construct the standardized index.

Factor	Effort (angler-hr)	Discards
Year		
2005	7968.5	3465
2006	6250.5	4230
2007	8048.5	5806
2008	9091	5195
2009	7006	6599
2010	8740.5	11749
Season		
fall	9009.5	7973
spring	15452	10629
summer	16448.5	12795
winter	6195	5647
State		
FL/GA	21867.5	13676
NC	16949.5	16142
SC	8288	7226
Party size		
<20	8377	8455
20-30	10209	12423
31-50	14803.5	8665
>50	13715.5	7501
Dock to Dock		
few	30899.5	31657
many	16205.5	5387

Table 5.4.3.3 The relative nominal DPUE, number of trips with positive discards, standardized index, and CV for the black sea bass headboat at sea observer data in the south Atlantic.

Year	Relative nominal DPUE	N	Standardized index	CV (index)
2005	0.556234	151	0.5577	0.111418
2006	0.865678	133	0.808044	0.108747
2007	0.922769	152	0.992652	0.123286
2008	0.730979	153	0.886894	0.118531
2009	1.204866	136	1.061863	0.117956
2010	1.719474	146	1.692846	0.101116

Table 5.5.1 Pearson correlation analysis (p-value) for indices recommended for use.

	MARMAP Chevron	Headboat	Headboat At-sea Discard	Commercial logbook vertical line	MARMAP Blackfish/FL trap combined
MARMAP Chevron	1	0.557(0.0086)	0.418(0.4089)	0.454(0.0585)	
Headboat		1	0.397(0.4353)	0.689(0.002)	0.956(0.0008)
Headboat At-sea Discard			1	0.824(0.043)	
Commercial logbook vertical line				1	
MARMAP Blackfish/FL trap combined					1

5.9 Figures

Figure 5.3.1 Relative standardized index (solid line, filled circles, 95% error bars) and relative nominal index (dashed) of black sea bass CPUE from MARMAP chevron trapping, 1990–2010.

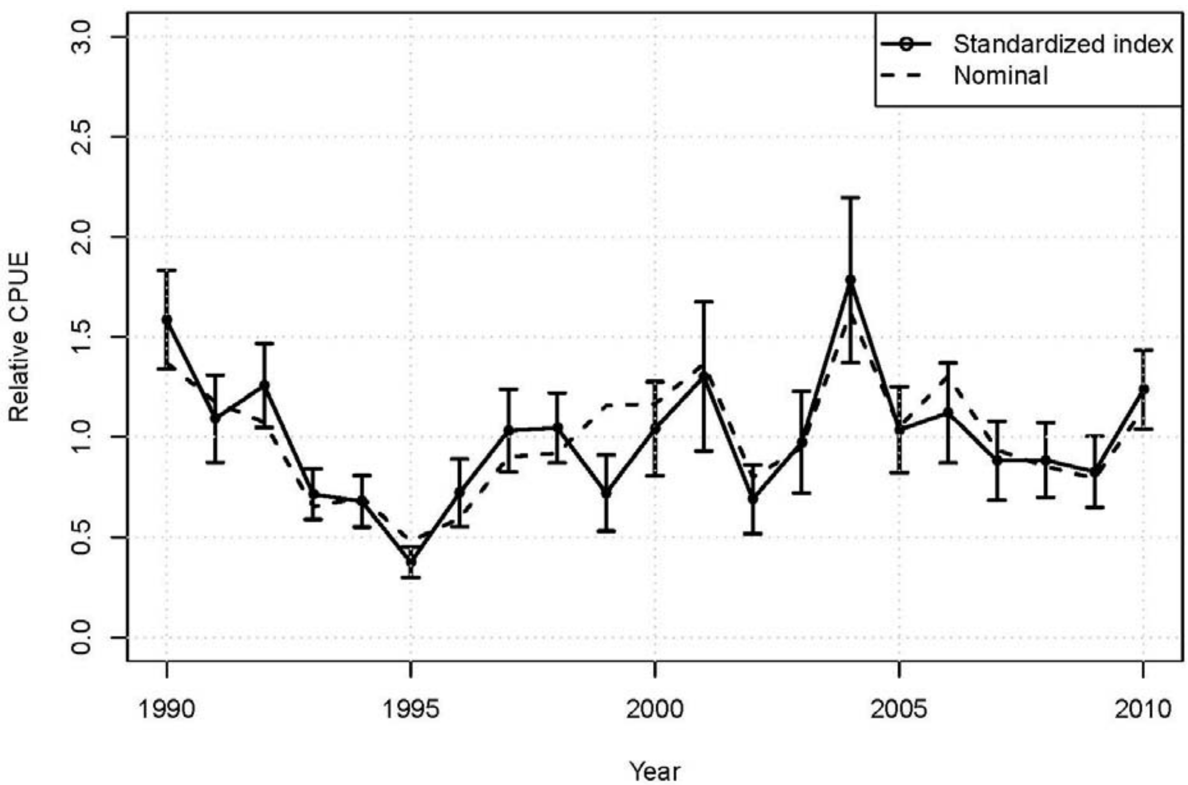


Figure 5.3.2 Relative standardized index (solid line, open circles, 95% error bars) and relative nominal index (dashed) of black sea bass CPUE in MARMAP blackfish and Florida snapper traps, 1981–1987.

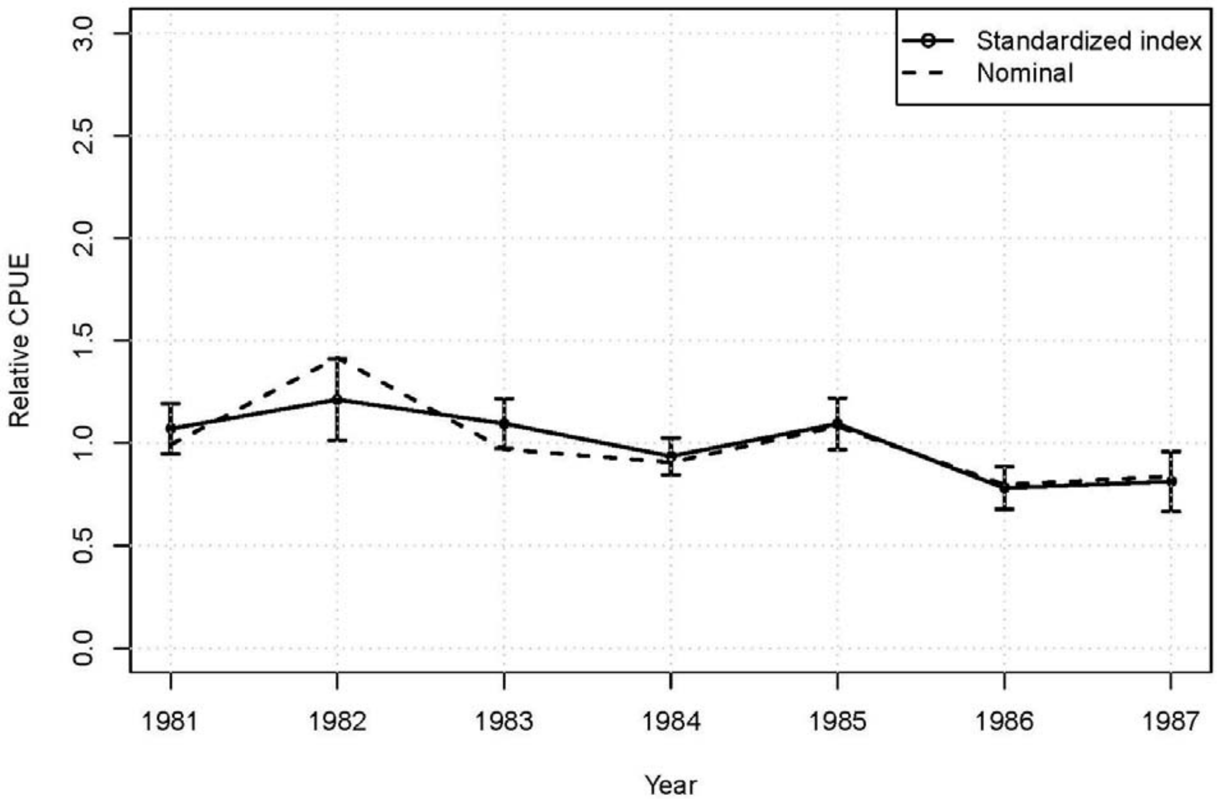


Figure 5.4.1.1 Spatial sampling strata from the headboat survey off the southeast Atlantic coast of the U.S. Areas 2, 3, 9, and 10 were combined as NC, areas 4 and 5 were combined as SC, and areas 6, 7, and 8 were combined as GA-FL. Areas 1, 11, 12, and 17 were not included in the development of the black sea bass WPUE.

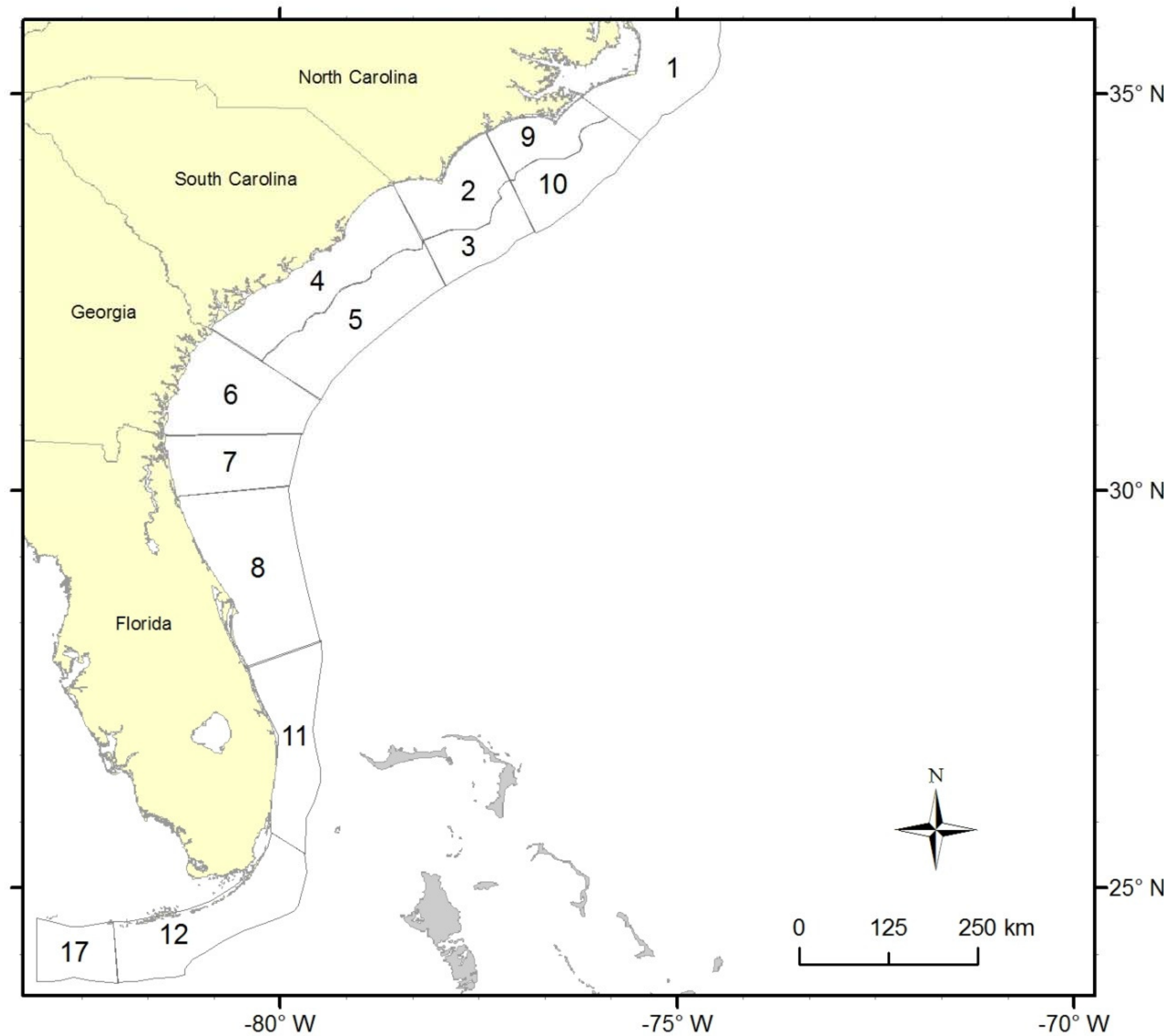


Figure 5.4.1.2 The standardized and nominal headboat index computed for black sea bass in the south Atlantic during 1979-2010. Scaling the CV to a maximum of 0.3 is shown as an example of how the assessment panel may decide to adjust the CV.

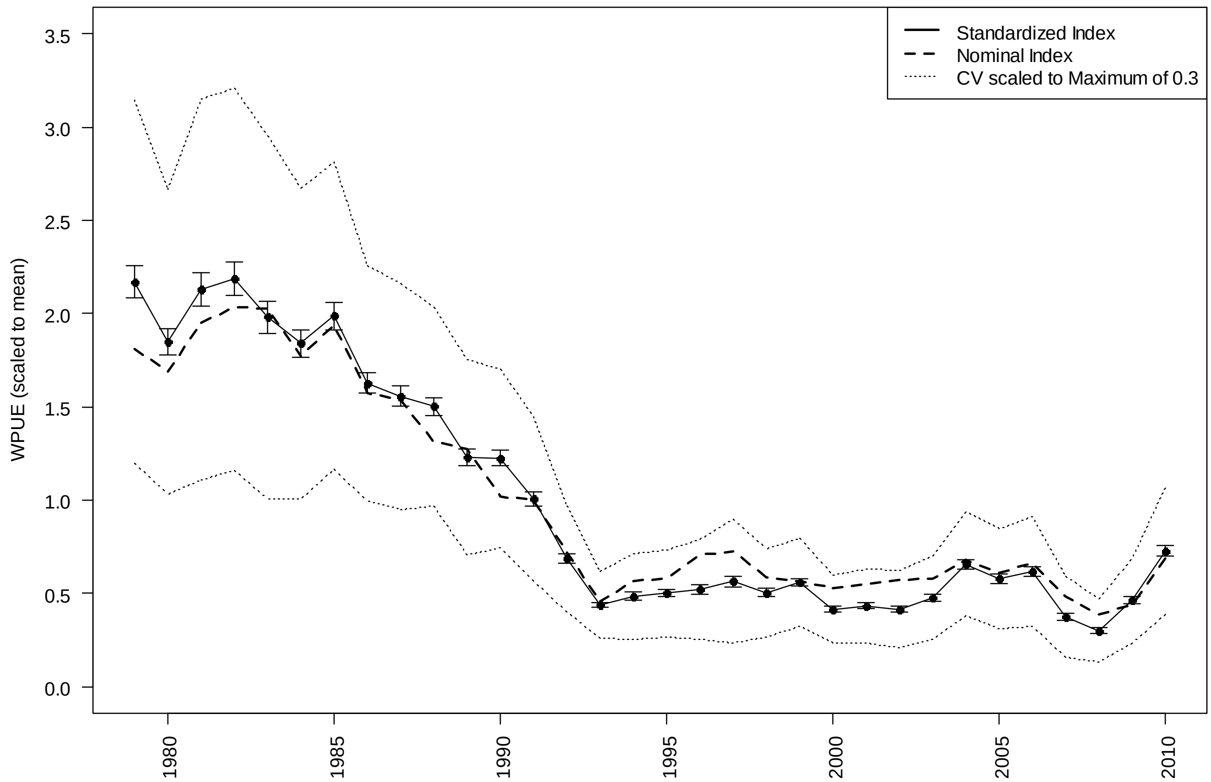


Figure 5.4.2.1 The full time series (1993-2010) black sea bass commercial vertical line index and the indices split due to the black sea bass minimum size change (1998/1999). Confidence intervals of the 1993-2010 index are also provided.

Figure 5.4.3.1 The standardized and nominal DPUE index computed for black sea bass in the south Atlantic from headboat at sea observer data during 2005-2010.

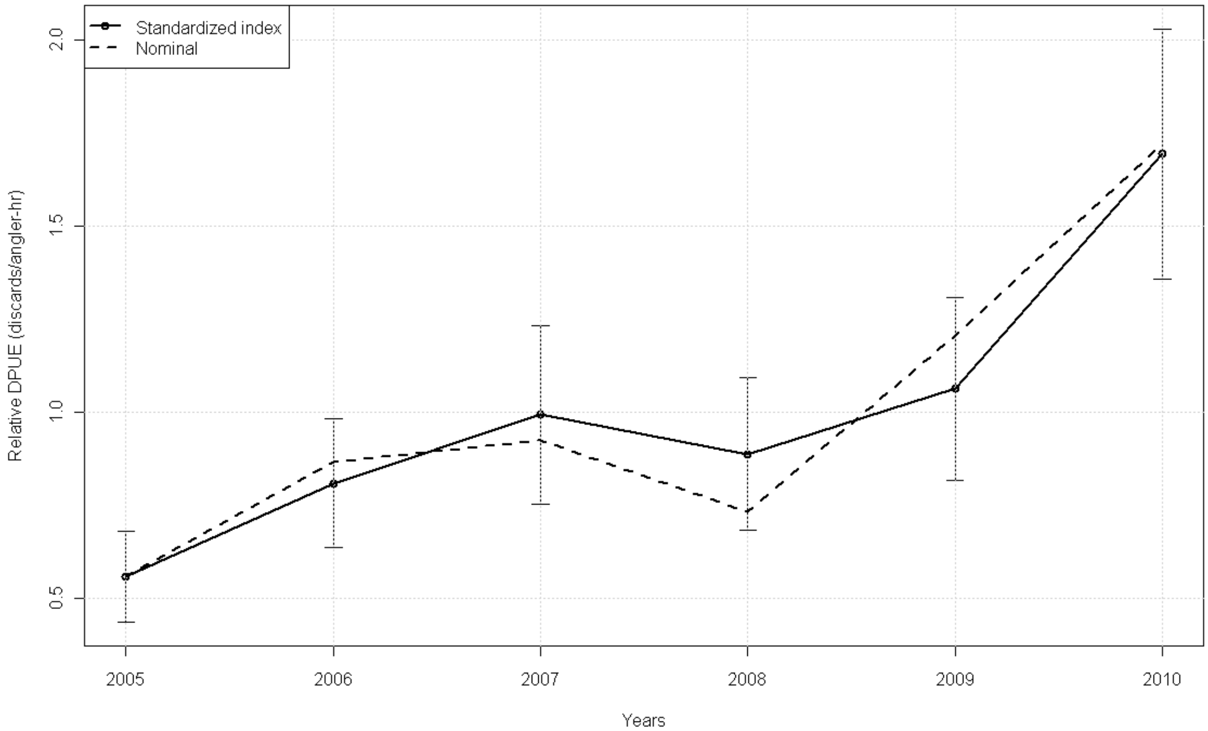


Figure 5.5.1 Sampling coverage for each tilefish indices for SEDAR 25.

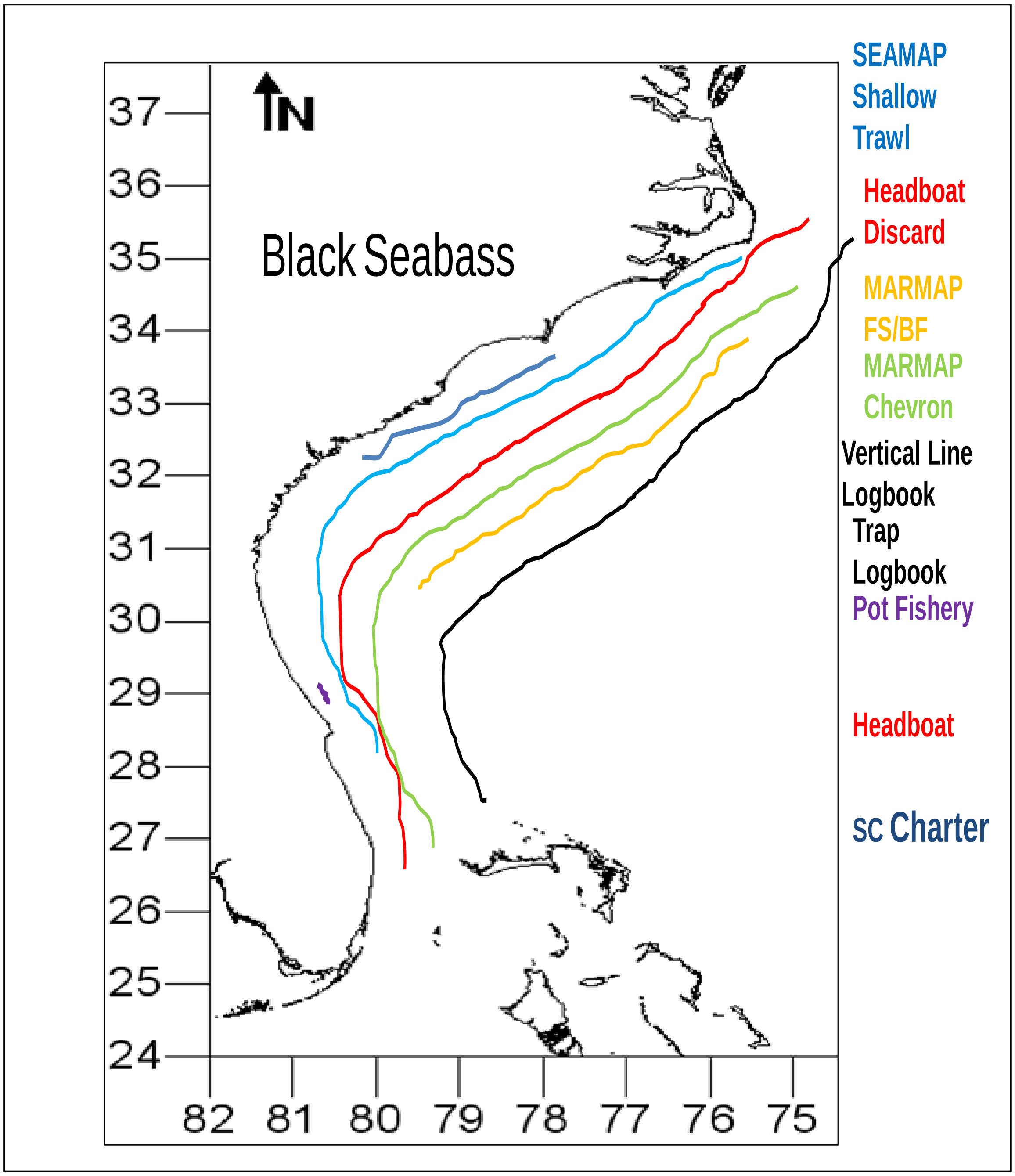
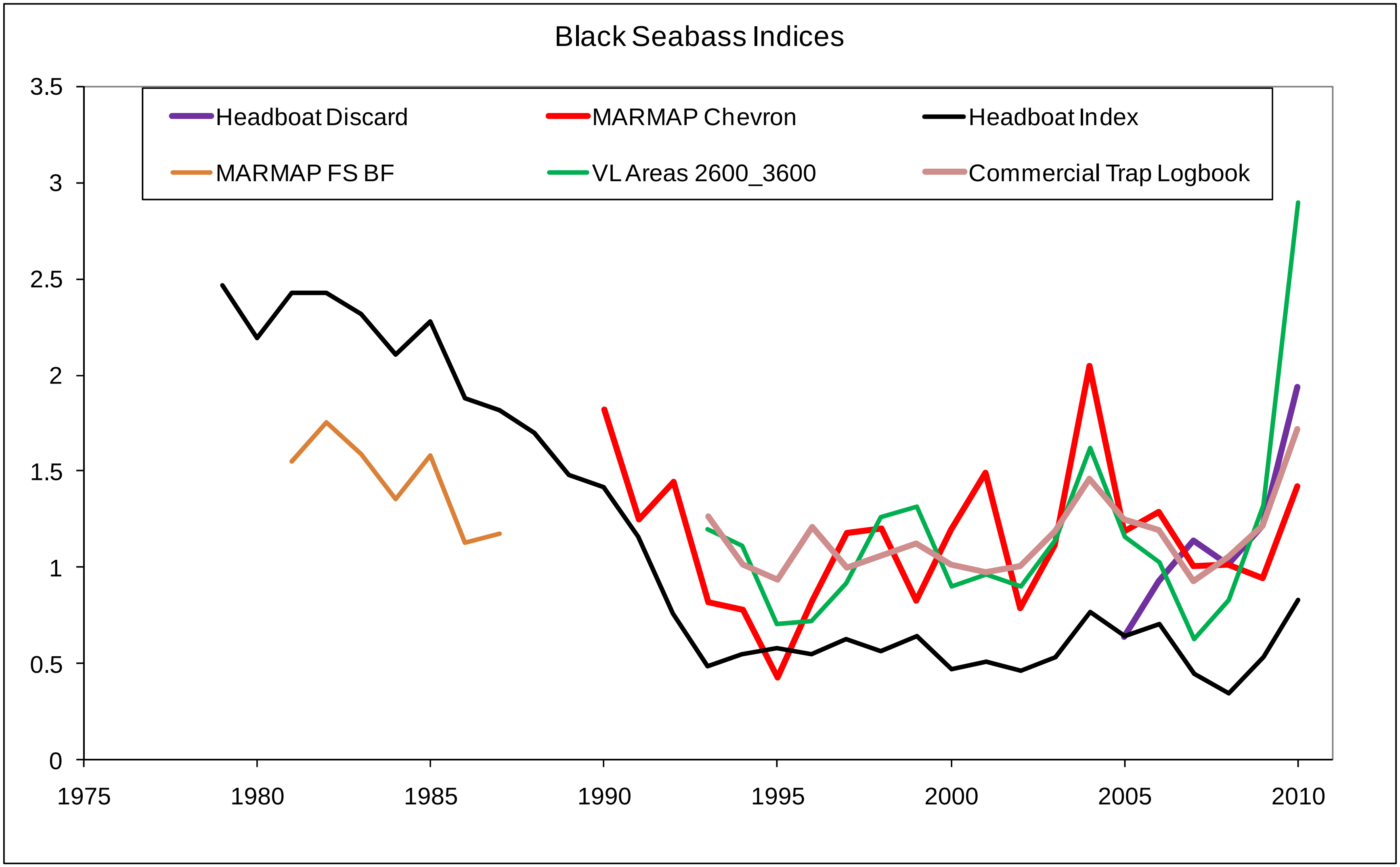


Figure 5.5.2 All indices (scaled to respective means) discussed and considered for use for black sea bass assessment at SEDAR 25.



6 Analytic Approach

6.1 Overview

The lead analyst for this species is Kyle Shertzer and the data compiler is Eric Fitzpatrick.

6.2 Suggested analytic approach given the data

The assessment models to be used for SEDAR 25 black sea bass are specified in the Assessment Workshop Terms of Reference. BAM and ASPIC models will be developed.

7 Research Recommendations

7.1 Life History

- Investigate the movements and migrations of black sea bass using otolith microchemistry, genetic studies, and expanding tagging studies.
- Investigate the movement and mixing of larval and juvenile black sea bass within the U.S. South Atlantic region.
- Sampling to include the entire Southeast region over a longer time period.
- Analyze size- or age-specific spawning frequency and spawning seasonality.
- Further develop the tagging model described by Rudershausen et al. (2010) to address the assumptions of the model.
- Depth appears to have an effect on the discard mortality rate. Currently depth-specific discard rates and estimates of discard numbers are not available. There is very little depth specific information on the private recreational fleet.
- Temperature and seasonality of discard mortality should be investigated.
- Circle hooks are now required by the SAFMC for fishermen operating in the snapper grouper fishery. The impact of this regulation cannot currently be incorporated into the discard mortality rate.
- Venting is not required in the South Atlantic but it is required in the Gulf of Mexico for snapper grouper fishermen. Research should be conducted on a variety of recompression techniques to determine the most effective method for reducing discard mortality.

7.2 Commercial Statistics

- The Commercial Workgroup recommends study of migration patterns, focusing on fish movements around the Cape Hatteras, NC area.
- Additionally, the group would suggest determining the impact/landings of the historical foreign fleet in the South Atlantic.
- Finally, collection of better spatial information in the fishery to determine potential localized depletion effects is recommended.

7.3 Recreational Statistics

- Increase sample size of at-sea observers and dockside validation for HB mode.
- Increase proportion of fish with biological data within MRFSS sampling.
- Development of hard part sampling coordinated with intercept surveys.
- Continue development of standardized method for calculating incomplete weight data
- Quantify historical fishing photos for use in future SEDARS.
- Develop method for capturing depth at capture within MRFSS At-Sea observer program and Headboat Survey.
- Conduct study looking at current compliance rates in logbook programs, develop recommendations for improving them, including increased education directed toward effect of not reporting accurately.
- Continued development of electronic reporting of headboat logbook for full implementation
- Continued development of higher degree of information of condition of released fish e.g. FL as the model
- Continued evaluation of methodology for mandatory reporting in the For-hire sector e.g. Gulf MRIP Pilot

7.4 Indices

- None submitted.

Appendix 1 - Index Report Cards

Appendix 5.1 MARMAP chevron trap
Appendix 5.2 MARMAP blackfish and FL trap combined
Appendix 5.3 Headboat
Appendix 5.4 Headboat Observer Discards
Appendix 5.5 Commercial logbook -Vertical Line
Appendix 5.6 SCDNR shallow water trawl survey
Appendix 5.7 Commercial logbook trap
Appendix 5.8 SC Charterboat

SEDAR

Southeast Data, Assessment, and Review

SEDAR 25

South Atlantic Black Sea Bass

SECTION III: Assessment Workshop Report

September 2011

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

1 Workshop Proceedings

1.1 Introduction

1.1.1 Workshop Time and Place The SEDAR 25 Assessment workshop for black sea bass (*Centropristis striata*) and tilefish (*Lopholatilus chamaeleonticeps*) was conducted as a workshop held June 21-23, 2011 in at the NMFS Laboratory in Beaufort, NC and five webinars. The webinars were held July 12, July 25, August 19, and September 2, 2011.

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 BAM and ASPIC assessment models.
   - Document all input data, assumptions, and equations for each model.
   - Include a model configuration consistent with the SEDAR 2 benchmark as subsequently updated ("Continuity run") incorporating additional data observations.
3. Provide estimates of stock population parameters.
   - Include fishing mortality, abundance, biomass, selectivity, stock-recruitment relationship, etc
   - 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 models.
6. Provide estimates for SFA criteria consistent with applicable FMPs, proposed FMPs and Amendments, other ongoing or proposed management programs, and National Standards.
   - Evaluating existing or proposed SFA benchmarks as specified in the management summary.
   - Recommend proxy values when necessary.
7. Provide declarations of stock status relative to SFA benchmarks.
8. Perform a probabilistic analysis of proposed reference points, stock status, and yield.
   - Provide the probability of overfishing at various harvest or exploitation levels.
   - Provide a probability density function for biological reference point estimates.
   - If the stock is overfished, provide the probability of rebuilding within mandated time periods as described in the management summary or applicable federal regulations.

9. Project future stock conditions (biomass, abundance, and exploitation) and evaluate the rebuilding schedule. Stock projections shall be developed in accordance with the following:

   A) If stock remains overfished and has not reached Bmsy:
      F=Frebuild (max that rebuild in allowed time)
      Landings = 847,000 (current fixed harvest rebuilding level)
      Fixed harvest value that rebuilds in the allotted time.

   B) If stock is neither overfished nor overfishing
      F=Fcurrent, F=Fmsy, F=Ftarget (OY)

   C) If stock is neither overfished nor overfishing
      F=Fcurrent, F=Fmsy, F=Ftarget (OY)

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. No later than September 23, 2011 complete the Assessment Workshop Report (Section III of the SEDAR Stock Assessment Report).

1.1.3 List of Participants

Appointee	Function	Affiliation
PANELISTS		
Kyle Shertzer	Lead analyst, BSB	SEFSC Beaufort
Erik Williams	Lead analyst, GT	SEFSC Beaufort
Kevin Craig	Assessment team, BSB	SEFSC Beaufort
Kate Andrews	Assessment team, GT	SEFSC Beaufort
Eric Fitzpatrick	Data compiler, BSB	SEFSC Beaufort
Rob Cheshire	Data compiler, GT	SEFSC Beaufort
John Boreman	SSC member	SAFMC
Chip Collier	SSC member	SAFMC
Andy Cooper	SSC member	SAFMC
Marcel Reichert	SSC member	SAFMC
Nikolai Klibanski	Academic	UNCW
COUNCIL REPRESENTATIVES		
Tom Burgess	Council member	SAFMC
Ben Hartig	Council member	SAFMC
APPOINTED OBSERVERS		
Tony Austin	Commercial	NC, BSB
Bobby Cardin	Commercial	FL, GT
Kenny Fex	Commercial	NC, BSB
Jimmy Hull	Commercial	FL, BSB
Joe Klosterman	Commercial	FL, GT
STAFF		
Kari Fenske	Coordinator	SEDAR
Rachael Silvas	Admin assistant	SEDAR
Gregg Waugh	Fishery biologist	SAFMC
Mike Errigo	Fishery biologist	SAFMC
Tyree Davis	IT support	SEFSC
John Carmichael		SAFMC
Brian Cheuvront		SAFMC
Jessica Stephen		SERO
Andy Strelcheck		SERO
Dan Carr		SEFSC
Gretchen Bath Martin		SEFSC
Jeff Kipp		SEFSC

Jennifer Potts	SEFSC
Lew Coggins	SEFSC

ATTENDEES

Samantha Port-Minner
Rusty Hudson
Peter Barile
Renzo Taschieri
Frank Hester
Brian Paul
Joey Ballenger
Paul Nelson

1.1.4 List of Assessment Workshop Working Papers

SEDAR25-AW01	Is pooling MARMAP chevron trap data justifiable for Black Sea Bass (*Centropristis striata*) in the South Atlantic Region?	Hull and Hester 2011

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 data are described in section 2 of the AW report.

2. Develop BAM and ASPIC assessment models.
   - Document all input data, assumptions, and equations for each model.
   - Include a model configuration consistent with the SEDAR 2 benchmark as subsequently updated ("Continuity run") incorporating additional data observations.

   BAM and ASPIC implementations are described in section 3 of the AW report. Input data are documented in the DW report and in section2 of the AW report. Model assumptions and equations of BAM are documented in SEDAR25-RW03, and those of ASPIC in the Prager (2005). A continuity run of BAM was configured as a sensitivity run of the SEDAR 25 implementation.

3. Provide estimates of stock population parameters.
   - Include fishing mortality, abundance, biomass, selectivity, stock-recruitment relationship, etc
   - 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 precision are described in section 3 of the AW report.

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

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

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

Estimated management benchmarks and alternatives are provided in section 3 of the AW report.

7. Provide declarations of stock status relative to SFA benchmarks.

Estimates of stock status are provided 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.

Probabilistic analyses were performed as part of the rebuilding projections, described in section 3 of the AW report.

9. Project future stock conditions (biomass, abundance, and exploitation) and evaluate the rebuilding schedule. Stock projections shall be developed in accordance with the following:

A) If stock remains overfished and has not reached Bmsy:

F=Frebuild (max that rebuild in allowed time)

Landings = 847,000 (current fixed harvest rebuilding level)

Fixed harvest value that rebuilds in the allotted time.

B) If stock is neither overfished nor overfishing

F=Fcurrent, F=Fmsy, F=Ftarget (OY)

C) If stock is neither overfished nor overfishing

F=Fcurrent, F=Fmsy, F=Ftarget (OY)

Projections are described in section 3 of the AW report. The scenarios examined fall into category A (overfished) and included various assumptions about the level of overage in 2011.

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 3.4.

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.

An Excel file of model output was supplied. Input data were included in this file, with the exception of observed landings (removed to avoid any possibility of breaching confidentiality requirements). Most of those values, however, were reported in the DW report and in section 2 of the AW report.

12. No later than TBD complete the Assessment Workshop Report (Section III of the SEDAR Stock Assessment Report).

This report was provided within the specified time frame.

2 Data Review and Update

Processing of data for the assessment is described in the SEDAR 25 Black Sea Bass Data Workshop Report. This section summarizes the data input for the Beaufort Assessment Model (BAM) base run and describes additional processing prior to and during the Assessment Workshop (AW). The data were also used for the surplus production model. A summary of the model input is given in Tables 1-25. Age and length composition samples sizes have been updated accordingly (Table 1).

2.1 Additional Data

Several data elements were discussed and recommended at the SEDAR 25 DW but were not completed by the Data Workshop (DW) panel. These data elements were addressed prior to the AW and included in the DW report. The following refer to data updates that have not been included in the DW report but were included as input to the BAM base model.

2.2 Life History

To estimate age at sex transition, logistic regressions were fit to data for males and females (n = 36,231) collected by the MARMAP program on US South Atlantic black sea bass from 1978 to 2010. In the DW report, the logistic regressions modeled the relationship between the percentages of males at fractional age. For the BAM base model, calendar age was required. These updated data are presented in Table 6.

Similarly, female maturity was reported in fractional age in the DW report. For the BAM base model, calendar age was required. These updated data are presented in Table 7.

Generation time is not typically computed at the DW but may be required for stock projections. Generation time was estimated from Eq. 3.4 in Gotelli (1998).
$G=Pl_xb_xx/Pl_xb_x$
where summation was over ages x=0 through 11 (by which age cumulative survival is near zero), l_x is the number of fish at age starting with 1 fish at age zero and decrementing based on natural mortality only, and b_x is per capita birth rate at age. We substitute the product of $P_{fx}M_{fx}f_x$ for b_x in this equation, where P_{fx} is the proportion female at age, M_{fx} is the proportion of mature females at age, and f_x is expected fecundity at age. This weighted average of age yields an estimate for generation time of 8 years (rounded up from 7.7 yrs.).

The number of annual spawning events per mature female was estimated to be 31 (Danson 2009). This value was not presented in the DW report, but is reported here because of its use in the assessment as a multiplier to predict population fecundity.

2.3 Commercial Landings

Commercial landings were presented by gear (handlines, pots, trawl and other) in the DW report. For the BAM base model input, landings from the ‘other’ category were combined with pots. Also, trawl landings after 1990 were combined with pots (Table 9). Trawling was banned in

1989 in waters under South Atlantic Fisheries Management Council (SAFMC) jurisdiction, but a relatively small amount of trawl landings remained.

2.4 Commercial Discards

In the DW report, commercial discard estimates were combined and reported as total discards by year for two fisheries (vertical line and pots). Also, these data were combined for years 2009 and 2010, which had open and closed seasons. For the BAM base model, these data were input separately by fishery and open or closed season. Discard estimates by fishery are presented in Table 10.

2.5 Commercial Length Composition

Due to low sample sizes, length compositions from the pot fishery were pooled across years (1984, 1988, 1990, 1991) and weighted by sample sizes (Table 17). These data were used to estimate selectivity during the 8” size limit.

2.6 MARMAP

In the DW report, length and age compositions from MARMAP sampling were not included, however these data were incorporated into the model (Table 21-22).

Prior to the AW, MARMAP staff identified that the number of trips for age compositions being reported represented the total number of MARMAP trips. The updated number of trips used in the BAM base model represents the number of positive black sea bass trips sampled.

In SEDAR-02, MARMAP age composition data were not used because of non-random sampling. In SEDAR-25, this issue of non-random sampling has been addressed for black sea bass otoliths collected by MARMAP chevron traps (see SEDAR25-RW07). However, the issue could not be addressed for fish collected by MARMAP blackfish/snapper traps, and thus age composition data from this gear were excluded from the assessment, with the exception of the composition from 1983 when all fish were aged.

2.7 Indices

The index working group and the DW panel discussed the unrealistically small variance associated with the fit of the headboat index. The working group discussed options for inflating the variance. The group recommended that the assessment panel consider increasing the CV to reflect the uncertainty in the data as well as the model fit.

Uncertainty in the headboat index was adjusted at the AW. The CV’s prior to 1984 were set to 0.3 and the CV after 1984 to 0.15. The value 0.15 was chosen to scale to the largest CV (0.15) from the MARMAP chevron trap index, and that value was doubled for years prior to the implementation of regulations, when reporting by headboat captains was suggested to be less precise. The value of CV= 0.3 is larger than CV’s for all other indices in all other years.

Pearson correlations and significance values (p-values) among indices are presented in Table 24. In addition, correlations of first differences among indices were computed at the AW and are presented in Table 25.

References

Gotelli, N.J. 1998. A Primer of Ecology 2nd Edition. Sinauer Associates, Inc., Sunderland, MA, 236p.

Danson. B.L. 2009. Estimating reef fish reproductive productivity on artificial and natural reefs off the Atlantic coast of the southeastern United States. M.S. Thesis, College of Charleston.

Table 1. Black sea bass length and age composition sample sizes (numbers of fish and trips) sampled by fishery or survey. A strikethrough indicates data that were excluded from the BAM, either because of low sample size or because age composition data took priority over length composition data.

	MRIP				Headboat				Headboat At-sea discard	
	Length comps		Age comps		Length comps		Age comps		Length Comps	
Year	N.fish	N.trip	N.fish	N.trip	N.fish	N.trip	N.fish	N.trip	N.fish	N.trip
1978					2353	330				
1979					1654	201				
1980					2418	276				
1981	194	97			3035	388				
1982	417	222			3686	439				
1983	174	113			5732	625				
1984	285	163			6086	694				
1985	488	222			5842	638				
1986	380	175			6549	682				
1987	668	387			6442	787				
1988	604	339			4253	545	~~7~~	~~3~~		
1989	605	445			3836	427	~~5~~	~~3~~		
1990	440	372			5772	481	~~25~~	~~11~~		
1991	334	220					85	43		
1992	655	492					60	31		
1993	494	345			3948	389	~~7~~	~~5~~		
1994	349	376			4215	350	~~5~~	~~2~~		
1995	363	281			3325	283	~~2~~	~~1~~		
1996	492	281			3212	285	~~27~~	~~12~~		
1997	306	301	~~8~~	~~1~~	3678	379	~~4~~	~~2~~		
1998	452	302	379	57	4364	462	~~75~~	~~9~~		
1999	706	315			4114	402				
2000	473	250			3419	333	~~1~~	~~1~~		
2001	775	452	~~9~~	~~4~~	2982	329				
2002	504	264	~~84~~	~~29~~	1957	304	~~23~~	~~15~~		
2003	998	413	~~77~~	~~21~~			105	31		
2004	1283	597	567	46			234	53		
2005	1039	395	139	36			480	104	2773	151
2006	1042	524	~~173~~	~~17~~			1,066	247	3913	133
2007	897	368	~~37~~	~~4~~			671	271	5408	152
2008	616	355	~~2~~	~~1~~			309	161	5038	153
2009	667	402	~~19~~	~~2~~			517	218	6388	136
2010	1125	542	~~29~~	~~4~~			1,029	341	11055	146

Table 1. (cont.)

	Pot				Handline			
	Length comps*		Age comps		Length comps		Age comps	
Year	N.fish	N.trip	N.fish	N.trip	N.fish	N.trip	N.fish	N.trip
1978								
1979								
1980								
1981								
1982								
1983	~~258~~	~~7~~			~~54~~	~~6~~	~~50~~	~~6~~
1984	757	9			1,528	66	~~2~~	~~66~~
1985					1,248	56	~~2~~	~~56~~
1986					695	45		
1987	~~694~~	~~5~~			804	50		
1988	1,080	12			814	52		
1989	~~265~~	~~3~~			695	30		
1990	770	9			1,140	43		
1991	470	7			812	46		
1992	~~477~~	~~5~~			~~404~~	~~26~~		
1993	~~115~~	~~2~~			398	32		
1994	~~250~~	~~3~~			~~570~~	~~41~~	77	41
1995					235	39		
1996					~~239~~	~~23~~		
1997					~~149~~	~~17~~	~~22~~	~~17~~
1998	~~319~~	~~1~~			~~184~~	~~20~~	~~29~~	~~20~~
1999					802	42		
2000	~~416~~	~~3~~			410	47		
2001	~~268~~	~~2~~			937	73		
2002	~~916~~	~~6~~			~~1,039~~	~~61~~	81	61
2003	~~1,238~~	~~7~~			~~394~~	~~53~~	443	53
2004	~~1,015~~	~~8~~	~~127~~	~~8~~	~~1,527~~	~~98~~	609	98
2005	~~670~~	~~16~~	~~423~~	~~16~~	~~1,339~~	~~116~~	836	116
2006	~~1,115~~	~~26~~	~~785~~	~~26~~	~~1,214~~	~~98~~	809	98
2007	~~1,958~~	~~47~~	2124	47	~~860~~	~~93~~	779	93
2008	~~1,945~~	~~79~~	2098	79	~~629~~	~~90~~	553	90
2009	~~2,218~~	~~89~~	2252	89	~~622~~	~~71~~	693	71
2010	~~1,883~~	~~74~~	1572	74	~~631~~	~~91~~	586	91

*due to low sample size by year, pooled 1984, 1988, 1990, 1991; weighted by sample size, used to estimate selectivity during 8" limit

Table 2. Meristic conversions for black sea bass caught off the U. S. South Atlantic.

Source	Equation	n	a	b	r^2	Range of data
SCDNR MARMAP Survey (SEDAR2)	TL = SL	34,382	-10.83	1.4	1	
SCDNR MARMAP Survey and Headboat Survey	Whole weight (g) = Total Length (mm): $W = aL^b$	174,214	$5.02*10^{-5}$	2.8	0.9	W:1 – 3370 L: 7 - 643

Table 3. Von Bertalanffy growth model parameter estimates for all data combined, corrected for minimum size limit bias (Diaz et al. 2004).

Parameter	Estimate	Standard Error
Linf	495.9	154.5
k	0.177	0.118
t_0	-0.92	0.61
CV	0.18	0.04

Table 4. Age-specific natural mortality for black sea bass from the South Atlantic using Lorenzen (2005) method for all data combined, scaled 0.38. Lorenzen mortality curve sensitivity runs scaled to a range of M from 0.27 to 0.53. SEDAR 2 used a point estimate of M = 0.3 for all ages.

Age	Scaled Lorenzen base	Scaled Lorenzen low	Scaled Lorenzen high
0	0.932	0.658	1.292
1	0.637	0.450	0.884
2	0.509	0.360	0.706
3	0.438	0.310	0.608
4	0.393	0.278	0.545
5	0.363	0.256	0.503
6	0.341	0.241	0.472
7	0.324	0.229	0.450
8	0.312	0.220	0.433
9	0.302	0.214	0.419
10	0.295	0.208	0.409
11	0.289	0.204	0.401

Table 5. Equation describing the relationship between the natural log of batch fecundity and whole fish weight in black sea bass collected off the Carolinas during 2000-2009. Data from the MARMAP program (Danson 2009) and an on-going study at the University of North Carolina at Wilmington (UNCW; Klibansky, Unpubl. data) were combined.

X	a	SE	b	SE	Adjusted r^2	F	N	Range of X	Equation
Whole fish weight (g)	7.69	0.17	0.0053	0.0006	0.38	87.15*	142	101-616	log (y) = a + bx

* p < 0.0001

Table 6. Percentage of observed and predicted transition to male black sea bass by calendar age.

Age	# Female	# Male	# Total	Obs. % Male	Pred % Male	Pred % Female
0	5	1	6	0.1667	0.0365	0.963
1	1034	187	1221	0.1532	0.0817	0.9180
2	6315	1655	7970	0.2077	0.1728	0.8270
3	8115	4793	12908	0.3713	0.3289	0.671
4	3308	4994	8302	0.6015	0.5349	0.465
5	781	3093	3874	0.7984	0.7297	0.27
6	163	1136	1299	0.8745	0.8637	0.136
7	38	453	491	0.9226	0.9370	0.063
8	14	114	128	0.8906	0.9721	0.028
9	1	26	27	0.9630	0.9879	0.012
10	0	4	4	1.0000	0.9948	0.005
11	0	1	1	1.0000	0.9978	0.002

Table 7. Percentage of observed and predicted mature female black sea bass by calendar age.

Age	# Immature	# Mature	# Total	Obs. % Mature	Pred % Mature
0	43	5	48	0.1042	0.0000
1	622	1199	1821	0.6584	0.5190
2	494	7541	8035	0.9385	0.8947
3	62	10333	10395	0.9940	0.9853
4	7	4745	4752	0.9985	0.9981
5	1	1318	1319	0.9992	0.9998
6	0	270	270	1.0000	1.0000
7	0	68	68	1.0000	1.0000
8	0	18	18	1.0000	1.0000
9	0	4	4	1.0000	1.0000
10	0	1	1	1.0000	1.0000
11					1.0000

Table 8. Discard mortality point estimates recommended by SEDAR 25 Data Workshop.

Gear	Point estimate	Minimum	Maximum
Hook and Line	0.07	0.04	0.15
Trap (1 1/2" panel)	0.05	-	0.15
Trap (2" panel)	0.01	-	0.15

Table 9. Black sea bass landings (1000 lb whole weight) as input into the BAM. Pots includes other and trawl landings post-1990 due to low landings. Horizontal dashed line indicates first year of the assessment model.

	GEAR				
	Commercial			Recreational	
Year	Handlines	Pots	Trawl	headboat	MRFSS
1950	305.0	0.1	0.3		
1951	217.0	0.0	1.5		
1952	158.0	0.1	1.0		
1953	113.3		1.1		
1954	70.8		0.9		
1955	38.9	3.1	0.3		
1956	62.2	5.2	2.6		
1957	59.5	8.9	1.1		
1958	61.8	8.4	1.0		
1959	87.9	9.8	1.4		
1960	95.2	37.4	1.8		
1961	120.9	510.3	38.4		
1962	85.9	518.9	28.3		
1963	126.2	393.8	17.5		
1964	88.4	463.7	18.9		
1965	90.3	467.4	22.5		
1966	78.6	711.9	21.3		
1967	69.3	1361.1	22.8		
1968	97.1	723.6	19.7		
1969	64.4	1275.7	16.0		
1970	51.0	1511.8	12.8		
1971	72.0	1045.4	8.1		
1972	93.8	1145.2	3.6		
1973	58.8	872.2	4.0		
1974	102.5	1292.5	4.5		
1975	93.1	799.4	14.9	965.1	
1976	72.3	367.8	16.2	612.3	
1977	62.4	284.3	42.7	614.8	
1978	118.7	134.4	31.8	532.2	
1979	140.5	676.7	27.3	571.2	

1980	107.9	888.2	25.4	617.8	
1981	163.8	1028.2	32.2	678.3	462.1
1982	150.9	788.2	20.6	701.4	1725.6
1983	145.7	484.3	8.5	690.3	671.9
1984	194.5	410.4	17.8	661.1	1805.9
1985	164.1	395.8	23.8	568.1	1080.9
1986	163.3	502.5	22.3	536.8	541.5
1987	149.3	403.4	7.5	616.5	1037.1
1988	236.6	513.7	21.2	635.2	2890.6
1989	248.5	517.7	13.5	478.0	1269.6
1990	258.7	684.6	13.6	379.6	602.2
1991	267.2	616.6		286.2	841.8
1992	226.6	546.3		215.9	723.0
1993	188.9	508.0		143.0	611.6
1994	213.9	531.0		132.4	625.7
1995	141.5	413.3		127.6	721.3
1996	128.0	511.8		146.5	718.4
1997	162.3	541.0		147.7	577.5
1998	221.1	450.8		142.5	393.6
1999	187.5	501.3		192.6	312.5
2000	92.8	407.6		144.6	287.1
2001	88.7	492.7		172.0	567.5
2002	98.0	419.8		123.3	312.6
2003	91.6	484.2		134.1	415.0
2004	107.1	626.4*		237.6	1026.7
2005	66.9	384.4		179.7	626.4
2006	62.2	483.3*		174.1	624.3
2007	54.9	351.9*		162.1	560.6
2008	57.6	360.0		99.3	398.4
2009	87.7	564.6		163.2	277.3
2010	64.4	408.3		289.2	526.8

*Pots and other combined, excluding trawl due to confidentiality

Table 10. Black sea bass discards (1000 fish) as input into the BAM.

	Recreational		Commercial
Year	Headboat	MRFSS	Handline/Pots[1]
1981[2]		1126.0[2]	
1982[2]		1008.8[2]	
1983[2]		418.9[2]	
1984[2]		1039.7[2]	
1985[2]		1021.9[2]	
1986	256.4	832.5	
1987	290.3	1200.7	
1988	96.5	1027.2	
1989	70.3	933.5	
1990	4.9	505.9	
1991	160.0	829.8	
1992	63.1	850.1	
1993	27.2	775.6	153.9
1994	81.8	1347.8	216.5
1995	56.6	931.2	187.7
1996	68.3	782.6	207.8
1997	63.5	1120.7	189.2
1998	46.3	825.0	191.4
1999	105.5	1190.0	176.7
2000	94.2	1672.6	132.2
2001	108.9	1809.1	160.6
2002	75.9	1235.5	68.9
2003	68.6	1397.7	170.8
2004	105.4	2688.0	118.2
2005	125.8	2147.2	185.5
2006	123.2	2549.0	242.6
2007	109.0	3224.8	64.5
2008	69.9	2382.4	67.1
2009	104.1	2096.9	119.2[3]
2010	165.1	2888.1	56.7[3]

[1] Commercial gears combined due to confidentiality

[2] Combination of headboat and MRFSS

[3] Combined discards from open and closed seasons

Table 11. Headboat length compositions as input into the BAM base model.

Headboat	N.fish	N.trips	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
1978	2353	330	0.0000	0.0000	0.0000	0.0000	0.0007	0.0073	0.0128	0.0151	0.0313	0.0502	0.0480	0.0639	0.0587	0.0599	0.0627	0.0583	0.0596	0.0550	0.0483	0.0424
1979	1654	201	0.0000	0.0000	0.0000	0.0000	0.0018	0.0044	0.0062	0.0107	0.0250	0.0447	0.0513	0.0686	0.0666	0.0991	0.0746	0.0743	0.0610	0.0545	0.0446	0.0481
1980	2418	276	0.0000	0.0000	0.0000	0.0007	0.0015	0.0074	0.0093	0.0231	0.0401	0.0700	0.0898	0.0875	0.0695	0.0665	0.0696	0.0759	0.0601	0.0496	0.0502	0.0335
1981	3035	388	0.0000	0.0006	0.0009	0.0040	0.0017	0.0074	0.0230	0.0260	0.0379	0.0554	0.0731	0.0903	0.0759	0.0851	0.0806	0.0706	0.0540	0.0527	0.0359	0.0445
1982	3686	439	0.0000	0.0006	0.0002	0.0006	0.0011	0.0017	0.0051	0.0170	0.0357	0.0612	0.0780	0.0703	0.0748	0.0780	0.0752	0.0740	0.0696	0.0640	0.0473	0.0435
1983	5732	625	0.0000	0.0000	0.0000	0.0000	0.0012	0.0034	0.0074	0.0151	0.0314	0.0611	0.0854	0.0824	0.0704	0.0795	0.0833	0.0750	0.0675	0.0556	0.0483	0.0402
1984	6086	694	0.0000	0.0000	0.0000	0.0000	0.0002	0.0004	0.0014	0.0026	0.0083	0.0257	0.0559	0.0943	0.1051	0.0876	0.0840	0.0784	0.0713	0.0612	0.0585	0.0479
1985	5842	638	0.0000	0.0000	0.0002	0.0004	0.0001	0.0010	0.0030	0.0085	0.0172	0.0408	0.0888	0.0962	0.0944	0.0810	0.0756	0.0767	0.0699	0.0629	0.0535	0.0474
1986	6549	682	0.0000	0.0003	0.0001	0.0000	0.0004	0.0024	0.0047	0.0108	0.0234	0.0545	0.0978	0.1089	0.0919	0.0862	0.0859	0.0798	0.0695	0.0612	0.0444	0.0403
1987	6442	787	0.0000	0.0000	0.0002	0.0001	0.0001	0.0013	0.0018	0.0062	0.0238	0.0668	0.0955	0.0998	0.0952	0.0868	0.0863	0.0768	0.0642	0.0612	0.0420	0.0393
1988	4253	545	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0026	0.0042	0.0222	0.0496	0.0691	0.0730	0.0947	0.0869	0.0909	0.0827	0.0605	0.0595	0.0564	0.0527
1989	3836	427	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0023	0.0023	0.0219	0.0499	0.0697	0.0874	0.0690	0.0973	0.0684	0.0689	0.0761	0.0590	0.0621	0.0514
1990	5772	481	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0032	0.0096	0.0322	0.0413	0.0906	0.0877	0.1347	0.0922	0.1069	0.0712	0.0565	0.0521	0.0464
1993	3948	389	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0011	0.0082	0.0212	0.0512	0.0747	0.0999	0.1066	0.1016	0.0915	0.0751	0.0738	0.0452
1994	4215	350	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0003	0.0015	0.0029	0.0275	0.0471	0.0599	0.1174	0.0865	0.1001	0.0827	0.0895	0.0721	0.0485
1995	3325	283	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0011	0.0005	0.0090	0.0331	0.0709	0.1050	0.0853	0.1068	0.0817	0.0774	0.0660	0.0690	0.0461
1996	3212	285	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0005	0.0005	0.0036	0.0174	0.0675	0.0723	0.1419	0.1242	0.0991	0.1107	0.0520	0.0609	0.0515
1997	3678	379	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0000	0.0031	0.0103	0.0318	0.0727	0.0863	0.0953	0.0882	0.0958	0.0746	0.0739	0.0785
1998	4364	462	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0003	0.0057	0.0146	0.0338	0.0779	0.0861	0.0684	0.0818	0.0849	0.0842	0.0766	0.0816
1999	4114	402	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0003	0.0022	0.0090	0.0130	0.0341	0.0859	0.1486	0.1425	0.1276	0.0869
2000	3419	333	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0022	0.0109	0.0228	0.0785	0.1456	0.1906	0.1385	0.0990
2001	2982	329	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0005	0.0005	0.0012	0.0087	0.0394	0.0936	0.1574	0.2103	0.1289	0.0933
2002	1957	304	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0013	0.0004	0.0019	0.0104	0.0432	0.0883	0.1434	0.1581	0.1355	0.0918

Headboat	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50+
1978	0.0404	0.0417	0.0357	0.0316	0.0272	0.0258	0.0213	0.0194	0.0152	0.0115	0.0133	0.0094	0.0094	0.0049	0.0050	0.0038	0.0033	0.0027	0.0013	0.0017	0.0013
1979	0.0450	0.0258	0.0261	0.0329	0.0210	0.0202	0.0193	0.0128	0.0130	0.0098	0.0096	0.0053	0.0019	0.0038	0.0071	0.0043	0.0026	0.0027	0.0003	0.0009	0.0003
1980	0.0326	0.0209	0.0275	0.0232	0.0156	0.0094	0.0197	0.0081	0.0077	0.0043	0.0077	0.0043	0.0013	0.0031	0.0027	0.0029	0.0002	0.0031	0.0007	0.0000	0.0004
1981	0.0361	0.0268	0.0285	0.0135	0.0126	0.0138	0.0112	0.0066	0.0059	0.0058	0.0039	0.0028	0.0031	0.0032	0.0017	0.0016	0.0007	0.0015	0.0003	0.0002	0.0006
1982	0.0319	0.0328	0.0192	0.0190	0.0184	0.0232	0.0083	0.0063	0.0069	0.0077	0.0068	0.0065	0.0063	0.0051	0.0011	0.0001	0.0012	0.0001	0.0002	0.0000	0.0008
1983	0.0346	0.0270	0.0299	0.0188	0.0177	0.0110	0.0113	0.0093	0.0065	0.0040	0.0062	0.0035	0.0038	0.0025	0.0021	0.0016	0.0016	0.0009	0.0002	0.0001	0.0003
1984	0.0405	0.0322	0.0305	0.0213	0.0191	0.0160	0.0124	0.0111	0.0057	0.0073	0.0053	0.0032	0.0034	0.0036	0.0027	0.0011	0.0003	0.0004	0.0002	0.0003	0.0005
1985	0.0391	0.0265	0.0249	0.0236	0.0168	0.0124	0.0102	0.0061	0.0072	0.0037	0.0022	0.0030	0.0014	0.0016	0.0014	0.0007	0.0007	0.0004	0.0000	0.0000	0.0003
1986	0.0322	0.0257	0.0176	0.0107	0.0126	0.0088	0.0076	0.0047	0.0039	0.0028	0.0028	0.0011	0.0017	0.0015	0.0013	0.0002	0.0005	0.0011	0.0000	0.0002	0.0007
1987	0.0315	0.0243	0.0190	0.0172	0.0144	0.0080	0.0076	0.0085	0.0061	0.0049	0.0046	0.0014	0.0014	0.0015	0.0008	0.0002	0.0007	0.0000	0.0003	0.0000	0.0002
1988	0.0385	0.0307	0.0244	0.0237	0.0175	0.0098	0.0088	0.0098	0.0085	0.0064	0.0037	0.0046	0.0023	0.0011	0.0017	0.0006	0.0001	0.0005	0.0012	0.0005	0.0007
1989	0.0427	0.0377	0.0323	0.0251	0.0148	0.0165	0.0154	0.0086	0.0040	0.0050	0.0025	0.0028	0.0028	0.0008	0.0009	0.0005	0.0005	0.0000	0.0016	0.0000	0.0000
1990	0.0329	0.0306	0.0298	0.0164	0.0148	0.0138	0.0076	0.0057	0.0063	0.0048	0.0030	0.0025	0.0021	0.0014	0.0013	0.0015	0.0004	0.0000	0.0001	0.0000	0.0002
1993	0.0484	0.0319	0.0353	0.0195	0.0228	0.0184	0.0145	0.0113	0.0108	0.0064	0.0064	0.0050	0.0069	0.0022	0.0035	0.0024	0.0010	0.0010	0.0005	0.0006	0.0011
1994	0.0461	0.0472	0.0289	0.0382	0.0208	0.0162	0.0144	0.0123	0.0101	0.0071	0.0058	0.0044	0.0032	0.0022	0.0020	0.0010	0.0012	0.0017	0.0004	0.0004	0.0003
1995	0.0444	0.0370	0.0278	0.0279	0.0161	0.0200	0.0155	0.0128	0.0088	0.0085	0.0069	0.0081	0.0036	0.0030	0.0023	0.0014	0.0019	0.0002	0.0006	0.0003	0.0007
1996	0.0310	0.0319	0.0270	0.0217	0.0165	0.0151	0.0118	0.0099	0.0045	0.0042	0.0060	0.0028	0.0046	0.0038	0.0019	0.0020	0.0011	0.0008	0.0004	0.0000	0.0008
1997	0.0519	0.0489	0.0387	0.0352	0.0210	0.0171	0.0184	0.0130	0.0095	0.0059	0.0090	0.0059	0.0040	0.0045	0.0018	0.0023	0.0002	0.0015	0.0001	0.0004	0.0002
1998	0.0483	0.0360	0.0391	0.0328	0.0301	0.0256	0.0205	0.0136	0.0100	0.0092	0.0114	0.0068	0.0039	0.0027	0.0043	0.0029	0.0031	0.0017	0.0010	0.0009	0.0002
1999	0.0656	0.0561	0.0463	0.0418	0.0254	0.0217	0.0195	0.0121	0.0133	0.0095	0.0103	0.0070	0.0079	0.0035	0.0038	0.0023	0.0013	0.0014	0.0005	0.0004	0.0000
2000	0.0666	0.0554	0.0376	0.0253	0.0273	0.0216	0.0149	0.0165	0.0082	0.0055	0.0091	0.0041	0.0052	0.0032	0.0056	0.0020	0.0016	0.0014	0.0008	0.0000	0.0000
2001	0.0723	0.0500	0.0337	0.0304	0.0181	0.0152	0.0090	0.0098	0.0062	0.0037	0.0049	0.0014	0.0049	0.0010	0.0027	0.0009	0.0005	0.0004	0.0000	0.0004	0.0005
2002	0.0693	0.0581	0.0447	0.0343	0.0344	0.0248	0.0101	0.0149	0.0093	0.0049	0.0082	0.0029	0.0052	0.0019	0.0008	0.0000	0.0002	0.0013	0.0000	0.0000	0.0000

Table 12. MRFSS length compositions as input into the BAM base model.

Year	N.fish	N.trips	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
1981	194	97	0.0000	0.0000	0.0000	0.0000	0.0000	0.0167	0.0142	0.0641	0.1703	0.1634	0.1278	0.0769	0.0530	0.0545	0.0488	0.0333	0.0673	0.0253	0.0253	0.0174
1982	417	222	0.0000	0.0000	0.0000	0.0000	0.0000	0.0198	0.0107	0.0106	0.0064	0.0152	0.0289	0.0147	0.0369	0.0228	0.0371	0.1061	0.1406	0.0644	0.0283	0.0768
1983	174	113	0.0000	0.0000	0.0000	0.0000	0.0000	0.0421	0.0241	0.0507	0.0711	0.0445	0.0582	0.0274	0.0081	0.0848	0.0218	0.0928	0.0958	0.0506	0.0657	0.0537
1984	285	163	0.0000	0.0000	0.0000	0.0000	0.0000	0.0164	0.0023	0.0086	0.0045	0.0540	0.0088	0.0256	0.0244	0.0074	0.0142	0.0409	0.0689	0.0958	0.0838	0.0648
1985	488	222	0.0000	0.0000	0.0000	0.0000	0.0000	0.0289	0.0271	0.0361	0.0320	0.1376	0.0176	0.0424	0.0152	0.0860	0.0537	0.0596	0.0653	0.0492	0.0250	0.0583
1986	380	175	0.0000	0.0000	0.0000	0.0000	0.0000	0.0166	0.0010	0.0143	0.0078	0.0622	0.0287	0.0417	0.0325	0.1852	0.0271	0.0460	0.0389	0.0303	0.0234	0.0890
1987	668	387	0.0000	0.0000	0.0000	0.0000	0.0000	0.0023	0.0017	0.0044	0.0058	0.0306	0.0565	0.0699	0.0885	0.0811	0.1304	0.0518	0.0411	0.0636	0.0264	0.0728
1988	604	339	0.0000	0.0000	0.0000	0.0000	0.0000	0.0008	0.0000	0.0000	0.0044	0.0009	0.0039	0.0028	0.0115	0.0228	0.0224	0.0504	0.1034	0.1021	0.0150	0.0253
1989	605	445	0.0000	0.0000	0.0000	0.0000	0.0000	0.0080	0.0018	0.0070	0.0089	0.0175	0.0163	0.0300	0.0467	0.0410	0.0401	0.0497	0.0552	0.0410	0.0934	0.1197
1990	440	372	0.0000	0.0000	0.0000	0.0000	0.0000	0.0049	0.0004	0.0184	0.0117	0.0052	0.0817	0.0507	0.0445	0.0521	0.0239	0.1224	0.1418	0.0315	0.0378	0.0563
1991	334	220	0.0000	0.0000	0.0000	0.0000	0.0000	0.0004	0.0009	0.0032	0.0024	0.0083	0.0237	0.0919	0.0676	0.0705	0.0698	0.0349	0.0663	0.0943	0.0605	0.0881
1992	655	492	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0053	0.0022	0.0033	0.0031	0.0110	0.0518	0.0456	0.0578	0.1205	0.0624	0.0577	0.0515	0.0548	0.0760
1993	494	345	0.0000	0.0000	0.0000	0.0000	0.0000	0.0012	0.0000	0.0084	0.0034	0.0064	0.0139	0.0335	0.0371	0.0532	0.0301	0.0660	0.0775	0.0545	0.0739	0.0369
1994	349	376	0.0000	0.0000	0.0000	0.0000	0.0000	0.0087	0.0040	0.0670	0.0027	0.0096	0.0062	0.0456	0.0652	0.0501	0.0341	0.0253	0.0628	0.1010	0.0888	0.0404
1995	363	281	0.0000	0.0000	0.0000	0.0000	0.0000	0.0017	0.0016	0.0027	0.0000	0.0022	0.0106	0.0644	0.0325	0.0241	0.0467	0.0578	0.0491	0.0198	0.0352	0.0427
1996	492	281	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0008	0.0000	0.0018	0.0008	0.0012	0.0264	0.0149	0.0453	0.0583	0.0519	0.0484	0.0484	0.0512	0.0222
1997	306	301	0.0000	0.0000	0.0000	0.0000	0.0000	0.0048	0.0008	0.0000	0.0023	0.0004	0.0058	0.0623	0.0316	0.0478	0.0463	0.0475	0.0624	0.1769	0.0633	0.0412
1998	452	302	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0092	0.0085	0.0083	0.0205	0.0206	0.0136	0.0206	0.0719	0.0698	0.0614	0.0460	0.0541	0.0884
1999	706	315	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0025	0.0049	0.0090	0.0075	0.0222	0.0091	0.0140	0.0419	0.0825	0.0833	0.0850	0.0683
2000	473	250	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0025	0.0020	0.0000	0.0300	0.0114	0.0060	0.0547	0.0349	0.0813	0.1135	0.1017	0.0615
2001	775	452	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0056	0.0000	0.0008	0.0110	0.0011	0.0045	0.0069	0.0282	0.0287	0.0730	0.1598	0.0706
2002	504	264	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0014	0.0092	0.0012	0.0144	0.0199	0.0805	0.0909	0.0888	0.0828

2003	998	413	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0015	0.0073	0.0079	0.0043	0.0289	0.0519	0.0977	0.0923	0.0899
2004	1283	597	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0031	0.0000	0.0006	0.0066	0.0040	0.0268	0.0416	0.0609	0.0950	0.0589
2005	1039	395	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0010	0.0000	0.0000	0.0025	0.0019	0.0040	0.0102	0.0103	0.0311	0.0401	0.0553	0.0712
2006	1042	524	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0019	0.0019	0.0056	0.0000	0.0016	0.0098	0.0165	0.0753	0.0761	0.1099	0.0737
2007	897	368	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0010	0.0041	0.0010	0.0000	0.0000	0.0298	0.0027	0.1176	0.0730	0.0786	0.0883
2008	616	355	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0035	0.0000	0.0000	0.0035	0.0071	0.0131	0.0113	0.0159	0.0341	0.0307	0.0555	0.0362
2009	667	402	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0027	0.0154	0.0000	0.0000	0.0038	0.0183	0.0343
2010	1125	542	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0069	0.0000	0.0000	0.0000	0.0031	0.0069	0.0077	0.0000	0.0069	0.0076	0.0013	0.0062	0.0147	0.0271

Table 12. cont.

Year	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50+
1981	0.0024	0.0037	0.0172	0.0005	0.0005	0.0000	0.0058	0.0000	0.0000	0.0116	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1982	0.0238	0.0844	0.0416	0.0517	0.0355	0.0276	0.0316	0.0306	0.0158	0.0094	0.0000	0.0025	0.0053	0.0134	0.0025	0.0000	0.0000	0.0000	0.0000	0.0003	0.0048
1983	0.0213	0.0557	0.0385	0.0336	0.0298	0.0067	0.0067	0.0000	0.0000	0.0000	0.0000	0.0067	0.0098	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1984	0.1474	0.1020	0.0364	0.0278	0.0223	0.0296	0.0126	0.0431	0.0198	0.0100	0.0000	0.0000	0.0110	0.0090	0.0090	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1985	0.0290	0.0523	0.0490	0.0202	0.0412	0.0094	0.0009	0.0258	0.0004	0.0002	0.0108	0.0044	0.0002	0.0087	0.0128	0.0001	0.0000	0.0002	0.0000	0.0000	0.0001
1986	0.0803	0.0229	0.0367	0.0969	0.0164	0.0259	0.0212	0.0274	0.0038	0.0193	0.0012	0.0022	0.0000	0.0013	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1987	0.0546	0.0434	0.0166	0.0162	0.0161	0.0230	0.0120	0.0002	0.0222	0.0053	0.0140	0.0345	0.0011	0.0078	0.0041	0.0006	0.0011	0.0005	0.0000	0.0000	0.0000
1988	0.0062	0.0197	0.0179	0.0015	0.0776	0.0735	0.1473	0.0010	0.0003	0.0730	0.0725	0.0719	0.0001	0.0001	0.0719	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1989	0.0167	0.0365	0.0447	0.0569	0.0405	0.0227	0.0480	0.0179	0.0059	0.0252	0.0118	0.0182	0.0082	0.0061	0.0379	0.0007	0.0000	0.0075	0.0000	0.0000	0.0182
1990	0.0358	0.0360	0.0334	0.0200	0.0101	0.0109	0.0287	0.0090	0.0091	0.0030	0.0015	0.0015	0.0000	0.0000	0.0174	0.0061	0.0114	0.0000	0.0000	0.0030	0.0800
1991	0.0952	0.0249	0.0118	0.0109	0.0148	0.0357	0.0155	0.0029	0.0000	0.0180	0.0000	0.0597	0.0005	0.0150	0.0125	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1992	0.0803	0.0541	0.0887	0.0187	0.0182	0.0222	0.0126	0.0475	0.0188	0.0081	0.0018	0.0050	0.0039	0.0039	0.0024	0.0024	0.0008	0.0032	0.0008	0.0000	0.0036
1993	0.0611	0.0747	0.0984	0.0650	0.0079	0.0459	0.0111	0.0264	0.0016	0.0153	0.0034	0.0312	0.0066	0.0187	0.0059	0.0054	0.0016	0.0038	0.0000	0.0000	0.0199
1994	0.0397	0.0496	0.0249	0.0326	0.0991	0.0168	0.0446	0.0152	0.0019	0.0101	0.0179	0.0010	0.0055	0.0162	0.0056	0.0063	0.0001	0.0000	0.0000	0.0000	0.0012
1995	0.0553	0.0260	0.0352	0.0971	0.0312	0.0119	0.1023	0.0287	0.1130	0.0209	0.0101	0.0057	0.0327	0.0103	0.0068	0.0107	0.0034	0.0000	0.0034	0.0000	0.0040
1996	0.0966	0.0895	0.0552	0.0169	0.0256	0.0161	0.0849	0.0196	0.0120	0.0411	0.0068	0.0497	0.0767	0.0018	0.0250	0.0051	0.0000	0.0017	0.0000	0.0021	0.0020
1997	0.0365	0.0674	0.0456	0.0284	0.0394	0.0610	0.0240	0.0764	0.0027	0.0033	0.0026	0.0060	0.0000	0.0029	0.0073	0.0000	0.0029	0.0000	0.0000	0.0000	0.0000
1998	0.1262	0.0686	0.0700	0.0225	0.0230	0.0458	0.0607	0.0089	0.0078	0.0187	0.0064	0.0124	0.0093	0.0040	0.0046	0.0051	0.0000	0.0008	0.0026	0.0000	0.0099
1999	0.0597	0.0697	0.0858	0.0486	0.0478	0.0505	0.0510	0.0497	0.0227	0.0159	0.0127	0.0180	0.0144	0.0083	0.0032	0.0059	0.0040	0.0000	0.0000	0.0020	0.0000
2000	0.1000	0.1444	0.0242	0.0841	0.0290	0.0536	0.0239	0.0084	0.0068	0.0033	0.0037	0.0044	0.0081	0.0047	0.0007	0.0013	0.0000	0.0000	0.0000	0.0000	0.0000
2001	0.0667	0.0634	0.0753	0.0762	0.0590	0.0969	0.0387	0.0391	0.0267	0.0248	0.0171	0.0148	0.0009	0.0023	0.0027	0.0034	0.0004	0.0000	0.0000	0.0004	0.0009
2002	0.1443	0.1253	0.0579	0.0247	0.1137	0.0308	0.0361	0.0201	0.0200	0.0054	0.0056	0.0000	0.0079	0.0027	0.0079	0.0083	0.0000	0.0000	0.0000	0.0000	0.0002

2003	0.0637	0.0440	0.1498	0.0836	0.0822	0.0506	0.0356	0.0294	0.0212	0.0106	0.0167	0.0116	0.0009	0.0067	0.0011	0.0071	0.0001	0.0033	0.0000	0.0000	0.0000
2004	0.1154	0.0742	0.0897	0.0694	0.0869	0.0783	0.0341	0.0364	0.0349	0.0196	0.0096	0.0250	0.0098	0.0061	0.0069	0.0063	0.0000	0.0000	0.0000	0.0000	0.0000
2005	0.1448	0.0923	0.1073	0.0658	0.0645	0.0052	0.0184	0.0229	0.0502	0.0015	0.1604	0.0000	0.0048	0.0000	0.0021	0.0000	0.0323	0.0000	0.0000	0.0000	0.0000
2006	0.0593	0.0807	0.0647	0.0813	0.0788	0.1564	0.0267	0.0258	0.0157	0.0097	0.0068	0.0032	0.0000	0.0008	0.0112	0.0065	0.0000	0.0000	0.0000	0.0000	0.0000
2007	0.0767	0.0783	0.0861	0.0857	0.0732	0.0286	0.0314	0.0486	0.0223	0.0308	0.0117	0.0171	0.0066	0.0000	0.0006	0.0000	0.0000	0.0000	0.0000	0.0000	0.0060
2008	0.0524	0.0614	0.0980	0.1039	0.0982	0.0829	0.1171	0.0426	0.0501	0.0307	0.0196	0.0080	0.0106	0.0018	0.0000	0.0000	0.0000	0.0018	0.0098	0.0000	0.0000
2009	0.0695	0.1107	0.1709	0.1634	0.1131	0.0439	0.1411	0.0590	0.0115	0.0080	0.0149	0.0164	0.0000	0.0033	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2010	0.0901	0.1425	0.1321	0.1790	0.1088	0.0560	0.0889	0.0417	0.0088	0.0328	0.0098	0.0071	0.0043	0.0080	0.0016	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table 13. Headboat age composition as input into BAM base model.

Year	N.fish	N.trips	1	2	3	4	5	6	7	8	9	10	11
1991	85	43	0.0112	0.4650	0.3774	0.1250	0.0200	0.0012	0.0000	0.0002	0.0000	0.0000	0.0000
1992	60	31	0.0000	0.2407	0.6346	0.1004	0.0236	0.0007	0.0000	0.0000	0.0000	0.0000	0.0000
2003	105	31	0.0000	0.1485	0.6087	0.2337	0.0086	0.0005	0.0000	0.0000	0.0000	0.0000	0.0000
2004	234	53	0.0294	0.3785	0.4748	0.1034	0.0139	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2005	480	104	0.0171	0.1783	0.5264	0.2282	0.0409	0.0064	0.0024	0.0000	0.0001	0.0000	0.0000
2006	1,066	247	0.0023	0.0724	0.5327	0.3170	0.0684	0.0070	0.0001	0.0000	0.0000	0.0000	0.0000
2007	671	271	0.0024	0.0528	0.2623	0.5451	0.1247	0.0119	0.0008	0.0001	0.0000	0.0000	0.0000
2008	309	161	0.0045	0.1190	0.3715	0.2697	0.2107	0.0240	0.0003	0.0003	0.0000	0.0000	0.0000
2009	517	218	0.0000	0.0404	0.2658	0.4768	0.1646	0.0520	0.0004	0.0000	0.0000	0.0000	0.0000
2010	1,029	341	0.0000	0.0308	0.3444	0.3896	0.2124	0.0198	0.0029	0.0000	0.0000	0.0000	0.0000

Table 14. MRFSS age composition as input into BAM base model.

Year	N.fish	N.trips	1	2	3	4	5	6	7	8	9	10	11
1998	379	57	0.1462	0.3129	0.2645	0.2138	0.0582	0.0034	0.0009	0.0000	0.0000	0.0000	0.0000
2004	567	46	0.0000	0.1046	0.4619	0.3421	0.0837	0.0076	0.0002	0.0000	0.0000	0.0000	0.0000
2005	139	36	0.0011	0.1926	0.5157	0.2607	0.0246	0.0053	0.0000	0.0000	0.0000	0.0000	0.0000

Table 15. Headboat at-sea observer length composition as input into BAM base model.

Year	N.fish	N.trips	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
2005	2773	151	0.0061	0.0090	0.0061	0.0137	0.0188	0.0335	0.0314	0.0664	0.0858	0.0999	0.1172	0.1284	0.1082	0.1132	0.0956	0.0501	0.0108	0.0014	0.0011	0.0014
2006	3913	133	0.0005	0.0008	0.0036	0.0056	0.0130	0.0184	0.0276	0.0312	0.0555	0.0815	0.1071	0.1319	0.1426	0.1467	0.1165	0.0820	0.0217	0.0061	0.0026	0.0013
2007	5408	152	0.0009	0.0017	0.0031	0.0057	0.0085	0.0196	0.0277	0.0416	0.0547	0.0671	0.0786	0.0910	0.1015	0.1106	0.0973	0.0984	0.0790	0.0533	0.0327	0.0172
2008	5038	153	0.0016	0.0022	0.0048	0.0075	0.0107	0.0214	0.0318	0.0417	0.0520	0.0633	0.0726	0.1050	0.0933	0.0913	0.0893	0.0824	0.0717	0.0597	0.0530	0.0316
2009	6388	136	0.0003	0.0019	0.0014	0.0028	0.0056	0.0100	0.0161	0.0218	0.0358	0.0548	0.0839	0.0975	0.1000	0.0953	0.0982	0.0886	0.0866	0.0723	0.0581	0.0402
2010	11055	146	0.0002	0.0015	0.0006	0.0017	0.0041	0.0081	0.0136	0.0196	0.0266	0.0355	0.0576	0.0799	0.0854	0.1104	0.1036	0.1056	0.0949	0.0895	0.0779	0.0577

Year	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50+
2005	0.0000	0.0000	0.0000	0.0007	0.0007	0.0000	0.0000	0.0000	0.0004	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2006	0.0015	0.0013	0.0003	0.0003	0.0000	0.0000	0.0005	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2007	0.0076	0.0009	0.0000	0.0004	0.0000	0.0006	0.0002	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2008	0.0109	0.0008	0.0010	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2009	0.0252	0.0019	0.0008	0.0002	0.0003	0.0002	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2010	0.0227	0.0025	0.0002	0.0002	0.0002	0.0001	0.0001	0.0000	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001

Table 16. Commercial handline length composition as input into the BAM base model.

Year	N.fish	N.trips	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
1984	1,528	66	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0007	0.0020	0.0046	0.0105	0.0268	0.0406	0.0510	0.0452	0.0668	0.0563	0.0596	0.0602
1985	1,248	56	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0016	0.0024	0.0040	0.0152	0.0176	0.0401	0.0385	0.0673	0.0777	0.0737	0.0673
1986	695	45	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0014	0.0000	0.0072	0.0144	0.0201	0.0403	0.0504	0.0432	0.0489	0.0547	0.0647
1987	804	50	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0050	0.0100	0.0112	0.0174	0.0348	0.0323	0.0311	0.0585	0.0585	0.0609	0.0659
1988	814	52	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0012	0.0037	0.0123	0.0221	0.0369	0.0455	0.0786	0.0663	0.0688	0.1069	0.0602
1989	695	30	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0014	0.0029	0.0058	0.0129	0.0259	0.0432	0.0547	0.0432	0.0561	0.0576	0.0504	0.0647
1990	1,140	43	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0026	0.0123	0.0184	0.0395	0.0456	0.0553	0.0605	0.0702	0.0886	0.0772
1991	812	46	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0012	0.0135	0.0357	0.0591	0.0739	0.0727	0.0677	0.0788	0.0640	0.0567
1993	398	32	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0050	0.0201	0.0302	0.0528	0.0452	0.0578	0.0528	0.0854
1995	235	39	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0085	0.0298	0.0255	0.0340	0.0468	0.0511	0.0511
1999	802	42	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0012	0.0025	0.0125	0.0274	0.0474	0.0810	0.0810	0.0798	0.0736
2000	410	47	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0049	0.0268	0.0463	0.0805	0.0805	0.1000
2001	937	73	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0021	0.0000	0.0021	0.0011	0.0043	0.0192	0.0651	0.0512	0.0630	0.0587

Year	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50+
1984	0.0661	0.0772	0.0576	0.0510	0.0497	0.0393	0.0419	0.0314	0.0360	0.0262	0.0236	0.0229	0.0151	0.0137	0.0092	0.0026	0.0046	0.0020	0.0020	0.0020	0.0020
1985	0.0633	0.0617	0.0513	0.0441	0.0361	0.0401	0.0449	0.0433	0.0329	0.0465	0.0321	0.0232	0.0240	0.0160	0.0136	0.0056	0.0080	0.0040	0.0024	0.0008	0.0008
1986	0.0576	0.0561	0.0633	0.0547	0.0518	0.0432	0.0518	0.0417	0.0504	0.0388	0.0417	0.0345	0.0288	0.0115	0.0115	0.0072	0.0043	0.0029	0.0014	0.0014	0.0000
1987	0.0547	0.0734	0.0547	0.0448	0.0560	0.0460	0.0398	0.0348	0.0410	0.0286	0.0274	0.0386	0.0149	0.0211	0.0162	0.0050	0.0075	0.0050	0.0012	0.0037	0.0000
1988	0.0528	0.0639	0.0590	0.0553	0.0369	0.0393	0.0295	0.0381	0.0283	0.0270	0.0123	0.0147	0.0111	0.0111	0.0098	0.0025	0.0025	0.0025	0.0000	0.0012	0.0000
1989	0.0719	0.0590	0.0576	0.0547	0.0331	0.0475	0.0475	0.0388	0.0417	0.0273	0.0245	0.0201	0.0129	0.0129	0.0158	0.0072	0.0029	0.0029	0.0000	0.0014	0.0014
1990	0.0702	0.0746	0.0614	0.0640	0.0439	0.0421	0.0246	0.0298	0.0219	0.0149	0.0202	0.0175	0.0167	0.0079	0.0044	0.0070	0.0044	0.0018	0.0009	0.0000	0.0018
1991	0.0406	0.0480	0.0468	0.0443	0.0382	0.0382	0.0382	0.0308	0.0259	0.0209	0.0271	0.0172	0.0111	0.0111	0.0086	0.0111	0.0049	0.0037	0.0025	0.0025	0.0049
1993	0.0653	0.0829	0.0704	0.0653	0.0678	0.0302	0.0402	0.0578	0.0302	0.0276	0.0302	0.0151	0.0226	0.0176	0.0050	0.0050	0.0050	0.0075	0.0000	0.0050	0.0000

1995	0.0681	0.0511	0.0596	0.0511	0.0596	0.0213	0.0511	0.0638	0.0383	0.0723	0.0128	0.0426	0.0213	0.0298	0.0383	0.0000	0.0170	0.0128	0.0128	0.0085	0.0213
1999	0.0860	0.0661	0.0499	0.0648	0.0449	0.0561	0.0449	0.0324	0.0337	0.0287	0.0175	0.0125	0.0137	0.0087	0.0075	0.0050	0.0037	0.0112	0.0050	0.0000	0.0012
2000	0.0854	0.0732	0.0415	0.0488	0.0415	0.0585	0.0366	0.0561	0.0390	0.0244	0.0341	0.0439	0.0293	0.0171	0.0146	0.0024	0.0073	0.0049	0.0024	0.0000	0.0000
2001	0.0512	0.0790	0.0790	0.0736	0.0502	0.0566	0.0651	0.0448	0.0416	0.0342	0.0363	0.0203	0.0288	0.0299	0.0117	0.0043	0.0128	0.0043	0.0075	0.0021	0.0000

Table 17. Commercial pots length composition as input into the BAM base model. *Due to low sample size by year, pooled 1984, 1988, 1990, 1991; weighted by sample size, used to estimate selectivity during 8" limit.

Year	N.fish	N.trips	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
*pooled	3,077	37	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0027	0.0064	0.0290	0.0543	0.0819	0.0822	0.0761	0.0767	0.0695	0.0626	0.0516

Year	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50+
*pooled	0.0511	0.0598	0.0441	0.0501	0.0401	0.0346	0.0292	0.0225	0.0200	0.0117	0.0106	0.0102	0.0084	0.0055	0.0049	0.0024	0.0007	0.0006	0.0003	0.0000	0.0003

Table 18. Commercial pots age compositions as input into the BAM base model.

Year	N.age	N.trips	1	2	3	4	5	6	7	8	9	10	11
2007	2124	47	0.0000	0.0093	0.2383	0.5494	0.1657	0.0305	0.0054	0.0013	0.0000	0.0000	0.0000
2008	2098	79	0.0002	0.0444	0.3850	0.3735	0.1684	0.0243	0.0038	0.0003	0.0001	0.0000	0.0000
2009	2252	89	0.0012	0.0714	0.3910	0.4099	0.1041	0.0201	0.0024	0.0000	0.0000	0.0000	0.0000
2010	1572	74	0.0009	0.0910	0.4744	0.3156	0.1014	0.0101	0.0056	0.0008	0.0002	0.0000	0.0000

Table 19. Commercial vertical line age composition as input into the BAM base model.

Year	N.age	N.trips	1	2	3	4	5	6	7	8	9	10	11
1994	77	41	0.0000	0.0303	0.1885	0.5513	0.1505	0.0309	0.0485	0.0000	0.0000	0.0000	0.0000
2002	81	61	0.0000	0.0892	0.3008	0.3311	0.2403	0.0299	0.0087	0.0000	0.0000	0.0000	0.0000
2003	443	53	0.0027	0.0366	0.3617	0.3479	0.1787	0.0566	0.0132	0.0025	0.0000	0.0000	0.0000
2004	609	98	0.0000	0.0422	0.2632	0.4123	0.2129	0.0605	0.0056	0.0022	0.0011	0.0000	0.0000
2005	836	116	0.0011	0.0555	0.1870	0.3904	0.2657	0.0728	0.0249	0.0012	0.0013	0.0000	0.0000
2006	809	98	0.0006	0.0216	0.2686	0.3250	0.2415	0.1169	0.0180	0.0065	0.0012	0.0000	0.0000
2007	779	93	0.0015	0.0544	0.2868	0.3596	0.2163	0.0702	0.0106	0.0004	0.0001	0.0000	0.0000
2008	553	90	0.0000	0.0555	0.2735	0.3520	0.2514	0.0523	0.0134	0.0019	0.0000	0.0000	0.0000
2009	693	71	0.0000	0.0604	0.3009	0.4443	0.1498	0.0350	0.0096	0.0000	0.0000	0.0000	0.0000
2010	586	91	0.0000	0.0142	0.1878	0.5371	0.2177	0.0363	0.0062	0.0008	0.0000	0.0000	0.0000

Table 20. MARMAP blackfish/FL snapper trap length composition as input into the BAM base model.

Year	N.fish	N.trips	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
1981	4669	108	0.0000	0.0000	0.0000	0.0006	0.0000	0.0002	0.0020	0.0015	0.0056	0.0179	0.0624	0.1001	0.1338	0.1144	0.0925	0.0691	0.0661	0.0556	0.0456	0.0380
1982	4851	120	0.0000	0.0000	0.0000	0.0006	0.0017	0.0023	0.0039	0.0116	0.0232	0.0519	0.0919	0.1234	0.1371	0.1185	0.0850	0.0746	0.0529	0.0412	0.0321	0.0267
1984	7946	62	0.0000	0.0000	0.0001	0.0004	0.0009	0.0027	0.0075	0.0107	0.0179	0.0314	0.0581	0.0784	0.1127	0.1284	0.1209	0.0940	0.0694	0.0508	0.0435	0.0333
1985	5319	25	0.0000	0.0000	0.0000	0.0001	0.0008	0.0018	0.0012	0.0043	0.0154	0.0240	0.0516	0.0739	0.1032	0.1147	0.1063	0.0877	0.0651	0.0560	0.0477	0.0348
1986	3415	26	0.0003	0.0000	0.0000	0.0000	0.0001	0.0013	0.0065	0.0101	0.0296	0.0470	0.0743	0.0939	0.1026	0.1067	0.0874	0.0680	0.0689	0.0577	0.0497	0.0335
1987	2460	16	0.0000	0.0000	0.0000	0.0000	0.0000	0.0013	0.0043	0.0153	0.0230	0.0321	0.0628	0.0908	0.1442	0.1349	0.1018	0.0839	0.0693	0.0429	0.0398	0.0371

Year	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50+
1981	0.0363	0.0244	0.0268	0.0232	0.0186	0.0121	0.0096	0.0122	0.0071	0.0055	0.0054	0.0059	0.0031	0.0018	0.0006	0.0003	0.0015	0.0000	0.0003	0.0000	0.0000
1982	0.0209	0.0194	0.0169	0.0114	0.0104	0.0083	0.0083	0.0077	0.0043	0.0036	0.0032	0.0017	0.0019	0.0012	0.0007	0.0003	0.0000	0.0004	0.0004	0.0001	0.0003
1984	0.0321	0.0279	0.0211	0.0123	0.0102	0.0077	0.0072	0.0039	0.0047	0.0033	0.0022	0.0018	0.0015	0.0012	0.0006	0.0009	0.0003	0.0000	0.0000	0.0000	0.0000
1985	0.0338	0.0333	0.0281	0.0228	0.0230	0.0150	0.0136	0.0077	0.0094	0.0042	0.0058	0.0041	0.0027	0.0023	0.0027	0.0008	0.0010	0.0005	0.0003	0.0003	0.0000
1986	0.0338	0.0253	0.0220	0.0143	0.0134	0.0092	0.0119	0.0068	0.0040	0.0064	0.0042	0.0014	0.0021	0.0024	0.0025	0.0010	0.0008	0.0004	0.0000	0.0004	0.0000
1987	0.0250	0.0252	0.0141	0.0136	0.0099	0.0105	0.0035	0.0050	0.0039	0.0040	0.0017	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table 21. MARMAP blackfish/FL snapper trap age composition as input into the BAM base model.

Year	N.fish	N.trips	0	1	2	3	4	5	6	7	8	9	10	11
1983	5486	453	0.0013	0.0089	0.1260	0.4883	0.2373	0.1127	0.0199	0.0040	0.0013	0.0002	0.0002	0.0000

Table 22. MARMAP chevron trap age composition as input into the BAM base model.

Year	N.fish	N.trips	0	1	2	3	4	5	6	7	8	9	10	11
1990	2136	159	0.0000	0.0595	0.3366	0.3390	0.1437	0.0782	0.0243	0.0159	0.0014	0.0009	0.0005	0.0000
1991	4050	107	0.0000	0.1242	0.4746	0.2746	0.0812	0.0319	0.0062	0.0049	0.0025	0.0000	0.0000	0.0000
1992	4585	130	0.0000	0.0301	0.4866	0.2903	0.1195	0.0576	0.0098	0.0039	0.0015	0.0000	0.0007	0.0000
1993	3240	163	0.0000	0.1315	0.4250	0.3253	0.0694	0.0327	0.0102	0.0046	0.0009	0.0000	0.0003	0.0000
1994	3710	135	0.0000	0.0682	0.4081	0.2466	0.2164	0.0442	0.0105	0.0035	0.0022	0.0000	0.0003	0.0000
1995	3423	109	0.0003	0.1259	0.5355	0.2042	0.0844	0.0418	0.0067	0.0006	0.0000	0.0006	0.0000	0.0000
1996	3656	167	0.0000	0.0323	0.2924	0.5246	0.0968	0.0353	0.0126	0.0038	0.0008	0.0014	0.0000	0.0000
1997	4257	139	0.0014	0.1468	0.3643	0.2680	0.1879	0.0249	0.0052	0.0014	0.0000	0.0000	0.0000	0.0000
1998	4225	128	0.0000	0.1321	0.4033	0.2902	0.1183	0.0490	0.0052	0.0009	0.0009	0.0000	0.0000	0.0000
1999	4623	86	0.0000	0.0485	0.4229	0.4162	0.0822	0.0205	0.0069	0.0028	0.0000	0.0000	0.0000	0.0000
2000	4550	97	0.0002	0.0567	0.2530	0.4725	0.1721	0.0310	0.0077	0.0057	0.0011	0.0000	0.0000	0.0000
2001	4001	79	0.0000	0.1077	0.3162	0.2629	0.2209	0.0842	0.0065	0.0007	0.0007	0.0000	0.0000	0.0000
2002	2721	78	0.0000	0.0551	0.4528	0.2712	0.1305	0.0801	0.0077	0.0018	0.0007	0.0000	0.0000	0.0000
2003	1660	64	0.0000	0.0464	0.2922	0.4392	0.1470	0.0524	0.0145	0.0084	0.0000	0.0000	0.0000	0.0000
2004	5041	91	0.0000	0.0861	0.2740	0.3138	0.1635	0.1268	0.0218	0.0123	0.0018	0.0000	0.0000	0.0000
2005	5636	106	0.0000	0.0584	0.3242	0.2661	0.2074	0.1155	0.0206	0.0060	0.0016	0.0002	0.0000	0.0000
2006	4466	105	0.0000	0.0237	0.3003	0.3397	0.2163	0.0826	0.0246	0.0119	0.0007	0.0000	0.0002	0.0000

2007	3174	99	0.0000	0.0643	0.3674	0.3025	0.1790	0.0699	0.0069	0.0079	0.0013	0.0009	0.0000	0.0000
2008	710	102	0.0000	0.0394	0.3014	0.3493	0.1732	0.0901	0.0338	0.0070	0.0028	0.0014	0.0014	0.0000
2009	740	124	0.0014	0.1054	0.3324	0.3351	0.1514	0.0405	0.0162	0.0135	0.0041	0.0000	0.0000	0.0000
2010	1385	176	0.0007	0.0412	0.2245	0.4014	0.2296	0.0693	0.0159	0.0130	0.0043	0.0000	0.0000	0.0000

Table 23. Black sea bass indices of abundance as input into the BAM base model.

Years	MARMAP CH Trap	Headboat	HB At-sea discard	Comm Line	MARMAP BFT/FL	MARMAP CH Trap CV	Headboat CV	HB At-sea discard CV	Comm Line CV	MARMAP BFT/FL CV
1979		2.170					0.020			
1980		1.848					0.020			
1981		2.128			1.070		0.021			0.060
1982		2.186			1.210		0.021			0.080
1983		1.980			1.100		0.022			0.060
1984		1.839			0.940		0.020			0.050
1985		1.986			1.090		0.018			0.060
1986		1.627			0.780		0.017			0.070
1987		1.557			0.810		0.017			0.090
1988		1.501					0.016			
1989		1.231					0.019			
1990	1.590	1.224				0.080	0.017			
1991	1.090	1.006				0.100	0.019			
1992	1.260	0.685				0.090	0.019			
1993	0.710	0.438		1.046		0.090	0.018		0.216	
1994	0.680	0.485		0.971		0.100	0.021		0.206	
1995	0.370	0.500		0.614		0.100	0.021		0.216	
1996	0.720	0.522		0.630		0.120	0.023		0.219	
1997	1.030	0.565		0.798		0.100	0.026		0.212	
1998	1.050	0.504		1.098		0.090	0.021		0.210	
1999	0.720	0.561		1.149		0.130	0.019		0.219	
2000	1.040	0.413		0.788		0.110	0.020		0.232	
2001	1.300	0.433		0.842		0.150	0.020		0.217	
2002	0.690	0.415		0.784		0.130	0.023		0.220	
2003	0.970	0.475		0.998		0.130	0.021		0.225	
2004	1.780	0.656		1.413		0.120	0.019		0.225	

2005	1.040	0.579	0.558	1.010	0.110	0.021	0.111	0.228
2006	1.120	0.618	0.808	0.899	0.110	0.021	0.109	0.231
2007	0.880	0.376	0.993	0.550	0.110	0.026	0.123	0.238
2008	0.880	0.300	0.887	0.727	0.110	0.025	0.119	0.232
2009	0.830	0.462	1.062	1.158	0.110	0.022	0.118	0.230
2010	1.240	0.728	1.693	2.524	0.080	0.021	0.101	0.236

Table 24. Pearson correlation analysis (p-values for two-sided test of H0: correlation=0) for indices included in BAM base model input.

	MARMAP Chevron	Headboat	Headboat At-sea Discard	Commercial logbook vertical line	MARMAP Blackfish/FL trap combined
MARMAP Chevron	1	0.557(0.0086)	0.418 (0.4089)	0.454 (0.0585)	
Headboat		1	0.397 (0.4353)	0.689 (0.002)	0.956 (0.0008)
Headboat At-sea Discard			1	0.824 (0.043)	
Commercial logbook vertical line				1	
MARMAP Blackfish/FL trap combined					1

Table 25. Correlation of first differences (p-values for two-sided test of H0: correlation=0) for indices included in BAM base model input.

	MARMAP Chevron	Headboat	Headboat At-sea Discard	Commercial logbook vertical line	MARMAP Blackfish/FL trap combined
MARMAP Chevron	1	0.45 (0.04)	0.72 (0.17)	0.5 (0.036)	
Headboat		1	0.64 (0.24)	0.77 (0.00028)	0.96 (0.002)
Headboat At-sea Discard			1	0.68 (0.197)	
Commercial logbook vertical line				1	
MARMAP Blackfish/FL trap combined					1

3 Stock Assessment Models and Results

Following the Terms of Reference, two models of black sea bass were discussed during the Assessment Workshop (AW): the Beaufort assessment model (BAM) and a surplus-production model (ASPIC). The BAM was selected at the AW to be the primary assessment model, although results from both models are described here. Abbreviations and acronyms used in this report are defined in Appendix A.

3.1 Model 1: Beaufort Assessment Model

3.1.1 Model 1 Methods

3.1.1.1 **Overview** The primary model in this assessment was the Beaufort assessment model (BAM), which applies a statistical catch-age formulation. The model was implemented with the AD Model Builder software (ADMB Project 2011), and its structure and equations are detailed in SEDAR-25-RW03. In essence, the model simulates a population forward in time while including fishing processes (Quinn and Deriso 1999; Shertzer et al. 2008*a*). 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, among many applications, used by Fournier and Archibald (1982), by Deriso et al. (1985) in their CAGEAN model, and by Methot (1989; 2009) 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 previous SEDAR assessments of reef fishes in the U.S. South Atlantic, such as red porgy, tilefish, snowy grouper, gag grouper, greater amberjack, vermilion snapper, Spanish mackerel, red grouper, and red snapper, as well as in previous benchmark and update assessments of black sea bass (SEDAR 2003; 2005).

3.1.1.2 **Data Sources** The catch-age model included data from fishery independent surveys and from five fleets that caught black sea bass in southeast U.S. waters: commercial lines (primarily handlines), commercial pots, commercial trawls, recreational headboats, and general recreational boats. The model was fitted to data on annual landings (in units of 1000 lb whole weight), annual discard mortalities (in units of 1000 fish), annual length compositions of landings, annual age compositions of landings, annual length compositions of discards, two fishery independent indices of abundance (MARMAP blackfish/snapper traps and chevron traps), and three fishery dependent indices (commercial lines, headboat, and headboat discards). Not all of the above data sources were available for all fleets in all years. Data used in the model are tabulated in the DW report and in §III(2) of this assessment report.

The general recreational fleet was sampled by the Marine Recreational Fishing Statistical Survey (MRFSS) starting in 1981. That sampling program is undergoing modifications, including a change of name to Marine Recreational Information Program (MRIP). In this report, acronyms MRFSS and MRIP are used synonymously to refer to sampling of the general recreational fleet. However, the sampling and estimation methodology for this assessment is that of MRFSS.

3.1.1.3 **Model Configuration and Equations** Model structure and equations of the BAM are detailed in SEDAR-25-RW03, along with AD Model Builder code for implementation. The assessment time period was 1978–2010. A general description of the assessment model follows.

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. The population was assumed closed to immigration and emigration. The model included age classes $0 - 11^{+}$, where the oldest age class 11^{+} allowed for the accumulation of fish (i.e., plus group).

Initialization Initial (1978) abundance at age was estimated in the model as follows. First, the equilibrium age structure was computed for ages 1–11 based on natural and fishing mortality (F), where F was set equal to the geometric mean fishing mortality from the first three assessment years (1978-1980) scaled by a multiplier (called $F_{\text{init.ratio}}$). Second, lognormal deviations around that equilibrium age structure were estimated. The deviations were lightly penalized, such that the initial abundance of each age could vary from equilibrium if suggested by early composition data, but remain estimable if data were uninformative. Given the initial abundance of ages 1–11, initial (1978) abundance of age-0 fish was computed using the same methods as for recruits in other years (described below).

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. As in previous SEDAR assessments, the Lorenzen estimates of M_a were rescaled to provide the same fraction of fish surviving from age-1 through the oldest observed age (11 yr) as would occur with constant $M = 0.38$ from the DW. This approach using cumulative mortality allows that fraction at the oldest age to be consistent with the findings of Hoenig (1983) and Hewitt and Hoenig (2005).

Growth Mean size at age of the population (total length, TL) was modeled with the von Bertalanffy equation, and weight at age (whole weight, WW) was modeled as a function of total length (Figure 3.1, Table 3.1). Parameters of growth and conversions (TL-WW) were estimated by the DW and were treated as input to the assessment model. The von Bertalanffy parameter estimates from the DW were $L_\infty = 495.9$, $K = 0.177$, and $t_0 = -0.92$. For fitting length composition data, the distribution of size at age was assumed normal with coefficient of variation (CV) estimated by the assessment model. A constant CV, rather than constant standard deviation, was suggested by the size at age data.

Sex transition Black sea bass is a protogynous hermaphrodite. Proportion female at age was modeled with a logistic function, estimated by the DW (Table 3.1). The age at 50% transition to male was estimated to be 3.83 years.

Female maturity and fecundity Female maturity was modeled with a logistic function; the age at 50% female maturity was estimated to be ~ 1 year. Annual egg production by mature females was computed as eggs spawned per batch, a function of body weight, multiplied by the number of batches per year. Maturity and fecundity parameters were provided by the DW and treated as input to the assessment model (Table 3.1).

Spawning stock Spawning stock was modeled as population fecundity of mature females (i.e., total annual egg production) measured at the time of peak spawning. For black sea bass, peak spawning was considered to occur at the end of March.

In cases when reliable estimates of fecundity are unavailable, spawning biomass is commonly used as a proxy for population fecundity. The previous SEDAR assessments of black sea bass (SEDAR 2003; 2005) modeled spawning stock as total mature biomass. For protogynous stocks, use of total mature biomass, rather than that of females or males only, has been found to provide more reliable estimates of management quantities over a broad range of conditions (Brooks et al. 2008).

Recruitment Expected recruitment of age-0 fish was predicted from spawning stock using the Beverton–Holt spawner-recruit model. Annual variation in recruitment was assumed to occur with lognormal deviations.

Landings The model included time series of landings from five fleets: commercial lines, commercial pots, commercial trawls, headboat, and general recreational. The commercial trawl time series was extended through 1990 (trawling was banned in January, 1989 within federal waters of the SAFMC's jurisdiction).

Landings were modeled with the Baranov catch equation (Baranov 1918) and were fitted in units of weight (1000 lb whole weight). The DW provided observed landings back to the first assessment year (1978) for each fleet except general recreational, because the MRFSS started in 1981. Thus for years 1978–1980, general recreational landings were predicted in the assessment model (but not fitted to data), by applying the geometric mean recreational F from the years 1981–1983.

Discards As with landings, discard mortalities (in units of 1000 fish) were modeled with the Baranov catch equation (Baranov 1918), which required estimates of discard selectivities and release mortality probabilities. Discards were assumed to have gear-specific mortality probabilities, as suggested by the DW (lines, 0.07; pots with 1.5-inch panels, 0.05; and pots with 2-inch panels, 0.01). Annual discard mortalities, as fitted by the model, were computed by multiplying total discards (tabulated in the DW report) by the gear-specific release mortality probability.

For the commercial fleets, discards from handline and pot gears were combined, and were modeled starting in 1984 with implementation of the 8-inch size limit. Commercial discards prior to 1984 were considered negligible and not modeled. Data on commercial discards were available from the DW starting in 1993. Thus for years 1984–1992, commercial discards were predicted in the assessment model (but not fitted to data), by applying the geometric mean commercial discard F from the years 1993–1998 (the 10-inch limit began in 1999).

For headboat and general recreational fleets, discard time series were assumed to begin in 1978, as observations from MRFSS indicated the occurrence of recreational discards prior to implementation of the 8-inch size limit. Headboat discard estimates were separated from MRFSS beginning in 1986, and were combined for 1978–1985. Because MRFSS began in 1981, the 1978–1980 general recreational (plus headboat) discards were predicted in the assessment model (but not fitted to data), by applying the geometric mean recreational discard F from the years 1981–1983.

For fishery discard length composition data collected under a size limit regulation, the normal distribution of size at age was truncated at the size limit, such that length compositions of discards would include only fish of sublegal size. Mean length at age of discards were computed from these truncated distributions, and thus average weight at age of discards would differ from those in the population at large. Commercial discards in 2009–2010 included a portion of fish that were of legal size as a result of the closed seasons.

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

Selectivities Selectivity curves applied to landings and MARMAP survey gears were estimated using a parametric approach. This approach applies plausible structure on the shape of the selectivity curves, and achieves greater parsimony than occurs with unique parameters for each age. Selectivities of landings from all fleets were modeled as flat-topped, using a two-parameter logistic function, as were selectivities of MARMAP (fishery independent) trap gears. Although selectivities of trap gear are often considered dome-shaped, the AW believed them to be flat-topped for this stock, because 1) the traps are physically able to catch the largest (oldest) fish, 2) analysis of age-depth data suggested no strong relationship for the ages that would be represented by the descending limb of a dome-shaped curve (thus, older fish are available to the gear), and 3) catch curve analysis did not generally indicate higher Z estimates for trap gears than for handline gears. Selectivities of fishery dependent indices were the same as those of the relevant fleet.

Selectivity of each fleet was fixed within each block of size-limit regulations, but was permitted to vary among blocks where possible or reasonable. Commercial fisheries experienced three blocks of size-limit regulations: no limit prior to 1983, 8-inch limit during 1983–1999, and 10-inch limit during 1999–2010. Recreational fisheries experience four blocks of size-limit regulations, which were the same as those of the commercial fisheries but with a 12-inch size limit implemented in 2007.

Age and length composition data are critical for estimating selectivity parameters, and ideally, a model would have sufficient composition data from each fleet over time to estimate distinct selectivities in each period of regulations. That was not the case here, and thus additional assumptions were applied to define selectivities, as follows. Because no age and very few length composition data were available from commercial trawls, selectivity of this fleet was assumed equal to that of the commercial pots. With no composition data from commercial fleets prior to regulations, commercial line selectivities in the first and second regulatory blocks were set equal, as were commercial pot selectivities, consistent with the DW recommendation that the 8-inch size limit had little effect on commercial fishing. Length composition data from MRFSS were quite noisy, and thus selectivities of recreational headboat and general recreational fleets were set equal.

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.

Indices of abundance The model was fit to two fishery independent indices of relative abundance (MARMAP blackfish/snapper traps 1981–1987; and MARMAP chevron traps 1990–2010) and three fishery dependent indices (headboat 1979–2010; headboat discards 2005–2010; and commercial lines 1993–2010). Predicted indices were conditional on selectivity of the corresponding fleet or survey and were computed from abundance or biomass (as appropriate) at the midpoint of the year. The headboat discard index, although relatively short in duration, tracks young fish and was included as a measure of recruitment strength at the end of the assessment period. All indices were positively correlated, and in most cases, significantly.

Catchability In the BAM, catchability scales indices of relative abundance to estimated population abundance at large. Several options for time-varying catchability were implemented in the BAM following recommendations of the 2009 SEDAR procedural workshop on catchability (SEDAR Procedural Guidance 2009). In particular, the BAM allows for density dependence, linear trends, and random walk, as well as time-invariant catchability. Parameters for these models could be estimated or fixed based on *a priori* considerations. For the base model, the AW assumed time-invariant catchability, following SEDAR-02. For a sensitivity run, however, the AW considered linearly increasing catchability with a slope of 2%, constant after 2003. Choice of the year 2003 was based on recommendations from fishermen regarding when the effects of Global Positioning Systems likely saturated in the southeast U.S. Atlantic (SEDAR 2009). This trend reflects the belief that catchability has generally increased over time as a result of improved technology (SEDAR Procedural Guidance 2009) and as estimated for reef fishes in the Gulf of Mexico (Thorson and Berkson 2010).

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 (expected values in arithmetic space). Computed benchmarks included MSY, fishing mortality rate at MSY (F_{MSY}), and spawning stock at MSY (SSB_{MSY}). In this assessment, spawning stock measures population fecundity of mature females. These benchmarks are conditional on the estimated selectivity functions and the relative contributions of each fleet's fishing mortality. The selectivity pattern used here was the effort-weighted selectivities at age, with effort from each fishery (including discard mortalities) estimated as the full F averaged over the last two years of the assessment. The last two years, rather than three (SEDAR custom), was applied because of the implementation of commercial seasonal closures starting in 2009.

Fitting criterion The fitting criterion was a penalized likelihood approach in which observed landings and discards were fit closely, and observed composition data and abundance indices were fit to the degree that they were compatible. Landings, discards, and index data were fitted using lognormal likelihoods. Length and age composition data were fitted using multinomial likelihoods.

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 adjusting CVs (lognormal components) or adjusting effective sample sizes (multinomial components). In this application to black sea bass, 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, age/length 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 trips sampled annually, rather than the number of fish measured, reflecting the belief that the basic sampling unit occurs at the level of trip. These initial weights were then adjusted until standard deviations of normalized residuals (SDNRs) were near 1.0 (SEDAR24-RW03, SEDAR25-RW05). Weights on four indices (all but the headboat discard index) were then adjusted upward to a value of 2.5 (SEDAR25-RW05), in accordance with the principle that abundance data should be given primacy (Francis 2011), which would seem particularly true when indices are highly correlated.

In addition, a lognormal likelihood was applied to the spawner-recruit relationship. The compound objective function also included several penalties or prior distributions, applied to CV of growth (based on the empirical estimate), $F_{\text{init.ratio}}$ (prior of 1.0), selectivity parameters, and spawner-recruit parameters [steepness based on Shertzer and Conn (In Press) and recruitment standard deviation based on Beddington and Cooke (1983) and Mertz and Myers (1996)]. Penalties or priors were applied to maintain parameter estimates near reasonable values, and to prevent the optimization routine from drifting into parameter space with negligible gradient in the likelihood.

Configuration of base run The base run was configured as described above with data provided by the DW. The AW did not necessarily consider this configuration to represent reality better than all other possible configurations, and attempted to portray uncertainty in point estimates through sensitivity analyses and through a Monte-Carlo/bootstrap approach (described below).

Sensitivity and retrospective analyses Sensitivity of results to some key model inputs and assumptions was examined through sensitivity analyses. These model runs, as well as retrospective analyses, vary from the base run as follows.

- S1: Low M at age (Lorenzen estimates rescaled so as to provide the same cumulative survival through the oldest observed age as would constant $M = 0.27$)
- S2: High M at age (Lorenzen estimates rescaled so as to provide the same cumulative survival through the oldest observed age as would constant $M = 0.53$)
- S3: Steepness $h = 0.4$
- S4: Steepness $h = 0.6$
- S5: Model component weights unadjusted
- S6: Model component weights adjusted using SDNRs, including indices of abundance (i.e., indices not up-weighted as in the base run)
- S7: Linearly increasing catchability with slope of 2% until 2003 and constant thereafter
- S8: Continuity run. Features include $M = 0.3$ constant across age, discard mortality of 0.15 for all gears, dome-shaped selectivity of MARMAP trap gears, and spawning biomass based on mature biomass of males and females combined.
- S9: Headboat index starts in 1984
- S10: Headboat index excluded entirely
- S11: Retrospective run with data through 2009
- S12: Retrospective run with data through 2008
- S13: Retrospective run with data through 2007

Retrospective analyses should be interpreted with caution because several data sources appear only near the end of the full time series. The headboat discard index began in 2005, commercial pot age composition data began in 2007, and closed-season commercial discards began in 2009.

3.1.1.4 **Parameters Estimated** The model estimated annual fishing mortality rates of each fishery, selectivity parameters, catchability coefficients associated with indices, parameters of the spawner-recruit model, annual recruitment deviations, and CV of size at age. Estimated parameters are described mathematically in the document, SEDAR-25-RW03.

3.1.1.5 **Per Recruit and Equilibrium Analyses** Static spawning potential ratio (static SPR) of each year was computed as the asymptotic spawners (population fecundity) per recruit given that year's fishery-specific *F*s 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 it represents SPR that would be achieved under an equilibrium age structure given the year-specific *F* (hence the word *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 §3.1.1.6), per recruit and equilibrium analyses applied the most recent selectivity patterns averaged across fisheries, weighted by each fleet's *F* from the last two years (2009–2010).

3.1.1.6 **Benchmark/Reference Point Methods** In this assessment of black sea bass, 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. The value of F_{MSY} is the F that maximizes equilibrium landings.

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 variance (σ_R^2) of recruitment deviation in log space: $\varsigma = \exp(\sigma_R^2/2)$. Then, equilibrium recruitment (R_{eq}) associated with any F is,

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

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 does the estimate of discard mortalities (D_{MSY}), here separated from ASY (and consequently, MSY).

Estimates of MSY and related benchmarks are conditional on selectivity pattern. The selectivity pattern used here was an average of terminal-year selectivities from each fishery, where each fishery-specific selectivity was weighted in proportion to its corresponding estimate of *F* averaged over the last two years (2009–2010). If the selectivities or relative fishing mortalities among fleets were to change, so would the estimates of MSY and related benchmarks.

The maximum fishing mortality threshold (MFMT) is defined by the SAFMC as F_{MSY}, and the minimum stock size threshold (MSST) as $\text{MSST} = (1-M)\text{SSB}_{\text{MSY}}$ (Restrepo et al. 1998), with constant M here equated to 0.38. Overfishing is defined as $F >$ MFMT and overfished as SSB < MSST. However, because this stock of black sea bass has already been declared overfished and is now under a rebuilding plan, this report focuses more on the ratio $\text{SSB:SSB}_{\text{MSY}}$ than on SSB:MSST, because reaching SSB_{MSY} is the criterion for rebuilding. Current status of the stock is represented by SSB in the latest assessment year (2010), and current status of the fishery is represented by the geometric mean of *F* from the latest two years (2009–2010).

In addition to the MSY-related benchmarks, the assessment considered proxies based on per recruit analyses (e.g., $F_{40\%}$). The values of $F_{X\%}$ are defined as those *F*s corresponding to X% spawning potential ratio, i.e., spawners (population fecundity) 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 of a fishing rate 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).

3.1.1.7 **Uncertainty and Measures of Precision** Uncertainty was in part examined through use of multiple models and sensitivity runs. 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). 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 $n = 3100$ 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 $n = 3100$ was chosen because at least 3000 runs were desired, and it was anticipated that not all runs would be valid. Of the 3100 trials, approximately 1.7% were discarded, because the model did not properly converge (in most cases, $F_{\rm init.ratio}$ became stuck at its lower bound). This left $n = 3048$ 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.

3.1.1.7.1 **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 ($\hat{O}_{s,y}$),

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

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 §III(2) of this assessment report).

Uncertainty in age and length compositions were included by drawing new distributions for each year of each data source, following a multinomial sampling process. Ages (or lengths) 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), and the effective sample sizes used for fitting (number of trips) was unmodified.

3.1.1.7.2 **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.

Natural mortality Point estimates of natural mortality ($M = 0.38$) 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 [0.27, 0.53]) with mean equal to the point estimate ($M = 0.38$) and standard deviation set to provide a lower 95% confidence limit at 0.27 (the low end of the DW range). 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 lines discard mortality was drawn for each MCB trial from a truncated normal distribution (DW range [0.04, 0.15]) with mean equal to the point estimate ($\delta = 0.07$) and standard deviation set to provide a lower 95% confidence limit at 0.04 (the low end of the DW range). The discard mortalities from commercial pots were then computed from the lines value by applying the ratio of pot:lines discard mortality point estimates: 0.05:0.07 (i.e., 5:7) ratio for 1.5-inch panel pots, and 0.01:0.07 (i.e., 1:7) ratio for 2-inch panel pots. This approach preserved the accepted relationship among discard mortality rates that the highest values were from lines and the lowest values were from pots with 2-inch panels.

Weighting of indices In the base run, external weights applied to four indices (commercial, headboat, MARMAP blackfish/snapper and chevron traps) were adjusted upward to a value of $\omega = 2.5$. In MCB trials, that weight was drawn from a uniform distribution with bounds at $\pm 25\%$ of 2.5.

3.1.1.8 **Acceptable Biological Catch** When a stock is not overfished, acceptable biological catch (ABC) could be computed through probability-based approaches, such as that of Shertzer et al. (2008*b*), designed to avoid overfishing. However, for overfished stocks, rebuilding projections would likely supersede other approaches for computing ABCs.

3.1.1.9 **Projection Methods** Projections were run to predict stock status in years after the assessment, 2011–2016. The year 2016 is the last year of the current rebuilding plan.

The structure of the projection model was the same as that of the assessment model, and parameter estimates were those from the assessment. 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 and discard mortalities according to the selectivity curves averaged across fisheries, using geometric mean F from the last two years of the assessment period.

Central tendencies of SSB (time of peak spawning), F, recruits, landings, and discards were represented by deterministic projections using parameter estimates from the base run. 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 SSB_{MSY}. Uncertainty in future time series was quantified through projections that extended the Monte Carlo/Bootstrap (MCB) fits of the stock assessment model.

Initialization of projections Point estimates of initial abundance at age in the projection (start of 2011), other than at age 0, were taken to be the 2010 estimates from the assessment, discounted by 2010 natural and fishing mortalities. The initial abundance at age 0 was computed using the estimated spawner-recruit model and a 2011 estimate of SSB. This estimate of SSB_{2011} required a three-month projection of initial abundance to the time of peak spawning, which was accomplished by applying F_{current}, but without mortality from commercial landings, reflecting the commercial closure at start of 2011, and with only one month of recreational fishing, reflecting the recreational closure in early February 2011.

Fishing rates or catch levels that define the projections were assumed to start in 2012, which is the earliest year management could react to this assessment. Because the assessment period ended in 2010, the projections required an initialization period (2011). The level of landings in 2011 was assumed equal to one of three values: the current quota of 847,000 lb, 150% the current quota, or 200% the current quota. The latter two were intended to address the possibility that landings in 2011 would exceed the quota.

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 carried forward uncertainties in natural mortality and in discard mortality, as well as in estimated quantities such as spawner-recruit parameters, selectivity curves, and in initial (start of 2011) 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,

$$R_y = \bar{R}_y \exp(\epsilon_y). \tag{3}$$

Here ϵ_y was 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 generated 20,000 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 would still differ as a result of stochasticity in projected recruitment streams. Precision of projections was represented graphically by the 5^{th} and 95^{th} percentiles of the replicate projections.

Rebuilding time frame Based on results from previous SEDAR assessments, black sea bass is currently under a 10-year rebuilding plan. In this plan, the target terminal year is 2016, and rebuilding is defined by the criterion that 50% of projection replicates achieve stock recovery (i.e., $SSB_{2016} \geq SSB_{MSY}$). The value of 0.5 probability of success was chosen by the SAFMC when the rebuilding plan was initiated.

Projection scenarios Three projection scenarios were considered. In each, the landings in 2011 assumed one of three values: 100%, 150%, or 200% of the current quota, 847,000 lb. The F_{rebuild} is defined as the maximum F that achieves rebuilding in the allowable time frame, and similarly, L_{rebuild} is the maximum landings that achieves rebuilding.

- Scenario 1: $F = F_{\text{rebuild}}$, with 2011 landings at 100% of current quota
- Scenario 2: $F = F_{\text{rebuild}}$, with 2011 landings at 150% of current quota
- Scenario 3: $F = F_{\text{rebuild}}$, with 2011 landings at 200% of current quota
- Scenario 4: $L = 847,000$ lb, with 2011 landings at 100% of current quota
- Scenario 5: $L = 847,000$ lb, with 2011 landings at 150% of current quota

- Scenario 6: $L = 847,000$ lb, with 2011 landings at 200% of current quota
- Scenario 7: $L = L_{\text{rebuild}}$, with 2011 landings at 100% of current quota
- Scenario 8: $L = L_{\text{rebuild}}$, with 2011 landings at 150% of current quota
- Scenario 9: $L = L_{\text{rebuild}}$, with 2011 landings at 200% of current quota

3.1.2 **Model 1 Results**

3.1.2.1 **Measures of Overall Model Fit** Generally, the Beaufort assessment model (BAM) fit well to the available data. Predicted length compositions from each fishery were reasonably close to observed data in most years, as were predicted age compositions (Figure 3.2).

The residuals from fits to length compositions show some consistent patterns of positive and negative values across years for the same length bins. These patterns might in part be a reflection of simplifying assumptions for modeling growth. For instance, the transition from age to length applied an age-length transition matrix, constructed with fixed growth parameters and one estimated parameter for CV of length at age. More complex growth models are possible but would likely require additional data to support estimation of additional parameters.

The model was configured to fit observed commercial and recreational landings closely (Figures 3.3–3.7), as well as observed discards (Figures 3.8–3.10). Fits to indices of abundance captured the general trends but not all annual fluctuations (Figures 3.11–3.15).

3.1.2.2 **Parameter Estimates** Estimates of all parameters from the catch-age model are shown in Appendix B. Estimates of management quantities and some key parameters, such as those of the spawner-recruit model, are reported in sections below.

3.1.2.3 **Stock Abundance and Recruitment** In general, estimated abundance at age showed truncation of the older ages through the mid-1990s, and more stable or increasing values since (Figure 3.16; Table 3.2). Total estimated abundance at the end of the assessment period showed some general increase from a low in 2004. Annual number of recruits is shown in Table 3.2 (age-0 column) and in Figure 3.17. In the most recent decade, a notably strong year class (age-0 fish) was predicted to have occurred in 2001 and better than expected recruitment (i.e., positive residuals) in 2006 and 2007.

3.1.2.4 **Total and Spawning Biomass** Estimated biomass at age followed a similar pattern as abundance at age (Figure 3.18; Table 3.3). Total biomass and spawning biomass showed similar trends—general decline from early 1980s until the mid-1990s, and general but gradual increase since (Figure 3.19; Table 3.4).

3.1.2.5 **Selectivity** Estimated selectivities of the two MARMAP trap gears were similar (Figure 3.20). Selectivities of landings from commercial and recreational fleets are shown in Figures 3.21–3.23. In general, selectivities shift toward older ages with increased size limits. In the most recent years, full selection occurred near age-4 for most gears, age-5 for commercial lines.

Selectivity of discard mortalities from commercial fleets was mostly on age-2 and age-3 fish, with relatively low selection of age-1 and age-4 fish (Figure 3.24). In 2009 and 2010, discard selectivities included more older fish (fish of legal size), accounting for black sea bass caught during closed seasons, mostly from handlines. Selectivity of discard mortalities from the headboat and general recreational fleets was mostly of age-2 and age-3 fish; since 2007, it included more older fish with the 12-inch size limit (Figure 3.25).

Average selectivities of landings and of discard mortalities were computed from F-weighted selectivities in the most recent period of regulations (Figure 3.26). These average selectivities were used to compute benchmarks and central-tendency projections. All selectivities from the most recent period, including average selectivities, are tabulated in Table 3.5.

3.1.2.6 **Fishing Mortality** The estimated fishing mortality rates (F) increased through the mid-1990s, and since then have been quite variable (Figure 3.27). The general recreational fleet has been the largest contributor to total F (Table 3.6).

Estimates of total F at age are shown in Table 3.7. In any given year, the maximum F at age (i.e., apical F) may be less than that year's sum of fully selected Fs across fleets. 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 have dome-shaped selectivity.

Table 3.8 shows total landings at age in numbers, and Table 3.9 in weight. In general, the majority of estimated landings were from the recreational sector, i.e., headboat and general recreational fleets (Figures 3.28, 3.29; Tables 3.10, 3.11). Estimated discard mortalities occurred on a smaller scale than landings (Figure 3.30; Tables 3.12, 3.13)

3.1.2.7 **Spawner-Recruitment Parameters** The estimated Beverton–Holt spawner-recruit curve is shown in Figure 3.31, along with the effect of density dependence on recruitment, depicted graphically by recruits per spawner as a function of spawners (population fecundity). Values of recruitment-related parameters were as follows: steepness $\hat{h} = 0.49$, unfished age-0 recruitment $\widehat{R_0} = 37,330,170$, unfished spawning biomass per recruit $\phi_0 = 1.098\text{E}{-5}$, and standard deviation of recruitment residuals in log space $\widehat{\sigma_R} = 0.38$ (which resulted in bias correction of $\varsigma = 1.08$). Uncertainty in these quantities was estimated through the Monte Carlo/bootstrap (MCB) analysis (Figure 3.32).

3.1.2.8 **Per Recruit and Equilibrium Analyses** Static spawning potential ratio (static SPR) showed a general trend of decline until the mid-1990s, followed by an increasing and then stable trend since 2000 (Figure 3.33, Table 3.4). Values lower than the MSY level imply that, given estimated fishing rates, population equilibria would be lower than desirable (as defined by MSY). Values near the end of the time series were only slightly lower than those expected at MSY.

Yield per recruit and spawning potential ratio were computed as functions of F (Figure 3.34). 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 two years (2009–2010). The yield per recruit curve peaked at F_{max} = 1.8, but this maximum was not well defined in the sense that a wide range of F provided nearly identical yield per recruit. The F that provides 50% SPR is $F_{50\%}$ = 2.1, but $F_{30\%}$ and $F_{40\%}$ were not defined over the range of F examined (0.0, 3.0). For comparison, F_{MSY} corresponds to about 66% SPR. Although this % SPR appears high, it occurs here because black sea bass mature quickly relative to the size limit, which in conjunction with the low discard mortality rate, offers some protection to mature females.

As in per recruit analyses, equilibrium landings and spawning biomass were computed as functions of F (Figure 3.35). By definition, the F that maximizes equilibrium landings is F_{MSY}, and the corresponding landings and spawning biomass are MSY and SSB_{MSY}. Equilibrium landings and discards could also be viewed as functions of biomass B, which itself is a function of F (Figure 3.36).

3.1.2.9 **Benchmarks / Reference Points** As described in §3.1.1.6, biological reference points (benchmarks) were derived analytically assuming equilibrium dynamics, corresponding to the expected spawner-recruit curve (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 SSB_{MSY}). Reference points estimated were F_{MSY}, MSY, B_{MSY} and SSB_{MSY}. Based on F_{MSY}, three possible values of F at optimum yield (OY) were considered—F_{OY} = 65%F_{MSY}, F_{OY} = 75%F_{MSY}, and F_{OY} = 85%F_{MSY}—and for each, the corresponding yield was computed. Standard errors of benchmarks were approximated as those from Monte Carlo/bootstrap analysis (§3.1.1.7).

Estimates of benchmarks are summarized in Table 3.14. Point estimates of MSY-related quantities were F_{MSY} = 0.698 (y^{-1}), MSY = 1767 (klb), B_{MSY} = 5399 (mt), and SSB_{MSY} = 248 (1E10 eggs). Distributions of these benchmarks from the MCB analysis are shown in Figure 3.37.

3.1.2.10 **Status of the Stock and Fishery** Estimated time series of stock status (SSB/MSST and SSB/SSB_{MSY}) showed general decline until the mid-1990s and some increase since (Figure 3.38, Table 3.4). The increase in stock status appears to have been initiated by a strong year class in 1994 and perhaps reinforced later by additional recruitment pulses and by management regulations. Base-run estimates of spawning biomass have remained near MSST and below SSB_{MSY} since the early 1990s. Current stock status was estimated in the base run to be SSB_{2010}/MSST = 1.13 and SSB_{2010}/SSB_{MSY} = 0.70 (Table 3.14), indicating that the stock is not overfished but is also not fully rebuilt. Uncertainty from the MCB analysis suggested that the estimate of SSB relative to SSB_{MSY} is robust, but that the status relative to MSST is less certain (Figures 3.39, 3.40). Age structure estimated by the base run showed fewer older fish in the last decade than the (equilibrium) age structure expected at MSY (Figure 3.41), however with improvement in the terminal year (2010), particularly for ages younger than six.

The estimated time series of F/F_{MSY} suggests that overfishing has been occurring throughout most of the assessment period (Table 3.4), but with much uncertainty demonstrated by the MCB analysis (Figure 3.38). Current fishery status in the terminal year, with current F represented by the geometric mean from 2009–2010, was estimated by the base run to be $F_{2009-2010}/F_{MSY}$ = 1.07 (Table 3.14), but again with much uncertainty in that estimate (Figures 3.39, 3.40).

3.1.2.11 **Sensitivity and Retrospective Analyses** Sensitivity runs, described in §3.1.1.3, may be useful for evaluating implications of assumptions in the base assessment model, and for interpreting MCB results in terms of expected effects from input parameters. Time series of F/F_{MSY} and $\mathrm{SSB}/\mathrm{SSB}_{\mathrm{MSY}}$ are plotted to demonstrate sensitivity to natural mortality (Figure 3.42), steepness (Figure 3.43), model component weights (Figure 3.44), catchability (Figure 3.45), continuity assumptions (Figure 3.46), and the headboat index (Figure 3.47). The qualitative results on terminal stock status were the same across all sensitivity runs, indicating that the stock is not yet rebuilt ($\mathrm{SSB} < \mathrm{SSB}_{\mathrm{MSY}}$). Most of these runs, but not all, suggested that overfishing is still occurring (Figure 3.48, Table 3.15). In concert, sensitivity analyses were in general agreement with those of the MCB analysis.

Retrospective analyses did not suggest any patterns of substantial over- or underestimation in terminal-year estimates (Figure 3.49).

3.1.2.12 **Projections** By design, projections based on F_{rebuild} predicted the stock to rebuild in 2016 with probability of 0.5 (Figures 3.50–3.52, Tables 3.16–3.18). Lower levels of landings in 2011 allowed for higher levels of F_{rebuild} in subsequent years.

Projections based on the current quota (847,000 lb) predicted the stock to rebuild with probability that exceeded 0.5 (Figures 3.53–3.55, Tables 3.19–3.21).

Again by design, projections based on L_{rebuild} predicted the stock to rebuild in 2016 with probability of 0.5 (Figures 3.56–3.58, Tables 3.22–3.24). Lower levels of landings in 2011 allowed for higher levels of L_{rebuild} in subsequent years.

3.2 Model 2: Surplus Production Model

3.2.1 Model 2 Methods

3.2.1.1 **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 and decomposing population dynamics into multiple processes including growth, mortality, and recruitment. A simplified approach is to aggregate data across age or length classes, and to summarize the relationship among complex population processes by using a simple mathematical model such as the logistic population model.

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

3.2.1.2 **Data Sources** For use in the production model, data developed at the DW required some additional formatting, described below.

Landings The landings input to ASPIC must be in units of biomass. Headboat (1978–2010) and MRFSS private and charter mode (1981–2010) recreational landings in numbers and weight were developed at the SEDAR-25 DW. To extend the MRFSS landings to 1978 (similar to the headboat landings), MRFSS landings for the years 1978–1980 were computed as the geometric mean of MRFSS landings from 1981–1983. The years 1981–1983 were chosen because this is the period for which data were available prior to the first regulation of the fishery. MRFSS and headboat landings in weight were summed to give total recreational landings.

Historical recreational landings (1950–1977) in weight were developed using ratios of recreational to commercial landings. Commercial landings in weight for pots, trawls, vertical lines, and 'other' gear during 1950–2010 were developed at the SEDAR-25 DW. These were summed to give total commercial landings. Recreational landings during 1950–1977 were then hindcast assuming ratios of recreational to commercial landings of 0.5: 1, 1:1, 2:1, and 3:1. The 0.5:1 ratio was based on recommendations of fishermen who did not believe recreational landings were historically higher than commercial landings. The remaining ratios were based on an analysis of data from 1978–2010 indicating that total annual commercial to recreational landings (in weight) ranged 0.67–4.72 (mean = 1.95); these ratios are similar to those used in the SEDAR 2005 update assessment of black sea bass.

Dead Discards Estimates of recreational discards in numbers during 1981–2010 were developed at the SEDAR-25 DW. The number of recreational discards during 1978–1980 were imputed as the geometric mean of those from the period 1981–1983, as described above. Recreational discards in numbers were converted to weight via a three-step process. First, a mortality rate of 0.07 developed at the SEDAR-25 DW was applied to the total number of recreational discards to estimate discard mortality. Second, the mean length of these discards was estimated from length compositions of headboat discards (2005–2010) that were developed at the SEDAR-25 DW. The mean total length (mm) of recreational discards was estimated for each year of 1978–2010 as the mean TL of fish below the size limit in place that year from these at-sea discard length compositions. This approach probably provides a more realistic estimate of the size of discarded fish than using the annual size limit (which ranged 8–12 inches), but assumes the length composition of headboat discards from 2005–2010 are representative of all recreational discards over the modeled period (1978–2010 or 1950–2010). Third, mean whole weight of recreational discards was calculated from mean TL using the length-weight relationship provided by the SEDAR-25 DW. This mean weight was then multiplied by the estimated number of discard mortalities to give total recreational discards in weight. For the historical period (1950–1977), recreational discards were assumed to be a constant proportion of recreational landings. This proportion was taken as the geometric mean proportion of recreational discards relative to recreational landings during 1978–1983, the period during which data were available but the fishery was unregulated.

Estimates of commercial discards in numbers during 1993–2010 for the vertical line and trap fisheries were provided by the SEDAR-25 DW. These were converted to weight of commercial discards as described above for recreational discards, except that gear-specific discard mortality rates were used. These were provided by the SEDAR-25 DW and were 0.07 for vertical lines, 0.05 for traps with 1.5-inch back panels, and 0.01 for traps with 2-inch back panels. No data on commercial discards were available for 1984–1992, a period when an 8-inch commercial size limit was in place. Commercial discards during this period were calculated using the geometric mean fishing effort and discard rate (provided by the SEDAR-25 DW) from 1993–1998 and the method to convert to weight described above. The period 1993–1998 was chosen because this was the period over which data were available and the 8-inch minimum size limit was also in place. Commercial discards prior to 1984, when no size limit was in place, were assumed to be negligible.

On average recreational discards were less than two percent and commercial discards were less than one percent of landings on a weight basis, suggesting discards comprise a small amount of the yield from the system. Total commercial and recreational discards and landings were summed to give the total annual removals from the system (Figure 3.59 and Table 3.25).

Indices of Abundance The surplus–production model was fit to four indices of abundance: (1) MARMAP chevron trap (1990–2010), (2) Headboat (1979–2010), (3) Commercial vertical lines (1993–2010), and (4) MARMAP blackfish/snapper traps (1981–1987). The headboat index and vertical line index were developed in units of weight/hr and weight/hook-hr, respectively, at the SEDAR-25 DW. The two MARMAP indices were developed in units of number/trap-hr at the SEDAR-25 DW. These units were converted to weight by calculating mean length for each year from the survey length composition data and using the length-weight relationship to convert to mean weight (Table 3.25).

3.2.1.3 **Model Configuration and Equations** Production modeling used the 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). Estimation 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) and an intrinsic rate of population growth. 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 the absence of density dependence, and K is the 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.

For black sea bass, one base run and four sensitivity runs of the production model were recommended during the SEDAR-25 AW. The base run was developed for 1978–2010 to match the period of the base run for the age-structured model. The four sensitivity runs considered alternative ratios to hindcast recreational landings for the historical period (1950–1977) when commercial landings were available but recreational landings were not. These ratios of recreational to commercial landings were 0.5:1, 1:1, 2:1, and 3:1. Each run used total removals (commercial and recreational landings and discards) as described above and the four indices of abundance for fitting the model. $B1/K$ was allowed to vary freely for all model runs. Initial values for model parameters and convergence criteria were set to those recommended in Prager (2005). Nonparametric confidence intervals were estimated through bootstrapping ($n = 500$).

3.2.2 Model 2 Results

3.2.2.1 **Model Fit** The fit to the four indices were similar across model runs (Figure 3.60). The model captured the decline in the headboat index beginning in the mid 1980's, the consistently low headboat CPUE through the mid 2000's and the slight increase in CPUE in (2009–2010). Even so, the model tended to underfit the headboat index during the period of decline (1979–1992). Several attempts were made to increase the weight of the headboat index during the fitting process, but these did not noticeably improve the fit. The model fit the other three indices reasonably well but tended to smooth over strong year-to-year variability in the indices, as would be expected with a surplus production model. Because all runs were conditioned on catch, landings were fit exactly.

3.2.2.2 **Management Benchmarks, Sensitivity Analysis, and Uncertainty** Trends in relative fishing mortality (F/F_{MSY}) and relative biomass (B/B_{MSY}) during 1978–2010 are consistent with a stock that is below B_{MSY} and is undergoing overfishing (Figure 3.61). In the base model configuration of ASPIC, estimates of F/F_{MSY} varied around 1.0 during 1978–1987, rose sharply in the late 1980's, remained high through 2007 (though with considerable annual variability), and has decreased in more recent years to about $F_{2010}/F_{\text{MSY}} = 1.22$. Estimates of B/B_{MSY} varied around 1.0 during 1978–1988 and then declined sharply in the late 1980's as fishing mortality increased. Annual variability in relative biomass was less pronounced than in relative fishing mortality, with B/B_{MSY} varying from 0.3 to 0.45 through most of the 1990's and 2000's. Since 2007, B/B_{MSY} has increased until the terminal year, $B_{2011}/B_{\text{MSY}} = 0.5$. The 80% confidence bands of the 500 bootstrap replicates showed considerable uncertainty in the time series of F/F_{MSY} and B/B_{MSY} (Figure 3.61). Output from the ASPIC base run, including bootstrap results, is in Appendix C.

The four sensitivity runs based on different assumed ratios of recreational to commercial landings led to qualitative differences (i.e., below vs. above 1.0) in F/F_{MSY} and B/B_{MSY} during the historical period (1950–1977), however the current status indicators were all in qualitative agreement (Figure 3.62). Across the model configurations, terminal-year estimates of F_{2010}/F_{MSY} ranged from 1.13 to 1.48, and estimates of B_{2011}/B_{MSY} ranged from 0.29 to 0.56 (Table 3.26). Thus, qualitative results of all sensitivity runs agreed with those of the base run. This suggests that the general conclusions about current stock and fishery status are robust to uncertainty in historic landings (Table 3.26).

In general, results from ASPIC were qualitatively similar to those from the BAM.

3.3 Discussion

3.3.1 Comments on Assessment Results

Estimated benchmarks played a central role in this assessment. Values of SSB_{MSY} and F_{MSY} were used to gauge the status of the stock and fishery. For rebuilding projections, SSB reaching SSB_{MSY} was the criterion that defined a successfully rebuilt stock. Computation of benchmarks was conditional on selectivity. If selectivity patterns change in the future, for example as a result of new size limits or different relative catch allocations among sectors, estimates of benchmarks would likely change as well.

The base run of the BAM indicated that the stock is not yet rebuilt ($\text{SSB}_{2010}/\text{SSB}_{\text{MSY}} = 0.70$), and that overfishing is occurring ($F_{2009-2010}/F_{\text{MSY}} = 1.07$). The same qualitative findings resulted from the production model applications. In addition, these results were generally consistent across sensitivity runs and MCB analyses, but with more uncertainty in the overfishing status than in the rebuilding status. It should be noted that overfishing can be sustainable, but in the long-term, it tends to result in lower than desirable levels of stock size.

Of the sensitivity runs conducted with the BAM, results were least sensitive to the increase in catchability and to the headboat index. They were most sensitive to natural mortality, steepness, and model component weights. Sensitivity to natural mortality and steepness is common in stock assessment. Sensitivity to model component weights occurred here primarily because the alternative weighting schemes gave lower priority to the indices (relative to other data sources) than did the base run. This led to quite different estimates of spawner-recruit parameters (lower steepness, higher $R0$), which in turn led to different estimates of benchmarks (Table 3.15). The AW increased the base-run weighting on indices, noting that the strong positive correlations between indices suggested they were tracking the same underlying signal (abundance). This approach was consistent with the principle that indices should be given top priority because they provide direct information about abundance, the stock assessment output of primary interest (Francis 2011).

The continuity run resulted in higher F/F_{MSY} and lower SSB/SSB_{MSY} than did the base run. These differences in the continuity run occurred for two main reasons: the lower and age-invariant natural mortality rate ($M = 0.3$) and the different measure of spawning biomass (mature biomass rather than fecundity). Model runs with either of these features resulted in status indicators much more similar to the continuity run than to the base run (results not shown).

Since the previous assessment of black sea bass in 2005 (SEDAR 2005), stock biomass is estimated to be increasing. The 2010 biomass estimate was near the highest level predicted since the early 1990s. Anecdotal reports from fishermen suggest continued increase in 2011. Such reports would be consistent with the prediction of strong recruitment classes in 2006 and 2007 (ages 5 and 4 in 2011, respectively) that have both become fully selected starting in 2011.

Although stock biomass is estimated to be increasing, the rate of increase has likely been dampened by levels of landings that routinely exceed the quota. An approximate comparison of estimated total landings (Table 3.11) and the relevant quotas (1310 in 2006, 1160 in 2007, and 847 in 2008–2010, all in units of 1000 lb whole weight) reveals only minimal overages in 2006 and 2007, but higher since then (e.g., ~45% in 2010). The previous comparison is *approximate* because the estimated landings apply to calendar years and the quotas to fishing years. Nonetheless, the pattern of overages appears real and, along with stock biomass and age structure, contributes to the continued estimates of overfishing, despite implementation of quotas below MSY.

Compared to other stocks of the southeast U.S., black sea bass are effectively sampled by traps. As a result, data from MARMAP's chevron traps provide one of the southeast's more reliable fishery independent indices of abundance. Strong correlations between this index and others used in the assessment provide support for the notion that these indices are tracking similar signals of relative abundance.

Most assessed stocks in the southeast U.S. have shown histories of heavy exploitation. High rates of fishing mortality can lead to adaptive responses in life-history characteristics, such as growth and maturity schedules. Such adaptations can affect expected yield and stock recovery, and thus resource managers might wish to consider possible evolutionary effects of fishing in their management plans (Dunlop et al. 2009; Enberg et al. 2009).

The assessment accounted for the protogyny of black sea bass by measuring spawning biomass (population fecundity) from a population with a decreasing proportion of females at age. Accounting for protogynous sex change is important for stock assessment (Alonzo et al. 2008), and the approach taken here has the advantage of being tractable. However, it ignores possible dynamics of sexual transition, which may be quite complex (e.g., density dependent, mating-system dependent, occurring at local spatial scales). In addition, a protogynous life history accompanied by size- or age-selective harvest places disproportionate fishing pressure on males. This situation creates the possibility for population growth to become limited by the proportion of males. When this occurs, accounting for male (sperm) limitation may be important to the stock assessment (Alonzo and Mangel 2004; Brooks et al. 2008); however, in practice there is typically little or no information available to quantify sperm limitation. For this assessment, the life-history group of the Data Workshop did not think sperm limitation to be likely for this stock of black sea bass.

3.3.2 Comments on 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 were based on the calendar year because they are extensions of the assessment model. A shift in the fishing year relative to calendar year may introduce some unquantified disconnect between projection results and management implementation. However, if quotas are reached each year prior to December 31, as might be expected, all fishing mortality within a fishing year would also occur within the same calendar year.
- 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 evenly throughout the year. This assumption is violated when seasonal closures are in effect, introducing additional and unquantified uncertainty into the projection results.
- The 2011 landings were expected to exceed the quota, but at the time of this assessment, the degree of overage is unknown. When that information becomes available, projections may need revision, as results were sensitive to 2011 landings in the L_{rebuild} and F_{rebuild} scenarios. Revised projections might additionally account for any Accountability Measures implemented in response to exceeding the 2011 quota.

3.4 Research Recommendations

- The assessment panel recommended increasing the number of age samples collected from the general recreational sector.

- Black sea bass in the southeast U.S. were modeled in this assessment as a unit stock, as recommended by the DW and supported by genetic analysis (SEDAR-25-RD42). For any stock, variation in exploitation and life-history characteristics might be expected at finer geographic scales. Modeling such sub-stock structure would require more data, such as information on the movements and migrations of adults and juveniles, as well as spatial patterns of recruitment. Even when fine-scale spatial structure exists, incorporating it into a model may or may not lead to better assessment results (e.g., greater precision, less bias). Spatial structure in a black sea bass assessment model might range from the very broad (e.g., a single Atlantic stock) to the very narrow (e.g., a connected network of meta-populations living on individual reefs). What is the optimal level of spatial structure to model in an assessment of snapper-grouper species such as black sea bass?

- The assessment time period (1978–2010) is short relative to some other assessments of South Atlantic reef fishes. Extending the assessment back in time might provide improved understanding of the stock's potential productivity and therefore sustainable yield, assuming the historic productivity is still relevant. Such an extension would require historic landings estimates from all fleets in operation. Although historic estimates from the commercial sector are available, those from the recreational sector are not. Hindcasting the historic recreational landings might require the development of new methods, or at least analysis of existing methods.

- Protogynous life history: 1) Investigate possible effects of hermaphroditism on the steepness parameter; 2) Investigate the sexual transition for temporal patterns, considering possible mechanistic explanations if any patterns are identified; 3) Investigate methods for incorporating the dynamics of sexual transition in assessment models.

- In this assessment, the number of spawning events per mature female per year assumed a constant value of $X = 31$. That number was computed from the estimated spawning frequency and spawning season duration. If either of those characteristics depends on age or size, X would likely also depend on age or size. For black sea bass, does spawning frequency or spawning season duration (and therefore X) depend on age or size? Such dependence would have implications for estimating spawning potential as it relates to age structure in the stock assessment.

- For this assessment, the age-dependent natural mortality rate was estimated by indirect methods. More direct methods, e.g. tag-recapture, might prove useful. Some tag-recapture studies have demonstrated relatively high tag return rates for black sea bass, at least compared to those of other reef fishes of the southeast U.S.

3.5 References

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3.6 Tables

Table 3.1. Life-history characteristics at age of the population, including average body size and weight (mid-year), annual fecundity per mature female (number batches X eggs per batch), proportion females mature, and proportion females at age.

Age	Total length (mm)	Total length (in)	CV length	Whole weight (kg)	Whole weight (lb)	Fecundity (1E6 eggs)	Female maturity	Proportion female
0	110.2	4.3	0.14	0.02	0.05	0.08	0.00	0.963
1	172.8	6.8	0.14	0.08	0.17	0.10	0.52	0.918
2	225.2	8.9	0.14	0.16	0.36	0.16	0.90	0.827
3	269.1	10.6	0.14	0.27	0.60	0.28	0.98	0.671
4	305.9	12.0	0.14	0.39	0.85	0.52	1.00	0.465
5	336.7	13.3	0.14	0.50	1.11	0.98	1.00	0.270
6	362.5	14.3	0.14	0.62	1.36	1.79	1.00	0.136
7	384.2	15.1	0.14	0.72	1.60	3.16	1.00	0.063
8	402.3	15.8	0.14	0.82	1.81	5.33	1.00	0.028
9	417.5	16.4	0.14	0.91	2.01	8.53	1.00	0.012
10	430.2	16.9	0.14	0.99	2.18	12.97	1.00	0.005
11	440.9	17.4	0.14	1.06	2.34	18.75	1.00	0.002

Table 3.2. Estimated total abundance at age (1000 fish) at start of year.

Year	0	1	2	3	4	5	6	7	8	9	10	11	Total
1978	52118.70	11789.83	7155.89	3226.75	1682.90	923.20	502.19	278.51	157.04	89.35	51.29	70.28	78045.92
1979	66710.04	20555.53	6150.31	3742.69	1602.61	856.55	481.71	267.25	151.21	86.11	49.49	68.01	100721.51
1980	59977.59	26303.38	10647.18	2991.77	1664.90	724.56	396.42	227.36	128.68	73.54	42.30	58.30	103235.99
1981	24029.91	23646.59	13589.98	5043.82	1279.40	725.66	323.53	180.53	105.63	60.39	34.86	48.16	69068.46
1982	71886.14	9474.78	12244.13	6642.28	2279.51	582.53	337.41	153.39	87.32	51.60	29.80	41.38	103810.28
1983	24294.11	28339.95	4887.65	5611.88	2624.75	908.64	237.43	140.24	65.04	37.40	22.32	31.10	67200.52
1984	23994.64	9580.35	14735.72	2472.22	2648.02	1258.46	446.00	118.85	71.62	33.55	19.48	28.11	55407.03
1985	63678.31	9458.28	4960.89	7220.79	949.18	982.22	475.20	171.69	46.68	28.41	13.44	19.26	88004.34
1986	47161.26	25106.86	4915.47	2544.86	3184.56	412.74	435.42	214.78	79.17	21.74	13.36	15.54	84105.75
1987	42653.83	18595.27	13042.49	2524.85	1165.80	1459.86	193.19	207.81	104.57	38.93	10.80	14.50	80011.90
1988	23633.00	16815.97	9649.38	6575.15	1061.44	481.71	614.93	82.97	91.05	46.28	17.40	11.42	59080.69
1989	31480.77	9309.95	8609.61	4147.47	1779.81	258.01	117.94	153.39	21.11	23.40	12.01	7.56	55921.05
1990	18582.69	12407.09	4799.68	4035.54	1456.80	571.34	83.29	38.78	51.46	7.15	8.01	6.77	42048.60
1991	22729.87	7324.76	6402.09	2290.42	1577.06	526.33	207.61	30.83	14.65	19.63	2.76	5.75	41131.75
1992	14591.36	8957.56	3763.75	2918.99	791.73	493.36	164.93	66.26	10.04	4.82	6.52	2.85	31772.17
1993	24508.07	5749.82	4593.16	1680.90	971.03	235.11	146.30	49.81	20.41	3.12	1.51	2.98	37962.22
1994	38660.23	9656.99	2943.81	2019.62	544.68	278.96	67.35	42.68	14.82	6.13	0.95	1.38	54237.58
1995	27230.56	15227.74	4897.41	1178.49	535.68	119.27	59.88	14.71	9.51	3.33	1.39	0.53	49278.51
1996	21273.57	10723.49	7715.44	1905.72	269.69	96.97	21.11	10.78	2.70	1.76	0.62	0.36	42022.22
1997	20961.55	8380.60	5472.26	3246.54	526.53	59.37	20.86	4.62	2.41	0.61	0.40	0.23	38675.97
1998	22529.50	8260.39	4299.18	2459.33	1092.63	151.13	16.83	6.02	1.36	0.72	0.18	0.19	38817.46
1999	16231.38	8880.71	4261.23	2054.67	956.84	372.27	51.07	5.79	2.11	0.48	0.26	0.14	32816.94
2000	26053.87	6403.63	4665.30	2412.81	716.75	254.91	92.33	12.78	1.48	0.54	0.13	0.10	40614.64
2001	36493.08	10278.83	3362.81	2654.21	947.66	239.74	83.20	30.58	4.32	0.50	0.19	0.08	54095.19
2002	21390.18	14397.02	5392.15	1876.61	851.28	240.23	59.33	20.90	7.83	1.12	0.13	0.07	44236.84
2003	25828.62	8439.04	7568.98	3078.78	700.07	261.56	71.61	17.93	6.44	2.44	0.35	0.06	45975.89
2004	16520.09	10190.19	4437.71	4341.97	1217.42	233.85	85.49	23.75	6.07	2.20	0.84	0.14	37059.72
2005	21274.54	6517.34	5343.59	2464.18	1347.02	291.38	54.61	20.26	5.74	1.48	0.54	0.25	37320.93
2006	25957.35	8393.14	3419.49	3006.37	896.15	411.43	88.64	16.90	6.40	1.83	0.48	0.26	42198.43
2007	26828.58	10240.34	4397.10	1900.06	1025.20	256.50	117.43	25.75	5.01	1.92	0.55	0.22	44798.66
2008	24121.93	10584.16	5365.46	2477.57	690.31	243.98	60.13	28.12	6.30	1.24	0.48	0.20	43579.89
2009	23465.98	9516.73	5558.77	3082.80	1026.17	211.56	73.67	18.50	8.84	2.00	0.40	0.22	42965.65
2010	26923.73	9258.04	5001.44	3209.07	1324.74	350.62	71.08	25.19	6.46	3.12	0.71	0.22	46174.43

Table 3.3. Estimated biomass at age (1000 lb) at start of year

Year	0	1	2	3	4	5	6	7	8	9	10	11	Total
1978	2618.0	2057.8	2601.9	1921.8	1429.5	1022.9	682.8	444.7	284.8	179.7	112.0	164.2	13520.1
1979	3351.0	3587.6	2236.1	2229.1	1361.1	949.1	655.0	426.6	274.3	173.1	108.0	159.0	15510.4
1980	3012.8	4590.7	3871.3	1781.8	1414.0	802.9	539.0	363.1	233.5	147.9	92.4	136.2	16985.5
1981	1207.0	4127.1	4941.2	3004.0	1086.7	804.0	439.8	288.1	191.6	121.5	76.1	112.7	16400.0
1982	3611.0	1653.7	4452.0	3956.0	1936.1	645.5	458.8	244.9	158.3	103.6	65.0	96.8	17381.7
1983	1220.3	4946.3	1777.1	3342.2	2229.3	1006.9	322.8	224.0	117.9	75.2	48.7	72.8	15383.4
1984	1205.3	1672.0	5357.9	1472.5	2249.2	1394.4	606.5	189.8	129.9	67.5	42.5	65.7	14453.1
1985	3198.7	1650.8	1803.8	4300.6	806.2	1088.4	646.2	274.0	84.7	57.1	29.3	45.0	13984.8
1986	2369.1	4381.9	1787.3	1515.7	2704.9	457.5	592.2	342.8	143.5	43.7	29.1	36.4	14403.7
1987	2142.7	3245.4	4742.1	1503.8	990.1	1617.8	262.8	331.8	189.6	78.3	23.6	34.0	15161.6
1988	1187.2	2934.8	3508.4	3916.1	901.5	533.7	836.2	132.5	165.1	93.0	37.9	26.7	14273.4
1989	1581.4	1624.8	3130.3	2470.1	1511.7	285.9	160.3	244.9	38.4	47.0	26.2	17.6	11138.9
1990	933.4	2165.4	1745.2	2403.5	1237.2	633.2	113.3	61.9	93.3	14.3	17.4	15.9	9434.0
1991	1141.8	1278.5	2327.9	1364.0	1339.5	583.1	282.2	49.2	26.7	39.5	6.0	13.4	8451.9
1992	733.0	1563.3	1368.4	1738.6	672.4	546.7	224.2	105.8	18.3	9.7	14.3	6.6	7001.2
1993	1231.1	1003.5	1670.0	1001.1	824.7	260.6	198.9	79.6	37.0	6.2	3.3	7.1	6323.1
1994	1942.1	1685.4	1070.3	1202.8	462.5	309.1	91.5	68.1	26.9	12.3	2.0	3.3	6876.7
1995	1368.0	2657.7	1780.7	702.0	455.0	132.1	81.4	23.6	17.2	6.6	3.1	1.3	7228.5
1996	1068.6	1871.5	2805.4	1134.9	229.1	107.4	28.7	17.2	4.9	3.5	1.3	0.9	7273.5
1997	1052.9	1462.8	1989.7	1933.5	447.3	65.7	28.4	7.3	4.4	1.3	0.9	0.4	6994.6
1998	1131.6	1441.6	1563.1	1464.8	927.9	167.6	22.9	9.7	2.4	1.5	0.4	0.4	6734.0
1999	815.3	1549.8	1549.4	1223.8	812.6	412.5	69.4	9.3	3.7	0.9	0.7	0.2	6447.9
2000	1308.7	1117.5	1696.2	1437.0	608.7	282.4	125.4	20.5	2.6	1.1	0.2	0.2	6601.1
2001	1833.1	1793.9	1222.7	1580.7	804.9	265.7	113.1	48.7	7.9	1.1	0.4	0.2	7672.5
2002	1074.5	2512.8	1960.6	1117.7	723.1	266.1	80.7	33.3	14.1	2.2	0.2	0.2	7785.6
2003	1297.4	1472.9	2752.0	1833.6	594.6	289.9	97.4	28.7	11.7	4.9	0.7	0.2	8384.0
2004	829.8	1778.5	1613.6	2586.0	1034.0	259.0	116.2	37.9	11.0	4.4	1.8	0.4	8272.8
2005	1068.6	1137.4	1942.9	1467.6	1144.2	323.0	74.3	32.4	10.4	3.1	1.1	0.7	7205.4
2006	1303.8	1464.8	1243.4	1790.6	761.0	455.9	120.6	26.9	11.7	3.7	1.1	0.7	7184.0
2007	1347.7	1787.3	1598.8	1131.6	870.8	284.2	159.6	41.0	9.0	3.7	1.1	0.4	7235.8
2008	1211.7	1847.3	1950.9	1475.6	586.2	270.3	81.8	45.0	11.5	2.4	1.1	0.4	7484.3
2009	1178.8	1661.0	2021.2	1836.0	871.5	234.4	100.1	29.5	16.1	4.0	0.9	0.4	7954.1
2010	1352.5	1615.8	1818.6	1911.2	1125.2	388.5	96.6	40.1	11.7	6.2	1.5	0.4	8368.5

Table 3.4. Estimated time series and status indicators. Fishing mortality rate is apical F, which includes discard mortalities. Total biomass (B, mt) is at the start of the year, and spawning biomass (SSB, population fecundity, 1E10 eggs) at the time of peak spawning (end of March). The MSST *is defined by* $\mathrm{MSST} = (1 - M)\mathrm{SSB}_{\mathrm{MSY}}$, *with constant* $M = 0.38$. *SPR is static spawning potential ratio. Prop.fem is proportion of age-*2^+ *population that is female.*

Year	F	F/F_{MSY}	B	B/B_{unfished}	SSB	$\mathrm{SSB}/\mathrm{SSB}_{\mathrm{MSY}}$	SSB/MSST	SPR	Prop.fem
1978	0.291	0.417	6133	0.502	249	1.004	1.619	0.699	0.651
1979	0.411	0.589	7035	0.576	273	1.103	1.779	0.623	0.644
1980	0.447	0.640	7705	0.631	325	1.311	2.114	0.601	0.699
1981	0.406	0.582	7439	0.609	367	1.480	2.388	0.628	0.723
1982	0.538	0.771	7884	0.646	327	1.321	2.131	0.569	0.706
1983	0.352	0.504	6978	0.571	337	1.363	2.198	0.660	0.640
1984	0.615	0.881	6556	0.537	313	1.265	2.040	0.579	0.709
1985	0.454	0.651	6343	0.519	254	1.025	1.654	0.635	0.655
1986	0.400	0.573	6533	0.535	281	1.134	1.829	0.651	0.629
1987	0.505	0.724	6877	0.563	311	1.256	2.026	0.614	0.717
1988	1.049	1.502	6474	0.530	294	1.186	1.913	0.485	0.704
1989	0.772	1.106	5053	0.414	228	0.919	1.482	0.543	0.716
1990	0.654	0.937	4279	0.350	202	0.815	1.315	0.570	0.680
1991	0.802	1.149	3834	0.314	171	0.689	1.111	0.531	0.699
1992	0.858	1.229	3176	0.260	144	0.582	0.938	0.519	0.681
1993	0.892	1.278	2868	0.235	118	0.478	0.771	0.511	0.709
1994	1.182	1.693	3119	0.255	112	0.451	0.727	0.463	0.698
1995	1.375	1.970	3279	0.268	137	0.553	0.893	0.446	0.752
1996	1.180	1.690	3299	0.270	152	0.615	0.992	0.478	0.780
1997	0.903	1.294	3173	0.260	146	0.591	0.954	0.520	0.747
1998	0.727	1.042	3055	0.250	138	0.557	0.898	0.565	0.717
1999	1.046	1.499	2925	0.240	136	0.550	0.887	0.591	0.708
2000	0.765	1.097	2994	0.245	132	0.533	0.859	0.626	0.722
2001	1.042	1.492	3480	0.285	138	0.559	0.901	0.574	0.694
2002	0.857	1.228	3531	0.289	166	0.671	1.081	0.613	0.732
2003	0.764	1.094	3803	0.311	181	0.729	1.176	0.630	0.746
2004	1.100	1.576	3752	0.307	177	0.713	1.151	0.567	0.698
2005	0.833	1.193	3268	0.268	151	0.608	0.980	0.604	0.712
2006	0.896	1.284	3259	0.267	140	0.564	0.910	0.587	0.686
2007	1.091	1.562	3282	0.269	141	0.570	0.919	0.589	0.708
2008	0.839	1.201	3395	0.278	157	0.634	1.022	0.630	0.732
2009	0.733	1.050	3608	0.295	170	0.688	1.110	0.648	0.722
2010	0.762	1.091	3796	0.311	173	0.700	1.129	0.643	0.702

Table 3.5. Selectivity at age for MARMAP blackfish/snapper traps (Mbft), MARMAP chevron traps (Mcvt), commercial lines (cl), commercial pots (cp), headboat (hb), commercial discard mortalities (D.comm), headboat discard mortalities (D.hb), selectivity of landings averaged across fisheries (L.avg), and selectivity of discard mortalities averaged across fisheries (D.avg). Selectivities of landings and discards from the general recreational fleet were assumed equal to those from the headboat fleet. Similarly, selectivity from the commercial trawl fleet (1978–1990) mirrored that of the commercial pot fleet. TL is total length. For time-varying selectivities, values shown are from the terminal assessment year.

Age	TL(mm)	TL(in)	Mbft	Mcvt	cl	cp	hb	D.comm	D.hb	L.avg	D.avg	L.avg+D.avg
0	110.2	4.3	0.000	0.001	0.000	0.000	0.000	0.002	0.002	0.000	0.000	0.000
1	172.8	6.8	0.002	0.011	0.001	0.001	0.000	0.121	0.132	0.001	0.005	0.005
2	225.2	8.9	0.214	0.164	0.009	0.049	0.018	0.772	0.842	0.026	0.031	0.057
3	269.1	10.6	0.970	0.775	0.112	0.840	0.407	1.000	1.000	0.501	0.036	0.538
4	305.9	12.0	1.000	0.984	0.629	0.998	0.963	0.546	0.492	0.927	0.018	0.945
5	336.7	13.3	1.000	0.999	0.958	1.000	0.999	0.695	0.251	0.990	0.009	0.999
6	362.5	14.3	1.000	1.000	0.997	1.000	1.000	0.699	0.129	0.995	0.005	1.000
7	384.2	15.1	1.000	1.000	1.000	1.000	1.000	0.693	0.071	0.995	0.003	0.998
8	402.3	15.8	1.000	1.000	1.000	1.000	1.000	0.689	0.043	0.996	0.002	0.997
9	417.5	16.4	1.000	1.000	1.000	1.000	1.000	0.688	0.028	0.996	0.001	0.997
10	430.2	16.9	1.000	1.000	1.000	1.000	1.000	0.687	0.019	0.996	0.001	0.996
11	440.9	17.4	1.000	1.000	1.000	1.000	1.000	0.686	0.014	0.996	0.001	0.996

Table 3.6. Estimated time series of fully selected fishing mortality rates for commercial lines (F.cl), commercial pots (F.cp), commercial trawl (F.ct), headboat (F.hb), general recreational (F.rec), commercial discard mortalities (F.comm.D), headboat discard mortalities (F.hb.D), general recreational discard mortalities (F.rec.D). Also shown is apical F, the maximum F at age summed across fleets, which may not equal the sum of fully selected F's because of dome-shaped selectivities.

Year	F.cl	F.cp	F.ct	F.hb	F.rec	F.comm.D	F.hb.D	F.rec.D	Apical F
1978	0.035	0.023	0.005	0.096	0.132	0.000	0.000	0.005	0.291
1979	0.045	0.120	0.005	0.109	0.132	0.000	0.000	0.005	0.411
1980	0.039	0.153	0.004	0.118	0.132	0.000	0.000	0.005	0.447
1981	0.063	0.151	0.005	0.112	0.076	0.000	0.000	0.006	0.406
1982	0.052	0.110	0.003	0.107	0.265	0.000	0.000	0.006	0.538
1983	0.045	0.076	0.001	0.116	0.113	0.000	0.000	0.003	0.352
1984	0.063	0.062	0.003	0.130	0.357	0.002	0.000	0.006	0.615
1985	0.061	0.067	0.004	0.111	0.211	0.002	0.000	0.008	0.454
1986	0.054	0.097	0.004	0.121	0.122	0.002	0.002	0.008	0.400
1987	0.059	0.069	0.001	0.140	0.236	0.002	0.002	0.007	0.505
1988	0.122	0.095	0.004	0.151	0.676	0.002	0.001	0.007	1.049
1989	0.151	0.115	0.003	0.138	0.365	0.002	0.001	0.008	0.772
1990	0.159	0.180	0.004	0.120	0.191	0.002	0.000	0.005	0.654
1991	0.182	0.185	0.000	0.109	0.326	0.002	0.002	0.010	0.802
1992	0.204	0.209	0.000	0.100	0.344	0.002	0.001	0.012	0.858
1993	0.214	0.230	0.000	0.084	0.364	0.002	0.000	0.013	0.892
1994	0.332	0.302	0.000	0.098	0.449	0.003	0.002	0.025	1.182
1995	0.340	0.253	0.000	0.118	0.664	0.002	0.001	0.014	1.375
1996	0.352	0.227	0.000	0.105	0.496	0.002	0.001	0.008	1.180
1997	0.285	0.218	0.000	0.081	0.318	0.002	0.001	0.013	0.903
1998	0.262	0.184	0.000	0.075	0.207	0.002	0.001	0.012	0.727
1999	0.293	0.357	0.000	0.151	0.245	0.002	0.001	0.017	1.046
2000	0.155	0.279	0.000	0.111	0.221	0.001	0.001	0.022	0.765
2001	0.143	0.334	0.000	0.129	0.435	0.002	0.002	0.026	1.042
2002	0.168	0.322	0.000	0.103	0.264	0.001	0.001	0.014	0.857
2003	0.143	0.270	0.000	0.087	0.264	0.001	0.001	0.013	0.764
2004	0.141	0.291	0.000	0.128	0.539	0.001	0.001	0.029	1.100
2005	0.085	0.223	0.000	0.113	0.411	0.002	0.002	0.026	0.833
2006	0.083	0.283	0.000	0.113	0.416	0.002	0.002	0.036	0.896
2007	0.086	0.261	0.000	0.161	0.576	0.000	0.001	0.042	1.091
2008	0.100	0.241	0.000	0.099	0.396	0.000	0.001	0.026	0.839
2009	0.120	0.279	0.000	0.124	0.208	0.000	0.001	0.021	0.733
2010	0.071	0.182	0.000	0.182	0.323	0.000	0.002	0.030	0.762

Table 3.7. Estimated instantaneous fishing mortality rate (per yr) at age, including discard mortality

Year	0	1	2	3	4	5	6	7	8	9	10	11
1978	0.000	0.011	0.138	0.260	0.285	0.291	0.291	0.291	0.291	0.291	0.291	0.291
1979	0.001	0.018	0.211	0.370	0.404	0.410	0.411	0.411	0.411	0.411	0.411	0.411
1980	0.001	0.020	0.237	0.409	0.440	0.446	0.447	0.447	0.447	0.447	0.447	0.447
1981	0.001	0.018	0.206	0.354	0.397	0.406	0.406	0.406	0.406	0.406	0.406	0.406
1982	0.001	0.022	0.270	0.488	0.530	0.537	0.538	0.538	0.538	0.538	0.538	0.538
1983	0.001	0.014	0.172	0.311	0.345	0.352	0.352	0.352	0.352	0.352	0.352	0.352
1984	0.001	0.018	0.203	0.517	0.602	0.614	0.615	0.615	0.615	0.615	0.615	0.615
1985	0.001	0.015	0.158	0.379	0.443	0.454	0.454	0.454	0.454	0.454	0.454	0.454
1986	0.001	0.015	0.156	0.341	0.390	0.399	0.400	0.400	0.400	0.400	0.400	0.400
1987	0.001	0.016	0.175	0.427	0.494	0.505	0.505	0.505	0.505	0.505	0.505	0.505
1988	0.002	0.029	0.334	0.867	1.024	1.047	1.049	1.049	1.049	1.049	1.049	1.049
1989	0.001	0.023	0.248	0.606	0.746	0.771	0.772	0.772	0.772	0.772	0.772	0.772
1990	0.001	0.022	0.230	0.500	0.628	0.652	0.654	0.654	0.654	0.654	0.654	0.654
1991	0.001	0.026	0.275	0.622	0.772	0.800	0.802	0.802	0.802	0.802	0.802	0.802
1992	0.001	0.028	0.296	0.661	0.824	0.856	0.857	0.858	0.858	0.858	0.858	0.858
1993	0.001	0.029	0.312	0.687	0.857	0.890	0.892	0.892	0.892	0.892	0.892	0.892
1994	0.002	0.039	0.405	0.887	1.129	1.179	1.182	1.182	1.182	1.182	1.182	1.182
1995	0.002	0.040	0.434	1.035	1.319	1.372	1.375	1.375	1.375	1.375	1.375	1.375
1996	0.002	0.033	0.356	0.846	1.124	1.176	1.180	1.180	1.180	1.180	1.180	1.180
1997	0.001	0.027	0.290	0.649	0.858	0.900	0.903	0.903	0.903	0.903	0.903	0.903
1998	0.001	0.022	0.228	0.504	0.687	0.725	0.727	0.727	0.727	0.727	0.727	0.727
1999	0.000	0.004	0.059	0.613	0.933	1.034	1.045	1.046	1.046	1.046	1.046	1.046
2000	0.000	0.004	0.054	0.495	0.705	0.760	0.765	0.765	0.765	0.765	0.765	0.765
2001	0.000	0.005	0.073	0.697	0.982	1.036	1.042	1.042	1.042	1.042	1.042	1.042
2002	0.000	0.003	0.050	0.546	0.790	0.850	0.857	0.857	0.857	0.857	0.857	0.857
2003	0.000	0.003	0.046	0.488	0.707	0.758	0.764	0.764	0.764	0.764	0.764	0.764
2004	0.000	0.006	0.078	0.730	1.040	1.095	1.100	1.100	1.100	1.100	1.100	1.100
2005	0.000	0.005	0.065	0.572	0.796	0.830	0.833	0.833	0.833	0.833	0.833	0.833
2006	0.000	0.006	0.078	0.636	0.861	0.894	0.896	0.896	0.896	0.896	0.896	0.896
2007	0.000	0.006	0.064	0.573	1.046	1.091	1.089	1.087	1.086	1.085	1.085	1.085
2008	0.000	0.004	0.044	0.441	0.793	0.837	0.839	0.837	0.837	0.836	0.836	0.836
2009	0.000	0.003	0.039	0.405	0.684	0.731	0.733	0.732	0.732	0.731	0.731	0.731
2010	0.000	0.005	0.045	0.398	0.727	0.762	0.761	0.760	0.759	0.758	0.758	0.758

Table 3.8. Estimated total landings at age in numbers (1000 fish)

Year	0	1	2	3	4	5	6	7	8	9	10	11
1978	13.02	87.78	707.15	592.40	349.11	197.15	108.31	60.61	34.33	19.62	11.31	15.50
1979	28.14	259.50	906.34	937.44	446.62	245.11	139.17	77.89	44.27	25.32	14.62	20.09
1980	28.98	380.40	1749.57	816.20	498.09	221.96	122.57	70.92	40.31	23.14	13.37	18.43
1981	10.23	301.90	1952.04	1213.22	351.38	205.72	92.63	52.14	30.64	17.60	10.20	14.10
1982	37.38	146.75	2256.30	2089.21	789.52	206.66	120.81	55.40	31.67	18.80	10.90	15.14
1983	8.11	282.88	599.11	1215.66	641.37	228.60	60.32	35.95	16.75	9.67	5.80	8.08
1984	14.40	119.53	2068.31	809.79	1010.60	493.72	176.61	47.47	28.72	13.51	7.88	11.37
1985	28.26	91.58	539.95	1818.08	285.16	304.81	148.92	54.28	14.82	9.06	4.31	6.17
1986	19.61	244.84	523.18	579.95	862.06	115.43	122.99	61.20	22.66	6.25	3.86	4.49
1987	21.22	198.49	1564.16	701.76	382.15	493.09	65.88	71.49	36.13	13.51	3.76	5.05
1988	23.68	346.05	2128.33	3146.92	581.84	270.70	348.52	47.39	52.21	26.64	10.06	6.60
1989	22.27	144.30	1444.14	1533.13	793.59	119.09	54.95	72.07	9.96	11.09	5.71	3.60
1990	11.54	187.70	758.70	1288.15	573.97	234.38	34.51	16.21	21.59	3.01	3.39	2.86
1991	17.04	128.52	1170.17	858.60	719.89	249.26	99.26	14.86	7.09	9.54	1.35	2.81
1992	11.66	169.37	732.06	1142.37	377.76	244.26	82.44	33.39	5.08	2.45	3.33	1.46
1993	20.54	115.13	936.39	677.36	475.60	119.44	75.03	25.75	10.59	1.63	0.79	1.56
1994	40.97	245.56	733.51	958.64	316.10	167.81	40.88	26.10	9.10	3.78	0.59	0.85
1995	33.09	416.78	1331.35	627.53	338.56	77.75	39.37	9.74	6.32	2.22	0.93	0.36
1996	21.08	244.43	1789.05	895.83	156.11	58.28	12.80	6.59	1.66	1.09	0.39	0.23
1997	16.17	155.62	1042.77	1253.11	258.06	30.39	10.78	2.41	1.26	0.32	0.21	0.12
1998	13.40	121.06	657.83	779.64	459.36	66.86	7.52	2.71	0.62	0.33	0.08	0.09
1999	0.40	7.02	136.11	753.46	493.71	207.48	28.88	3.30	1.21	0.28	0.15	0.08
2000	0.45	3.89	118.58	736.69	305.88	116.34	42.73	5.97	0.69	0.26	0.06	0.05
2001	0.92	9.46	123.73	1058.71	504.61	133.74	46.95	17.39	2.47	0.29	0.11	0.05
2002	0.41	9.74	154.42	633.09	393.91	118.37	29.63	10.53	3.96	0.57	0.07	0.04
2003	0.46	5.27	196.03	950.09	299.69	119.29	33.10	8.36	3.02	1.15	0.17	0.03
2004	0.47	10.54	174.69	1789.37	671.08	134.72	49.80	13.95	3.58	1.30	0.50	0.09
2005	0.46	5.20	164.24	840.36	625.21	141.19	26.76	10.01	2.85	0.74	0.27	0.12
2006	0.56	6.93	112.77	1096.52	437.80	209.19	45.56	8.76	3.33	0.96	0.25	0.13
2007	0.27	4.13	89.59	631.66	557.29	146.14	67.71	14.98	2.93	1.12	0.33	0.13
2008	0.20	3.36	88.87	682.74	315.55	118.16	29.50	13.92	3.13	0.62	0.24	0.10
2009	0.18	2.70	88.56	795.93	423.33	93.38	32.98	8.36	4.01	0.91	0.18	0.10
2010	0.19	2.63	71.36	795.41	567.91	158.86	32.62	11.67	3.01	1.46	0.34	0.10

Table 3.9. Estimated total landings at age in whole weight (1000 lb)

Year	0	1	2	3	4	5	6	7	8	9	10	11
1978	0.65	15.32	257.12	352.82	296.51	218.46	147.27	96.77	62.27	39.44	24.71	36.24
1979	1.41	45.29	329.54	558.31	379.34	271.61	189.23	124.36	80.30	50.90	31.93	46.95
1980	1.46	66.39	636.13	486.10	423.05	245.95	166.67	113.22	73.13	46.51	29.20	43.07
1981	0.51	52.69	709.75	722.56	298.45	227.96	125.95	83.25	55.59	35.37	22.28	32.95
1982	1.88	25.61	820.38	1244.27	670.57	229.00	164.27	88.44	57.45	37.78	23.81	35.38
1983	0.41	49.37	217.83	724.01	544.74	253.30	82.02	57.39	30.38	19.44	12.67	18.88
1984	0.81	20.88	752.05	482.29	858.35	547.08	240.14	75.78	52.09	27.14	17.17	26.46
1985	1.59	16.00	196.33	1082.80	242.20	337.75	202.49	86.66	26.88	18.19	9.38	14.35
1986	1.10	42.77	190.23	345.40	732.19	127.91	167.23	97.71	41.09	12.55	8.41	10.44
1987	1.19	34.67	568.74	417.95	324.58	546.39	89.58	114.13	65.52	27.13	8.20	11.76
1988	1.33	60.45	773.87	1874.22	494.19	299.96	473.90	75.66	94.69	53.50	21.92	15.36
1989	1.25	25.21	525.10	913.09	674.03	131.96	74.72	115.06	18.06	22.26	12.45	8.36
1990	0.65	32.79	275.87	767.19	487.50	259.71	46.92	25.87	39.16	6.05	7.39	6.66
1991	0.96	22.45	425.48	511.36	611.44	276.20	134.97	23.73	12.86	19.16	2.93	6.53
1992	0.66	29.59	266.18	680.36	320.85	270.66	112.09	53.31	9.21	4.91	7.25	3.39
1993	1.15	20.11	340.48	403.42	403.95	132.35	102.02	41.11	19.21	3.27	1.73	3.62
1994	2.30	42.89	266.71	570.94	268.47	185.94	55.59	41.67	16.50	7.59	1.28	1.98
1995	1.86	72.80	484.09	373.74	287.55	86.16	53.53	15.55	11.46	4.47	2.03	0.83
1996	1.18	42.70	650.51	533.53	132.59	64.57	17.40	10.51	3.00	2.18	0.84	0.52
1997	0.91	27.18	379.16	746.32	219.18	33.67	14.66	3.84	2.28	0.64	0.46	0.28
1998	0.75	21.15	239.19	464.33	390.15	74.08	10.23	4.33	1.12	0.65	0.18	0.20
1999	0.02	1.23	49.49	448.74	419.33	229.91	39.27	5.27	2.19	0.56	0.32	0.18
2000	0.03	0.68	43.12	438.75	259.79	128.91	58.11	9.53	1.26	0.51	0.13	0.11
2001	0.05	1.65	44.99	630.54	428.59	148.20	63.83	27.77	4.47	0.58	0.24	0.11
2002	0.02	1.70	56.15	377.05	334.56	131.17	40.29	16.80	7.18	1.14	0.15	0.08
2003	0.03	0.92	71.28	565.85	254.54	132.19	45.01	13.35	5.47	2.30	0.36	0.07
2004	0.03	1.84	63.52	1065.70	569.98	149.28	67.71	22.27	6.48	2.62	1.09	0.20
2005	0.03	0.91	59.72	500.49	531.02	156.45	36.39	15.99	5.17	1.48	0.59	0.29
2006	0.03	1.21	41.00	653.06	371.85	231.80	61.95	13.98	6.04	1.92	0.55	0.31
2007	0.01	0.72	32.57	376.20	473.33	161.94	92.07	23.91	5.31	2.26	0.71	0.31
2008	0.01	0.59	32.31	406.62	268.01	130.93	40.11	22.22	5.68	1.24	0.52	0.23
2009	0.01	0.47	32.20	474.04	359.55	103.47	44.85	13.35	7.27	1.83	0.40	0.23
2010	0.01	0.46	25.95	473.73	482.35	176.03	44.35	18.63	5.45	2.93	0.73	0.24

Table 3.10. Estimated time series of landings in numbers (1000 fish) for commercial lines (L.cl), commercial pots (L.cp), commercial trawl (L.ct), headboat (L.hb), and general recreational (L.rec)

Year	L.cl	L.cp	L.ct	L.hb	L.rec	Total
1978	112.16	209.69	49.66	769.12	1055.68	2196.30
1979	134.89	1095.09	44.16	846.50	1023.86	3144.51
1980	106.10	1642.26	46.85	1036.34	1152.39	3983.93
1981	172.99	1983.22	62.08	1209.09	824.43	4251.81
1982	169.14	1427.61	37.29	1194.53	2949.96	5778.53
1983	161.21	813.22	14.27	1075.63	1047.97	3112.29
1984	203.01	752.17	32.57	1019.71	2794.44	4801.90
1985	178.76	647.37	38.94	840.39	1599.91	3305.38
1986	172.92	834.50	36.90	757.73	764.47	2566.51
1987	149.86	771.89	14.32	977.65	1642.99	3556.70
1988	263.09	972.23	40.19	1041.69	4671.74	6988.94
1989	293.15	988.70	25.78	796.17	2110.09	4213.90
1990	304.35	1243.49	24.38	603.26	960.53	3136.02
1991	303.10	1152.23	0.00	456.75	1366.30	3278.39
1992	259.36	1016.80	0.00	344.69	1184.76	2805.61
1993	217.18	981.97	0.00	235.92	1024.73	2459.81
1994	245.43	1040.47	0.00	225.23	1032.76	2543.88
1995	175.13	989.47	0.00	259.98	1459.43	2884.00
1996	180.79	1213.24	0.00	312.56	1480.92	3187.52
1997	233.13	1157.62	0.00	281.21	1099.24	2771.21
1998	285.48	893.15	0.00	247.66	683.21	2109.50
1999	215.60	710.55	0.00	269.04	436.89	1632.08
2000	108.00	599.21	0.00	208.49	415.89	1331.59
2001	103.29	724.02	0.00	245.42	825.69	1898.41
2002	114.38	611.83	0.00	176.71	451.81	1354.72
2003	108.92	704.77	0.00	199.37	603.58	1616.65
2004	128.87	916.88	0.00	346.22	1458.10	2850.08
2005	78.54	560.47	0.00	254.60	923.79	1817.40
2006	70.72	703.77	0.00	244.96	903.32	1922.77
2007	62.30	503.81	0.00	207.34	742.82	1516.27
2008	67.64	527.41	0.00	132.61	528.73	1256.39
2009	103.41	775.03	0.00	214.16	358.04	1450.63
2010	74.25	561.10	0.00	364.31	645.90	1645.55

Table 3.11. Estimated time series of landings in whole weight (1000 lb) for commercial lines (L.cl), commercial pots (L.cp), commercial trawl (L.ct), headboat (L.hb), and general recreational (L.rec)

Year	L.cl	L.cp	L.ct	L.hb	L.rec	Total
1978	118.67	134.35	31.82	532.22	730.52	1547.58
1979	140.58	677.63	27.33	571.90	691.73	2109.17
1980	107.99	890.23	25.39	618.98	688.30	2330.89
1981	163.96	1029.32	32.22	678.90	462.91	2367.32
1982	150.98	789.60	20.62	702.59	1735.07	3398.86
1983	145.90	486.03	8.53	693.92	676.07	2010.46
1984	194.74	410.51	17.78	662.28	1814.93	3100.24
1985	164.09	396.09	23.83	568.44	1082.17	2234.62
1986	163.60	505.43	22.35	540.42	545.23	1777.04
1987	149.25	402.94	7.47	615.61	1034.56	2209.84
1988	236.10	512.23	21.17	632.58	2836.95	4239.03
1989	248.29	517.07	13.48	477.42	1265.31	2521.57
1990	259.69	692.46	13.58	381.92	608.11	1955.76
1991	270.18	625.62	0.00	288.69	863.57	2048.07
1992	229.18	561.13	0.00	218.19	749.96	1758.46
1993	191.48	513.09	0.00	143.70	624.15	1472.42
1994	208.68	519.59	0.00	131.34	602.26	1461.87
1995	141.06	410.16	0.00	127.44	715.41	1394.08
1996	126.14	500.19	0.00	145.21	688.02	1459.56
1997	162.12	541.21	0.00	147.74	577.52	1428.59
1998	220.48	450.66	0.00	142.40	392.84	1206.38
1999	187.12	503.55	0.00	192.78	313.06	1196.52
2000	93.31	412.59	0.00	145.27	289.77	940.93
2001	89.05	504.93	0.00	173.46	583.58	1351.01
2002	98.60	426.93	0.00	123.92	316.85	966.30
2003	90.86	466.23	0.00	132.66	401.62	1091.37
2004	106.14	616.29	0.00	235.69	992.59	1950.71
2005	67.34	396.91	0.00	182.41	661.86	1308.52
2006	62.50	496.77	0.00	175.87	648.56	1383.71
2007	55.22	361.27	0.00	164.29	588.56	1169.34
2008	57.56	356.66	0.00	99.11	395.16	908.48
2009	86.44	525.74	0.00	159.25	266.25	1037.68
2010	63.74	392.63	0.00	279.31	495.19	1230.86

Table 3.12. Estimated time series of dead discards in numbers (1000 fish) for commercial (D.comm), headboat (D.hb), and general recreational (D.rec). D.rec and D.hb are combined under D.rec prior to 1986.

Year	D.comm	D.hb	D.rec	Total
1978	0.00	0.00	36.54	36.54
1979	0.00	0.00	38.22	38.22
1980	0.00	0.00	50.21	50.21
1981	0.00	0.00	78.82	78.82
1982	0.00	0.00	70.62	70.62
1983	0.00	0.00	29.33	29.33
1984	22.21	0.00	72.77	94.98
1985	17.46	0.00	71.55	89.01
1986	14.20	17.95	58.29	90.44
1987	22.35	20.32	84.04	126.71
1988	21.00	6.75	71.90	99.65
1989	16.71	4.92	65.34	86.98
1990	13.03	0.35	35.42	48.80
1991	11.44	11.20	58.10	80.74
1992	9.39	4.42	59.57	73.38
1993	7.79	1.91	54.27	63.96
1994	10.94	5.72	94.36	111.03
1995	9.50	3.96	65.16	78.62
1996	10.50	4.78	54.75	70.02
1997	9.57	4.44	78.46	92.47
1998	9.66	3.24	57.76	70.66
1999	8.91	7.39	83.35	99.64
2000	6.68	6.59	117.12	130.40
2001	8.11	7.63	126.91	142.65
2002	3.53	5.31	86.47	95.32
2003	8.64	4.80	97.67	111.12
2004	5.94	7.38	188.54	201.86
2005	9.32	8.81	150.56	168.69
2006	12.23	8.62	178.82	199.67
2007	0.80	7.63	226.39	234.83
2008	0.75	4.89	166.52	172.16
2009	1.99	7.28	146.08	155.36
2010	1.56	11.55	201.48	214.59

Table 3.13. Estimated time series of dead discards in whole weight (1000 lb) for commercial (D.comm), headboat (D.hb), and general recreational (D.rec). D.rec and D.hb are combined under D.rec prior to 1986.

Year	D.comm	D.hb	D.rec	Total
1978	0.00	0.00	7.58	7.58
1979	0.00	0.00	7.74	7.74
1980	0.00	0.00	10.14	10.14
1981	0.00	0.00	16.31	16.31
1982	0.00	0.00	14.95	14.95
1983	0.00	0.00	5.94	5.94
1984	4.66	0.00	15.27	19.93
1985	3.71	0.00	15.18	18.89
1986	2.80	3.54	11.50	17.85
1987	4.60	4.18	17.29	26.07
1988	4.38	1.41	14.99	20.78
1989	3.51	1.03	13.73	18.27
1990	2.70	0.07	7.35	10.13
1991	2.39	2.34	12.12	16.84
1992	1.95	0.92	12.34	15.21
1993	1.62	0.40	11.27	13.28
1994	2.20	1.15	19.00	22.36
1995	1.88	0.78	12.88	15.54
1996	2.16	0.98	11.27	14.42
1997	2.00	0.93	16.39	19.32
1998	2.00	0.67	11.97	14.65
1999	2.77	2.30	25.94	31.01
2000	2.15	2.12	37.61	41.87
2001	2.51	2.36	39.24	44.10
2002	1.06	1.59	25.87	28.52
2003	2.77	1.54	31.34	35.65
2004	1.92	2.38	60.87	65.17
2005	3.00	2.83	48.41	54.24
2006	3.90	2.75	57.02	63.67
2007	0.25	2.87	85.09	88.21
2008	0.23	1.87	63.54	65.64
2009	0.75	2.89	57.97	61.61
2010	0.60	4.67	81.48	86.75

Table 3.14. Estimated status indicators, benchmarks, and related quantities from the Beaufort catch-age model, conditional on estimated current selectivities averaged across fisheries. Precision is represented by standard errors (SE) approximated from Monte Carlo/Bootstrap analysis. Estimates of yield do not include discards; D_{MSY} represents discard mortalities expected when fishing at F_{MSY}. 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) is measured as population fecundity. Symbols, abbreviations, and acronyms are listed in Appendix A.

Quantity	Units	Estimate	SE
F_{MSY}	y^{-1}	0.698	0.395
$85\%F_{MSY}$	y^{-1}	0.593	0.336
$75\%F_{MSY}$	y^{-1}	0.524	0.296
$65\%F_{MSY}$	y^{-1}	0.454	0.257
$F_{30\%}$	y^{-1}	NA	NA
$F_{40\%}$	y^{-1}	NA	NA
$F_{50\%}$	y^{-1}	2.118	0.635[1]
B_{MSY}	mt	5399	672
SSB_{MSY}	1E10 eggs	248	22
MSST	1E10 eggs	154	22
MSY	1000 lb	1767	92
D_{MSY}	1000 fish	240	106
R_{MSY}	1000 age-0 fish	34393	11764
Y at $85\%F_{MSY}$	1000 lb	1760	91
Y at $75\%F_{MSY}$	1000 lb	1746	88
Y at $65\%F_{MSY}$	1000 lb	1720	84
$F_{2009-2010}/F_{MSY}$	—	1.07	0.38
$SSB_{2010}/MSST$	—	1.13	0.31
SSB_{2010}/SSB_{MSY}	—	0.70	0.14

[1]In approximately 25% of MCB runs, $F_{50\%}$ was estimated at the upper bound of 3.0

Table 3.15. Results from sensitivity runs of the Beaufort catch-age model. Current F represented by geometric mean of last two 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)	$F_{2009-2010}/F_{MSY}$	$SSB_{2010}/MSST$	SSB_{2010}/SSB_{MSY}	steep	R0(1000)
Base	—	0.698	248	5399	1767	1.07	1.13	0.7	0.49	37330
S1	M=0.27	0.429	270	5671	2038	1.96	0.69	0.51	0.57	18859
S2	M=0.53	1.135	279	7296	1739	0.54	1.81	0.91	0.39	99383
S3	h=0.4	0.492	322	7033	1996	1.52	0.86	0.54	0.4	47462
S4	h=0.6	0.935	216	4744	1706	0.8	1.3	0.8	0.6	33160
S5	Unweighted	0.325	563	12525	2600	1.34	0.8	0.49	0.31	84424
S6	SDNR weights	0.329	601	13337	2842	1.93	0.58	0.36	0.32	95911
S7	q 0.02	0.595	271	5894	1803	1.21	1.07	0.66	0.45	40402
S8	Continuity	0.379	4828[1]	6231	2113	1.98	0.58	0.41	0.66	13749
S9	HB index 1984	0.762	242	5286	1782	0.99	1.15	0.72	0.52	36444
S10	No HB index	0.787	262	5690	1848	1.15	1.12	0.7	0.49	38355

[1] SSB based on biomass of mature males and females

Table 3.16. Projection results under scenario 1—fishing mortality rate fixed at $F = F_{rebuild}$, with 2011 landings equal to 100% of the quota (847,000 lb*) and with rebuilding probability of 0.5 in 2016. F = fishing mortality rate (per year), Pr(*$SSB > SSB_{MSY}$*) = proportion of stochastic projection replicates exceeding* SSB_{MSY}*, SSB = spawning stock (1E10 eggs) at peak spawning time, R = recruits (1000 age-0 fish), D = discard mortalities (1000 fish or 1000* lb *whole weight), L = landings (1000 fish or 1000* lb *whole weight), and Sum L = cumulative landings (1000* lb*). For reference, estimated benchmarks are* $F_{MSY} = 0.698$ *(per yr),* $SSB_{MSY} = 248$ *(1E10 eggs), and* MSY = 1767 *(1000 lb). Expected values presented are from deterministic projections (klb = 1000 lb).*

Year	F(per yr)	Pr(SSB > SSB_{MSY})	SSB(1E10 eggs)	R(1000)	D(1000)	D(klb)	L(1000)	L(klb)	Sum L(klb)
2011	0.45	0.04	186.5	30,739	112	45	1092	847	847
2012	0.5	0.14	200.9	31,718	136	54	1313	1061	1908
2013	0.5	0.26	218.4	32,799	151	60	1418	1151	3060
2014	0.5	0.38	233.8	33,669	162	65	1576	1276	4335
2015	0.5	0.45	245.8	34,298	168	68	1703	1391	5726
2016	0.5	0.5	254.7	34,740	173	70	1792	1478	7204

Table 3.17. Projection results under scenario 2—fishing mortality rate fixed at $F = F_{rebuild}$, with 2011 landings equal to 150% of the quota (847,000 lb*) and with rebuilding probability of 0.5 in 2016. Column headers as described in Table 3.16.*

Year	F(per yr)	Pr(SSB > SSB_{MSY})	SSB(1E10 eggs)	R(1000)	D(1000)	D(klb)	L(1000)	L(klb)	Sum L(klb)
2011	0.748	0.04	186.5	30,739	181	72	1651	1271	1271
2012	0.48	0.09	191.7	31,106	129	50	1126	881	2152
2013	0.48	0.24	214.2	32,553	145	57	1312	1040	3192
2014	0.48	0.36	231.9	33,568	154	62	1508	1208	4400
2015	0.48	0.45	245.2	34,266	161	65	1640	1339	5739
2016	0.48	0.5	255.1	34,758	166	67	1734	1434	7173

Table 3.18. Projection results under scenario 3—fishing mortality rate fixed at $F = F_{rebuild}$, with 2011 landings equal to 200% of the quota (847,000 lb*) and with rebuilding probability of 0.5 in 2016. Column headers as described in Table 3.16.*

Year	F(per yr)	Pr(SSB > SSB_{MSY})	SSB(1E10 eggs)	R(1000)	D(1000)	D(klb)	L(1000)	L(klb)	Sum L(klb)
2011	1.125	0.04	186.5	30,739	261	102	2223	1694	1694
2012	0.46	0.05	182.4	30,445	121	47	947	713	2407
2013	0.46	0.21	209.7	32,279	138	55	1207	931	3338
2014	0.46	0.35	229.8	33,449	147	59	1438	1137	4475
2015	0.46	0.44	244.3	34,221	153	62	1575	1285	5760
2016	0.46	0.5	255.2	34,766	159	64	1674	1388	7148

Table 3.19. Projection results under scenario 4—landings fixed at the current quota (847,000 lb*), with 2011 landings equal to 100% of the quota. F = fishing mortality rate (per year), Pr(*SSB > SSB_{MSY}*) = proportion of stochastic projection replicates exceeding* SSB_{MSY}*, SSB = spawning stock (1E10 eggs) at peak spawning time, R = recruits (1000 age-0 fish), D = discard mortalities (1000 fish or 1000* lb *whole weight), L = landings (1000 fish or 1000* lb *whole weight), and Sum L = cumulative landings (1000* lb*). For reference, estimated benchmarks are* F_{MSY} = 0.698 *(per yr),* SSB_{MSY} = 248 *(1E10 eggs), and* MSY = 1767 *(1000 lb). Expected values presented are from deterministic projections (klb = 1000 lb).*

Year	F(per yr)	Pr(SSB > SSB_{MSY})	SSB(1E10 eggs)	R(1000)	D(1000)	D(klb)	L(1000)	L(klb)	Sum L(klb)
2011	0.45	0.04	186.5	30,739	112	45	1092	847	847
2012	0.382	0.14	201.8	31,777	106	42	1044	847	1694
2013	0.324	0.32	225.5	33,207	101	40	1022	847	2541
2014	0.267	0.48	248.7	34,443	91	37	1004	847	3388
2015	0.224	0.61	270.8	35,491	80	33	974	847	4235
2016	0.192	0.7	291.1	36,356	73	30	943	847	5082

Table 3.20. Projection results under scenario 5—landings fixed at the current quota (847,000 lb*), with 2011 landings equal to 150% of the quota. Column headers as described in Table 3.19.*

Year	F(per yr)	Pr(SSB > SSB_{MSY})	SSB(1E10 eggs)	R(1000)	D(1000)	D(klb)	L(1000)	L(klb)	Sum L(klb)
2011	0.748	0.04	186.5	30,739	181	72	1651	1271	1271
2012	0.458	0.09	187.6	30,816	123	48	1081	847	2118
2013	0.372	0.25	214.9	32,595	114	45	1062	847	2965
2014	0.296	0.42	238.6	33,927	98	40	1036	847	3812
2015	0.243	0.56	261.5	35,062	85	35	995	847	4659
2016	0.206	0.66	282.5	35,998	76	31	960	847	5506

Table 3.21. Projection results under scenario 6—landings fixed at the current quota (847,000 lb*), with 2011 landings equal to 200% of the quota. Column headers as described in Table 3.19.*

Year	F(per yr)	Pr(SSB > SSB_{MSY})	SSB(1E10 eggs)	R(1000)	D(1000)	D(klb)	L(1000)	L(klb)	Sum L(klb)
2011	1.125	0.04	186.5	30,739	261	102	2223	1694	1694
2012	0.567	0.05	173.7	29,799	147	57	1129	847	2541
2013	0.436	0.2	203.7	31,901	130	52	1110	847	3388
2014	0.331	0.35	227.7	33,332	106	43	1073	847	4235
2015	0.266	0.5	251.1	34,564	90	37	1018	847	5082
2016	0.223	0.61	272.9	35,582	81	33	978	847	5929

Table 3.22. Projection results under scenario 7—landings fixed at $L = L_{rebuild}$, with 2011 landings equal to 100% of the quota (847,000 lb) and with rebuilding probability of 0.5 in 2016. F = fishing mortality rate (per year), Pr(SSB > SSB_{MSY}) = proportion of stochastic projection replicates exceeding SSB_{MSY}, SSB = spawning stock (1E10 eggs) at peak spawning time, R = recruits (1000 age-0 fish), D = discard mortalities (1000 fish or 1000 lb whole weight), L = landings (1000 fish or 1000 lb whole weight), and Sum L = cumulative landings (1000 lb). For reference, estimated benchmarks are F_{MSY} = 0.698 (per yr), SSB_{MSY} = 248 (1E10 eggs), and MSY = 1767 (1000 lb). Expected values presented are from deterministic projections (klb = 1000 lb).

Year	F(per yr)	Pr(SSB > SSB_{MSY})	SSB(1E10 eggs)	R(1000)	D(1000)	D(klb)	L(1000)	L(klb)	Sum L(klb)
2011	0.45	0.04	186.5	30,739	112	45	1092	847	847
2012	0.612	0.14	201.8	31,777	165	65	1550	1249	2096
2013	0.595	0.24	212.4	32,442	177	70	1564	1249	3345
2014	0.536	0.34	226.2	33,249	171	68	1578	1249	4594
2015	0.47	0.43	239.9	33,996	157	63	1557	1249	5843
2016	0.416	0.5	253.3	34,673	144	59	1522	1249	7092

Table 3.23. Projection results under scenario 8—landings fixed at $L = L_{rebuild}$, with 2011 landings equal to 150% of the quota (847,000 lb) and with rebuilding probability of 0.5 in 2016. Column headers as described in Table 3.22.

Year	F(per yr)	Pr(SSB > SSB_{MSY})	SSB(1E10 eggs)	R(1000)	D(1000)	D(klb)	L(1000)	L(klb)	Sum L(klb)
2011	0.748	0.04	186.5	30,739	181	72	1651	1271	1271
2012	0.667	0.09	187.6	30,816	175	68	1476	1149	2420
2013	0.607	0.2	204.6	31,957	179	70	1486	1149	3569
2014	0.515	0.31	220.7	32,934	162	65	1480	1149	4718
2015	0.437	0.41	237	33,839	144	58	1438	1149	5867
2016	0.378	0.5	252.8	34,646	131	53	1396	1149	7016

Table 3.24. Projection results under scenario 9—landings fixed at $L = L_{rebuild}$, with 2011 landings equal to 200% of the quota (847,000 lb) and with rebuilding probability of 0.5 in 2016. Column headers as described in Table 3.22.

Year	F(per yr)	Pr(SSB > SSB_{MSY})	SSB(1E10 eggs)	R(1000)	D(1000)	D(klb)	L(1000)	L(klb)	Sum L(klb)
2011	1.125	0.04	186.5	30,739	261	102	2223	1694	1694
2012	0.741	0.05	173.7	29,799	189	73	1403	1047	2741
2013	0.62	0.17	196.4	31,424	180	71	1404	1047	3788
2014	0.49	0.29	214.9	32,594	151	61	1375	1047	4835
2015	0.401	0.4	233.9	33,674	131	53	1315	1047	5882
2016	0.34	0.5	252.2	34,616	117	48	1268	1047	6929

Table 3.25. Input for black sea bass surplus production model base run. Commercial and recreational landings (L) and discards (D), total removals, and four indices of abundance used for the base run (1978–2010). For indices, Mcvt represents MARMAP chevron traps, and Mbft represents MARMAP blackfish/snapper traps.

	Removals						Indices			
	Rec L (lb)	Comm L (lb)	Rec D (lb)	Comm D (lb)	Total Removals (lb)	Total Removals (mt)	Mcvt (lb/trap-hr)	Headboat (lb/hr)	Comm lines (lb/hook-hr)	Mbft (lb/trap-hr)
1978	1344360.4	284842.0	6584.2	0.0	1635786.7	1635.8				
1979	1383391.2	844562.0	6584.2	0.0	2234537.5	2234.5		2.2		
1980	1429951.0	1021495.0	6584.2	0.0	2458030.3	2458.0		1.8		
1981	1140319.5	1224239.0	9496.2	0.0	2374054.6	2374.1		2.1		0.6
1982	2426939.6	959675.0	8508.0	0.0	3395122.6	3395.1		2.2		0.5
1983	1362187.2	638557.0	3533.0	0.0	2004277.1	2004.3		2.0		0.5
1984	2466942.6	622729.0	8768.0	1157.0	3099596.6	3099.6		1.8		0.4
1985	1649048.4	583698.0	8618.7	1157.0	2242522.0	2242.5		2.0		0.6
1986	1078340.8	688109.0	9183.7	1157.0	1776790.5	1776.8		1.6		0.4
1987	1653639.8	560176.0	12574.6	1157.0	2227547.4	2227.5		1.6		0.4
1988	3525797.2	771537.0	9476.8	1157.0	4307967.9	4308.0		1.5		
1989	1747623.5	779760.0	8465.3	1157.0	2537005.8	2537.0		1.2		
1990	981734.3	956899.0	4308.5	1157.0	1944098.7	1944.1	0.6	1.2		
1991	1128065.1	883730.0	8347.5	1157.0	2021299.6	2021.3	0.4	1.0		
1992	938841.4	772894.0	7701.1	1157.0	1720593.5	1720.6	0.5	0.7		
1993	754622.7	696950.0	6770.7	938.3	1459281.7	1459.3	0.3	0.4	1.0	
1994	758136.4	744910.0	12056.2	1318.1	1516420.7	1516.4	0.3	0.5	1.0	
1995	848911.4	554739.0	8330.8	1144.5	1413125.8	1413.1	0.1	0.5	0.6	
1996	864915.7	634303.0	7175.7	1264.9	1507659.3	1507.7	0.3	0.5	0.6	
1997	725279.8	703285.0	9986.9	1152.6	1439704.4	1439.7	0.4	0.6	0.8	
1998	536117.1	671945.0	7348.3	1163.4	1216573.8	1216.6	0.4	0.5	1.1	
1999	505066.3	688888.0	16901.1	1660.1	1212515.5	1212.5	0.3	0.6	1.1	
2000	431674.8	500499.0	23049.7	1245.3	956468.7	956.5	0.4	0.4	0.8	
2001	739532.5	579037.0	25023.9	1511.6	1345105.0	1345.1	0.5	0.4	0.8	
2002	435905.4	517797.0	17108.4	658.8	971469.6	971.5	0.3	0.4	0.8	
2003	549152.4	575831.0	19129.2	1611.1	1145723.7	1145.7	0.4	0.5	1.0	
2004	1264326.5	733619.0	36443.4	1107.8	2035496.7	2035.5	0.8	0.7	1.4	
2005	806019.0	451295.0	29653.8	1737.6	1288705.4	1288.7	0.5	0.6	1.0	
2006	798410.7	545442.0	34861.5	2278.5	1380992.7	1381.0	0.5	0.6	0.9	
2007	722666.4	406828.0	54405.8	149.9	1184050.1	1184.1	0.4	0.4	0.6	
2008	497671.6	417609.0	45987.1	140.1	961407.8	961.4	0.4	0.3	0.7	
2009	440457.3	652321.0	41275.3	270.0	1134323.6	1134.3	0.4	0.5	1.2	
2010	816060.7	472641.0	57255.5	96.1	1346053.3	1346.1	0.7	0.7	2.5	

Table 3.26. Parameter estimates and derived management benchmarks from the black sea bass surplus production model base run (1978–2010) and four sensitivity runs (1950–2010). Sensitivity runs labeled 0.5:1 to 3:1 represent alternative ratios of recreational to commercial landings used to reconstruct recreational landings during the historical period (1950–1977).

Quantity	Base	Sensitivity 0.5:1	Sensitivity 1:1	Sensitivity 2:1	Sensitivity 3:1
MSY (mt)	2317	2261	2222	2664	3211
K (mt)	13460	10590	12120	20120	31120
B1/K	0.503	0.88	0.63	0.901	0.984
B_{MSY} (mt)	6731	5293	6062	10060	15560
F_{MSY} (per yr)	0.344	0.427	0.367	0.265	0.206
$B_{2011}/B_{\mathrm{MSY}}$	0.498	0.564	0.541	0.386	0.289
$F_{2010}/F_{\mathrm{MSY}}$	1.22	1.13	1.18	1.36	1.48

3.7 Figures

Figure 3.1. Mean length at age (mm) and estimated upper and lower 95% confidence intervals of the population.

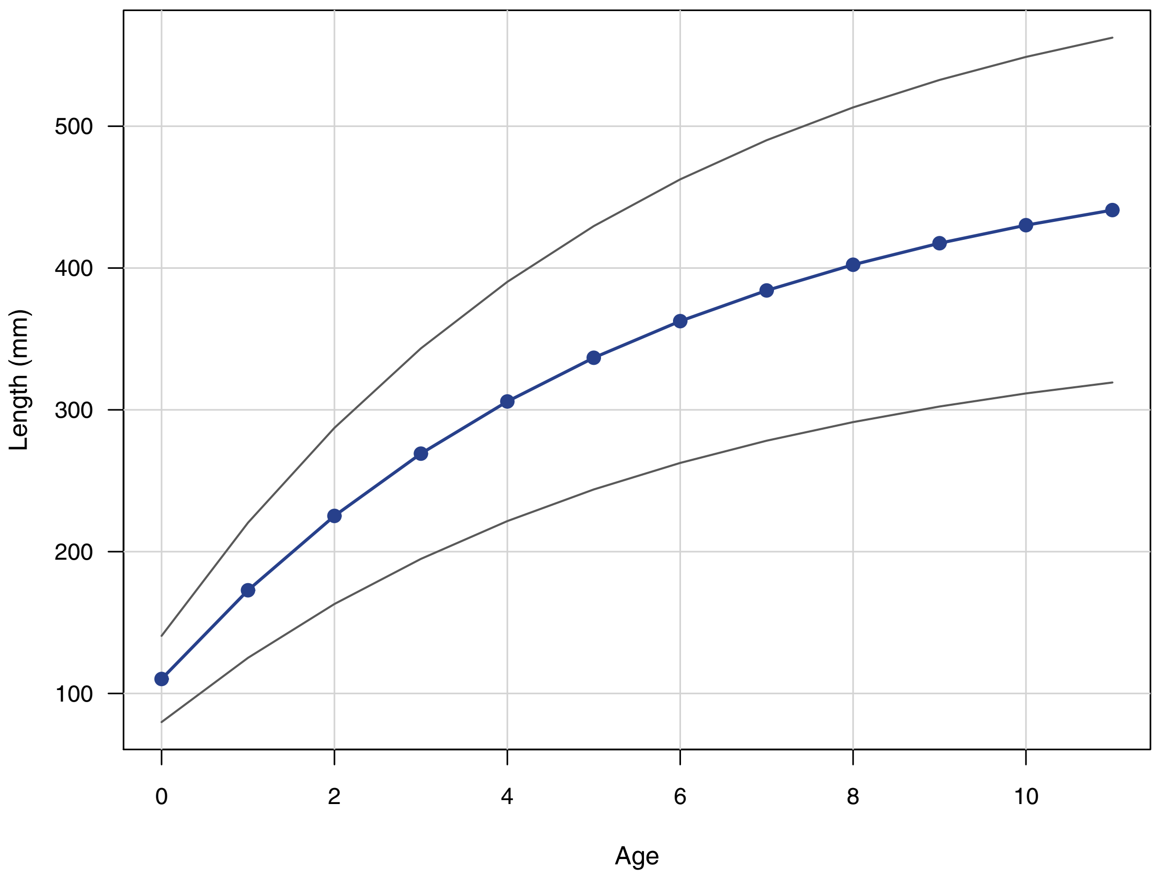


Figure 3.2. Observed (open circles) and estimated (solid line) annual length and age compositions by fleet or survey. In panels indicating the data set, lcomp refers to length compositions, acomp to age compositions, Mbft to MARMAP blackfish/snapper traps, Mcvt to MARMAP chevron traps, cl to commercial lines, cp to commercial pots, hb to headboat, mrip to general recreational, and hb.D to headboat discards. The one year of cp length data represents annual compositions pooled across years within the relevant time block of size-limit regulations. N indicates the number of trips from which individual fish samples were taken.

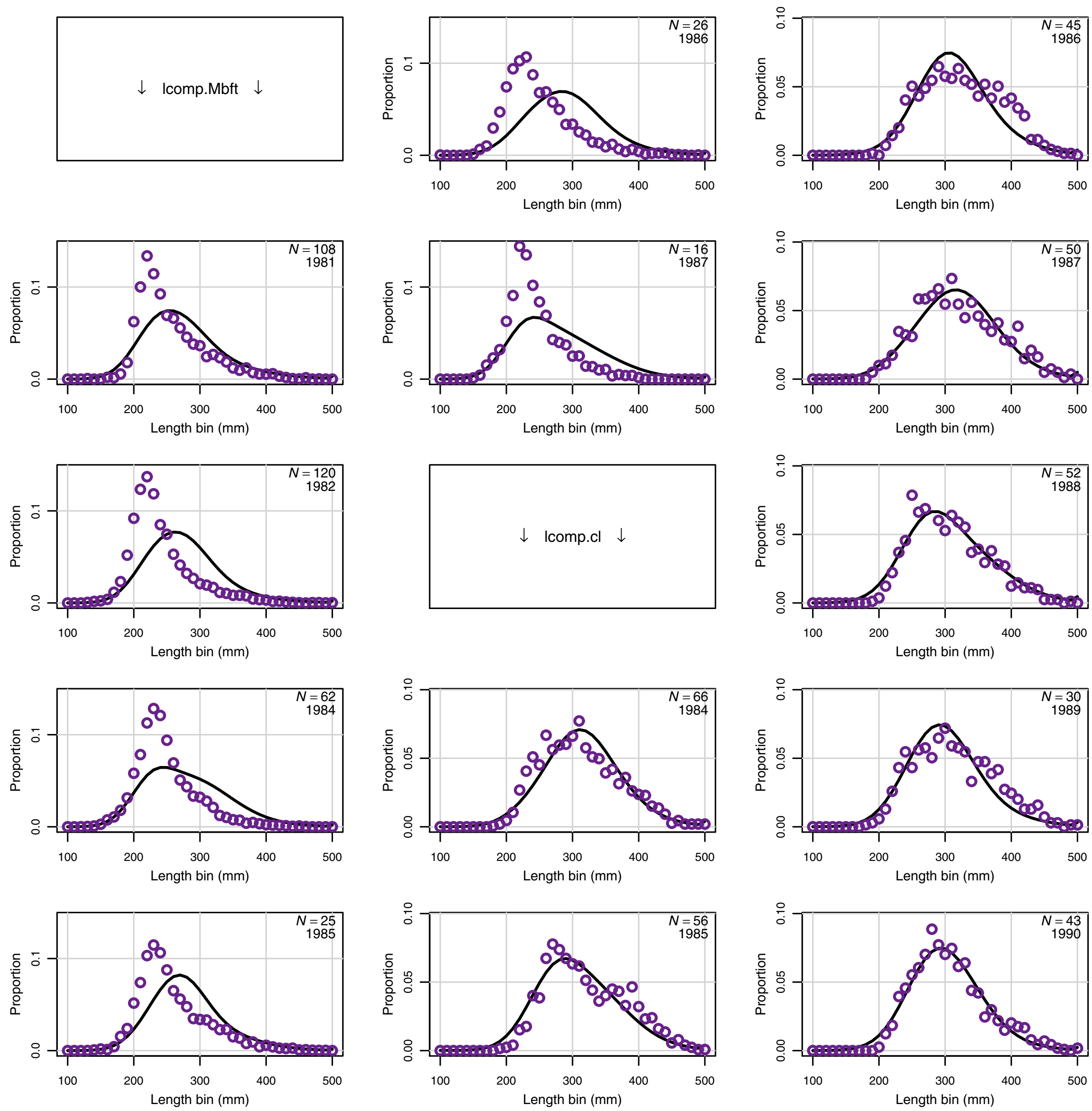


Figure 3.2. (cont.) Observed (open circles) and estimated (solid line) annual length and age compositions by fleet or survey.

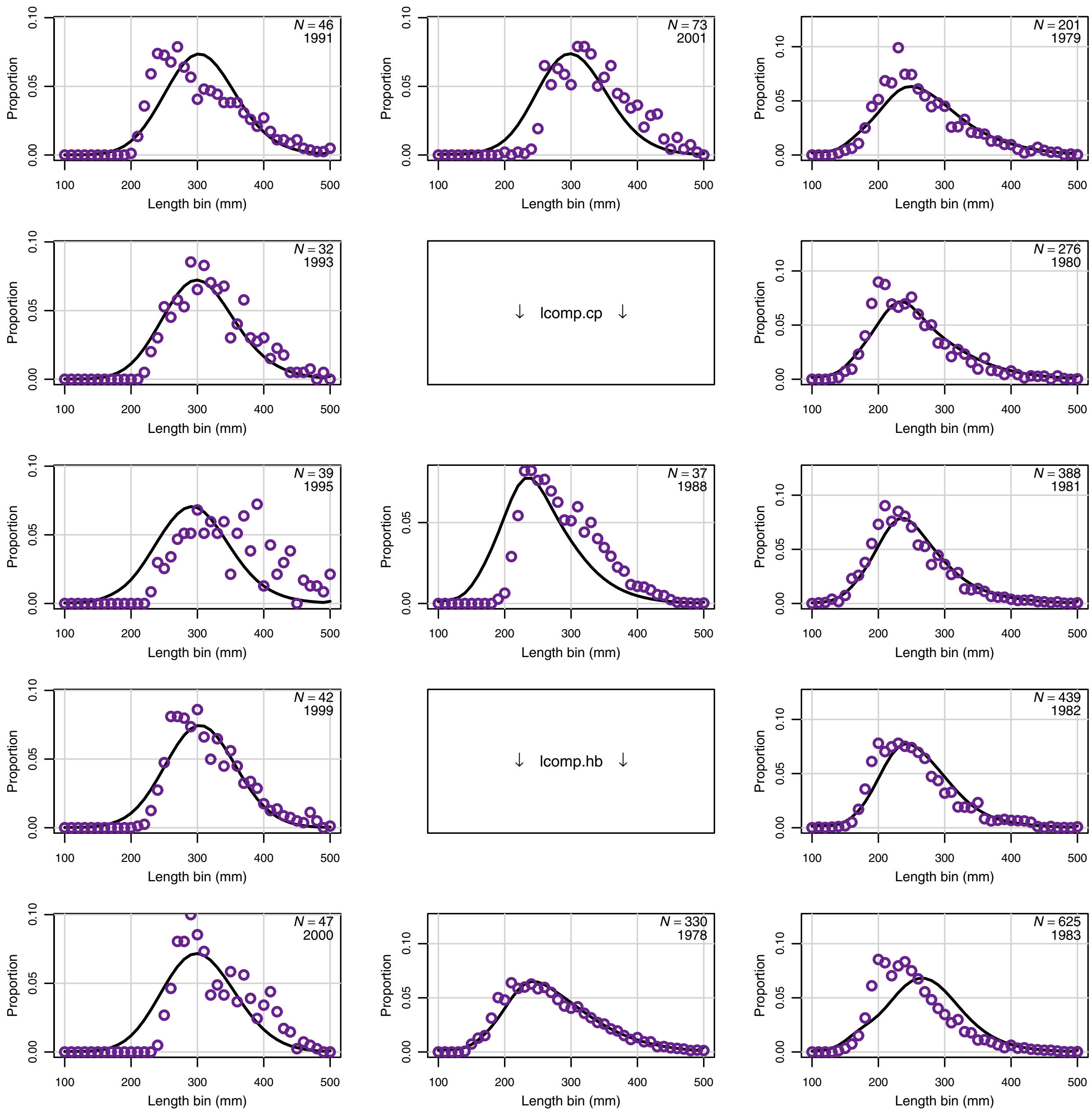


Figure 3.2. (cont.) Observed (open circles) and estimated (solid line) annual length and age compositions by fleet or survey.

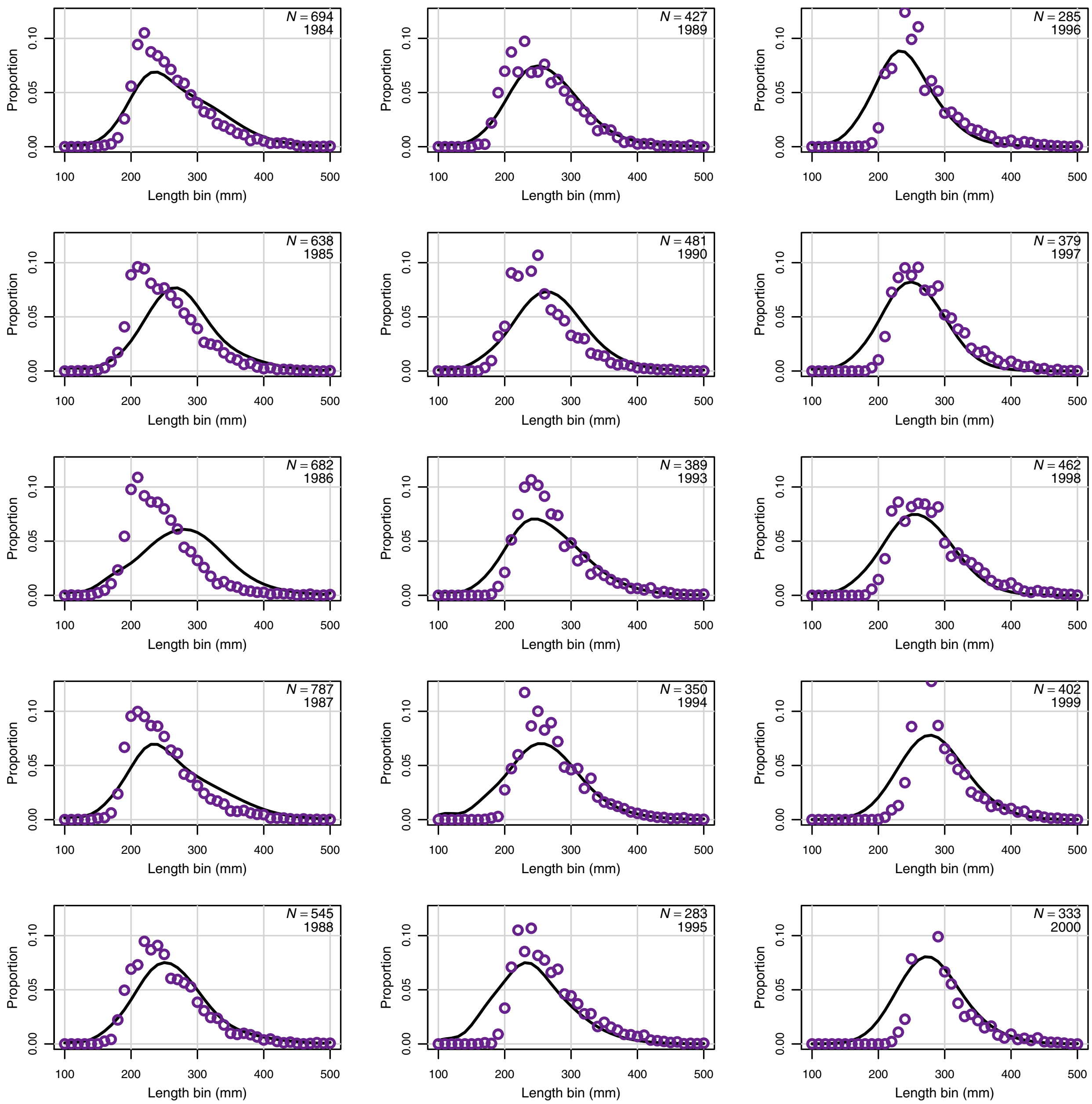


Figure 3.2. (cont.) Observed (open circles) and estimated (solid line) annual length and age compositions by fleet or survey.

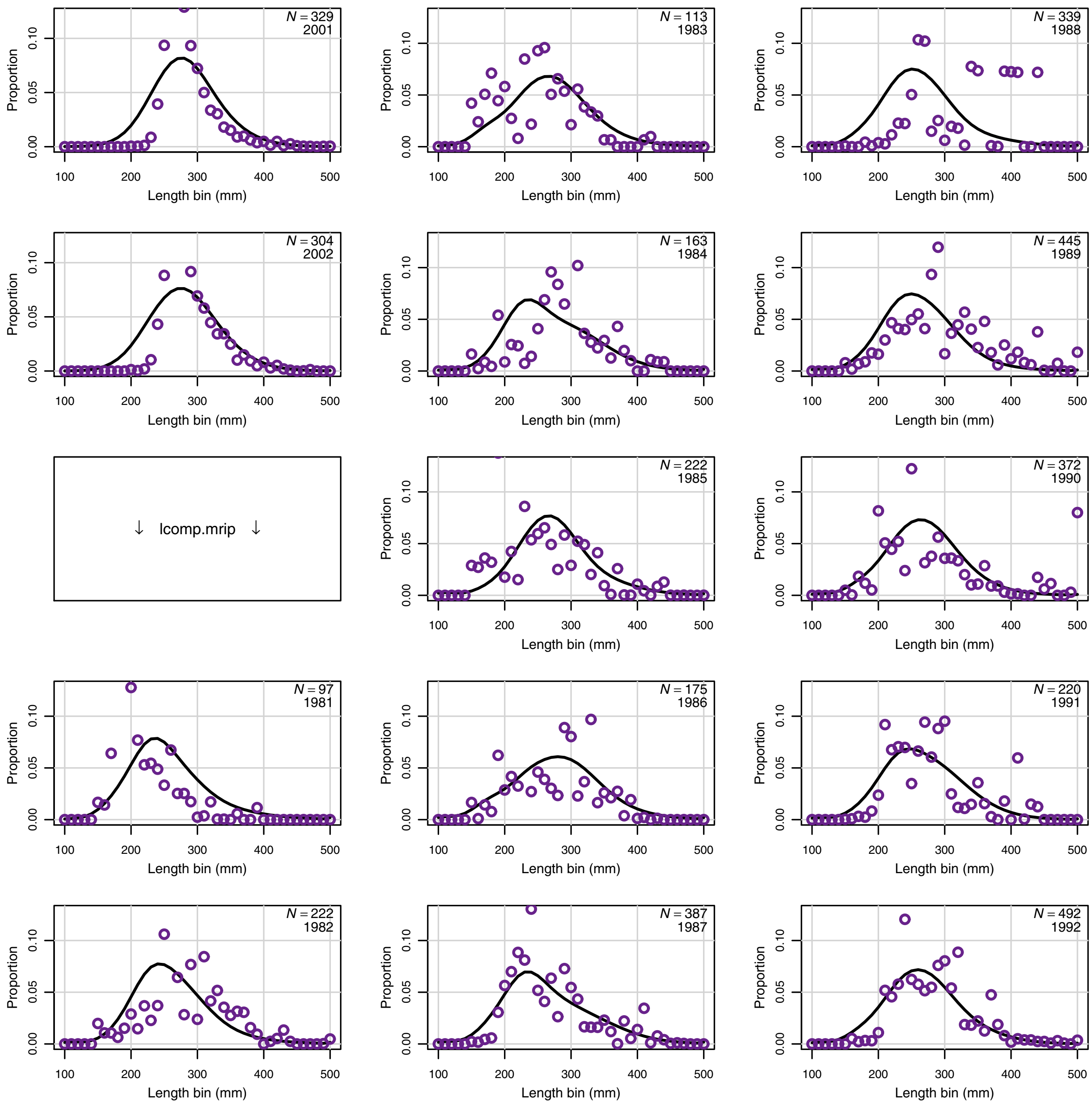


Figure 3.2. (cont.) Observed (open circles) and estimated (solid line) annual length and age compositions by fleet or survey.

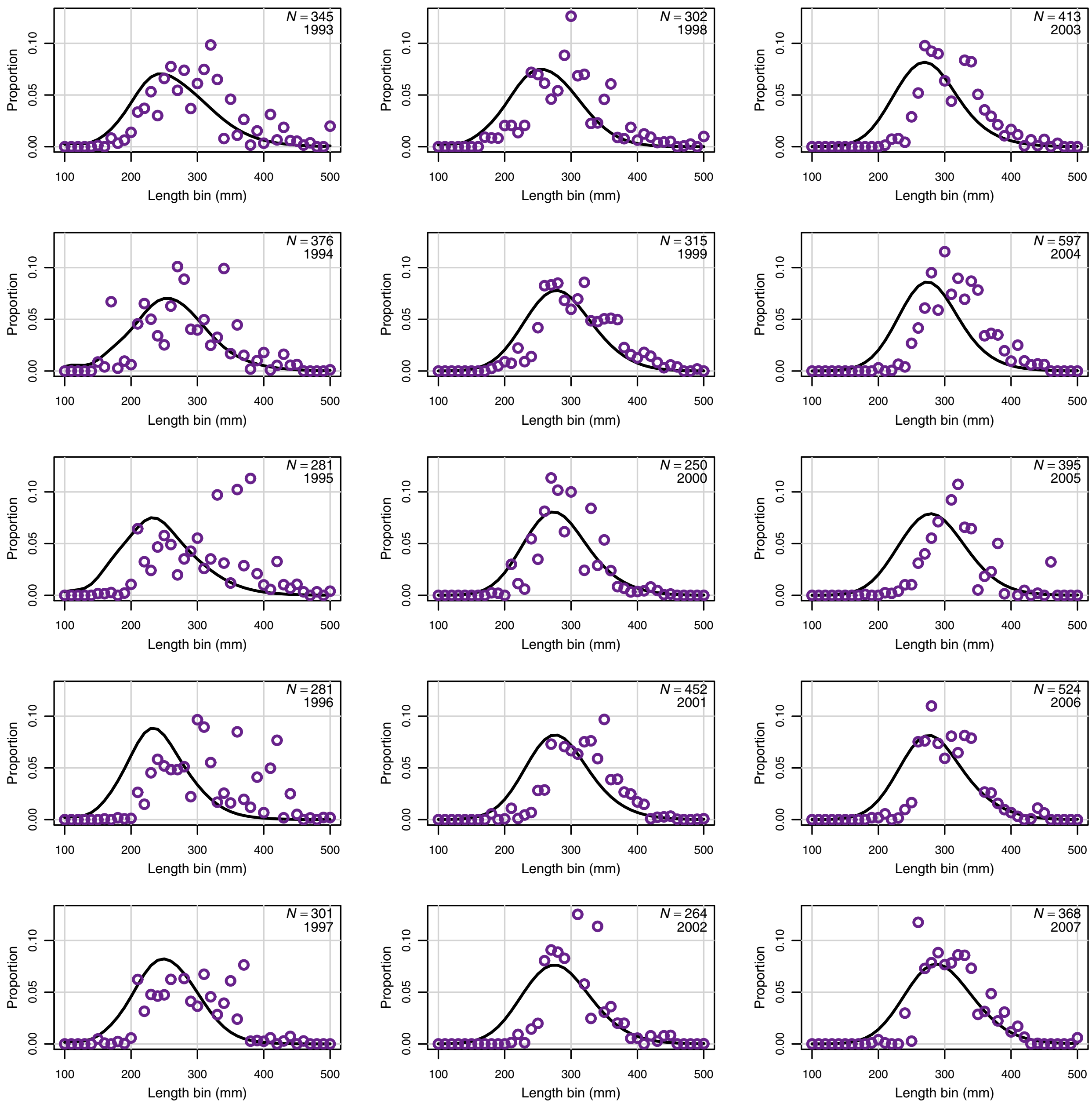


Figure 3.2. (cont.) Observed (open circles) and estimated (solid line) annual length and age compositions by fleet or survey.

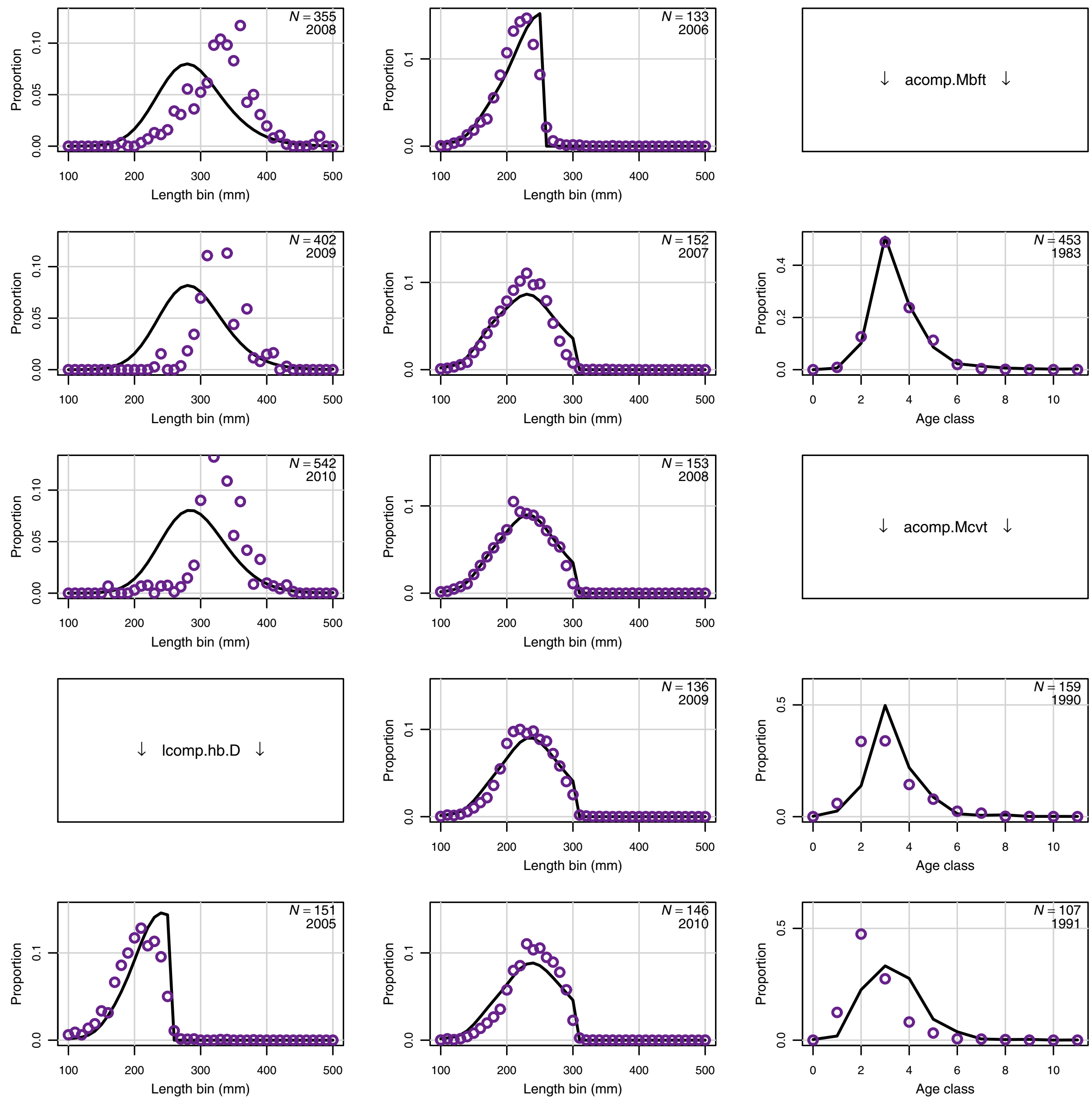


Figure 3.2. (cont.) Observed (open circles) and estimated (solid line) annual length and age compositions by fleet or survey.

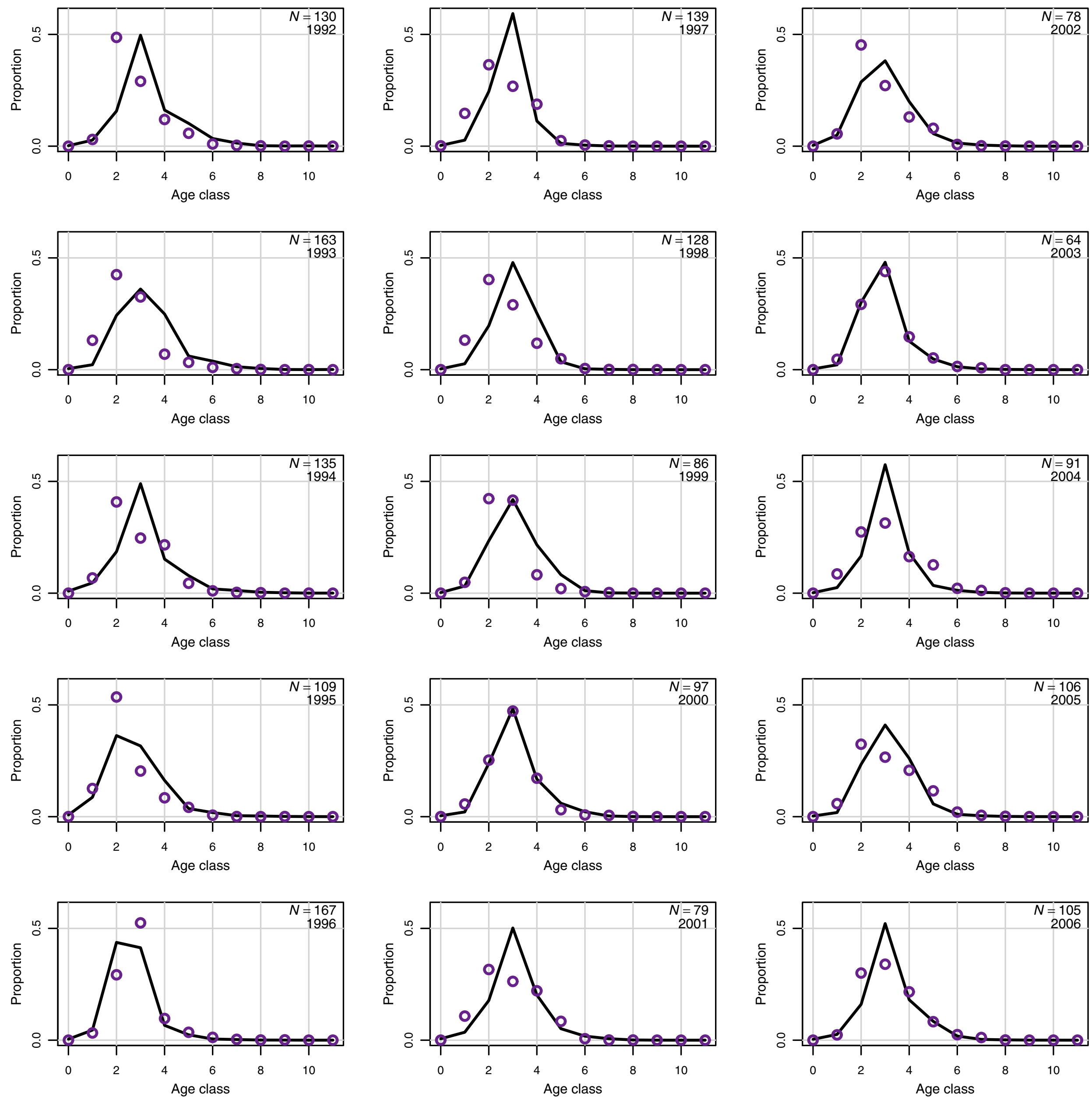


Figure 3.2. (cont.) Observed (open circles) and estimated (solid line) annual length and age compositions by fleet or survey.

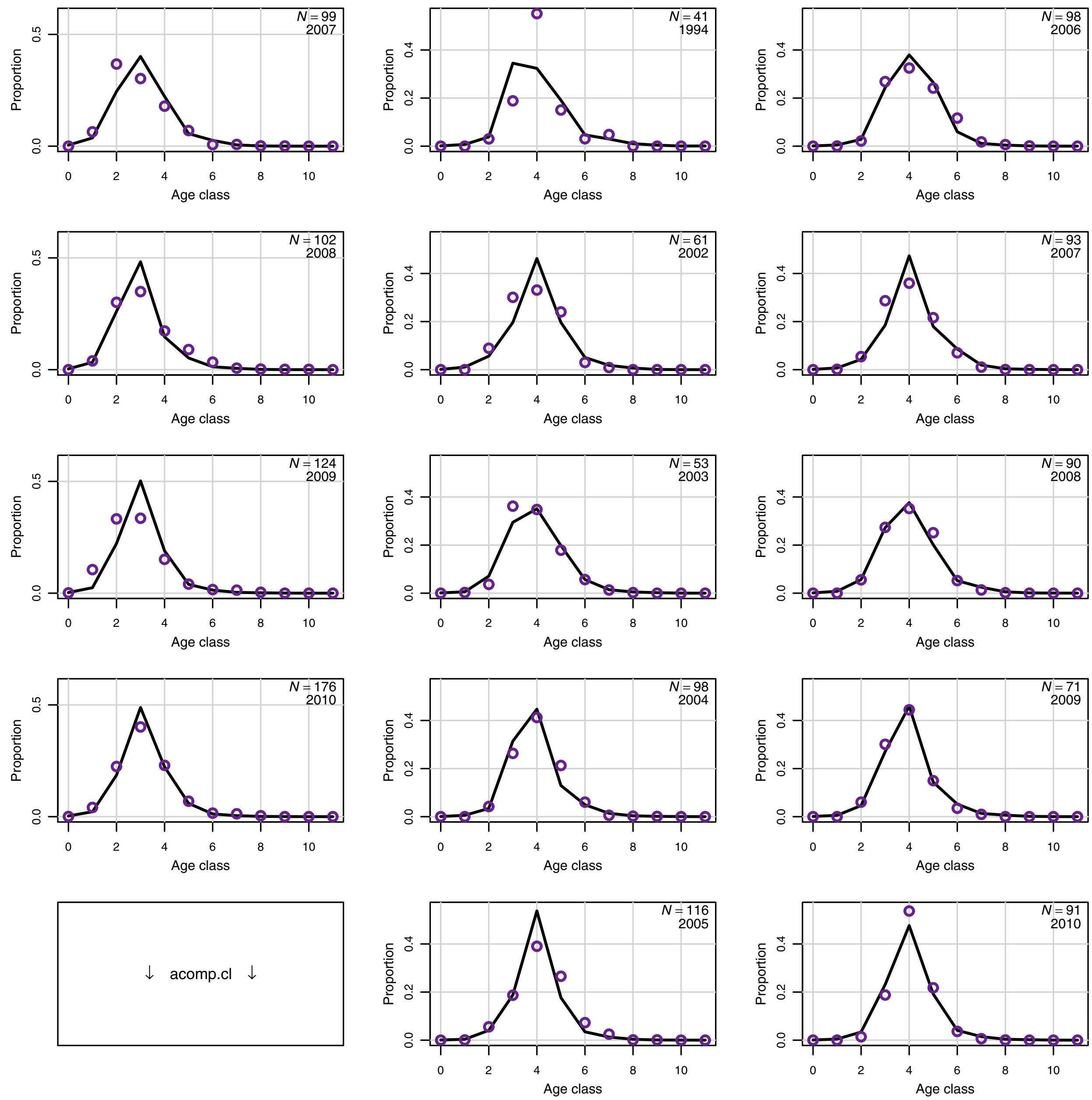


Figure 3.2. (cont.) Observed (open circles) and estimated (solid line) annual length and age compositions by fleet or survey.

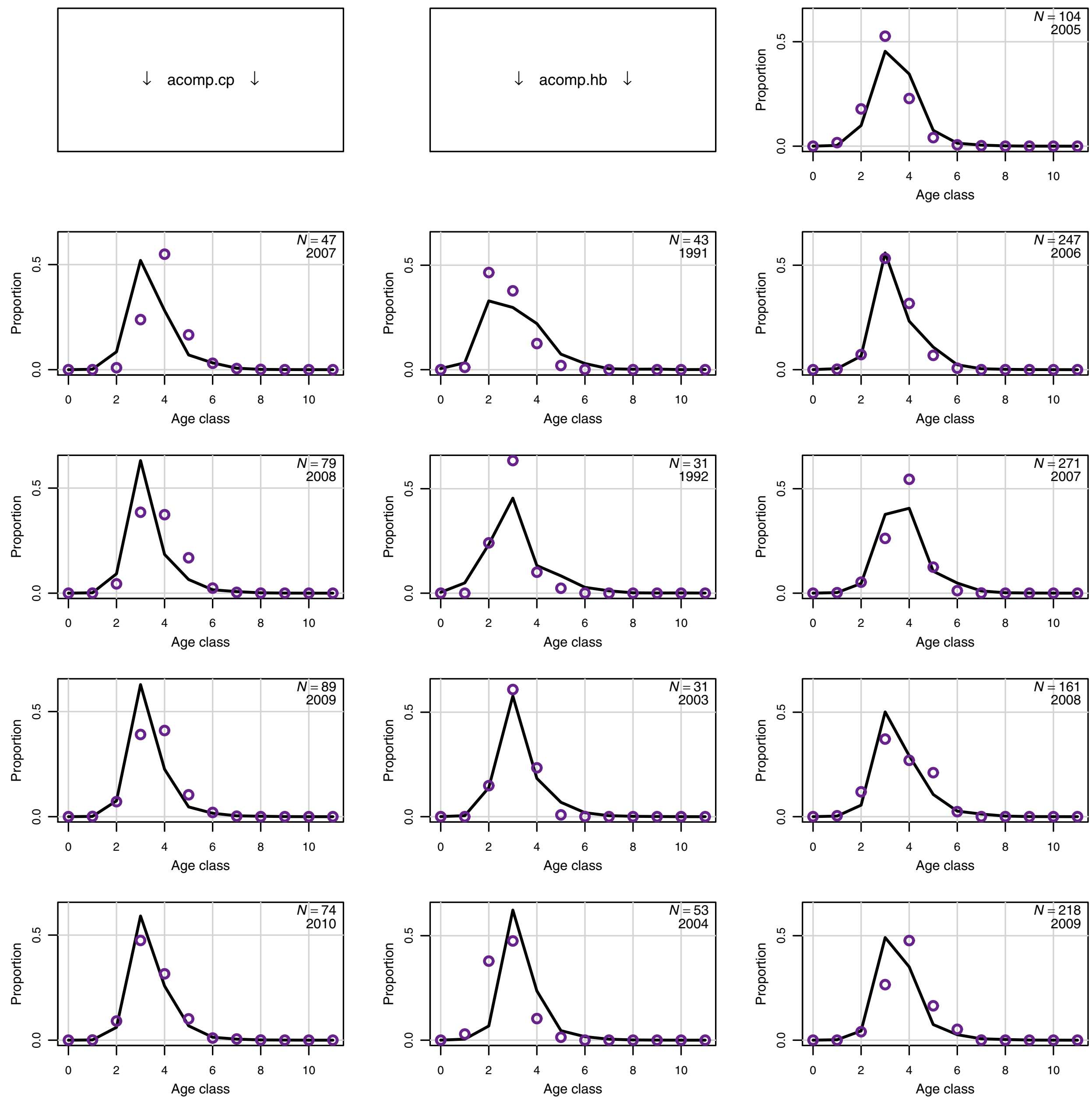


Figure 3.2. (cont.) Observed (open circles) and estimated (solid line) annual length and age compositions by fleet or survey.

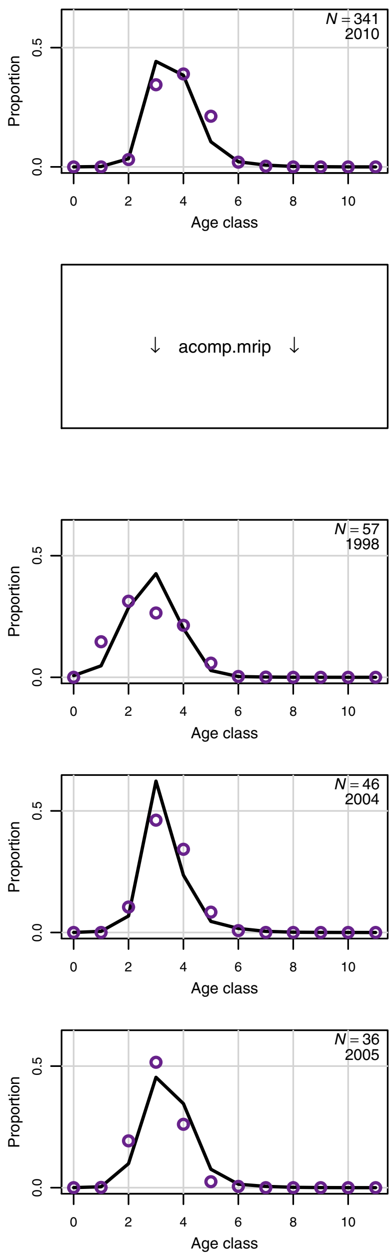


Figure 3.3. Observed (open circles) and estimated (line, solid circles) commercial lines landings (1000 lb whole weight).

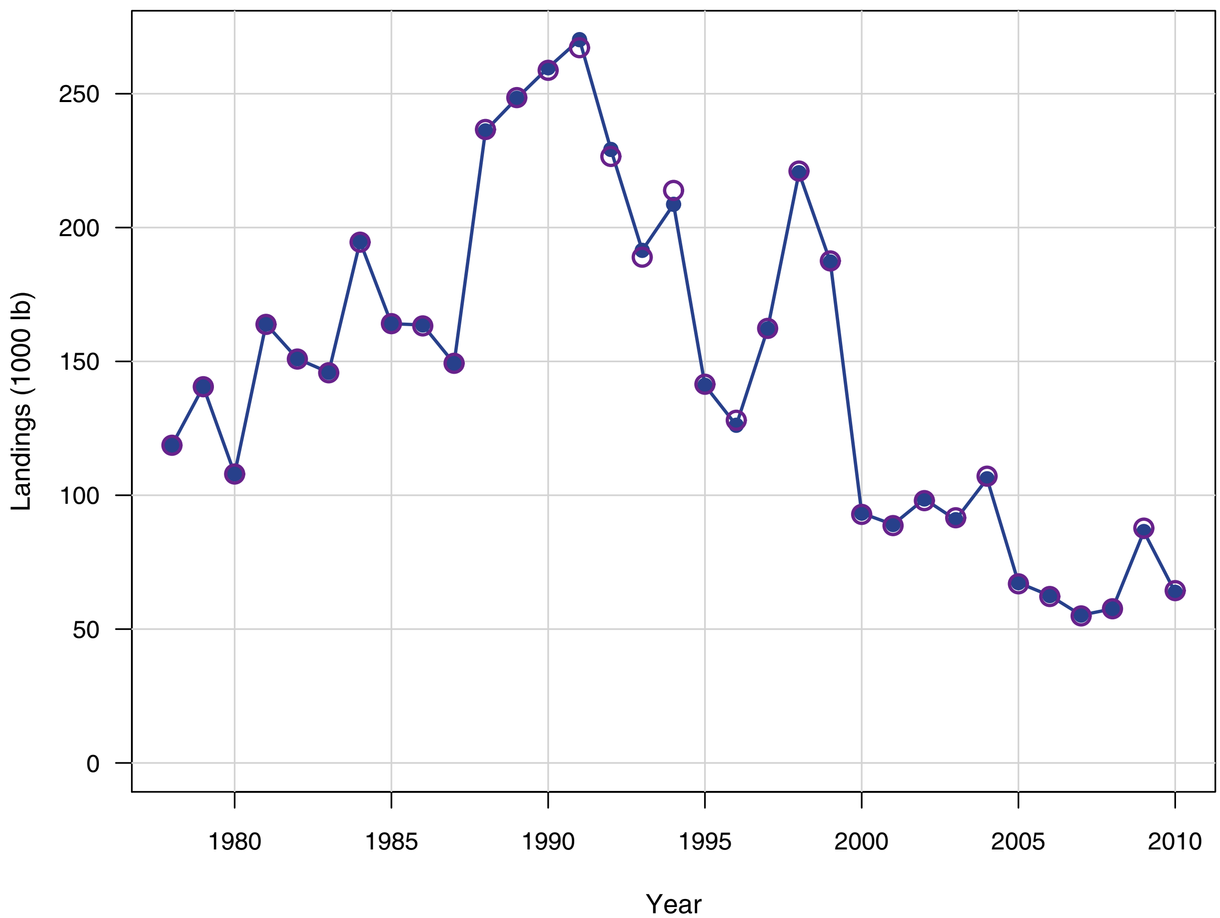


Figure 3.4. Observed (open circles) and estimated (line, solid circles) commercial pot landings (1000 lb whole weight).

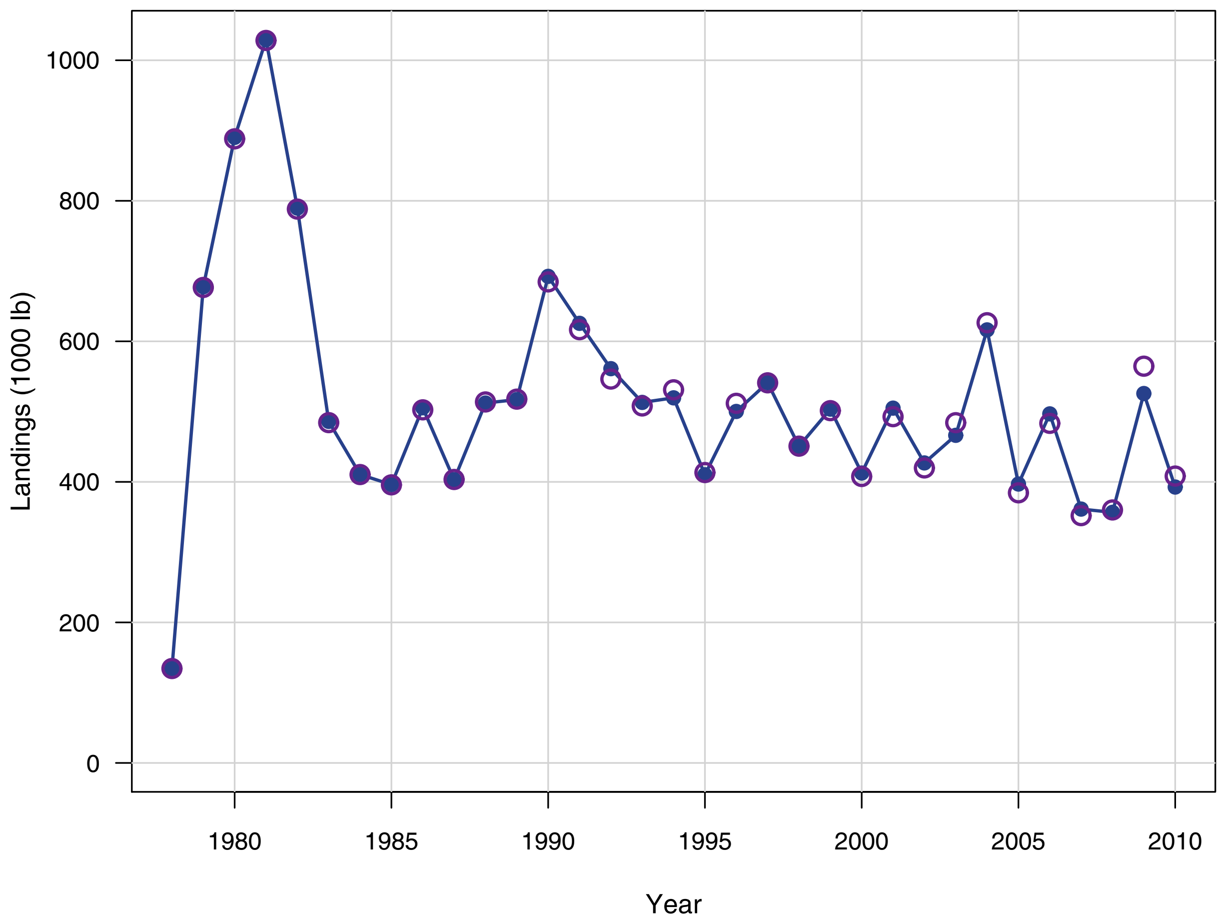


Figure 3.5. Observed (open circles) and estimated (line, solid circles) commercial trawl landings (1000 lb whole weight).

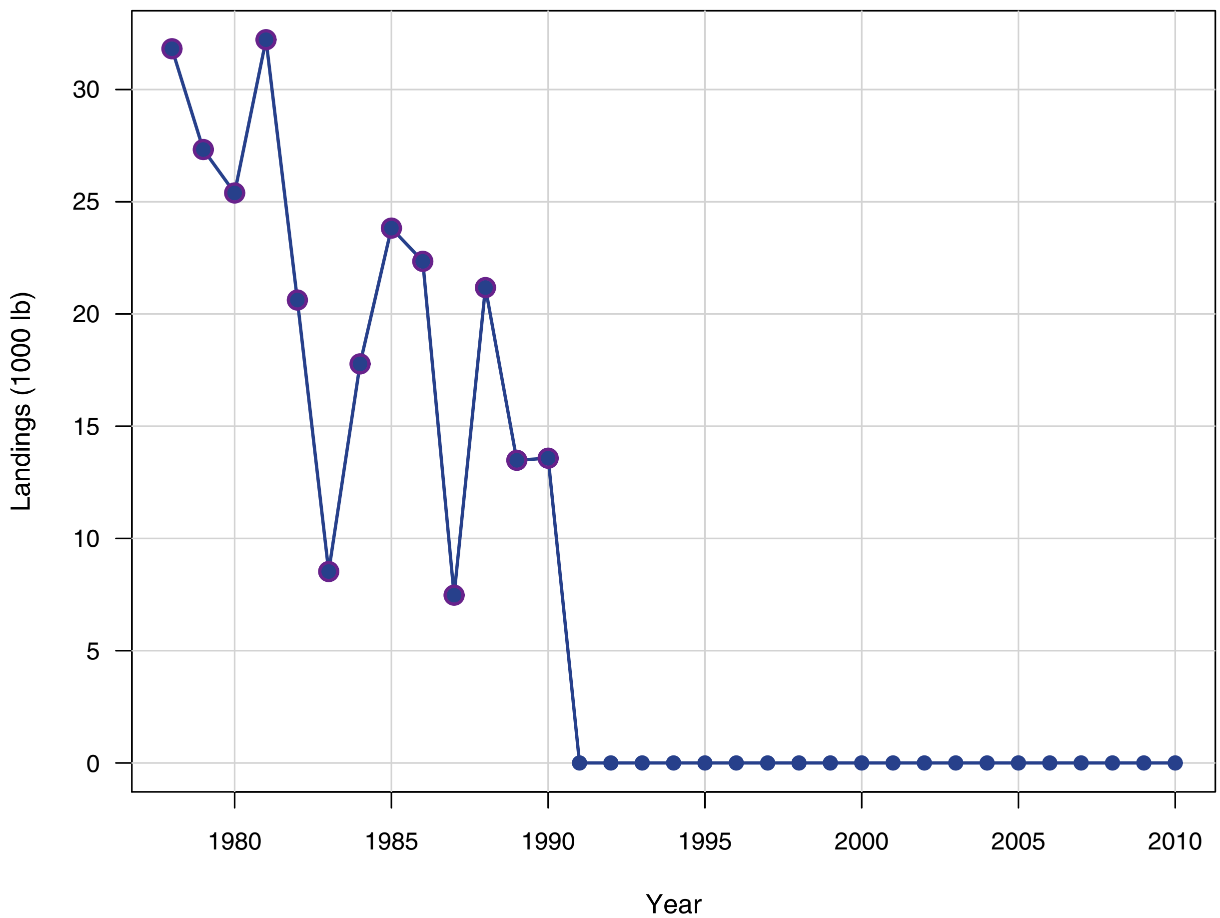


Figure 3.6. Observed (open circles) and estimated (line, solid circles) headboat landings (1000 lb whole weight).

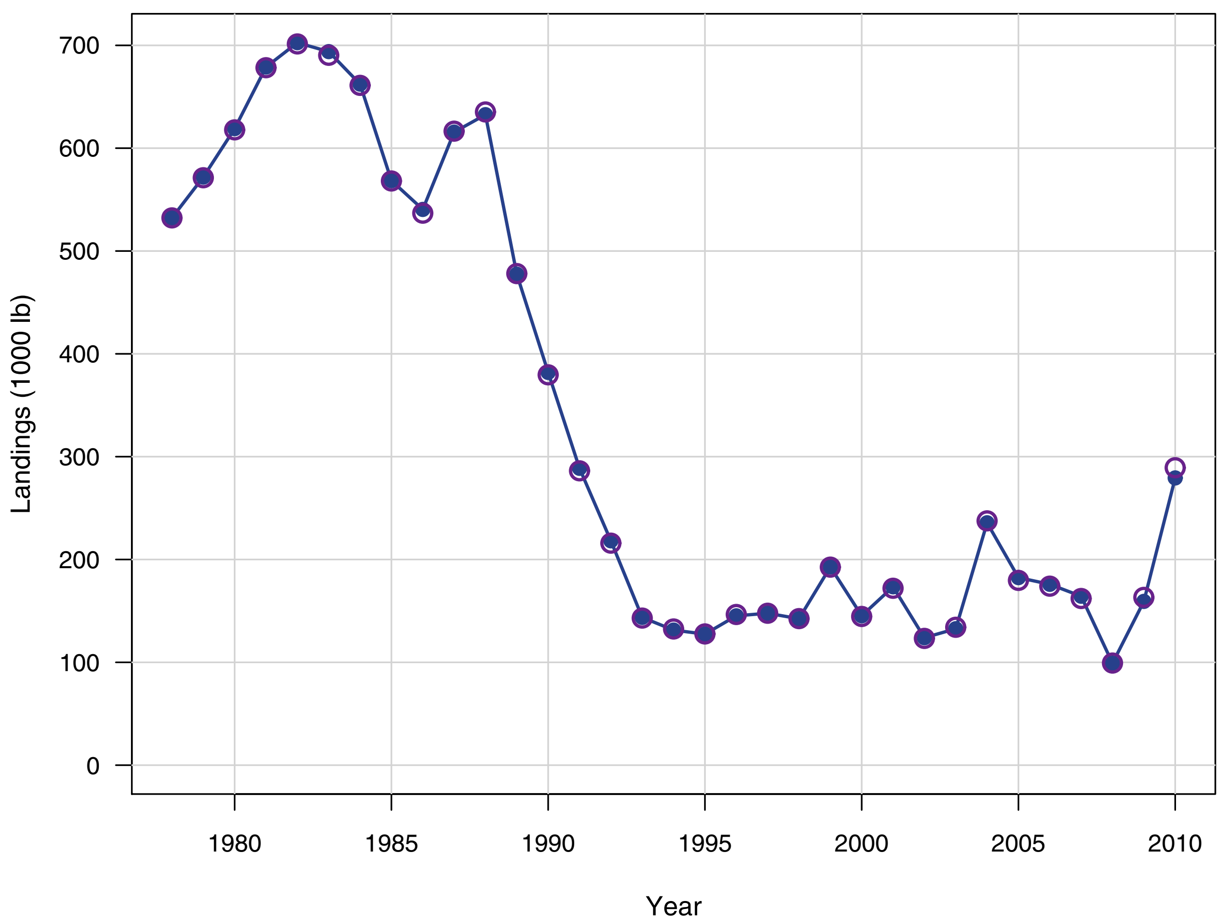


Figure 3.7. Observed (open circles) and estimated (line, solid circles) general recreational landings (1000 lb whole weight). In years without observations (1978–1980), values were predicted using average F (see §3.1.1.3 for details).

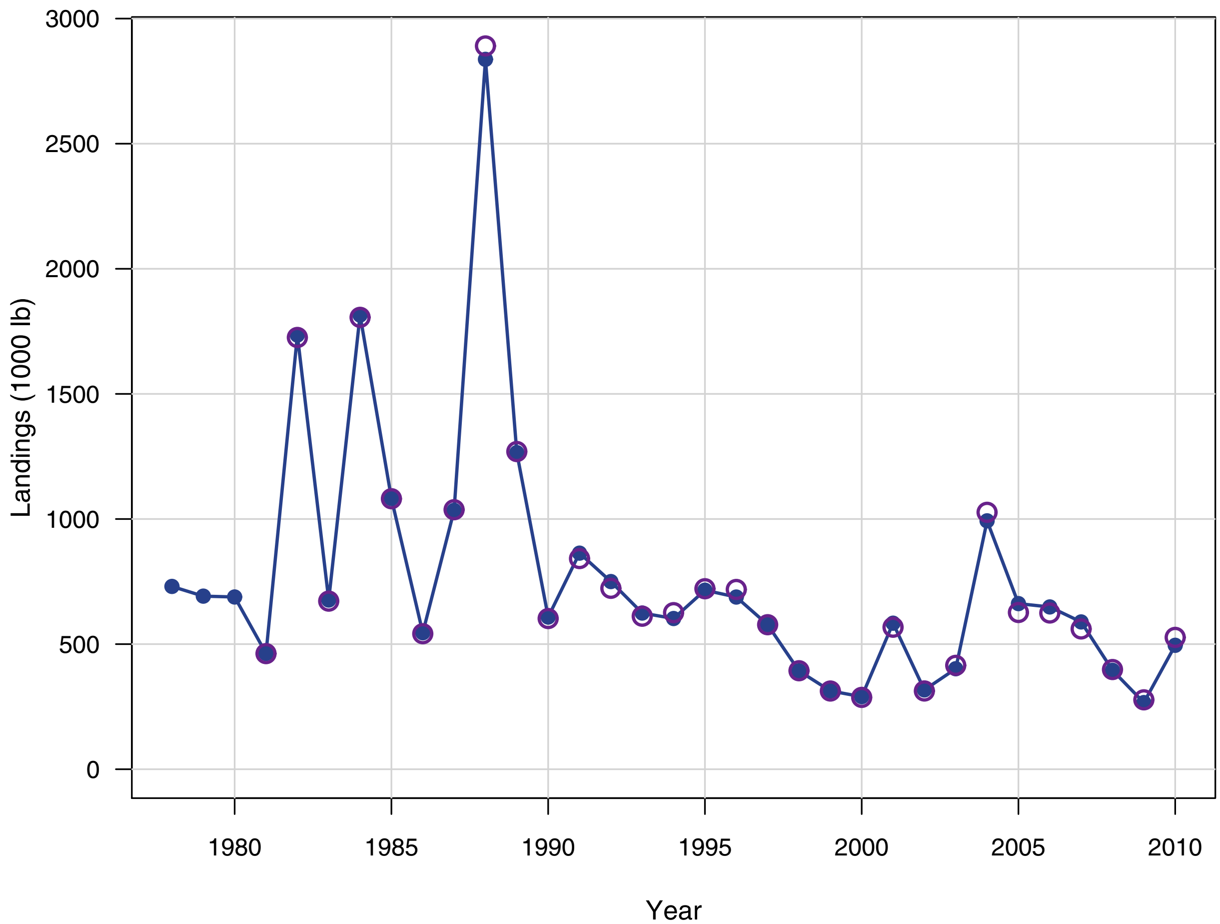


Figure 3.8. Observed (open circles) and estimated (line, solid circles) commercial (lines + pots) discard mortalities (1000 dead fish). In years without observations (1984–1992), values were predicted using average F (see §3.1.1.3 for details). Commercial discards were modeled starting in 1984 with implementation of the 8-inch size limit.

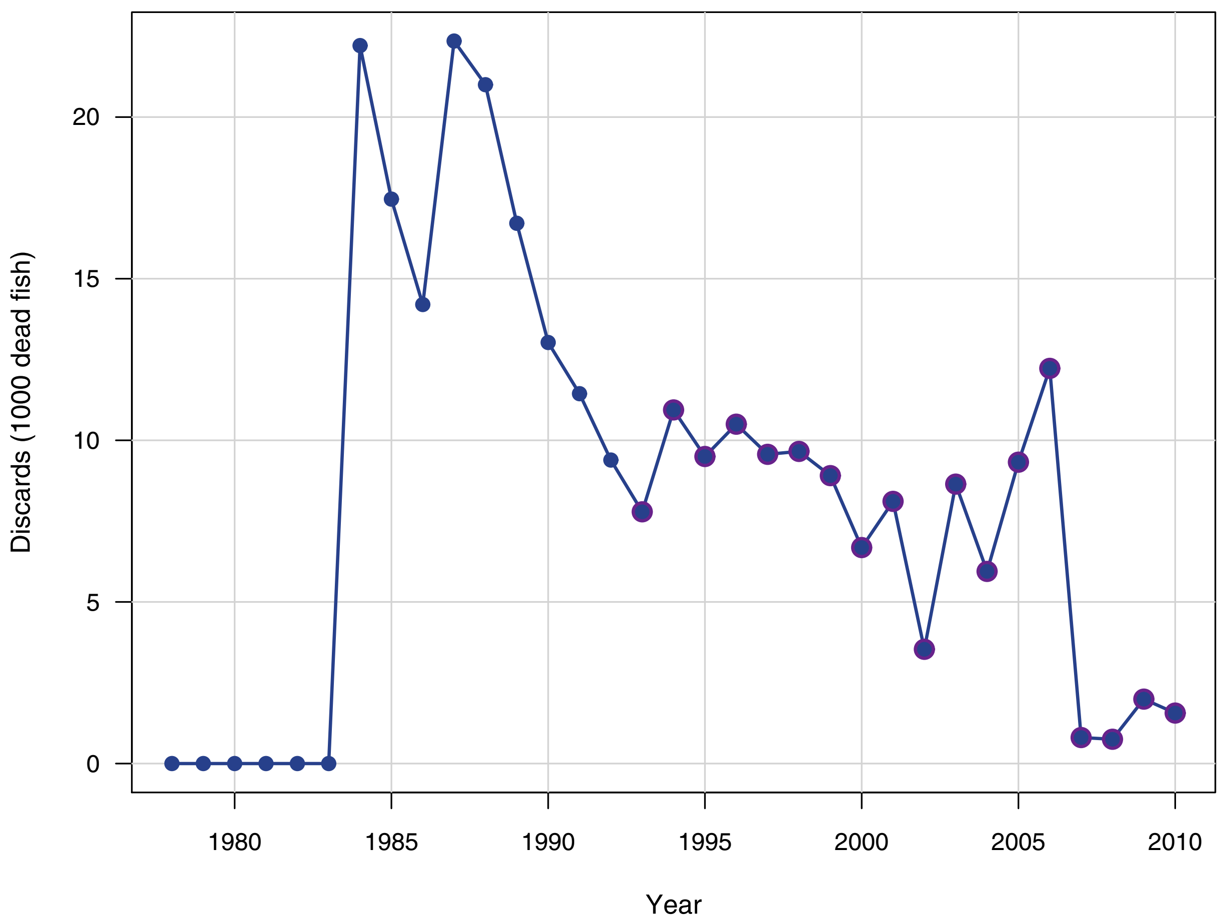


Figure 3.9. Observed (open circles) and estimated (line, solid circles) headboat discard mortalities (1000 dead fish). Estimates prior to 1986 were combined with the general recreational discards.

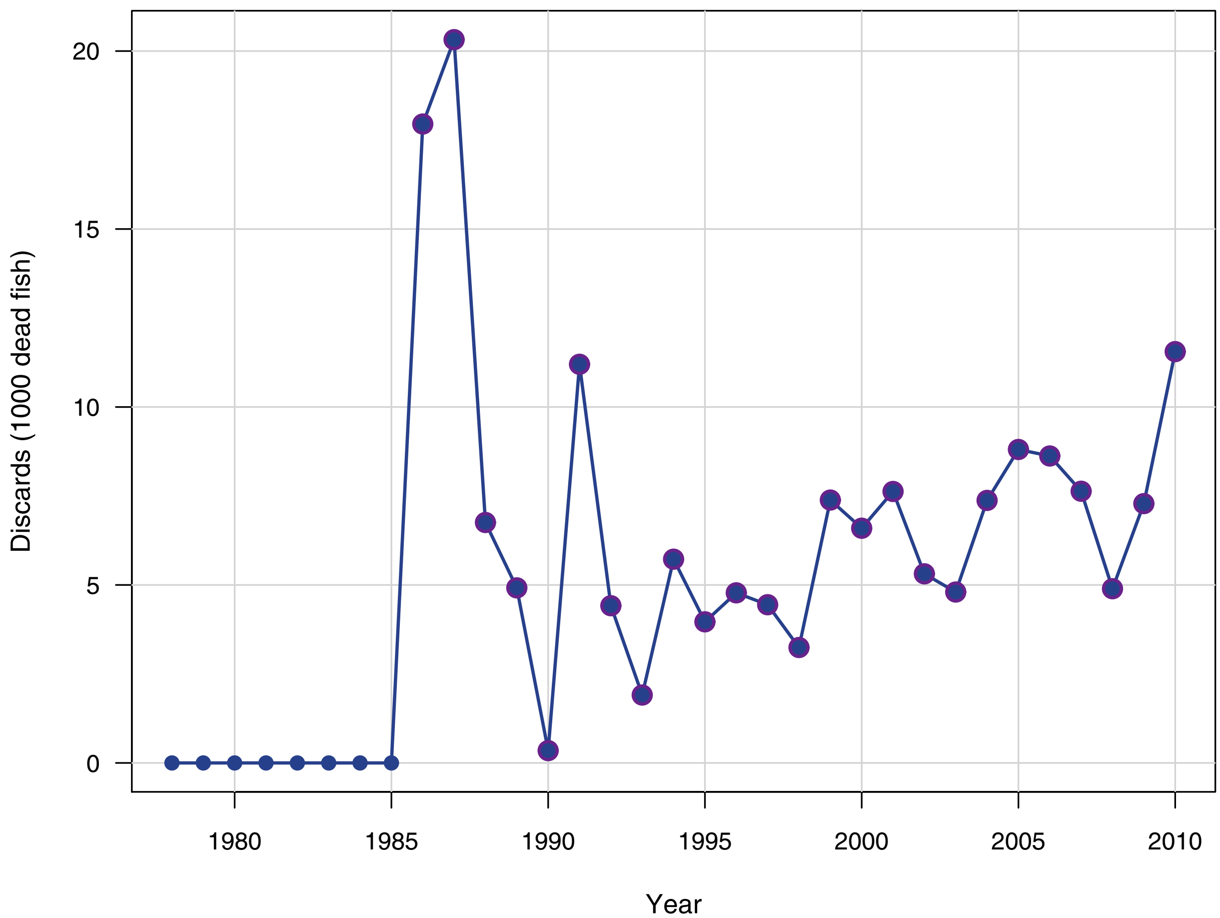


Figure 3.10. Observed (open circles) and estimated (line, solid circles) general recreational discard mortalities (1000 dead fish). Estimates prior to 1986 include headboat discard mortalities. In years without observations (1978–1980), values were predicted using average F (see §3.1.1.3 for details).

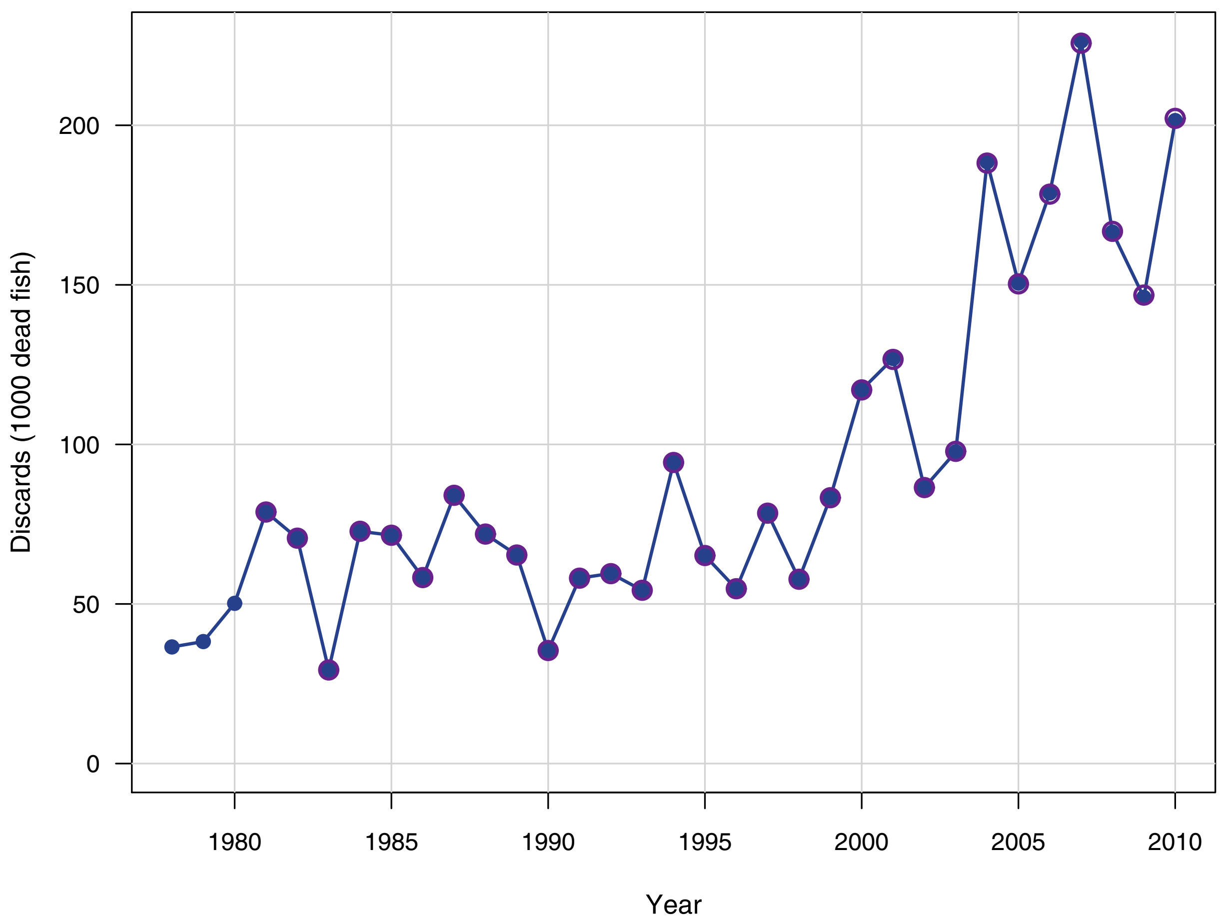


Figure 3.11. Observed (open circles) and estimated (line, solid circles) index of abundance from MARMAP blackfish/snapper traps.

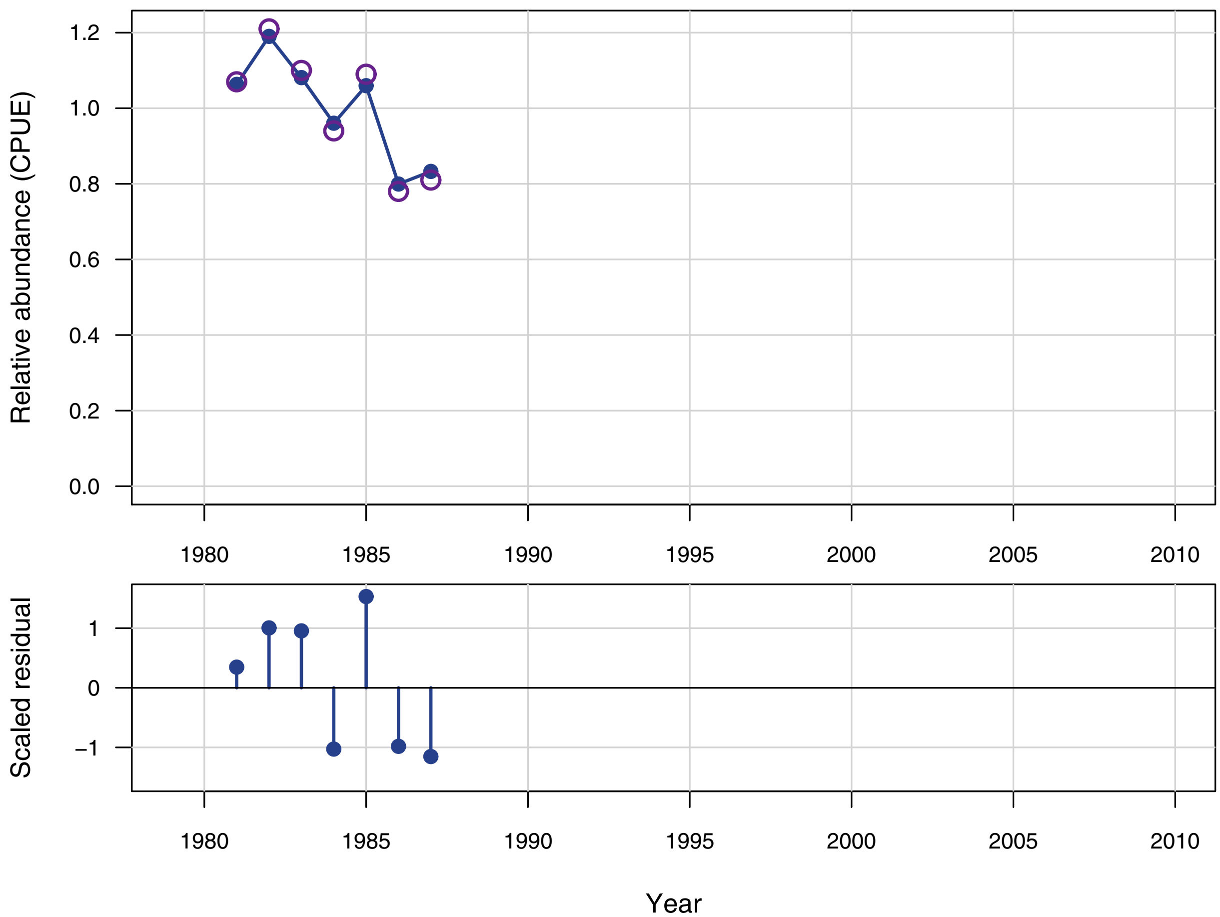


Figure 3.12. Observed (open circles) and estimated (line, solid circles) index of abundance from MARMAP chevron traps.

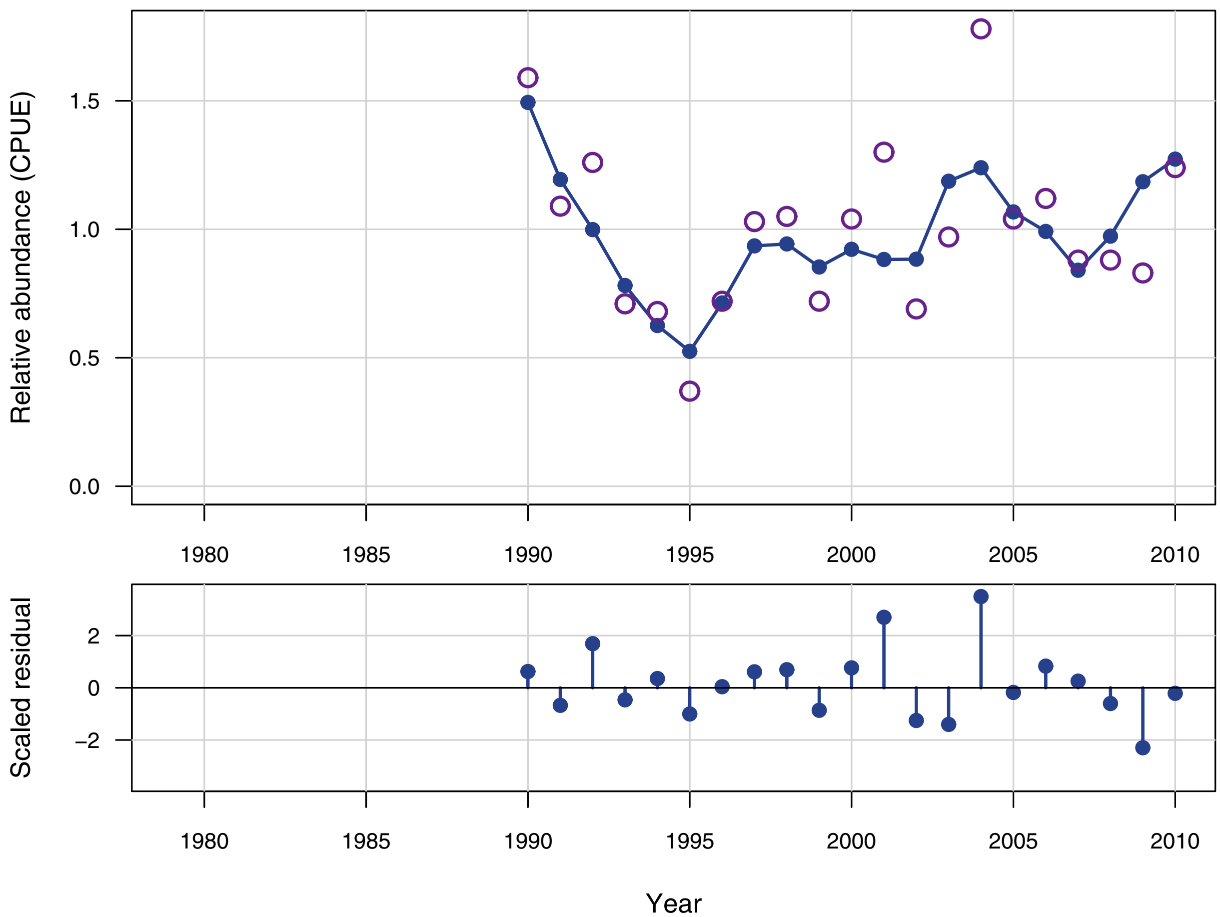


Figure 3.13. Observed (open circles) and estimated (line, solid circles) index of abundance from commercial lines.

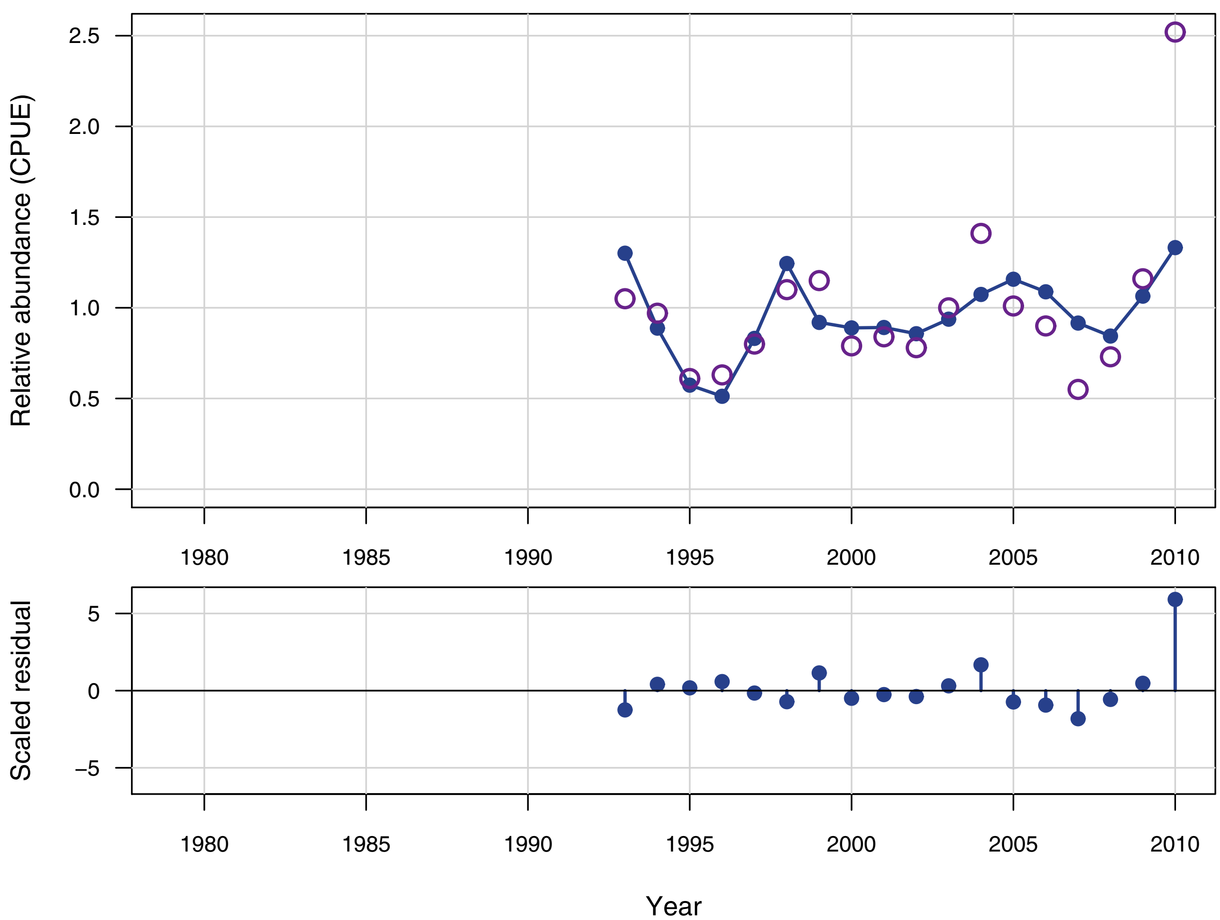


Figure 3.14. Observed (open circles) and estimated (line, solid circles) index of abundance from the headboat fleet.

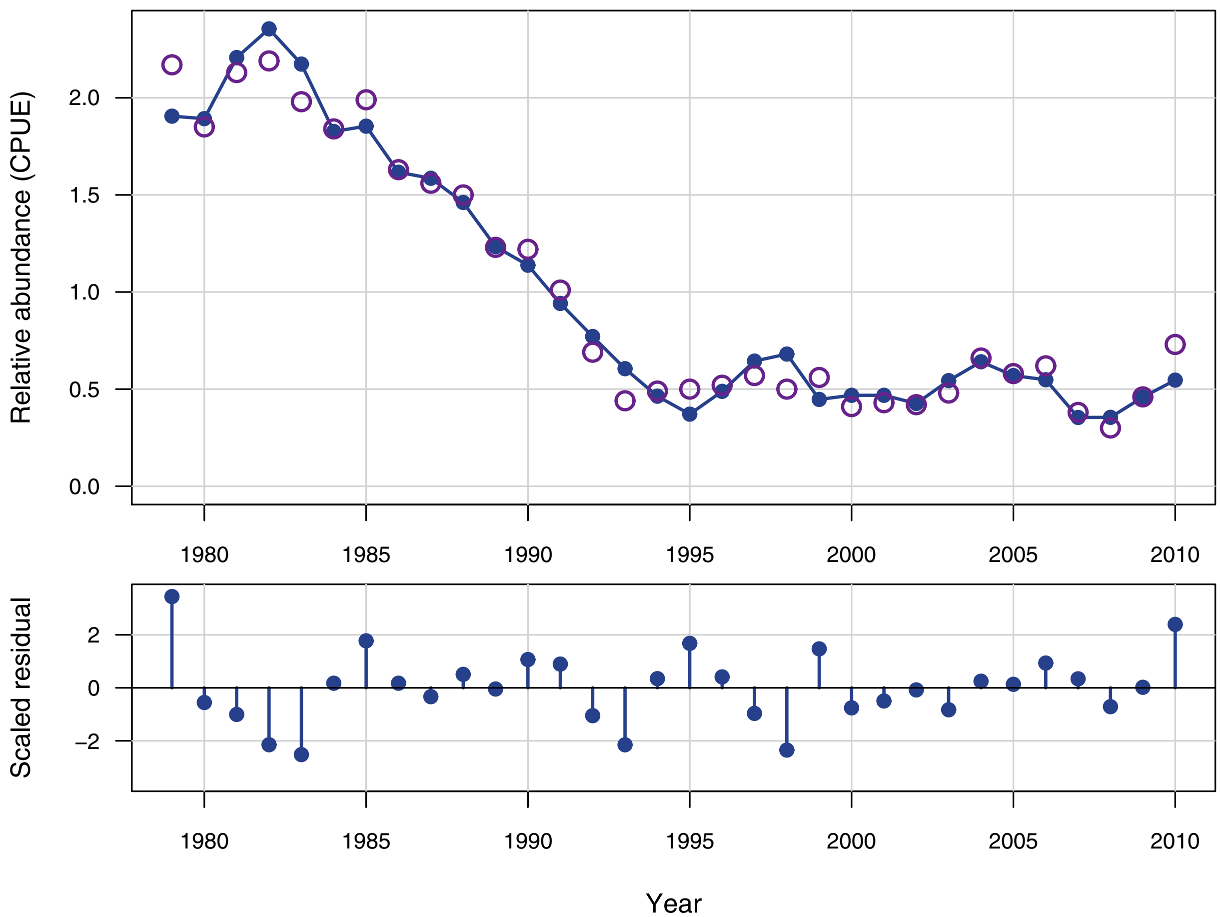


Figure 3.15. Observed (open circles) and estimated (line, solid circles) index of abundance from headboat discards.

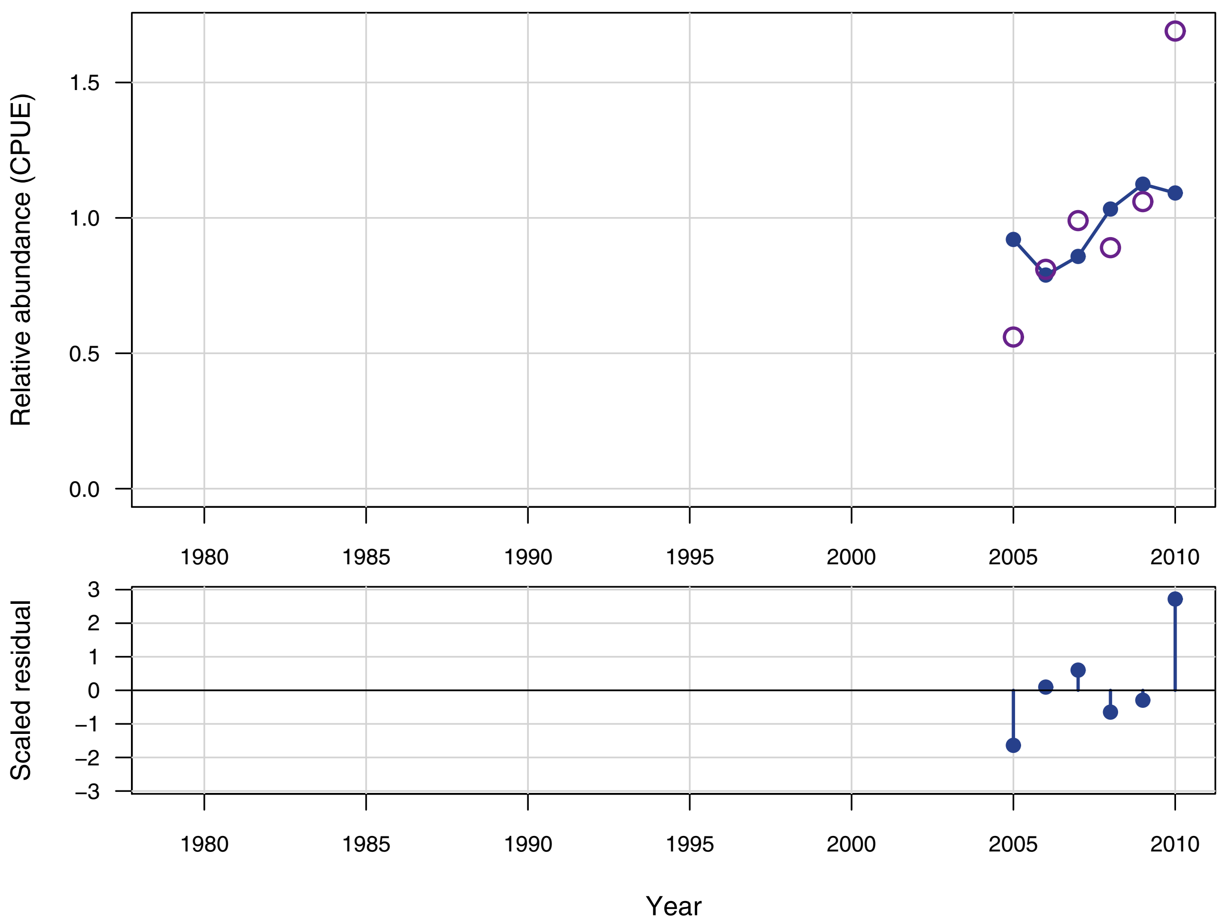


Figure 3.16. Estimated abundance at age at start of year.

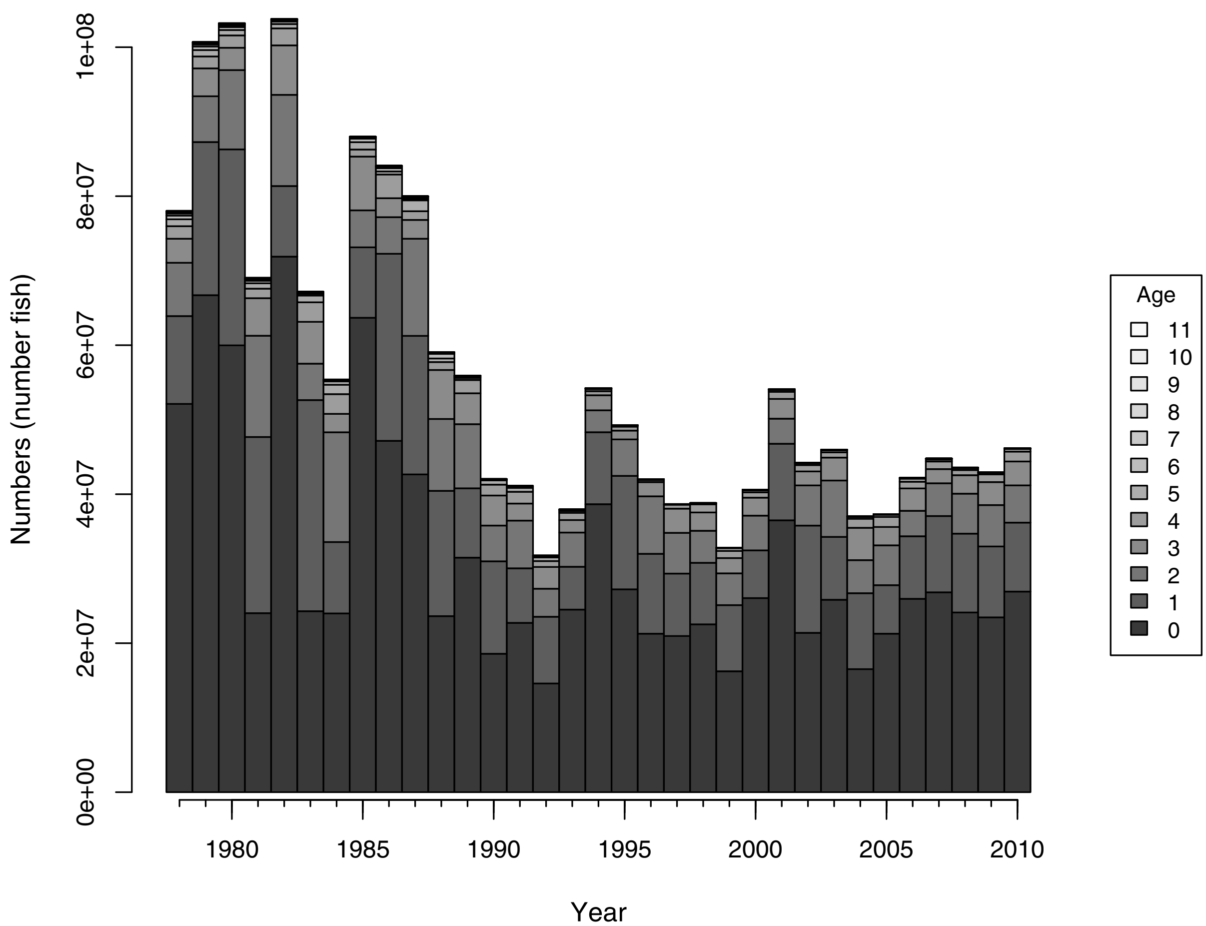


Figure 3.17. Top panel: Estimated recruitment of age-0 fish. Horizontal dashed line indicates R_{MSY}. Bottom panel: log recruitment residuals.

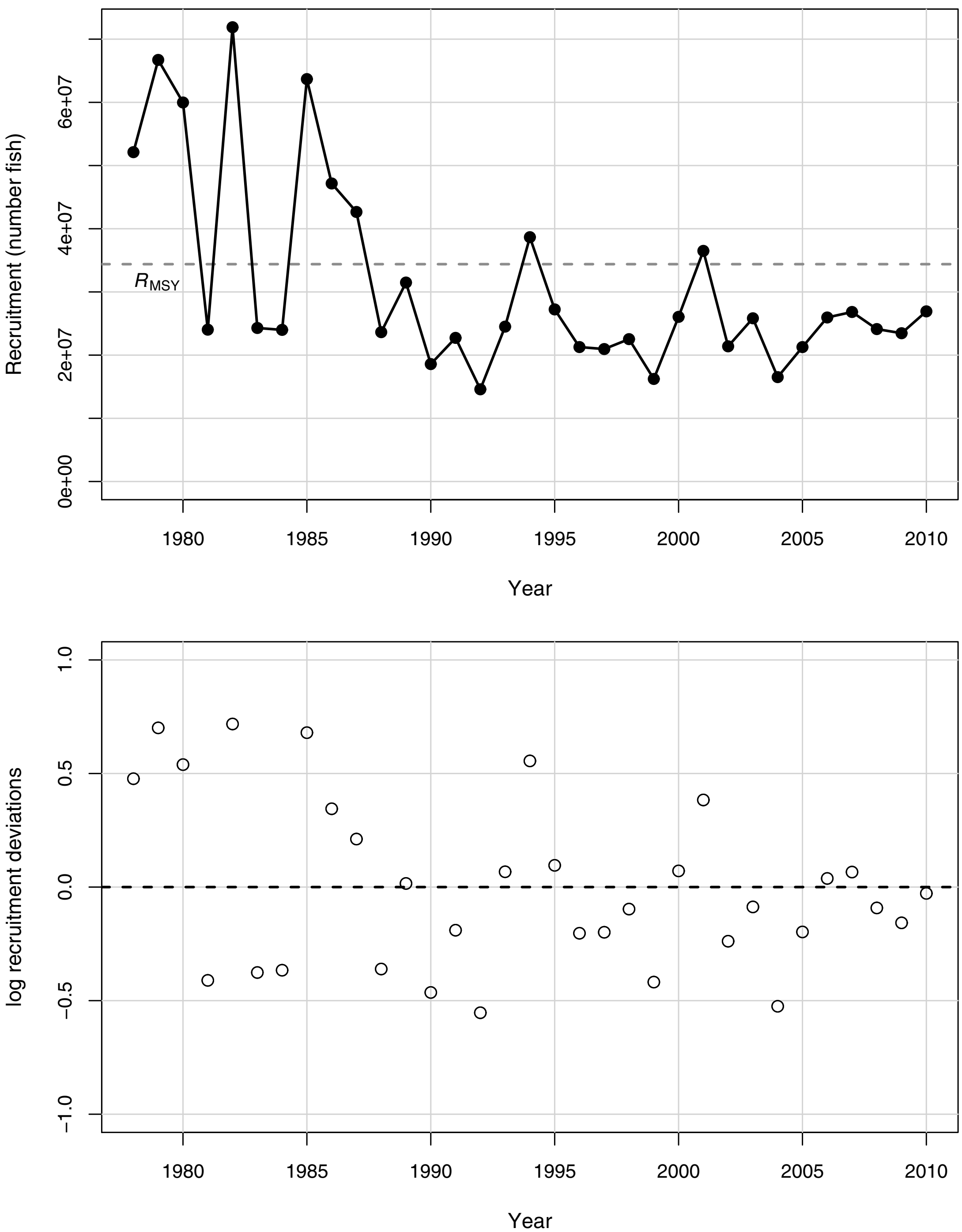


Figure 3.18. Estimated biomass at age at start of year.

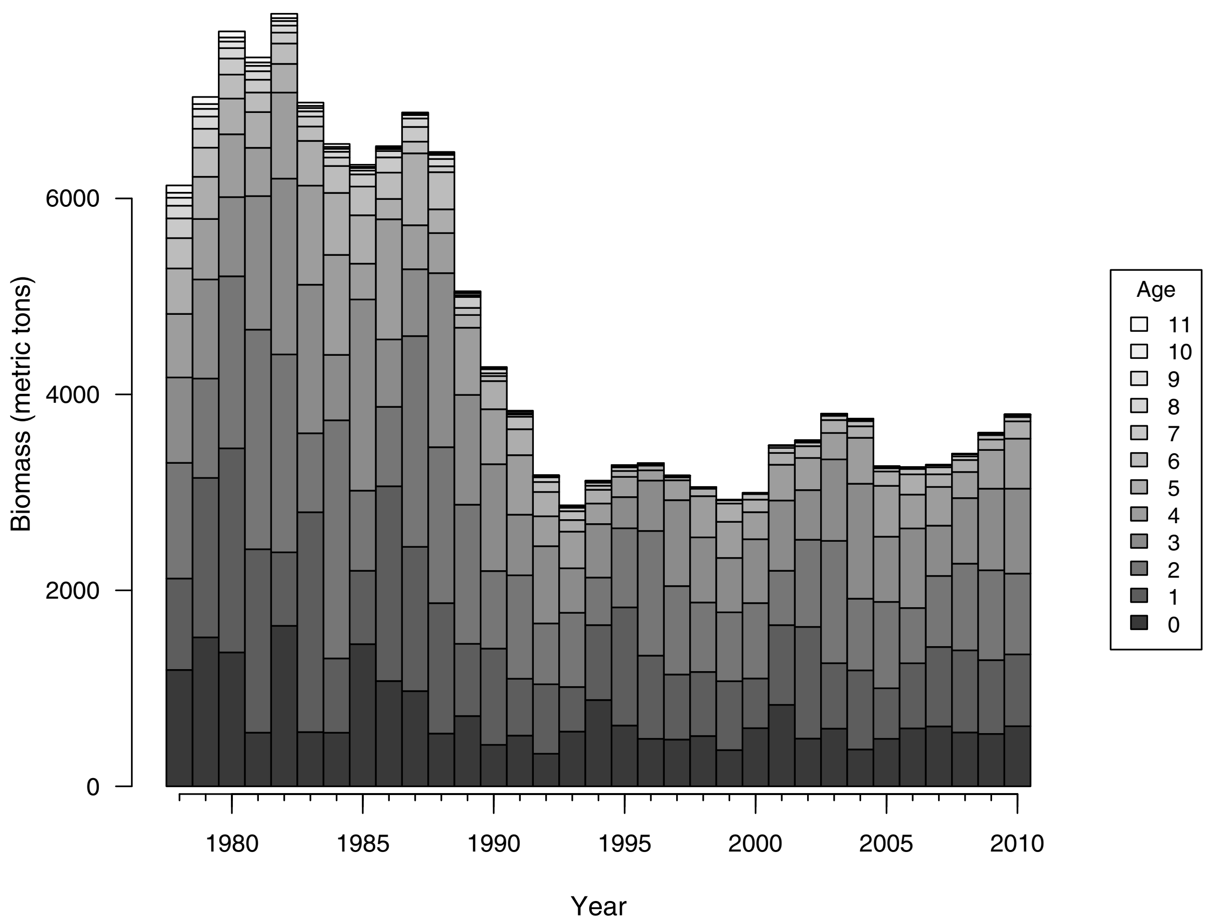


Figure 3.19. Top panel: Estimated total biomass (metric tons) at start of year. Horizontal dashed line indicates B_{MSY}. Bottom panel: Estimated spawning stock (population fecundity) at time of peak spawning.

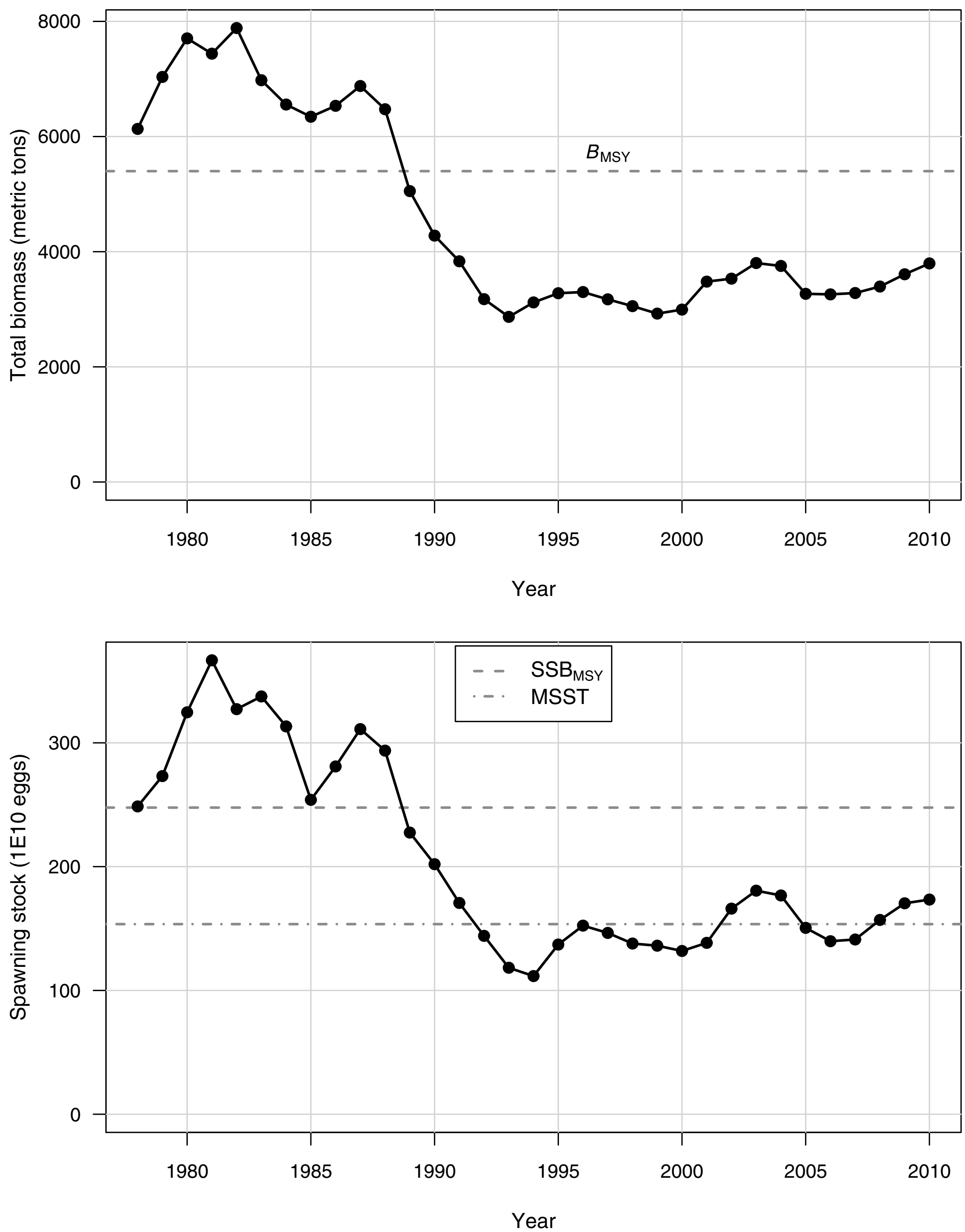


Figure 3.20. Selectivities of MARMAP gears. Top panel: blackfish/snapper traps. Bottom panel: chevron traps.

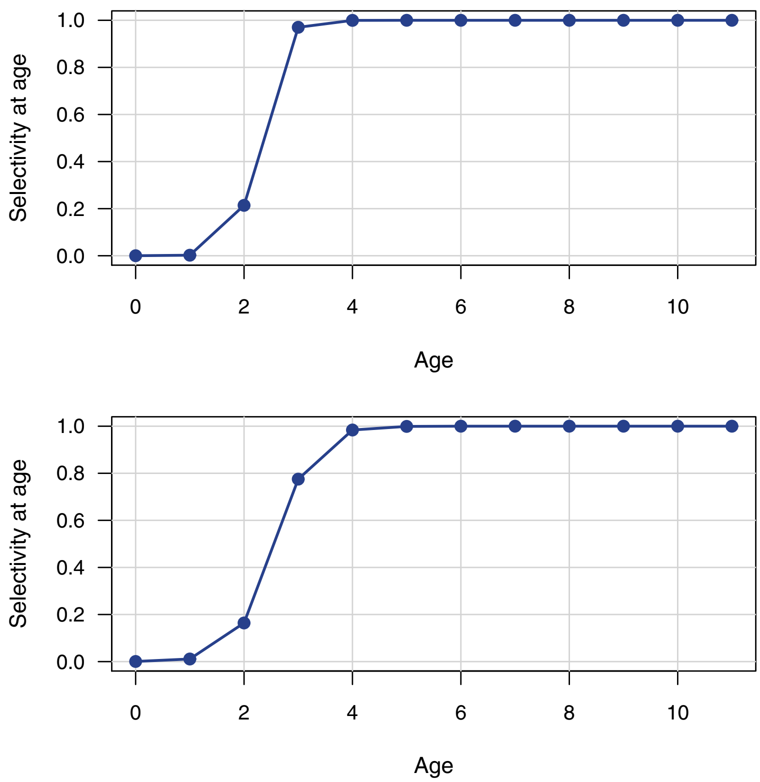


Figure 3.21. Selectivities of commercial lines. Top panel: 1978–1998. Bottom panel: 1999–2010.

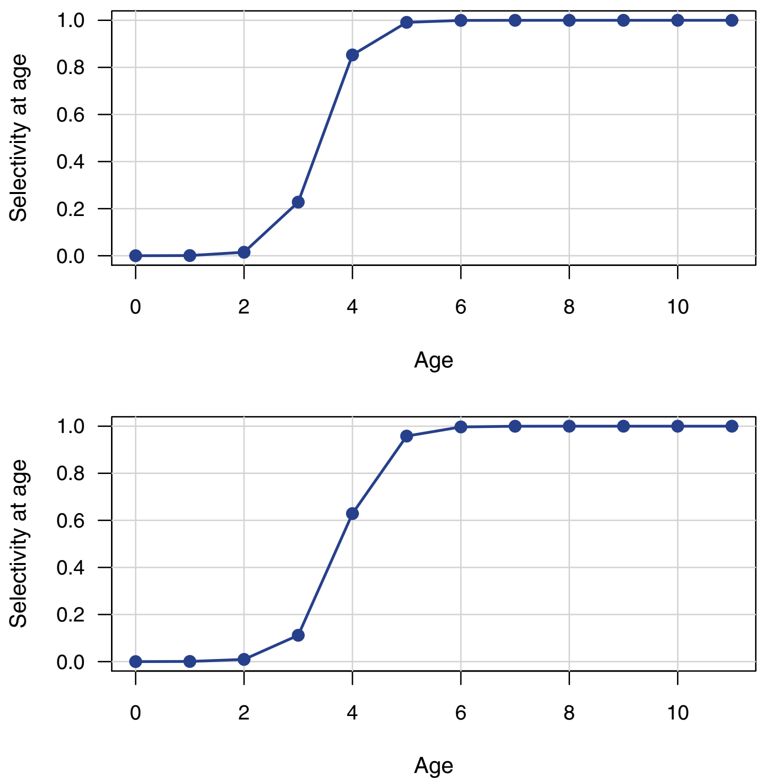


Figure 3.22. Selectivities of commercial pots. Selectivity of commercial trawl (1978–1990) mirrored that of commercial pots. Top panel: 1978–1998. Bottom panel: 1999–2010.

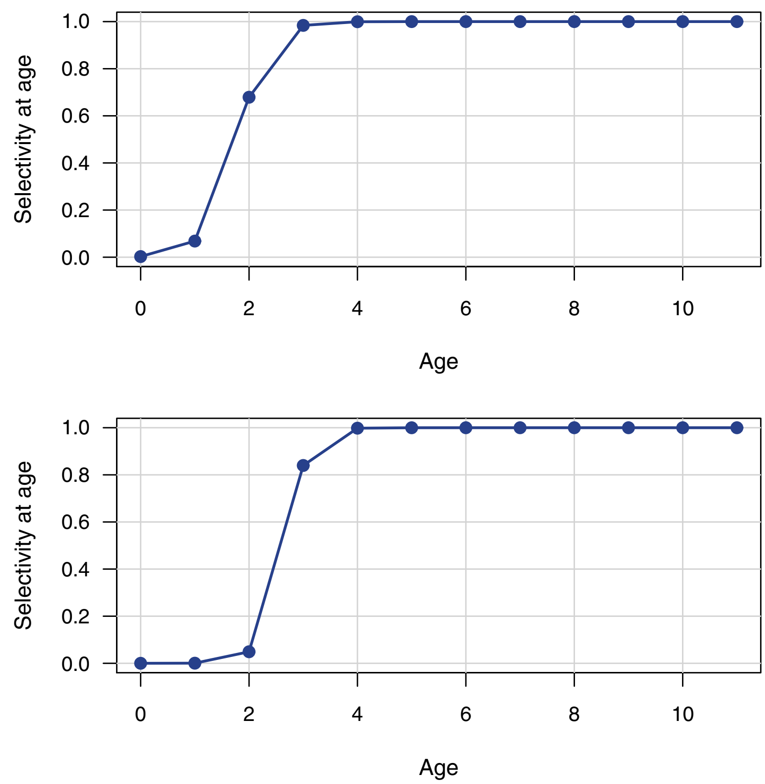


Figure 3.23. Selectivities of the headboat and general recreational fleets. First (top) panel: 1978–1983. Second panel: 1984–1998. Third panel: 1999–2006. Fourth panel: 2007–2010.

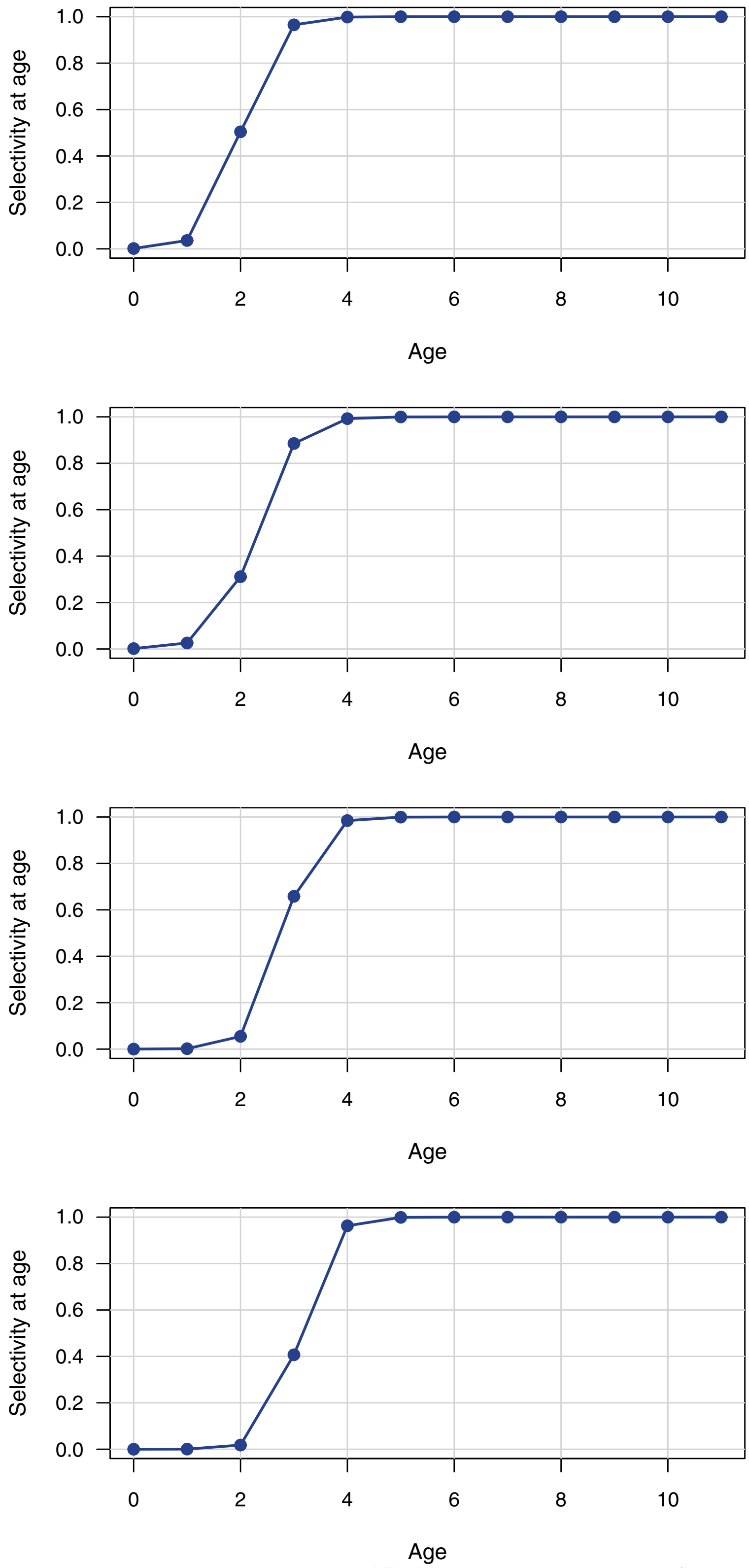


Figure 3.24. Selectivities of commercial discard mortalities. Top panel: 1984–1998. Middle panel: 1999–2008. Bottom panel: 2009–2010.

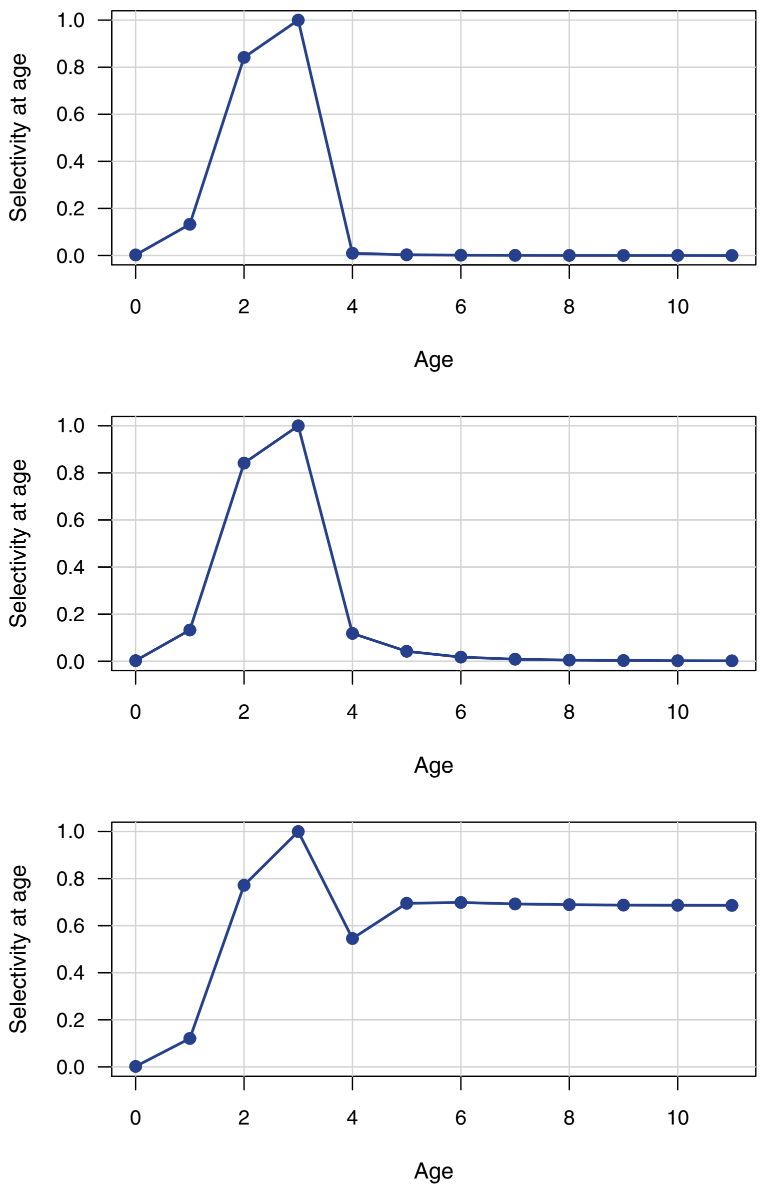


Figure 3.25. Selectivities of headboat and general recreational discard mortalities. Top panel: 1978–1998. Middle panel: 1999–2006. Bottom panel: 2007–2010.

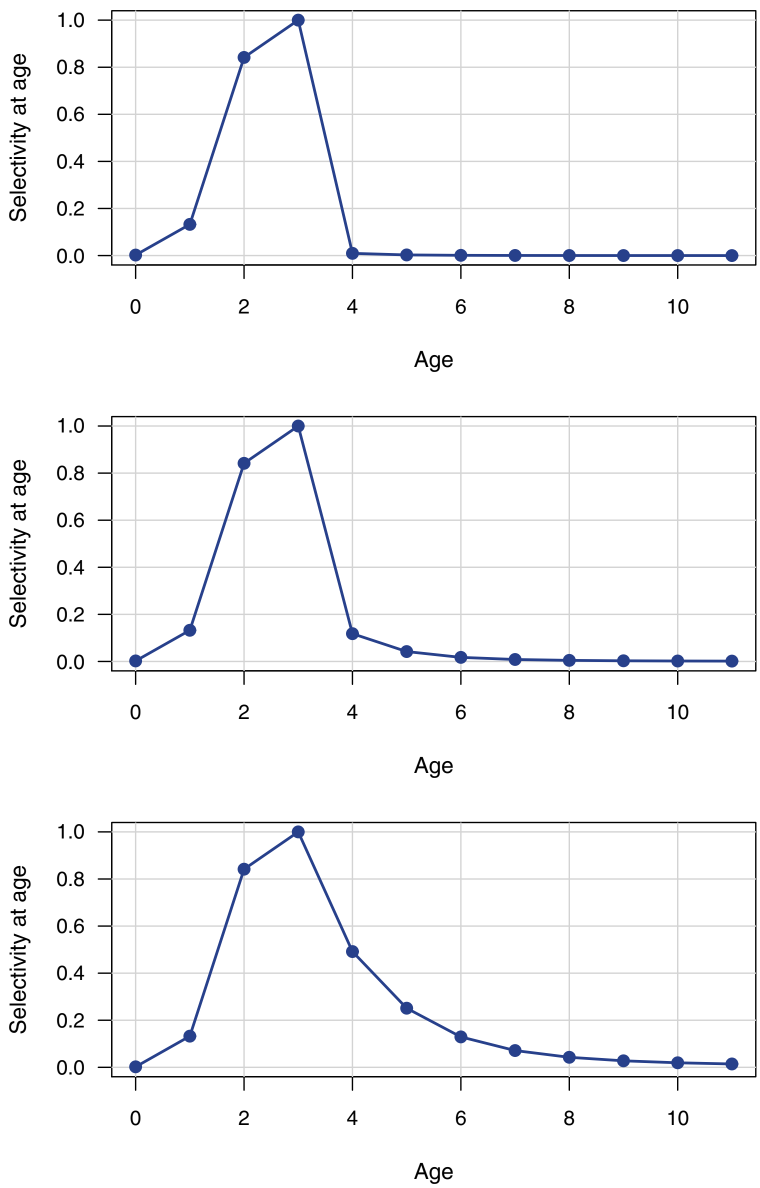


Figure 3.26. Average selectivities from the terminal assessment year (2010), weighted by geometric mean Fs from the last two assessment years, and used in computation of benchmarks and central-tendency projections. Top panel: average selectivity applied to landings. Middle panel: average selectivity applied to discard mortalities. Bottom panel: total average selectivity.

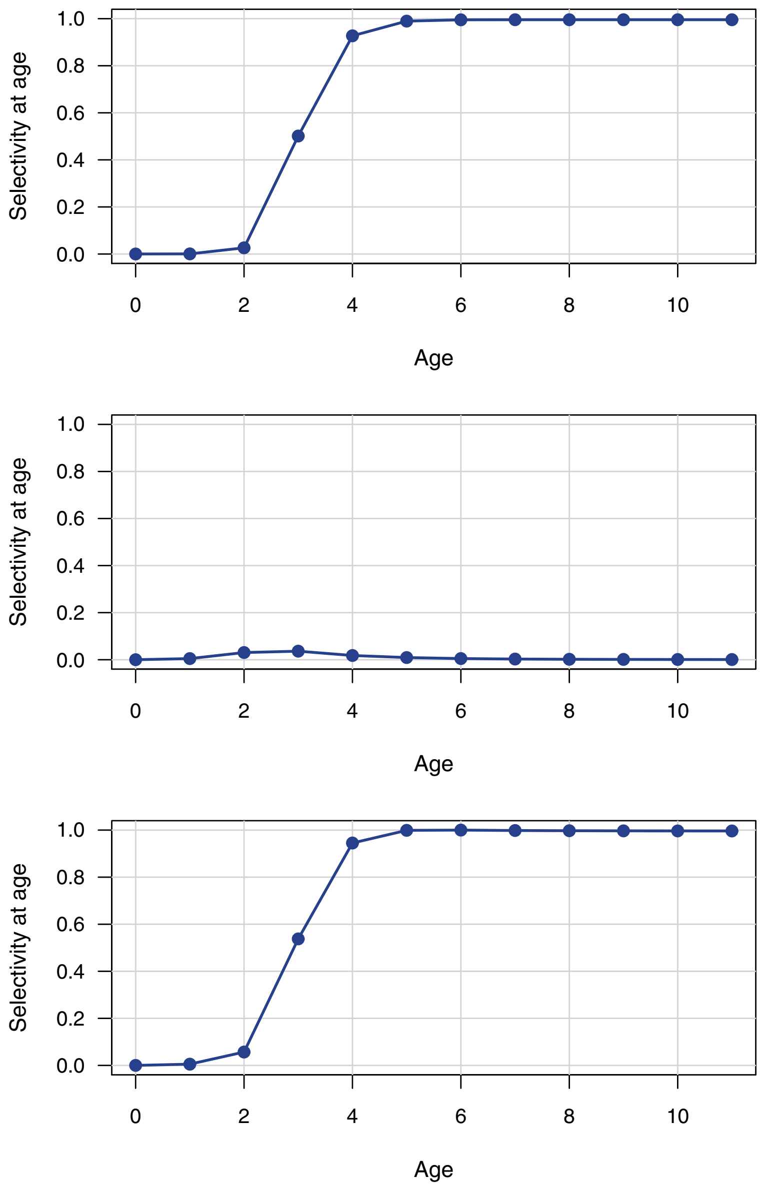


Figure 3.27. Estimated fully selected fishing mortality rate (per year) by fishery. cl refers to commercial lines, cp to commercial pots, ct to commercial trawl, hb to headboat, mrip to general recreational, comm.D to commercial discard mortalities, hb.D to headboat discard mortalities, and mrip.D to general recreational discard mortalities.

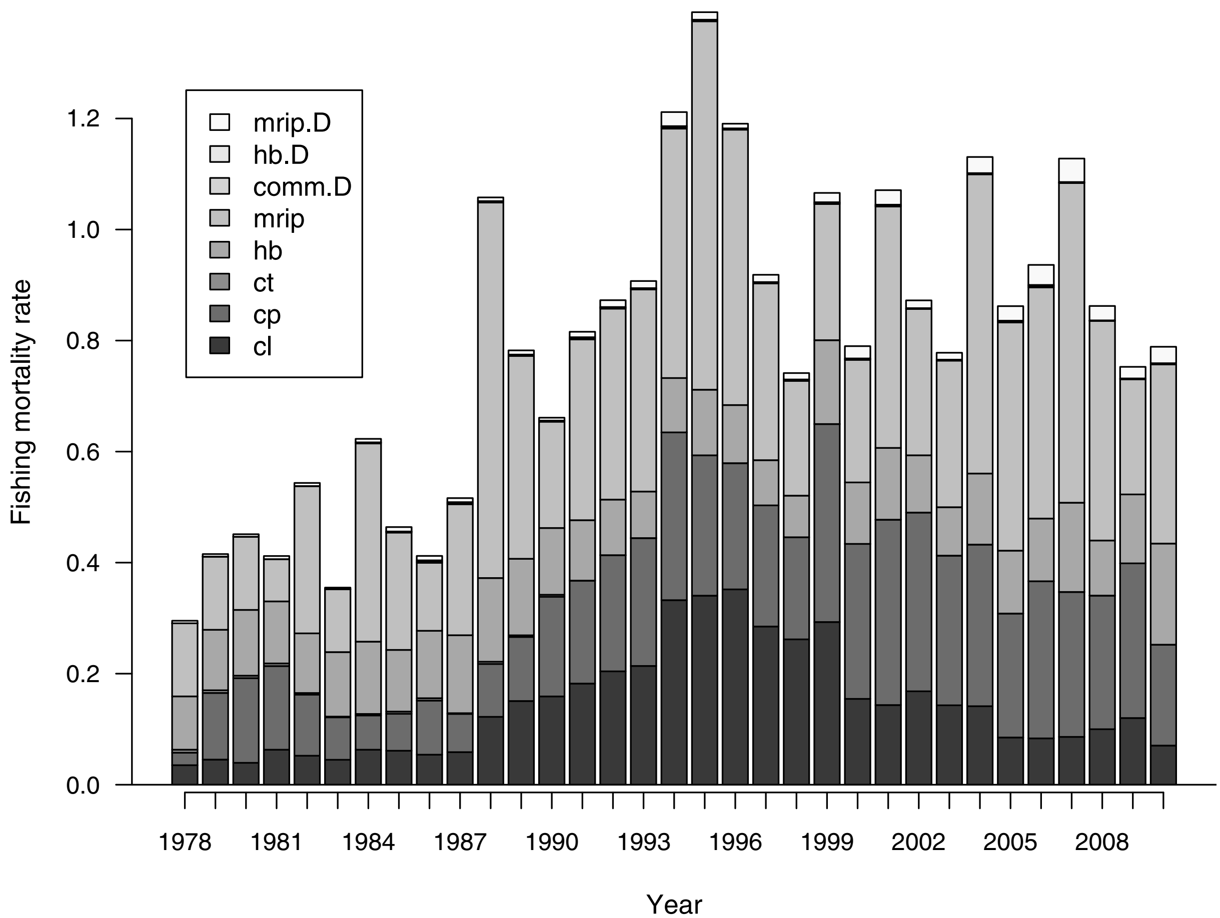


Figure 3.28. Estimated landings in numbers by fishery from the catch-age model. cl refers to commercial lines, cp to commercial pots, ct to commercial trawl, hb to headboat, mrip to general recreational.

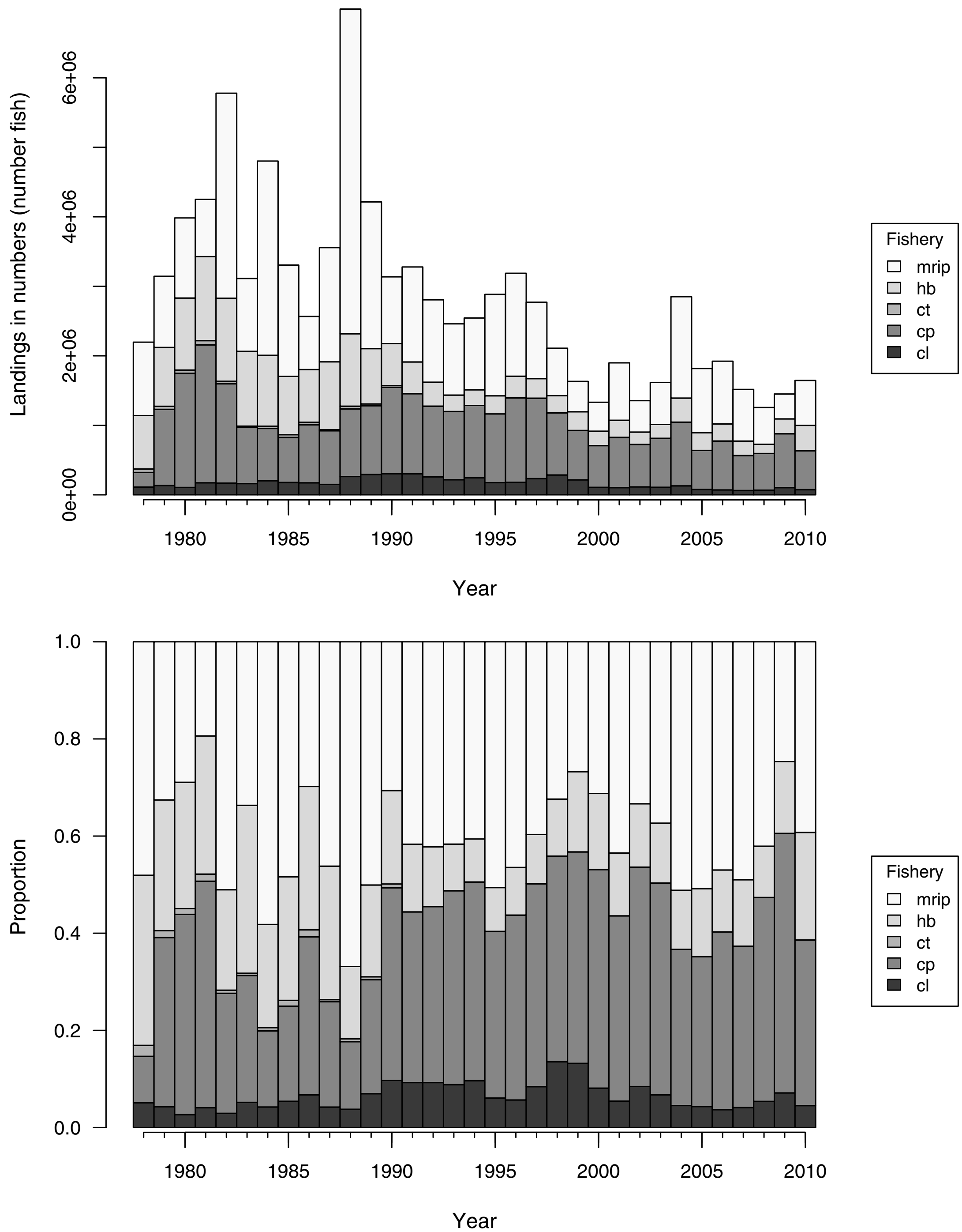


Figure 3.29. Estimated landings in whole weight by fishery from the catch-age model. cl refers to commercial lines, cp to commercial pots, ct to commercial trawl, hb to headboat, mrip to general recreational. Horizontal dashed line in the top panel corresponds to the point estimate of MSY.

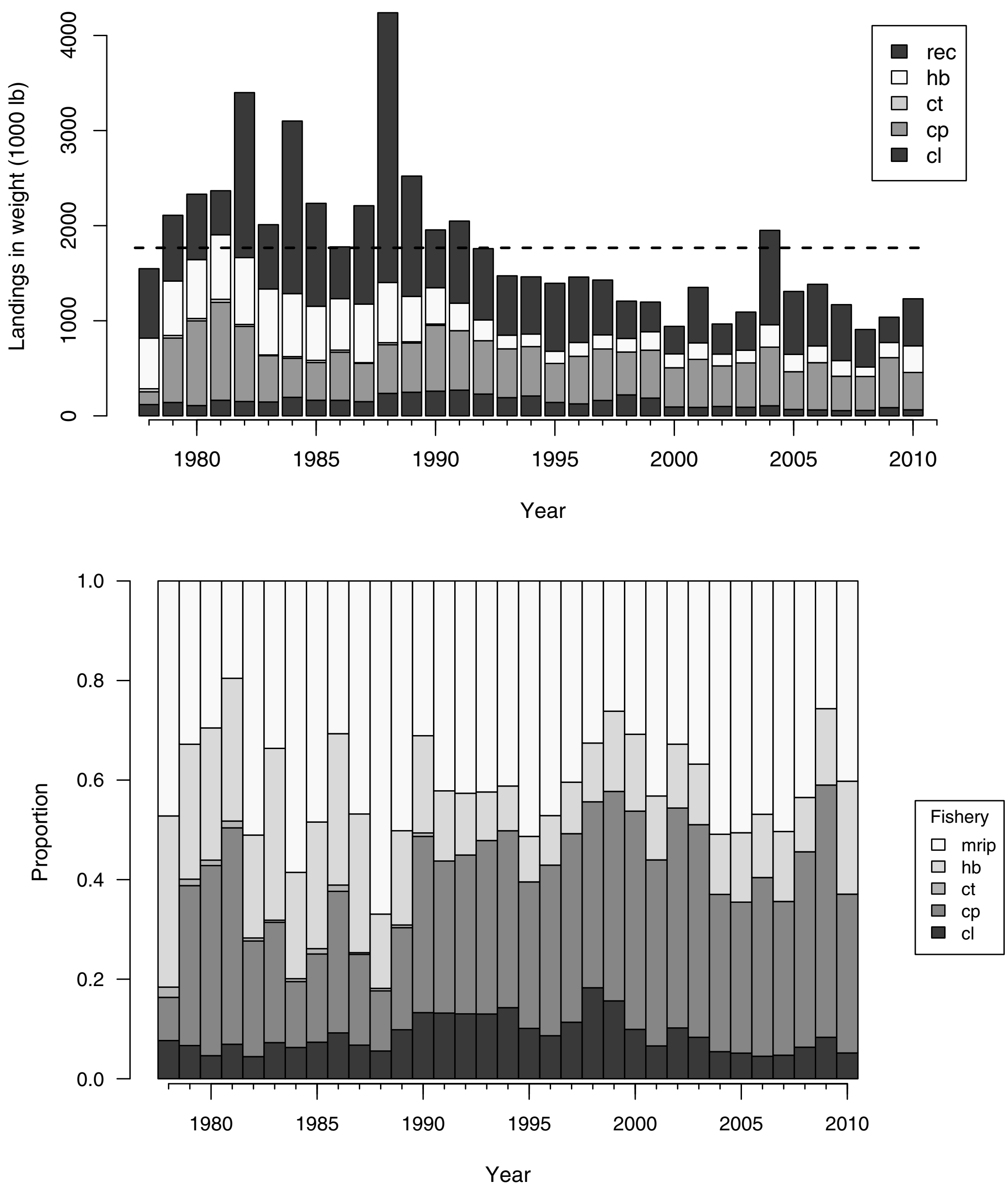


Figure 3.30. Estimated discard mortalities by fishery from the catch-age model. comm refers to commercial (lines and pots combined), hb to headboat, mrip to general recreational. Discards from hb were included with mrip prior to 1986.

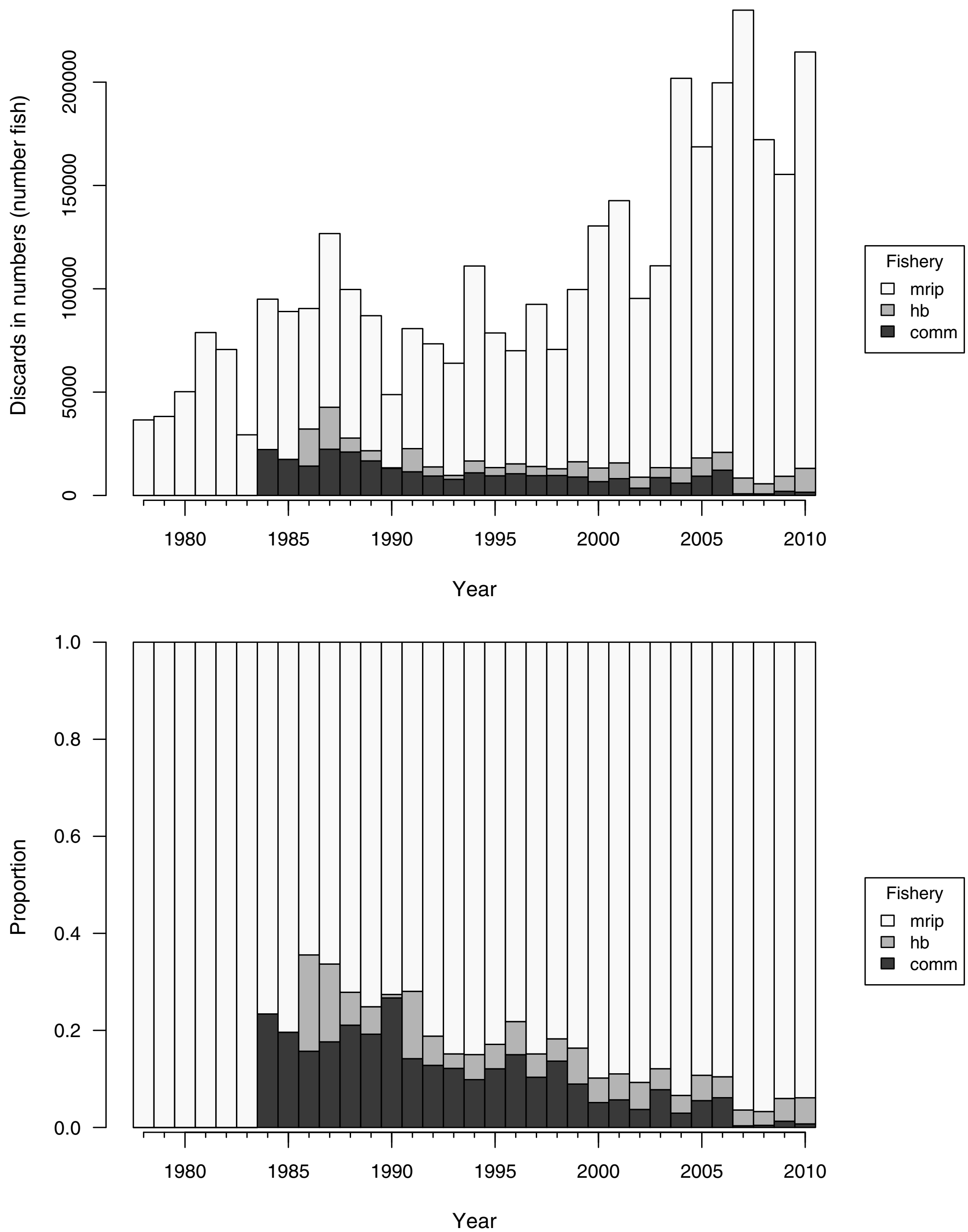


Figure 3.31. Top panel: Beverton–Holt spawner-recruit curves, with and without lognormal bias correction. The expected (upper) curve was used for computing management benchmarks. Years within panel indicate year of recruitment generated from spawning biomass. Diagonal line indicates MSY-level replacement.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

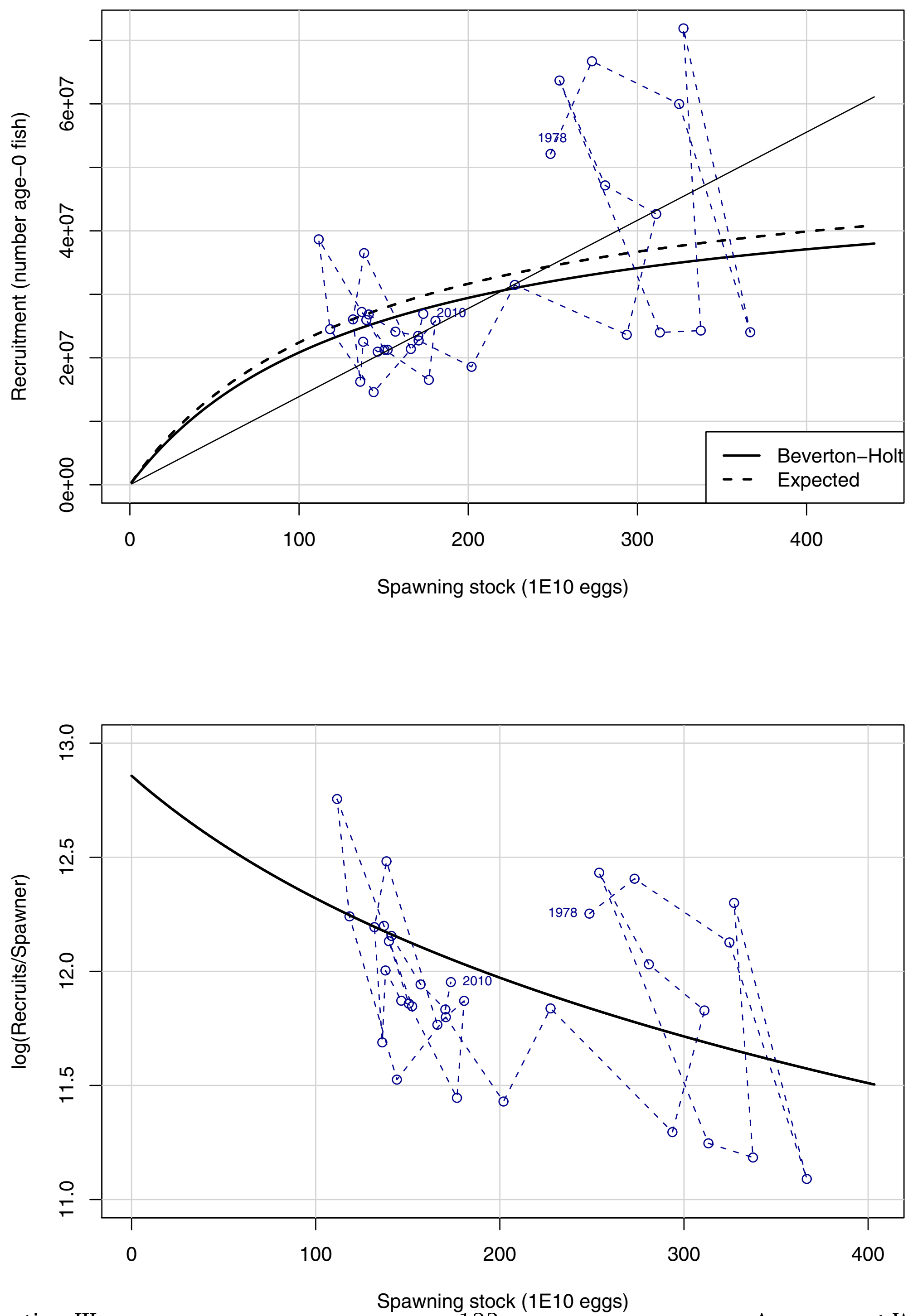


Figure 3.32. Probability densities of spawner-recruit quantities R0 (unfished recruitment of age-0 fish), steepness, unfished spawners per recruit, and standard deviation of recruitment residuals in log space. Vertical lines represent point estimates or values from the base run of the Beaufort Assessment Model.

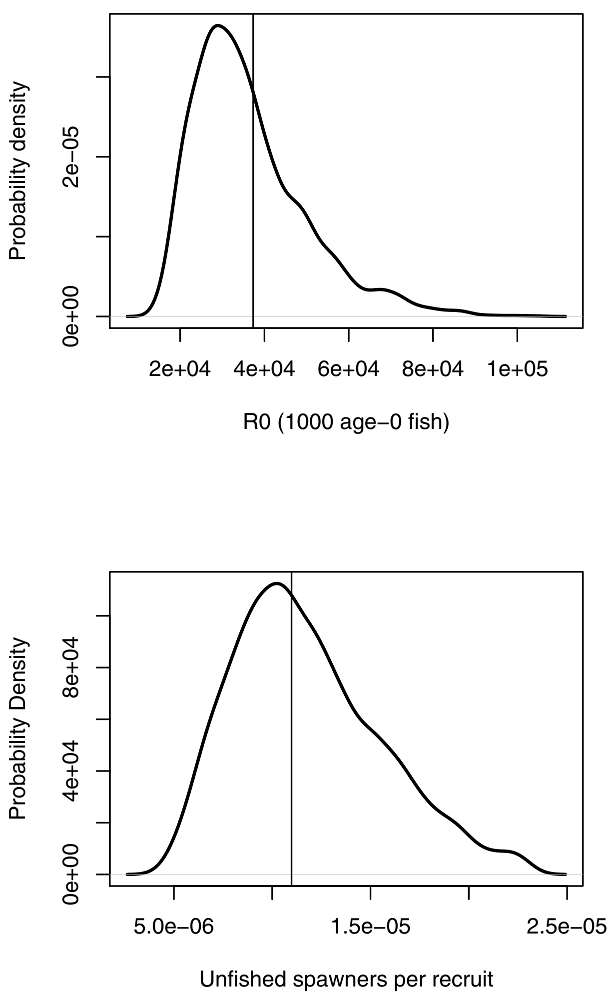


Figure 3.33. Estimated time series of static spawning potential ratio, the annual equilibrium spawners per recruit relative to that at the unfished level. Horizontal dashed line indicates the equilibrium MSY level, given current selectivity patterns.

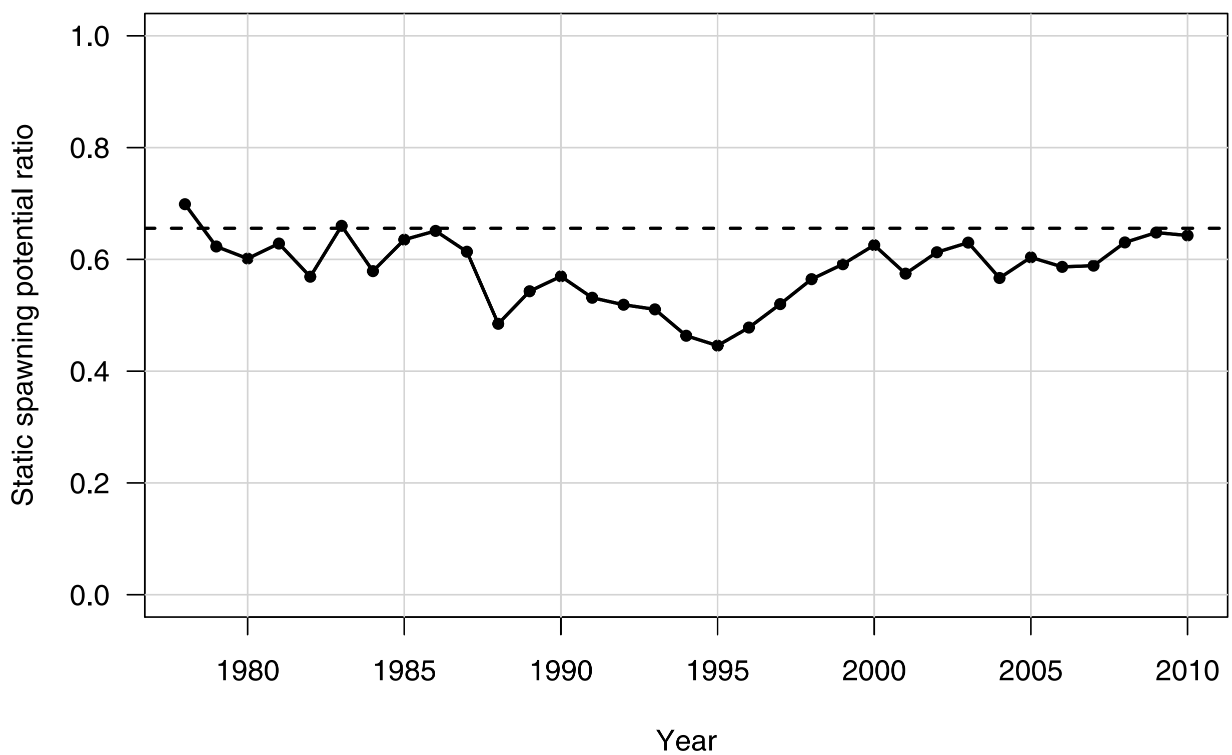


Figure 3.34. Top panel: yield per recruit. Bottom panel: spawning potential ratio (spawning biomass per recruit relative to that at the unfished level), from which the X% level of SPR provides $F_{X\%}$. Both curves are based on average selectivity from the end of the assessment period.

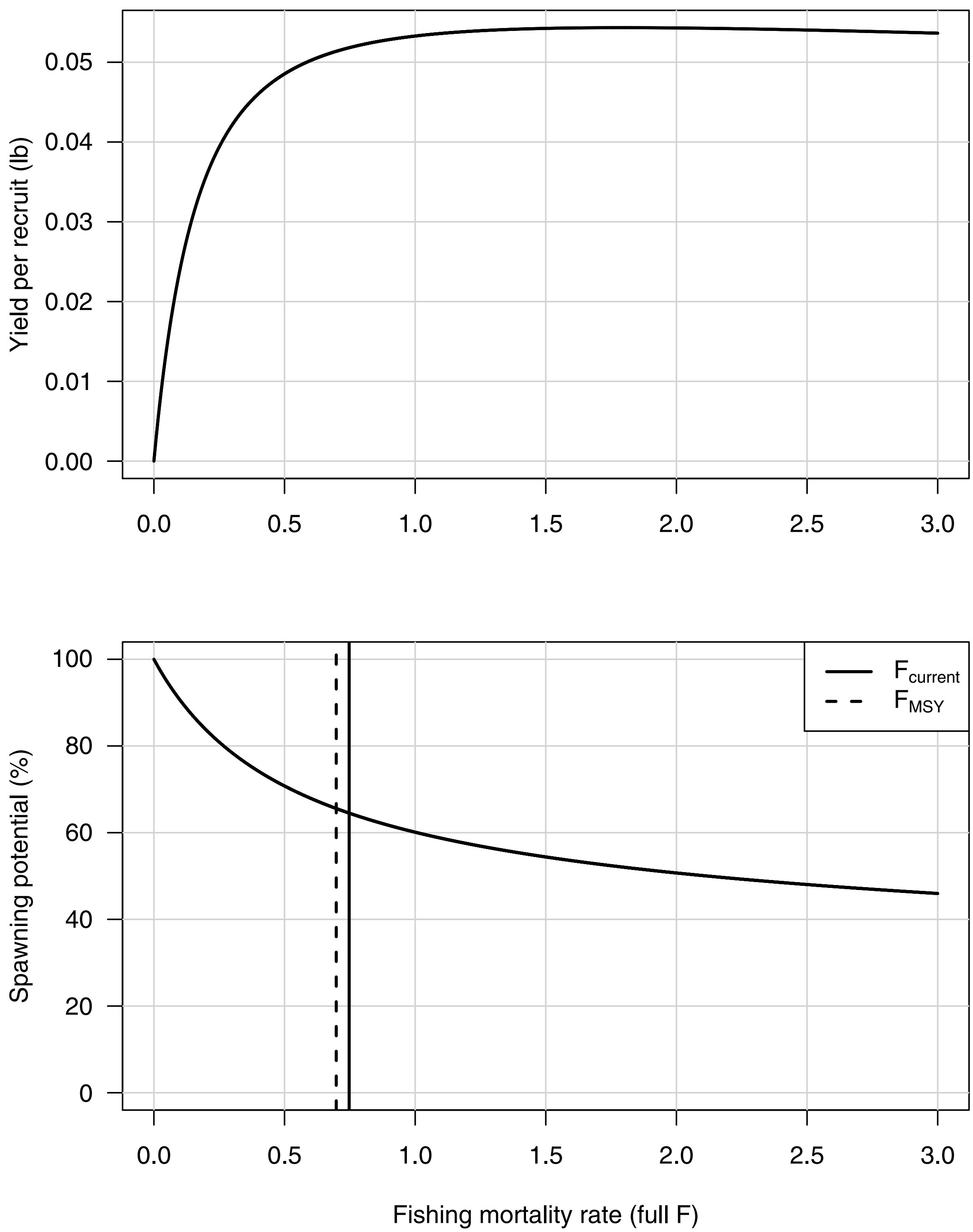


Figure 3.35. Top panel: equilibrium landings. The peak occurs where fishing rate is $F_{\mathrm{MSY}} = 0.698$ *and equilibrium landings are* MSY = 1767 *(1000 lb). Bottom panel: equilibrium spawning biomass. Both curves are based on average selectivity from the end of the assessment period.*

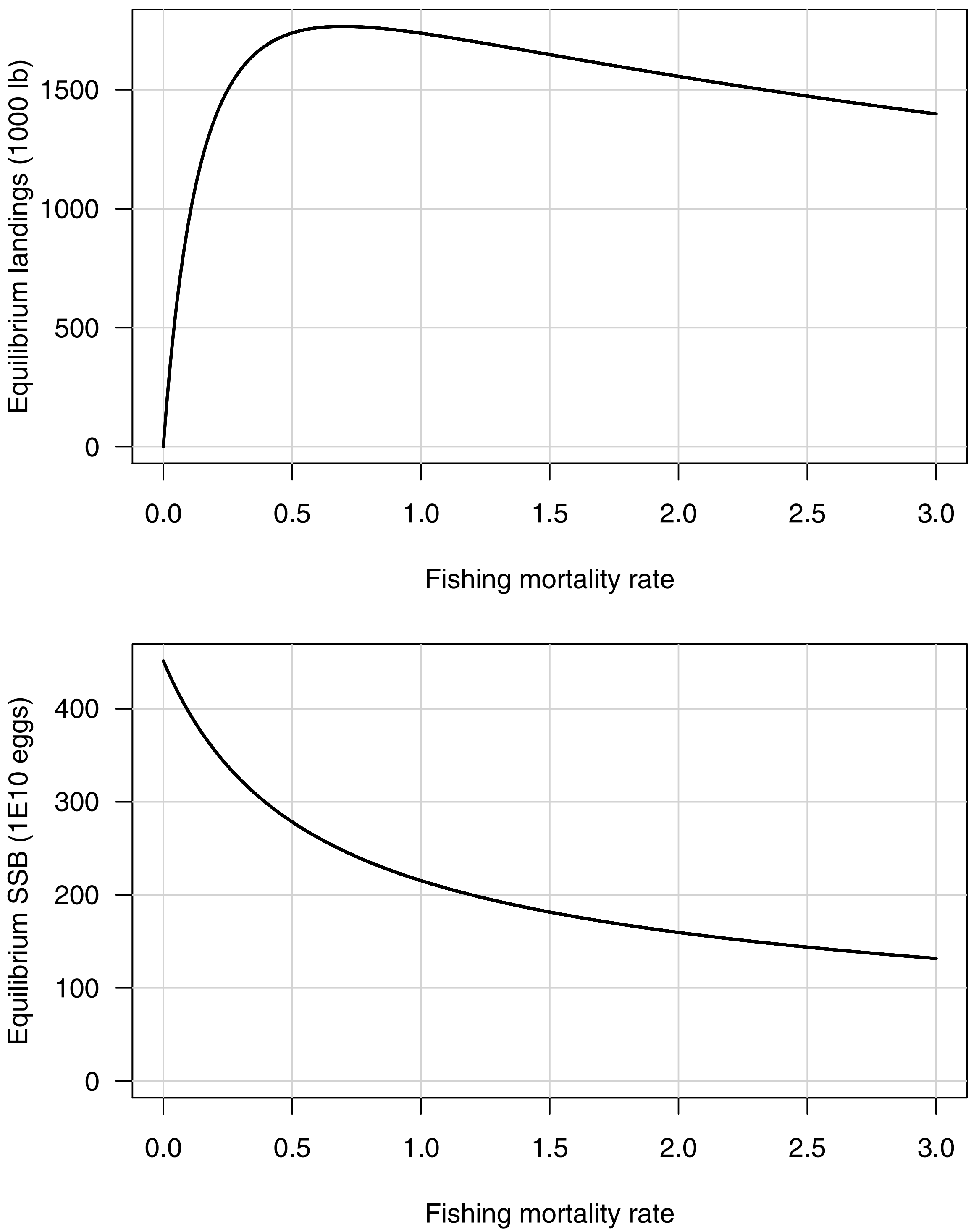


Figure 3.36. Top panel: equilibrium landings as a function of equilibrium biomass, which itself is a function of fishing mortality rate. The peak occurs where equilibrium biomass is B_{MSY} = 5399 *mt and equilibrium landings are* MSY = 1767 *(1000 lb). Bottom panel: equilibrium discard mortality as a function of equilibrium biomass.*

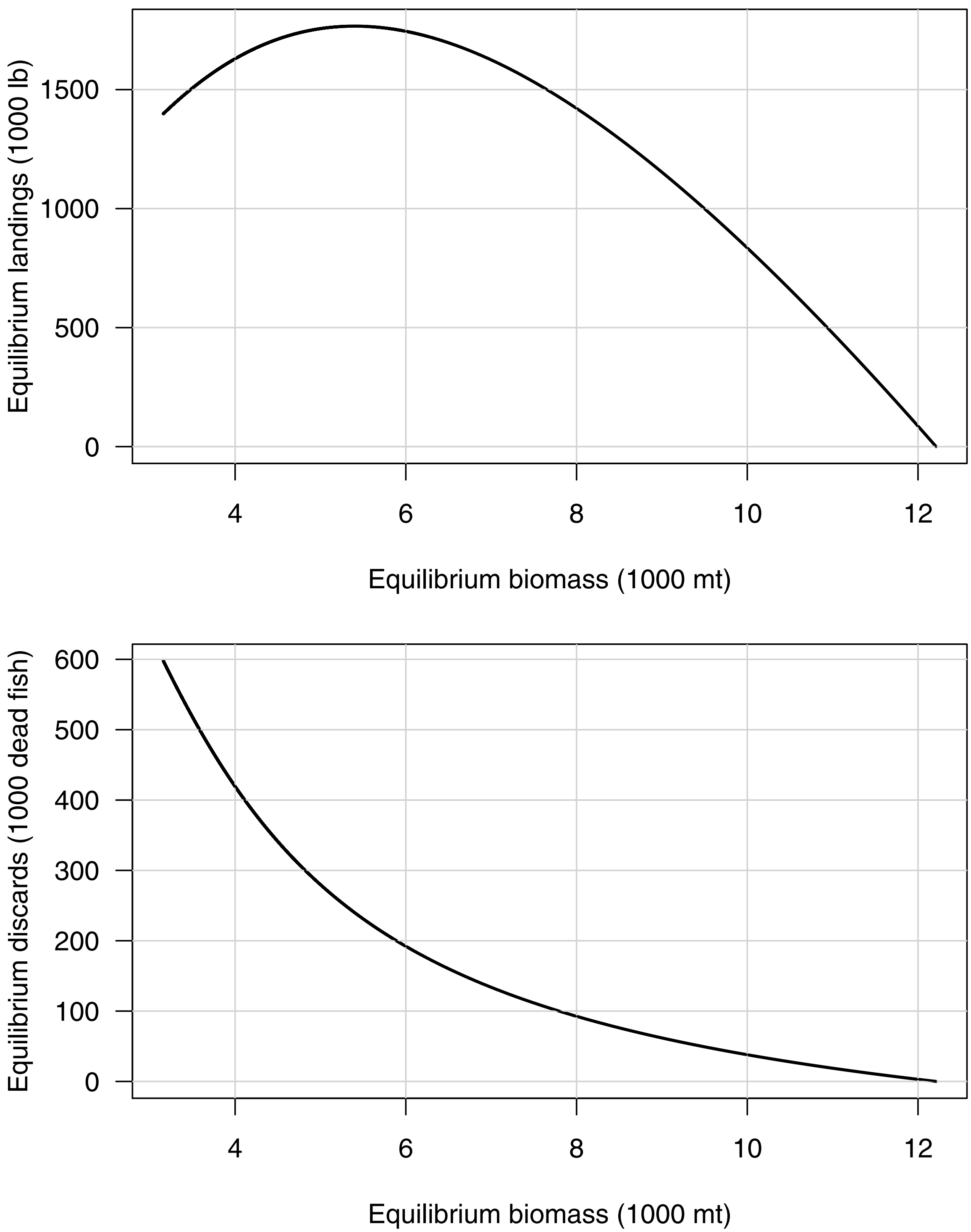


Figure 3.37. Probability densities of MSY*-related benchmarks from MCB analysis of the Beaufort Assessment Model. Vertical lines represent point estimates from the base run.*

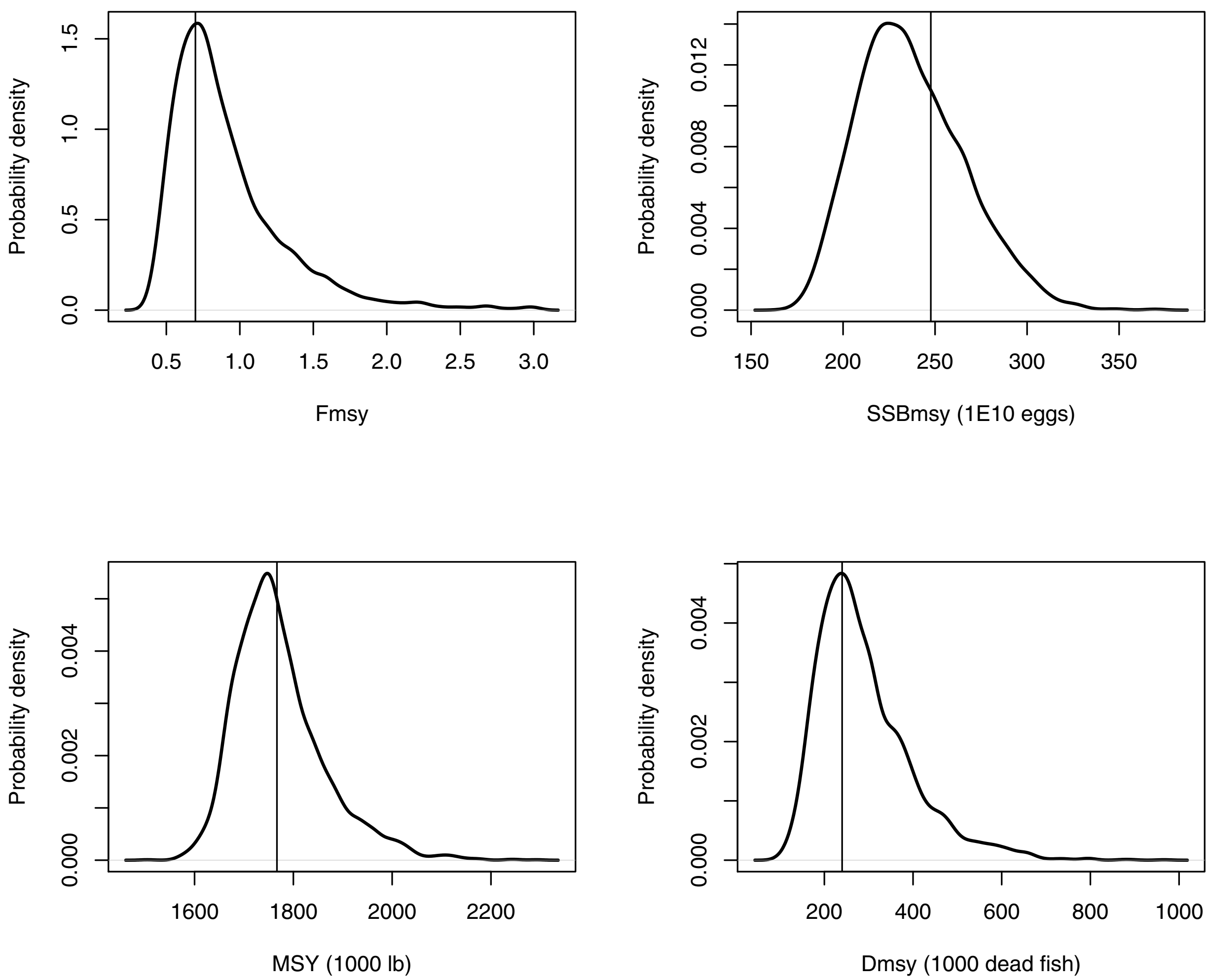


Figure 3.38. Estimated time series relative to benchmarks. Solid line indicates estimates from base run of the Beaufort Assessment Model; gray error bands indicate 5^{th} *and* 95^{th} *percentiles of the MCB trials. Top panel: spawning biomass relative to the minimum stock size threshold (*MSST*). Middle panel: spawning biomass relative to* $\mathrm{SSB_{MSY}}$*. Bottom panel: F relative to* F_{MSY}*.*

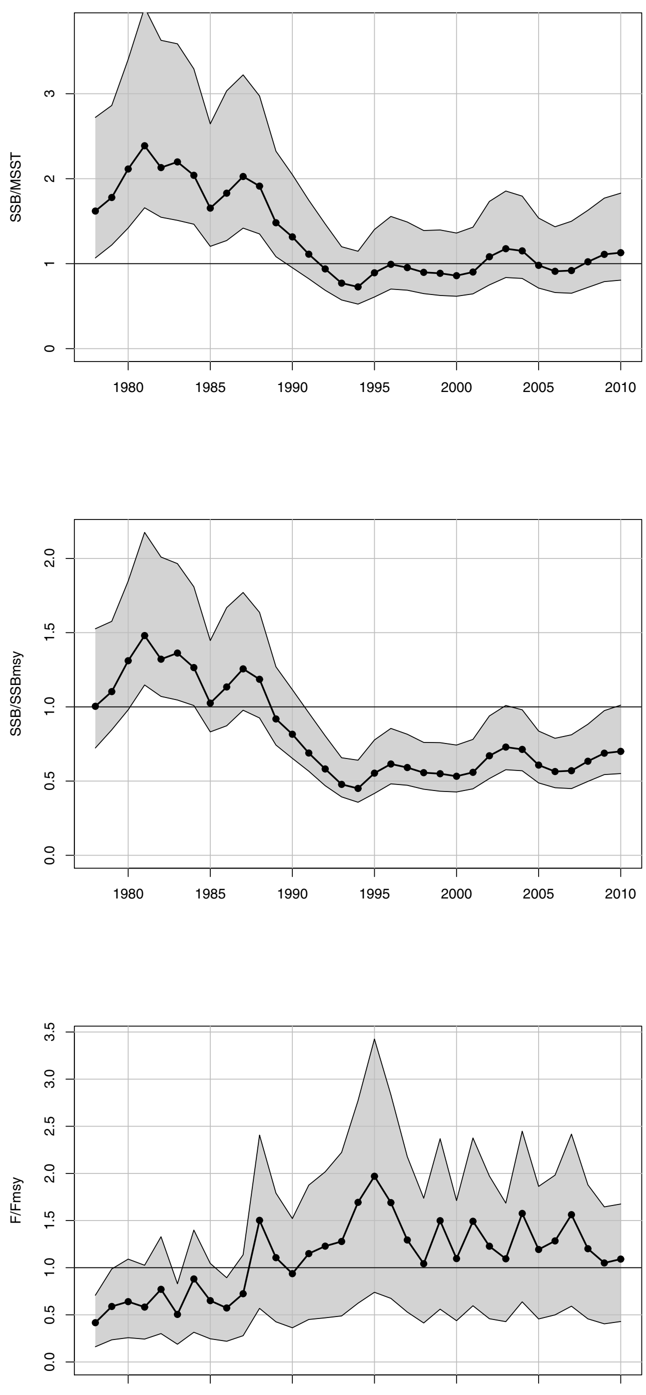


Figure 3.39. Probability densities of terminal status estimates from MCB analysis of the Beaufort Assessment Model. Vertical lines represent point estimates from the base run.

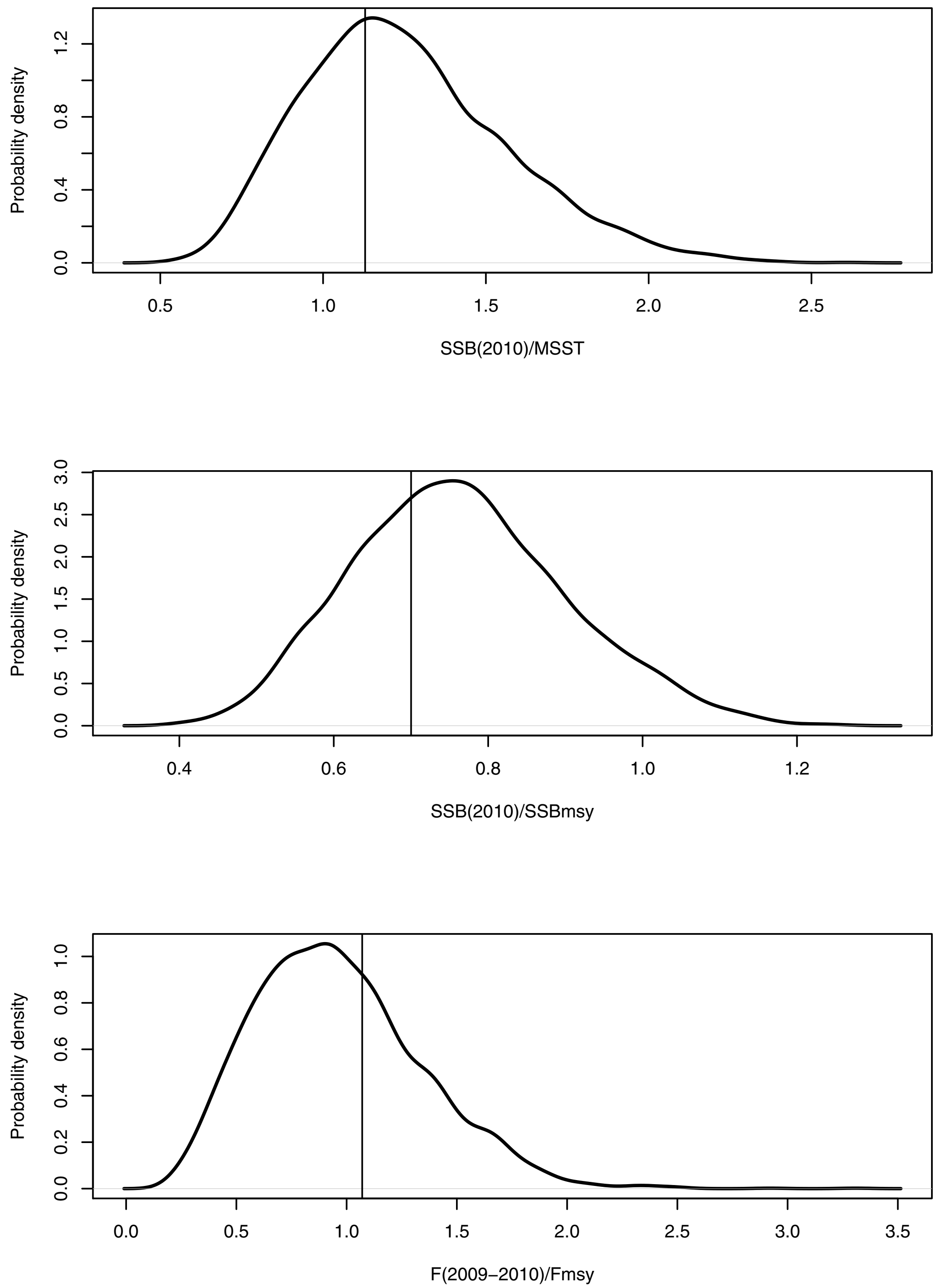


Figure 3.40. Phase plot of terminal status estimates from MCB analysis of the Beaufort Assessment Model. The intersection of crosshairs indicates estimates from the base run; lengths of crosshairs defined by 5^{th} and 95^{th} percentiles.

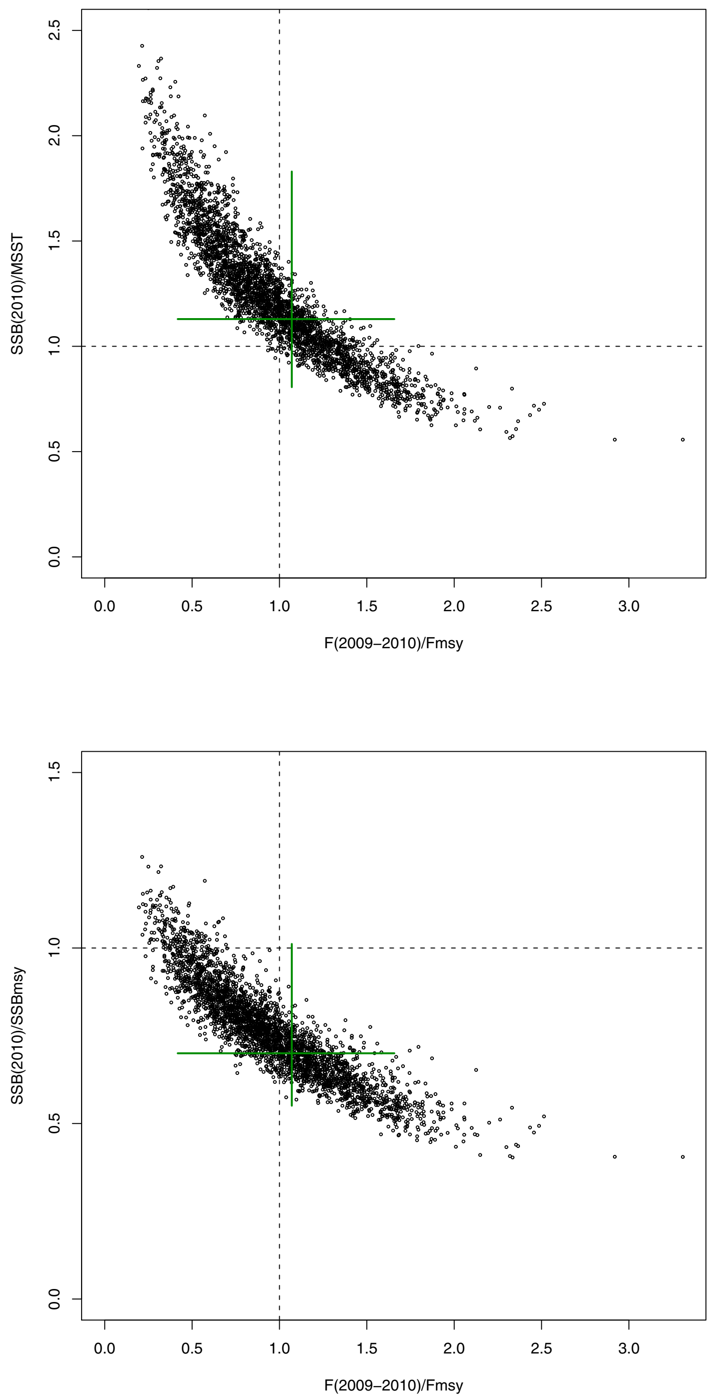


Figure 3.41. Age structure relative to the equilibrium expected at MSY.

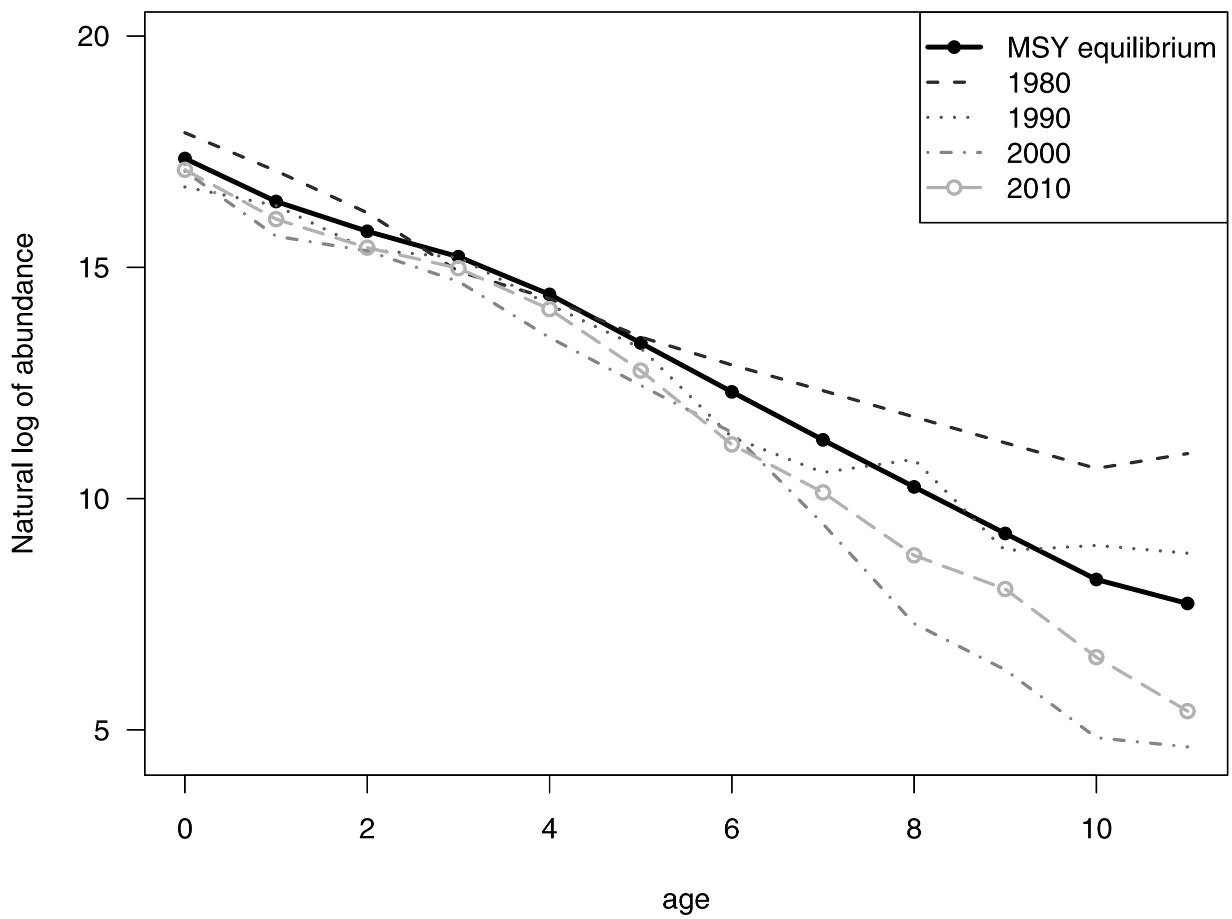


Figure 3.42. Sensitivity to changes in natural mortality (sensitivity runs S1–S2). Top panel: Ratio of F to F_{MSY}. Bottom panel: Ratio of SSB *to* SSB_{MSY}.

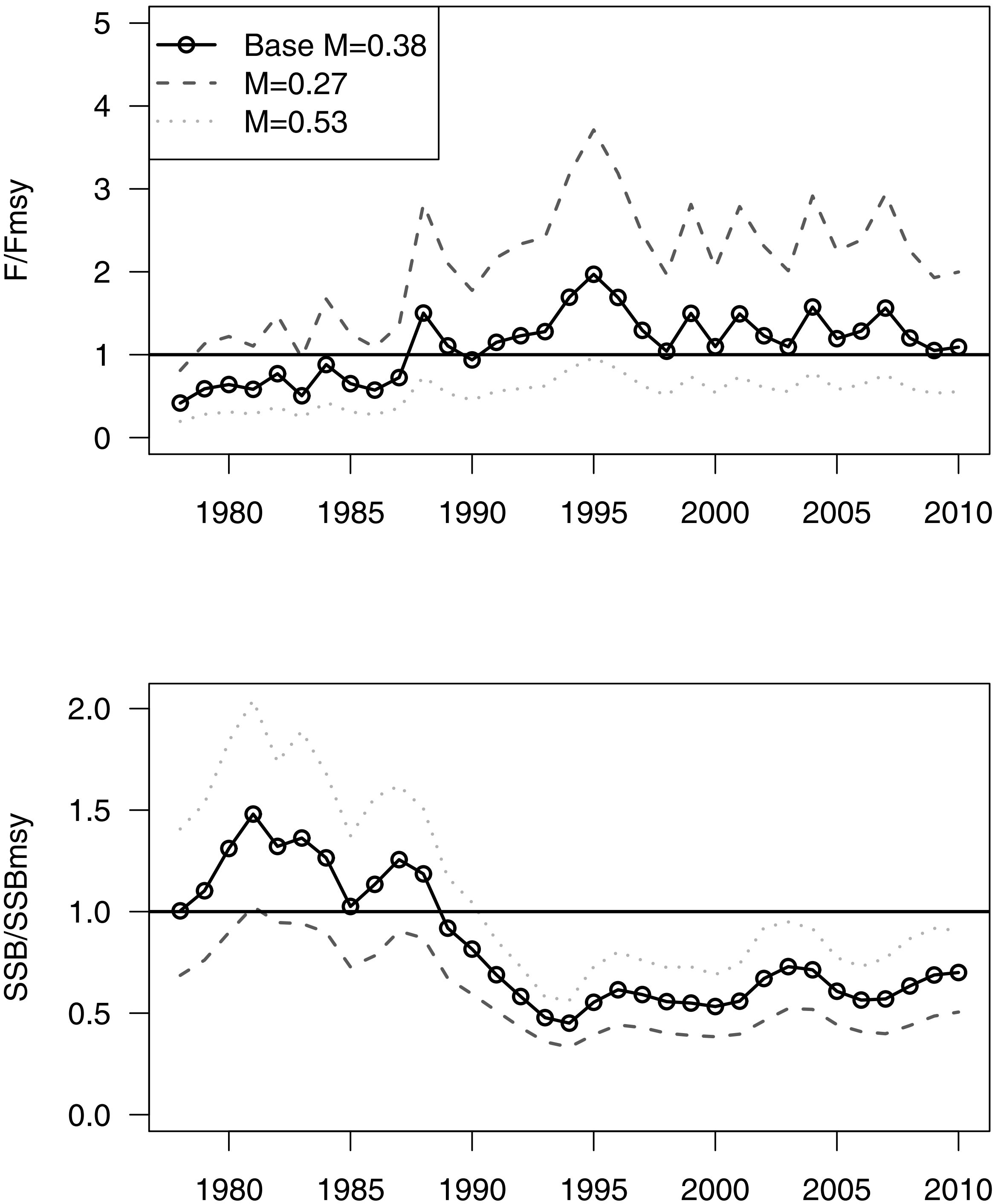


Figure 3.43. Sensitivity to steepness (sensitivity runs S3–S4). Top panel: Ratio of F to F_{MSY}. Bottom panel: Ratio of SSB *to* SSB_{MSY}.

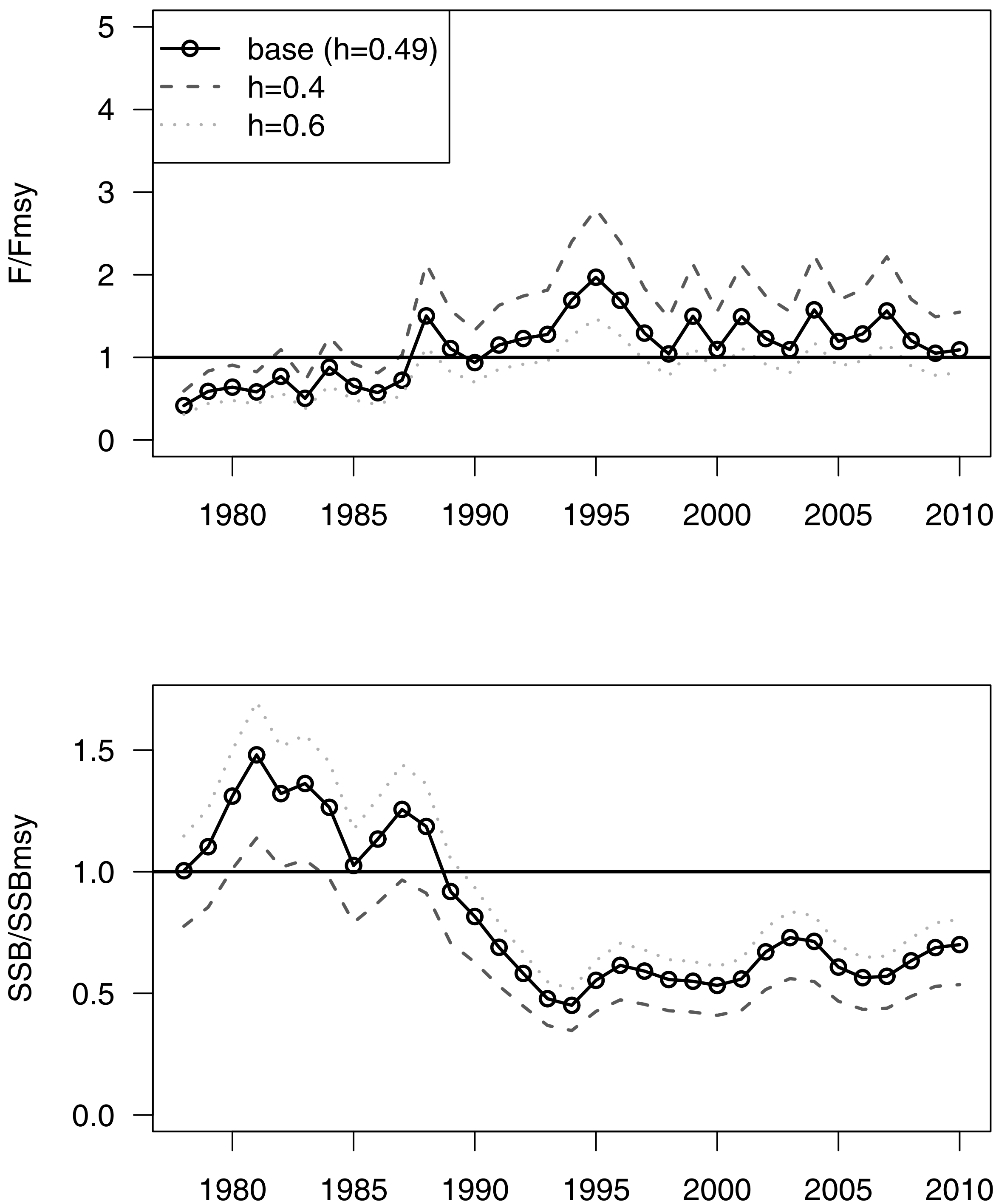


Figure 3.44. Sensitivity to model component weights (sensitivity runs S5–S6). Top panel: Ratio of F to F_{MSY}. Bottom panel: Ratio of SSB *to* SSB_{MSY}.

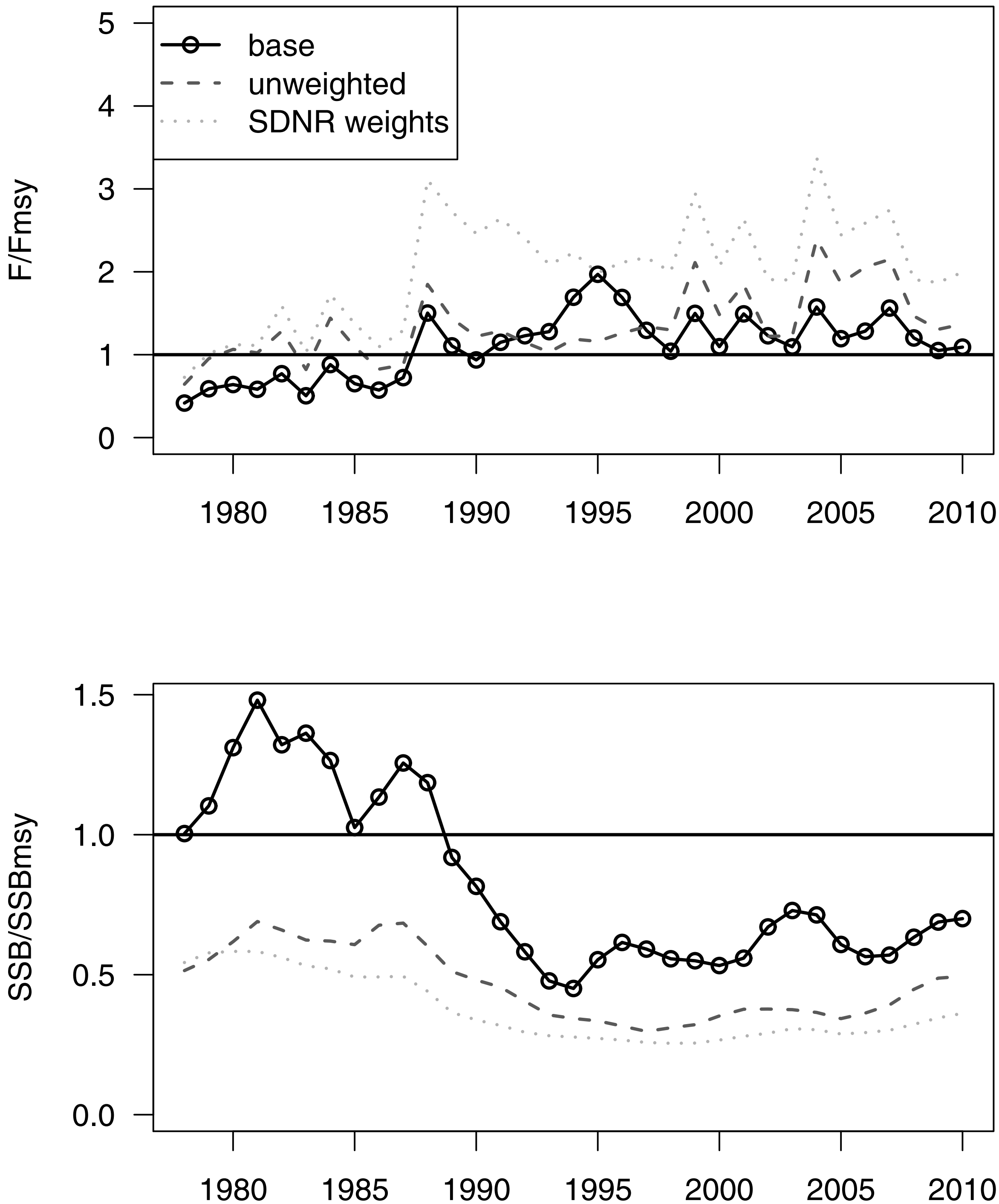


Figure 3.45. Sensitivity to catchability assumptions (sensitivity run S7). Top panel: Ratio of F to F_{MSY}. Bottom panel: Ratio of SSB *to* SSB_{MSY}.

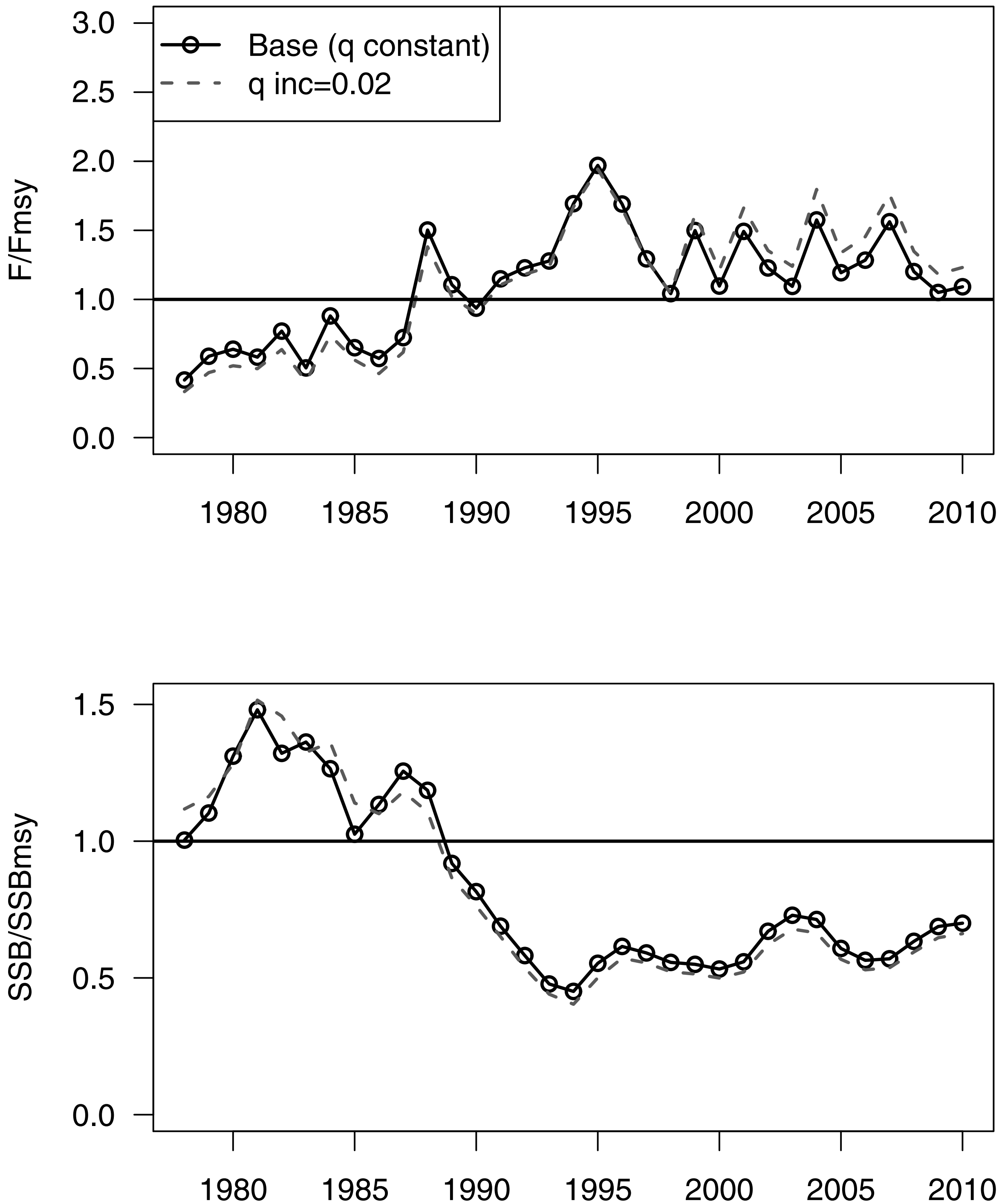
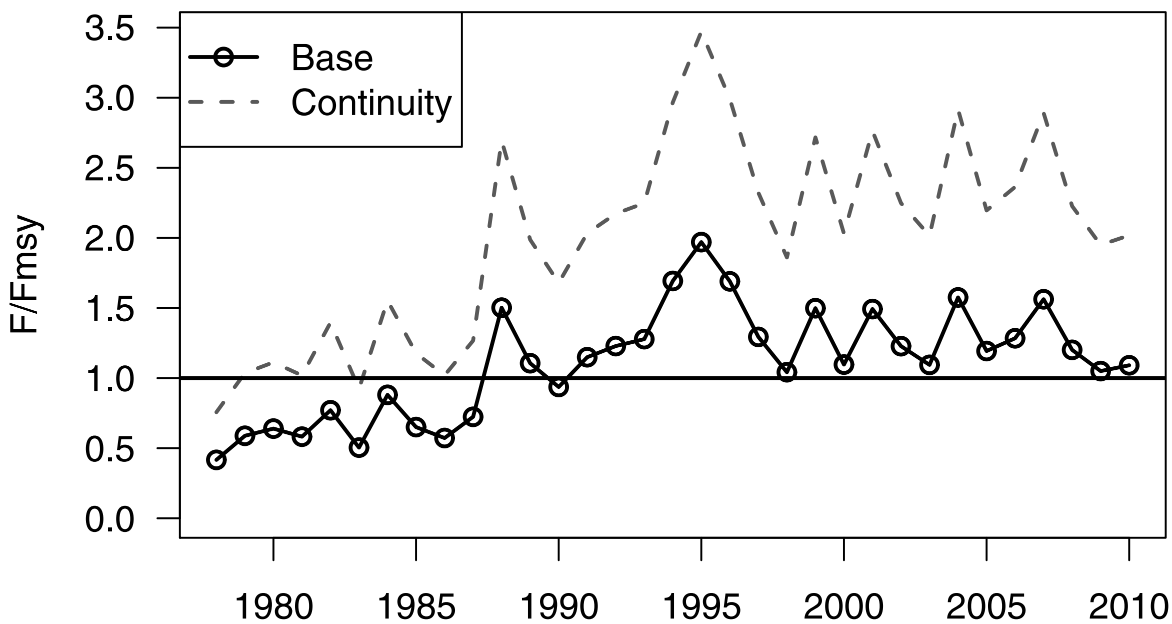


Figure 3.46. Comparison to continuity assumptions (sensitivity run S8). Top panel: Ratio of F to F_{MSY}. Bottom panel: Ratio of SSB *to* SSB_{MSY}.



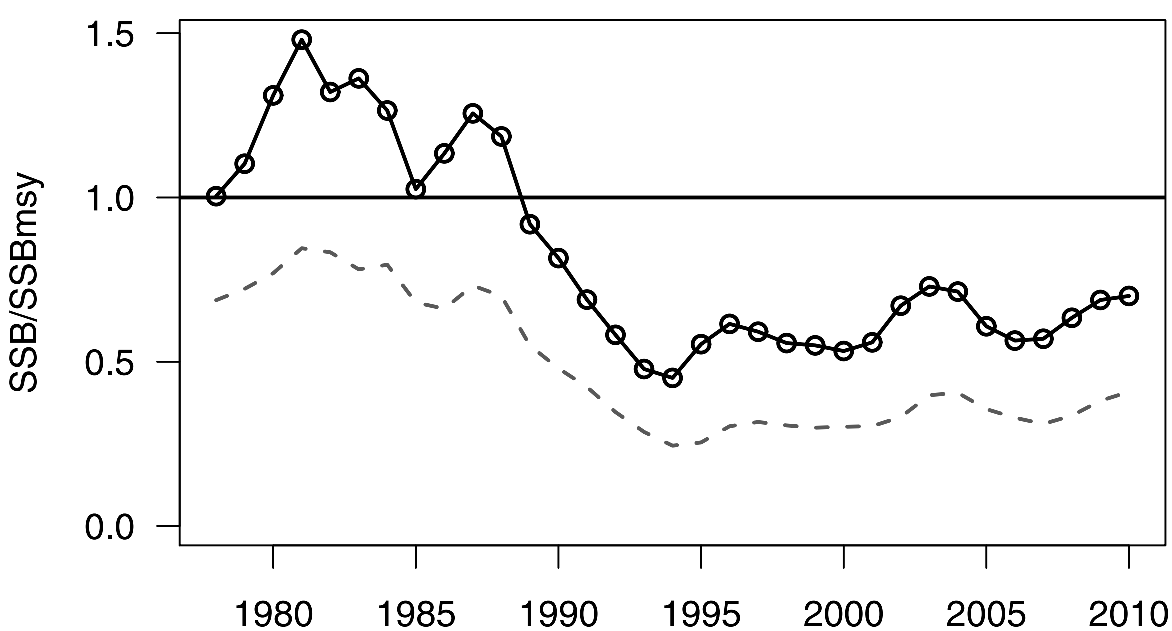


Figure 3.47. Sensitivity to model component weights (sensitivity runs S9–S10). Top panel: Ratio of F to F_{MSY}. Bottom panel: Ratio of SSB to SSB_{MSY}. Any lines not visible overlap results of the base run.

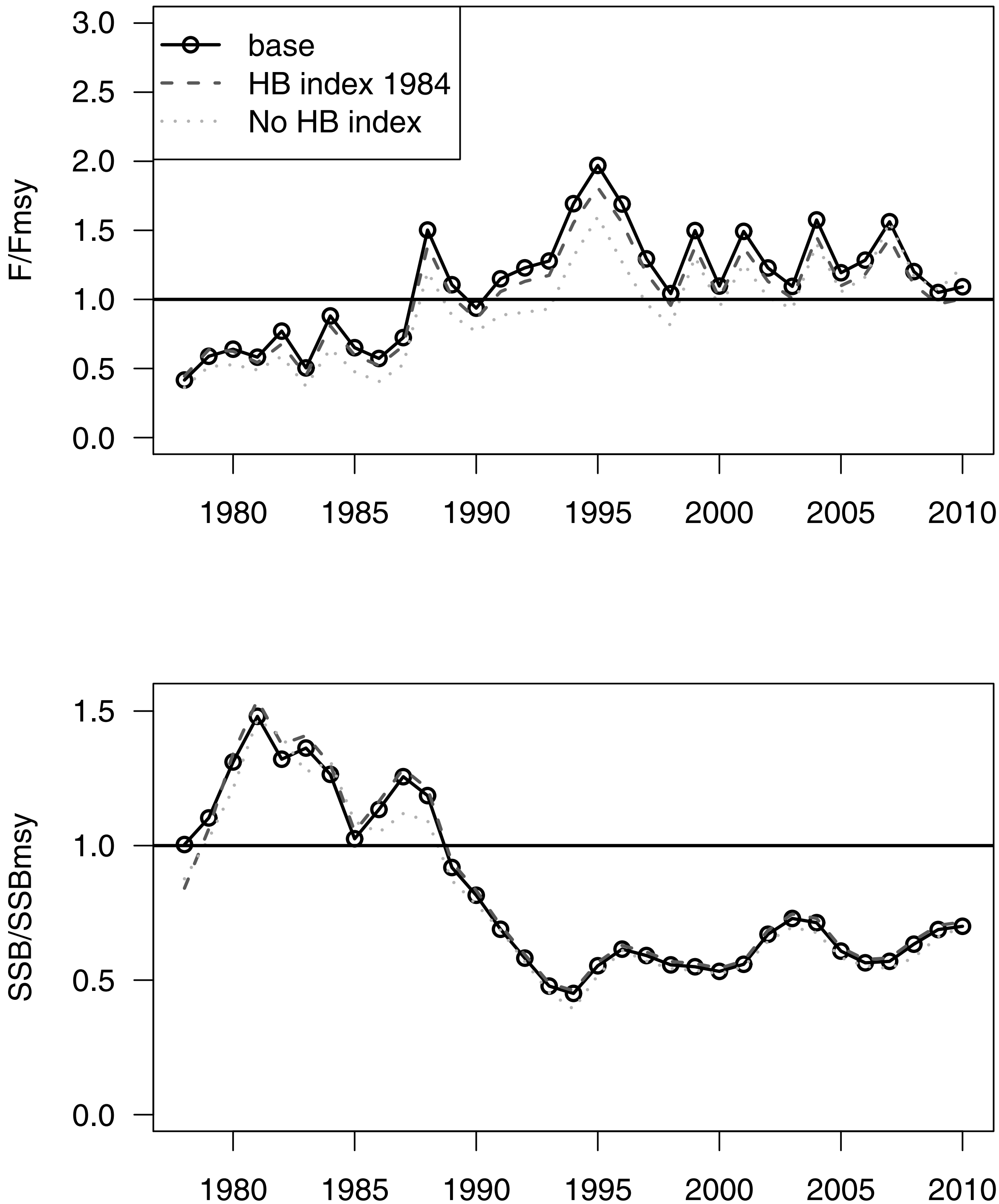


Figure 3.48. Phase plot of terminal status estimates from sensitivity runs of the Beaufort Assessment Model.

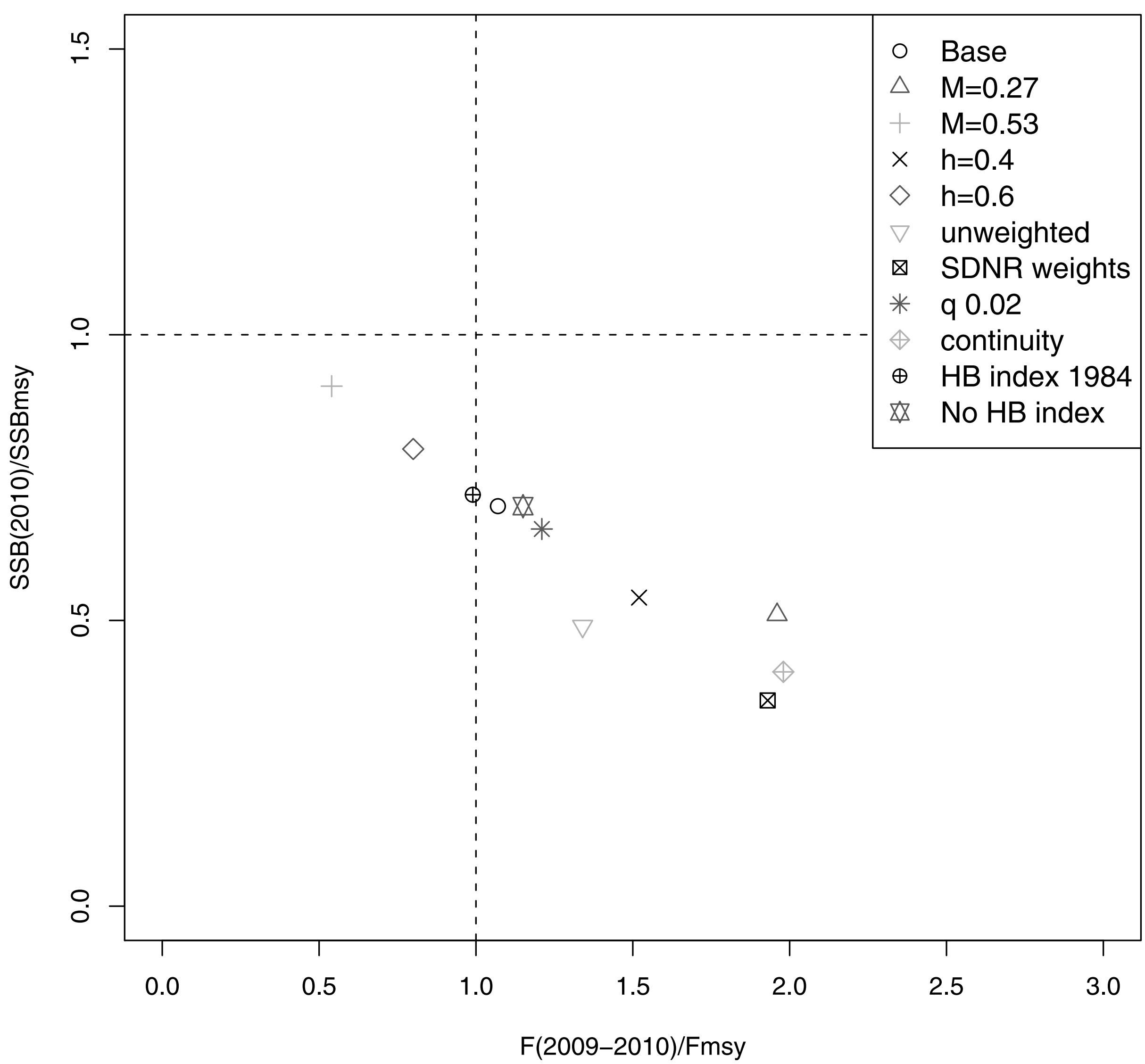


Figure 3.49. Retrospective analyses. Sensitivity to terminal year of data (sensitivity runs S11–S13). Top panel: Fishing mortality rates. Middle panel: Recruits. Bottom panel: Spawning biomass. Closed circles show terminal-year estimates. Imperceptible lines overlap results of the base run.

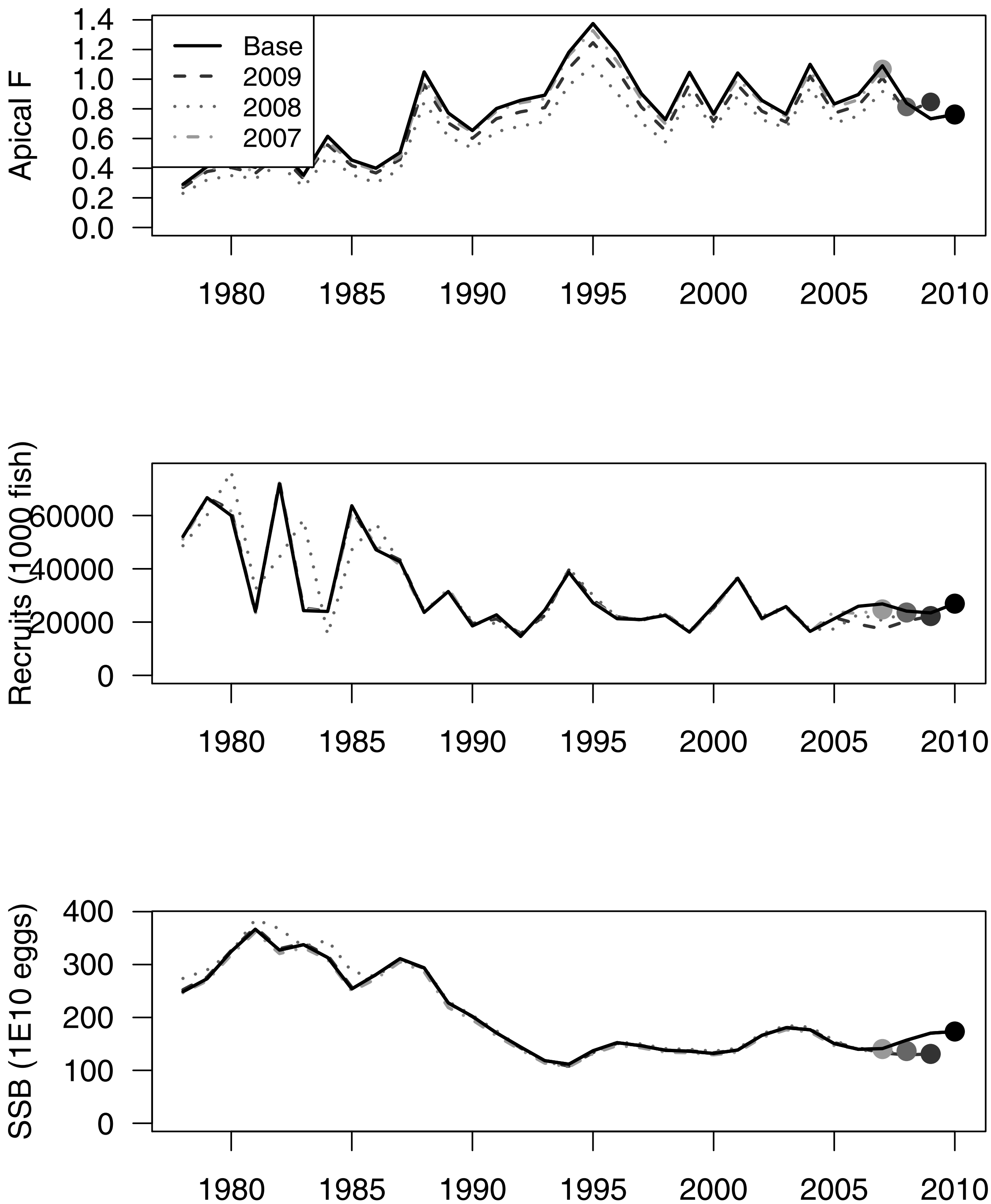


Figure 3.50. Projection results under scenario 1—fishing mortality rate fixed at $F = F_{\mathrm{rebuild}}$, with 2011 landings at 100% of the current quota. In top four panels, expected values represented by dotted solid lines, and uncertainty represented by thin lines corresponding to 5^{th} and 95^{th} percentiles of replicate projections. Horizontal lines mark MSY*-related quantities. Spawning stock (SSB) is at time of peak spawning. In bottom panel, the curve represents the proportion of projection replicates for which SSB has reached at least* $\mathrm{SSB}_{\mathrm{MSY}} = 248$.

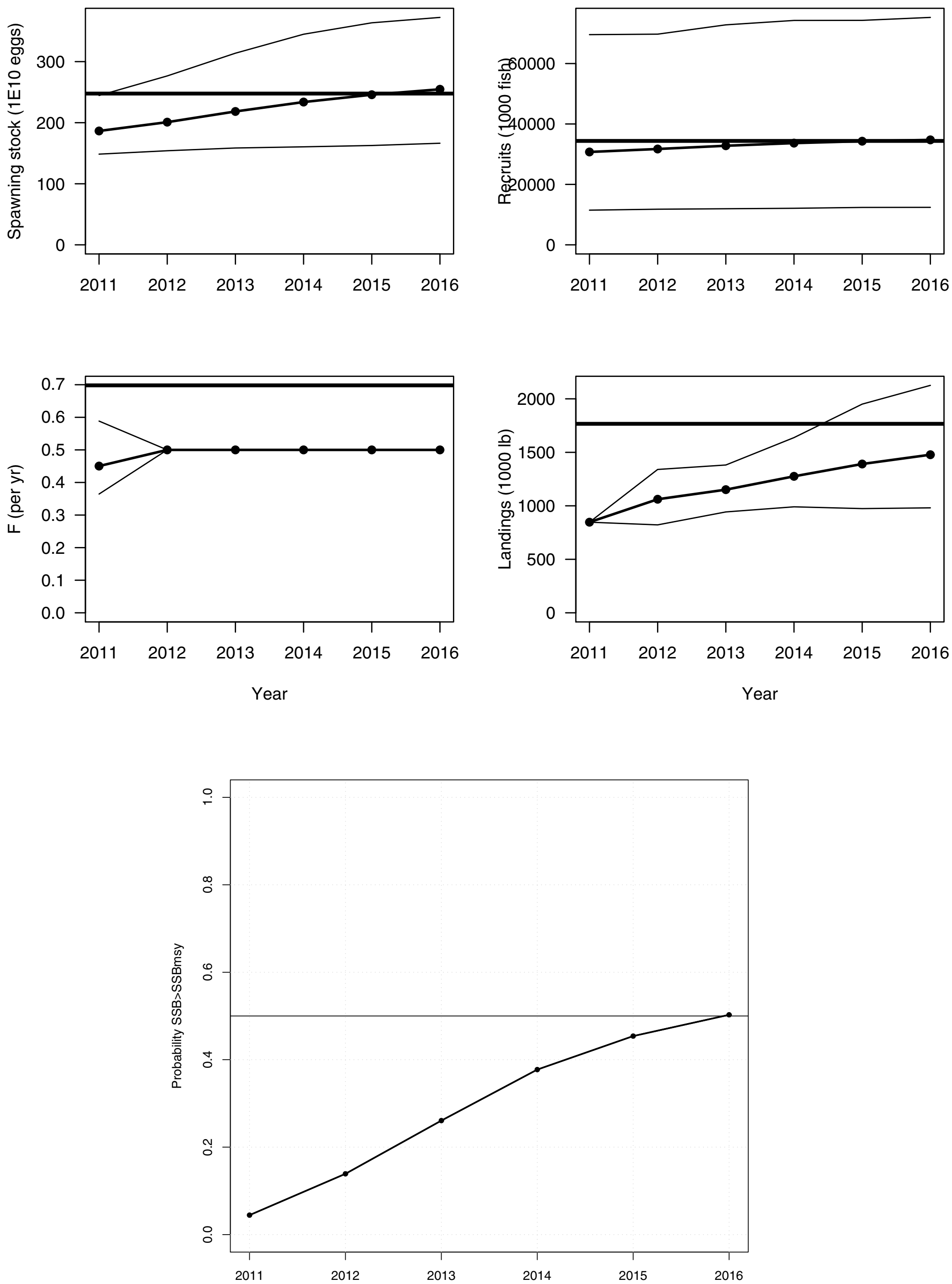


Figure 3.51. Projection results under scenario 2—fishing mortality rate fixed at $F = F_{\text{rebuild}}$, with 2011 landings at 150% of the current quota. In top four panels, expected values represented by dotted solid lines, and uncertainty represented by thin lines corresponding to 5^{th} and 95^{th} percentiles of replicate projections. Horizontal lines mark MSY*-related quantities. Spawning stock (SSB) is at time of peak spawning. In bottom panel, the curve represents the proportion of projection replicates for which SSB has reached at least* $\text{SSB}_{\text{MSY}} = 248$.

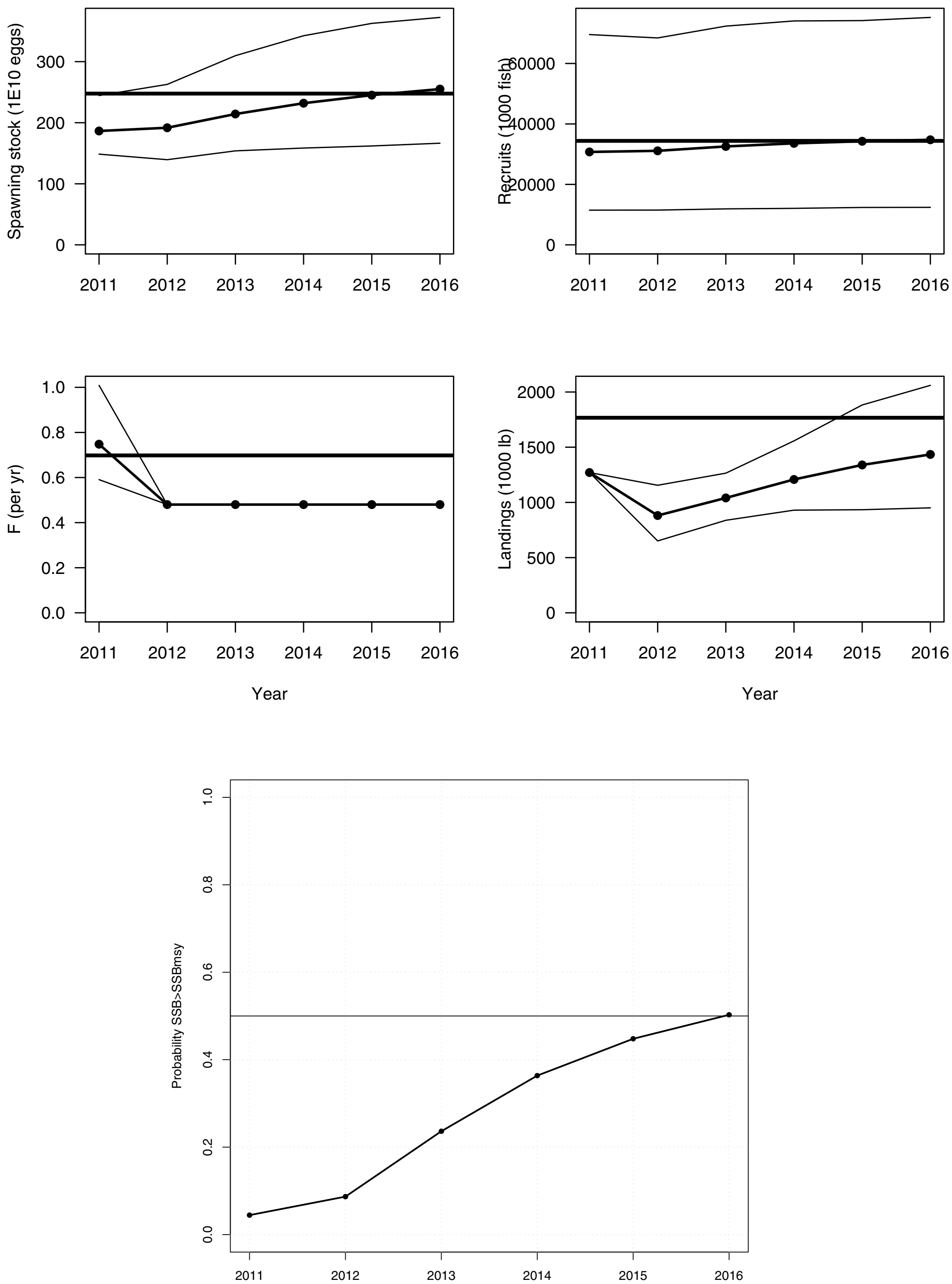


Figure 3.52. Projection results under scenario 3—fishing mortality rate fixed at $F = F_{\text{rebuild}}$, with 2011 landings at 200% of the current quota. In top four panels, expected values represented by dotted solid lines, and uncertainty represented by thin lines corresponding to 5^{th} and 95^{th} percentiles of replicate projections. Horizontal lines mark MSY*-related quantities. Spawning stock (SSB) is at time of peak spawning. In bottom panel, the curve represents the proportion of projection replicates for which SSB has reached at least* $\text{SSB}_{\text{MSY}} = 248$.

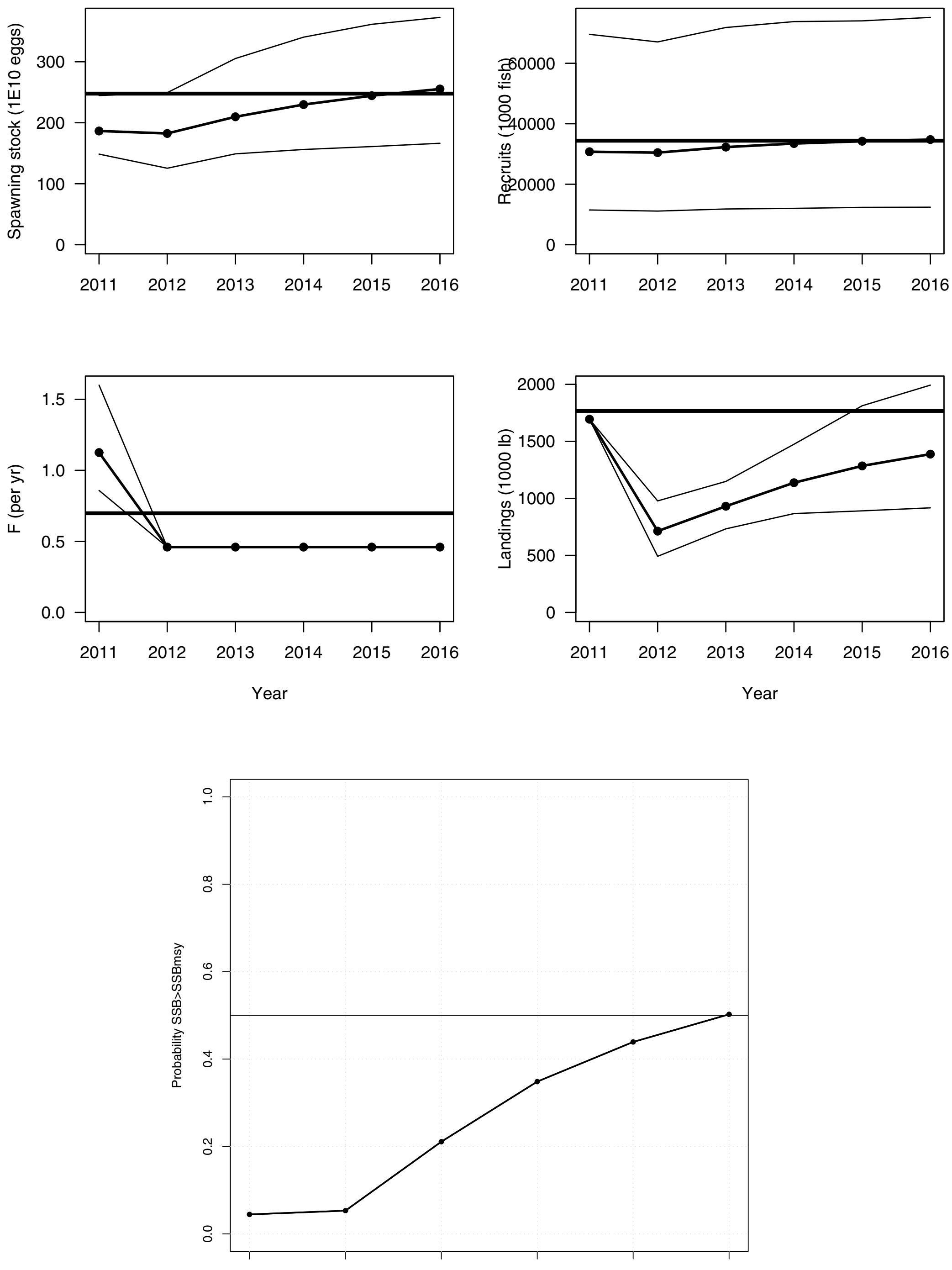


Figure 3.53. Projection results under scenario 4—landings fixed at the current quota (847,000 lb), with 2011 landings at 100% of the current quota. In top four panels, expected values represented by dotted solid lines, and uncertainty represented by thin lines corresponding to 5^{th} *and* 95^{th} *percentiles of replicate projections. Horizontal lines mark* MSY*-related quantities. Spawning stock (SSB) is at time of peak spawning. In bottom panel, the curve represents the proportion of projection replicates for which SSB has reached at least* $\mathrm{SSB}_{\mathrm{MSY}} = 248$.

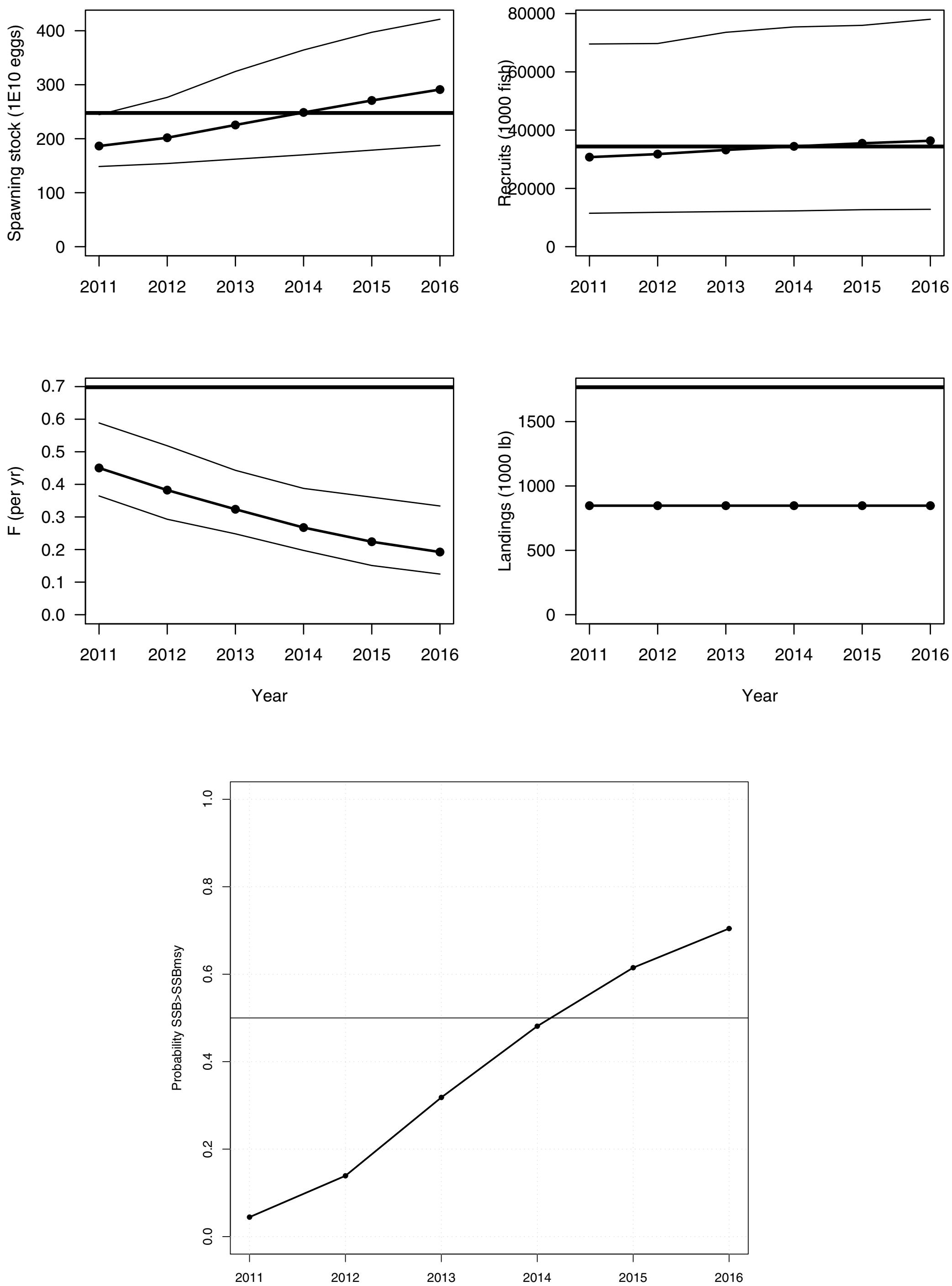


Figure 3.54. Projection results under scenario 5—landings fixed at the current quota (847,000 lb), with 2011 landings at 150% of the current quota. In top four panels, expected values represented by dotted solid lines, and uncertainty represented by thin lines corresponding to 5^{th} *and* 95^{th} *percentiles of replicate projections. Horizontal lines mark* MSY*-related quantities. Spawning stock (SSB) is at time of peak spawning. In bottom panel, the curve represents the proportion of projection replicates for which SSB has reached at least* $SSB_{MSY} = 248$.

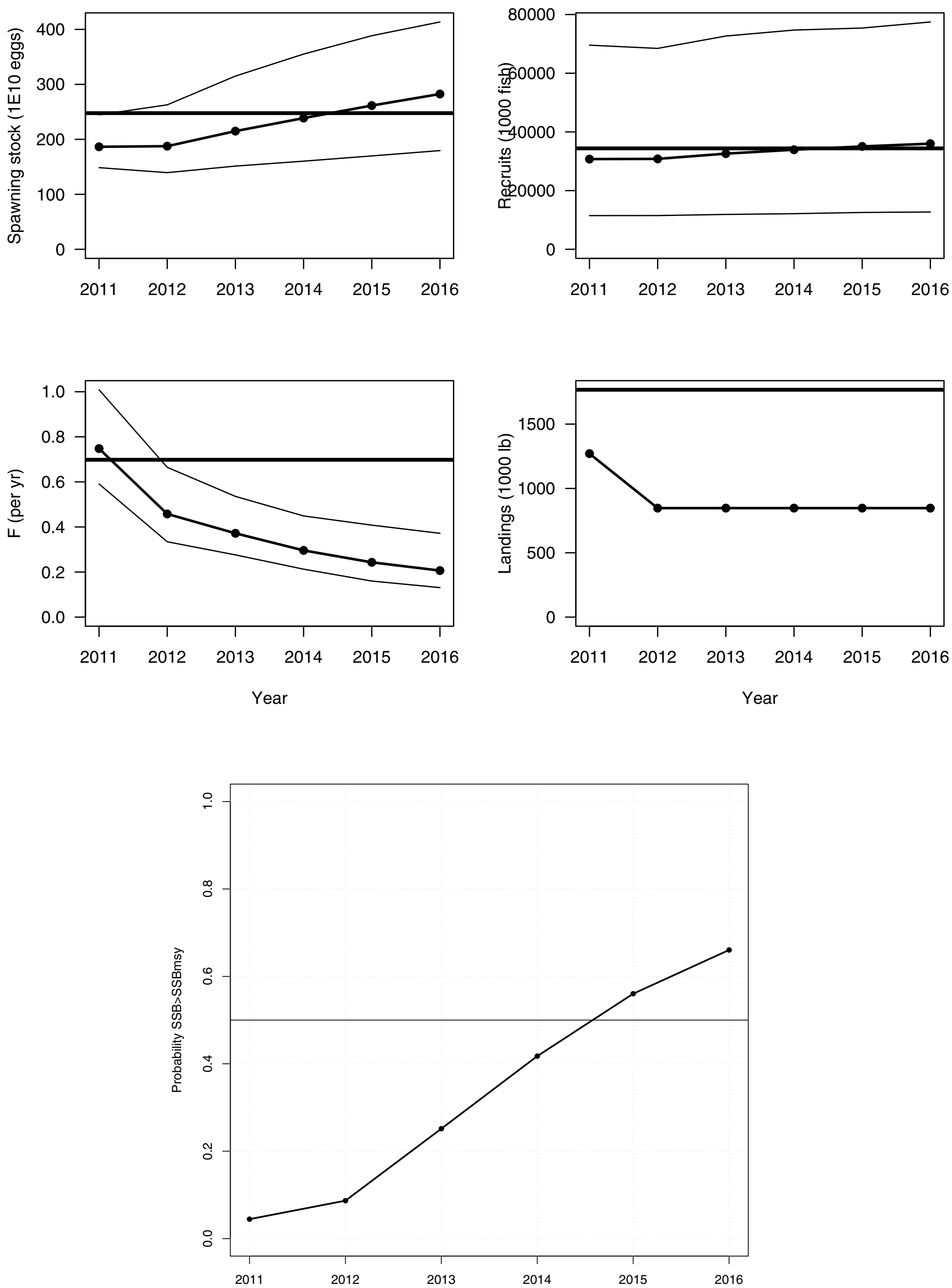


Figure 3.55. Projection results under scenario 6—landings fixed at the current quota (847,000 lb), with 2011 landings at 200% of the current quota. In top four panels, expected values represented by dotted solid lines, and uncertainty represented by thin lines corresponding to 5^{th} *and* 95^{th} *percentiles of replicate projections. Horizontal lines mark* MSY*-related quantities. Spawning stock (SSB) is at time of peak spawning. In bottom panel, the curve represents the proportion of projection replicates for which SSB has reached at least* $\mathrm{SSB_{MSY}} = 248$.

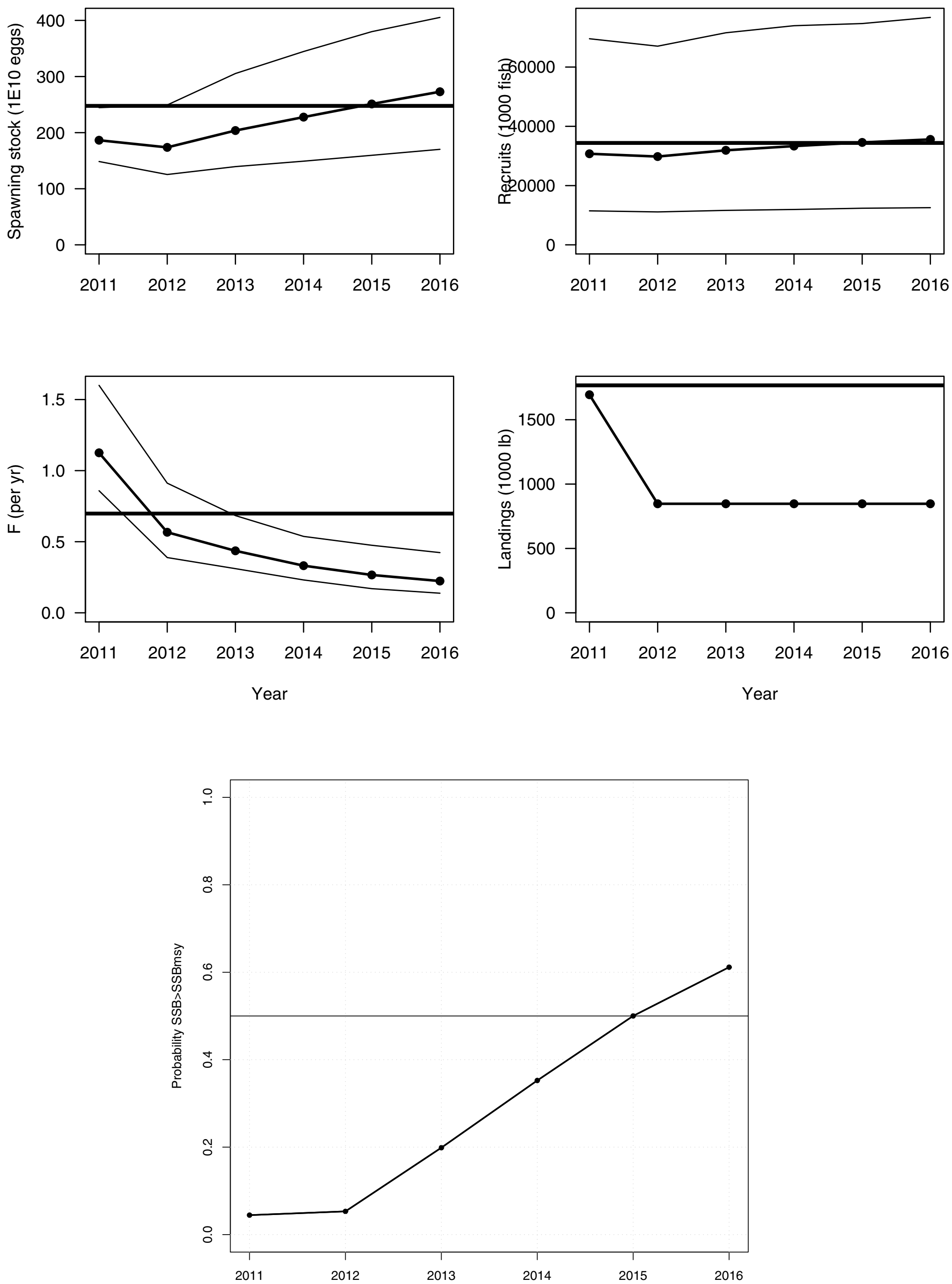


Figure 3.56. Projection results under scenario 7—landings fixed at $L = L_{\text{rebuild}}$*, with 2011 landings at 100% of the current quota. In top four panels, expected values represented by dotted solid lines, and uncertainty represented by thin lines corresponding to* 5^{th} *and* 95^{th} *percentiles of replicate projections. Horizontal lines mark* MSY*-related quantities. Spawning stock (SSB) is at time of peak spawning. In bottom panel, the curve represents the proportion of projection replicates for which SSB has reached at least* $\text{SSB}_{\text{MSY}} = 248$.

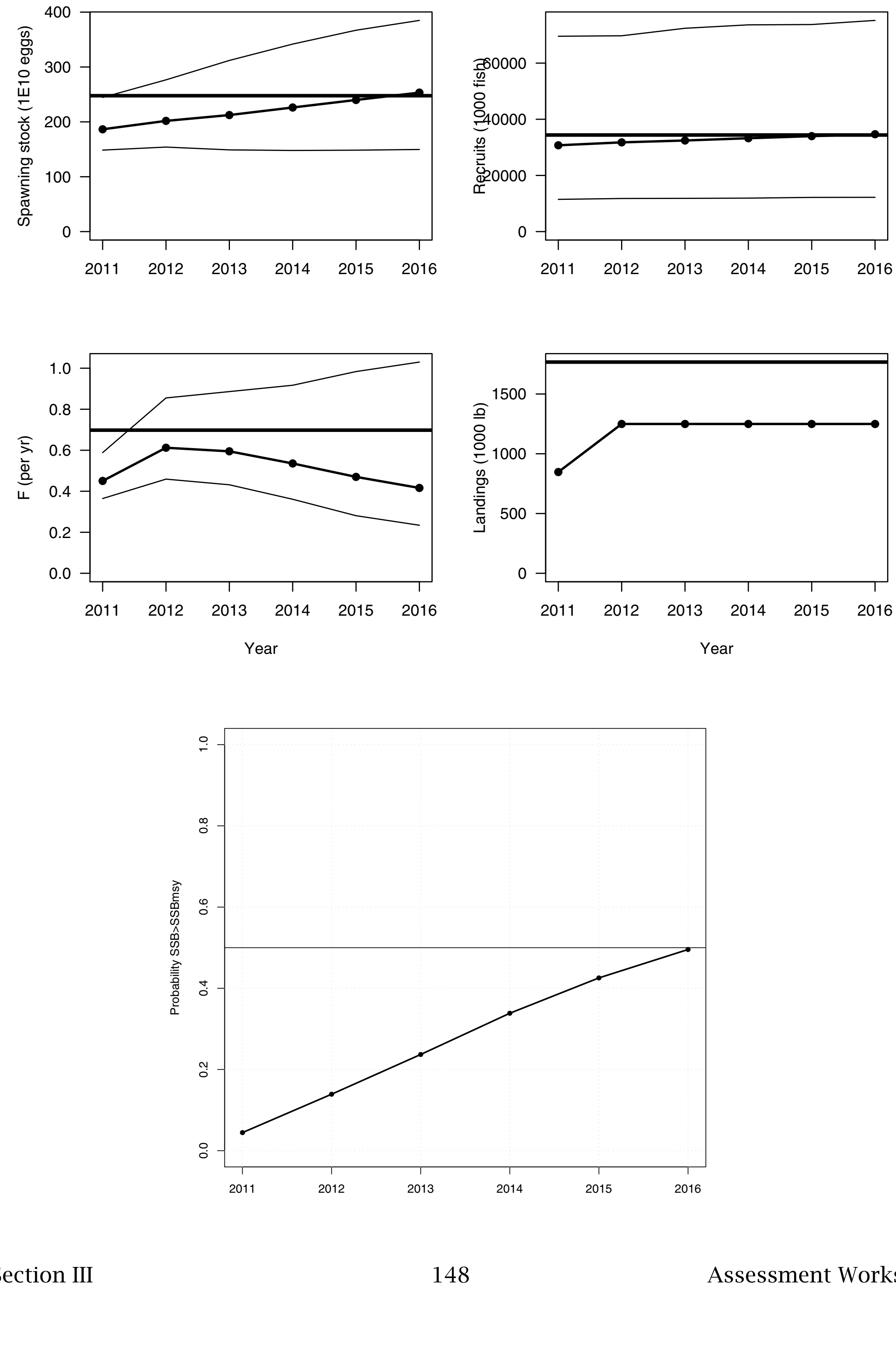


Figure 3.57. Projection results under scenario 8—landings fixed at $L = L_{\text{rebuild}}$, with 2011 landings at 150% of the current quota. In top four panels, expected values represented by dotted solid lines, and uncertainty represented by thin lines corresponding to 5^{th} and 95^{th} percentiles of replicate projections. Horizontal lines mark MSY*-related quantities. Spawning stock (SSB) is at time of peak spawning. In bottom panel, the curve represents the proportion of projection replicates for which SSB has reached at least* $\text{SSB}_{\text{MSY}} = 248$.

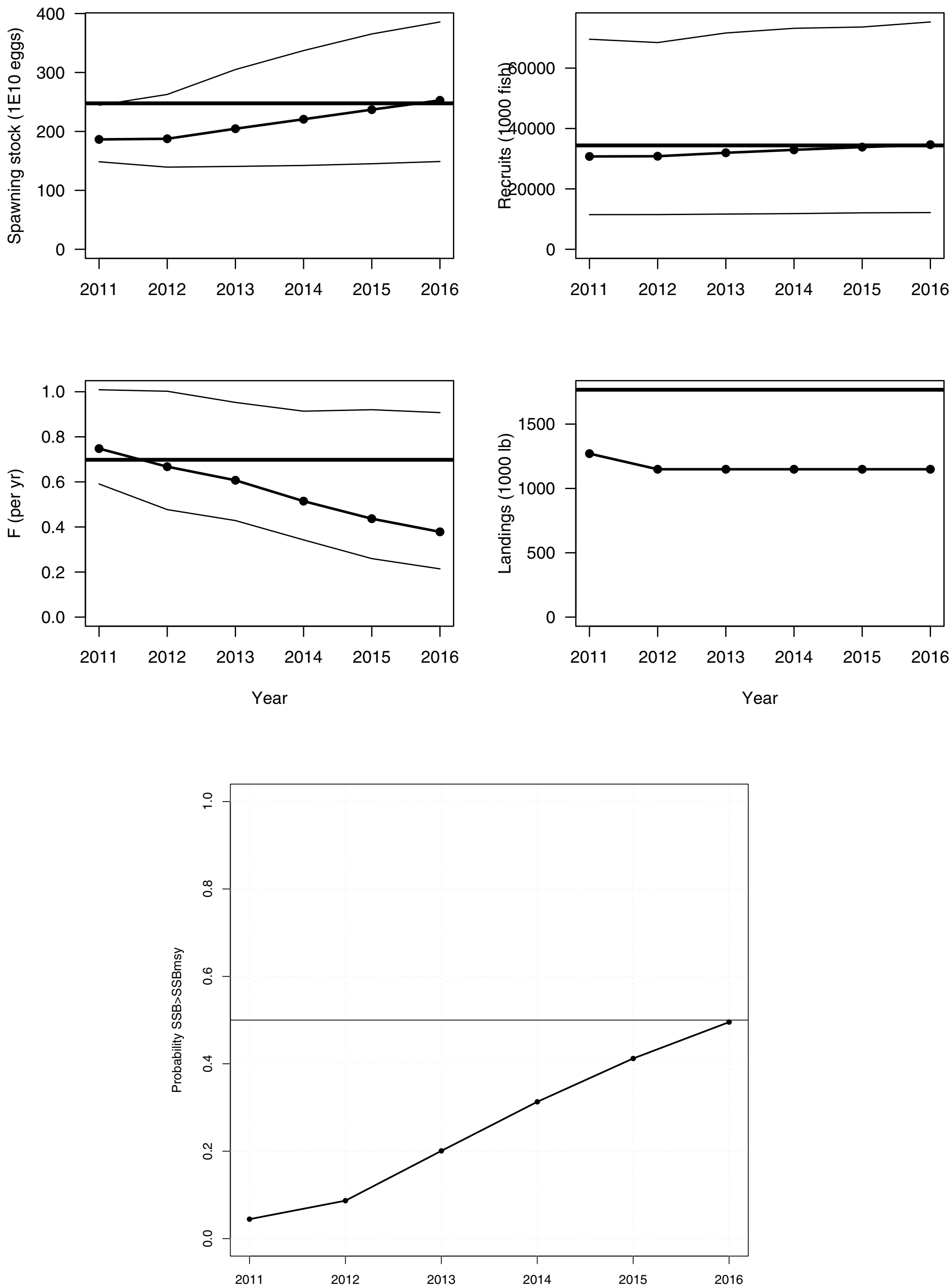


Figure 3.58. Projection results under scenario 9—landings fixed at $L = L_{\text{rebuild}}$*, with 2011 landings at 200% of the current quota. In top four panels, expected values represented by dotted solid lines, and uncertainty represented by thin lines corresponding to* 5^{th} *and* 95^{th} *percentiles of replicate projections. Horizontal lines mark* MSY*-related quantities. Spawning stock (SSB) is at time of peak spawning. In bottom panel, the curve represents the proportion of projection replicates for which SSB has reached at least* $\text{SSB}_{\text{MSY}} = 248$.

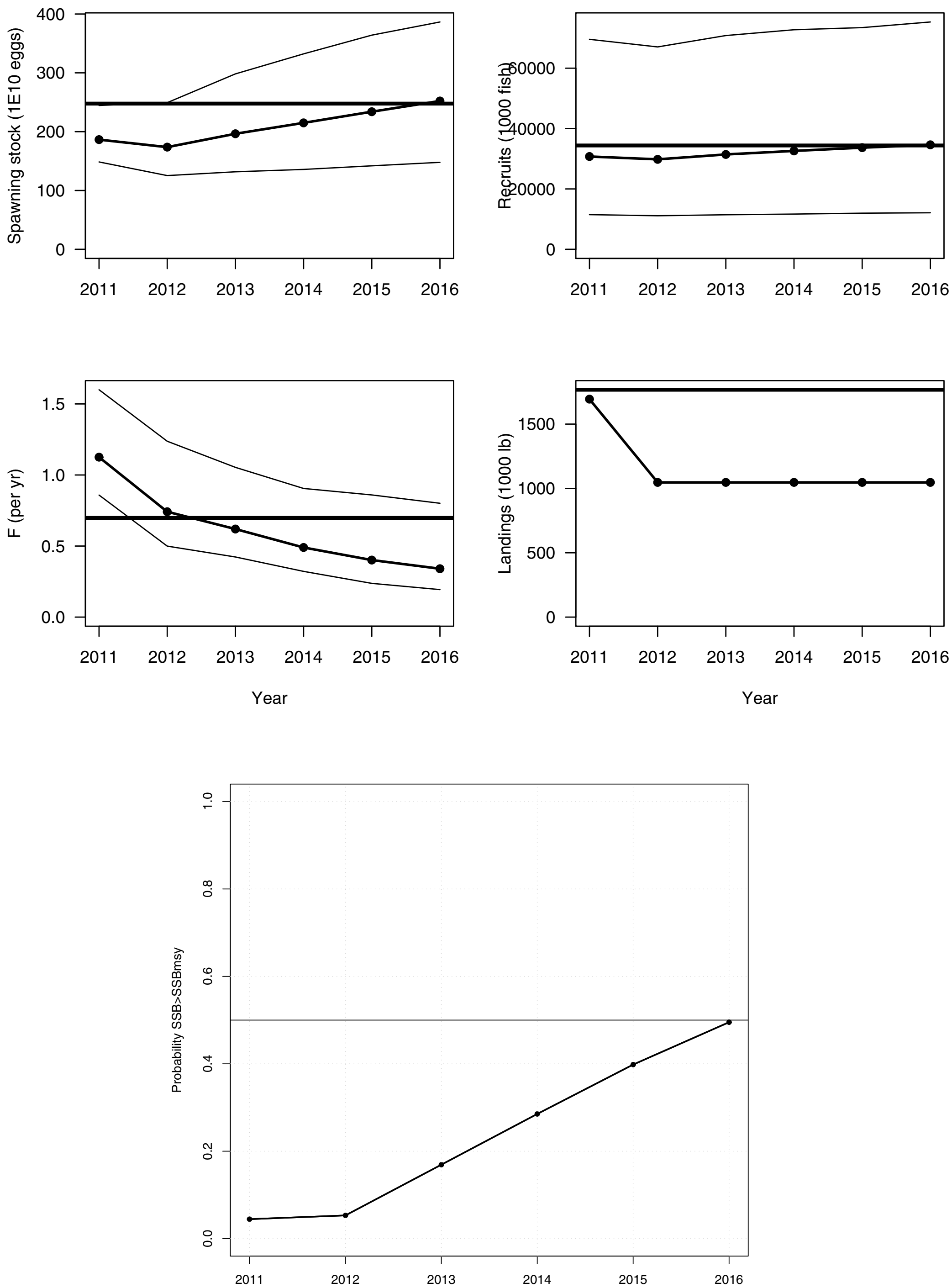


Figure 3.59. Black sea bass production model: Summed commercial and recreational landings and discards (yield) of black sea bass for the base run and four sensitivity runs assuming alternative ratios of historical recreational to commercial landings.

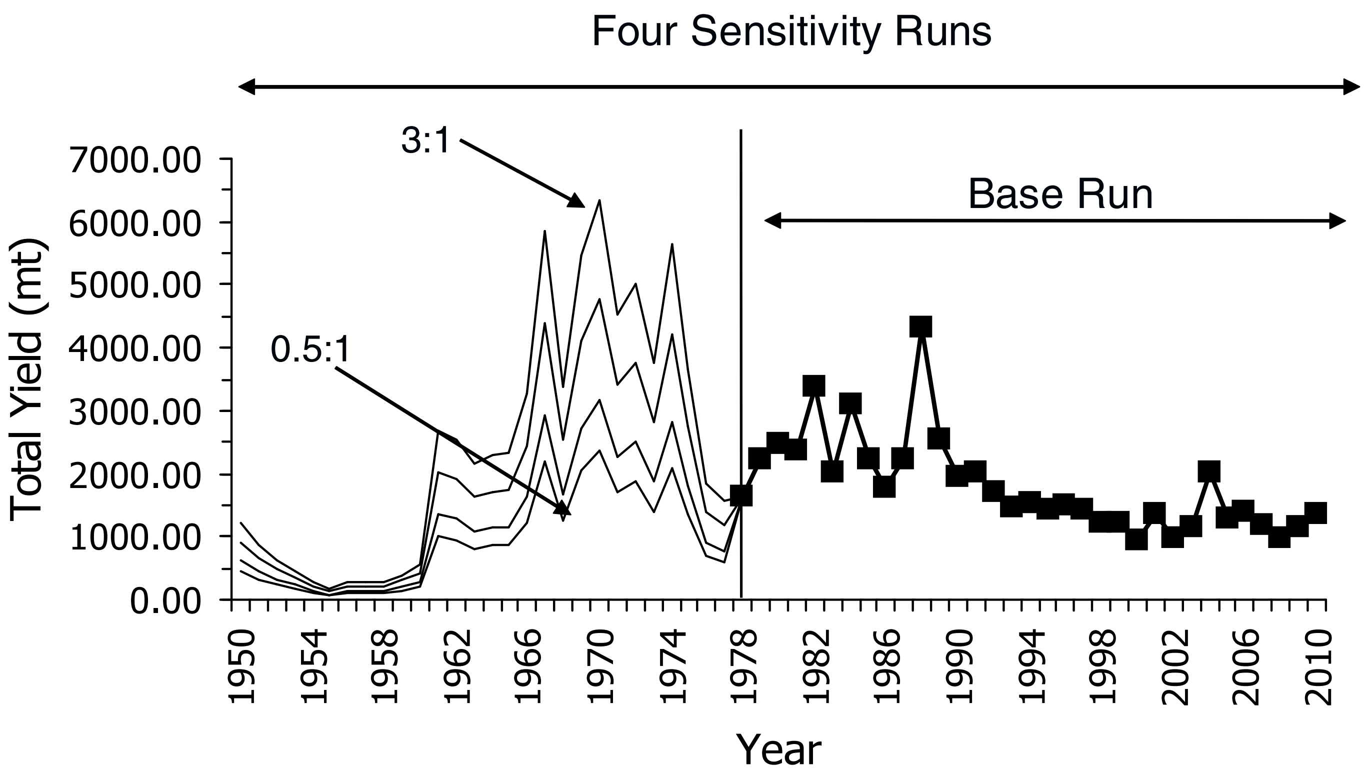


Figure 3.60. Black sea bass production model: Observed (closed circles) and model fit (open diamonds) for two fishery-independent (MARMAP chevron trap and MARMAP blackfish/snapper trap) and two fishery-dependent (headboat and commercial vertical line) indices of abundance.

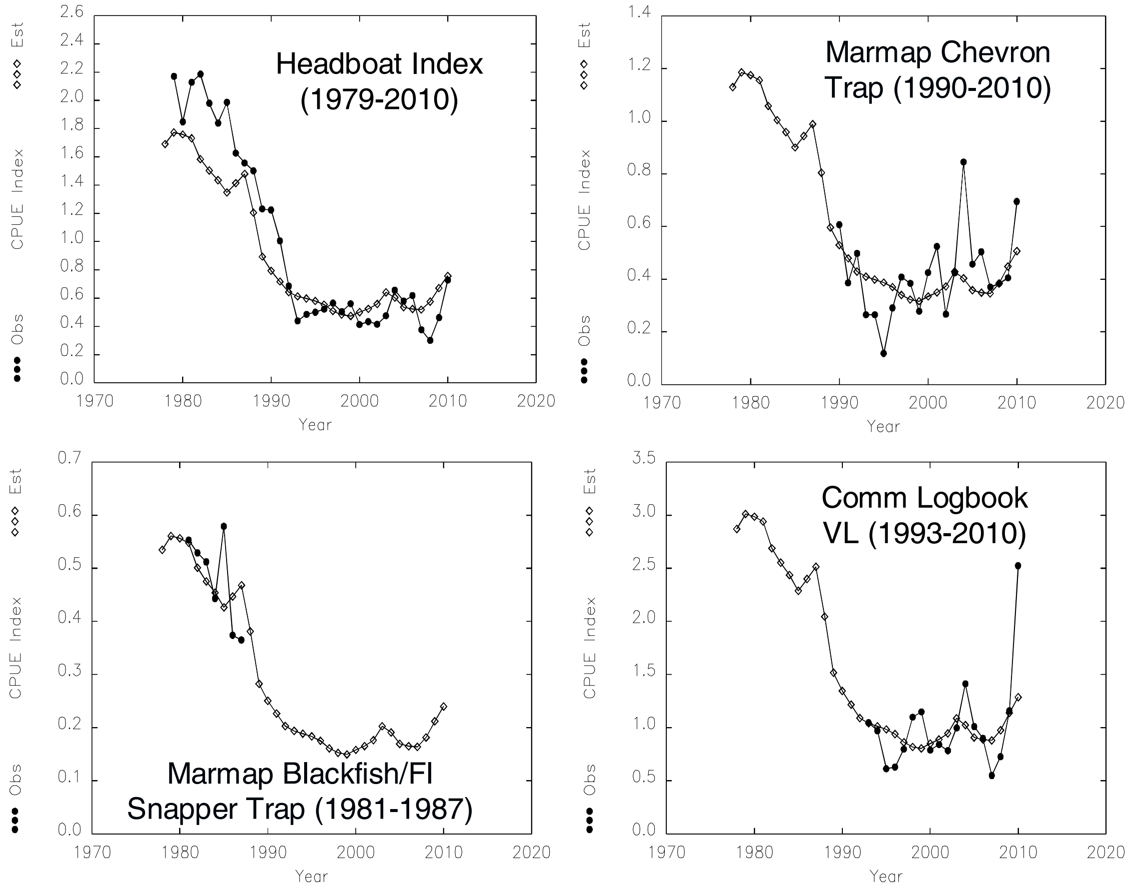


Figure 3.61. Black sea bass production model: Trends in relative fishing mortality (F/F_{MSY}, top panel) and relative biomass (B/B_{MSY}, bottom panel) estimated by the base run, with 80% confidence bands (dashed lines).

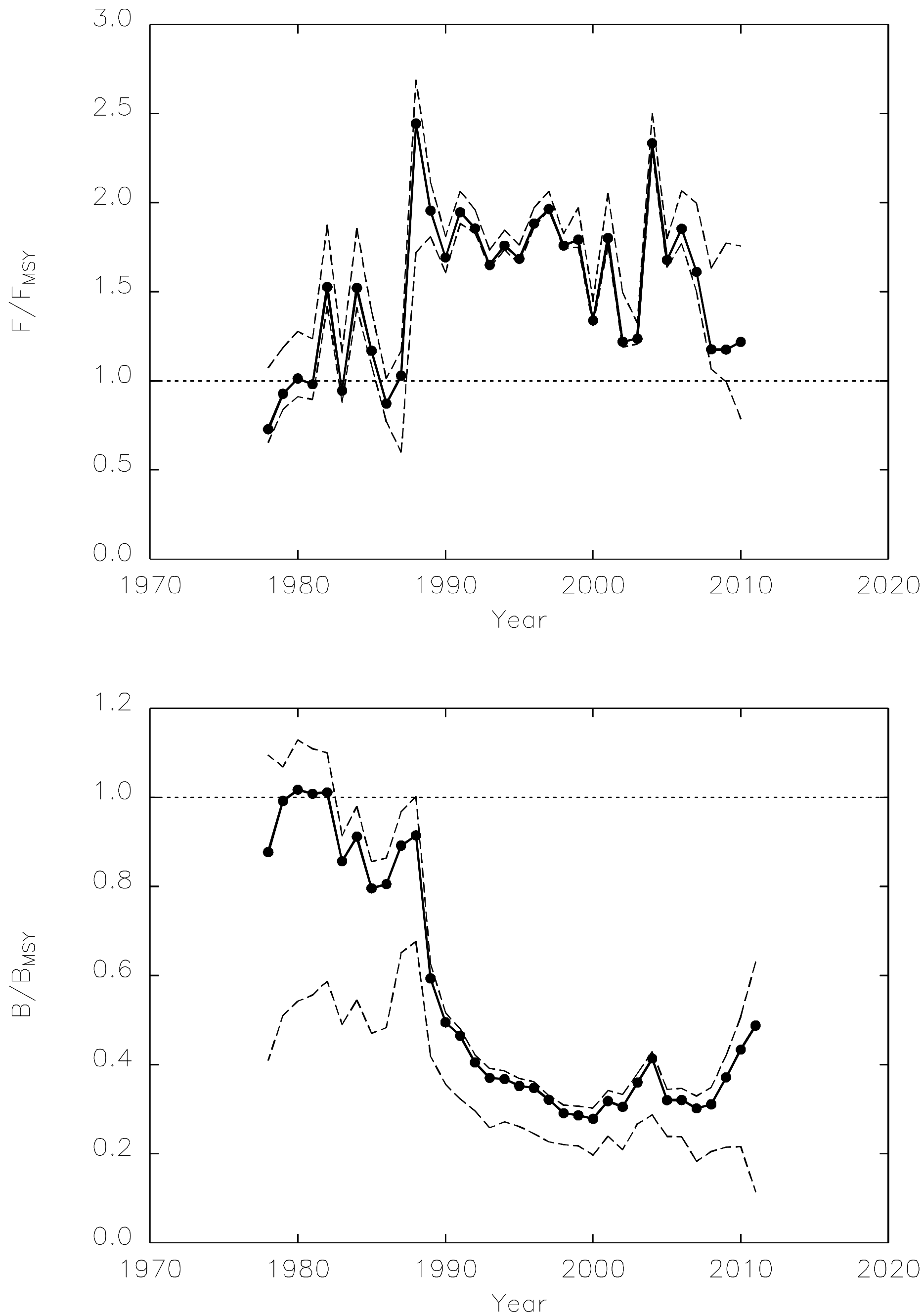
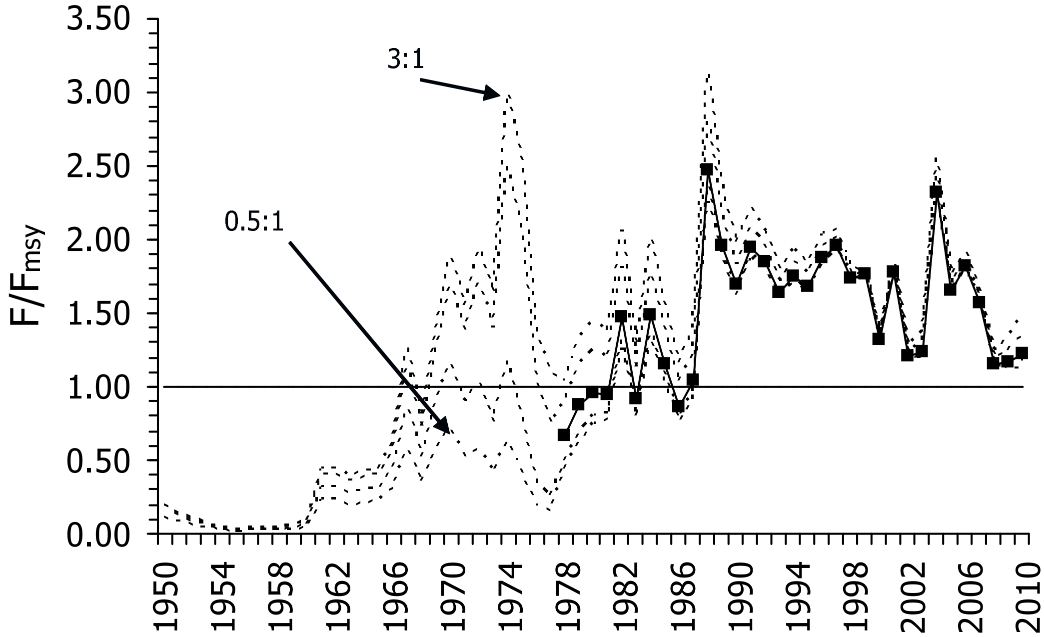
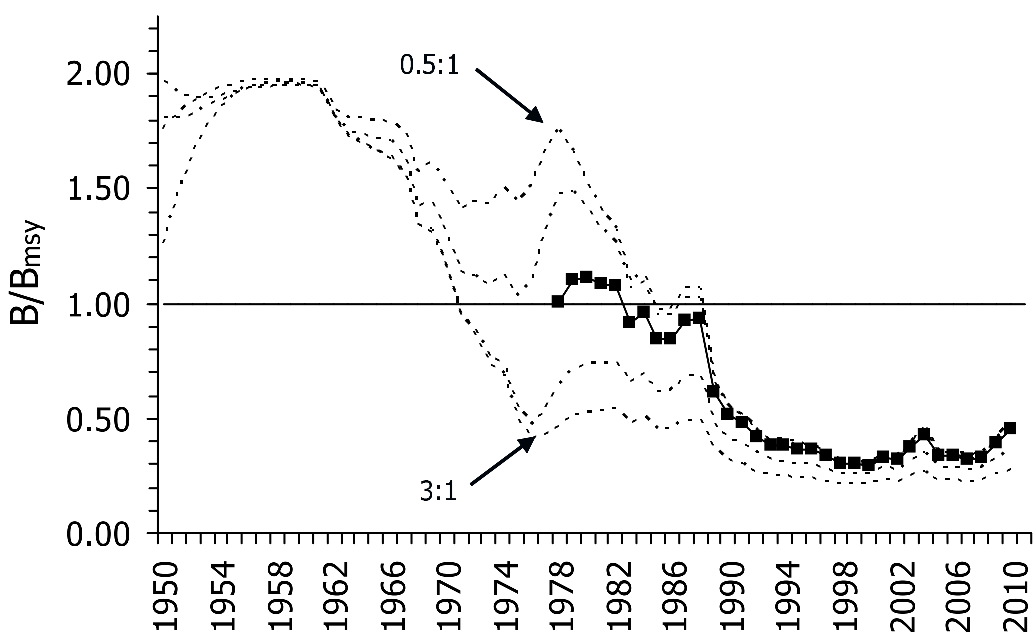


Figure 3.62. Black sea bass production model: Trends in relative fishing mortality (F/F_{MSY}, top panel) and relative biomass (B/B_{MSY}, bottom panel) for the base run (filled squares, solid line) and four sensitivity runs (dashed lines) that assumed different ratios of recreational to commercial catch ranging from 0.5:1 to 3:1.





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 black sea bass)
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 black sea bass)
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/Bootstrap, 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 black sea bass 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 ≤ 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 Parameter estimates from the Beaufort Assessment Model

```
# Number of parameters = 300  Objective function value = 703.775  Maximum gradient component = 8.44532e-05
# len_cv_val:
0.140702243023
# log_Nage_dev:
 -0.0788094796488 0.0720129078566 -0.0886328233193 -0.0691314929985 -0.0268532085554 -0.0185950147183 -0.0107274113603 -0.00633546573092
 -0.00286015924328 -0.000616857329665 -0.00199924241044
# log_R0:
17.4353123862
# steep:
0.494706454434
# rec_sigma:
0.381603073042
# log_rec_dev:
 0.477104324868 0.700965453919 0.539146754920 -0.410764596321 0.717905920337 -0.376127542804 -0.366051601422 0.679807467525 0.344713041369
 0.211380717211 -0.360821342351 0.0159116718877 -0.464067392846 -0.190046222691 -0.553235625475 0.0673835294056 0.555389795007 0.0956301026466
 -0.203368794160 -0.199045681901 -0.0968804934675 -0.418322723652 0.0711599234112 0.383417284454 -0.238350259361 -0.0873767341129 -0.524711026728
 -0.197567951872 0.0379329892932 0.0660305340046 -0.0918697675702 -0.157413593752 -0.0278581597756
# selpar_L50_Mbft:
2.27172265055
# selpar_slope_Mbft:
4.78888915765
# selpar_L50_Mcvt:
2.56815275593
# selpar_slope_Mcvt:
2.86585503482
# selpar_L50_cL2:
3.40981496277
# selpar_slope_cL2:
2.97889372051
# selpar_L50_cL3:
3.79717317927
# selpar_slope_cL3:
2.59872754482
# selpar_L50_cP2:
1.77729997381
# selpar_slope_cP2:
3.36120509115
# selpar_L50_cP3:
2.64159818357
# selpar_slope_cP3:
4.62163678220
# selpar_L50_HB1:
1.99495331437
# selpar_slope_HB1:
3.30455709137
# selpar_L50_HB2:
2.27992511875
# selpar_slope_HB2:
2.83636072225
# selpar_L50_HB3:
2.81299640427
# selpar_slope_HB3:
3.50487249627
# selpar_L50_HB4:
3.10374810637
# selpar_slope_HB4:
3.62911944331
# selpar_Age0_HB_D_logit:
-6.14227394584
# selpar_Age1_HB_D_logit:
-1.87971756579
# selpar_Age2_HB_D_logit:
1.67043764484
# log_q_Mbft:
-15.7342953978
# log_q_Mcvt:
-14.7831147419
# log_q_cL:
-6.47293903142
# log_q_HB:
-7.89687266022
# log_q_HBD:
-15.6227655652
# log_avg_F_cL:
-2.16607632883
# log_F_dev_cL:
 -1.18158549291 -0.929093281453 -1.06702023203 -0.597487509621 -0.786720273044 -0.935875143956 -0.597349590965 -0.627949805418 -0.751207398742
 -0.668958800790 0.0646533926600 0.273680073504 0.327278952068 0.463221432221 0.577408771337 0.623809728177 1.06464065076 1.08872333577
 1.12133246815 0.910671795028 0.825984602763 0.938567873431 0.299513291384 0.224550163805 0.383780947152 0.221266738846 0.210011820111
 -0.298287620432 -0.316977200516 -0.285438150881 -0.136300918077 0.0468686111313 -0.485713229474
# log_avg_F_cP:
-1.78093910415
# log_F_dev_cP:
 -2.01084798364 -0.339057900122 -0.0991405186260 -0.111776006454 -0.425267412567 -0.790937463174 -1.00398052015 -0.928731297053
 -0.547528731261 -0.894987663164 -0.570113590892 -0.378283460413 0.0636987690151 0.0959427695199 0.216758433410 0.312726823467
 0.584241860196 0.405766259702 0.299807275490 0.258328967501 0.0876819016971 0.749875347431 0.504740301157 0.683943080791 0.647686637409
 0.469997549323 0.546843726200 0.281607796532 0.518525485446 0.437705915502 0.356404100591 0.503032293166 0.0753372539695
# log_avg_F_cT:
```

```
-5.72075428498
# log_F_dev_cT:
 0.488508448864 0.390088175716 0.283734711002 0.364042982422 -0.130524347051 -0.894100250285 -0.203588995293 0.200271690937 0.273780870274
 -0.942551683711 0.183720756604 -0.0851750391746 0.0717926796943
# log_avg_F_HB:
-2.16886454584
# log_F_dev_HB:
 -0.174640775578 -0.0481786662242 0.0359102847875 -0.0229962546225 -0.0619859034858 0.0160911632875 0.130533047301 -0.0290612728793 0.0601672611704
 0.205756058513 0.277042565875 0.187035153233 0.0507990402168 -0.0487782204684 -0.132962656799 -0.310229943102 -0.154361343481 0.0335322526477
 -0.0880285796450 -0.338611480397 -0.422517731670 0.278465164460 -0.0320223815549 0.122941933858 -0.103222533894 -0.270508400698 0.112981230479
 -0.00912227427879 -0.0120387468908 0.341163435013 -0.141510935417 0.0824602107677 0.465899299478
# log_avg_F_mrip:
-1.20234888590
# log_F_dev_mrip:
 -1.37244717259 -0.124465180906 -0.976481815806 0.172135673887 -0.351740554298 -0.897487919591 -0.241641234205 0.811212585289 0.195190602678
 -0.450583843952 0.0804257392564 0.135164479145 0.191935057727 0.402005482826 0.792230206276 0.501065234858 0.0581528546885 -0.374290531853
 -0.203218723515 -0.308026543623 0.369661946468 -0.130976630979 -0.129326424196 0.584282106687 0.313154354479 0.326444342374 0.650716303462
 0.275026507915 -0.370124253753 0.0720073512500
# F_init_ratio:
0.760481635339
# log_avg_F_comm_D:
-6.93372412543
# log_F_dev_comm_D:
 0.634092163735 1.10305575496 0.711158015541 0.508140684116 0.494200617480 0.686584036461 0.610103167503 0.259651997448 0.540072721103
 -0.531009353098 0.127165759176 -0.0606377726012 0.511663233494 0.931509852108 -1.82493660996 -2.08980568786 -1.19235934025 -1.41864923935
# log_avg_F_HB_D:
-6.96245013258
# log_F_dev_HB_D:
 0.952581259456 0.622927748295 -0.416080519935 -0.505090614143 -2.90977738747 0.696861270958 -0.0357043417709 -0.743961112691 0.484006924345
 -0.134085087579 -0.250148256329 -0.243670771280 -0.375819207150 0.451407567767 0.275225573961 0.507255913703 -0.0947256949913 -0.432039946055
 0.183873118234 0.483349998723 0.611123822346 0.408709247340 -0.216988075327 0.0955867533289 0.585181816261
# log_avg_F_mrip_D:
-4.35829369537
# log_F_dev_mrip_D:
 -0.820439788699 -0.819091137687 -1.44685268234 -0.699228127383 -0.475557041254 -0.473853537523 -0.561482491308 -0.655274626241 -0.522523658338
 -0.885457042663 -0.261141480472 -0.0382676620227 7.86901191470e-05 0.682266044097 0.0613034293075 -0.415777361842 0.0229675545202 -0.100312061188
 0.270779393868 0.548089573927 0.714820002451 0.0908014495614 -0.0234412211769 0.820794645775 0.718007189044 1.03881659877 1.19423351312
 0.706017063588 0.489974129832 0.839750642157
```

Appendix C ASPIC Output: Results of production model run matched to the base run of the BAM with (1978–2010).

```
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                                                                           Monday, 15 Aug 2011 at 10:39:02
ASPIC -- A Surplus-Production Model Including Covariates (Ver. 5.31)
                                                                                          BOT program mode
Author:     Michael H. Prager; NOAA Center for Coastal Fisheries and Habitat Research   LOGISTIC model mode
            101 Pivers Island Road; Beaufort, North Carolina  28516  USA                   YLD conditioning
            Mike.Prager@noaa.gov                                                          SSE optimization

Reference:  Prager, M. H. 1994. A suite of extensions to a nonequilibrium            ASPIC Users Manual is available
            surplus-production model.  Fishery Bulletin 92: 374-389.                     gratis from the author.

CONTROL PARAMETERS (FROM INPUT FILE)          Input file: c:\...cuments\aspicwork\bsb-landings&discards_78-10-boot.inp
------------------------------------------------------------------------------------------------------------------------
Operation of ASPIC:  Fit logistic (Schaefer) model by direct optimization with bootstrap.
Number of years analyzed:                        33          Number of bootstrap trials:                        501
Number of data series:                            4          Bounds on MSY (min, max):       1.000E+02     2.000E+05
Objective function:                   Least squares          Bounds on K (min, max):         1.000E+03     5.000E+07
Relative conv. criterion (simplex):       1.000E-08          Monte Carlo search mode, trials:       0          20000
Relative conv. criterion (restart):       3.000E-08          Random number seed:                             3941285
Relative conv. criterion (effort):        1.000E-04          Identical convergences required in fitting:           6
Maximum F allowed in fitting:                 8.000


PROGRAM STATUS INFORMATION (NON-BOOTSTRAPPED ANALYSIS)                                              error code   0
------------------------------------------------------------------------------------------------------------------------
Normal convergence


CORRELATION AMONG INPUT SERIES EXPRESSED AS CPUE (NUMBER OF PAIRWISE OBSERVATIONS BELOW)
------------------------------------------------------------------------------------------------------------------------
                                    |
 1  HB Index (WPUE), Yield (mt)     |   1.000
                                    |      32
                                    |
 2  MARMAP Chevron Trap             |   0.430   1.000
                                    |      21      21
                                    |
 3  MARMAP Blackfish/Fl Snapper Trap |   0.910   0.000   1.000
                                    |       7       0       7
                                    |
 4  Comm logbook vertical line      |   0.690   0.617   0.000   1.000
                                    |      18      18       0      18
                                     --------------------------------------------------
                                            1       2       3       4


GOODNESS-OF-FIT AND WEIGHTING (NON-BOOTSTRAPPED ANALYSIS)
------------------------------------------------------------------------------------------------------------------------
                                                  Weighted             Weighted      Current     Inv. var.    R-squared
Loss component number and title                        SSE       N          MSE       weight        weight      in CPUE

Loss(-1)  SSE in yield                           0.000E+00
Loss(0)   Penalty for B1 > K                     0.000E+00       1          N/A    0.000E+00           N/A
Loss(1)   HB Index (WPUE), Yield (mt)            2.138E+00      32    7.128E-02    1.000E+00     1.163E+00        0.827
Loss(2)   MARMAP Chevron Trap                    3.185E+00      21    1.676E-01    1.000E+00     4.947E-01        0.113
Loss(3)   MARMAP Blackfish/Fl Snapper Trap       1.963E-01       7    3.927E-02    1.000E+00     2.112E+00        0.065
Loss(4)   Comm logbook vertical line             1.531E+00      18    9.570E-02    1.000E+00     8.666E-01        0.288
............................................................................................
TOTAL OBJECTIVE FUNCTION, MSE, RMSE:         7.05059580E+00            9.930E-02    3.151E-01
Estimated contrast index (ideal = 1.0):              0.4101            C* = (Bmax-Bmin)/K
Estimated nearness index (ideal = 1.0):              1.0000            N* = 1 - |min(B-Bmsy)|/K
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```

MODEL PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter		Estimate	User/pgm guess	2nd guess	Estimated	User guess
B1/K	Starting relative biomass (in 1978)	5.030E-01	5.000E-01	8.949E-01	1	1
MSY	Maximum sustainable yield	2.317E+03	2.000E+03	1.532E+03	1	1
K	Maximum population size	1.346E+04	8.000E+04	9.195E+03	1	1
phi	Shape of production curve (Bmsy/K)	0.5000	0.5000	----	0	1
---------	Catchability Coefficients by Data Series ---------------					
q(1)	HB Index (WPUE), Yield (mt)	2.374E-04	1.450E-04	1.378E-02	1	1
q(2)	MARMAP Chevron Trap	1.585E-04	1.210E-04	1.150E-02	1	1
q(3)	MARMAP Blackfish/Fl Snapper Trap	7.507E-05	8.500E-04	8.075E-02	1	1
q(4)	Comm logbook vertical line	4.029E-04	1.500E-04	1.425E-02	1	1

MANAGEMENT and DERIVED PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter		Estimate	Logistic formula	General formula
MSY	Maximum sustainable yield	2.317E+03	----	----
Bmsy	Stock biomass giving MSY	6.731E+03	K/2	K*n**(1/(1-n))
Fmsy	Fishing mortality rate at MSY	3.442E-01	MSY/Bmsy	MSY/Bmsy
n	Exponent in production function	2.0000	----	----
g	Fletchers gamma	4.000E+00	----	[n**(n/(n-1))]/[n-1]
B./Bmsy	Ratio: B(2011)/Bmsy	4.989E-01	----	----
F./Fmsy	Ratio: F(2010)/Fmsy	1.224E+00	----	----
Fmsy/F.	Ratio: Fmsy/F(2010)	8.168E-01	----	----
Y.(Fmsy)	Approx. yield available at Fmsy in 2011	1.156E+03	MSY*B./Bmsy	MSY*B./Bmsy
	...as proportion of MSY	4.989E-01	----	----
Ye.	Equilibrium yield available in 2011	1.735E+03	4*MSY*(B/K-(B/K)**2)	g*MSY*(B/K-(B/K)**n)
	...as proportion of MSY	7.489E-01	----	----
---------	Fishing effort rate at MSY in units of each CE or CC series ---------			
fmsy(1)	HB Index (WPUE), Yield (mt)	1.450E+03	Fmsy/q(1)	Fmsy/q(1)

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ESTIMATED POPULATION TRAJECTORY (NON-BOOTSTRAPPED)

Obs	Year or ID	Estimated total F mort	Estimated starting biomass	Estimated average biomass	Observed total yield	Model total yield	Estimated surplus production	Ratio of F mort to Fmsy	Ratio of biomass to Bmsy
1	1978	0.230	6.772E+03	7.122E+03	1.636E+03	1.636E+03	2.307E+03	6.672E-01	1.006E+00
2	1979	0.299	7.443E+03	7.472E+03	2.235E+03	2.235E+03	2.289E+03	8.688E-01	1.106E+00
3	1980	0.332	7.497E+03	7.409E+03	2.458E+03	2.458E+03	2.293E+03	9.638E-01	1.114E+00
4	1981	0.326	7.332E+03	7.293E+03	2.374E+03	2.374E+03	2.301E+03	9.456E-01	1.089E+00
5	1982	0.509	7.259E+03	6.672E+03	3.395E+03	3.395E+03	2.312E+03	1.478E+00	1.078E+00
6	1983	0.316	6.176E+03	6.335E+03	2.004E+03	2.004E+03	2.308E+03	9.192E-01	9.175E-01
7	1984	0.513	6.480E+03	6.045E+03	3.100E+03	3.100E+03	2.290E+03	1.490E+00	9.627E-01
8	1985	0.395	5.670E+03	5.680E+03	2.243E+03	2.243E+03	2.260E+03	1.147E+00	8.424E-01
9	1986	0.299	5.688E+03	5.951E+03	1.777E+03	1.777E+03	2.285E+03	8.673E-01	8.451E-01
10	1987	0.357	6.196E+03	6.236E+03	2.228E+03	2.228E+03	2.304E+03	1.038E+00	9.206E-01
11	1988	0.849	6.273E+03	5.076E+03	4.308E+03	4.308E+03	2.158E+03	2.465E+00	9.320E-01
12	1989	0.674	4.122E+03	3.766E+03	2.537E+03	2.537E+03	1.865E+03	1.957E+00	6.125E-01
13	1990	0.582	3.451E+03	3.339E+03	1.944E+03	1.944E+03	1.728E+03	1.692E+00	5.127E-01
14	1991	0.669	3.235E+03	3.021E+03	2.021E+03	2.021E+03	1.612E+03	1.944E+00	4.807E-01
15	1992	0.636	2.826E+03	2.705E+03	1.721E+03	1.721E+03	1.488E+03	1.848E+00	4.199E-01
16	1993	0.565	2.594E+03	2.582E+03	1.459E+03	1.459E+03	1.437E+03	1.642E+00	3.853E-01
17	1994	0.603	2.571E+03	2.515E+03	1.516E+03	1.516E+03	1.408E+03	1.752E+00	3.820E-01
18	1995	0.578	2.462E+03	2.444E+03	1.413E+03	1.413E+03	1.377E+03	1.680E+00	3.658E-01
19	1996	0.646	2.426E+03	2.333E+03	1.508E+03	1.508E+03	1.328E+03	1.877E+00	3.604E-01
20	1997	0.672	2.246E+03	2.143E+03	1.440E+03	1.440E+03	1.240E+03	1.952E+00	3.337E-01
21	1998	0.599	2.047E+03	2.032E+03	1.217E+03	1.217E+03	1.188E+03	1.739E+00	3.041E-01
22	1999	0.607	2.018E+03	1.997E+03	1.213E+03	1.213E+03	1.171E+03	1.764E+00	2.998E-01
23	2000	0.453	1.976E+03	2.109E+03	9.565E+02	9.565E+02	1.224E+03	1.317E+00	2.936E-01

24	2001	0.610	2.244E+03	2.205E+03	1.345E+03	1.345E+03	1.269E+03	1.772E+00	3.334E-01
25	2002	0.414	2.168E+03	2.348E+03	9.715E+02	9.715E+02	1.334E+03	1.202E+00	3.221E-01
26	2003	0.424	2.531E+03	2.701E+03	1.146E+03	1.146E+03	1.486E+03	1.232E+00	3.760E-01
27	2004	0.800	2.871E+03	2.544E+03	2.036E+03	2.036E+03	1.419E+03	2.325E+00	4.266E-01
28	2005	0.571	2.254E+03	2.257E+03	1.289E+03	1.289E+03	1.293E+03	1.659E+00	3.349E-01
29	2006	0.628	2.259E+03	2.200E+03	1.381E+03	1.381E+03	1.267E+03	1.823E+00	3.356E-01
30	2007	0.542	2.145E+03	2.183E+03	1.184E+03	1.184E+03	1.259E+03	1.576E+00	3.187E-01
31	2008	0.397	2.220E+03	2.421E+03	9.614E+02	9.614E+02	1.366E+03	1.154E+00	3.299E-01
32	2009	0.401	2.625E+03	2.826E+03	1.134E+03	1.134E+03	1.537E+03	1.166E+00	3.900E-01
33	2010	0.421	3.027E+03	3.194E+03	1.346E+03	1.346E+03	1.677E+03	1.224E+00	4.498E-01
34	2011		3.358E+03						4.989E-01

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RESULTS FOR DATA SERIES # 1 (NON-BOOTSTRAPPED) HB Index (WPUE), Yield (mt)

Data type CC: CPUE-catch series Series weight: 1.000

Obs	Year	Observed CPUE	Estimated CPUE	Estim F	Observed yield	Model yield	Resid in log scale	Statist weight
1	1978	*	1.691E+00	0.2297	1.636E+03	1.636E+03	0.00000	1.000E+00
2	1979	2.170E+00	1.773E+00	0.2991	2.235E+03	2.235E+03	-0.20178	1.000E+00
3	1980	1.848E+00	1.759E+00	0.3318	2.458E+03	2.458E+03	-0.04955	1.000E+00
4	1981	2.128E+00	1.731E+00	0.3255	2.374E+03	2.374E+03	-0.20640	1.000E+00
5	1982	2.186E+00	1.584E+00	0.5089	3.395E+03	3.395E+03	-0.32233	1.000E+00
6	1983	1.980E+00	1.504E+00	0.3164	2.004E+03	2.004E+03	-0.27523	1.000E+00
7	1984	1.839E+00	1.435E+00	0.5127	3.100E+03	3.100E+03	-0.24813	1.000E+00
8	1985	1.986E+00	1.348E+00	0.3948	2.243E+03	2.243E+03	-0.38741	1.000E+00
9	1986	1.627E+00	1.413E+00	0.2986	1.777E+03	1.777E+03	-0.14130	1.000E+00
10	1987	1.557E+00	1.480E+00	0.3572	2.228E+03	2.228E+03	-0.05053	1.000E+00
11	1988	1.501E+00	1.205E+00	0.8486	4.308E+03	4.308E+03	-0.21970	1.000E+00
12	1989	1.231E+00	8.939E-01	0.6737	2.537E+03	2.537E+03	-0.31999	1.000E+00
13	1990	1.224E+00	7.925E-01	0.5823	1.944E+03	1.944E+03	-0.43467	1.000E+00
14	1991	1.006E+00	7.170E-01	0.6691	2.021E+03	2.021E+03	-0.33865	1.000E+00
15	1992	6.850E-01	6.422E-01	0.6360	1.721E+03	1.721E+03	-0.06456	1.000E+00
16	1993	4.380E-01	6.128E-01	0.5652	1.459E+03	1.459E+03	0.33587	1.000E+00
17	1994	4.850E-01	5.969E-01	0.6030	1.516E+03	1.516E+03	0.20765	1.000E+00
18	1995	5.000E-01	5.800E-01	0.5783	1.413E+03	1.413E+03	0.14847	1.000E+00
19	1996	5.220E-01	5.538E-01	0.6462	1.508E+03	1.508E+03	0.05909	1.000E+00
20	1997	5.650E-01	5.087E-01	0.6718	1.440E+03	1.440E+03	-0.10503	1.000E+00
21	1998	5.040E-01	4.823E-01	0.5987	1.217E+03	1.217E+03	-0.04397	1.000E+00
22	1999	5.610E-01	4.739E-01	0.6073	1.213E+03	1.213E+03	-0.16873	1.000E+00
23	2000	4.130E-01	5.007E-01	0.4534	9.565E+02	9.565E+02	0.19257	1.000E+00
24	2001	4.330E-01	5.234E-01	0.6100	1.345E+03	1.345E+03	0.18959	1.000E+00
25	2002	4.150E-01	5.574E-01	0.4137	9.715E+02	9.715E+02	0.29504	1.000E+00
26	2003	4.750E-01	6.412E-01	0.4241	1.146E+03	1.146E+03	0.30001	1.000E+00
27	2004	6.560E-01	6.038E-01	0.8002	2.036E+03	2.036E+03	-0.08296	1.000E+00
28	2005	5.790E-01	5.356E-01	0.5711	1.289E+03	1.289E+03	-0.07782	1.000E+00
29	2006	6.180E-01	5.223E-01	0.6276	1.381E+03	1.381E+03	-0.16825	1.000E+00
30	2007	3.760E-01	5.182E-01	0.5424	1.184E+03	1.184E+03	0.32071	1.000E+00
31	2008	3.000E-01	5.747E-01	0.3971	9.614E+02	9.614E+02	0.65003	1.000E+00
32	2009	4.620E-01	6.708E-01	0.4014	1.134E+03	1.134E+03	0.37294	1.000E+00
33	2010	7.280E-01	7.582E-01	0.4214	1.346E+03	1.346E+03	0.04059	1.000E+00

* Asterisk indicates missing value(s).

BSB SEDAR25 (landings and discards) June 2011 Page 5

RESULTS FOR DATA SERIES # 2 (NON-BOOTSTRAPPED) MARMAP Chevron Trap

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Data type I1: Abundance index (annual average) Series weight: 1.000

Obs	Year	Observed effort	Estimated effort	Estim F	Observed index	Model index	Resid in log index	Statist weight
1	1978	0.000E+00	0.000E+00	--	*	1.129E+00	0.00000	1.000E+00
2	1979	0.000E+00	0.000E+00	--	*	1.185E+00	0.00000	1.000E+00
3	1980	0.000E+00	0.000E+00	--	*	1.175E+00	0.00000	1.000E+00
4	1981	0.000E+00	0.000E+00	--	*	1.156E+00	0.00000	1.000E+00
5	1982	0.000E+00	0.000E+00	--	*	1.058E+00	0.00000	1.000E+00

6	1983	0.000E+00	0.000E+00	--	*	1.004E+00	0.00000	1.000E+00
7	1984	0.000E+00	0.000E+00	--	*	9.584E-01	0.00000	1.000E+00
8	1985	0.000E+00	0.000E+00	--	*	9.004E-01	0.00000	1.000E+00
9	1986	0.000E+00	0.000E+00	--	*	9.435E-01	0.00000	1.000E+00
10	1987	0.000E+00	0.000E+00	--	*	9.887E-01	0.00000	1.000E+00
11	1988	0.000E+00	0.000E+00	--	*	8.048E-01	0.00000	1.000E+00
12	1989	0.000E+00	0.000E+00	--	*	5.971E-01	0.00000	1.000E+00
13	1990	1.000E+00	1.000E+00	--	6.070E-01	5.293E-01	0.13691	1.000E+00
14	1991	1.000E+00	1.000E+00	--	3.860E-01	4.789E-01	-0.21567	1.000E+00
15	1992	1.000E+00	1.000E+00	--	4.980E-01	4.289E-01	0.14933	1.000E+00
16	1993	1.000E+00	1.000E+00	--	2.650E-01	4.093E-01	-0.43477	1.000E+00
17	1994	1.000E+00	1.000E+00	--	2.650E-01	3.987E-01	-0.40849	1.000E+00
18	1995	1.000E+00	1.000E+00	--	1.180E-01	3.874E-01	-1.18881	1.000E+00
19	1996	1.000E+00	1.000E+00	--	2.910E-01	3.699E-01	-0.23985	1.000E+00
20	1997	1.000E+00	1.000E+00	--	4.080E-01	3.398E-01	0.18305	1.000E+00
21	1998	1.000E+00	1.000E+00	--	3.840E-01	3.222E-01	0.17562	1.000E+00
22	1999	1.000E+00	1.000E+00	--	2.780E-01	3.165E-01	-0.12979	1.000E+00
23	2000	1.000E+00	1.000E+00	--	4.250E-01	3.344E-01	0.23966	1.000E+00
24	2001	1.000E+00	1.000E+00	--	5.240E-01	3.496E-01	0.40475	1.000E+00
25	2002	1.000E+00	1.000E+00	--	2.670E-01	3.723E-01	-0.33248	1.000E+00
26	2003	1.000E+00	1.000E+00	--	4.240E-01	4.283E-01	-0.01000	1.000E+00
27	2004	1.000E+00	1.000E+00	--	8.450E-01	4.033E-01	0.73972	1.000E+00
28	2005	1.000E+00	1.000E+00	--	4.570E-01	3.578E-01	0.24479	1.000E+00
29	2006	1.000E+00	1.000E+00	--	5.040E-01	3.489E-01	0.36793	1.000E+00
30	2007	1.000E+00	1.000E+00	--	3.700E-01	3.461E-01	0.06679	1.000E+00
31	2008	1.000E+00	1.000E+00	--	3.830E-01	3.838E-01	-0.00219	1.000E+00
32	2009	1.000E+00	1.000E+00	--	4.050E-01	4.481E-01	-0.10104	1.000E+00
33	2010	1.000E+00	1.000E+00	--	6.950E-01	5.064E-01	0.31660	1.000E+00

* Asterisk indicates missing value(s).

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RESULTS FOR DATA SERIES # 3 (NON-BOOTSTRAPPED) MARMAP Blackfish/Fl Snapper Trap

Data type I1: Abundance index (annual average) Series weight: 1.000

Obs	Year	Observed effort	Estimated effort	Estim F	Observed index	Model index	Resid in log index	Statist weight
1	1978	0.000E+00	0.000E+00	--	*	5.346E-01	0.00000	1.000E+00
2	1979	0.000E+00	0.000E+00	--	*	5.609E-01	0.00000	1.000E+00
3	1980	0.000E+00	0.000E+00	--	*	5.562E-01	0.00000	1.000E+00
4	1981	1.000E+00	1.000E+00	--	5.530E-01	5.475E-01	0.01002	1.000E+00
5	1982	1.000E+00	1.000E+00	--	5.290E-01	5.008E-01	0.05469	1.000E+00
6	1983	1.000E+00	1.000E+00	--	5.120E-01	4.755E-01	0.07390	1.000E+00
7	1984	1.000E+00	1.000E+00	--	4.430E-01	4.538E-01	-0.02408	1.000E+00
8	1985	1.000E+00	1.000E+00	--	5.790E-01	4.264E-01	0.30603	1.000E+00
9	1986	1.000E+00	1.000E+00	--	3.740E-01	4.467E-01	-0.17774	1.000E+00
10	1987	1.000E+00	1.000E+00	--	3.650E-01	4.681E-01	-0.24889	1.000E+00
11	1988	0.000E+00	0.000E+00	--	*	3.811E-01	0.00000	1.000E+00
12	1989	0.000E+00	0.000E+00	--	*	2.827E-01	0.00000	1.000E+00
13	1990	0.000E+00	0.000E+00	--	*	2.506E-01	0.00000	1.000E+00
14	1991	0.000E+00	0.000E+00	--	*	2.268E-01	0.00000	1.000E+00
15	1992	0.000E+00	0.000E+00	--	*	2.031E-01	0.00000	1.000E+00
16	1993	0.000E+00	0.000E+00	--	*	1.938E-01	0.00000	1.000E+00
17	1994	0.000E+00	0.000E+00	--	*	1.888E-01	0.00000	1.000E+00
18	1995	0.000E+00	0.000E+00	--	*	1.834E-01	0.00000	1.000E+00
19	1996	0.000E+00	0.000E+00	--	*	1.751E-01	0.00000	1.000E+00
20	1997	0.000E+00	0.000E+00	--	*	1.609E-01	0.00000	1.000E+00
21	1998	0.000E+00	0.000E+00	--	*	1.525E-01	0.00000	1.000E+00
22	1999	0.000E+00	0.000E+00	--	*	1.499E-01	0.00000	1.000E+00
23	2000	0.000E+00	0.000E+00	--	*	1.584E-01	0.00000	1.000E+00
24	2001	0.000E+00	0.000E+00	--	*	1.655E-01	0.00000	1.000E+00
25	2002	0.000E+00	0.000E+00	--	*	1.763E-01	0.00000	1.000E+00
26	2003	0.000E+00	0.000E+00	--	*	2.028E-01	0.00000	1.000E+00
27	2004	0.000E+00	0.000E+00	--	*	1.909E-01	0.00000	1.000E+00
28	2005	0.000E+00	0.000E+00	--	*	1.694E-01	0.00000	1.000E+00
29	2006	0.000E+00	0.000E+00	--	*	1.652E-01	0.00000	1.000E+00
30	2007	0.000E+00	0.000E+00	--	*	1.639E-01	0.00000	1.000E+00
31	2008	0.000E+00	0.000E+00	--	*	1.817E-01	0.00000	1.000E+00

32	2009	0.000E+00	0.000E+00	--	*	2.122E-01	0.00000	1.000E+00
33	2010	0.000E+00	0.000E+00	--	*	2.398E-01	0.00000	1.000E+00

* Asterisk indicates missing value(s).

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RESULTS FOR DATA SERIES # 4 (NON-BOOTSTRAPPED) Comm logbook vertical line

Data type I1: Abundance index (annual average) Series weight: 1.000

Obs	Year	Observed effort	Estimated effort	Estim F	Observed index	Model index	Resid in log index	Statist weight
1	1978	0.000E+00	0.000E+00	--	*	2.870E+00	0.00000	1.000E+00
2	1979	0.000E+00	0.000E+00	--	*	3.010E+00	0.00000	1.000E+00
3	1980	0.000E+00	0.000E+00	--	*	2.985E+00	0.00000	1.000E+00
4	1981	0.000E+00	0.000E+00	--	*	2.939E+00	0.00000	1.000E+00
5	1982	0.000E+00	0.000E+00	--	*	2.688E+00	0.00000	1.000E+00
6	1983	0.000E+00	0.000E+00	--	*	2.552E+00	0.00000	1.000E+00
7	1984	0.000E+00	0.000E+00	--	*	2.436E+00	0.00000	1.000E+00
8	1985	0.000E+00	0.000E+00	--	*	2.288E+00	0.00000	1.000E+00
9	1986	0.000E+00	0.000E+00	--	*	2.398E+00	0.00000	1.000E+00
10	1987	0.000E+00	0.000E+00	--	*	2.513E+00	0.00000	1.000E+00
11	1988	0.000E+00	0.000E+00	--	*	2.045E+00	0.00000	1.000E+00
12	1989	0.000E+00	0.000E+00	--	*	1.517E+00	0.00000	1.000E+00
13	1990	0.000E+00	0.000E+00	--	*	1.345E+00	0.00000	1.000E+00
14	1991	0.000E+00	0.000E+00	--	*	1.217E+00	0.00000	1.000E+00
15	1992	0.000E+00	0.000E+00	--	*	1.090E+00	0.00000	1.000E+00
16	1993	1.000E+00	1.000E+00	--	1.046E+00	1.040E+00	0.00550	1.000E+00
17	1994	1.000E+00	1.000E+00	--	9.710E-01	1.013E+00	-0.04262	1.000E+00
18	1995	1.000E+00	1.000E+00	--	6.140E-01	9.846E-01	-0.47222	1.000E+00
19	1996	1.000E+00	1.000E+00	--	6.300E-01	9.400E-01	-0.40018	1.000E+00
20	1997	1.000E+00	1.000E+00	--	7.980E-01	8.635E-01	-0.07883	1.000E+00
21	1998	1.000E+00	1.000E+00	--	1.098E+00	8.187E-01	0.29349	1.000E+00
22	1999	1.000E+00	1.000E+00	--	1.149E+00	8.044E-01	0.35651	1.000E+00
23	2000	1.000E+00	1.000E+00	--	7.880E-01	8.499E-01	-0.07566	1.000E+00
24	2001	1.000E+00	1.000E+00	--	8.420E-01	8.884E-01	-0.05369	1.000E+00
25	2002	1.000E+00	1.000E+00	--	7.840E-01	9.462E-01	-0.18805	1.000E+00
26	2003	1.000E+00	1.000E+00	--	9.980E-01	1.088E+00	-0.08671	1.000E+00
27	2004	1.000E+00	1.000E+00	--	1.413E+00	1.025E+00	0.32112	1.000E+00
28	2005	1.000E+00	1.000E+00	--	1.010E+00	9.093E-01	0.10508	1.000E+00
29	2006	1.000E+00	1.000E+00	--	8.990E-01	8.866E-01	0.01390	1.000E+00
30	2007	1.000E+00	1.000E+00	--	5.500E-01	8.796E-01	-0.46952	1.000E+00
31	2008	1.000E+00	1.000E+00	--	7.270E-01	9.755E-01	-0.29403	1.000E+00
32	2009	1.000E+00	1.000E+00	--	1.158E+00	1.139E+00	0.01680	1.000E+00
33	2010	1.000E+00	1.000E+00	--	2.524E+00	1.287E+00	0.67356	1.000E+00

* Asterisk indicates missing value(s).

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ESTIMATES FROM BOOTSTRAPPED ANALYSIS

Param name	Point estimate	Estimated bias in pt estimate	Estimated relative bias	Bias-corrected approximate confidence limits 80% lower	80% upper	50% lower	50% upper	Inter-quartile range	Relative IQ range
B1/K	5.030E-01	8.204E-03	1.63%	3.926E-01	8.633E-01	4.937E-01	5.666E-01	7.289E-02	0.145
K	1.346E+04	6.377E+03	47.37%	8.759E+03	2.901E+04	1.184E+04	1.522E+04	3.379E+03	0.251
q(1)	2.374E-04	-4.983E-05	-21.00%	2.610E-05	2.953E-04	1.926E-04	2.670E-04	7.438E-05	0.313
q(2)	1.585E-04	2.539E-05	16.02%	1.729E-05	9.644E-04	1.435E-04	1.896E-04	4.609E-05	0.291
q(3)	7.507E-05	6.361E-05	84.73%	4.517E-05	1.525E-04	7.006E-05	9.895E-05	2.889E-05	0.385
q(4)	4.029E-04	-3.727E-05	-9.25%	2.372E-04	1.734E-03	3.775E-04	4.859E-04	1.084E-04	0.269
MSY	2.317E+03	9.359E+03	403.93%	1.920E+03	2.341E+03	2.043E+03	2.317E+03	2.739E+02	0.118
Ye(2011)	1.735E+03	-1.407E+02	-8.11%	1.482E+03	2.310E+03	1.692E+03	2.074E+03	3.821E+02	0.220
Y.@Fmsy	1.156E+03	1.953E+04	1689.82%	7.631E+02	5.183E+04	9.465E+02	1.332E+03	3.858E+02	0.334
Bmsy	6.731E+03	3.189E+03	47.37%	4.379E+03	1.450E+04	5.920E+03	7.609E+03	1.689E+03	0.251
Fmsy	3.442E-01	4.960E-01	144.09%	1.970E-01	3.932E-01	2.317E-01	3.493E-01	1.176E-01	0.342

fmsy(1)	1.450E+03	2.420E+04	1668.44%	1.262E+03	7.874E+04	1.343E+03	1.618E+03	2.757E+02	0.190
fmsy(2)	2.171E+03	5.067E+04	2333.46%	3.949E+02	2.409E+03	1.853E+03	2.213E+03	3.596E+02	0.166
fmsy(3)	4.586E+03	4.091E+04	892.11%	3.238E+03	5.661E+03	3.761E+03	4.795E+03	1.035E+03	0.226
fmsy(4)	8.543E+02	2.074E+04	2428.08%	2.621E+02	9.781E+02	7.337E+02	8.764E+02	1.426E+02	0.167
B./Bmsy	4.989E-01	4.420E-01	88.60%	1.855E-01	1.753E+00	3.860E-01	5.454E-01	1.594E-01	0.320
F./Fmsy	1.224E+00	-3.103E-01	-25.34%	2.633E-02	1.761E+00	1.092E+00	1.464E+00	3.720E-01	0.304
Ye./MSY	7.489E-01	-2.151E-01	-28.72%	4.376E-01	9.245E-01	7.051E-01	8.695E-01	1.644E-01	0.219
q2/q1	6.679E-01	1.323E-01	19.81%	6.008E-01	9.566E+00	6.586E-01	2.302E+00	1.644E+00	2.461
q3/q1	3.163E-01	3.929E-01	124.22%	2.449E-01	5.589E-01	2.715E-01	3.629E-01	9.134E-02	0.289
q4/q1	1.697E+00	9.573E-02	5.64%	1.527E+00	1.383E+01	1.690E+00	5.508E+00	3.819E+00	2.250

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INFORMATION FOR REPAST (Prager, Porch, Shertzer, & Caddy. 2003. NAJFM 23: 349-361)
------------------------------------------------------------------------------------------------------------------------
Unitless limit reference point in F (Fmsy/F.):            0.8168
CV of above (from bootstrap distribution):                 29.91


NOTES ON BOOTSTRAPPED ESTIMATES:
------------------------------------------------------------------------------------------------------------------------
- Bootstrap results were computed from 501 trials.
- Results are conditional on bounds set on MSY and K in the input file.
- All bootstrapped intervals are approximate. The statistical literature recommends using at least 1000 trials
  for accurate 95% intervals. The default 80% intervals used by ASPIC should require fewer trials for equivalent
  accuracy. Using at least 500 trials is recommended.
- Bias estimates are typically of high variance and therefore may be misleading.

Trials replaced for lack of convergence:      0          Trials replaced for MSY out of bounds:              0
Trials replaced for q out-of-bounds:        267
Trials replaced for K out-of-bounds:          0          Residual-adjustment factor:                    1.0481

Elapsed time: 1 hours, 29 minutes, 8 seconds.
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SEDAR

Southeast Data, Assessment, and Review

SEDAR 25

South Atlantic Black Sea Bass

SECTION IV: Research Recommendations

October 2011

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

Section IV: Research Recommendations

Contents

Data Workshop Research Recommendations

Life History

- Investigate the movements and migrations of black sea bass using otolith microchemistry, genetic studies, and expanding tagging studies.
- Investigate the movement and mixing of larval and juvenile black sea bass within the U.S. South Atlantic region.
- Sampling to include the entire Southeast region over a longer time period.
- Analyze size- or age-specific spawning frequency and spawning seasonality.
- Further develop the tagging model described by Rudershausen et al. (2010) to address the assumptions of the model.
- Depth appears to have an effect on the discard mortality rate. Currently depth-specific discard rates and estimates of discard numbers are not available. There is very little depth specific information on the private recreational fleet.
- Temperature and seasonality of discard mortality should be investigated.
- Circle hooks are now required by the SAFMC for fishermen operating in the snapper grouper fishery. The impact of this regulation cannot currently be incorporated into the discard mortality rate.
- Venting is not required in the South Atlantic but it is required in the Gulf of Mexico for snapper grouper fishermen. Research should be conducted on a variety of recompression techniques to determine the most effective method for reducing discard mortality.

Commercial Statistics

- The Commercial Workgroup recommends study of migration patterns, focusing on fish movements around the Cape Hatteras, NC area.
- Additionally, the group would suggest determining the impact/landings of the historical foreign fleet in the South Atlantic.
- Finally, collection of better spatial information in the fishery to determine potential localized depletion effects is recommended.

Recreational Statistics

- Increase sample size of at-sea observers and dockside validation for HB mode.
- Increase proportion of fish with biological data within MRFSS sampling.
- Development of hard part sampling coordinated with intercept surveys.
- Continue development of standardized method for calculating incomplete weight data
- Quantify historical fishing photos for use in future SEDARS.

- Develop method for capturing depth at capture within MRFSS At-Sea observer program and Headboat Survey.
- Conduct study looking at current compliance rates in logbook programs, develop recommendations for improving them, including increased education directed toward effect of not reporting accurately.
- Continued development of electronic reporting of headboat logbook for full implementation
- Continued development of higher degree of information of condition of released fish e.g. FL as the model
- Continued evaluation of methodology for mandatory reporting in the For-hire sector e.g. Gulf MRIP Pilot

Indices

- None submitted.

Assessment Workshop Research Recommendations

- The assessment panel recommended increasing the number of age samples collected from the general recreational sector.

- Black sea bass in the southeast U.S. were modeled in this assessment as a unit stock, as recommended by the DW and supported by genetic analysis (SEDAR-25-RD42). For any stock, variation in exploitation and life-history characteristics might be expected at finer geographic scales. Modeling such sub-stock structure would require more data, such as information on the movements and migrations of adults and juveniles, as well as spatial patterns of recruitment. Even when fine-scale spatial structure exists, incorporating it into a model may or may not lead to better assessment results (e.g., greater precision, less bias). Spatial structure in a black sea bass assessment model might range from the very broad (e.g., a single Atlantic stock) to the very narrow (e.g., a connected network of meta-populations living on individual reefs). What is the optimal level of spatial structure to model in an assessment of snappergrouper species such as black sea bass?

- The assessment time period (1978–2010) is short relative to some other assessments of South Atlantic reef fishes. Extending the assessment back in time might provide improved understanding of the stock's potential productivity and therefore sustainable yield, assuming the historic productivity is still relevant. Such an extension would require historic landings estimates from all fleets in operation. Although historic estimates from the commercial sector are available, those from the recreational sector are not. Hindcasting the historic recreational landings might require the development of new methods, or at least analysis of existing methods.

- Protogynous life history: 1) Investigate possible effects of hermaphroditism on the steepness parameter; 2) Investigate the sexual transition for temporal patterns, considering possible mechanistic explanations if any patterns are identified; 3) Investigate methods for incorporating the dynamics of sexual transition in assessment models.

- In this assessment, the number of spawning events per mature female per year assumed a constant value of $X = 31$. That number was computed from the estimated spawning frequency and spawning season duration. If either of those characteristics depends on age or size, X would likely also depend on age or size. For black sea bass, does spawning frequency or spawning season duration (and therefore X) depend on age or size? Such dependence would have implications for estimating spawning potential as it relates to age structure in the stock assessment.

- For this assessment, the age-dependent natural mortality rate was estimated by indirect methods. More direct methods, e.g. tag-recapture, might prove useful. Some tag-recapture studies have demonstrated relatively high tag return rates for black sea bass, at least compared to those of other reef fishes of the southeast U.S.

Review Workshop Research Recommendations

The RP was in agreement with the research recommendations from the Data Workshop and Assessment Workshop reports. These identify the main shortcomings in the data and assessment which might be improved by research. It is worth noting that alongside any improvements in methodology and information, allowance should be made for backwards compatibility with existing long time-series. The recommendations are extensive and some priority may be placed so that research having the greatest impact on the assessment might be given the greatest priority.

High Priority

Life history: There are a number of uncertainties over the life history of this species which are critical in setting up reliable age-structured stock assessment models. Any studies that improve understanding of size or age specific spawning frequency, spawning seasonality, and functions modeling sex-change should be given high priority, particularly because they are critical in defining SSB and therefore stock status. This is particularly important in black sea bass because it depends on a calculation of female fecundity where mortality is apparently focused on the males (protogyny with age specific selectivity and low undersize discard mortality).

Ageing: Age data is an important part of the assessment. Where possible, age sampling should be improved in terms of coverage by maximizing the number of trips sampled from both the recreational and commercial landings and discards.

Discards: Discards make up a significant proportion of the catch, but mortality of discards is estimated as low. This mortality estimate is important in the stock assessment, and research to improve its accuracy could have significant impact on the assessment. Studies could improve estimates by relating mortality to temperature and depth and improving the routine collection of temperature and depth data. Also, any improvement on estimates of discards and research that would reduce discard mortality (e.g. hook type, venting) should have high priority.

Recreational Statistics: The RP believed that research recommendations with the objective of improving recreational statistics could have significant impact on the black sea bass stock assessment. Any program to improve recreational fishery data would cover a wide number of other stocks making it efficient. High priority research and data collection should include improvements in the headboat survey, in methods to estimate weight from length, compliance with logbook programs and development of electronic logbooks where appropriate. Also, the improvements would be enhanced with the research on discards, discard mortality and ageing outlined above.

Historical catches: The AW recommended extending the catch history further back than 1978. The RP considers that this is a high priority as it can significantly change the perception of the productivity of the stock. However, it should be noted that any such extension is almost always associated with great uncertainty both in the estimation of historical catch and in the implicit comparison with a historical baseline that might have changed due to climate and other factors.

Medium Priority

Stock structure: A number of research recommendations by the DW and AW indicated possible ways to improve definitions of stock structure (e.g. genetic analyses). The RP found no very significant problem with this issue in this assessment. However, stock structure, including smaller scale spatial structure, movement and resident times could be valuable. The AW also suggested carrying out simulations to look at how spatial data and models might be included in a stock assessment, and the RP agrees that this might be a good start point before more expensive research is undertaken.

Indices: Abundance indices are usually the main information drivers in the stock assessments in these fisheries. The RP recommended improving the fishery independent index if possible, ensuring geographical coverage of the stock is complete. Also, local absolute stock size estimates might be obtained from underwater video surveys, tagging, depletion fishing experiments within a small area, or some combination of these three. Estimating absolute biomass should be done in a way which is informative on catchability and selectivity in the model (could be included as a prior, for example).

Recreational Statistics: Some research on the recreational fishery, while useful, was in the opinion of the RP, less urgent. This included analysis of historical photos to obtain lengths, research to obtain and interpret condition information on discarded fish and the evaluation of some data collection programs.

Life history: The AW recommended looking at estimating age-dependent natural mortality directly. While the RP recognized that natural mortality is an important parameter, estimating this quantity is likely to be very difficult and may not be practical. Similarly, ontogenetic migration and other movement patterns, a possible cause of dome-shaped selectivity and local depletion, could be investigated. If a tagging program was being implemented for other purposes, these issues could and should be included.

Recruitment Patterns: The RP noted that the apparent variance in the recruitment residuals had decreased over time. The recruitments are estimates of the model, so it was not necessarily clear that this was a real change in the stock dynamics, random chance or an artifact of the model. Nevertheless, the RP believed that some simple research to support or discount recruitment change could be undertaken by reviewing recruitment in other stocks or correlating this change with environmental variables where some causal link could be hypothesized.

Low Priority

The Commercial Statistics working group suggested examining the impact of the historical foreign fleet. However, the RP believed that the impact of any activities on black sea bass would be low, obtaining any data would be difficult and could be unsuccessful.

Ultimately the interval between the current and next assessment is a policy decision, requiring scientific input. The RP wants to highlight scientific factors that should be taken into consideration when making this decision. The current black sea bass assessment indicates the stock is not overfished, but not yet rebuilt; and is undergoing overfishing. This indicates the stock is likely in need of regular assessments to track its status, ensure overfishing ends, and the stock is on a trajectory to rebuild. No new data sources are expected to be available, at least in the short term, limiting the utility of conducting a new benchmark assessment in the short term.

If management actions change, conducting a new assessment after their implementation has the potential to identify the impacts of the new management actions on the stock, as well as better identify the stock's dynamics. A new assessment could provide improved information on benchmarks such as MSY or status indicators such as B/B_{MSY}.

The RP recommends that assessment updates be conducted regularly, at the interval of a high risk stock, and more often in response to changes in management regulations. If an update assessment indicates the stock's status is declining or new data become available, the RP recommends moving forward with a full benchmark assessment.

SEDAR

Southeast Data, Assessment, and Review

SEDAR 25

South Atlantic Black Sea Bass

SECTION V: Review Workshop Report

October 2011

SEDAR
4055 Faber Place Drive, Suite 201
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Section V: Review Workshop Report

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1 Introduction

1.1 Workshop Time and Place

The SEDAR 25 Review Workshop was held October 11-13, 2011, in North Charleston, SC.

1.2 Terms of Reference

1. Evaluate the adequacy, appropriateness, and application of data used in the assessment.

2. Evaluate the adequacy, appropriateness, and application of methods used to assess the stock.

3. Recommend appropriate estimates of stock abundance, biomass, and exploitation.

4. Evaluate the methods used to estimate population benchmarks and management parameters (*e.g., MSY, Fmsy, Bmsy, MSST, MFMT, or their proxies*); recommend appropriate management benchmarks, provide estimated values for management benchmarks, and provide declarations of stock status.

5. Evaluate the adequacy, appropriateness, and application of the methods used to project future population status; recommend appropriate estimates of future stock condition (e.g., exploitation, abundance, biomass).

6. Evaluate the adequacy, appropriateness, and application of methods used to characterize uncertainty in estimated parameters. Provide measures of uncertainty for estimated parameters. 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. Ensure that stock assessment results are clearly and accurately presented in the Stock Assessment Report and that reported results are consistent with Review Panel recommendations.[*]

8. Evaluate the SEDAR Process as applied to the reviewed assessment and identify any Terms of Reference which were inadequately addressed by the Data or Assessment Workshops.

9. 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 future assessments. Recommend an appropriate interval for the next assessment, and whether a benchmark or update assessment is warranted.

10. 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 no later than TBD.

* 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

Appointee	Function	Affiliation
REVIEW PANEL		
Anne Lange	Review Panel Chair	SAFMC SSC
Michael Bell	Reviewer	CIE
Jim Berkson	Reviewer	SAFMC SSC
Steve Cadrin	Reviewer	SAFMC SSC
Paul Medley	Reviewer	CIE
Michael Smith	Reviewer	CIE
ASSESSMENT WORKSHOP REPRESENTATIVES		
Kyle Shertzer	Lead analyst, BSB	SEFSC Beaufort
Erik Williams	Lead analyst, GT	SEFSC Beaufort
Rob Cheshire	Data compiler, GT	SEFSC Beaufort
Eric Fitzpatrick	Data compiler, BSB	SEFSC Beaufort
Kate Andrews	Assessment team, GT	SEFSC Beaufort
Kevin Craig	Assessment team, BSB	SEFSC Beaufort
COUNCIL REPRESENTATIVES		
Tom Burgess	Council member	SAFMC
Ben Hartig	Council member	SAFMC
STAFF & AGENCY		
Kari Fenske	Coordinator	SEDAR
Rachael Silvas	Administrative assistant	SEDAR
Tyree Davis	IT support	SEFSC Miami
Myra Brouwer		SAFMC
John Carmichael		SAFMC
Brian Cheuvront		SAFMC
Mike Errigo		SAFMC
Julie Neer		SEDAR
Bonnie Ponwith		SEFSC Miami
Jessica Stephen		SERO
Gregg Waugh		SAFMC
OBSERVERS		
Joey Ballenger		
Peter Barile		
Rusty Hudson		
Marcel Reichert		
Helen Takade-Heumacher		
Renzo Tascheri		
Tracey Smart		

1.4 List of Review Workshop Working Papers & Documents

Documents Prepared for the Review Workshop		
SEDAR25-RW01	Comments and notes received during the data, assessment and review for SEDAR 25	Multiple authors
SEDAR25-RW02	Comments and notes received during the assessment and review for SEDAR 25	Multiple authors
SEDAR25-RW03	The Beaufort Assessment Model (BAM) with application to black sea bass: model description, implementation details, and computer code	Sustainable Fisheries Branch, NMFS 2011
SEDAR25-RW04	The Beaufort Assessment Model (BAM) with application to tilefish: model description, implementation details, and computer code	Sustainable Fisheries Branch, NMFS 2011
SEDAR25-RW05	Development and diagnostics of the Beaufort assessment model applied to black sea bass	Sustainable Fisheries Branch, NMFS 2011
SEDAR25-RW06	Development and diagnostics of the Beaufort assessment model applied to tilefish	Sustainable Fisheries Branch, NMFS 2011
SEDAR25-RW07	Use of MARMAP age compositions in SEDAR 25 – Methods of addressing sub-sampling concerns from SEDAR 2 and SEDAR 17	Ballenger, Reichert, and Stephen, 2011
SEDAR25-RW08	Fisheries management actions confound the ability of the Beaufort Assessment Model (BAM) to explain dynamics of the Golden Tilefish fishery off of east Florida	Hull and Barile, 2011
SEDAR25-RW09	A note on the use of flat-topped selectivity curves in SEDAR 25	Hull and Hester, 2011
SEDAR25-RW10	On steepness	Hull and Hester, 2011
SEDAR25-RW11	Some considerations of area interactions	Hull and Hester, 2011

2. Review Panel Report

The South Atlantic black sea bass stock assessment presented by the SEDAR 25 Assessment Workshop (AW) provided the Review Panel (RP) with outputs and results from two statistical 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 current stock status in the base run was estimated to be $SSB_{2010}/MSST=1.13$ and $SSB_{2010}/SSB_{MSY} = 0.70$. The current level of fishing is $F_{2009\text{-}2010}/F_{MSY} = 1.07$. Therefore, the RP concludes that the stock is not overfished but it is also not fully rebuilt. In addition, the RP concludes that the stock is currently subject to overfishing. The qualitative results on terminal stock status were the same across all sensitivity runs, indicating that the stock is not yet rebuilt. Most of these runs, but not all, suggested that overfishing is still occurring. The outcomes of sensitivity analyses were in general agreement with those of the (Monte Carlo Bootstrap, MCB) analysis. In general, results from ASPIC were qualitatively similar to those from BAM. The major sources of uncertainty in the stock assessment are related to monitoring the recreational fishery.

The terms of reference from the Data Workshop (DW) and AW were met.

2.1. Statements addressing each Term of Reference

2.1.1. Evaluate the adequacy, appropriateness, and application of data used in the assessment.

Stock definition for South Atlantic black sea bass remains unchanged since SEDAR 2, covering sea areas between Cape Hatteras in the north and Florida Keys in the south. Studies using mitochondrial DNA indicate that this is a genetically distinct stock, with some mixing with Mid-Atlantic stocks around Cape Hatteras. The RP supported the adoption of revised life-history parameters for the assessment. Age-dependent estimates of M were derived from modeling natural mortality as an inverse function of length, scaled according to longevity estimates, and with upper and lower bounds for sensitivity runs scaled according to a range of estimates from other methods. Growth parameters were based on size at age data from both fishery-independent and fishery-dependent samples, accounting for the effects of minimum sizes in the latter source. Black sea bass are protogynous hermaphrodites, and the transitions from female to male were modeled by estimating a logistic curve. It is likely that the transitions may vary according to environmental and demographic conditions, and this may warrant further attention in future assessments, but for the current assessment there was no rational basis for departing from an assumption of a fixed relationship with age. Immature females were rare in the age samples, and by age 2 virtually all females were mature. Information was lacking on the proportions of immature females at the youngest ages, but it was reasonable to assume zero maturity at age zero. Batch fecundity was used as the measure of spawning potential, based on a fecundity-weight relationship and an estimate of 31 egg batches annually per female. The RP noted that it will be important to refine this measure in future assessments, based on studies of spawning frequency at age and size.

General recreational landings were the most important component of total fishery removals of black sea bass, followed landings from by commercial pots. Commercial vertical line and trawl fleets were also distinguished, together with recreational headboats, making a total of five fleets used in the assessment. Incomplete landings data for some fleets were dealt with in the assessment model by using geometric mean fishing mortality values to bridge years of no data. Size limits for commercial and recreational fleets were introduced in 1984 (8-inch), changed in 1999 (10-inch) and in the 2007 fishing year (12-inch for commercial fleets). These changes were used to define time blocks for selectivity in the assessment model. Significant discarding occurs in both commercial and recreational fleets, and these were included as additional fleets in the assessment. Discarding data exist for commercial pots and vertical lines (combined) for 1993 onwards. For the years after the introduction of an 8-inch size limit discards were estimated in the assessment using geometric means of discard fishing mortality calculated over the years for which this size limit applied. Recreational discard data are available for 1981 onwards, and were modeled for earlier years using the geometric mean discard fishing mortality for 1981-93. Given the negligible contribution of the trawl fishery to total landings, trawl discards were assumed zero. Discard mortality was previously set at 15% in SEDAR 2, and this value was used in a continuity run of the assessment model and as an upper bound in uncertainty runs (MCB). Otherwise, lower gear-specific values were used, with a tagging study providing a lower bound for commercial vertical line discards in the uncertainty runs. The RP noted that discard mortality likely varies with depth, temperature and season; there is currently no basis for including such variation in the assessment model, but the RP concurs with research recommendations regarding this issue.

Data on length and age composition of landings and discards were incorporated in the age-based model. Data were selected for inclusion avoiding double counting of fish that were both aged and measured and gave primacy to age compositions.

The RP supports the adoption of five abundance indices in the assessment. Fishery-dependent series standardized by delta-lognormal GLM (landings) or GLM (discards) were constructed for the commercial vertical line fleet (CPUE), headboat landings (WPUE) and headboat discards (DPUE). Standardization of the headboat landings series provided unrealistically low CVs, likely due to the coarse level of reporting quantities, and these CVs were inflated for use in the age-based assessment model. Two fishery-independent surveys were also available, covering non-overlapping time periods: Florida blackfish/snapper trap data for 1981-87; MARMAP chevron traps, which are well sampled for black sea bass, provide values for 1990 onwards. Delta GLM standardized CPUE series from these surveys were used as abundance indices. Significant positive correlations among the indices supported their interpretation as tracking underlying stock trends.

Overall, the RP concluded that data on life-history, fishery removals and abundance indices were appropriate and adequate for the assessment and supported their application and the choice of indices.

2.1.2. Evaluate the adequacy, appropriateness, and application of methods used to assess the stock.

The BAM was used as the principal assessment method. It is an age-structured population assessment model implemented using ADMB. This made use of all available data, including total annual landings and discards, age and length compositions, and indices of biomass abundance.

The model was fitted to the data using appropriate methods. The model used a lognormal likelihood to fit to abundance indices and catches, and a multinomial likelihood to fit to compositions. The fitting criterion was a penalized likelihood approach, with additional penalty functions to avoid unrealistic results. These penalties generally only applied during some of the Monte Carlo simulations and avoided numerical errors.

Not all data were available or used. Where data were absent, such as landings or discards data missing from some fleets early in the time series, reasonable decisions were made in filling these gaps to allow the model to fit. Where adequate age and length composition data occurred in the same stratum, only the age data were used to avoid "double counting" the same sample.

The treatment of the data and the relative importance given to the various components was appropriate:

- The landings and discards were fitted very closely (effectively exactly), because they were measured with relatively high accuracy. The RP identified that discards were less precisely sampled, but that it is not possible to account for this in the current model.
- Annual CVs for the landings and discard components were fixed small values, and for the annual values abundance indices were derived from the delta-lognormal GLM used to standardise the indices.
- The effective multinomial observation variance was based on sample size of trips rather than individual fish measured, because fish within the same trip are not independent.
- The weights between the likelihood components were fitted using an iterative scheme, which actively maintained appropriate fits to the indices and did not allow the compositions to dominate the likelihood.

The model structure was adequate to capture the main patterns in the data.

- Selectivity was modelled as a logistic function of age. The RP discussed the possibility of dome-shape selectivity but no mechanism for dome-shaped selectivity was identified (e.g. gear, selectivity, spatial availability or ontogenetic movement of exploited sizes). Although there appeared to be some spatial structure in the population, the fishery covered the entire resource area.
- Black sea bass are protogynous hermaphrodites and a logistic sex-change function was used to model sex transition, estimated by the DW, such that the age at 50% transition to male was estimated to be 3.83 years.
- Model estimates of abundance indices were conditional on selectivity of the corresponding fleet or survey and were computed from abundance or biomass (as appropriate) at the midpoint of the year.
- For the base model, time invariant catchability was assumed within blocks, although some reasonable alternative scenarios were considered where catchability was allowed to change.
- Spawning stock was modeled as the population fecundity of mature females (i.e. total annual egg production) measured at the time of peak spawning, because reasonable estimates of fecundity were available.
- The stock-recruitment model used was appropriate, and the estimates of parameters used were within the reasonable range based on the available evidence. Uncertainty in steepness was explicitly considered in the MCB and sensitivity analyses.
- Uncertainty in model results was evaluated using sensitivity analyses and Monte Carlo parametric bootstraps.

Some improvements in the model might be possible in future. For example, lengths might be fitted within the model conditional upon age in those cases where both age and length are present. However, it is not expected that such improvements would have significant impact of the model results.

While there might be other important processes in the stock dynamics, such as spatial changes (e.g. local depletion), there are not sufficient data to support including these in the stock assessment at this time.

The RP concluded that the BAM was appropriate for the data and adequate for providing management advice.

An alternative biomass dynamics stock assessment was carried out using the software ASPIC. Biomass dynamics (production) models require fewer parameters and fit only to the total catch weight and abundance indices. Results also used a bootstrap to characterize uncertainty.

The biomass dynamics model was considered as a confirmatory analysis, because the BAM alternative made effective use of additional data and represented a more detailed investigation of population dynamics. However, the ASPIC model provided a useful comparison with the Beaufort Assessment Model results, which it broadly supports, showing the same relative status of the stock in relation to MSY benchmarks.

2.1.3. Recommend appropriate estimates of stock abundance, biomass, and exploitation.

The RP accepted estimates from the base run of the BAM as final estimates of black sea bass spawning stock biomass (SSB – couched in terms of annual fecundity) and fishing mortality (F). The estimate of SSB_{2010} is below SSB_{MSY} but above MSST, indicating that the South Atlantic sea bass stock is not overfished. However, there is currently a rebuilding program for the stock and the assessment indicates that it is not yet fully rebuilt. The $F_{2009\text{-}2010}$ estimate is higher than, but close to, F_{MSY}. Uncertainty runs (MCB) of the base assessment model indicate a high probability of SSB_{2010} being less than SSB_{MSY}, but greater uncertainty about overfishing – almost half of runs showed $F_{2009\text{-}2010}$ at or above F_{MSY}. Point estimates from sensitivity runs showed SSB_{2010} less than SSB_{MSY} in every case and $F_{2009\text{-}2010}$ above F_{MSY} in most cases. Outcomes of a biomass dynamic model (ASPIC) also confirmed the BAM base model conclusions about stock status in relation to the MSY-based reference points.

2.1.4. Evaluate the methods used to estimate population benchmarks and management parameters (*e.g., MSY, F_{MSY}, B_{MSY}, MSST, MFMT, or their proxies*); recommend appropriate management benchmarks, provide estimated values for management benchmarks, and provide declarations of stock status.

The RP supports the approach of estimating MSY reference points and derived management benchmarks using equilibrium expectations derived from the base model (BAM):

- MSY=1.767M lb whole weight
- F_{MSY}=0.698
- B_{MSY}=5399mt=11.9M lb whole weight
- SSB_{MSY}=2.48E12 eggs
- MSST=1.54E12 eggs

Several aspects of reference point estimation were discussed at the review workshop, including the rebuilding target and comparisons to MSY estimates from the biomass dynamics model. Given that the stock has not yet recovered, catch limits should be based on rebuilding to SSB_{MSY}, so an evaluation of consistency between the rebuilding target and stochastic projection method was requested. The equilibrium calculation of SSB_{MSY} was compared to the distribution of SSB after fishing at F_{MSY} over the long-term. Long-term stochastic projections confirm the equilibrium expectations. The equilibrium calculation of SSB_{MSY} is essentially the same as the long-term mean SSB. Therefore, the equilibrium calculation is consistent with the projection and is appropriate as a rebuilding target.

Relative stock status (F/F_{MSY} and B/B_{MSY}) is generally consistent between the age-based assessment (BAM) and a biomass dynamics model (ASPIC), and the Review Workshop agreed that the age-based analysis (BAM) provided more information on stock dynamics than the production model.

2.1.5. Evaluate the adequacy, appropriateness, and application of the methods used to project future population status; recommend appropriate estimates of future stock condition (e.g., exploitation, abundance, biomass).

The MCB methodology for carrying out projections for black sea bass involved generating a large number of replicate projections by sampling from the MCB assessment runs, in each case stochastically projecting forward the assessment terminal population and fishing mortality.

Initial populations were the point estimates for 2010 abundance at age and initial fishing mortality was the geometric mean of the last 2 years of the assessment period. Management for each projection scenario took place from 2012 to 2016 (the remaining scheduled duration of the rebuilding plan) and 3 scenarios for landings in the intermediate year (2011) were implemented, being 100%, 150% and 200% of current landings (847,000 lb). These alternative intermediate year scenarios take account of quota overage which has occurred and looks likely to continue in 2011.

Projections implemented the SR relationship with lognormal bias correction such that they were consistent in the long term with reference points derived from deterministic projections of the base run.

The RP requested additional log term projections at F_{MSY}, to confirm that the projections were consistent with the deterministic expectations. These were provided (Table 1, Figure 1). They confirmed that long term means of projected values were consistent with the deterministic expectations for recruitment, SSB and landings.

The RP noted that the SR fit had larger and more positive residuals early in the time series and smaller and more negative residuals later (Figure 2). Although the estimated recruitment series is something of ‘a one way trip’ (declining SSB through time) the pattern of residuals through time may imply reduced variability in recruitment in recent years with possibly also a tendency for recent recruitments to be lower than expectations.

The RP requested that some additional projection runs be carried out to explore the implications of reduced recruitment variability, but stressed that these should be considered only in an exploratory context. These were provided (Figures 3 and 4) and show the SSB and CI trajectories and the probability of reaching the current SSB_{MSY} target using the current F or yield based schedules. They indicate that with reduced recruitment variability the CIs of the projections are narrowed, but because they are lognormally distributed the effect on the upper CI is greater than on the lower CI. This results in a slightly reduced probability of achieving the current SSB_{MSY} target, but note that it is likely that this target would be somewhat lower under the revised recruitment scenario. These projections only account for reduced variability in recruitment, not for the possibility of reduced recruitment should this be a real effect.

The RP concluded that despite some temporal pattern in recruitment residuals, the existing projections provide a basis for estimating future stock conditions.

2.1.6. Evaluate the adequacy, appropriateness, and application of methods used to characterize uncertainty in estimated parameters. Provide measures of uncertainty for estimated parameters. 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.

The RP considered the MCB approach to be best practise in quantifying uncertainty. It is also recommended by the SEDAR Procedural guidance 2010. The RP concluded that the MCB provided a good characterisation of current stock status.

Sensitivity runs were qualitatively very similar to the base run, indicative of overfishing occurring and the stock being below the rebuilding target of SSB_{MSY}. There were a few exceptions where overfishing was not indicated (high M, high steepness and marginal when the headboat index was truncated in 1984). The base run was, with the above exceptions, optimistic when compared with the other sensitivity runs. Retrospective analyses showed results were not unduly influenced by the most recent data points, with a slight tendency to overestimate SSB and underestimate F.

Alternative model dynamics provided by comparison with ASPIC were also in qualitative agreement with BAM. Results therefore appeared consistent given available data on uncertainty, across a range of BAM model configurations and for different population dynamics assumptions.

The RP requested that the current assessment results be compared with a projection from the previous assessment (SEDAR 4). This was provided (Figure 5), but it was pointed out that it had been difficult to identify the projection corresponding to the current management plan and that many input parameters had been changes for the current assessment (including M, fecundity, discard estimates, age composition data, model component weight) and that this may have resulted in a rescaling of the assessment outputs. The historic projection also incorporated a lower level of variability. The RP discussed the output and noted that the historic projection indicated the stock rebuilding, whilst there was little evidence of any significant recent increase in SSB in the current assessment. Slow rebuilding could be due to higher catches than originally anticipated in the projections as well as lower than expected recruitment and other unforeseen factors.

2.1.7. Ensure that stock assessment results are clearly and accurately presented in the Stock Assessment Report and that reported results are consistent with RP recommendations.

The RP felt that the workshop reports were extremely well organized, clear and concise. The consistency of format among the two SEDAR 25 assessments and previous SEDAR assessments helped to make the review more efficient. Data and assessment methods and decisions were clearly documented, and the reports help to achieve a transparent process. In addition, the summary indicating whether each of the TOR were met or not, which appeared in the AW report was extremely helpful. The RP recommends the continuation of this section in future AW reports and the addition of this section to future DW reports.

2.1.8. Evaluate the SEDAR Process as applied to the reviewed assessment and identify any Terms of Reference which were inadequately addressed by the Data or Assessment Workshops.

The RP found the SEDAR process to be highly effective as structured for the black sea bass assessment. The DW addressed all of its terms of reference with the exception of providing maps of fishery effort and harvest for commercial catch statistics and recreational catch statistics, due to insufficient time. The AW addressed all of its terms of reference.

2.1.9. 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 future assessments. Recommend an appropriate interval for the next assessment, and whether a benchmark or update assessment is warranted.

The RP was in agreement with the research recommendations from the Data Workshop and Assessment Workshop reports. These identify the main shortcomings in the data and assessment which might be improved by research. It is worth noting that alongside any improvements in methodology and information, allowance should be made for backwards compatibility with existing long time-series. The recommendations are extensive and some priority may be placed so that research having the greatest impact on the assessment might be given the greatest priority.

High Priority

Life history: There are a number of uncertainties over the life history of this species which are critical in setting up reliable age-structured stock assessment models. Any studies that improve understanding of size or age specific spawning frequency, spawning seasonality, and functions modeling sex-change should be given high priority, particularly because they are critical in defining SSB and therefore stock status. This is particularly important in black sea bass because it depends on a calculation of female fecundity where mortality is apparently focused on the males (protogyny with age specific selectivity and low undersize discard mortality).

Ageing: Age data is an important part of the assessment. Where possible, age sampling should be improved in terms of coverage by maximizing the number of trips sampled from both the recreational and commercial landings and discards.

Discards: Discards make up a significant proportion of the catch, but mortality of discards is estimated as low. This mortality estimate is important in the stock assessment, and research to improve its accuracy could have significant impact on the assessment. Studies could improve estimates by relating mortality to temperature and depth and improving the routine collection of temperature and depth data. Also, any improvement on estimates of discards and research that would reduce discard mortality (e.g. hook type, venting) should have high priority.

Recreational Statistics: The RP believed that research recommendations with the objective of improving recreational statistics could have significant impact on the black sea bass stock assessment. Any program to improve recreational fishery data would cover a wide number of other stocks making it efficient. High priority research and data collection should include improvements in the headboat survey, in methods to estimate weight from length, compliance with logbook programs and development of electronic logbooks where appropriate. Also, the improvements would be enhanced with the research on discards, discard mortality and ageing outlined above.

Historical catches: The AW recommended extending the catch history further back than 1978. The RP considers that this is a high priority as it can significantly change the perception of the productivity of the stock. However, it should be noted that any such extension is almost always associated with great uncertainty both in the estimation of historical catch and in the implicit comparison with a historical baseline that might have changed due to climate and other factors.

Medium Priority

Stock structure: A number of research recommendations by the DW and AW indicated possible ways to improve definitions of stock structure (e.g. genetic analyses). The RP found no very significant problem with this issue in this assessment. However, stock structure, including smaller scale spatial structure, movement and resident times could be valuable. The AW also suggested carrying out simulations to look at how spatial data and models might be included in a stock assessment, and the RP agrees that this might be a good start point before more expensive research is undertaken.

Indices: Abundance indices are usually the main information drivers in the stock assessments in these fisheries. The RP recommended improving the fishery independent index if possible, ensuring geographical coverage of the stock is complete. Also, local absolute stock size estimates might be obtained from underwater video surveys, tagging, depletion fishing experiments within a small area, or some combination of these three. Estimating absolute biomass should be done in a way which is informative on catchability and selectivity in the model (could be included as a prior, for example).

Recreational Statistics: Some research on the recreational fishery, while useful, was in the opinion of the RP, less urgent. This included analysis of historical photos to obtain lengths, research to obtain and interpret condition information on discarded fish and the evaluation of some data collection programs.

Life history: The AW recommended looking at estimating age-dependent natural mortality directly. While the RP recognized that natural mortality is an important parameter, estimating this quantity is likely to be very difficult and may not be practical. Similarly, ontogenetic migration and other movement patterns, a possible cause of dome-shaped selectivity and local depletion, could be investigated. If a tagging program was being implemented for other purposes, these issues could and should be included.

Recruitment Patterns: The RP noted that the apparent variance in the recruitment residuals had decreased over time. The recruitments are estimates of the model, so it was not necessarily clear that this was a real change in the stock dynamics, random chance or an artifact of the model. Nevertheless, the RP believed that some simple research to support or discount recruitment change could be undertaken by reviewing recruitment in other stocks or correlating this change with environmental variables where some causal link could be hypothesized.

Low Priority

The Commercial Statistics working group suggested examining the impact of the historical foreign fleet. However, the RP believed that the impact of any activities on black sea bass would be low, obtaining any data would be difficult and could be unsuccessful.

Ultimately the interval between the current and next assessment is a policy decision, requiring scientific input. The RP wants to highlight scientific factors that should be taken into consideration when making this decision. The current black sea bass assessment indicates the stock is not overfished, but not yet rebuilt; and is undergoing overfishing. This indicates the stock is likely in need of regular assessments to track its status, ensure overfishing ends, and the stock is on a trajectory to rebuild. No new data sources are expected to be available, at least in the short term, limiting the utility of conducting a new benchmark assessment in the short term.

If management actions change, conducting a new assessment after their implementation has the potential to identify the impacts of the new management actions on the stock, as well as better identify the stock's dynamics. A new assessment could provide improved information on benchmarks such as MSY or status indicators such as B/B_{MSY}.

The RP recommends that assessment updates be conducted regularly, at the interval of a high-risk stock, and more often in response to changes in management regulations. If an update assessment indicates the stock's status is declining or new data become available, the RP recommends moving forward with a full benchmark assessment.

2.1.10. 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 no later than October 28, 2011.

This report constitutes the RP's summary evaluation of the black sea bass stock assessment and discussion of the Terms of Reference. The RP will complete edits to its report and submit to SEDAR by 10/28/11.

2.2. Summary Results of Analytical Requests *(Sensitivities, corrections, additional analyses etc)*

The RP requested three sets of additional analyses: 1) long-term projections with F equal to the point estimate of F_{MSY}; 2) projections with reduced standard deviation of log recruitment residuals, estimated from the period 1990−2010; and 3) comparison of biomass from a previous projection to that estimated by the current assessment.

The long-term projections (item 1) provided a comparison between estimated management quantities and analogous central tendencies at projected equilibria (Table 1, Figure 1).

The projections with reduced recruitment variance (item 2) were requested as a sensitivity analysis to indicate into how this source of stochasticity translates into uncertainty in future stock size and other projected quantities. The RP noted that log recruitment residuals showed some trend over time in magnitude and perhaps direction (Figure 2). This discussion was couched in the context of regime shift, where more recent residuals may better indicate short-term future residuals than would those from the full assessment time series. The projections with reduced recruitment variance were run under Projection Scenario 1 (Figure 3) and Projection Scenario 7 (Figure 4).

The comparison of biomass from a previous projection to that from the current assessment (item 3) was considered for its potential relevance in assessing rebuilding trajectories (Figure 5). Although this comparison may be illustrative, it should be interpreted along with the caveats that much is different in the SEDAR 25 assessment (e.g., M, fecundity, discard estimates, age composition data, model component weights) and that no single projection from the previous assessment matches the current management policy.

Table 1. Expected values and equilibria from projections with $F=F_{MSY}$

Quantity	Expected	Projected mean*	Projected median*
SSB (1E10 eggs)	248	245	236
Landings (1000 lb)	1767	1718	1662
Recruits (1000)	34,393	34,892	29,912

*Means and medians are taken across replicates within years, and then across last 20 years

Figure 1. Expected values and equilibria from projections with F=Fmsy (values presented in Table 1). Distributions shown are from the Monte Carlo Bootstrap analysis.

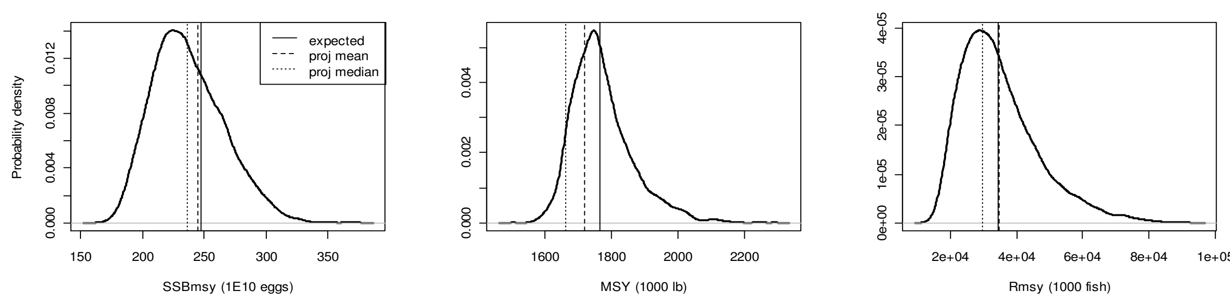


Figure 2. Estimated log recruitment residuals. Reproduced from Figure 3.17 of the assessment report.

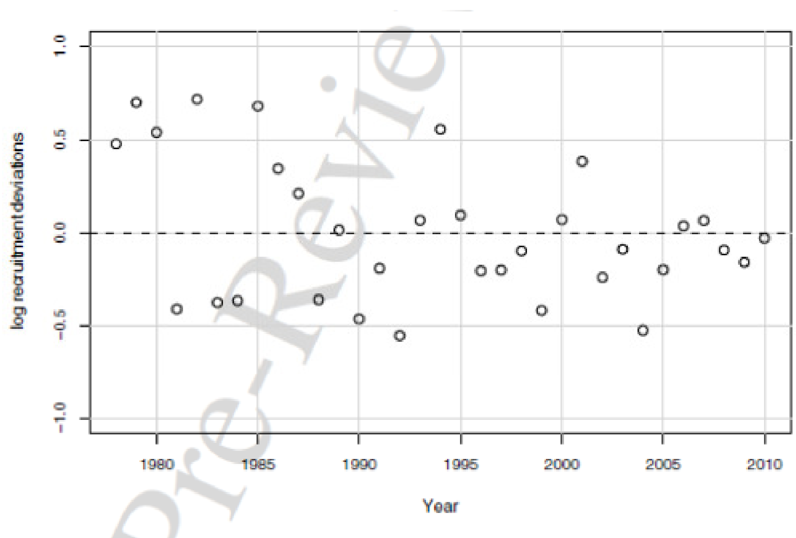


Figure 3. Projection using $F=F_{rebuild}$ as described in the assessment report, with 2011 landings at 100% of quota (Scenario 1).

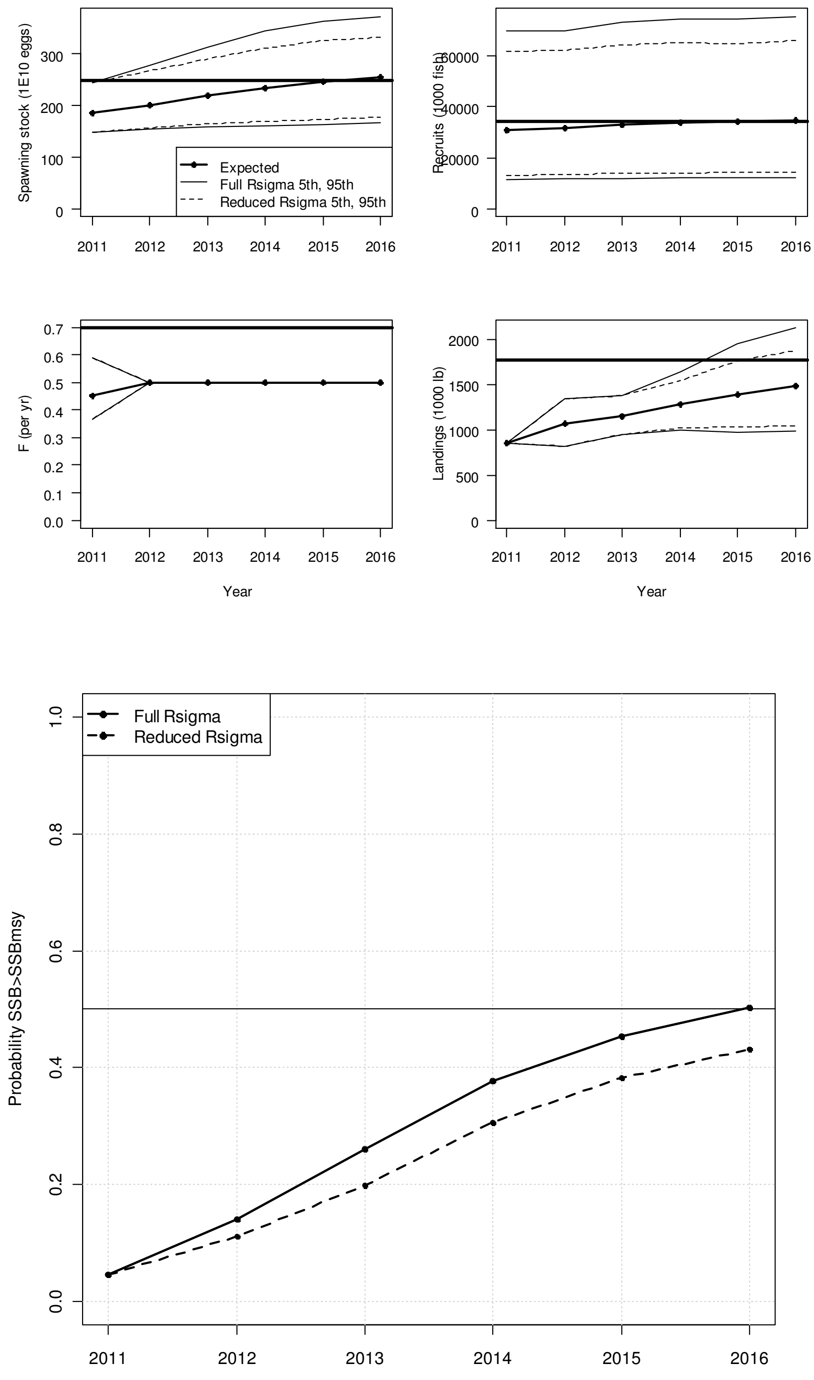
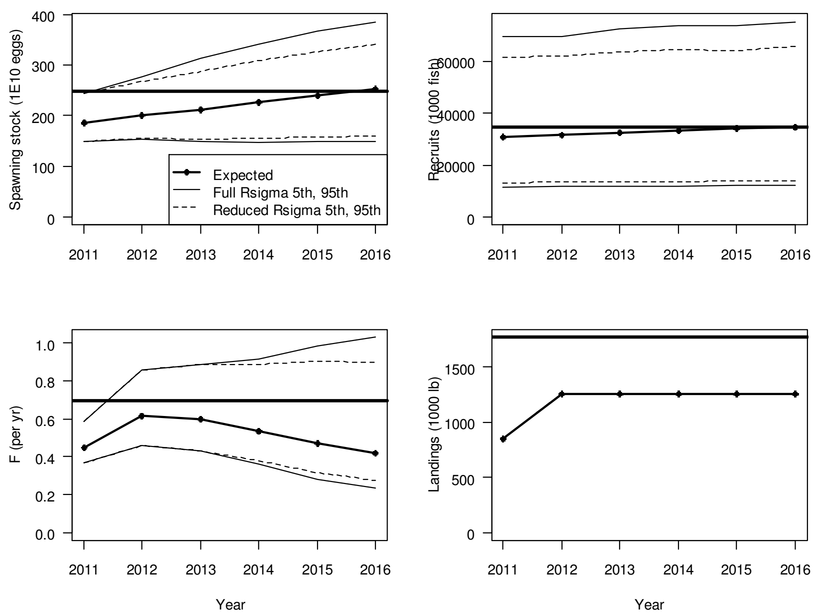


Figure 4. Projection using L=lrebuild as described in the assessment report, with 2011 landings at 100% of quota (Scenario 7).



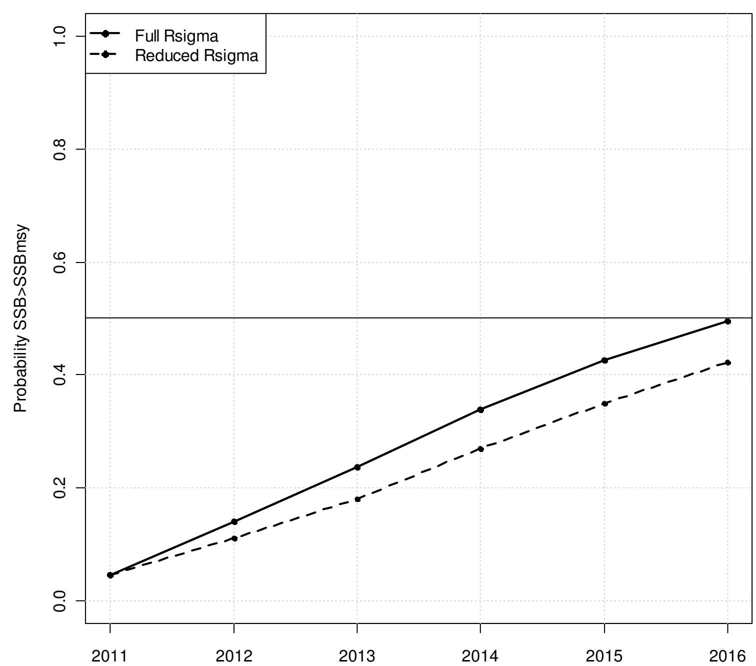
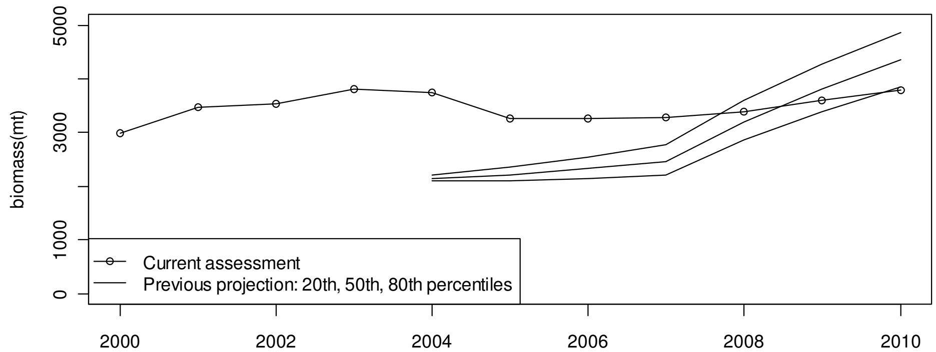
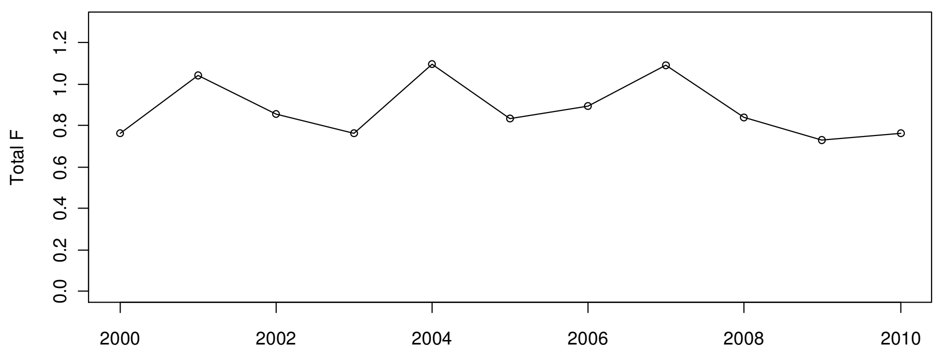


Figure 5. Comparison of biomass from a previous projection to that estimated by the current assessment





2.3. Additional Comments (*if necessary, to address issues or discussions not encompassed above)*

No additional comments needed.

3. Submitted Comment

None received

VI. Addenda

No revisions or corrections to preceding sections.