Southeast Data, Assessment, and Review

SEDAR 32

Stock Assessment Report

South Atlantic Blueline Tilefish

November 2013

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

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South Atlantic Blueline Tilefish

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 blueline tilefish 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, establishes a management regime for the fishery for snappers, groupers and related demersal species of the Continental Shelf of the southeastern United States in the exclusive economic zone (EEZ) under the area of authority of the South Atlantic Fishery Management Council (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. Regulations apply only to federal waters.

SAFMC FMP Amendments affecting blueline tilefish

Description of Action	FMP/Amendment	Effective Date
-Gear limitations – poisons, explosives, fish traps, trawls -Designated modified habitats or artificial reefs as Special Management Zones (SMZs)	FMP (1983)	08/31/83
-Prohibited trawl gear to harvest fish south of Cape Hatteras, NC and north of Cape Canaveral, FL. -Directed fishery defined as vessel with trawl gear and ≥200 lbs s-g on board. -Established rebuttable assumption that vessel with s-g on board had harvested such fish in EEZ.	Amendment #1 (1988a)	01/12/89
-Required catch and effort reports from selected, permitted vessels; -Required that fish in the snapper grouper fishery be made available, upon request, to an authorized officer; -Required permitted vessels to display their official numbers; -Made vessel operators responsible for ensuring that no fish from the snapper grouper fishery below the minimum size limit or without their heads and fins attached are possessed aboard the vessel	Amendment #3 (1990b)	01/31/91
-Prohibited gear: fish traps except black sea bass traps north of Cape Canaveral, FL; entanglement nets; longline gear inside 50 fathoms; bottom longlines to harvest wreckfish; powerheads and bangsticks in designated SMZs off S. Carolina. -Required permits (commercial & for-hire)	Amendment #4 (1991)	01/01/92

and specified data collection regulations -Established an assessment group and annual adjustment procedure (framework) -No retention of snapper grouper spp. caught in other fisheries with gear prohibited in snapper grouper fishery if captured snapper grouper had no bag limit or harvest was prohibited. If had a bag limit, could retain only the bag limit. -charter/headboats and excursion boat possession limits extended		
-Set up separate commercial Total Allowable Catch (TAC) levels for golden tilefish and snowy grouper -Established commercial trip limits for snowy grouper, golden tilefish, speckled hind, and warsaw grouper -Included golden tilefish in grouper recreational aggregate bag limits -Prohibited sale of warsaw grouper and speckled hind -100% logbook coverage upon renewal of permit -Created of the *Oculina* Experimental Closed Area -Specified data collection needs for evaluation of possible future IFQ system	Amendment #6 (1993)	07/27/94
-Required dealer, charter and headboat federal permits -Allowed sale under specified conditions -Specified allowable gear and made allowance for experimental gear -Allowed multi-gear trips in N. Carolina -Added localized overfishing to list of problems and objectives -Adjusted bag limit and crew specs. for charter and head boats -Modified framework procedure	Amendment #7 (1994a)	01/23/95
-Established program to limit initial eligibility for snapper grouper fishery: Must demonstrate landings of any species in SG FMU in 1993, 1994, 1995 or 1996; and have held valid SG permit between 02/11/96 and 02/11/97. -Granted transferable permit with unlimited landings if vessel landed ≥ 1,000 lbs. of snapper grouper spp. in any of the years -Granted non-transferable permit with 225 lb. trip limit to all other vessels -Modified problems, objectives, OY, and overfishing definitions	Amendment #8 (1997a)	12/14/98

-Expanded Council's habitat responsibility -Allowed retention of snapper grouper spp. in excess of the bag limit on permitted vessels fishing in the EEZ off North Carolina with a sink net -Allowed retention of snapper grouper spp. in excess of bag limit on permitted vessel fishing in the South Atlantic EEZ with a single bait net or cast net on board -Allowed permitted vessels to possess filleted fish harvested in the Bahamas under certain conditions.		
-Specified 5-fish aggregate grouper bag limit, which includes tilefish species, including blueline tilefish. -Vessels with longline gear aboard may only possess snowy, warsaw, yellowedge, and misty grouper, and golden, blueline and sand tilefish.	Amendment #9 (1998b)	2/24/99
-Identified EFH and established HAPCs for species in the SG FMU.	Amendment #10 (1998d)	07/14/00
-MSY proxy = 30% static SPR -OY = 40% static SPR -Approved definitions for overfished and overfishing. MSST = [(1-M) or 0.5 whichever is greater]*B_{MSY}. MFMT = F_{MSY}	Amendment #11 (1998e)	12/02/99
-Extended for an indefinite period the regulation prohibiting fishing for and possessing snapper grouper spp. within the *Oculina* Experimental Closed Area.	Amendment #13A (2003b)	04/26/04
-Established eight deepwater Type II marine protected areas (MPAs) to protect a portion of the population and habitat of long-lived deepwater snapper grouper species.	Amendment #14 (2007)	2/12/09
-Prohibited the sale of bag-limit caught snapper grouper species. -Adjusted commercial renewal periods and transferability requirements. -Implemented plan to monitor and assess bycatch.	Amendment #15B (2008b)	2/15/10
-Reduced 5-fish aggregate grouper bag limit, which includes tilefish species including blueline tilefish, to a 3-fish aggregate. -Captain and crew on for-hire trips cannot retain the bag limit of species within the 3-fish grouper aggregate, which includes	Amendment # 16 (2009)	7/29/09

blueline tilefish.		
-Required use of non-stainless steel circle hooks when fishing for snapper grouper species with hook-and-line gear north of 28 deg. N latitude in the South Atlantic EEZ	Amendment #17A (SAFMC 2010a)	circle hooks March 3, 2011
-Updated the framework procedure for specification of OFL, ABC, ACLs, and ACTs. -Established prohibition on possession of deepwater snapper grouper species, including blueline tilefish, seaward of 240 feet in the South Atlantic EEZ.	Amendment #17B (SAFMC 2010b)	January 31, 2011
-Provided presentation of spatial information for Essential Fish Habitat (EFH) and EFH-Habitat Areas of Particular Concern (EFH-HAPC) designations under the Snapper Grouper FMP - Designated deepwater coral HAPCs	Amendment #19 (Comprehensive Ecosystem-based Amendment 1) (SAFMC 2010c)	7/22/10
-Established species groupings. Blueline tilefish in included in the Deepwater Complex (along with yellowedge grouper, silk snapper, misty grouper, queen snapper, sand tilefish, black snapper, and blackfin snapper) -Blueline tilefish ABC = 592,6024 based on SSC recommendation. -Blueline tilefish allocations = 47.39% commercial; 52.61% recreational -Established the following for the Deepwater Complex: ABC/ACL= 675,908 pounds ww. Commercial ACL = 343,869 pounds ww. Recreational ACL = 332,039 pounds ww. Recreational ACT = 205,516 pounds ww. In-season and post-season AMs: Commercial - If the commercial sector ACL for the Deepwater Complex is met or projected to be met, all purchase and sale is prohibited and harvest and/or possession is limited to the bag limit. If the commercial sector ACL is exceeded and one of the species in the complex is overfished, the Regional Administrator shall publish a notice to reduce the commercial sector ACL in the following season by the amount of the overage. Recreational - If the recreational sector ACL for the Deepwater Complex is exceeded, the following year's landings	Comprehensive ACL Amendment (Amendment 25)(SAFMC 2011c)	4/16/12

would be monitored in-season for persistence in increased landings. The Regional Administrator will publish a notice to reduce the length of the fishing season as necessary.		
- Designated the Deepwater MPAs as EFH-HAPCs	Amendment #23 (Comprehensive Ecosystem-based Amendment 2; SAFMC 2011f)	1/30/12
- Improved the accuracy, timing, and quantity of fisheries statistics	Amendment #18A (SAFMC 2012a)	7/1/12

SAFMC Regulatory Amendments affecting blueline tilefish

Description of Action	Amendment	Effective Date
-Prohibited fishing in SMZs except with hand-held hook-and-line and spearfishing gear.	Regulatory Amendment #1 (1987)	03/27/87
-Established 2 artificial reefs off Ft. Pierce, FL as SMZs.	Regulatory Amendment #2 (1988b)	03/30/89
-Established artificial reef at Key Biscayne, FL as SMZ. Fish trapping, bottom longlining, spear fishing, and harvesting of Goliath grouper prohibited in SMZ.	Regulatory Amendment #3 (1989)	11/02/90
-Established 8 SMZs off S. Carolina, where only hand-held, hook-and-line gear and spearfishing (excluding powerheads) was allowed.	Regulatory Amendment #5 (1992c)	07/31/93
-Established 10 SMZs at artificial reefs off South Carolina.	Regulatory Amendment #7 (1998)	01/29/99
-Established 12 SMZs at artificial reefs off Georgia; revised boundaries of 7 existing SMZs off Georgia to meet CG permit specs; restricted fishing in new and revised SMZs	Regulatory Amendment #8 (2000a)	11/15/00
- Eliminated the 240 ft closure for six deepwater species, including blueline tilefish.	Regulatory Amendment # 11 (2011b)	5/10/12

2.2. Emergency and Interim Rules (if any)

Emergency Action effective September 3, 1999: reopen the Amendment 8 Snapper Grouper Permit application process.

2.3. Secretarial Amendments (if any)

None

2.4. Control Date Notices (if any)

Notice of Control Date effective July 30, 1991: 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.

Notice of Control Date effective October 14, 2005: The Council is considering management measures to further limit participation or effort in the commercial fishery for snapper grouper species (excluding Wreckfish).

Notice of Control Date effective March 8, 2007: The Council may consider measures to limit participation in the snapper grouper for-hire fishery.

Notice of Control Date effective January 31, 2011: Anyone entering federal snapper grouper fishery off S. Atlantic states after 09/17/10 was not assured of future access if limited entry program is developed.

2.5. Management Program Specifications

Table 2.5.1. General Management Information
South Atlantic

Species	Blueline Tilefish
Management Unit	Southeastern US
Management Unit Definition	NC/VA border southward to the SAFMC/GMFMC boundary
Management Entity	South Atlantic Fishery Management Council
Management Contacts SERO / Council	SAFMC: Myra Brouwer SERO: Jack McGovern
Current stock exploitation status	Unknown
Current stock biomass status	Unknown

Table 2.5.2. Management Parameters

<table>
<tr><td rowspan="2">Criteria</td><td colspan="3">South Atlantic – Proposed (values from SEDAR 32)</td></tr>
<tr><td>Definition</td><td>Base Run Values</td><td>Median of Base Run MCBs</td></tr>
<tr><td rowspan="2">MSST[1]</td><td>(1-M) B_{MSY}</td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>0.5 B_{MSY}</td></tr>
<tr><td>MFMT</td><td>F_{MSY}, if available; $F_{30\% \text{ SPR}}$ proxy [2]</td><td></td><td></td></tr>
<tr><td>F_{MSY}</td><td>F_{MSY}</td><td></td><td></td></tr>
<tr><td>MSY</td><td>Yield at F_{MSY}, landings and discards, pounds and numbers</td><td></td><td></td></tr>
</table>

B_{MSY}[1]	Total or spawning stock, to be defined		
R_{MSY}	Recruits at MSY		
F Target	75% F_{MSY}		
Yield at F_{TARGET} (equilibrium)	Landings and discards, pounds and numbers		
M	Natural mortality, average across ages		
Terminal F	Exploitation		
Terminal Biomass[1]	Biomass		
Exploitation Status	F/MFMT		
Biomass Status[1]	B/MSST		
	B/B_{MSY}		
Generation Time			
$T_{REBUILD}$ (if appropriate)			

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

2. If an acceptable estimate of F_{MSY} is not provided by the assessment a proxy value may be considered. The current F_{MSY} proxy for this stock is F30% SPR; other values may be recommended by the assessment process for consideration by the SSC.

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

NOTE: Because this is the first assessment of these stocks, there are no existing values for management parameters. The default proxy for Fmsy is F30%SPR.

Table 2.5.3. Stock Rebuilding Information

n/a

Table 2.5.4. General Projection Specifications

South Atlantic

First Year of Management	2015
Interim basis	ACL, if ACL is met Average exploitation, if ACL is not met
Projection Outputs	
Landings	Pounds and numbers
Discards	Pounds and numbers
Exploitation	F & Probability F>MFMT
Biomass (total or SSB, as appropriate)	B & Probability B>MSST (and Prob. $B>B_{MSY}$ if under rebuilding plan)
Recruits	Number

Table 2.5.5. Base Run Projections Specifications. Long Term and Equilibrium conditions.

Criteria	Definition	If overfished	If overfishing	Neither overfished nor overfishing
Projection Span	Years	$T_{REBUILD}$	10	10
Projection Values	$F_{CURRENT}$	X	X	X
	F_{MSY}	X	X	X
	75% F_{MSY}	X	X	X
	$F_{REBUILD}$	X		
	F=0	X		

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

Table 2.5.6. P-star projections. Short term specifications for OFL and ABC recommendations. Additional P-star projections may be requested by the SSC once the ABC control rule is applied.

Criteria		Overfished	Not overfished
Projection Span	Years	5	5
Probability Values	50%	Probability of stock rebuild	Probability of overfishing

Table 2.5.7. Quota Calculation Details

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

Applicable to the Deepwater Complex (black snapper, blackfin snapper, blueline tilefish, misty grouper, queen snapper, sand tilefish, silk snapper, yellowedge grouper). Sector specific ACLs are in place for the Deepwater Complex.

Current Acceptable Biological Catch (ABC) and Total Annual Catch Level (ACL) Value for Blueline Tilefish	592,602 pounds whole weight
Commercial ACL for all Species in the Deepwater Complex	343,869 pounds whole weight
Recreational ACL for all Species in the Deepwater Complex	332,039 pounds whole weight
Next Scheduled Quota Change	n/a
Annual or averaged quota?	Annual
If averaged, number of years to average	n/a
Does the quota include bycatch/discard ?	No

How is the quota calculated - conditioned upon exploitation or average landings?
The South Atlantic SSC recommended the ABC for blueline tilefish in April 2011. The Council then set ABC=ACL through the Comprehensive ACL Amendment. The Council included blueline tilefish in the Deepwater Complex and established a Deepwater Complex commercial and recreational ACL based on historic landings. Below is the rationale provided for the SSC's recommendation (from the April 2011 SSC Report):

This may be a developing fishery north of Cape Hatteras, NC, but south of Cape Hatteras in the headboat landings in the 1970s it was in most of the catches sampled, and targeted as a desirable member of the snapper-grouper complex caught on deep reef habitat.

This may have become a directed fishery recently, in response to snowy grouper regulations. Growth of the fishery is occurring in the area mainly off North Carolina, north of Cape Hatteras where concentrations are targeted that were not previously fished. It is possible that ocean environmental variation has caused a northward shift in distribution north of Cape Hatteras where it was not previously common. Fish north of Cape Hatteras are caught on longlines and mono on soft bottoms while not catching snowy grouper. Blueline tilefish off SC are caught on rocky bottoms at the shelf edge and on slope reefs.

Assessment is scheduled for 2013.

One concern is inhibiting growth that may be possible in a developing fishery. Suggest using the highest observed point for an ABC value, given that an assessment is coming soon; therefore, there is little long-term risk. This will cap the catch at current level. The current biomass or rate of exploitation is unknown, and it is unknown whether the fishery has already exceeded sustainable levels.

Port sampling is occurring to obtain length composition of the catch and aging structures. The SSC advises that this biological sampling should continue for this fishery. A life history study is in progress and will support the pending assessment. There is also a need to address the spatial extent of the fishery for possible differences north and south of Cape Hatteras. Note: highest landings pre-2006 was 296,301 lbs.

The SSC agreed to allow some increase in landings from that period of perceived stability. This would allow some growth; recommend basing ABC on pre-2006 landings x 2 = 592,602 lbs. Must add caveats to any recommendation given.

Reported fishery ongoing for long time, some information suggesting signs of considerable exploitation even pre-2006 (e.g., Harris et al, Onslow Bay, South area covered in that, different area than current growth)

OFL is unknown.

The Comprehensive ACL established the Deepwater Complex and assigned an ACL for the Complex based on the sum of the individual ACLs for each of the species in the Complex. The overall ACL is 675,908 pounds ww.

Does the quota include bycatch/discard estimates? I f so, what is the source of the bycatch/discard values? What are the bycatch/discard allowances?

The SSC's recommended ABC (and hence the ACL) based on landed catch only and did not include estimates of discard and bycatch.

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

See excerpt above.

2.6. Management and Regulatory Timeline

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

Table 2.6.1. Annual Commercial Blueline Tilefish Regulatory Summary (please fill out as appropriate)

Year	Fishing Year	Size Limit	Bag Limit	Open Date	Close Date	Other
1993	Calendar Year	none	none			
1994	Calendar Year	none	none			
1995	Calendar Year	none	none			
1996	Calendar Year	none	none			
1997	Calendar Year	none	none			
1998	Calendar Year	none	none			
1999	Calendar Year	none	none			
2000	Calendar Year	none	none			
2001	Calendar Year	none	none			
2002	Calendar Year	none	none			
2003	Calendar Year	none	none			
2004	Calendar Year	none	none			
2005	Calendar Year	none	none			
2006	Calendar Year	none	none			
2007	Calendar Year	none	none			
2008	Calendar Year	none	none			
2009	Calendar Year	none	none			
2010	Calendar Year	none	none			
2011	Calendar Year	none	none			Beginning January 31, 2011, a 240' closure for blueline tilefish and 5 other deepwater species went into effect. The 240' closure was removed on May 10, 2012.

Table 2.6.2. Annual Recreational Blueline Tilefish Regulatory Summary (Please fill out as appropriate)

Year	Fishing Year	Size Limit	Possession Limit	Open Date	Close Date	Other
1993	Calendar Year	none	none			
1994	Calendar Year	none	none			
1995	Calendar Year	none	none			
1996	Calendar Year	none	none			
1997	Calendar Year	none	none			
1998	Calendar Year	none	none			
1999	Calendar Year	none	5 fish grouper aggregate, which includes tilefish species			
2000	Calendar Year	none	5 fish grouper aggregate, which includes tilefish species			
2001	Calendar Year	none	5 fish grouper aggregate, which includes tilefish species			
2002	Calendar Year	none	5 fish grouper aggregate, which includes tilefish species			
2003	Calendar Year	none	5 fish grouper aggregate, which includes tilefish species			
2004	Calendar Year	none	5 fish grouper aggregate, which includes tilefish species			
2005	Calendar Year	none	5 fish grouper aggregate, which includes tilefish species			
2006	Calendar Year	none	5 fish grouper aggregate, which includes tilefish species			
2007	Calendar Year	none	5 fish grouper aggregate, which includes tilefish species			
2008	Calendar Year	none	5 fish grouper aggregate, which includes tilefish species			
2009	Calendar Year	none	3 fish grouper aggregate, which includes tilefish species. Captain and crew on for hire trips cannot retain bag limit of blueline tilefish within the 3-			

			grouper/tilefish aggregate.			
2010	Calendar Year	none	3 fish grouper aggregate, which includes tilefish species. Captain and crew on for hire trips cannot retain bag limit of blueline tilefish within the 3-grouper/tilefish aggregate.			
2011	Calendar Year	none	3 fish grouper aggregate, which includes tilefish species. Captain and crew on for hire trips cannot retain bag limit of blueline tilefish within the 3-grouper/tilefish aggregate.			Beginning January 31, 2011, a 240’ closure for blueline tilefish and 5 other deepwater species went into effect. The 240’ closure was removed on May 10, 2012.

Table 7. State Regulatory History

North Carolina

There are no NC state regulations for blueline tilefish. NC complements the federal regulations via proclamation authority based on NC code sections: 15A NCAC 03M .0506 and 15A NCAC 03M .0512 (see below). All current snapper grouper regulations are contained in a single proclamation, which gets updated anytime there is an opening/closing of a particular species in the complex, as well as any changes in allowable gear, etc. The most current Snapper Grouper proclamation (and all previous versions) can be found using this link: http://portal.ncdenr.org/web/mf/proclamations.

15A NCAC 03M .0506 SNAPPER-GROUPER COMPLEX

(a) In the Atlantic Ocean, it is unlawful for an individual fishing under a Recreational Commercial Gear License with seines, shrimp trawls, pots, trotlines or gill nets to take any species of the Snapper-Grouper complex.
(b) The species of the snapper-grouper complex listed in the South Atlantic Fishery Management Council Fishery
Management Plan for the Snapper-Grouper Fishery of the South Atlantic Region are hereby incorporated by reference and copies are available via the Federal Register posted on the Internet at www.safmc.net and at the Division of Marine Fisheries, P.O. Box 769, Morehead City, North Carolina 28557 at no cost.
History Note: Authority G.S. 113-134; 113-182; 113-221; 143B-289.52;
Eff. January 1, 1991;
Amended Eff. April 1, 1997; March 1, 1996; September 1, 1991;
Temporary Amendment Eff. December 23, 1996;
Amended Eff. August 1, 1998; April 1, 1997;
Temporary Amendment Eff. January 1, 2002; August 29, 2000; January 1, 2000; May 24, 1999;
Amended Eff. October 1, 2008; May 1, 2004; July 1, 2003; April 1, 2003; August 1, 2002.

15A NCAC 03M .0512 COMPLIANCE WITH FISHERY MANAGEMENT PLANS

(a) In order to comply with management requirements incorporated in Federal Fishery Management Council Management Plans or Atlantic States Marine Fisheries Commission Management Plans or to implement state management measures, the Fisheries Director may, by proclamation, take any or all of the following actions for species listed in the Interjurisdictional Fisheries Management Plan:
(1) Specify size;
(2) Specify seasons;
(3) Specify areas;
(4) Specify quantity;
(5) Specify means and methods; and
(6) Require submission of statistical and biological data.
(b) Proclamations issued under this Rule shall be subject to approval, cancellation, or modification by the Marine Fisheries Commission at its next regularly scheduled meeting or an emergency meeting held pursuant to G.S. 113-221.1.
History Note: Authority G.S. 113-134; 113-182; 113-221; 113-221.1; 143B-289.4;
Eff. March 1, 1996;
Amended Eff. October 1, 2008.

South Carolina:
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 blueline tilefish regulations are (and have been) pulled directly from the federal regulations as promulgated under Magnuson. I am not aware of any separate blueline tilefish regulations that have been codified in the SC Code.

Georgia:
There are currently no GA state regulations for blueline tilefish. However, the authority rests with the GA Board of Natural Resources to regulate this species if deemed necessary in the future.

Florida:
No historical regulatory information for blueline tilefish found. Not aware of Florida ever having state regulations for blueline tilefish.

References
None provided.

3. Assessment History & Review

Blueline tilefish is currently managed under the purview of the Snapper-Grouper Fishery Management Plan. South Atlantic blueline tilefish has not been previously assessed under the SEDAR process and there are no earlier assessments. Data relevant for an assessment of blueline tilefish were assembled during SEDAR 04, but no formal assessment was conducted then (SEDAR 2004). Some studies have suggested that increases in total mortality (Z) since the 1970s and declines in mean length may be due to increased harvest in the snapper-grouper fishery (Ross and Huntsman 1982, Harris et al. 2004, Rudershausen et al. 2008).

References Cited:

Harris, P.J., D.M. Wyanski, and P.T.P. Mikell. 2004. Age, growth, and reproductive biology of blueline tilefish along the southeastern coast of the United States, 1982-1999. Transactions of the American Fisheries Society 133:1190-1204.

Ross, J.L. and G.R. Huntsman. 1982. Age, growth and mortality of blueline tilefish from North Carolina and South Carolina. Transactions of the American Fisheries Society 111:585-592.
Rudershausen, P.J., E.H. Williams, J.A. Buckel, J.C. Potts, and C.S. Manooch III. 2008. Comparison of reef fish catch-per-unit-effort and total mortality between the 1970s and 2005-2006 in Onslow Bay, North Carolina. Transactions of the American Fisheries Society 137:1389-1405.

SEDAR, 2004. SEDAR 4: Stock Assessment of the Deepwater Snapper-Grouper Complex in the South Atlantic.

4. Regional Maps

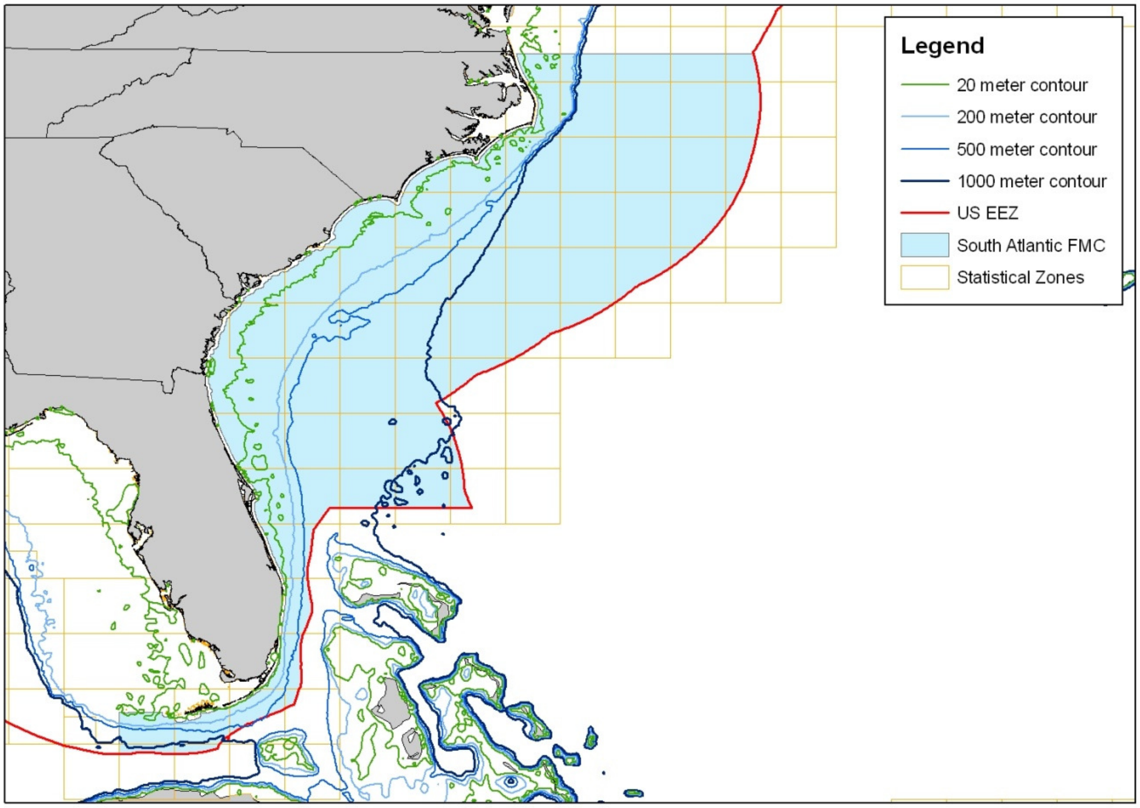

Figure 4.1: South Atlantic Fishery Management Council and EEZ boundaries.

5. Assessment Summary Report

The Summary Report provides a broad but concise view of the salient aspects of the 2013 South Atlantic blueline tilefish stock assessment (SEDAR 32). It recapitulates: (a) the information available to and prepared by the Data Workshop (DW); (b) the application of those data, development and execution of one or more assessment models, and identification of the base-run model configuration by the Assessment Workshop (AW); and (c) the findings and advice determined during the Review Workshop.

Executive Summary

The stock assessment presented by the SEDAR 32 Assessment Workshop (AW) provided the Review Panel with outputs and results from two statistical assessment models and a catch curve analysis. The primary model was the Beaufort Assessment Model (BAM), while a secondary, surplus-production model (ASPIC), provided a comparison of model results. The Review Panel endorses the AW recommendation to determine stock status using the BAM base configuration. Fishing mortality in 2011 is estimated as 0.39, which is greater than the estimate of F_{MSY} (0.302), so overfishing is estimated to be occurring. Spawning biomass in 2011 is estimated as 445,000 lb, which is 91% of the estimate of Minimum Stock Size Threshold (489,000 lb), so the stock is estimated to be overfished.

Stock Status and Determination Criteria

Point estimates from the base model indicate that the U.S. southeast stock of blueline tilefish is overfished and overfishing is occurring.

Estimated time series of stock status (SSB/MSST, SSB/SSB $_{MSY}$) showed a rapid decline in the late 1970s, a stable trend in the 1990s and early 2000s and an increase and then decrease since the mid 2000s. The decline in stock status in the 1980s may have been driven by the rapid increase and decrease in landings in the early to mid 1980s (Figure 5.1). Base run estimates of spawning biomass have been below MSST except for during the 1970s and 80s and several years in the mid 2000s. Current stock status in the base run was estimated to be SSB_{2011}/MSST = 0.909, indicating that the stock is overfished. The MCB analysis suggests that the estimate of a stock that is not overfished (i.e., SSB>MSST) is highly uncertain. Age structure estimated from the base run shows more older fish than the (equilibrium) age structure expected at MSY during the 1980s and fewer than the equilibrium age structure since the 1990s.

The estimated time series of F/F_{MSY} from the base run suggests that overfishing has been occurring over most of the assessment period but with considerable uncertainty, particularly since the mid 2000s, as demonstrated by the MCB analysis. Current fishery status, with current F represented by the geometric mean from 2009-2011, is estimated by the base run to be $F_{2009-2011}$/FMSY = 2.37, but 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. Rate estimates (F) are in units of y^{-1}; status indicators are dimensionless; and biomass estimates are in units of metric tons or pounds, as indicated. Spawning stock biomass (SSB) and minimum stock size threshold (MSST) are measured by total biomass of mature females.

Criteria	Recommended Values from SEDAR 32	
	Definition	Base Run Values
M (Instantaneous natural mortality; per year)	Average of Lorenzen or Charnov M (if used)	0.1
Fcurrent (per year)	Geometric mean of apical fishing mortality rates for 2009-2011 ($F_{2009-2011}$)	0.715
F_{2011}	Apical fishing mortality in 2011	0.393
F_{MSY} (per year)	F_{MSY}	0.302
B_{MSY} (metric tons)	Biomasss at MSY	679.5
SSB_{2011} (metric tons)	Spawning stock biomass in 2011	202
SSB_{MSY} (metric tons)	Spawning stock biomass at MSY	246.6
MSST (metric tons)	MSST = [(1-M) or 0.5 whichever is greater]*B_{MSY}	221.9
MFMT (per year)	F_{MSY}, if available. $F_{30\%SPR}$ proxy.	0.302
MSY (1000 lb)	Yield at F_{MSY}	226.5
OY	Yield at F_{OY}	
F_{OY}	F_{OY} = 65%,75%, 85% F_{MSY}	65% F_{MSY}=0.196 75% F_{MSY}=0.226 85% F_{MSY}=0.256
Biomass Status	SSB_{2011}/MSST	0.909
	SSB_{2011}/SSB_{MSY}	0.818
Exploitation Status	$F_{2009-2011}/F_{MSY}$	2.37
	F_{2011}/F_{MSY}	1.30

Stock Identification and Management Unit

Blueline tilefish are distributed from Campeche, Mexico northward to Cape Charles, Virginia (Dooley 1978) with reports of catches as far north as Maine. There is no known information on different stock structures throughout the geographic range, however a proposal by VIMS to investigate stock structure using molecular genetics is being monitored. The development of a recreational fishery for deep-water snapper-grouper (including blueline tilefish) off Virginia since the 2000s suggests a portion of the population resides north of Cape Hatteras, a biogeographic break for many species. Based on what is known about the geographic range from landings data and other sources, it is recommended to have two stock jurisdictions: Gulf of Mexico and South Atlantic. South Atlantic stock includes the SAFMC jurisdiction of the Florida Keys, South of U.S. Hwy 1, northward along the east coast of Florida to as far north as landings of blueline tilefish are recorded from the U.S. Atlantic waters. Most landings are from VA/NC south to Florida, but they are reported as far north as Maine. The management unit extends from the NC/VA border through the SAFMC jurisdiction of the Florida Keys.

Assessment Methods

Several stock assessment models of blueline tilefish were discussed during the Assessment Process including a catch-age model (the Beaufort assessment model, BAM), an age-structured surplus production model, an age-aggregated surplus production model (ASPIC), and stock reduction analysis (SRA). The BAM was selected by the assessment process panelists to be the primary assessment model and an age-aggregated surplus production model was selected as the secondary 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 (Fournier et al. 2012), and its structure and equations are detailed in SEDAR-32-RW-01. In essence, a statistical catch-age model simulates a population forward in time while including fishing processes (Quinn and Deriso 1999; Shertzer et al. 2008a). Quantities to be estimated are systematically varied until characteristics of the simulated population match available data on the real population. Statistical catch-age models share many attributes with ADAPT-style tuned and untuned VPAs.

A logistic age-aggregated surplus production model, implemented in ASPIC (Prager 2005), was developed for blueline tilefish. 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. Qualitative results from the production model were similar to those from the catch-age model, with predicted declines in biomass in the early 1980s when the fishery first developed, relatively stable biomass from the late 1980s to early 2000s, and a decline in the mid 2000s.

Assessment Data

The catch-age model included data from three fishery dependent surveys, and from both recreational and commercial fisheries that caught southeastern U.S. blueline tilefish. The model was fitted to data on annual combined recreational landings and discards (1974-2011), annual combined commercial landings and discards from the handline fleet (1974-2011), annual commercial landings from the longline fleet (1979-2011), a combined age composition of recreational landings (2003, 2008, 2009-2011), annual age compositions from the longline fleet (2006-2011), annual age compositions from the handline fleet (2005-2011), and three fishery-dependent indices of abundance (the South Atlantic Regional Headboat Survey index (SRHS, 1980-1992), the handline commercial fishery index (1993-2010), and the longline commercial fishery index (1993-2004)). Discards were a small proportion of landings and no information on size or age of discards was available to estimate discard selectivity; therefore, discards were combined with landings. Not all of the above data sources were available for all fleets that caught blueline tilefish in all years.

The recreational landings estimates include headboat landings, developed by the headboat survey, and the general recreational landings for private recreational, charterboat, and shore modes of the Marine Recreational Information Program (MRIP). This sampling program began in 1981 under the name Marine Recreational Fishing Statistical Survey (MRFSS). In 2004 the sampling and estimation methodology changed, and calibration factors were developed to adjust prior landings under MRFSS (1981-2003) to the new MRIP methodology.

Release Mortality

A literature search yielded no peer-reviewed sources of information on discard mortality for blueline tilefish. Data presented in SEDAR32 – DW11 from the commercial discard logbook indicate that the majority of discarded blueline tilefish are dead. To be consistent with other deepwater species (i.e., snowy grouper, golden tilefish) that have been assessed through the SEDAR process, the Data Workshop Panel recommended assuming a discard mortality of 100%. However, if new management is implemented to reduce the discard mortality rate, it might be appropriate for population projections to consider something lower than 100%. The fate of the fish swimming down is unknown but currently the survivorship is thought to be low.

Discards were a small proportion of landings (mean: 0.001 for recreational discards, none reported from the longline fleet, and a mean of 18 fish per year reported from the handline fleet) and no information was available to estimate discard selectivity. The Data Workshop recommended a discard mortality rate of 1.0 given that blueline tilefish are harvested from deep water. Therefore, discards were combined with landings as total recreational removals (landings plus discards) and total commercial handline removals (landings plus discards). Data on commercial discards were available from 1993-2011 and were assumed negligible prior to 1993 (the number of fish discarded over this time ranged from 12 to 27 fish per year). Data on recreational discards were available from 1981-2011, with no discards reported in half of these years. Recreational discards were assumed negligible prior to 1981.

Catch Trends

Commercial handline landings peaked in the early 1980s, declined and remained relatively stable throughout the 1990s and early 2000s, and increased again in the mid to late 2000s. Commercial longline landings followed a similar trend with a peak in the early 1980s, a decline in the mid-late 1980s followed by relatively stable landings during the 1990s and early 2000s, and a second peak in the late 2000s. Commercial 'other' landings have remained relatively low and stable throughout the assessment period with a small increase seen in the 2000s. For the assessment, commercial 'other' landings were grouped with commercial handline landings. Commercial discards were provided from 1993 – 2011 and made up a very small proportion of the overall fishery.

The observed recreational landings remained relatively low throughout the majority of the assessment period with the exception of the mid 2000s. A steep increase in landings occurred in the mid 2000s, peaking in 2007 and was followed by a sharp decline with landings reaching levels more similar to the rest of the time series by 2010. Recreational discards were low throughout the assessment period with the exception of 2007 when recreational discards were estimated to be over 37,000 fish. See Figures 5.1 and 5.2 for landings and discard trends by fleet.

Fishing Mortality Trends

The estimated time series of fishing mortality rates (F) from BAM was highly variable. There was a drop in F in the mid 1980s and 1990s followed by an increase in the mid 2000s. The commercial longline and handline fleets have made similar contributions to total F throughout the time series, while F from the recreational fleet was generally low until the mid 2000s when it was comparable in magnitude to the commercial fisheries (Figure 5.3).

Stock Abundance and Biomass Trends

Estimated abundance at age showed a truncation of the oldest ages in the 1970s and early 1980s. Total estimated abundance has varied about two-fold since the 1970s with a decline in the early 1980s and since the mid 2000s. Below average recruitment was predicted through the 1990s with several strong year classes predicted to have occurred in the early 2000s.

Estimated biomass at age follows the same general pattern as estimated abundance at age. Total biomass and spawning biomass showed similar trends – high biomass in the 1970s followed by low but stable biomass during the 1980s and 1990s, with a second peak in biomass in the mid 2000s (Figure 5.4).

Scientific Uncertainty

Sensitivity analysis can be useful for evaluating the consequences of assumptions made 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 Section 3.7 of the Assessment Report to demonstrate sensitivity to natural mortality, steepness, an alternative maturity schedule, model component weights, catchability assumptions, ageing error, exclusion of indices, years over which recruitment deviations were estimated, and selectivity (domed vs. flat-topped) for the recreational fishery. The qualitative results on terminal stock status were similar across most sensitivity runs, with the exception of natural mortality, generally indicated that the stock is overfished ($SSB/SSB_{MSY} > 1$) and that overfishing is occurring ($F/F_{MSY} < 1$) (Figure 5.8). Sensitivity analyses were in general agreement with the results of the MCB analysis.

Of the sensitivity runs conducted with the BAM, results were least sensitive to assumptions about catchability, the maturity schedule, and dome-shaped selectivity for the recreational fleet. Results were most sensitive to natural mortality and ageing error, with moderate sensitivity to steepness, model component weights, exclusion of indices, and the years over which recruitment deviations were estimated. Sensitivity to natural mortality is common in stock assessment. Ageing error suggests a less robust stock than in the base run. Upweighting indices suggests a more robust stock compared to that in the base run. Effects of data weighting were most pronounced at the end of the assessment period.

Retrospective analyses suggested some patterns in F, B, SSB, recruits, SSB/SSB_{MSY}, or F/F_{MSY} but this was likely due to changes in available datasets and sampling intensity over the most recent five years of the assessment. The handline index was only available through 2010 and sampling intensity for commercial age compositions did not begin until 2005-06, with increases in sampling intensity in 2008-09.

Perhaps the greatest uncertainty in this assessment was the spawner-recruit relationship. Steepness could not be estimated reliably (tended toward the upper bound), and, therefore, had to be fixed at a value agreed on by the Assessment Panel (h=0.84). Hence, MSY-based management quantities are conditional on this particular value of steepness. An alternative approach would be to choose a proxy for F_{MSY}, most likely $F_{X\%}$ (such as $F_{30\%}$ or $F_{40\%}$). However, such proxies do not provide biomass-based benchmarks. If managers wish to gauge stock status, further assumptions about equilibrium recruitment levels would be necessary. Furthermore, choice of X% implies an underlying steepness, as described by Brooks et al. (2009). Thus, choosing a proxy equates to choosing steepness. Given the two alternative approaches, it seems preferable to focus on steepness, as its value is less arbitrary, and can be evaluated relative to other species by comparison to previous meta-analysis (Myers et al. 2002; Shertzer and Conn 2012).

Significant Assessment Modifications

The review panel accepted the base run as developed by the assessment panel. Additional requests were made by the review panel, including geographic plots of the fishery to evaluate the extent of the spatial distribution of the fishery, results of the model fit to the length compositions from the base model, and further exploration of the data to examine any period of potential overlap between the recreational and commercial indices to detect similar or dissimilar trends.

Sources of Information

The contents of this summary report were taken from the SEDAR 32 South Atlantic blueline tilefish data, assessment, and review reports.

Figures

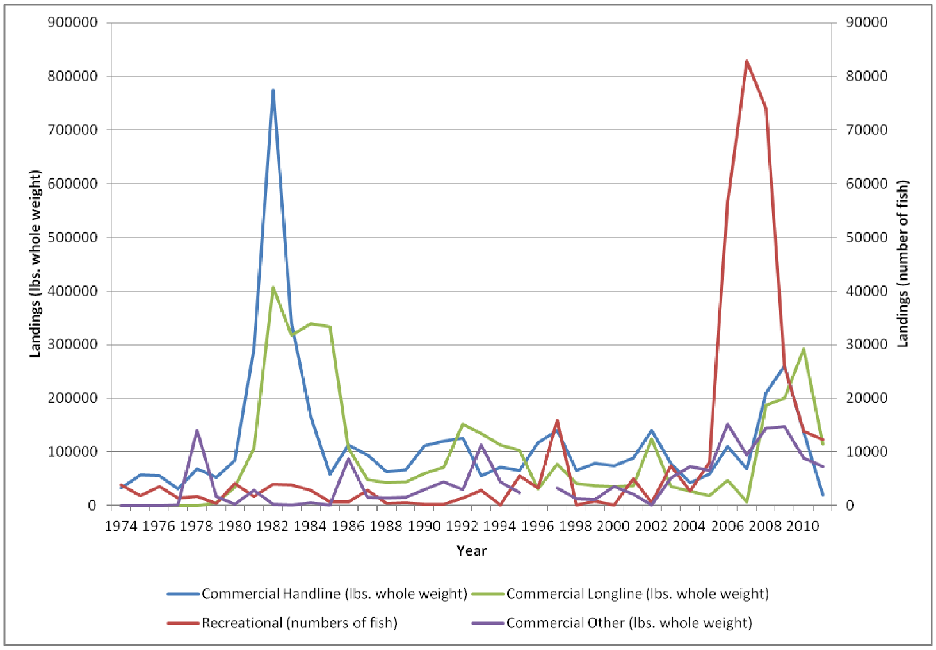

Figure 5.1: South Atlantic blueline tilefish commercial and recreational landings by fleet. Commercial landings are in pounds of whole weight. Recreational landings are in numbers of fish. *(Generated from data in Table 2.6 and 2.11 of the Assessment Report.)*

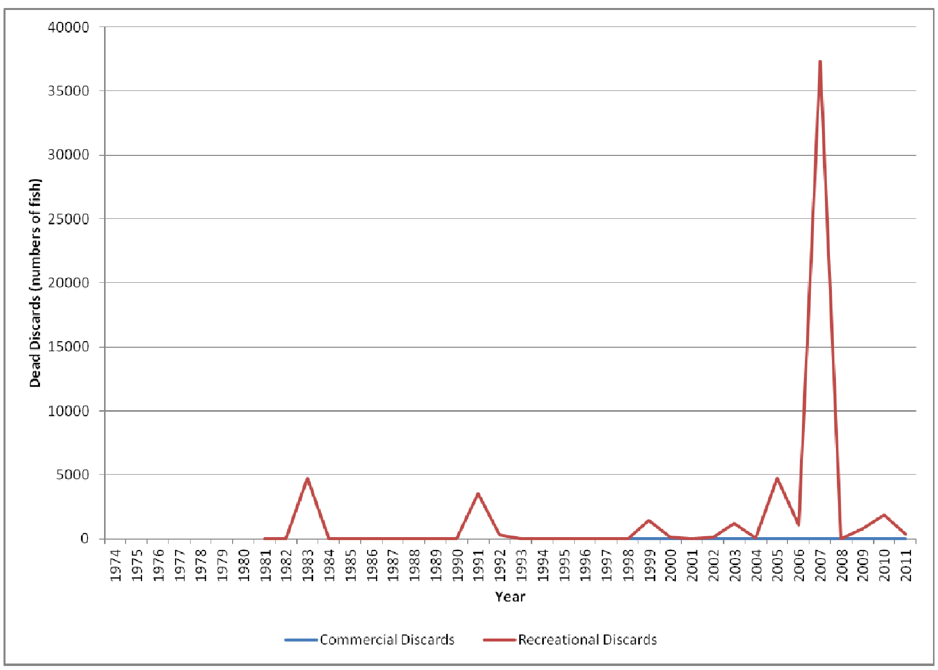

Figure 5.2: South Atlantic blueline tilefish commercial and recreational dead discards. Commercial and recreational discards are in numbers of fish. *(Generated from data in Table 2.6 and 2.11 of the Assessment Report.)*

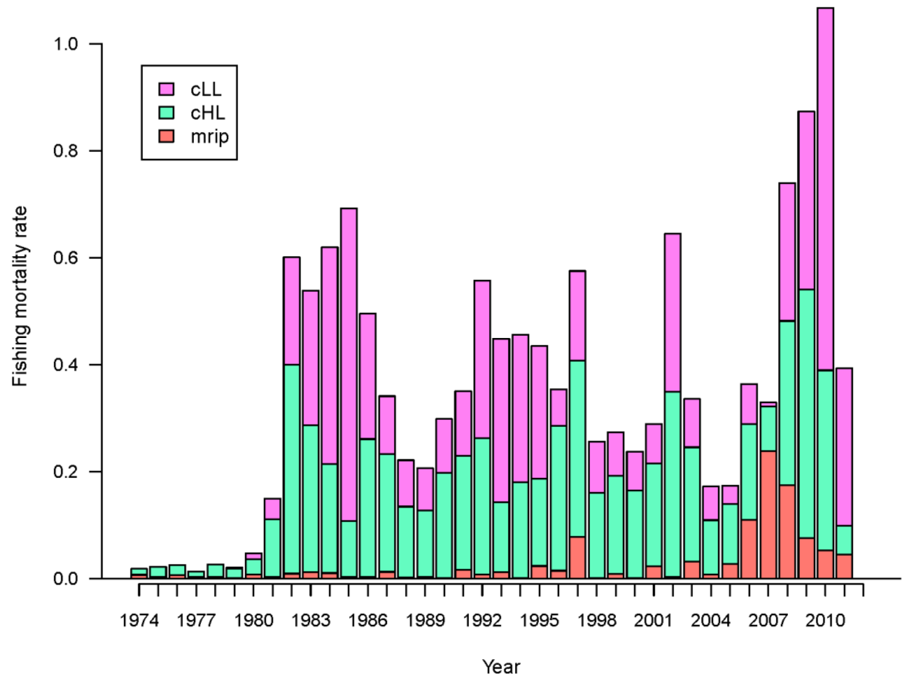

Figure 5.3: Estimated fully selected fishing mortality rate (per year) by fishery. cHL refers to commercial handline, cLL to commercial longline, and mrip to recreational; discards included. *(Extracted from Figure 3.18 of the Assessment Report.)*

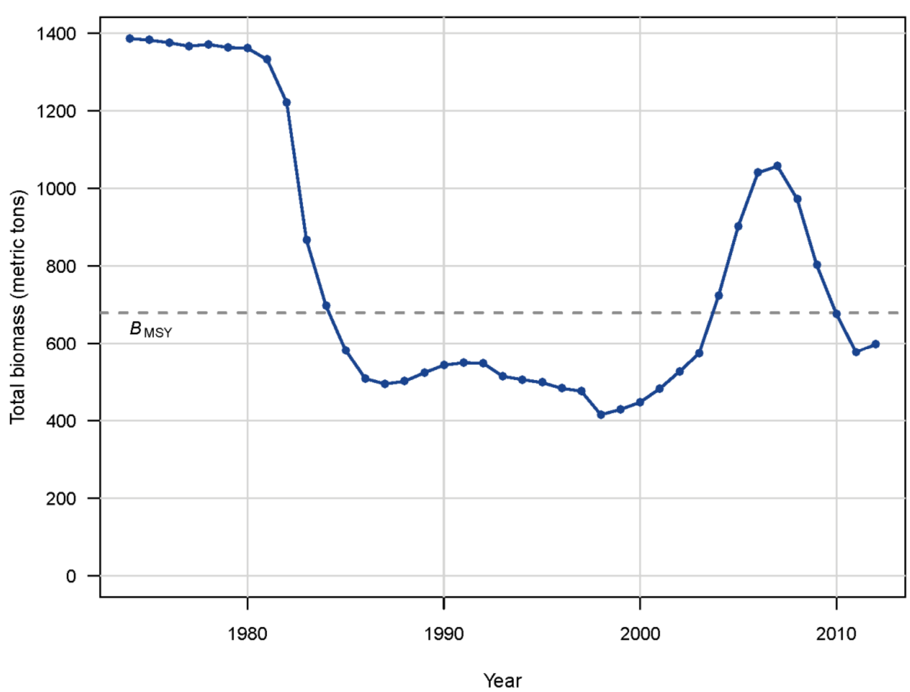

Figure 5.4a: Estimated total biomass (metric tons) at start of year. Horizontal dashed line indicates B_{MSY}. *(Extracted from Figure 3.15 of the Assessment Report.)*

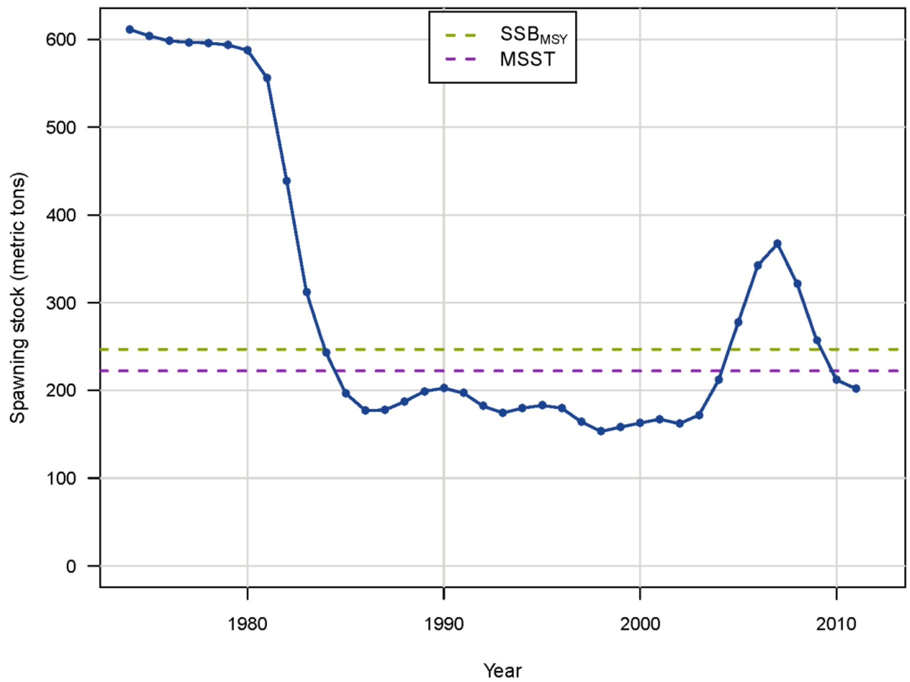

Figure 5.4b: Estimated spawning stock (mature female biomass) at time of peak spawning. *(Extracted from Figure 3.15 of the Assessment Report.)*

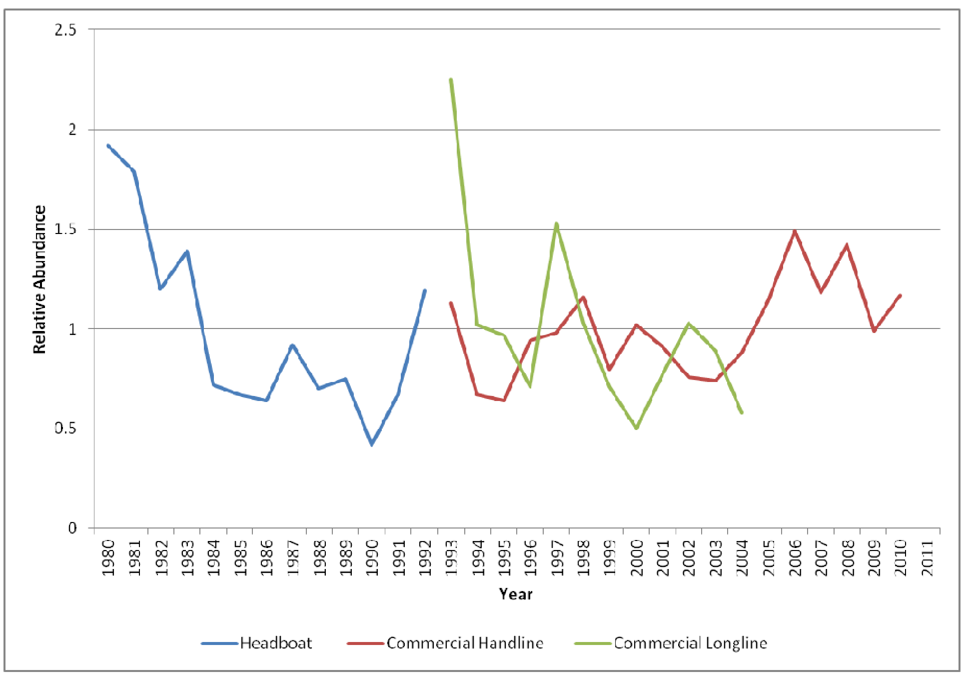

Figure 5.5: SEDAR 32 South Atlantic blueline tilefish indices of abundance. Each index is scaled to its mean value. *(Generated from data in Table 2.14 of the Assessment Report.)*

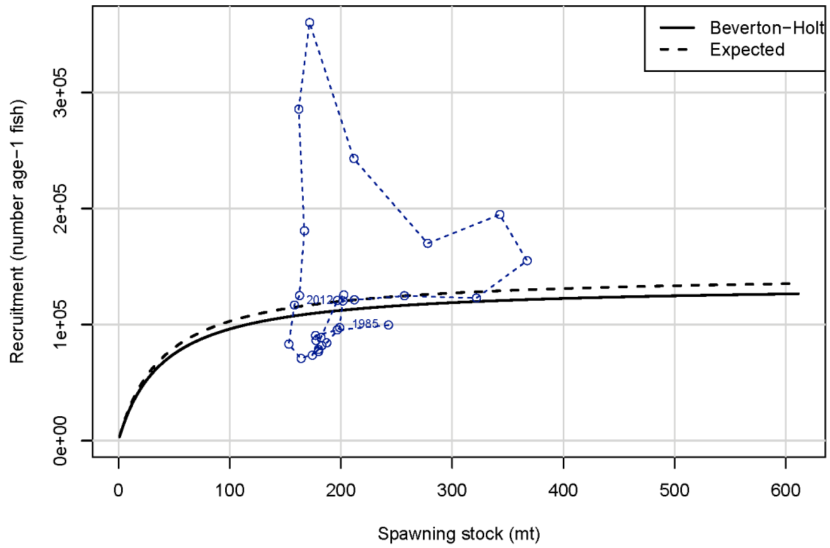

Figure 5.6: Beverton-Holt spawner-recruit curves, with and without lognormal bias correction. The expected (upper) curve was used for computing management benchmarks. Years within figure indicate year of recruitment generated from spawning biomass one year prior. *(Extracted from Figure 3.21 of the Assessment Report.)*

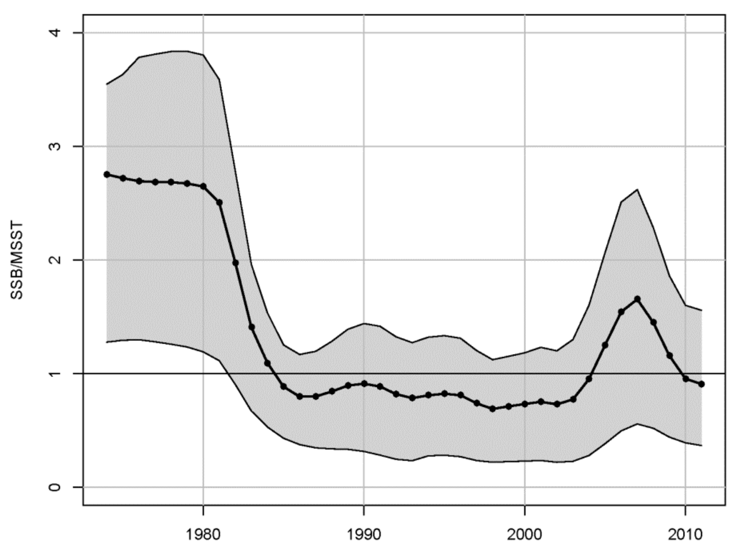

Figure 5.7a: Estimated time relative to benchmarks. Solid line indicates estimates from base run of Beaufort Assessment Model; gray error bands indicate 5th and 95th percentiles of the MCB trials. Spawning biomass relative to the minimum stock size threshold (MSST). *(Extracted from Figure 3.28 of the Assessment Report.)*

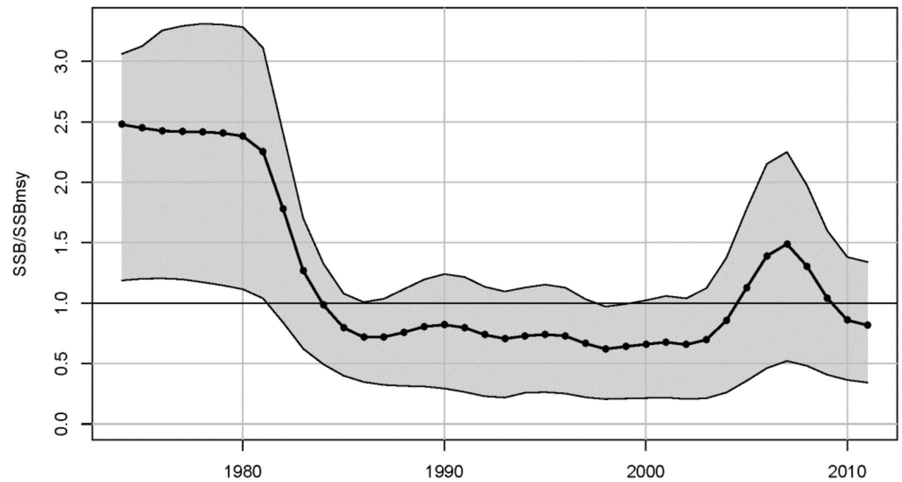

Figure 5.7b: Estimated time relative to benchmarks. Solid line indicates estimates from base run of Beaufort Assessment Model; gray error bands indicate 5th and 95th percentiles of the MCB trials. Spawning biomass relative to SSB_{MSY}. *(Extracted from Figure 3.28 of the Assessment Report.)*

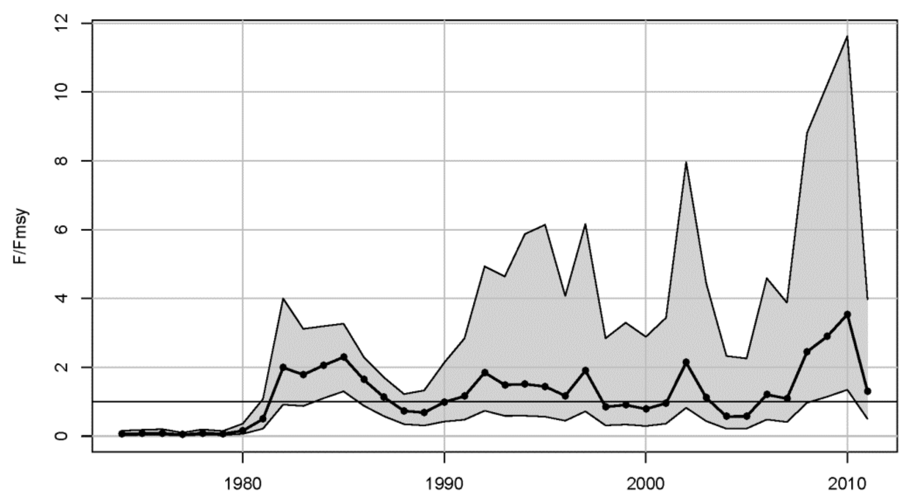

Figure 5.7c: Estimated time relative to benchmarks. Solid line indicates estimates from base run of Beaufort Assessment Model; gray error bands indicate 5th and 95th percentiles of the MCB trials. F relative to F_{MSY}. *(Extracted from Figure 3.28 of the Assessment Report.)*

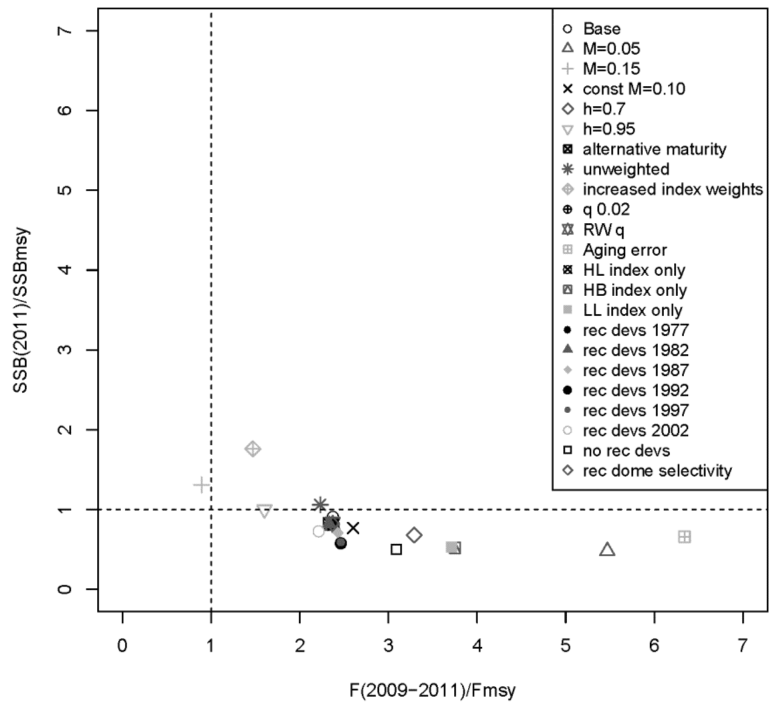

Figure 5.8: Phase plot of terminal status estimates from sensitivity runs of the Beaufort Assessment Model. *(Extracted from Figure 3.41 of the Assessment Report.)*

6. SEDAR Abbreviations

ABC	Allowable Biological Catch
ACCSP	Atlantic Coastal Cooperative Statistics Program
ADMB	AD Model Builder software program
ALS	Accumulated Landings System; SEFSC fisheries data collection program
ASMFC	Atlantic States Marine Fisheries Commission
B	stock biomass level
BMSY	value of B capable of producing MSY on a continuing basis
CFMC	Caribbean Fishery Management Council
CIE	Center for Independent Experts
CPUE	catch per unit of effort
EEZ	exclusive economic zone
F	fishing mortality (instantaneous)
FMSY	fishing mortality to produce MSY under equilibrium conditions
FOY	fishing mortality rate to produce Optimum Yield under equilibrium
FXX% SPR	fishing mortality rate that will result in retaining XX% of the maximum spawning production under equilibrium conditions
FMAX	fishing mortality that maximizes the average weight yield per fish recruited to the fishery
F0	a fishing mortality close to, but slightly less than, Fmax
FL FWCC	Florida Fish and Wildlife Conservation Commission
FWRI	(State of) Florida Fisheries and Wildlife Research Institute
GA DNR	Georgia Department of Natural Resources
GLM	general linear model
GMFMC	Gulf of Mexico Fishery Management Council
GSMFC	Gulf States Marine Fisheries Commission

GULF FIN	GSMFC Fisheries Information Network
M	natural mortality (instantaneous)
MARMAP	Marine Resources Monitoring, Assessment, and Prediction
MFMT	maximum fishing mortality threshold, a value of F above which overfishing is deemed to be occurring
MRFSS	Marine Recreational Fisheries Statistics Survey; combines a telephone survey of households to estimate number of trips with creel surveys to estimate catch and effort per trip
MRIP	Marine Recreational Information Program
MSST	minimum stock size threshold, a value of B below which the stock is deemed to be overfished
MSY	maximum sustainable yield
NC DMF	North Carolina Division of Marine Fisheries
NMFS	National Marine Fisheries Service
NOAA	National Oceanographic and Atmospheric Administration
OY	optimum yield
SAFMC	South Atlantic Fishery Management Council
SAS	Statistical Analysis Software, SAS Corporation
SC DNR	South Carolina Department of Natural Resources
SEAMAP	Southeast Area Monitoring and Assessment Program
SEDAR	Southeast Data, Assessment and Review
SEFIS	Southeast Fishery-Independent Survey
SEFSC	Fisheries Southeast Fisheries Science Center, National Marine Fisheries Service
SERO	Fisheries Southeast Regional Office, National Marine Fisheries Service
SPR	spawning potential ratio, stock biomass relative to an unfished state of the stock
SSB	Spawning Stock Biomass
SSC	Science and Statistics Committee

TIP	Trip Incident Program; biological data collection program of the SEFSC and Southeast States.
VIMS	Virginia Institute of Marine Science
Z	total mortality, the sum of M and F

SEDAR

Southeast Data, Assessment, and Review

SEDAR 32

South Atlantic Blueline Tilefish

SECTION II: Data Workshop Report

April 18, 2013

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

Contents

1. Introduction

1.1 Workshop Time and Place

The SEDAR 32 Data Workshop was held February 11 – 15, 2013 in North Charleston, South Carolina. Webinars were held January 16, 2013 and March 12, 2013.

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.
   - Evaluate age, growth, natural mortality, and reproductive characteristics.
   - Provide appropriate models to describe growth, maturation, and fecundity by age, sex, or length as applicable.
   - Evaluate the adequacy of available life-history information for conducting stock assessments and recommend life history information for use in population modeling.
3. Recommend discard mortality rates.
   - Review available research and published literature.
   - Consider research directed at these species as well as similar species from the SE and other areas.
   - Provide estimates of discard mortality rate by fishery, gear type, depth, and other feasible or appropriate strata.
   - Include thorough rationale for recommended discard mortality rates.
   - Provide justification for any recommendations that deviate from the range of discard mortality provided in the last benchmark or other prior assessment.
4. Provide measures of population abundance that are appropriate for stock assessment.
   - Consider and discuss all available and relevant fishery dependent and independent data sources.
   - Document all programs evaluated; address program objectives, methods, coverage, sampling intensity, and other relevant characteristics.
   - Provide maps of fishery and survey coverage.
   - Develop fishery and survey CPUE indices by appropriate strata (e.g., age, size, area, and fishery) and include measures of precision and accuracy.
   - Discuss the degree to which available indices adequately represent fishery and population conditions.
   - Recommend which data sources are considered adequate and reliable for use in assessment modeling.
   - Complete the SEDAR index evaluation worksheet for each index considered.
   - Rank the available indices with regard to their reliability and suitability for use in assessment modeling.

5. Provide commercial catch statistics, including both landings and discards in both pounds and number.
    - Evaluate and discuss the adequacy of available data for accurately characterizing harvest and discard by species and fishery sector or gear.
    - Provide length and age distributions for both landings and discards if feasible.
    - Provide maps of fishery effort and harvest.
6. Provide recreational catch statistics, including both landings and discards in both pounds and number.
    - Evaluate and discuss the adequacy of available data for accurately characterizing harvest and discard by species and fishery sector or gear.
    - Provide length and age distributions for both landings and discards if feasible.
    - Provide maps of fishery effort and harvest.
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. Prepare the Data Workshop report providing complete documentation of workshop actions and decisions in accordance with project schedule deadlines (Section II. of the SEDAR assessment report).

1.3 List of Participants

Data Workshop Panelists

Kate Andrews NMFS/SEFSC
Neil Baertlein, NMFS/SEFSC
Joey Ballenger, SCDNR
Carolyn Belcher, GADNR/SSC
Ken Brennan, NMFS/SEFSC
Mark Brown, SC Charter/Headboat
Steve Brown, FL FWC
Mike Burton, NMFS/SEFSC
Julie Califf, GADNR*
Dan Carr, NMFS/SEFSC
Rob Cheshire, NMFS/SEFSC
Chip Collier, NCDMF/SSC
Lew Coggins, NMFS/SEFSC
Michael Cooper, NMFS/SEFSC
Kevin Craig, NMFS/SEFSC
Julie DeFilippi, ACCSP
Amy Dukes, SCDNR
Eric Fitzpatrick, NMFS/SEFSC
Eric Hiltz, SCDNR
Robert Johnson, FL Charter/Headboat
Amanda Kelly, SCDNR/CofC
Kathy Knowlton, GADNR*
Kevin Kolmos, SCDNR
Mark Marhefka, SC Commercial*
Ed Martino, ACCSP*
Vivian Matter, NMFS/SEFSC
Kevin McCarthy, NMFS/SEFSC
Stephanie McInerny, NCDMF
Paulette Mikell, SCDNR
Andy Ostrowski, NMFS/SEFSC
Michelle Pate, SCDNR
Jennifer Potts, NMFS/SEFSC
Marcel Reichert, SSC
Beverly Sauls, FL FWC
Michael Schmidtke, ODU
George Sedberry, SSC

Dave Gloeckner, NMFS/SEFSC
Terrell Gould, NC Charter/Headboat*
David Grubbs, FL Commercial
Dewey Hemilright, NC Commercial
Kyle Shertzer, NMFS/SEFSC
Chris Wilson, NCDMF
David Wyanski, SCDNR
Kelly Fitzpatrick, NMFS/SEFSC

* Appointees marked with an * were appointed to the workshop panel but did not attend the workshop. They provided data and reviewed the use of the data, and were available via email or phone for questions as needed.

Council Representative
Michelle Duvall, SAFMC

Council and Agency Staff
Julia Byrd, SEDAR Coordinator
Tyree Davis, NMFS/SEFSC
Michael Errigo, SAFMC Staff
Andrea Grabman, SEDAR
Myra Brower, SAFMC Staff
Julie Neer, SEDAR
John Carmichael, SEDAR/SAFMC Staff

Data Workshop Observers
Joe Evans, SCDNR
Dawn Glascow, SCDNR
Rusty Hudson, DSF, Inc.
Betsy Laban, NOS/SCDNR
Jessica Lewis, NMFS/SEFSC
Adam Lytton, SCDNR
Lisa Scarano, SCDNR

1.4 List of Data Workshop Working Papers

South Atlantic blueline tilefish and gray triggerfish data workshop document list.

Document #	Title	Authors
Documents Prepared for the Data Workshop		
SEDAR32-DW01	MRIP Recreational Survey Data for Gray triggerfish and Blueline tilefish in the Atlantic	Matter 2013
SEDAR 32-DW02	MRFSS to MRIP Adjustment Ratios and Weight Estimation Procedures for South Atlantic and Gulf of Mexico Managed Species	Matter and Rios 2013
SEDAR32-DW03	Report on Age Determination and Reproductive Classification Workshops for Gray Triggerfish (*Balistes capriscus*), September 2011 and October 2012	Kolmos et al. 2013
SEDAR32-DW04	Trends in relative abundance of gray triggerfish in waters off the SE US based on fishery-independent surveys	Ballenger et al. 2013
SEDAR32-DW05	Marine Resources Monitoring, Assessment and Prediction Program: Report on South Atlantic Gray Triggerfish, *Balistes capriscus*, for the	Kolmos et al. 2013

	SEDAR 32 Data Workshop	
SEDAR32-DW06	Evaluation of MRFSS Intercept Data for Developing Gray Triggerfish and Blueline Tilefish Abundance Indices	Martino et al. 2013
SEDAR32-DW07	Fractions of Blueline Tilefish and Gray Triggerfish to Total Tilefishes and Triggerfishes from Sampling Data (TIP) 1983-2012	Beerkircher and Gloeckner 2013
SEDAR32-DW08	SCDNR Charterboat Logbook Program Data, 1993 - 2011	Errigo et al. 2013
SEDAR32-DW09	Standardized catch rates of Southeast US Atlantic gray triggerfish (*Balistes capriscus*) from headboat logbook data	Sustainable Fisheries Branch, NMFS 2013
SEDAR32-DW10	Standardized catch rates of U.S. gray triggerfish (*Balistes capriscus*) from commercial logbook data	Sustainable Fisheries Branch, NMFS 2013
SEDAR32-DW11	Calculated discards of gray triggerfish and blueline tilefish from US South Atlantic commercial fishing vessels	McCarthy 2013
SEDAR32-DW12	Discard Mortality Reference List	Discard mortality sub-group 2013
SEDAR32-DW13	Standardized catch rates of Southeast US Atlantic blueline tilefish (*Caulolatilus microps*) from headboat logbook data	Sustainable Fisheries Branch, NMFS 2013
SEDAR32-DW14	A Summary of Data on the Size Distribution and Release Condition of Gray Triggerfish Discards from Recreational Fishery Surveys in the Atlantic Ocean	Sauls et al. 2013
SEDAR32-DW15	Indices of Abundance Report Cards	SEDAR 32 Panel
SEDAR32-DW16	Standardized catch rates of U.S. blueline tilefish (*Caulolatilus microps*) from commercial logbook handline data	Sustainable Fisheries Branch, NMFS 2013
SEDAR32-DW17	Standardized catch rates of U.S. blueline tilefish (*Caulolatilus microps*) from commercial logbook longline data	Sustainable Fisheries Branch, NMFS 2013
SEDAR32-DW18	Standardized catch rates of gray triggerfish (*Balistes capriscus*) from headboat at-sea-observer data	Sustainable Fisheries Branch, NMFS 2013
	Reference Documents	
SEDAR32-RD01	List of documents and working papers for SEDAR 4 (Caribbean – Atlantic Deepwater Snapper Grouper) – all documents available on the SEDAR website.	SEDAR 4
SEDAR32-RD02	Comparison of Reef Fish Catch per Unit Effort and Total Mortality between the 1970s and 2005–2006 in Onslow Bay, North Carolina	Rudershausen et al. 2008
SEDAR32-RD03	Source document for the snapper-grouper fishery	SAFMC 1983

	of the South Atlantic region.	
SEDAR32-RD04	FMP, regulatory impact review, and final environmental impact statement for the SG fishery of the South Atlantic region	SAFMC 1983
SEDAR32-RD05	Age, growth and reproductive biology of blueline tilefish along the southeastern coast of the United States, 1982-99	Harris et al. 2004
SEDAR32-RD06	List of documents and working papers for SEDAR 9 (Gulf of Mexico Gray Triggerfish, Greater Amberjack, and Vermillion Snapper)	SEDAR 9
SEDAR32-RD07	Estimated Conversion Factors for Adjusting MRFSS Gulf of Mexico Red Snapper Catch Estimates and Variances in 1981-2003 to MRIP Estimates and Variances	Rios et al. 2012
SEDAR32-RD08	Estimates of Historic Recreational Landings of Spanish Mackerel in the South Atlantic Using the FHWAR Census Method	Brennan and Fitzpatrick 2012
SEDAR32-RD09	Excerpt from ASMFC Atlantic Croaker Stock Assessment & Peer Review Reports 2003 – Information on Jacquard Index	ASMFC 2003
SEDAR32-RD10	Survival estimates for demersal reef fishes released by anglers	Collins 1994
SEDAR32-RD11	Indirect estimation of red snapper (Lutjanus campechanus) and gray triggerfish (Balistes capriscus) release mortality	Patterson et al. 2002
SEDAR32-RD12	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
SEDAR32-RD13	Commercial catch composition with discard and immediate release mortality proportions off the southeastern coast of the United States	Stephen and Harris 2010
SEDAR32-RD14	Migration and Standing Stock of Fishes Associated with Artificial and Natural Reefs on Georgia's Outer Continental Shelf	Ansley & Harris 1981
SEDAR32-RD15	Age, Growth, and Reproductive Biology of the Gray Triggerfish (*Balistes capriscus*) from the Southeastern United States, 1992-1997	Moore 2001

2. Life History

2.1 Overview

Group Membership

Jennifer Potts – NMFS, Leader
Katie Andrews – NMFS
Michael Burton – NMFS
Daniel Carr – NMFS
Michael Cooper – NMFS
Chip Collier – NCDMF, SSC
Robert Johnson – Fishing Industry
Amanda Kelly – SCDNR, College of Charleston
Kevin Kolmos - SCDNR
Jessica Lewis - NMFS
Paulette Mikell - SCDNR
Andy Ostroswki - NMFS
Marcel Reichert – SCDNR, SSC
Michael Schmidtke - ODU
George Sedberry – NOAA, SSC
Tracey Smart - SCDNR
David Wyanski - SCDNR

Discard Mortality Ad-hoc Subgroup

Carolyn Belcher – GADNR, SSC, Leader
Beverly Sauls – FL FWC
Chip Collier – NCDMF, SSC
David Grubbs – Fishing industry
Robert Johnson – Fishing industry
Kevin McCarthy – NMFS

Observers

Joseph Evans
Sharleen Johnson
Adam Lytton
Lisa Scarano

Issues

The Life History Work Group (LH group) was tasked with defining the South Atlantic stock, calculating meristic conversion equations, combining age data sets for various laboratories, producing growth models for the population and the fisheries, recommending various reproductive parameters and estimating natural mortality. There was concern about the validation of opaque zones on the otoliths as annuli and consistency in age readings between the laboratories processing the otoliths. An age workshop was held and calibration sets were exchanged between labs to address these issues. The limited life history data was also a major concern.

2.2 Review of Working Papers

There were no working papers to review for the LH group.

2.3 Stock Definition and Description

Blueline tilefish are distributed from Campeche, Mexico northward to Cape Charles, Virginia (Dooley 1978) with reports of catches as far north as Maine. There is no known information on different stock structures throughout the geographic range, however a proposal by VIMS to investigate stock structure using molecular genetics is being monitored. The development of a recreational fishery for deep-water snapper-grouper (including blueline tilefish) off Virginia since the 2000s suggests a portion of the population resides north of Cape Hatteras, a biogeographic break for many species Blueline tilefish inhabit the shelf edge and upper slope reefs at depths of 46-256m (Sedberry et al. 2006) and temperatures between 15-23°C, where they construct burrows in relatively soft, sandy sediments at 91-150m depth (Able, et al. 1987). Primarily used for predator avoidance, they can be occupied by up to three individuals as well as other species. Blueline tilefish are considered opportunistic predators that feed on prey associated with substrate (crabs, shrimp, fish, echinoderms, polychaetes, etc) (Ross 1982). They are considered relatively sedentary and are not thought to undertake north-south migrations along the coast. Based on what is known about the geographic range from landings data and other sources, it is recommended to have two stock jurisdictions: Gulf of Mexico and South Atlantic.

Recommendation: South Atlantic stock includes the SAFMC jurisdiction of the Florida Keys, South of US Hwy 1, northward along the east coast of Florida to as far north as landings of blueline tilefish are recorded from the US Atlantic waters.

2.4 Natural Mortality

The LH group reviewed natural mortality (M) estimators used in past SEDARs, a review paper on M (SEDAR19-RD29), and a relatively new estimator from Charnov et al. (2012). The LH group discussed the likelihood that the natural mortality rate varies by age, and an age-variable approach was advocated (e.g., SEDARs 4, 10, 12,15A, 19, and 22). Three methods for estimating age-dependent natural mortality were discussed - Lorenzen (2005), Gislason et al. (2010), and Charnov et al. (2012). Charnov et al. (2012) provides an equation which is an improvement to the empirical equation in Gislason et al. (2010). Charnov et al. (2012) also provide meta-analyses that include the Lorenzen (2005) equation as well as other estimators of M. They also take into account various aspects of life history traits and habitat of a wide variety of exploited marine and brackish water fishes. The LH group agreed that the Charnov et al. (2012) equation was the best initial estimate of M-at-age. Though, as in past SEDARs, which used the age-varying M calculated from Lorenzen, the asymptotic M was much higher than Hewitt and Hoenig (2005) estimate, 0.10. Considering the longevity of the species and other life history traits, as well as consistency with past SEDARs, the Charnov M curve was scaled to the Hewitt and Hoenig (2005) point estimate based on the survivorship of the fully recruited ages (Figure 1). Another consideration was the percent survivorship to the oldest age of the fully recruited ages. The unscaled Charnov mortality resulted in 0% surviving to maximum age. The scaled Charnov mortality resulted in 2.5% of the population surviving to the oldest age. Because the age data, limited as they are, do include fish that are in their 20s, 30s and 40s, it is more biologically reasonable to assume survivorship to age 43 is greater than zero.

Life history parameters derived from the combined age data sets were used in the calculations of M. Maximum age in the blueline tilefish population was 43 years. The age at full recruitment to the fishery was age-7seven based on inspection of age composition data. The estimated size of the fish at each age was calculated from the von Bertalanffy growth model for the entire population (see Table 3). The results are shown in Figure 1.

Recommendation: Use the Charnov natural mortality curve scaled to the Hewitt and Hoenig point estimate for the assessment. Variance about the M curve will be investigated for the Assessment Workshop.

2.5 Discard Mortality

A literature search yielded no peer-reviewed sources of information on discard mortality for blueline tilefish. Data presented in SEDAR32 – DW11 from the commercial discard logbook indicate that the majority of discarded blueline tilefish are dead (Table 1). To be consistent with other deepwater species (i.e., snowy grouper, golden tilefish) that have been assessed through the SEDAR process, the subgroup recommended assuming a discard mortality of 100%. However, if new management is implemented to reduce the discard mortality rate, it might be appropriate for population projections to consider something lower than 100%. The fate of the fish swimming down is unknown but currently the survivorship is thought to be low.

2.6 Age

Age data sets for blueline tilefish were available from NMFS Beaufort Laboratory (NMFS), SCDNR, and ODU (Table 2). The NMFS dataset included fishery-dependent age samples from the commercial and recreational fisheries operating from Virginia to the east coast of Florida from 2003 – 2011 (n=3,085). The SCDNR dataset included fishery-independent and fishery-dependent age samples from North Carolina through Florida for the years 1982-1987, 1991, and 1996-1998 (n = 955; Harris et al. 2004). The ODU dataset included fishery-independent and fishery-dependent age samples from Virginia from 2009-2011 (n = 893) (Table 2).

Consistency in age determination between the labs is required to be able to combine data sets for the assessment model. The three labs participated in an age workshop to discuss processing techniques and growth zone interpretation of the sagittal otoliths. All three labs acknowledged the difficulty in aging this species, because the opaque zones were difficult to distinguish as annuli. At the time of the SEDAR32 Data Workshop, no age validation analysis has been completed, though ODU is conducting a marginal increment analysis. To determine consistency in age readings, 280 prepared samples were exchanged between the laboratories, of which 271 were read by all four “readers”. The average difference in annuli counts was 4 and ranged from 0 – 14. One measure of consistency is the average percent error (APE) between all readers. ODU and SCDNR provided consensus readings and NMFS provided two individual readers’ data. Overall APE between the four readers was 25%, which points to a large inconsistency in age estimation between laboratories. ODU and SCDNR appeared to be the most consistent in age readings with an APE of 12%. Between NMFS and SCDNR, the APE was 20%. Between NMFS and ODU, the APE was 25%. APE does not account for any bias in age readings. Bias plots of the paired age readings did not reveal a significant bias between laboratories, though there was some concern that SCDNR and ODU did age the fish older than NMFS. An age error matrix will be developed from these paired age readings to account for the difference in ageing.

To address the issue of the adequacy of the age samples to be used in the assessment, the LH group discussed the sampling methodology to obtain them. NMFS fishery-dependent age samples were assumed to be randomly collected from the fisheries according to TIP, Headboat Survey and MRIP protocols. NMFS fishery-dependent samples were dominated by commercially landed fish and very few recreational samples (n = 96). The commercial age samples came from two distinct gears – longline (LL) and vertical hook and line (HL) gear. The LH group felt that the recreational fishery would have been fishing in the same habitats as the commercial hook and line fishery; therefore, the selectivity of commercial and recreational HL gear are probably similar. Fishery-dependent samples in the SCDNR age data set were not randomly collected and represented only one vessel fishing off SC. Thus, SCDNR fishery-dependent samples will not be used in the age composition data for the commercial catch. The Fishery-independent samples were consistent with MARMAP survey protocol and were representative of the fish caught in the survey. ODU samples were collected using both fishery dependent (n=783) and fishery independent sampling (n=200) and include only fish landed in Virginia. Fishery independent samples were caught in Norfolk Canyon, approximately 70 miles east of Virginia Beach, VA. Blueline tilefish were caught at depths of around 200-600 feet, typically in hard-bottomed areas. Fishery dependent sampling consisted of both cleaned carcasses and whole fish donated by recreational (n=730) and commercial fishermen (n=53). Carcasses were stored in freezers at local cleaning stations prior to being transported to the Center for Quantitative Fisheries Ecology (CQFE) for processing.

The portion of the blueline tilefish stock off of Virginia appears to have undergone more recent exploitation compared to the rest of the South Atlantic. Mean length-at-age of the Virginia fish was different from the rest of the South Atlantic, with smaller size at age for fish < 11 years old and larger size at age for fish >11 years old for Virginia fish compared to the rest of the South Atlantic (Figure 2). This could be due to latitudinal gradients in growth, as has been seen for other species, the more recent exploitation history of the Virginia fishery, the non-random nature of the majority of the Virginia samples, and/or errors in aging. Because of these issues, the LH group felt that fishery-dependent samples from Virginia should be used with caution in characterizing the age composition of the entire South Atlantic fishery.

Recommendations:
An age error matrix needs to be used in the assessment model to account for differences and uncertainty in ageing of blueline tilefish between laboratories.

SCDNR fishery-dependent age samples should not be used in the age composition of the fishery landings.

Selectivity of the commercial hook and line fishery appears similar to that of the recreational hook and line fishery.

NMFS commercial hook and line and longline age samples should be used separately in the age composition of the commercial landings.

2.7 Growth

The blueline tilefish, like other tilefish species, is a large, long-lived fish, ranging up to about 900 mm FL and 43 years. This species also exhibits dimorphic growth with males attaining larger size-at-age than females. Males are predominant in the size categories greater than 650 mm FL. Because the commercial fishery tends to land blueline tilefish gutted, the sex of the fish is not recorded. For the purposes of this assessment, the LH group modeled population growth for all samples combined (Figure 3) from VA through the east coast of FL. Because of the perceived difference in size at age of the VA fish compared to the fish from NC – FL, population growth was modeled on the age samples from NC – FL only. The resulting growth model was essentially the same as when VA fish were included. The fish caught off of VA are considered a part of the South Atlantic stock and should be included in the calculation of growth. Population growth for females only, which can be used in calculating spawning biomass, was calculated also (Figure 4). Due to lack of the small fish (<250 mm FL), the limited range of ages (3 – 13 years) over which samples were available, and the sexually dimorphic growth pattern, the von Bertalanffy growth model had difficulty fitting the data, especially for growth in the first few years. The model estimated large, negative t_0 values, thus the LH group fixed t_0 to a more biologically reasonable value of -0.5 for the population (Table 3). The spread of residuals about the theoretical values were evenly distributed with no apparent bias or skew.

To estimate the size-at-age of fish landed in the fishery, growth was modeled for all fishery-dependent samples from NC through the east coast FL and for Virginia through the east coast of FL, due to the reasons stated in section 1.6 (Figure 5). The model was allowed to freely estimate all parameters. All parameter values, standard errors and 95% confidence intervals are in table 3.

Recommendations:

Use population growth model with t_0 fixed to -0.5 for the entire stock.

Use female growth model with t_0 fixed to -0.5 for entire stock to estimate spawning biomass.

To estimate size-at-age of fish caught in the fisheries, use VA-FL specific model.

2.8 Reproduction

2.8.1 Spawning Seasonality

The earliest study in the region on reproduction in female blueline tilefish found that spawning off the Carolinas takes place between April and October, with data from North Carolina showing peaks in May-June and September-October (Ross and Merriner 1983). The spawning season coincides with rapid increases and decreases in day length, which is a more conservative cue than bottom temperatures at shelf edge habitats given that the seasonal profile of temperature can be masked by cold-water intrusions from deeper areas and meandering of the Gulf Stream (Ross and Merriner 1983). Based on a larger sample size (n=586 vs. n < 200), Harris et al. (2004) reported an even longer spawning season, February - October, with a peak in a gonadosomatic index (GSI) during May. Both studies examined specimens captured off the Carolinas and utilized a histological method as well as a GSI to characterize reproductive seasonality. Blueline tilefish probably spawn in the evening time based on prevalence of hydrated oocytes still surrounded by a follicle cell layer during daylight hours (Harris et al. 2004). They are classified as indeterminate spawners, with up to 120 spawnings per individual based on the estimates of a spawning event every 2 days during a spawning season of approximately 240 d (Harris et al. 2004). After the Data Workshop, the data from Harris et al. (2004) were examined to re-assess the estimate of spawning season duration. Given the small sample size for February (n=2), the start of the spawning season for the assessment is considered to be late March (26^{th}), which is the next date on which a spawning individual was captured. The revised estimates of spawning season duration and number of spawning events per season will therefore be 219 d and 110, respectively.

Recommendation (presented at the 12 March webinar):
For the assessment, spawning season duration and number of spawning events per season will be 219 d (March 26 through October 30) and 110 events rather than 240 d and 120 events in Harris et al. (2004).

2.8.2 Fecundity and Spawning Frequency

Ross and Merriner (1983) provides equations to estimate fecundity in blueline tilefish based on total length or whole fish weight, but those equations yield a point estimate (i.e., total fecundity at a point in time), not an estimate of potential annual fecundity (PAF). Estimates of batch fecundity and spawning frequency are necessary to estimate PAF in species with indeterminate fecundity. Harris et al. (2004) provides equations to estimate batch fecundity based on total length, fork length, and whole fish weight (Table 4). Batch fecundity was not regressed against age owing to the low number (n=10) of specimens assigned an age. To estimate spawning frequency, Harris et al. (2004) examined the occurrence of migratory nucleus or hydrated oocytes, which are indicators of imminent spawning, among females that were reproductively active (i.e., presence of oocytes undergoing vitellogenesis) during 1996-1998. The proportion of specimens with these spawning indicators was consistently high, ranging from 0.68 to 0.75 in

April, June, July, and September, the exception being August (0.18); monthly sample sizes ranged from 22 in August to 53 in April. The average monthly proportion was 0.64, a value similar to the proportion (0.59; n=472) observed in samples from all years (1980-1999). The inverse of these proportions corresponded to the occurrence of a spawning event approximately every 2 d.

After the Data Workshop, the data from Harris et al. (2004) were examined to re-assess the estimate of spawning frequency because there was concern among the workshop panel that use of the number of spawning events (120) reported in the publication would cause the assessment model to overestimate the reproductive potential of the population. Put another way, the workshop panel wondered if each adult female in the population exhibits this high level of reproductive activity throughout the spawning season. To address this question, an analysis was run to calculate the proportion of spawners among all adult females (active+inactive) by month. This calculation differs from spawning frequency, which considers only the reproductively active females (i.e., those with oocytes undergoing vitellogenesis, thus they have potential to spawn in the current season).

The results confirm that blueline tilefish are prolific spawners, as the proportion of females with at least one indicator of imminent spawning or recent spawning (postovulatory follicles) ranges from 0.71 to 0.93 during Mar through Oct (Table 5); the mean size of the specimens sampled over those months was similar (503-550 mm TL). To determine if age (size) has an effect on spawning proportion, the data were also examined by 5-yr age groups within month. The results showed that the average monthly proportion of spawners at Ages 11+ was high (≥ 0.90) and the monthly values relatively consistent over most (April-October) of the spawning season (Table 6). At younger ages, the average monthly proportion was somewhat lower, 0.65 for Ages 2-5 and 0.76 for Ages 6-10, and the monthly values less consistent. Similar trends were evident when proportion spawners was examined by 100-mm FL size classes (Table 7)

Multiplying the estimated number of spawning events (110) by batch fecundity (BF) estimates for blueline tilefish 341-591 mm FL ($\log_e$ BF=7.310 + 0.00701*FL) yields estimates of PAF that range from 1,795,700 to 10,359,200 oocytes.

Recommendations (presented at the 12 March webinar):
Utilize the estimates of batch fecundity and spawning frequency found in Harris et al. (2004).

To calculate potential annual fecundity (PAF), utilize the modified number of spawning events (n=110) noted in the Spawning Seasonality sub-section. The estimates of PAF for Ages ≤ 10 could be reduced to reflect the proportion of spawners at those ages by using the overall proportion of spawners at those ages during March – October (see Table 6).

2.8.3 Age and size at maturity

The MARMAP database has only three immature female and two immature male blueline tilefish. The smallest mature female was 338 mm TL, and the youngest was Age 2; the largest immature female was 387 mm TL and the oldest was Age 6 (Tables 8 and 9). The smallest mature male was 385 mm TL, and the youngest was Age 3; the largest immature male was 440 mm TL and the oldest was Age 3 (Tables 10 and 11). The female maturity ogive was produced by using information from two sources, the data from a published study (Harris et al. 2004) and the maturity ogive used for tilefish (*Lopholatilus chamaeleonticeps*) in SEDAR25. The observed maturity data for these two tilefish species, albeit limited at critical ages, does appear to reveal a similar pattern. It should be noted that the proportion mature based on observed data available for blueline tilefish ≥ Age 3 matches the maturity ogive used for SEDAR25 except for Age 6. In addition to reporting observed data from Harris et al. (2004), predicted values of proportion mature were generated using the standard normal cumulative distribution function for use in a sensitivity run (Table 9). For females, age at 50% maturity (A_{50}) appears to be around 3 yr. For males, A_{50} appears to be < 3 yr (Tables 9 and 11).

Recommendation (presented at the 12 March webinar):

For the base run of the assessment model, the workgroup recommends use of the female maturity ogive for tilefish in SEDAR25: 10% at Age 1, 25% at Age 2, 50% at Age 3, and 100% at Age 4 and older. If included in the model, the Age 0 value should be 0%. The workgroup also includes the caveat that the assessment team is given liberty to investigate other methods to estimate values for Ages 0-3. The assessment team may choose to use the sensitivity run proposed by the workgroup (Table 9), which differs by using predicted values generated from data in Harris et al. (2004) for Ages ≥ 3. The value for Age 3 allows for a steeper slope at the inflection point, with a more gradual rise thereafter to 100% maturity.

2.8.4 Sex Ratio

Two published studies and three unpublished datasets were examined to determine a value for the sex ratio in the adult portion of the blueline tilefish population (Table 12). Three of the six sources showed a 1:1 sex ratio, including the earliest published study (Ross and Merriner 1983) which examined specimens collected from the fishery off the Carolinas during the early years of its development (the 1970s). Data collected during 2009-2011 from a more recently developed fishery off Virginia also revealed a 1:1 ratio. The final dataset with a 1:1 ratio represents samples collected during 1996-1998 by MARMAP, with the limitation that 89% of the samples came from one commercial vessel off the Carolinas. In looking at the three sources that did not show a 1:1 ratio, the fishery-independent dataset from Virginia has the smallest sample size (n=194) and the MARMAP fishery-independent data has evidence of non-randomness in the length data (see Harris et al. (2004)). The NMFS fishery-dependent data is strongly skewed toward males, but may be due to the selectivity of the fishery for the largest fish, either due to gear selectivity or optimization of catch for market purposes.

Recommendation (presented at 12 March webinar):
Utilize a 1:1 sex ratio in the assessment based on the sex ratio observed during the early years of fishery development off the Carolinas and Virginia.

2.9 Movements and Migrations

Blueline tilefish are considered to be sedentary fish. They will construct burrows in sandy areas in close association with rocky outcroppings.

2.10 Meristic Conversions

Length – length, whole weight (WW) – gutted weight (GW), and weight – length conversions were needed for blueline tilefish. Data for the length-length and whole weight – length regressions were pulled from the Headboat Survey, NMFS Trip Interview Program (TIP), Old Dominion University (ODU) blueline tilefish study, SCDNR MARMAP, and Florida FWC. Fork length was agreed upon to be the length type used in the assessment. Linear regressions were run to convert total length and standard length to fork length (Table 13). Log transformed whole weight (kg) and length (mm) regressions were run for all three length types. The regression equations were then converted to power equations which included ½ MSE to account for the transformation bias (Table 13). Whole weight – gutted weight (kg) paired data were obtained from a 2005-2006 Fisheries Resource Grant project in North Carolina and an Atlantic States Marine Fisheries Commission conversion project which obtained data from fish landed in North Carolina. A no-intercept conversion equation was derived from the data: WW = 1.06*GW ($n = 259$, $R^2 = 0.9991$).

2.11 Comments on the Adequacy of Data for Assessment Analyses

The LH group has concerns over the amount and distribution of age samples available for the assessment. The majority of the samples are from the commercial fishery in the most recent decade. Very few age samples were collected from the recreational fisheries from NC – FL. The age samples from VA may have been collected in a non-random manner due to the reliance on donated fish.

The estimates of reproductive parameters are based on the most accurate technique (histology) used to assess reproductive condition in fishes. Sample size limitations have been noted throughout the report where appropriate.

2.12 Literature Cited

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2.13 Tables

Table 1. Reported discard dispositions for blueline tilefish from commercial logbooks. Totals of 'kept as bait' were excluded from this table. N fish is the total number of fish discarded. Totals may not sum to 100 percent due to data confidentiality constraints.

Species	Gear	All dead	Majority dead	All alive	Majority alive	Unable to determine	Not reported	N fish
Blueline tilefish	Vertical line	92.9%						28

Table 2. Count of blueline tilefish age samples available for SEDAR32. A. Commercial table: HL = vertical hook and line; LL = longline; TR = traps. B. Recreational table: CB = charter boat; HB = headboat; Virginia Unknown = charter boat and headboat combined. C. Fishery-independent: same gear codes as commercial.

a. Commercial

	Handline				Longline			Trap	Grand Total
Year	FL	VA	NC	SC	FL	NC	SC	NC	
2003	1				5				6
2004						2			2
2005	8		22				21		51
2006				16			30		46
2007	8		58	21	21		3		111
2008	24		61	22		20	15		142
2009	36		60	26		509	7		638
2010	39		113	28		701	70	6	957
2011		50	104	1		571			726
Grand Total		50	418	114	26	1803	146	6	2679

b. Recreational

	FL			NC		VA	Grand Total
Year	CH	HB	Unknown	CH	HB	Unknown	
2003				20			20
2007						72	72
2008					1	67	68
2009	8	2				87	97
2010			7			191	198
2011		43	15			388	446
Grand Total	8	45	22	20	1	805	901

c. Fishery-Independent

Year	NC	SC	VA	Grand Total
1982		223		223
1983		145		145
1984		45		45
1985		50		50
1986		65		65
1987		1		1
1991		1		1
1996		7		7
1997		29		29
1998		16		16
1999				
2000				
2001				
2002				
2003	24			24
2004				
2005	125			125
2006	54			54
2008				
2009				
2010			75	75
2011			102	102
Grand Total	**203**	**582**	**177**	**962**

Table 3. Blueline Tilefish von Bertalanffy growth model parameters.

Model	**t0**	**L_∞**	**K**	**t_0**	**CV**
Popn-all fish	t0 estimated	609.3 (3.396)	.281 (.01065)	-1.112 (0.14683)	.1555 (0.00161)
Popn-all fish	t0 fixed	600.3 (2.541)	.3296 (.00528)	-0.5	.15596 (.001610)
Popn-female	t0 estimated	615.7 (10.296)	.1113 (.01020)	-5.082 (0.007094)	.13853(.003197)
Popn-female	t0 fixed	554.9(4.346)	.2581 (.007272)	-0.5	.15103 (.003497)
Fishery-all fish	t0 estimated	621.3 (4.287)	.28152 (.012385)	-1.2473 (0.17607)	.15151 (.001697)

Table 4. Linear regression coefficients and 95% confidence intervals for the relationship between $\log_e$ batch fecundity (BF; number of hydrated and migratory nucleus oocytes) and total length (TL, mm), fork length (FL, mm), whole and ovary-free weight (wt, g) in blueline tilefish, *Caulolatilus microps*. Specimens were collected during April through October off North Carolina and South Carolina. Results from MARMAP study by Harris et al. (2004). **P<0.0001 and *P<0.001.

Dependent Variable	Range	a	95% CI	b (X10-3)	95% CI (X 10-3)	Adj. R2	F	n
TL (mm)	366-629	7.266	5.557-8.975	6.670	3.45-9.89	0.306	17.71	39
FL (mm)	341-591	7.310	5.609-9.012	7.010	3.61-10.41	0.302	17.43	39
Whole Wt (g)	560-2880	9.509	8.943-10.076	0.743	0.431-1.055	0.369	23.22	39
Ovary-free wt (g)	544-2732	9.534	8.952-10.116	0.756	0.423-1.089	0.346	21.09	39

Table 5. Proportion of spawning female blueline tilefish among all adult females (active+inactive) by month. Spawners had at least one indicator of imminent or recent spawning (i.e., migratory nucleus oocytes, hydrated oocytes, and postovulatory follicles). MARMAP histology data from Harris et al. (2004) were analyzed.

Month	# spawners	# adults	Proportion spawners
Jan	0	10	0.000
Feb	2	2	1.000
Mar	10	14	0.714
Apr	53	75	0.707
May	125	139	0.899
Jun	80	95	0.842
Jul	38	41	0.927
Aug	54	70	0.771
Sep	133	145	0.917
Oct	19	22	0.864
Nov		0	
Dec		0	
Total	514	613	0.838

Table 6. Proportion of spawning female blueline tilefish among all adult females (active+inactive) by 5-yr age groups within month. Spawners had at least one indicator of imminent or recent spawning (i.e., migratory nucleus oocytes, hydrated oocytes, and postovulatory follicles). MARMAP histology data from Harris et al. (2004) were analyzed.

Month	2-5	n=	6-10	n=	11-15	n=	16-20	n=	21-25	n=	25-43	n=
Jan	0.00	4	0.00	1	0.00	1						
Feb					1.00	1						
Mar	0.50	2	0.80	5					0.67	3		
Apr	0.00	6	0.62	32	0.90	10	1.00	7	1.00	2	1.00	4
May			1.00	7	1.00	20	1.00	7	0.92	13	1.00	9
Jun			0.55	11	0.95	19	0.88	16	0.87	15	0.80	10
Jul	1.00	1	0.75	4	1.00	11	1.00	5	1.00	1	1.00	6
Aug	0.41	17	0.73	30	1.00	17	0.94	18	0.77	13	0.93	14
Sep	1.00	1	0.90	20	0.88	26	1.00	18	1.00	15	0.91	11
Oct	1.00	1	0.75	12	1.00	4	1.00	1	1.00	1		
Nov												
Dec												
Total	**0.65**	32	**0.76**	122	**0.96**	109	**0.97**	72	**0.90**	63	**0.94**	54

(shaded) average monthly proportion for Mar - Oct

Prop. spawners	**0.34**	32	**0.73**	122	**0.94**	109	**0.96**	72	**0.89**	63	**0.93**	54

Table 7. Proportion of spawning female blueline tilefish among all adult females (active+inactive) by 100 mm FL size classes within month. Spawners had at least one indicator of imminent or recent spawning (i.e., migratory nucleus oocytes, hydrated oocytes, and postovulatory follicles). MARMAP data from Harris et al. (2004) were analyzed.

Month	301-400	n=	401-500	n=	501-600	n=	601-700	n=
Jan	0.000	5	0.000	4			0.000	1
Feb					1.000	2		
Mar			0.625	8	0.833	6		
Apr	0.375	8	0.590	39	0.964	28		
May	1.000	2	0.870	46	0.905	84	0.800	5
Jun	0.500	4	0.828	29	0.887	53	0.750	8
Jul			0.857	21	1.000	16	1.000	4
Aug	0.500	16	0.745	47	0.873	71	1.000	9
Sep	0.500	6	0.900	50	0.952	84	1.000	4
Oct			0.750	12	1.000	10		
Nov								
Dec								
Total	**0.575**	41	**0.771**	256	**0.927**	354	**0.910**	31

(shaded) average monthly proportion for Mar - Oct

Prop. Spawners	**0.439**	41	**0.777**	256	**0.918**	354	**0.871**	31

Table 8. Proportion of mature female blueline tilefish by 1-cm TL size classes. MARMAP histology data from Harris et al. (2004) were analyzed.

Length (cm TL)	Immature	Mature	Total	% Mature	Logistic - Cauchy Prop. Mat
33	1	0	1	0.00	0.022
34	1	2	3	0.67	0.949
35	0	0	0	NA	0.988
36	0	1	1	1.00	0.993
37	0	3	3	1.00	0.995
38	0	3	3	1.00	0.996
39	1	4	5	0.80	0.997
40	0	5	5	1.00	0.998
41	0	7	7	1.00	0.998
42	0	16	16	1.00	0.998
43	0	15	15	1.00	0.998
44	0	23	23	1.00	0.999
45	0	17	17	1.00	0.999
46	0	20	20	1.00	0.999
47	0	15	15	1.00	0.999
48	0	30	30	1.00	0.999
49	0	16	16	1.00	0.999
50	0	31	31	1.00	0.999
51	0	26	26	1.00	0.999
52	0	38	38	1.00	0.999
53	0	38	38	1.00	0.999
54	0	49	49	1.00	0.999
55	0	31	31	1.00	0.999
56	0	39	39	1.00	0.999
57	0	40	40	1.00	0.999
58	0	51	51	1.00	0.999
59	0	28	28	1.00	0.999
60	0	41	41	1.00	0.999
61	0	27	27	1.00	0.999
62	0	26	26	1.00	0.999
63	0	21	21	1.00	0.999
64	0	12	12	1.00	0.999
65	0	7	7	1.00	1.000
66	0	8	8	1.00	1.000
67	0	3	3	1.00	1.000
68	0	3	3	1.00	1.000
69	0	0	0	NA	1.000
70	0	2	2	1.00	1.000
71	0	1	1	1.00	1.000

Table 9. Proportion of mature female blueline tilefish by age class. MARMAP histology data from Harris et al. (2004) were analyzed.

Age	MARMAP obs. Data, n=	MARMAP - prop. mat.	Pred. prop. Mature	SEDAR32 Prop. Mature	Source of value	Sensitivity run	Source of value
0			0.540	0.000	Decision of workgroup	0.000	Decision of workgroup
1			0.663	0.100	SEDAR 25 - tilefish	0.100	SEDAR 25 - tilefish
2	1	1.00	0.770	0.250	SEDAR 25 - tilefish	0.250	SEDAR 25 - tilefish
3	2	0.50	0.856	0.500	MARMAP obs., SEDAR25 - tilefish	0.856	MARMAP, predicted
4	5	1.00	0.916	1.000	MARMAP obs., SEDAR25 - tilefish	0.920	MARMAP, predicted
5	25	1.00	0.956	1.000	MARMAP obs., SEDAR25 - tilefish	0.960	MARMAP, predicted
6	27	0.93	0.978	1.000	SEDAR 25 - tilefish	0.980	MARMAP, predicted
7	23	1.00	0.990	1.000	MARMAP obs., SEDAR25 - tilefish	0.990	MARMAP, predicted
8	21	1.00	0.996	1.000	MARMAP obs., SEDAR25 - tilefish	0.996	MARMAP, predicted
9	30	1.00	0.999	1.000	MARMAP obs., SEDAR25 - tilefish	0.999	MARMAP, predicted
10	25	1.00	1.000	1.000	MARMAP obs., SEDAR25 - tilefish	1.000	MARMAP, predicted
11+	304	1.00	1.000	1.000	MARMAP obs., SEDAR25 - tilefish	1.000	MARMAP, predicted

Table 10. Proportion of mature male blueline tilefish by 1-cm TL size classes. MARMAP histology data from Harris et al. (2004) were analyzed.

Length (cm TL)	Immature	Mature	Total	% Mature	Logistic - clog-log Prop. Mat
38	0	1	1	1.00	0.667
39	0	1	1	1.00	0.736
40	1	1	2	0.50	0.801
41	0	2	2	1.00	0.859
42	0	1	1	1.00	0.907
43	0	1	1	1.00	0.943
44	1	11	12	0.92	0.969
45	0	8	8	1.00	0.985
46	0	17	17	1.00	0.994
47	0	9	9	1.00	0.998
48	0	26	26	1.00	0.999
49	0	19	19	1.00	1.000
50	0	28	28	1.00	1.000
51	0	24	24	1.00	1.000
52	0	19	19	1.00	1.000
53	0	23	23	1.00	1.000
54	0	31	31	1.00	1.000
55	0	12	12	1.00	1.000
56	0	15	15	1.00	1.000
57	0	13	13	1.00	1.000
58	0	14	14	1.00	1.000
59	0	8	8	1.00	1.000
60	0	21	21	1.00	1.000
61	0	13	13	1.00	1.000
62	0	17	17	1.00	1.000
63	0	16	16	1.00	1.000
64	0	17	17	1.00	1.000
65	0	10	10	1.00	1.000
66	0	20	20	1.00	1.000
67	0	13	13	1.00	1.000
68	0	15	15	1.00	1.000
69	0	11	11	1.00	1.000
70	0	12	12	1.00	1.000
71	0	9	9	1.00	1.000
72	0	18	18	1.00	1.000
73	0	18	18	1.00	1.000
74	0	7	7	1.00	1.000
75	0	5	5	1.00	1.000
76	0	5	5	1.00	1.000
77	0	1	1	1.00	1.000
78	0	5	5	1.00	1.000

Table 11. Proportion of mature male blueline tilefish by age class. MARMAP histology data from Harris et al. (2004) were analyzed.

Age	Immature	Mature	Total	% Mature	Logistic - Logit Prop. Mat
3	1	3	4	0.75	0.7500
4	0	11	11	1.00	1.0000
5	0	37	37	1.00	1.0000
6	0	37	37	1.00	1.0000
7	0	31	31	1.00	1.0000
8	0	39	39	1.00	1.0000
9	0	27	27	1.00	1.0000
10	0	25	25	1.00	1.0000
11+	0	148	148	1.00	1.0000

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Table 12. Two published studies and three unpublished datasets that were examined to determine a value for sex ratio in the adult portion of the blueline tilefish population.

Data source	Data source	Years	Sampling area	Gear	Method	Adults only?	N =	% female	% male	1:1 sex ratio?	P	Comments
VIMS, NMFS; Fishery-indep. + Fishery.dep	Ross and Merriner (1983)	1972-1977	Carolinas	HL	Most histo.	no	371	47.4	52.6	yes	0.50 > P > 0.25	
MARMAP, 89% fishery-dep.	Harris et al. (2004)	1996-1999	Carolinas	Longline	Histo.	Yes	587	46.0	54.0	yes	0.1 > P > 0.05	One commercial vessel
Old Dominion Univ., Fishery-dep.	unpubl. data	2009-2011	Virginia	HL	Macro.	?	692	49.0	51.0	yes	0.75 > P > 0.50	Mostly recreational
MARMAP, fishery-indep.	Harris et al. (2004)	1982-1987	Carolinas	Bandit, longline, Kali pole	Histo.	Yes	509	68.0	32.0	no	< 0.001	Evidence of non-randomness in LF plot
NMFS, fishery-dep.	unpubl. data	2003-2011	FL, NC	HL, longline	Macro.	?	439	29.0	71.0	no	< 0.001	93% commercial (95% longline)
Old Dominion Univ., fishery-indep.	unpubl. data	2009-2011	Virginia	HL	Macro.	?	194	38.0	62.0	no	< 0.001	Norfolk Canyon; scientists on private charter or headboat

Table 13. Meristic conversion regression equations for blueline tilefish. TIP = NMFS Trip Intercept Program; FWC = Florida Fish and Wildlife Commission; MARMAP = SCDNR Marine Monitoring and Prediction Program; VA = Virginia.

	Length - length					
Source	Equation	Units	n	R^2	SE	Range of X
Headboat Survey, TIP, FWC, MARMAP, VA	**FL = 1.32 + 0.94*TL**	**mm**	**1335**	**0.996**	**0.875, 0.002**	**267 -884**
	FL = 28.28 +1.09*SL	mm	1074	0.988	1.694, 0.004	262 - 672
	TL = 0.66 +1.06*FL	mm	1335	0.996	0.930, 0.002	220 - 833
	TL = 25.22 + 1.17*SL	mm	1523	0.981	1.913, 0.004	262 - 672

	Ln(Weight) = Ln(Length)							Converted Power Equation: $W = a L^b$
Source	a (SE)	b (SE)	MSE	Units	n	R^2	Range of length	
Headboat Survey, TIP, FWC, MARMAP, VA	**-18.85 (0.095)**	**3.11 (0.015)**	**0.009**	**WW, kg FL, mm**	**1113**	**0.97**	**220 - 833**	**$W = 6.54 \times 10^{-9} L^{3.11}$**
	-18.76 (0.098)	3.07 (0.015)	0.012	WW, kg TL, mm	1708	0.960	267 - 884	$W = 7.17 \times 10^{-9} L^{3.07}$
	-17.11 (0.123)	2.90 (0.020)	0.012	WW, kg SL, mm	1302	0.942	262 - 650	$W = 3.7 \times 10^{-8} L^{2.09}$

2.14 Figures

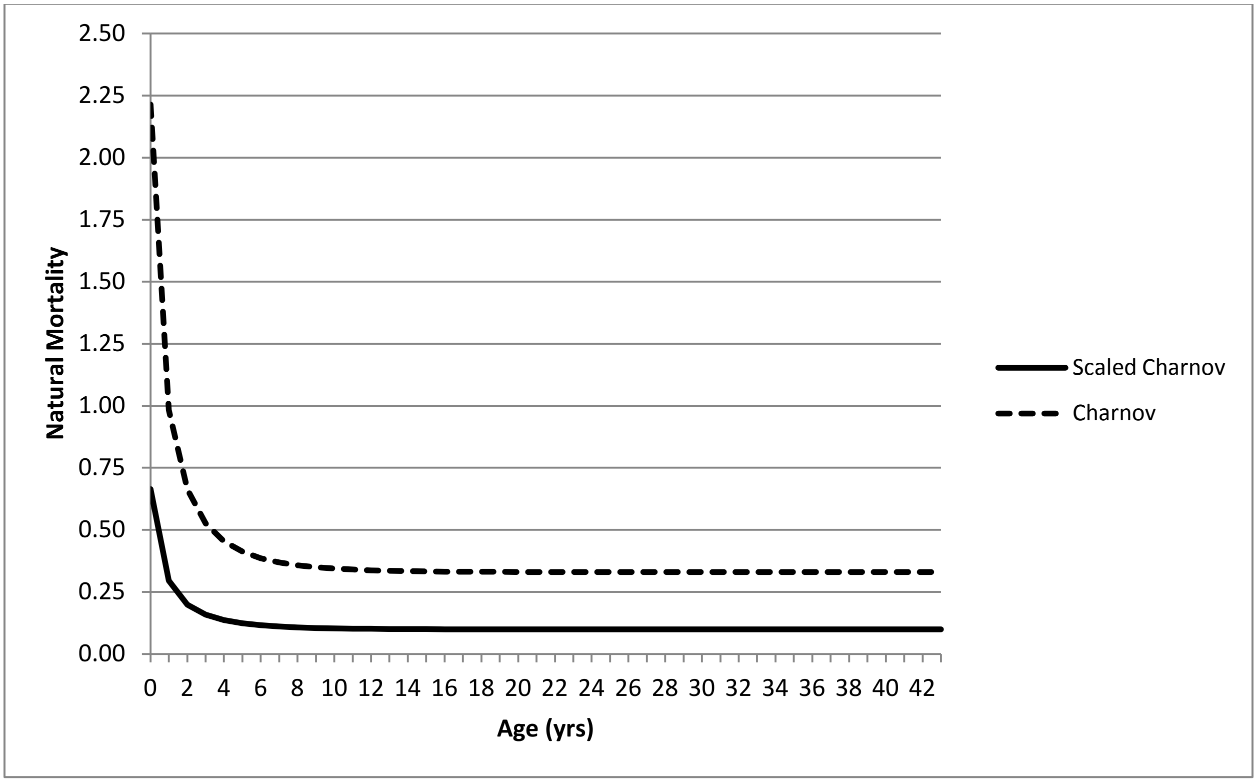

Figure 1. Blueline tilefish natural mortality at age curve based on estimates calculated from Charnov et al. (2012) and Charnov et al. scaled to Hewitt and Hoenig (2005) point estimate of 0.10.

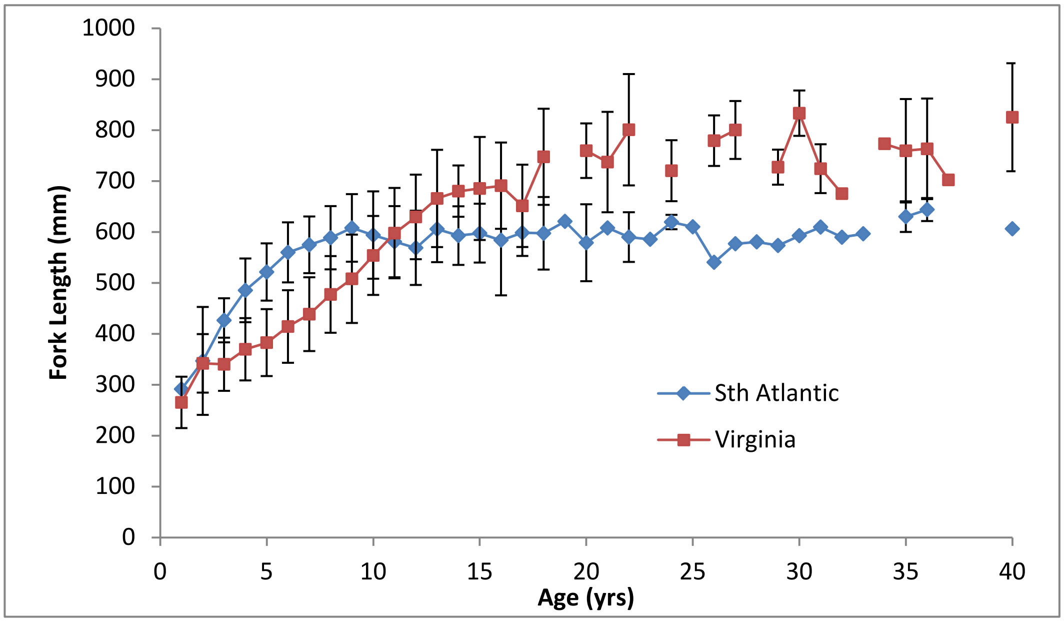

Figure 2. Comparison of fork length-at-age of blueline tilefish caught off of Virginia versus those caught off the US South Atlantic.

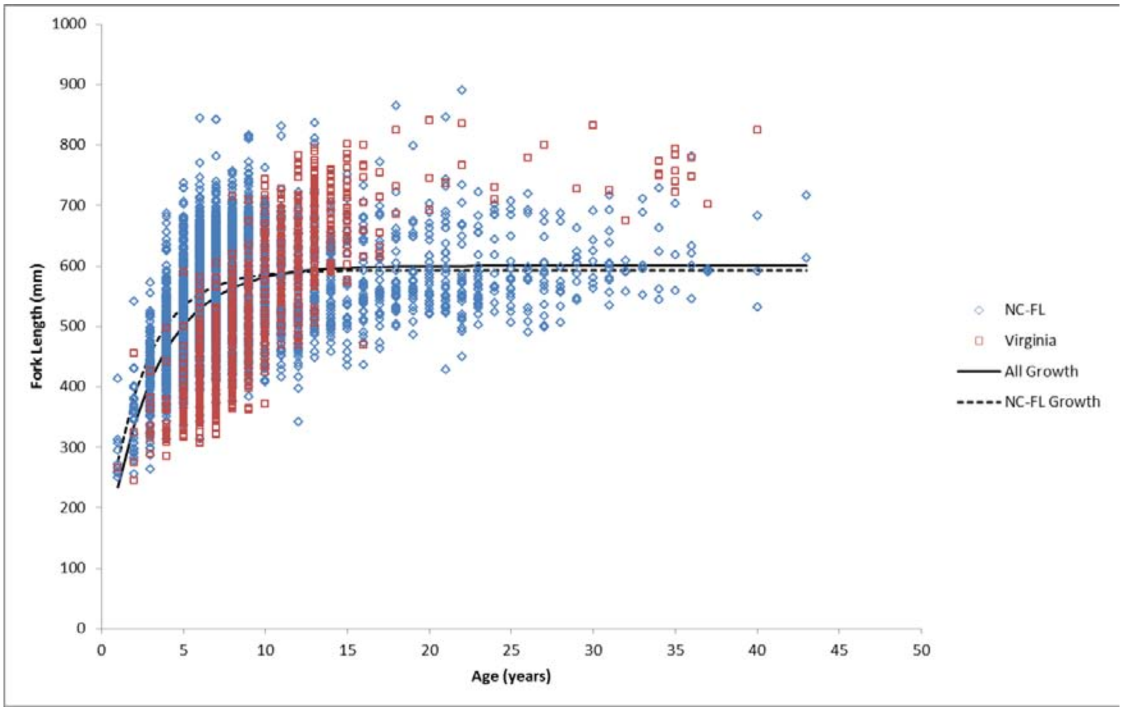

Figure 3. Blueline tilefish fork length-at-age of fish caught off of Virginia through the east coast of Florida. Population growth model with all fish and model with fish landed in NC – FL, only.

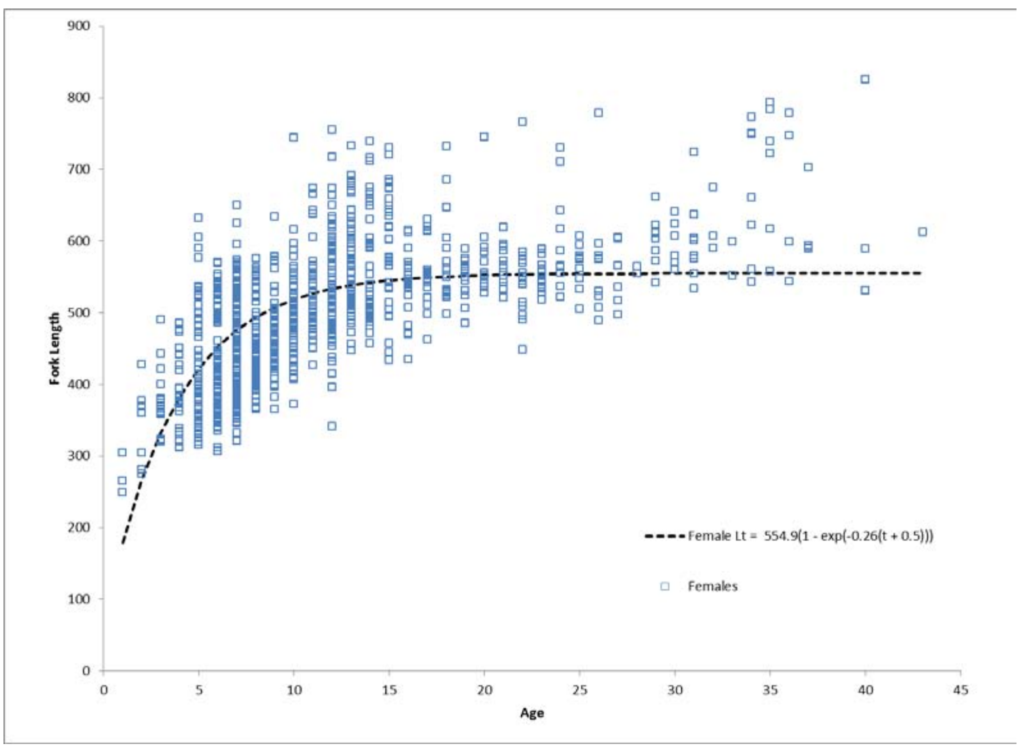

Figure 4. Female blueline tilefish fork length at age and growth model of fish caught off of Virginia through the east coast of Florida.

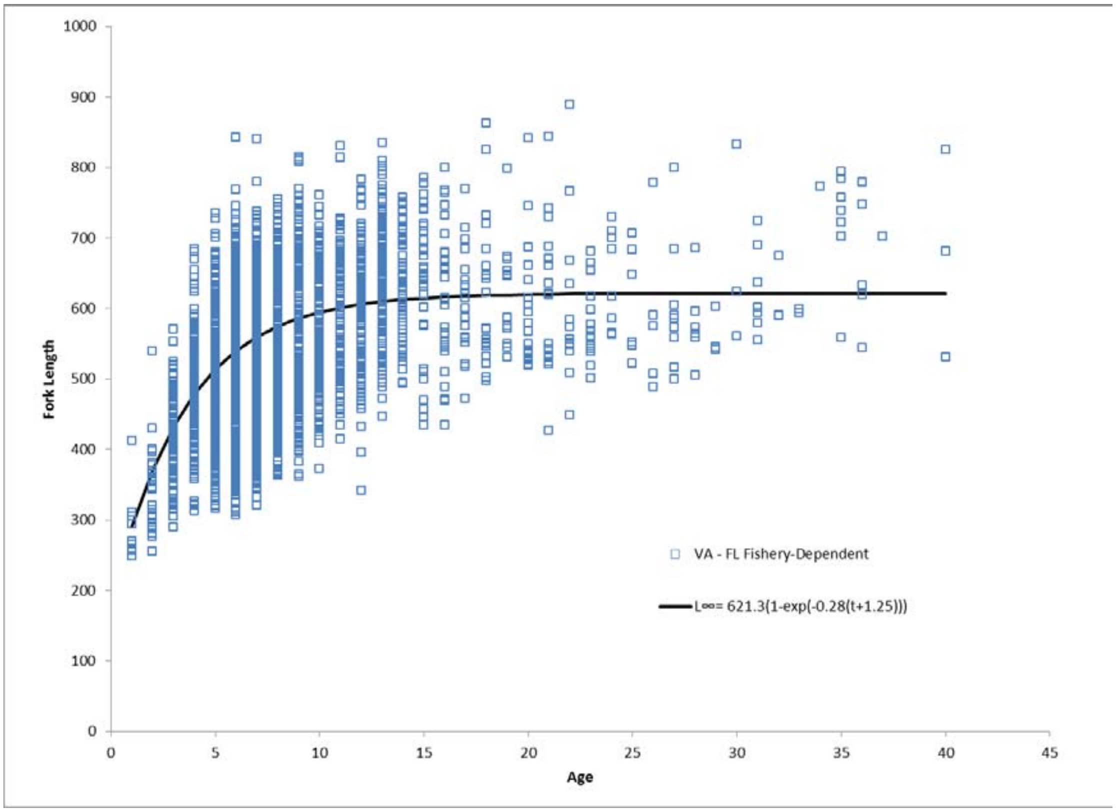

Figure 5. Blueline tilefish caught in commercial and recreational fisheries of Virginia through the east coast of Florida.

3. Commercial Fishery Statistics

3.1 Overview

Commercial landings for the US South Atlantic blueline tilefish stock were developed by gear (handlines, longlines, and other) in whole weight for the period 1950–2011 based on federal and state databases. Corresponding landings in numbers were based on mean weights estimated from the Trip Interview Program (TIP) by year, state, and gear.

Commercial discards were calculated from vessels fishing in the US South Atlantic using data from the Coastal Fisheries Logbook Program (CFLP) from 1993–2012.

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

3.1.1 Commercial Workgroup Participants

Neil Baertlein	Workgroup leader	SEFSC Miami
Stephanie McInerny	Rapporteur/Data provider	NC DMF
Steve Brown	Data provider	FL FWC
Julie Califf*	Data provider	GA DNR
Julie DeFilippi	Data Provider	ACCSP
Amy Dukes	Data provider	SC DNR
Dave Gloeckner	Data Provider	SEFSC Miami
David Grubbs	Commercial	FL, GT
Dewey Hemilright	Commercial	NC, BLT
Robert Johnson	Charter/Commercial	FL
Mark Marhefka*	Commercial	SC, GT/BLT
Ed Martino*	Data Provider	ACCSP
Kevin McCarthy	Data Provider	SEFSC Miami

*Did not attend workshop

3.1.2 Issues Discussed at the Data Workshop

Issues discussed by the commercial workgroup concerning blueline tilefish landings included stock boundaries, gear groupings, and the apportioning of unclassified tilefish. For discards, the workgroup discussed the limited available data from the CFLP discard logbook.

3.2 Review of Working Papers

SEDAR32-DW07: This working paper provided proportions of blueline tilefish from the total tilefish in the South Atlantic. Proportions were calculated from TIP by year, state, and gear grouping. These proportions were plotted against CFLP data and were deemed appropriate for NC only. For SC, data in TIP were not available to the species level before 2005 so proportions were not considered accurate. Many of the proportions calculated for GA and FL had low sample sizes. Proportions for NC will be applied to the unclassified landings only.

SEDAR32-DW11: This working paper describes the number of blueline tilefish discards in the South Atlantic commercial fishing fleet. Data are provided by CFLP. Several methods were presented to the Commercial Workgroup for discussion. Section 3.4 contains a summary of this report and the discussion and conclusions of the Commercial Workgroup. The results of these analyses were accepted by the Commercial Workgroup and the Plenary as best available data for estimating discards for blueline tilefish.

3.3 Commercial Landings

Commercial landings of blueline tilefish were compiled from 1950 through 2011 for the entire US Atlantic Coast. Sources for landings in the US South Atlantic (Florida through North Carolina) included the Florida Fish and Wildlife Conservation Commission trip ticket program (FWC), South Carolina Department of Natural Resources (SCDNR), North Carolina Division of Marine Fisheries (NCDMF), and the Atlantic Coastal Cooperative Statistics Program (ACCSP). Landings from the Mid and North Atlantic (north of the NC-VA border) were solely from ACCSP. Further discussion of how landings were compiled from the above sources can be found in section 3.3.4. Detailed descriptions of historical federal and state data collections can be found in Appendix A.

3.3.1 Commercial Gears Considered

The workgroup investigated reported gears landing blueline tilefish from various data sources (ACCSP, CFLP, FWC, SCDNR, & NCDMF) and determined the predominate gears to be longline or some type of handline. It was the workgroup's recommendation to then categorize landings into three gear groups: longline, handline, and other. A list of gears included in the longline and handline categories can be found in Table 3.1.

Decision 1: The workgroup suggested three gear groupings to characterize the blueline tilefish fishery (handlines, longlines, and other). Handlines include hook and line, electric/hydraulic bandit reels, and trolling.

This decision was approved by the plenary.

3.3.2 Stock Boundaries

DW ToR #1*: Review stock structure and unit stock definitions and consider whether changes are required.*

Blueline tilefish landings are reported as far north as Rhode Island so landings along the entire US Atlantic coast were examined. Several years contain landings of unclassified tilefish. These landings would need to be proportioned out to only include blueline tilefish. Proportions are only available for the South Atlantic region and would not be representative of the tilefish species in other regions in the Atlantic; therefore, only landings identified as blueline tilefish will be used from states north of NC.

Decision 2: Because blueline tilefish landings were reported as far north as Rhode Island, the Workgroup recommended using commercial landings from along the entire US Atlantic coast to represent landings from the Atlantic blueline tilefish stock.

This decision was approved by the plenary.

The Commercial Workgroup considered the southern boundary and determined that the South Atlantic-Gulf of Mexico Council boundary along US Highway 1 in Monroe County, FL would be used as the dividing line between the South Atlantic and Gulf of Mexico stocks (see Figure 3.2). From 1986–2011, logbook proportions were used to divide landings in Monroe county. An annual region proportion was applied for years 1993-2011. A mean proportion across all years was applied to Monroe landings between 1986-1992. From 1962-1986, general canvas proportions were used to divide landings in Monroe county. The annual region proportion was applied for years 1976-1986. A mean proportion across all years was applied to Monroe landings between 1962-1975. These decisions are based on the granularity of the data available.

Decision 3: The Workgroup recommends using the east coast of FL and the SA jurisdiction of the FL keys as the southern boundary of the Atlantic blueline tilefish stock.

This decision was approved by the plenary.

A map of the area in which landings of blueline tilefish were considered can be found in Figure 3.1. A close up of the southern boundary, as determined by the South Atlantic/Gulf of Mexico Council boundary, can be seen in Figure 3.2.

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 for both landings and discards if feasible. Provide maps of fishery effort and harvest.*

3.3.3 Misidentification and Unclassified Tilefish

Species similar to blueline tilefish are landed in each state but markets, habitats, and regulations are different so there should be no misidentification. For SC and FL, all landings of tilefish are reported at the species level. No unclassified tilefish landings are reported. For GA, unclassified landings occur between 1985 and 1995. Any unclassified landings will be apportioned using average proportions from CFLP by gear. For NC, tilefish landings from 1985–1993 are all unclassified and should be proportioned out to determine landings of blueline tilefish during this time period. TIP data will be used to calculate proportions by year and gear for NC since logbook estimates are not available until 1993.

Decision 4: The Workgroup recommends applying a proportion to all unclassified landings to account for blueline tilefish. All identified landings of blueline tilefish will not be modified.

This decision was approved by the plenary.

Prior to 1985, all tilefish landings are reported as tilefish, which typically is referred to golden tilefish, in the ACCSP data warehouse. After 1985, landings are broken out by species (golden tilefish, blueline tilefish, blackline tilefish, sand tilefish, etc.) and also include an unclassified tilefish category. In SEDAR 4 and SEDAR 25, it was assumed that “tilefish” landings prior to 1985 were all golden tilefish.

Because of the abrupt appearance of substantial blueline tilefish in the database in 1985, testimonies from fishermen catching blueline tilefish before 1985, and observed dockside sampling in TIP before 1985, the Commercial Workgroup recommends that the “tilefish” landings before 1985 be treated as unclassified tilefish and be proportioned out to account for blueline landings.

Decision 5: Average proportions will be applied to the tilefish (golden tilefish) landings before 1985 to account for blueline tilefish. Average proportions by year and gear from TIP will be used for NC. Average proportions for SC, GA, and FL will come from CFLP by year and gear (FL) and by year across gears (SC, GA).

This decision was approved by the plenary.

3.3.4 Commercial Landings by Gear and State

Statistics on commercial landings (1950 to present) for all species on the Atlantic coast are maintained in the Atlantic Coastal Cooperative Statistics Program (ACCSP) Data Warehouse. The Data Warehouse is an online database of fisheries dependent data provided by the ACCSP state and federal partners. Data sources and collection methods are illustrated by state in Figure 3.3. The Data Warehouse was queried in February 2013 for all tilefish landings (annual summaries by gear category) from 1950‒2011 from Florida (east coast including Monroe County) through Maine (ACCSP 2013). Data are presented using the gear categories as determined at the Data Workshop. The specific ACCSP gears in each category are listed in Table 3.1. Commercial landings in pounds (whole weight) were developed based on methodologies for gear as defined by the Workgroup for each state as available by gear for 1950‒2011.

Decision 6: The Workgroup recommends providing all available data from 1950–2011.

This decision was approved by the plenary.

Florida

Comparisons were made between Florida's commercial trip ticket data (1986-2011) to both the NMFS general canvass (1976-1996) and logbook data (1992-2011). All three datasets exhibited similar trends in total annual landings for matching years, but varied considerably by gear. Hook and line landings in the early 90's were higher than other gears in Florida trip ticket while both NMFS general canvas and logbook showed longline landings to be higher. Two peaks in 2005 and 2008 trip ticket longline landings were in contrast to a gradual decline in longline landings from the logbook data during the same period. It was later shown that those same years in the trip ticket data were likely influenced by landings thought to be from Monroe County, Florida reported Gulf of Mexico landings. The workgroup decided to use the total blueline tilefish landings from the Florida trip ticket data over the general canvas and logbook. The general canvas data were of a much shorter time series (no blueline to species prior to 1992). Logbook data were also from a shorter time series and there appeared to be underreporting of landings from South Atlantic waters of Florida in logbook until 2009. Blueline tilefish landings have always been reported to species in Florida trip ticket with no unclassified tilefish category used for the entire time series. All landings are reported as gutted.

One issue that arose with regard to blueline tilefish landings from Florida South Atlantic waters in the trip ticket data was how to separate South Atlantic from Gulf of Mexico landings in Monroe County (Florida Keys). Blueline tilefish landings in Monroe County are a significant portion of the Florida SA landings and it was estimated from the NMFS logbook data that the amount of Florida South Atlantic blueline tilefish landed in Monroe County was as much as 87% in a given year. It was decided to use the NMFS logbook data to proportion out South Atlantic blueline tilefish in the trip ticket data since it is believed that fisher reported area fished data were generally more accurate than area fished data reported by dealers. Additionally, it was decided to use NMFS logbook data to apportion landings by gear in the trip ticket data. While both programs collected gear by trip over the same time series (since 1992), the workgroup decided that gear reported by fisher would generally be more accurate than dealer reported gears.

The amount of South Atlantic blueline tilefish by year in the Florida trip ticket data was determined by calculating the proportion of Monroe County South Atlantic blueline tilefish in the logbook data for years 1993-2011. This was done by dividing the amount of SA blueline tilefish into total blueline tilefish landings for Monroe County only, then applying those proportions to the corresponding years for Monroe County total blueline tilefish landings from the trip ticket data. An average proportion for SA Monroe County was calculated from the combined 1993-2011 logbook data and applied to corresponding total Monroe blueline tilefish landings in the trip ticket data from 1986-1992. SA Monroe County and non-Monroe SA landings were then combined into total SA blueline tilefish landings in the Florida trip ticket data. NMFS logbook data were then used to calculate proportions of Florida SA blueline tilefish harvest by gear. This was done by dividing landings for each gear into total Florida SA landings, then applying those proportions to the Florida trip ticket SA landings by year from 1993-2011. The average proportion of logbook landings over all years by gear was then applied to trip ticket landings from 1986-1992.

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

SCDNR provided landings data for blueline tilefish from 1975–2011. Data from 1975–2003 were collected in monthly totals through collaborative efforts by SCDNR and the NMFS Cooperative Statistics Program and all data were correlated and confirmed with the ACCSP data warehouse. Data provided from 2004–2011 were more comprehensive because SCDNR instituted a mandatory Trip Ticket Program in late 2003.

Blueline tilefish were landed gutted, and those weights were converted to whole weight using a conversion of 1.06 which was provided by the Life History Workgroup. Additionally, all landings through this time period were associated with gears used; therefore, landings data were partitioned by year/gear combinations. Gear combinations provided in SEDAR-DW07 for tilefish were handline, longline, and other and these same gear groupings were recommended by the Commercial Workgroup for SEDAR 32.

Between the years 1975 and 1983, landings were assigned to tilefish only (landings for specific blueline tilefish did not appear until 1984) and there was a general concern that some of these tilefish (historically known as golden tilefish) may have contained some blueline tilefish landings. In order to proportion some of these landings to blueline, commercial logbook data was used to calculate a proportion percentage. All years (1993-2011) and gears were combined to calculate the used proportion percentage of 22.44%. All gutted to whole weight calculations were performed before data from these presumed unclassified tilefish were proportioned. Mean weights by year and gear provided by TIP were used to convert pounds to numbers of fish.

North Carolina

NCDMF provided landings data for blueline tilefish from 1985–2011. Data from 1985–1993 were provided by the NMFS Cooperative Statistics Program and are also stored in the NCDMF database; data from 1994–2011 were provided by the NC Trip Ticket Program. Up to three gears can be listed on a trip ticket therefore, landings were analyzed to look at gear combinations and 'gear1' was reassigned where necessary (Table 3.2). Data from NCDMF is also stored in the ACCSP data warehouse. Data were provided by NCDMF to capture all three gears and would contain the most recent edits to the data.

The majority of blueline tilefish landed in NC are in gutted condition. Those reported as gutted were converted to whole weight using a conversion of 1.06 provided by the Life History Workgroup. Landings reported as whole were not modified. A small percentage of landings reported as fillet were converted to whole pounds using the NCDMF conversion factor of 2.94, then converted to gutted weight using the NCDMF conversion factor of 1.09, and finally converted back to whole weight using the 1.06 conversion. All gutted to whole weight calculations were performed before data from unclassified tilefish were proportioned out.

Unclassified tilefish are reported along with identified blueline tilefish from 1985–1993. After 1993, there are no unclassified tilefish reported. Proportions from TIP were used to determine the proportion of blueline tilefish from the unclassified landings. TIP proportions are provided by year, state, and gear grouping in SEDAR-DW07 for 1983–2011. Gear groupings provided in SEDAR-DW07 for tilefish were handline, longline, and other and match the gear groupings recommended by the Commercial Workgroup. Average proportions by gear were used for years before 1983 and for any year in the other gear group where a proportion was not available. Final blueline tilefish landings for 1985–1993 were calculated by adding the proportioned blueline tilefish from the unclassified landings to the landings identified as blueline tilefish by year and gear. Mean weights by year and gear provided by TIP were used to convert pounds to numbers of fish.

Combined State Results

Landings by gear category are presented in pounds whole weight (Table 3.3), and numbers of fish (Table 3.4), and shown graphically in Figures 3.4 and 3.5. Longlines are the dominant gear and account for 55% of the total landings for the period of 1950–2011. Handlines were used more frequently in the earlier part of the time series and account for about 44% of the total landings.

Decision 7: The Workgroup made the following recommendations for reporting commercial landings:

- Landings should be reported as whole weight in pounds and number of fish
- Final landings data would come from the following sources:
    - VA-North: 1950-2011 (ACCSP)
    - NC: 1950-1993 (ACCSP)
1994-2011 (NCDMF)
    - SC: 1950-1979 (ACCSP)
1980-2011 (SCDNR)
    - GA: 1950-2011 (ACCSP)
    - FL: 1950-1985 (ACCSP)
1986-2011 (FL FWC)

This decision was approved by the plenary.

Whole vs. Gutted Weight

The majority of blueline tilefish in the Atlantic are landed in gutted condition and converted by the states to whole weight. For this analysis, landings by state were converted back to gutted weight using the state/federal conversion and then converted to whole weight using a conversion of 1.06 provided by the Life History Group.

Confidentiality Issues

Landings of blueline tilefish were pooled across states by gear to meet the rule of 3 and ensure confidential landings were not presented in this report. Confidential landings for other gear in 1996 have been masked. Landings by state and gear will be provided to the data compiler for use in the assessment.

3.3.5 Converting Landings in Weight to Landings in Numbers

The weight in pounds for each sample was calculated, as was the mean weight by state, gear and year. Where the sample size was less than 30 fish, the mean across all gears for that year was used (Table 3.5). If the sample was less than 30 for mean within the strata and the mean across all gears for the year, then the mean across all years for that gear was used. If the strata mean, mean by year across gears, and mean across all years for the gear all had sample sizes less than

30, then the mean across all gears and all years was used. The landings in pounds whole weight were then divided by the mean weight for that stratum to derive landings in numbers (Table 3.4 and Figure 3.5).

3.4 Commercial Discards

Methods used to calculate commercial discards are described in document SEDAR32-DW11. Available data useful for calculating discards included self-reported discard rates and gear-specific effort from the commercial fishery. The number of trips from 2002-2012 with reported discards of blueline tilefish (15 trips) was very low, severely limiting any analysis. Blueline tilefish discards were calculated for the vertical line fishery only. No blueline tilefish were reported from the bottom longline fishery. Reports of blueline tilefish discards from vessels fishing other gears included only three and one half percent of discarded blueline tilefish for the period 2002-2012.

Due to the limited available discard data, discard rates were calculated as the nominal discard rate among all trips that reported to the discard logbook program over the period 2002-2012. Rates were calculated for vessels reporting use of vertical line gears. The discard rate was then applied to the yearly gear-specific total fishing effort (total hook-hours fished) reported to the coastal logbook program. Effort data were available for the period 1993-2012. Discards were calculated separately for those fish reported as discarded and those that were reported as “kept as bait or eaten”.

An increase in the number of reports of “no discards” (of any species) may have resulted in under-reporting of commercial discards. To explore the effects of possible discard underreporting, a discard rate was calculated using three separate data filters: including all records in the discard data set, excluding “no discards” reports from the analysis, and filtering the data set of records from vessels that never reported discards of any species during a year. Vessels with very few trips during a year may have had, by chance, no discards during those few trips. For the final data filtering approach, records from vessels with six or fewer trips reported in a year, all with no discards reported, were included in the analyses. Calculated discards and fish reported as “kept as bait” are provided in Table 3.6. For all years and data filtering approaches, the number of calculated discards was very low.

During the data workshop, the working group discussed the validity of reports of “no discards” from the South Atlantic commercial fishery. The group recommended that data from vessels that never reported discards of any species during a year be excluded from the analyses. The maximum number of trips without a report of discards was also discussed. The group recommended excluding data from vertical line vessels that reported more than 14 trips without reporting discards of any species (the mean number of reported trips prior to the first trip with reported discards plus two standard deviations of that mean). In addition, the group recommended examining the limited (59 trips during 2006-2011) South Atlantic commercial vertical line fishery observer data to determine the frequency of observer trips with no discards and to evaluate how representative those observer data are of the commercial fishery. Data filtering prior to calculating discard rate may be further adjusted following evaluation of the observer data.

Decision 8: The described ratio estimator method will be used for calculating discards.

This decision was approved by the plenary.

Decision 9: To address potential false reporting of 'no discard' trips, the workgroup recommends:

- Include a vessel's 'no discard' reports if the vessel's number of reports with 'no-discard' was below the 'no discard' threshold (the mean number of reported trips prior to the first trip with reported discards plus two standard deviations of that mean).
- Exclude a vessel's 'no discard' reports if the vessel's number of reports with 'no-discard' was above the 'no discard' threshold (the mean number of reported trips prior to the first trip with reported discards plus two standard deviations of that mean).

This decision was approved by the plenary pending investigation of the data provided by the observer program.

At the post data workshop webinar, an additional data filtering recommendation was made to exclude trips landing only mackerel. It was generally felt that the likelihood of blueline tilefish caught on trips targeting mackerel is extremely low and data from trips targeting mackerel should be excluded from discard estimations. To avoid mixed effort trips however, only trips with 100% mackerel landings were excluded. Calculated discards using the above described treatments can be found in Table 3.7.

Decision 10: Exclude trips that caught only mackerel for discard calculations (for both discard rate and effort).

This decision was approved by the plenary.

Following the DW and post-DW webinar data filtering recommendations resulted in the following loss of discard data. One trip with 100% mackerel landings also had a blueline discard (there had been only 2 total trips with blueline tilefish discards reported once 2012 data were excluded). Also, 680 trips with 100% mackerel landings also had 'other' discards (12,011 total 'other' discard trips reported) and 77 trips with only mackerel landings reported 'other' discards kept as bait. In total, there were 4,764 trips with 100% mackerel landings of which 15.6% (744 trips) reported discards or fish kept as bait. Of those 744 trips, 353 had mackerel discards or mackerel kept as bait. This suggests that vessels targeting mackerel may have discards of other species including blueline tilefish.

3.5 Commercial Effort

The distribution of directed commercial effort in trips by year was compiled from the Coastal Fisheries Logbook Program (CFLP) for 1993-2011 and supplied here for information purposes. These data are presented in **Error! Reference source not found.**6. The distribution of harvest, as reported to the CFLP, is also displayed in Figure 3.7.

3.6 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 was not collected shore-side. These data were further limited to those that could be assigned a year, gear, and state. Data that had an unknown sampling year, gear, or sampling state were deleted from the file. TIP data must also be weighted spatially by the landings for the particular year, state, and gear stratum to correct for differences in sampling intensities across states. 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.

3.6.1 Sampling Intensity

The number of trips sampled ranged from a high of 76 for handline gear in 2009 to a low of zero for many strata (Table 3.8). The number of trips sampled was consistently greater than 10 trips for handline gear from 1984 to 2011; 1984-1986, 1991-1996, 2001-2004, 2006, and 2008-2011 for longline gear; and was always less than 10 for other gears with samples collected in 1990, 1991, 1995, 2000, and 2010 only.

The number of fish sampled had a high of 3,663 for longline gear in 1993 to lows of zero for many of the strata (Table 3.9). The number of lengths sampled was consistently greater than 100 for handline gear for 1984-1996 and 1998-2011. Longline lengths sampled were well above 100 lengths per year for most years, excluding 1987, 1989, 1999, 2005 and 2007. For other gears, the numbers of length samples available were below 100 for all years.

3.6.2 Length/Age Distributions

All blueline tilefish lengths were converted to FL in mm using the formula provided by the SEDAR 32 Life History Group 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 were divided into handlines, longlines, and other gears. Annual length compositions of blueline tilefish are summarized in Figures 3.8-3.12. Length was converted to weight (whole weight in pounds) using conversions provided by the SEDAR 32 Life History Group.

Ages samples of blueline tilefish came from 413 trips between 2003 and 2011. The lowest numbers of trips sampled were in 2003 and 2004, at two and one trips respectively. The highest number of trips sampled was in 2010 at 122. More handline trips were sampled (251 trips) than longline (161 trips). Only one trip fishing other gear was sampled. The number of commercial trips sampled for blueline tilefish ages can be found by year, gear, and state in Table 3.11. Unweighted age compositions produced for handline and longline can be found in Figures 3.13 and 3.14.

3.6.3 Adequacy for Characterizing Catch

Length sampling has been inadequate for other gears and there are a few years where sample sizes are low for handline and longline gears. Sampling fractions are less than 0.05 for many years in the handline and longline gear categories. Sample size needs to be paid particular attention when using the length compositions. Length sampling fractions are displayed in Table 3.10. The number of samples for other gears may indicate that length compositions for this gear category should be supplemented with handline and longline length compositions to obtain a reasonable sample size.

3.7 Comments on Adequacy of Data for Assessment Analyses

The workgroup feels the landings data for assessment analyses are adequate. There is a clear landings history for the available time series. Tilefish (blueline or otherwise) landings were nonexistent prior to 1958, so it is likely that any blueline tilefish landings made prior to 1950 were negligible, if not nonexistent. There was little issue concerning species identification. Tilefish reported from 1985 forward were mostly reported to the species level. Prior to 1985, all tilefish were reported as ‘Tilefish’. These earlier, and later unclassified, tilefish landings likely contained blueline tilefish and were apportioned accordingly. Definition of stock boundaries and landed condition (gutted vs. whole) were not an issue.

Discard calculations are less adequate as there may be issues concerning the quality of self-reported data, especially where ‘no discard’ reports are concerned. While it is generally accepted that a trip without discards, of any kind, can and will happen, there is high level of uncertainty in the accuracy of ‘no discard’ reports. There has been an increase in the number of ‘no discard’ reports over the past ten years; from roughly 30% to 60% of all discard reports. It is likely that some fishers may simply report ‘no discards’ to satisfy their reporting requirements. However, due to the relatively low discard rate for this particular species, the inclusion, or exclusion, of all ‘no discard’ reports has little impact on the overall take of blueline tilefish.

Some biological sampling data may be inadequate. As discussed in the previous section, length samples are low, or nonexistent, over the entire time series for ‘other’ gear, and are low in some years for handline and longline.

3.8 Literature Cited

Atlantic Coastal Cooperative Statistics Program. 2013. Annual landings by custom gear category; generated by Julie Defilippi using ACCSP Data Warehouse, Arlington, VA: accessed February 2013.

3.9 Tables

Table 3.1 Specific ACCSP gears in each gear category for blueline tilefish commercial landings.

HANDLINE			
GEAR CODE	**GEAR NAME**	**TYPE CODE**	**GEAR TYPE**
300	HOOK AND LINE	007	HOOK AND LINE
301	HOOK AND LINE, MANUAL	007	HOOK AND LINE
302	HOOK AND LINE, ELECTRIC	007	HOOK AND LINE
303	ELECTRIC/HYDRAULIC, BANDIT REELS	007	HOOK AND LINE
304	HOOK AND LINE, CHUM	007	HOOK AND LINE
305	HOOK AND LINE, JIG	007	HOOK AND LINE
306	HOOK AND LINE, TROLL	007	HOOK AND LINE
307	HOOK AND LINE, CAST	007	HOOK AND LINE
308	HOOK AND LINE, DRIFTING EEL	007	HOOK AND LINE
309	HOOK AND LINE, FLY	007	HOOK AND LINE
310	HOOK AND LINE, BOTTOM	007	HOOK AND LINE
320	TROLL LINES	007	HOOK AND LINE
321	TROLL LINE, MANUAL	007	HOOK AND LINE
322	TROLL LINE, ELECTRIC	007	HOOK AND LINE
323	TROLL LINE, HYDRAULIC	007	HOOK AND LINE
324	TROLL LINE, GREEN-STICK	007	HOOK AND LINE
330	HAND LINE	013	HAND LINE
331	TROLL & HAND LINE CMB	013	HAND LINE
340	AUTO JIG	013	HAND LINE
700	HAND LINE	013	HAND LINE
701	TROLL AND HAND LINES CMB	013	HAND LINE
702	HAND LINES, AUTO JIG	013	HAND LINE
LONGLINE			
GEAR CODE	**GEAR NAME**	**TYPE CODE**	**GEAR TYPE**
400	LONG LINES	008	LONG LINES
401	LONG LINES, VERTICAL	008	LONG LINES
402	LONG LINES, SURFACE	008	LONG LINES
403	LONG LINES, BOTTOM	008	LONG LINES
404	LONG LINES, SURFACE, MIDWATER	008	LONG LINES
405	LONG LINES, TROT	008	LONG LINES
406	LONG LINES, TURTLE HOOKS	008	LONG LINES
407	LONG LINES, DRIFT W/HOOOKS	008	LONG LINES
408	BOUY GEAR	008	LONG LINES

Table 3.2 North Carolina Trip Ticket Program gear code reassignments for blueline tilefish (1994 – 2011).

NEW GEAR		GEAR1		GEAR2		GEAR3	
610	Rod-n-Reel	345	Fish Pot	610	Rod-n-Reel		
345	Fish Pot	480	Gill Net Set (sink)	345	Fish Pot		
610	Rod-n-Reel	480	Gill Net Set (sink)	610	Rod-n-Reel		
610	Rod-n-Reel	480	Gill Net Set (sink)	660	Trolling	610	Rod-n-Reel
610	Rod-n-Reel	480	Gill Net Set (sink)	610	Rod-n-Reel	660	Trolling
345	Fish Pot	660	Trolling	345	Fish Pot		
610	Rod-n-Reel	660	Trolling	345	Fish Pot	610	Rod-n-Reel
676	Longline Bottom	660	Trolling	676	Longline Bottom		
610	Rod-n-Reel	660	Trolling	610	Rod-n-Reel		
676	Longline Bottom	660	Trolling	676	Longline Bottom	677	Longline Shark

Table 3.3 Blueline tilefish landings, in whole weight pounds, for all states (FL-ME) by gear. Cells with a ‘*’ indicate confidential data and therefore were removed.

Year	Hand Line	Long Line	Other
1950	0	0	0
1951	0	0	0
1952	0	0	0
1953	0	0	0
1954	0	0	0
1955	0	0	0
1956	0	0	0
1957	0	0	0
1958	333	0	0
1959	167	0	66
1960	0	0	0
1961	0	0	0
1962	937	0	266
1963	937	0	133
1964	110	0	465
1965	7,210	0	0
1966	1,356	0	0
1967	3,220	0	0
1968	2,206	0	0
1969	1,893	0	0
1970	3,526	0	0
1971	6,357	0	0
1972	3,721	0	0
1973	14,603	0	0
1974	33,000	0	0
1975	56,456	0	0

1976	55,755	19	0
1977	30,898	0	97
1978	68,763	0	13,950
1979	52,174	5,891	1,734
1980	83,565	34,461	238
1981	293,139	107,641	2,825
1982	774,072	406,280	265
1983	338,780	317,818	92
1984	166,296	339,574	602
1985	58,207	333,759	89
1986	112,750	107,255	8,673
1987	94,468	49,017	1,585
1988	62,440	43,252	1,391
1989	66,580	44,450	1,582
1990	111,891	60,300	2,934
1991	119,674	70,784	4,396
1992	125,046	151,578	2,905
1993	54,962	133,940	11,302
1994	70,982	112,901	4,355
1995	65,079	103,386	2,416
1996	116,976	31,270	*
1997	140,236	76,508	3,244
1998	64,982	41,413	1,259
1999	78,708	36,428	1,107
2000	73,615	35,245	3,573
2001	89,113	36,604	2,107
2002	140,673	124,815	70
2003	78,996	34,954	5,129
2004	42,415	27,003	7,291
2005	59,083	18,364	6,489
2006	110,545	47,358	15,099
2007	68,717	6,904	9,482
2008	210,865	186,846	14,467
2009	260,283	199,873	14,688
2010	137,744	291,514	8,791
2011	19,904	114,343	7,255

Table 3.4 Blueline tilefish landings, in numbers of fish, for all states (FL-ME) by gear. Cells with a '*' indicate confidential data and therefore were removed.

Year	Hand Line	Long Line	Other
1950	0	0	0
1951	0	0	0
1952	0	0	0
1953	0	0	0
1954	0	0	0
1955	0	0	0
1956	0	0	0
1957	0	0	0
1958	93	0	0
1959	46	0	17
1960	0	0	0
1961	0	0	0
1962	188	0	66
1963	188	0	33
1964	22	0	116
1965	1,443	0	0
1966	271	0	0
1967	644	0	0
1968	441	0	0
1969	379	0	0
1970	706	0	0
1971	1,272	0	0
1972	745	0	0
1973	2,922	0	0
1974	6,603	0	0
1975	11,297	0	0
1976	11,157	4	0
1977	6,190	0	20
1978	15,686	0	3,471
1979	11,605	1,095	424
1980	18,288	6,424	63
1981	62,175	20,147	640
1982	158,638	76,368	61
1983	68,815	63,299	18
1984	37,233	64,727	123
1985	11,853	70,632	19
1986	21,533	23,092	1,792
1987	21,501	10,069	314
1988	15,818	8,648	277
1989	16,595	9,156	325
1990	34,429	14,517	722
1991	35,317	16,092	918
1992	34,176	35,427	581
1993	14,184	28,592	2,123

1994	19,256	24,545	1,019
1995	18,409	25,190	564
1996	38,070	7,854	*
1997	31,830	17,893	740
1998	18,423	8,847	475
1999	23,420	7,983	340
2000	21,340	7,215	1,008
2001	25,994	7,337	587
2002	40,906	34,499	21
2003	24,249	8,540	1,768
2004	12,534	6,238	2,460
2005	15,958	4,334	2,139
2006	39,605	9,954	4,387
2007	20,003	1,902	2,994
2008	56,020	38,383	3,196
2009	59,381	32,055	2,531
2010	29,380	45,996	1,457
2011	4,243	17,804	1,180

Table 3.5 Mean weights used for developing landings in numbers by year, state and gear.

	STATE											
	FL			GA			NC			SC		
YEAR	HAND LINE	LONG LINE	OTHER	HAND LINE	LONG LINE	OTHER	HAND LINE	LONG LINE	OTHER	HAND LINE	LONG LINE	OTHER
1983	5.041	5.041	5.041	4.835	4.835	4.835	4.360	4.360	4.360	5.012	5.012	5.012
1984	5.041	5.041	5.041	4.601	4.659	4.659	3.857	6.403	4.412	4.779	5.687	5.568
1985	5.004	4.700	4.729	4.835	4.835	4.835	4.578	6.044	4.742	4.526	4.532	4.526
1986	5.861	3.842	4.899	4.867	4.795	4.795	3.916	4.004	4.004	5.182	5.182	5.182
1987	5.041	5.041	5.041	3.504	3.504	3.504	3.984	4.361	4.361	5.284	5.253	5.284
1988	5.041	5.041	5.041	4.263	4.263	4.263	3.263	5.308	4.600	4.747	4.770	4.747
1989	5.041	5.041	5.041	5.044	5.044	5.044	3.302	4.507	3.808	5.012	5.012	5.012
1990	3.361	4.527	4.192	4.835	4.835	4.835	3.112	4.109	3.548	3.599	3.903	3.903
1991	5.041	5.041	5.041	4.835	4.835	4.835	2.930	4.005	3.528	4.539	4.398	4.539
1992	3.642	5.166	5.118	4.835	4.835	4.835	3.544	4.128	3.920	6.141	4.158	4.389
1993	4.051	5.135	5.079	8.610	8.610	8.610	3.536	3.802	3.749	5.012	5.012	5.012
1994	4.208	4.633	4.503	5.939	5.939	5.939	3.372	3.985	3.623	5.012	5.012	5.012
1995	5.325	4.456	4.810	4.835	4.835	4.835	3.051	3.148	3.148	4.322	4.322	4.322
1996	3.767	5.230	4.246	4.835	4.835	4.835	2.931	3.668	3.421	3.880	3.880	3.880
1997	4.474	4.558	4.520	4.835	4.835	4.835	4.360	4.360	4.360	4.200	4.200	4.200
1998	5.910	6.205	5.910	4.835	4.835	4.835	2.649	2.649	2.649	5.012	5.012	5.012
1999	5.298	5.324	5.324	4.835	4.835	4.835	3.073	2.866	3.044	5.012	5.012	5.012
2000	3.796	7.177	4.820	4.835	4.835	4.835	3.358	3.617	3.404	5.012	5.012	5.012
2001	3.852	6.640	4.833	4.835	4.835	4.835	3.320	3.750	3.503	5.387	5.399	5.387
2002	5.831	6.020	5.831	4.835	4.835	4.835	3.191	3.191	3.191	5.586	5.623	5.586
2003	6.755	6.882	6.755	4.835	4.835	4.835	2.900	2.900	2.900	3.542	4.553	4.275
2004	5.308	5.308	5.308	4.835	4.835	4.835	2.887	3.534	2.964	4.435	4.543	4.435
2005	5.895	6.699	6.699	4.835	4.835	4.835	2.964	2.964	2.964	4.315	4.265	4.315
2006	5.041	5.041	5.041	4.835	4.835	4.835	2.569	4.902	3.435	5.205	4.580	4.829
2007	6.976	6.976	6.976	4.835	4.835	4.835	3.148	3.148	3.148	6.554	6.228	6.228
2008	5.041	5.041	5.041	4.835	4.835	4.835	3.718	4.845	4.522	5.617	5.875	5.713
2009	6.119	6.119	6.119	4.835	4.835	4.835	4.341	6.237	5.802	6.060	6.058	6.058

2010	4.970	4.994	4.994	4.835	4.835	4.835	4.671	6.328	6.063	5.330	6.770	6.328
2011	5.041	5.041	5.041	4.835	4.835	4.835	4.647	6.466	6.168	5.012	5.012	5.012

Table 3.6 Calculated blueline tilefish discards and kept discards (bait). Discards are in numbers of fish. Effort is hook-hours fished.

Year	Total Effort	Calculated discards (all records)	Calculated discards (exclude vessels that never reported discards)	Calculated discards (exclude 'no discards' records)	Calculated kept as bait (all records)	Calculated kept as bait (exclude vessels that never reported discards)	Calculated kept as bait (exclude 'no discards' records)
1993	1,367,680	20	28	52	11	16	29
1994	1,706,792	25	35	65	14	20	37
1995	1,708,760	25	35	65	14	20	37
1996	1,690,267	25	34	64	14	19	36
1997	1,842,783	27	38	70	15	21	40
1998	1,389,722	20	28	53	12	16	30
1999	1,184,176	17	24	45	10	14	25
2000	1,233,937	18	25	47	10	14	26
2001	1,272,991	19	26	49	11	15	27
2002	1,172,216	17	24	45	10	13	25
2003	1,004,868	15	21	38	8	12	22
2004	916,359	14	19	35	8	11	20
2005	854,003	13	17	33	7	10	18
2006	961,042	14	20	37	8	11	21
2007	1,028,151	15	21	39	9	12	22
2008	1,052,358	16	21	40	9	12	23
2009	1,090,968	16	22	42	9	13	23
2010	893,566	13	18	34	7	10	19
2011	850,528	13	17	32	7	10	18

Table 3.7 Yearly calculated blueline tilefish discards and blueline tilefish kept as bait. Discards are in number of fish. Calculations followed the data workshop and webinar recommendations of excluding trips with only mackerel landings reported, excluding year-specific data from vessels that never reported discards of any species during that year, and excluding year-specific data from vessels that did not report discards within the limit of less than the 97.5 percentile of the number of trips to first reported discard. The 97.5 percentile limits were: vertical line = 15 trips; trap = 3 trips.

Year	Calculated discards	Calculated kept as bait
1993	0	21
1994	1	26
1995	1	26
1996	1	25
1997	1	27
1998	0	20
1999	0	17
2000	0	18
2001	0	18
2002	0	17
2003	0	14
2004	0	13
2005	0	12
2006	0	13
2007	0	15
2008	0	15
2009	0	15
2010	0	12
2011	0	12

Table 3.8 Number of trips without sampling biases sampled for blueline tilefish by year and gear.

YEAR	HAND LINE	LONG LINE	OTHER
1983	5	0	0
1984	49	17	0
1985	75	24	0
1986	46	15	0
1987	37	9	0
1988	26	8	0
1989	31	6	0
1990	40	9	1
1991	39	14	7
1992	29	42	0
1993	41	73	0
1994	32	24	0
1995	46	23	3
1996	24	13	0
1997	20	6	0
1998	17	5	0
1999	34	9	0
2000	52	9	1
2001	48	17	0
2002	33	28	0
2003	43	19	0
2004	46	18	0
2005	45	7	0
2006	50	15	0
2007	67	5	0
2008	64	13	0
2009	76	57	0
2010	70	57	2
2011	41	38	0

Table 3.9 Number of fish sampled without sampling biases for blueline tilefish by year and gear.

YEAR	HAND LINE	LONG LINE	OTHER
1983	22	0	0
1984	404	638	0
1985	560	1,023	0
1986	278	430	0
1987	232	95	0
1988	134	155	0
1989	136	73	0
1990	396	315	3
1991	169	354	33
1992	190	1,550	0
1993	339	3,663	0
1994	281	346	0
1995	375	372	88
1996	209	383	0
1997	62	137	0
1998	156	123	0
1999	342	72	0
2000	462	118	2
2001	334	400	0
2002	121	509	0
2003	337	248	0
2004	624	290	0
2005	463	87	0
2006	909	571	0
2007	329	35	0
2008	211	342	0
2009	361	890	0
2010	210	924	17
2011	136	596	0

Table 3.10 Fraction of landings sampled for length without sampling biases for blueline tilefish by year and gear.

YEAR	HAND LINE	LONG LINE	OTHER
1983	0.002	0.000	0.000
1984	0.012	0.033	0.000
1985	0.047	0.015	0.000
1986	0.013	0.019	0.000
1987	0.015	0.014	0.000
1988	0.008	0.024	0.000
1989	0.014	0.024	0.000
1990	0.012	0.022	0.036
1991	0.005	0.022	0.091
1992	0.006	0.044	0.000
1993	0.025	0.192	0.000
1994	0.015	0.031	0.000
1995	0.021	0.015	0.228
1996	0.006	0.049	0.000
1997	0.002	0.010	0.000
1998	0.009	0.092	0.000
1999	0.015	0.009	0.000
2000	0.022	0.044	0.020
2001	0.013	0.056	0.000
2002	0.003	0.085	0.000
2003	0.014	0.043	0.000
2004	0.050	0.046	0.000
2005	0.029	0.021	0.000
2006	0.023	0.057	0.000
2007	0.020	0.124	0.000
2008	0.004	0.009	0.000
2009	0.006	0.028	0.000
2010	0.007	0.020	0.046
2011	0.032	0.035	0.000

Table 3.11 Number of trips sampled for ages of blueline tilefish by year, gear, and state.

	Handline			Longline			Other
Year	FL	NC	SC	FL	NC	SC	NC
2003	1			1			
2004					1		
2005	2	9				2	
2006			8			8	
2007	5	14	11	4		1	
2008	5	28	15		3	2	
2009	10	23	20		45	3	
2010	12	42	14		47	6	1
2011		31	1		38		

3.10 Figures

Figure 3.1 Region of blueline tilefish landings included all landings along the US Atlantic Coast.

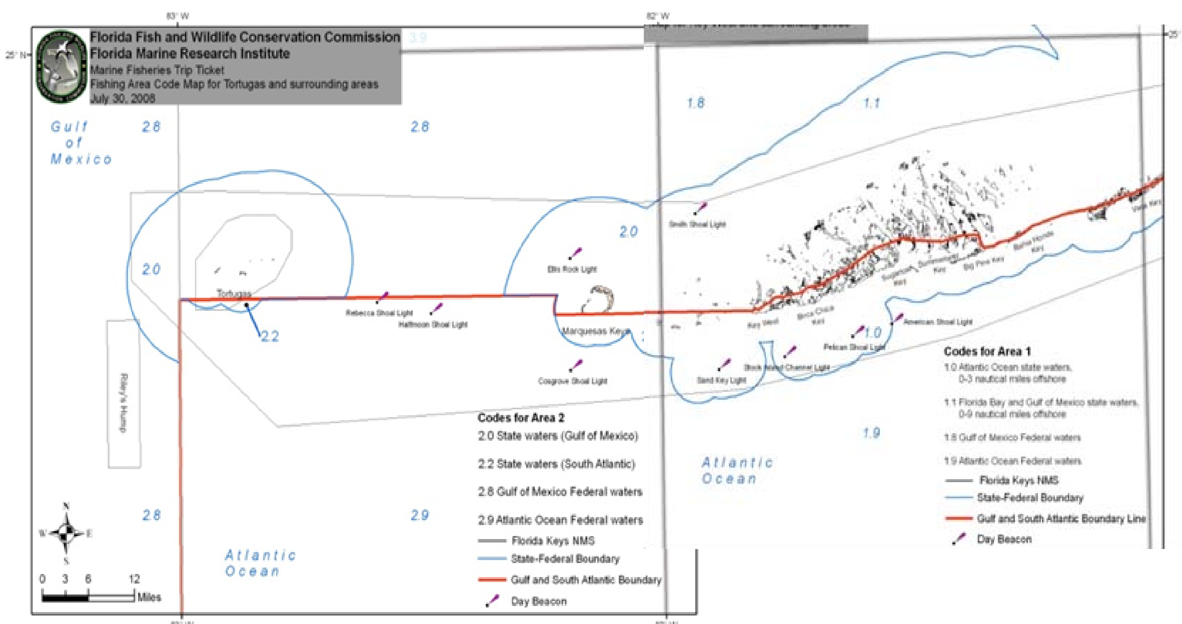

Figure 3.2 Close-up of the southern boundary as defined by the Gulf of Mexico/South Atlantic Council boundary.

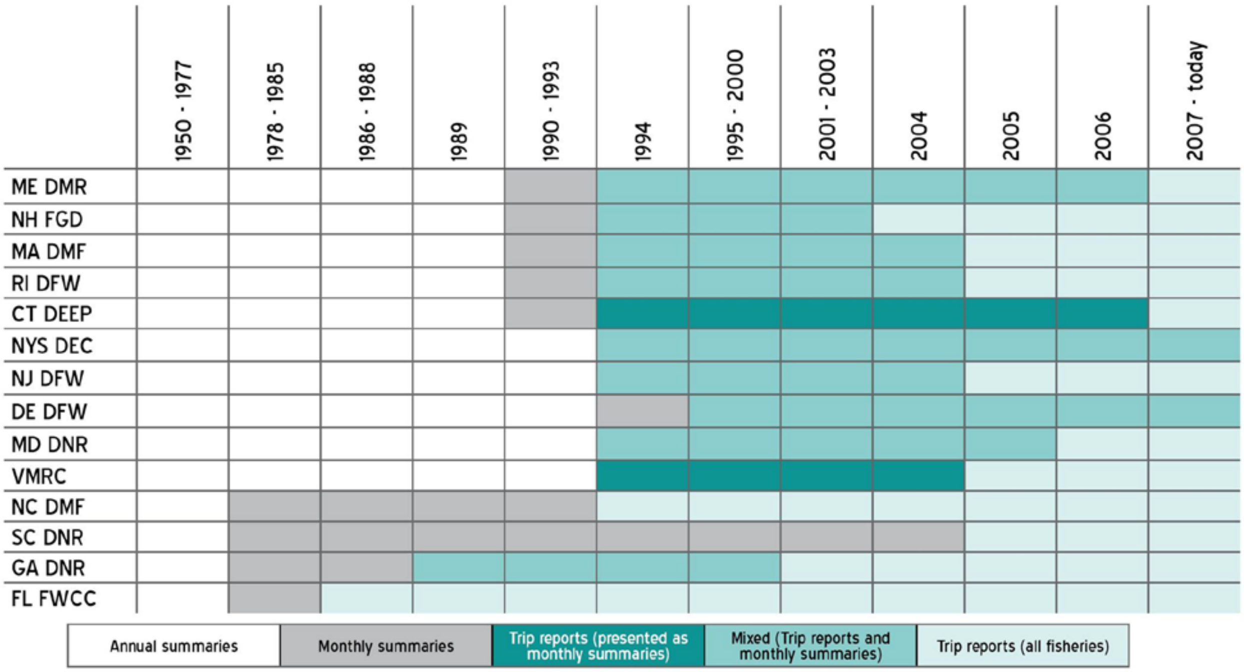

Figure 3. 3 Atlantic Coastal Cooperative Statistics Program (ACCSP) Data Warehouse – data sources and collection methods by state. Early summaries provided by NMFS.

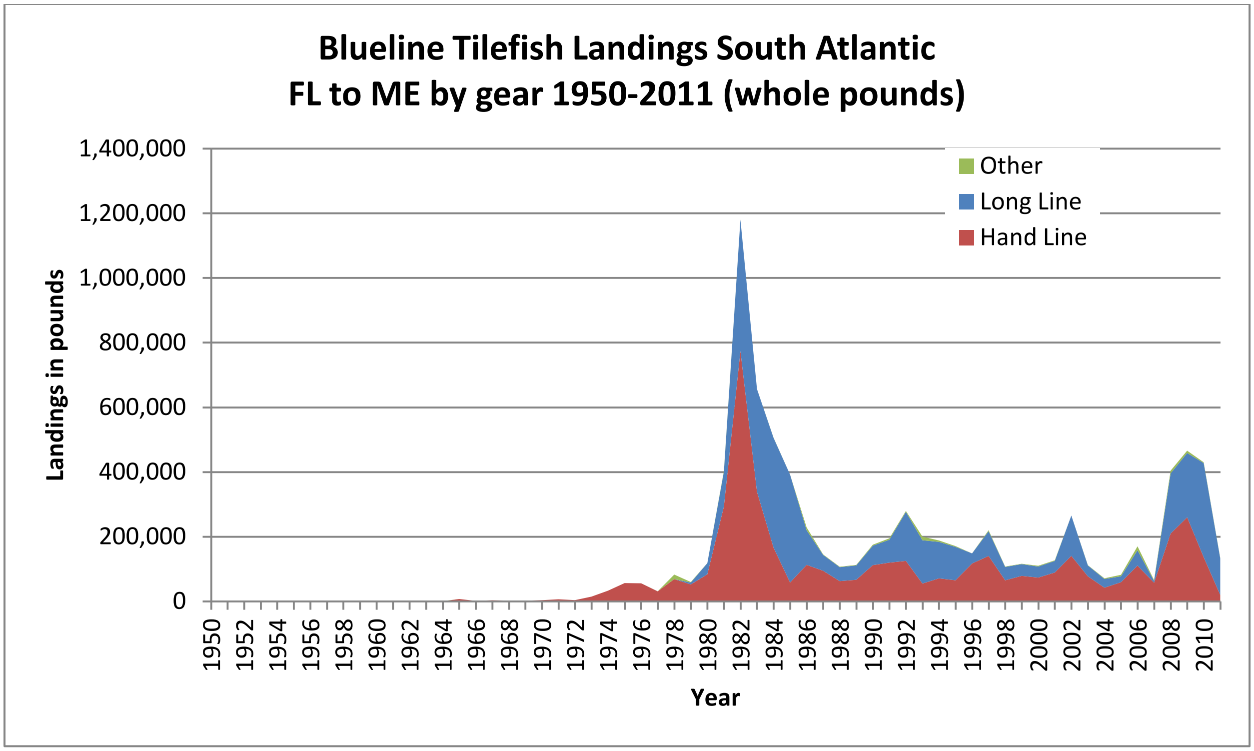

Figure 3.4 Blueline tilefish landings, in whole weight pounds, for all states (FL-ME) by gear.

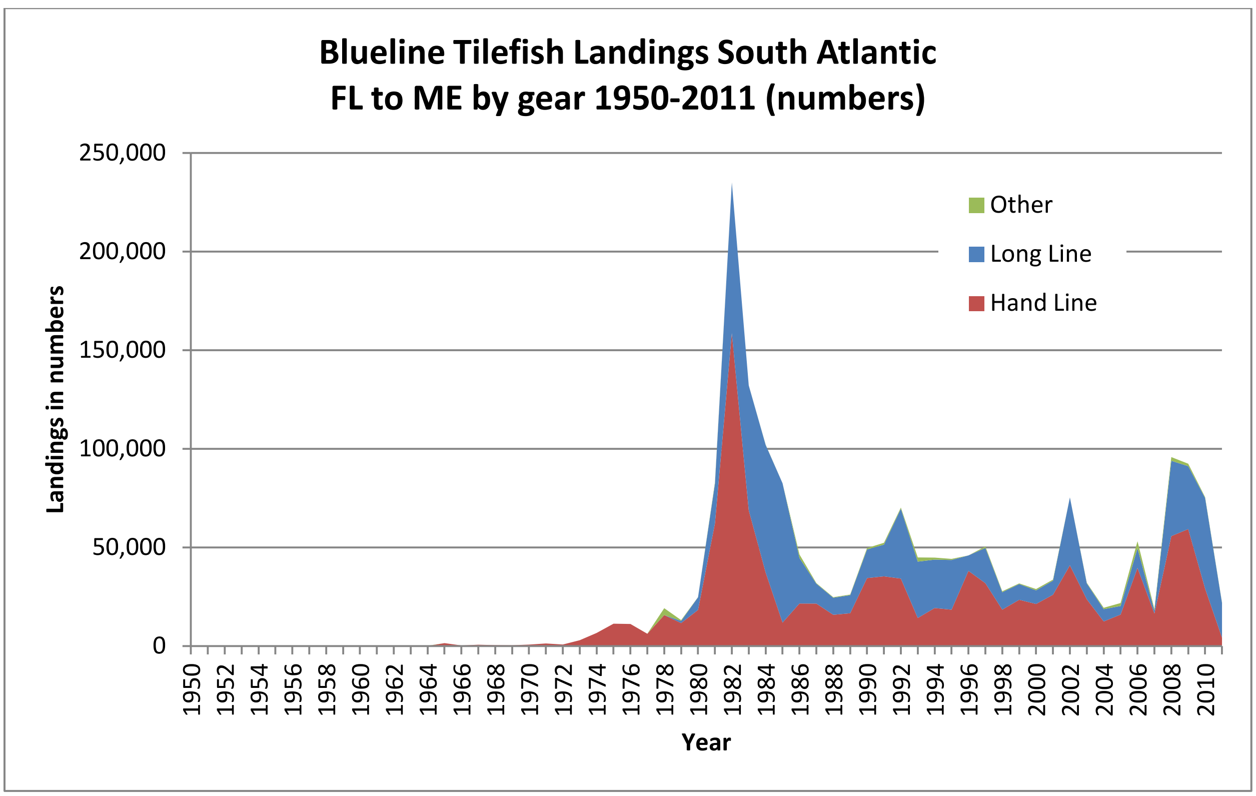

Figure 3.5 Blueline tilefish landings, in numbers of fish, for all states (FL-ME) by gear.

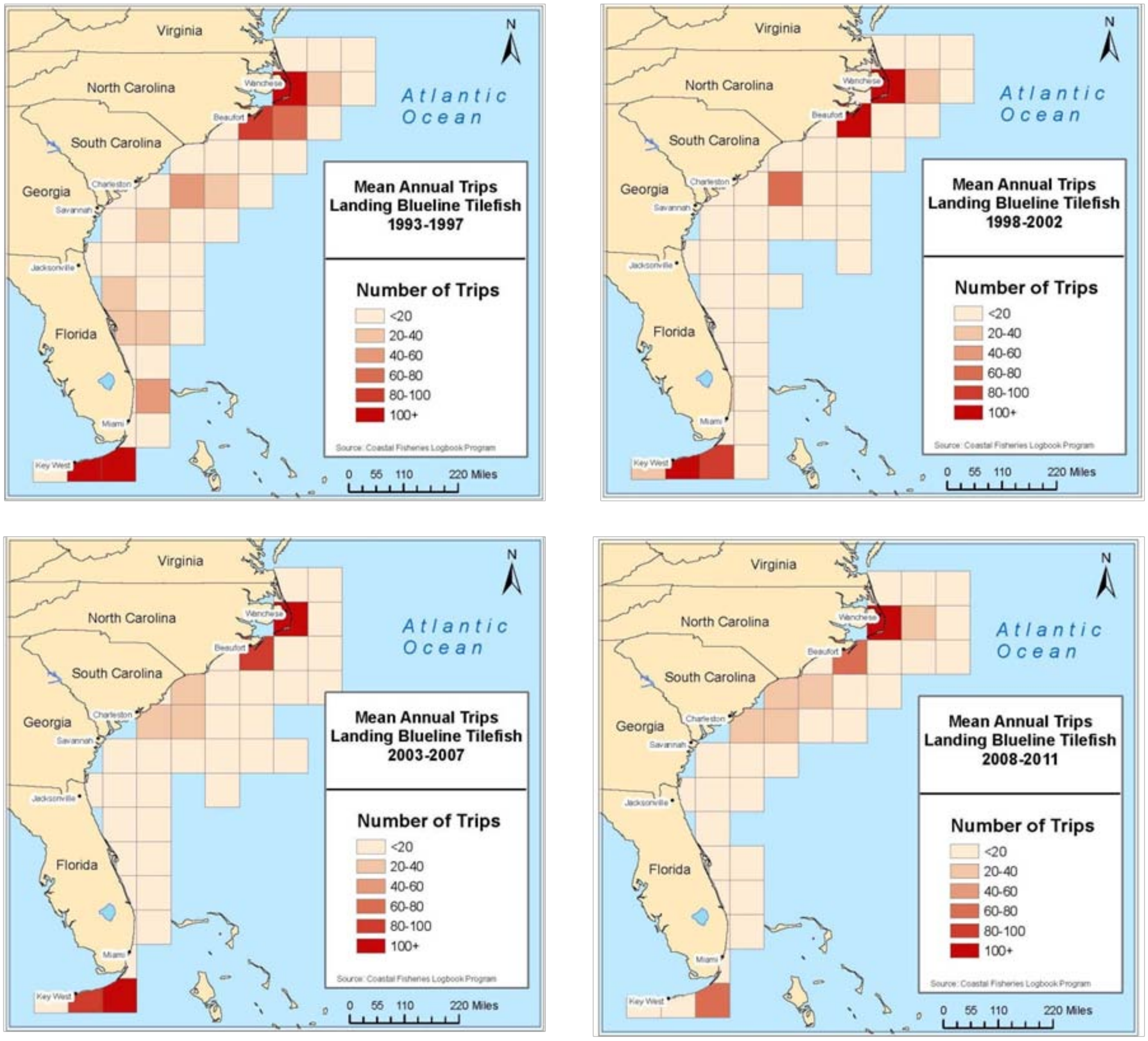

Figure 3.6 Maps of blueline tilefish effort in the South Atlantic as reported to the CFLP.

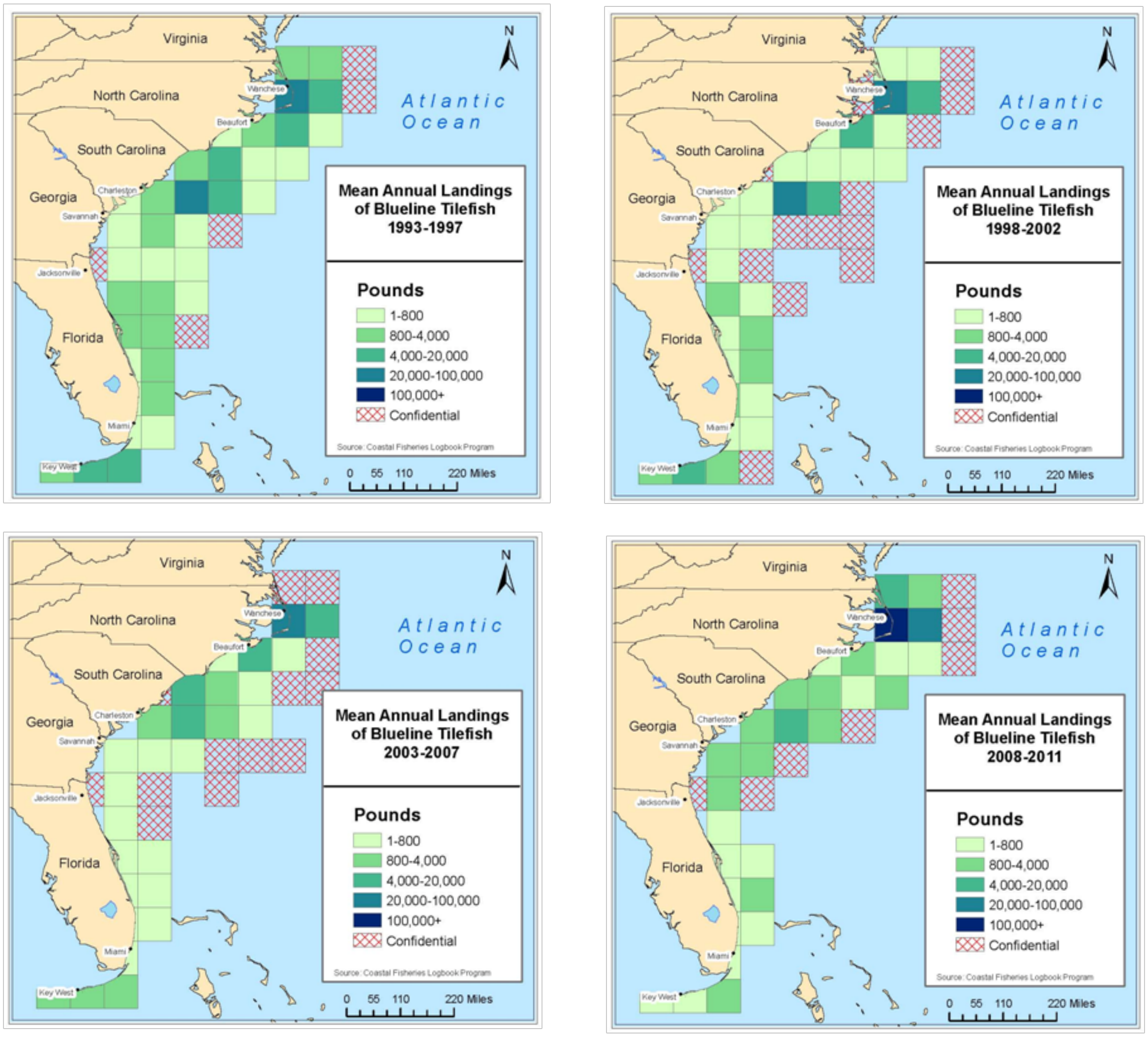

Figure 3.7 Maps of blueline tilefish harvest in the South Atlantic as reported to the CFLP.

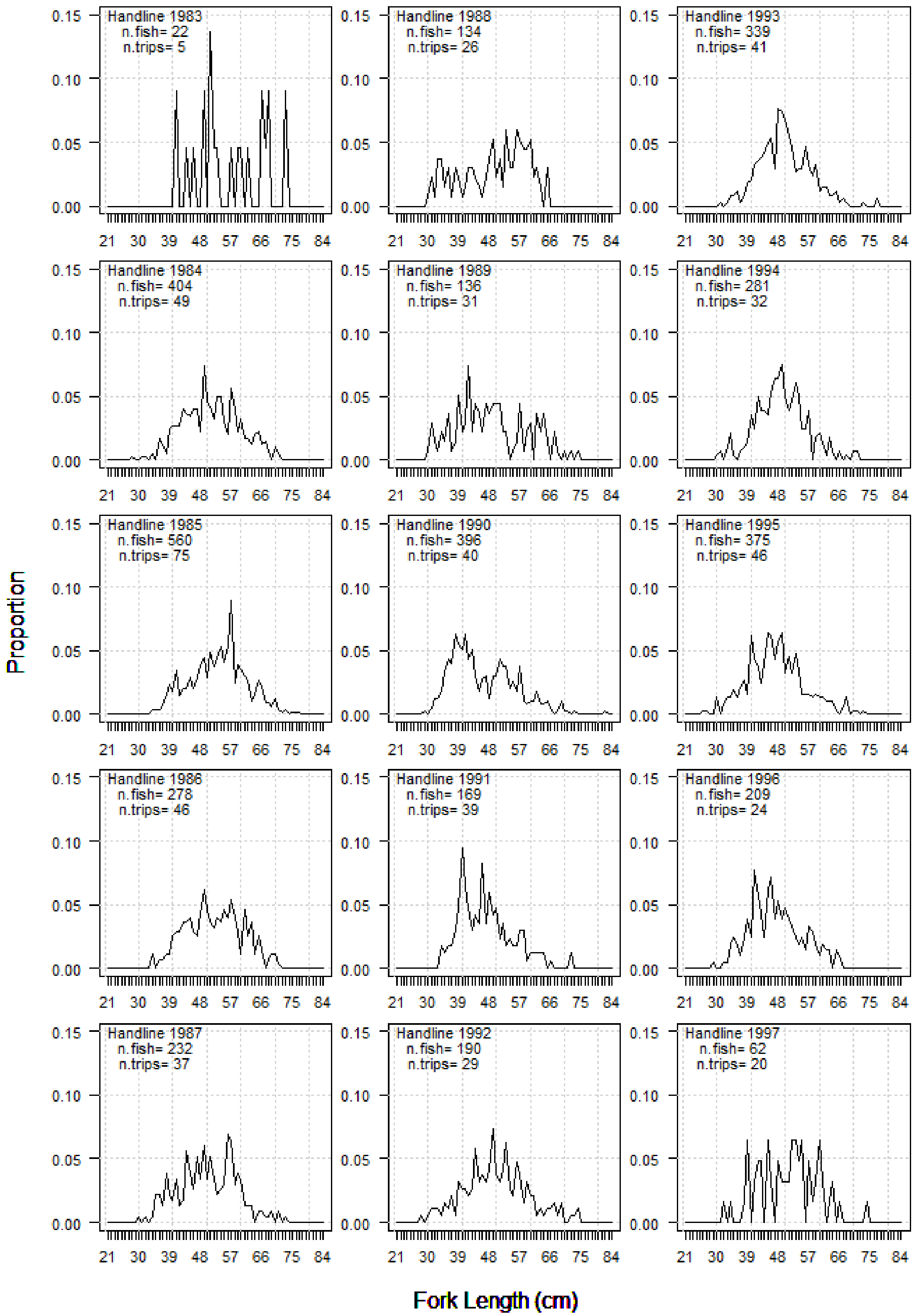

Figure 3.8 Annual length compositions (FL in cm) of commercial length samples, 1983-1997, for handline gear.

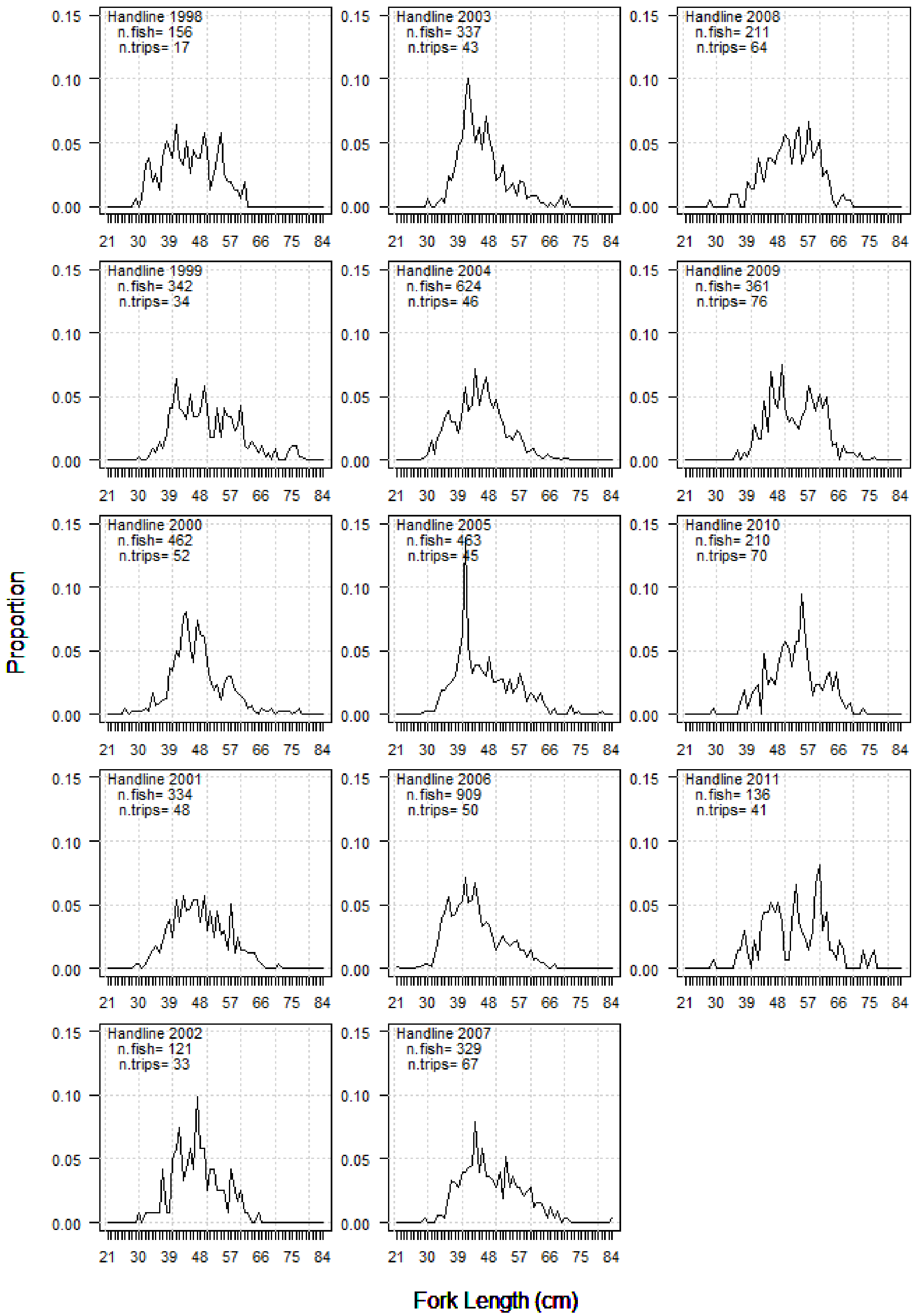

Figure 3.9 Annual length compositions (FL in cm) of commercial length samples, 1998-2011, for handline gear.

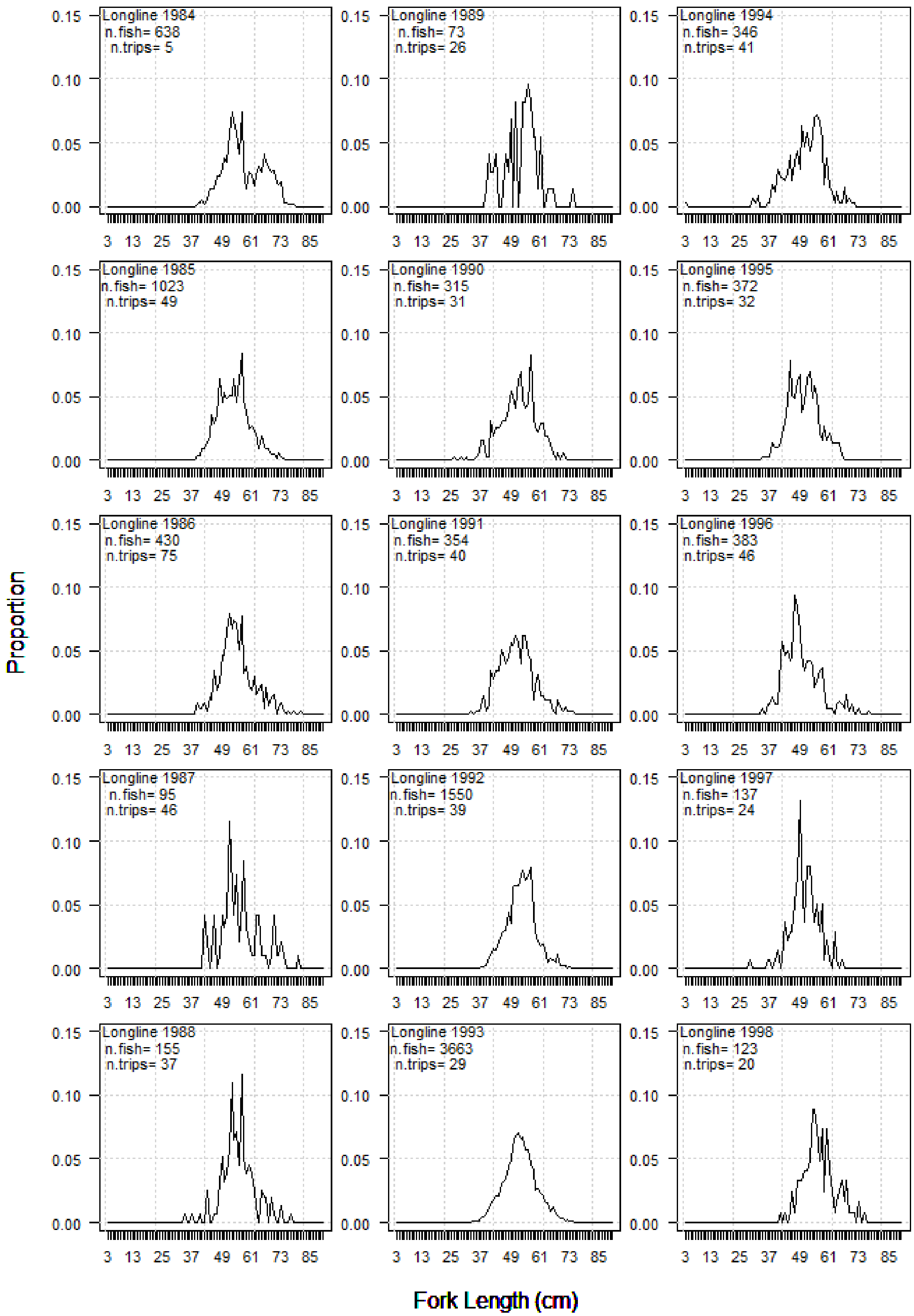

Figure 3.10 Annual length compositions (FL in cm) of commercial length samples, 1984-1998, for longline gear.

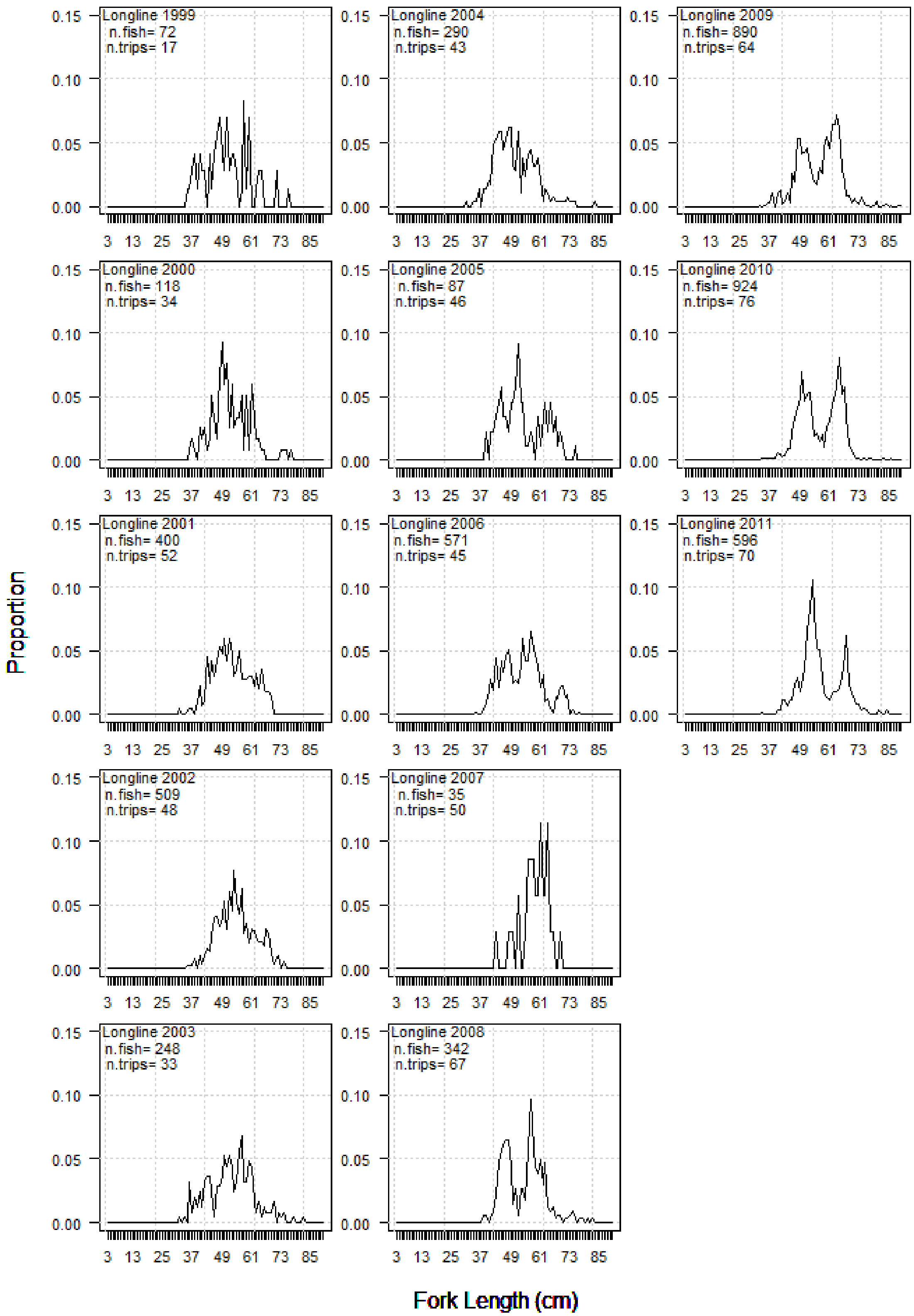

Figure 3.11 Annual length compositions (FL in cm) of commercial length samples, 1999-2011, for longline gear.

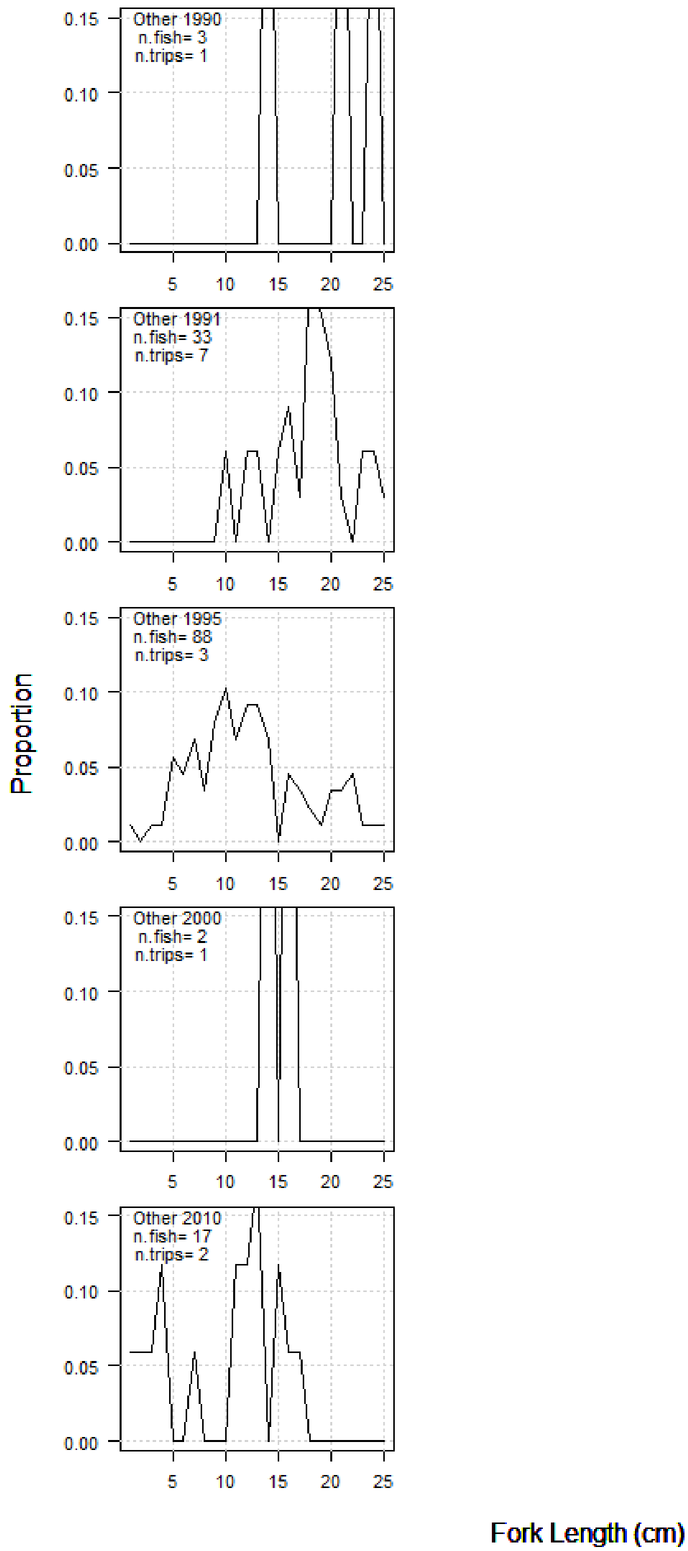

Figure 3.12 Annual length compositions (FL in cm) of commercial length samples, 1990, 1991, 1995, 2000, and 2010, for other gear.

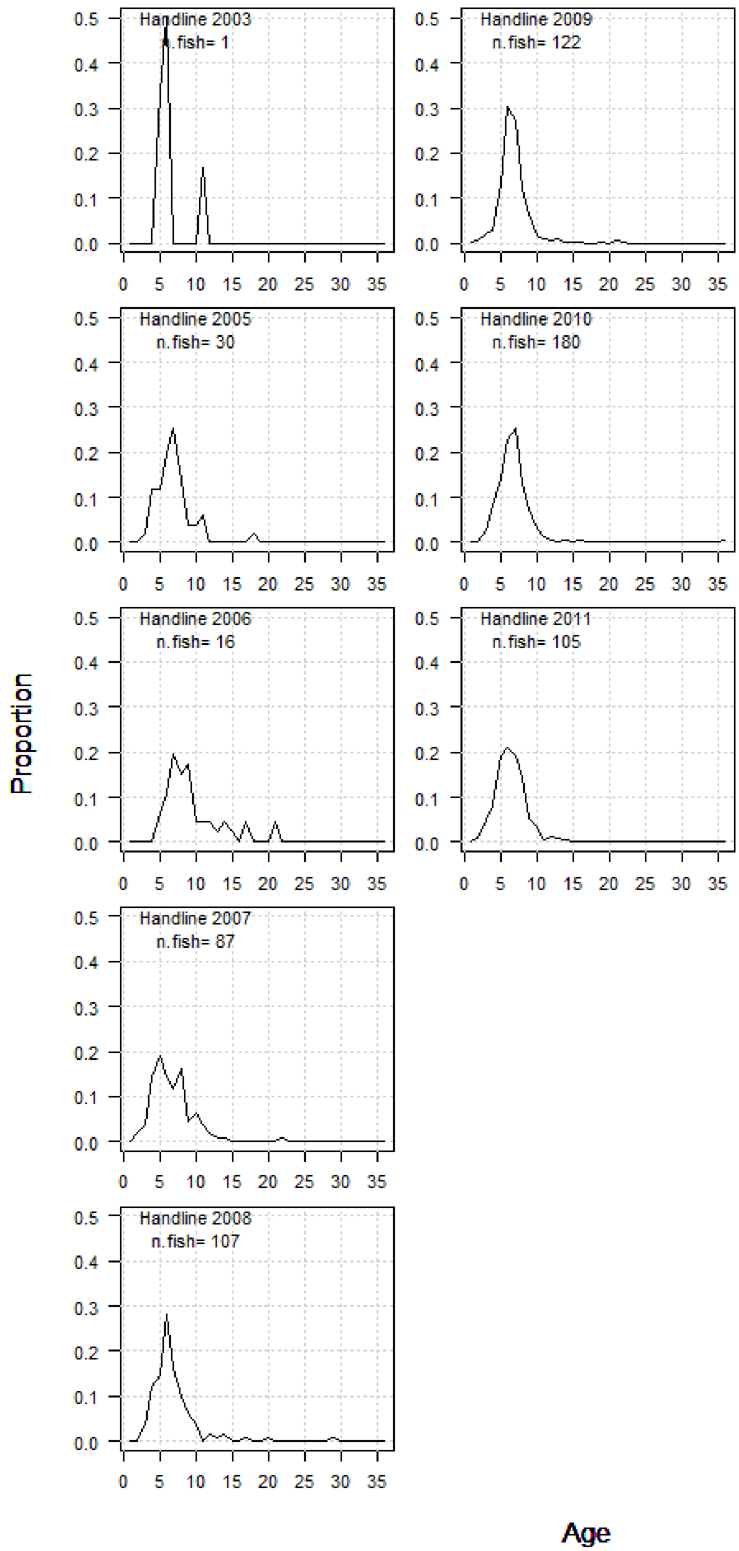

Figure 3.13 Annual unweighted age compositions for blueline tilefish handline samples for 2003-2011. There were no handline samples for 2004.

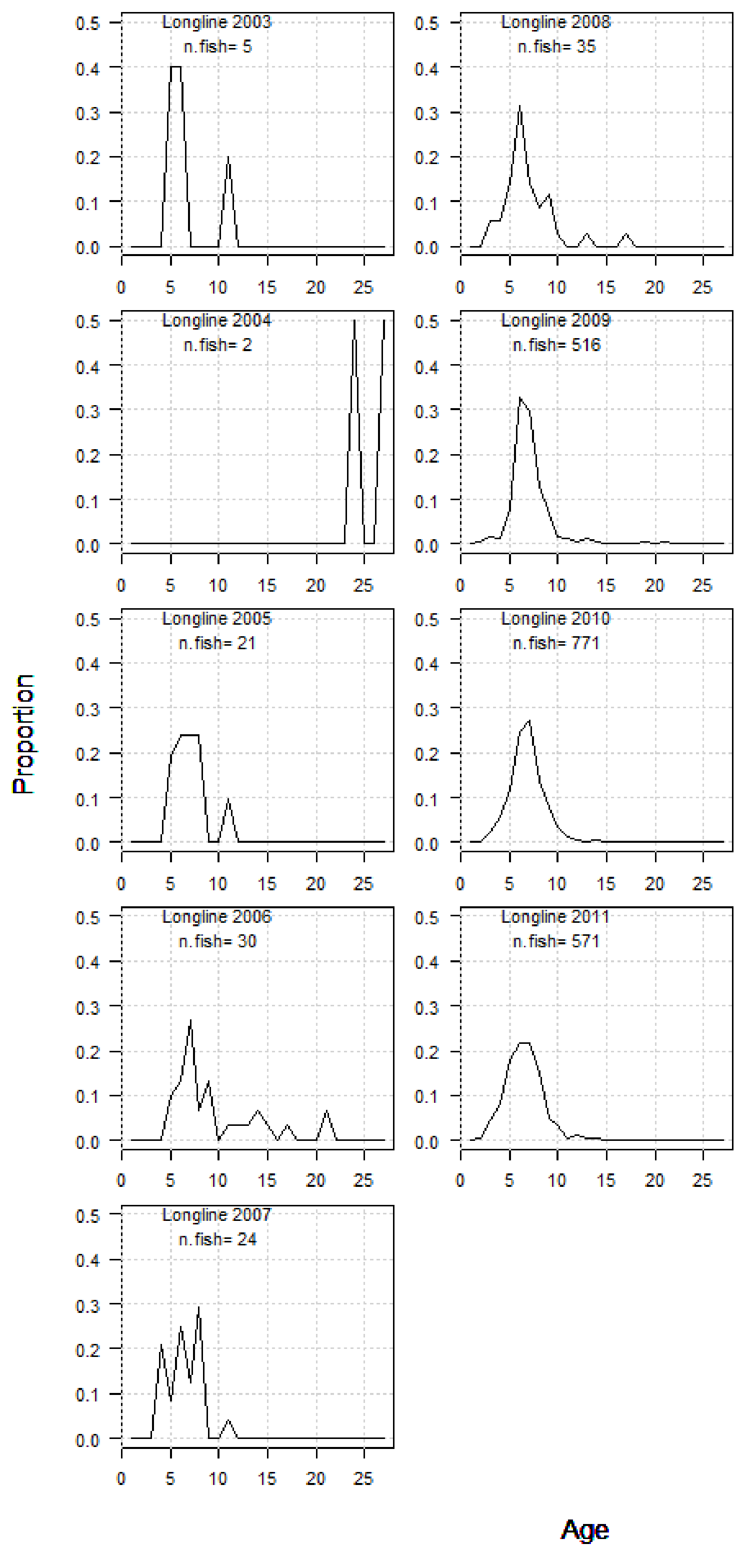

Figure 3.14 Annual unweighted age compositions for blueline tilefish longline samples for 2003-2011.

Appendix A

NMFS SECPR Accumulated Landings System (ALS)

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

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

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

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

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

1960 - Late 1980s
=================

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

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

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

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

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

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

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

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

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

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

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

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

North Carolina
===========

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

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

NMFS SECPR Annual Canvas Data for Florida

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

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

4. Recreational Fishery Statistics

4.1 Overview

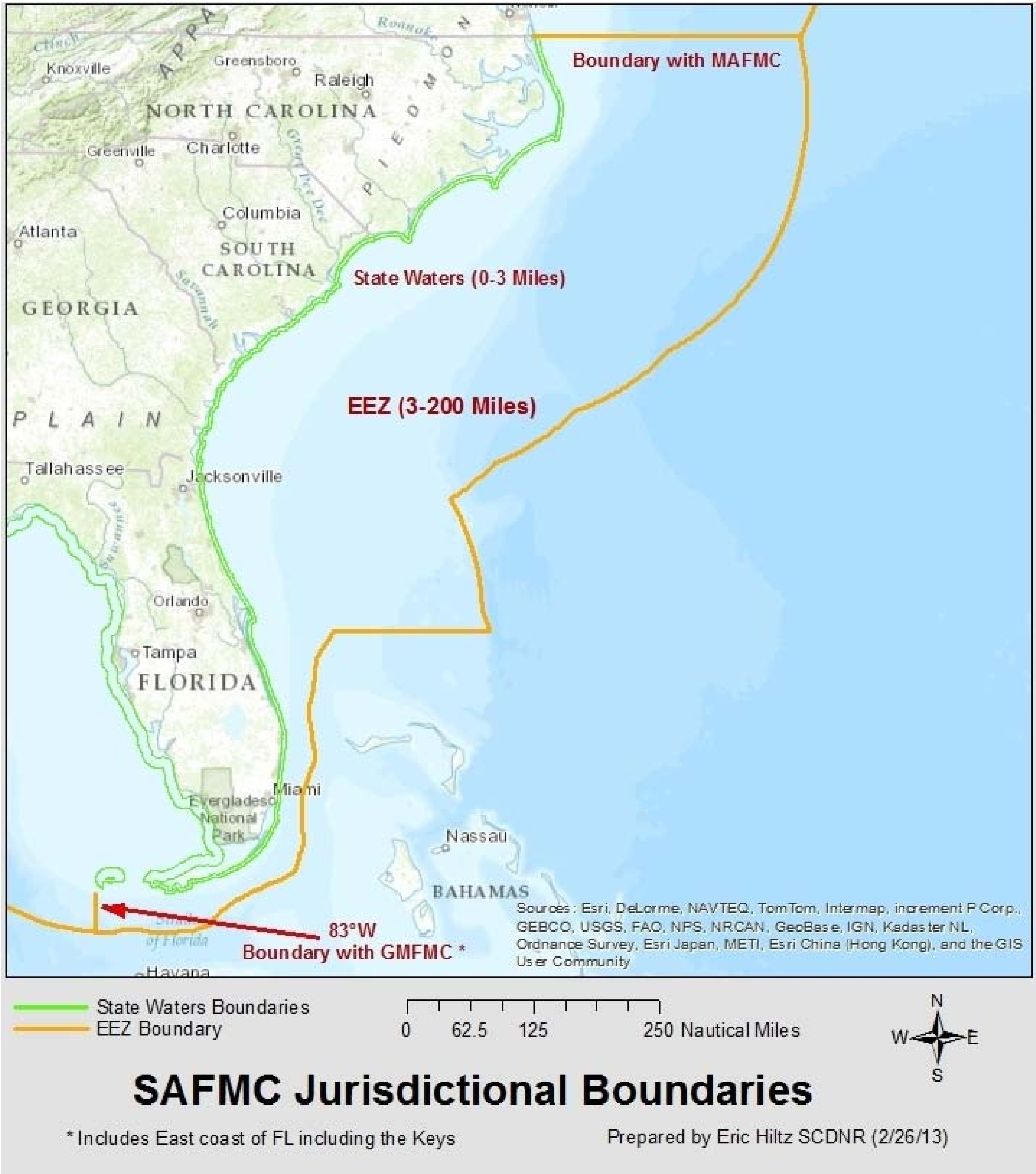
4.1.1 Group Membership

Members - Ken Brennan (Leader South Atlantic\NMFS Beaufort), Mark Brown (SAFMC Appointee/Industry rep SC), Kelly Fitzpatrick (NMFS Beaufort), Eric Hiltz (SCDNR), Robert Johnson (SAFMC Appointee\ Industry rep FL), Vivian Matter (NMFS SEFSC), Beverly Sauls (FL FWC), Chris Wilson (NCDNR).

4.1.2 Issues

1) Allocation of Monroe County catches to the Atlantic or the Gulf of Mexico: may vary by data source depending on differing spatial resolutions of the datasets.
2) Headboat logbook forms did not include blueline tilefish on a universal form until 1984.
3) Headboat estimated landings start in 1974 for NC and SC, 1977 in NEFL and 1981 in SEFL. Estimating blueline tilefish headboat landings from 1974 to1980 (date dependent on region) for periods of partial geographic coverage in the SRHS.
4) Headboat discards. Data are available from the SRHS since 2004. Review whether they are reliable for use, and determine if there are other sources of data prior to 2004 that could be used as a proxy to estimate headboat discards.
5) Charterboat landings: MRFSS charter survey methods changed in 2003 in East Florida and in 2004 for Georgia and north.
6) Combined charterboat/headboat landings, 1981-1985: Official headboat landings are available from the SRHS. Therefore, the headboat component of the MRFSS combined charter boat/headboat mode must be parsed out.
7) Usefulness of historical data sources such as the 1960, 1965, and 1970 U.S. Fish and Wildlife Service (FWS) surveys to generate estimates of landings prior to 1981. Review whether other data sources also available.
8) New MRIP weighted estimates are available for 2004-2011. MRFSS estimates available from 1981-2003.

4.1.3 South Atlantic Fishery Management Council Jurisdictional Boundaries



4.2 Review of Working Papers

SEDAR32-DW01, *MRIP Recreational Survey Data for Gray triggerfish and Blueline tilefish in the Atlantic. Vivian M. Matter 2013.*

This working paper presents MRIP survey data for gray triggerfish and blueline tilefish in the Atlantic. Issues addressed include the calibration of MRFSS charterboat estimates back in time, 1981-1985 adjustments and substitutions, calibration of MRFSS estimates for 1981-2003 to MRIP estimates, the allocation of Monroe County, FL estimates, and estimating recreational landings in weight.

SEDAR32-DW02, *MRFSS to MRIP Adjustment Ratios and Weight Estimation Procedures for South Atlantic and Gulf of Mexico Managed Species. Vivian M. Matter and Adyan Rios.* Ratio estimators were developed to appropriately adjust estimates from the Marine Recreational Fisheries Statistics Survey (MRFSS) to estimates from the Marine Recreational Information Program (MRIP) for all Gulf of Mexico and South Atlantic managed species. Weight estimation procedures are presented.

SEDAR32-DW-08 *SCDNR Charterboat Logbook Program Data, 1993 – 2011. M. Errigo et al. 2013.*
The South Carolina Department of Natural Resources (SCDNR) charterboat logbook program was used to develop indices of abundance for gray triggerfish and blueline tilefish from 1993 – 2011. The indices of abundance are standardized catch per unit effort (CPUE; catch per angler hour). For gray triggerfish, a delta-gamma GLM was used to produce annual abundance estimates. The indices are meant to describe the population trends of fish caught by V1 (6-pack) charter vessels operating in or off of South Carolina.

4.3 Recreational Landings

Total recreational landings are summarized below by survey. A map and figures summarizing the total recreational blueline tilefish landings are included in Figure 4.11.1.

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

Introduction

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

The MRFSS/MRIP survey covers coastal Atlantic coast states from Maine to Florida. The state of Florida is sampled as two sub-regions. The east Florida sub-region includes counties adjacent to the Atlantic coast from Nassau County south through Miami-Dade County, and the west

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

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

Survey methods for the for-hire fishing mode have seen the most improvement over time. Catch rate data have improved through increased sample quotas and additional sampling (requested and funded by the states) to the intercept portion of the survey. It was also recognized that the random household telephone survey was intercepting relatively few anglers in the for-hire fishing mode and the For-Hire Telephone Survey (FHS) was developed to estimate effort in the for-hire mode. The new method draws a random sample of known for-hire charter and guide vessels each week and vessel operators are called and asked directly to report their fishing activity. The FHS was officially adopted in the Gulf states in 2000, in East Florida in 2003, and in Georgia through Maine in 2005. The FHS was pilot tested in the Gulf of Mexico in 1998 and 1999 and in Georgia through Maine in 2004. The FHS does not consider the estimates during pilot years as official estimates; however, FHS data for these years have been used in past SEDARs (e.g. SEDAR 7 red snapper, SEDAR 16 king mackerel, SEDAR 25 black sea bass, etc).

A further improvement in the FHS method was the pre-stratification of Florida into smaller sub-regions for estimating effort. Pre-stratification defines the sample unit on a sub-state level to produce separate effort estimates by these finer geographical regions. The FHS sub-regions include three distinct regions bordering the Atlantic coast: Monroe County (sub-region 3), SE

Florida from Dade through Indian River counties (sub-region 4), and NE Florida from Martin through Nassau counties (sub-region 5). The coastal household telephone survey method for the for-hire fishing mode continues to run concurrently with the newer FHS method.

Calibration of traditional MRFSS charter boat estimates

Conversion factors have been estimated to calibrate the traditional MRFSS charterboat estimates with the FHS for 1986-2003 in the South Atlantic (SEDAR16-DW-15, Sminkey, 2008) and for 1981-2003 in the mid-Atlantic (SEDAR17-Data Workshop Report, 2008). 1986-2003 South Atlantic calibration factors were updated in 2011 (SEDAR25-Data Workshop Report, 2011). The relationship between the old charterboat method estimates of angler trips and the FHS estimates of angler trips was used to estimate the conversion factors. Since these factors are based on effort, they can be applied to all species' landings. In the Gulf of Mexico and the South Atlantic, the period of 1981-1985 could not be calibrated with the same ratios developed for 1986+ because in the earlier 1981-1985 time period, MRFSS considered charterboat and headboat as a single combined mode. Thus, in order to properly calibrate the estimates from 1981-1985, headboat data from the Southeast Region Headboat Survey (SRHS) were included in the analysis. To calibrate the MRFSS combined charterboat and headboat mode effort estimates in 1981-1985, conversion factors were estimated using 1986-1990 effort estimates from both modes, in equivalent effort units, an angler trip (SEDAR28-DW-12). These calibration factors were applied to the charterboat estimates and are tabulated in SEDAR32-DW-01.

Separation of SA combined charter/headboat mode

In the South Atlantic, 1981-1985 charter and headboat modes were combined into one single mode for estimation purposes. Since the NMFS Southeast Region Headboat Survey (SRHS) began in this region in 1981, the MRFSS combined charter/headboat mode must be split in order to not double estimate the headboat mode for these years. MRFSS charter/headboat mode was split in these years by using a ratio of SRHS headboat angler trip estimates to MRFSS charter boat angler trip estimates for 1986-1990. This method has been used in the past (SEDAR 28-Spanish mackerel and cobia). The mean ratio was calculated by state (or state equivalent to match SRHS areas to MRFSS states) and then applied to the 1981-1985 estimates to strip out the headboat component. These headboat estimates were then eliminated from the MRFSS estimates.

MRIP weighted estimates and the calibration of MRFSS estimates

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

Since new MRIP estimates are available for a portion of the recreational time series that the MRFSS covers, conversion factors between the MRFSS estimates and the MRIP estimates were developed in order to maintain one consistent time series for the recreational catch estimates. Ratio estimators, based on the ratios of the means, were developed for Atlantic blueline tilefish to hind-cast catch and variance estimates by fishing mode. In order to apply the charterboat ratio estimator back in time to 1981, charterboat landings were isolated from the combined cbt/hbt mode for 1981-1985. The MRFSS to MRIP calibration process is detailed in SEDAR31-DW25 and SEDAR32-DW-02.

Monroe County

Monroe County MRFSS landings from 1981 to 2003 can be post-stratified to separate them from the MRFSS West Florida estimates. Post-stratification proportionally distributes the state-wide (FLE and FLW) effort into finer scale sub-regions and then produces effort estimates at this finer geographical scale. This is needed for the private and shore modes (all years) and charter boat mode (prior to FHS). FHS charter boat mode estimates are already pre-stratified, as discussed above. Monroe County MRIP landings from 2004 to 2011 can be estimated separately from the remaining West Florida estimates using domain estimation. The Monroe County domain includes only intercepted trips returning to that county as identified in the intercept survey data. Estimates are then calculated within this domain using standard design-based estimation which incorporates the MRIP design stratification, clustering, and sample weights.

Although Monroe County estimates can be separated using these processes, they cannot be partitioned into those from the Atlantic Ocean and those from the Gulf of Mexico. Blueline tilefish is a deep-water species and Monroe County catches are most likely from the Atlantic side of the Keys. This species would not be associated with the shallow Gulf waters of Monroe County. Therefore, the recreational workgroup decided to allocate the Monroe County landings to the Atlantic.

Calculating landings estimates in weight

The MRFSS and the MRIP surveys use different methodologies to estimate landings in weight. To apply a consistent methodology over the entire recreational time series, the Southeast Fisheries Science Center (SEFSC) implemented a method for calculating average weights for the MRIP (and MRIP adjusted) landings. This method is detailed in SEDAR32-DW-02. The length-weight equation developed by the Life History Working Group (W=0.000000007*(L^3.114)) was used to convert blueline tilefish sample lengths into weights, when no weight was recorded. W is whole weight in kilograms and L is fork length in millimeters.

1981, wave 1

MRFSS began in 1981, wave 2. In the east coast of Florida, catch for 1981 wave 1 was estimated by determining the proportion of catch in wave 1 to catch in all other waves for 1982-

1984 by fishing mode and area. These proportions were then used to estimate wave 1 in 1981 from the estimated catches in other waves of that year. This methodology is consistent with past SEDARs (e.g. SEDAR 28 Spanish mackerel and cobia).

MRIP landings in numbers of fish and in whole weight in pounds are presented in Table 4.10.1. CVs associated with estimated landings in numbers are also shown.

4.3.2 Southeast Region Headboat Survey (SHRS)

Introduction

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

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

The headboat logbook was changed several times during the early years of the Headboat Survey. In the case of blueline tilefish, commonly referred to as gray tilefish early in the survey, the logbook used in North Carolina and South Carolina included “tilefish” starting in 1973, but did not specifically list blueline tilefish until 1980. The logbook form for Georgia and Florida included blueline tilefish in 1980. The Headboat Survey did not have a universal logbook form that included blueline tilefish for all areas until 1980. Dockside sampling records were reviewed for the years when only tilefish was listed and it was demonstrated that nearly all reported tilefish to be blueline tilefish prior to 1980.

Issue 1: From 1973-1980 tilefish was listed on the North Carolina and South Carolina logbook form. The logbook form did not include blueline tilefish on a universal form until 1980 for NC - FL.

Option 1: Start headboat time series in 1980 when a universal form listing blueline tilefish was in use in all areas from NC - FL. MFRSS headboat landings will be used 1981-1983.

Option 2: Use headboat logbook data when available (1973- 2011).

Decision: *Option 2*

Issue 2: The Headboat Survey had partial geographic coverage in the early years of the survey. Landings are available in NC and SC beginning in 1974. Landings are not available for GA/NEFL from 1974-1975 or SEFL from 1974-1980.

Estimates for these areas/time periods can be calculated from several methods using the ratio of NC and SC landings from 1974-1980 for periods of partial coverage. For GA/NEFL a three year ratio is calculated by dividing the total landings for NEFL (1976-1978) by NC and SC combined total landings (1976-1978). This ratio is then multipled to the 1974 and1975 combined total landings for NC and SC, resulting in the total landings for NEFL for 1974 and 1975. The same approach was used to calculate landings for SEFL 1974-1980 by using the total landings from 1981- 1983. Both three and five year ratios were used to estimate landings for the areas and time periods without coverage. After comparing both methods, the RWG concluded the five year ratio was less likely to mask real annual variability.

Option 1: Three-year ratio of NC & SC

Option 2: Five-year ratio of NC & SC

Option 3: Start headboat time series in 1981 when landings estimates are available for all areas from NC- FL.

Decision: Option 2 for estimating both number and weight to estimate landings for GA/EFL 1974-1976 and SEFL for 1974-1980.

Based on this decision the 5 year ratio was applied to the areas and periods when partial coverage occurred.

Catch Estimates
Final SRHS landings estimates are shown in Table 4.10.2. by year and state in Figure 4.11.2. SRHS areas 1-17 are included in the blueline tilefish stock.

4.3.3 Historic Recreational Landings

Introduction

The historic recreational landings time period is defined as pre-1981 for the charterboat, headboat, private boat, and shore fishing modes, which represents the start of the Marine Recreational Fisheries Statistics Survey (MRFSS) and availability of landings estimates for blueline tilefish. The Recreational Working Group was tasked with reviewing all available historical sources of blueline tilefish landings to evaluate potential methods 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) from 1960, 1965 &1970.
- Anderson, 1965.
- The National Survey of Fishing, Hunting, and Wildlife-Associated Recreation Survey (FHWAR) census method, SEDAR32-RD08.
- SAFMC 1983 Snapper and Grouper Source Documents, SEDAR32-RD03 and SEDAR32-RD04.

Salt Water Angler Surveys (SWAS)

The SWAS from 1960, 1965, and 1970 were reviewed for blueline tilefish landings. There were no blueline tilefish landings recorded in any of the SWAS from 1960 to 1970.

Anderson, 1965

The RWG discussed the Anderson study as a possible source of information for historical blueline tilefish landings. The study area designated as the Cape Canveral area included Brevard and Volusia counties in Florida. The recreational data was obtained from field surveys from February to October, 1963 and was further limited to the southern portion of the study area. After reviewing this document, the RWG determined there were no blueline tilefish included in the study.

FHWAR census method

The FHWAR method (SEDAR32-RD08) was used in SEDAR 28 to reconstruct landings back to 1950. The RWG considered using this same method for blueline tilefish, but determined that in order for this method to be applicable, evidence should show that these fish were harvested by anglers historically. After reviewing numerous black and white photos from the east coast of Florida charterboat and headboat fishery (courtesy of R. Hudson and M. Brown) back to the 1950’s; there were no tilefish visible in these recreational catches. Consequently, it was concluded by the RWG; using the MRIP average CPUE for blueline tilefish from 1981 – 1985, which is part of the FHWAR method, would not be appropriate.

SAFMC 1983 Snapper and Grouper Source Document
The RWG reviewed SEDAR32-RD03 and SEDAR32-RD04 as a source of potential landings for blueline tilefish prior to 1981. Tilefish landings were present in this document; however, these were limited to 1979 for the MRFSS. The RFWG concluded that these data were limited temporally to one year and did not offer a means to determine landings back in time.

Issue: Available historical blueline tilefish landings prior to 1981.

Option 1: Use available recreational time series for the MRFSS\MRIP 1981 to 2011 and headboat estimates 1974 - 2011.

Option 2: Use FHWAR census method to estimate blueline tilefish landings 1955-1980 in the South Atlantic. Use interpolation to complete time series.

Option 3: Use the FHWAR method effort only with sensitivity runs around the average CPUE time series. This approach was considered in SEDAR 31.

Decision: *Option 1*. Option #1 approved with the possibility of linear interpolation back to 1945 if analysts deem necessary.

4.3.4 Potential Sources for Additional Landings Data
There were no potential sources for additional landings data identified during the data workshop.

4.4 Recreational Discards
Total recreational discards are summarized below by survey. A map and figures summarizing the total recreational blueline tilefish discards are included in Figure 4.11.3.

4.4.1 MRFSS discards
Discarded live fish are reported by the anglers interviewed by the MRIP/MRFSS, so both the identity and quantities reported are unverified. Furthermore, discarded fish sizes are unknown for all fishing modes sampled by the MRFSS/MRIP. As such, lengths and weights of discarded fish are not estimated by the survey.

To characterize the size distribution of live discarded fishes, at-sea sampling of headboat discards was initiated in Atlantic states as part of the improved for-hire survey. However, the Beaufort, NC Logbook program (SRHS) produces estimates of total discards in the headboat fishery since that class of caught fish was added to their logbook (2004).

MRFSS/MRIP estimates of live released fish (B2 fish) were adjusted in the same manner as the landings (i.e. using charterboat calibration factors, MRIP adjustment, substitutions, etc. described above in section 4.3.1).

MRIP discards in numbers of fish and associated CVs by state are presented in Table 4.10.3.

4.4.2 Headboat Logbook Discards

The Southeast Region Headboat Survey logbook form was modified in 2004 to include a category to collect self-reported discards for each reported trip. This category is described on the form as the number of fish by species released alive and number released dead. Port agents instructed each captain on criteria for determining the condition of discarded fish. A fish is considered "released alive" if it is able to swim away on its own. If the fish floats off or is obviously dead or unable to swim, it is considered "released dead". These self-reported data are currently not validated within the Headboat Survey. Due to low blueline tilefish sample sizes in the MRFSS At-Sea Observer Headboat program, it was determined that the logbook discard data would be used from 2004-2011. The RWG considered the following two possible data sources to be used as a proxy for estimated headboat discards. However, due to negligible discards in the MRFSS charter boat and private boat modes prior to 2004 the RWG recommended assuming no discards of blueline tilefish for the SRHS in 1974-2003 (Figure 4.11.4).

- MRFSS charter boat discard estimates (corrected for FHS adjustment) applied– discards in 2005-2011 only with questionable spike in 2007.
- MRFSS private boat discard estimates– discards in 2003 only.

Issue: *Proxy for estimated headboat discards from 1974-2003.*

Option 1: Assume zero discards for the headboat fishery prior to 2004.

Decision: Option 1.

Final discard estimates from the SRHS are shown in Table 4.10.4 by year and state and in Figure 4.11.5.

4.4.3 Headboat At-Sea Observer Survey Discards

An observer survey of the recreational headboat fishery was launched in NC and SC in 2004 and in GA and FL in 2005 to collect more detailed information on recreational headboat catch, particularly for discarded fish. Headboat vessels are randomly selected throughout the year in each state, and the east coast of Florida is further stratified into northern and southern sample regions. Biologists board selected vessels with permission from the captain and observe anglers as they fish on the recreational trip. Data collected include number and species of fish landed and discarded, size of landed and discarded fish, and the release condition of discarded fish (FL only) Data are also collected on the length of the trip, area fished (inland, state, and federal waters) and, in Florida, the minimum and maximum depth fished. In the Florida Keys (sub-region 3) some vessels that run trips that span more than 24 hours are also sampled to collect information on trips that fish farther offshore and for longer durations, primarily in the vicinity of the Dry Tortugas. Due to low blueline tilefish sample sizes the MRFSS At-Sea Observer data was not recommended for use in this assessment.

4.4.4 Alternatives for characterizing discards

Due to low blueline tilefish sample sizes in the MRFSS At-Sea Observer data it was concluded that the headboat logbook discard estimates should be used from 2004-2011 for the South Atlantic headboat fishery. Further, the group decided to assume no discards prior to 2004 because the MRFSS charterboat and private boat modes showed negligible discards for 1981-2003.

4.5 Biological Sampling

4.5.1 Sampling Intensity Length/Age/Weight

MRFSS/MRIP Biological Sampling

The MRFSS/MRIP angler intercept survey includes the sampling of fish lengths from the harvested (landed, whole condition) catch. Up to 15 of each species landed per angler interviewed are measured to the nearest mm along a center line (defined as tip of snout to center of tail along a straight line, not curved over body). In those fish with a forked tail, this measure would typically be referred to as a fork length, and in those fish that do not have a forked tail it would typically be referred to as a total length with the exception of some fishes that have a single, or few, caudal fin rays that extend further. Weights are typically collected for the same fish measured. When time is constrained a weight may be collected without a length measurement. Aging structures and other biological samples are not collected during MRFSS/MRIP assignments because of concerns over the introduction of bias to survey data collection.

The number of blueline tilefish measured in the Atlantic (ME to FLE, including the Keys) from MRFSS/MRIP by year, mode, and state are summarized in Table 4.10.5. The number of angler trips with tilefish measured in the Atlantic (ME to FLE, including the Keys) in the MRFSS/MRIP charter fleet and private-rental mode are summarized in Matter (SEDAR32-DW01).

Headboat Survey Biological Sampling

Lengths were collected from 1972 to 2011 by headboat dockside samplers. From 1972 to 1975, only North Carolina and South Carolina were sampled whereas Georgia and northeast Florida were sampled beginning in 1976. The Southeast Region Headboat Survey conducted dockside sampling for the entire range of Atlantic waters along the southeast portion of the US from the NC-VA border through the Florida Keys beginning in 1978. Weights are typically collected for the same fish measured during dockside sampling. Also, biological samples (scales, otoliths, spines, stomachs, and gonads) are collected routinely and processed for aging, diet studies, and maturity studies.

Annual numbers of blueline tilefish measured for length in the headboat fleet and the number of trips from which blueline tilefish were measured are summarized in Table 4.10.6. Dockside mean weights for the headboat fishery are tabulated for 1974-2011 in Table 4.10.7.

Any existing total length measurements without an associated fork length measurement were converted to fork length using the following equation derived for the combined South Atlantic stock by the Life History Working Group at the SEDAR 32 data workshop:

$FL = 1.32 + 0.94 * TL$

Old Dominion University

An Old Dominion University (ODU) study provided lengths of blueline tilefish landed in Virginia during 2007-2011. The carcasses were collected in coolers or freezers at recreational ports or marinas. For this reason trip information is not available. The numbers of blueline tilefish measured for length in the ODU study are summarized in Table 4.10.8. Due to low sample sizes for blueline tilefish lengths, these data will be considered for the length composition and are included in the nominal length composition in Figure 4.11.6.

Any existing total length measurements without an associated fork length measurement were converted to fork length using the following equation derived for the combined South Atlantic stock by the Life History Working Group at the SEDAR 32 data workshop:

$FL = 1.32 + 0.94 * TL$

Age data

The number of age samples from the recreational fishery was insufficient to analyze using traditional methods. The use of age data from the recreational fishery is under review.

4.5.2 Length – Age Distributions

MRFSS and ODU

Lengths were taken from the MRFSS (charter boat, private/rental boat, and shore modes) during 1981 to 2011.

Nominal length frequency distributions for the MRFSS/MRIP, ODU and SRHS combined are provided in Figure 4.11.6.

Southeast Region Headboat Survey Length Frequency

Lengths were taken from the SRHS during 1978-2011. Nominal length frequency distributions for the MRFSS/MRIP, ODU and SRHS combined are provided in Figure 4.11.6.

Recreational Age Frequency

The number of age samples from the recreational fishery was insufficient to analyze using traditional methods. The use of age data from the recreational fishery is under review.

4.6 Recreational Effort

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

4.6.1 MRFSS/MRIP Effort

Effort estimates for the recreational fishery survey are produced via telephone surveys of both anglers (private/rental boats and shore fishers) and for-hire boat operators (charterboat anglers, and in early years, party or charter anglers). The methods have changed during the full time series (see section 4.3 for descriptions of survey method changes and adjustments to survey estimates for uniform time-series of catch estimates). MRFSS effort estimates are presented from 1981 to 2003. MRIP effort estimates are presented from 2004 to 2011. Angler trip estimates are tabulated in Table 4.10.9 by year and mode. Effort from the Florida Keys is included in the table. An angler-trip is defined as a single day of fishing by a single angler in the specified mode, not to exceed 24 hours.

4.6.2 Headboat Effort

Catch and effort data are reported on logbooks provided to all headboats in the survey. These forms are completed by the captain or designated crew member after each trip and represent the total number and weight of all the species kept, along with the total number of fish discarded for each species. Data on effort are provided as number of anglers on a given trip. Numbers of anglers are standardized, depending on the type of trip (length in hours), by converting number of anglers to "angler days" (e.g., 40 anglers on a half-day trip would yield 40 * 0.5 = 20 angler days). Angler days are summed by month for individual vessels. Each month, port agents collect these logbook trip reports and check for accuracy and completeness. Although reporting via the logbooks is mandatory, compliance is not 100% and is variable by location. To account for non-reporting, a correction factor is developed based on sampler observations, angler numbers from office books and all available information. This information is used to provide estimates of total catch (expanded or corrected for non-reporting) by month and area, along with estimates of effort.

Estimated headboat angler days have decreased in the South Atlantic in recent years (Table 4.10.10). The most obvious factor which impacted the headboat fishery in the Atlantic 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.

4.7 Comments of adequacy of data for assessment analyses

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

- Recreational landings are low for blueline tilefish since this is a limited recreational fishery. Based on the available data sources, the landings represented in this report appear to be adequate for the time period covered.
- Size data are limited but appear to adequately represent the landed catch for the charter and headboat sector.

4.8 Itemized list of tasks for completion following workshop

Recreational age data was insufficient and is under review.

4.9 Literature Cited

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4.10 Tables

Table 4.10.1. Atlantic (ME-FLE) blueline tilefish landings (numbers of fish and whole weight in pounds) for charterboat, headboat, private boat, and shore modes (MRFSS, NMFS, 1981-2003; MRIP, NMFS, 2004-2011). MRFSS estimates adjusted to MRIP estimates prior to 2004. CH mode adjusted for FHS conversion prior to 2004. After 2004 CH and HB modes are estimated separately in sub-regions 4 and 5. *CVs for CH mode 1981-1985 are unavailable.

	Estimated CH Landings			Estimated HB Landings		
YEAR	Number	CV*	Pounds	Number	CV	Pounds
1981	0		0			
1982	0		0			
1983	0		0			
1984	278		1,373			
1985	0		0			
1986	0	0.00	0			
1987	207	1.30	977			
1988	0	0.00	0			
1989	0	0.00	0			
1990	0	0.00	0			
1991	0	0.00	0			
1992	0	0.00	0			
1993	1,745	0.97	8,618			
1994	0	0.00	0			
1995	5,241	1.12	25,890			
1996	735	1.30	3,630			
1997	15,791	1.27	77,927			
1998	0	0.00	0			
1999	776	0.41	3,662			
2000	79	0.93	387			
2001	4,787	1.25	23,615			
2002	116	0.82	555			
2003	2,783	0.79	13,615			
2004	2,596	0.64	12,724	0	0.00	0
2005	7,791	0.61	31,510	0	0.00	0
2006	37,100	0.39	153,309	0	0.00	0
2007	69,139	0.36	351,291	0	0.00	0
2008	50,389	0.31	223,462	89	0.91	440
2009	11,142	0.34	63,676	256	0.94	1,259
2010	5,999	0.26	36,730	0	0.00	0
2011	6,557	0.47	36,792	0	0.00	0

Table 4.10.1. continued Atlantic (ME-FLE) blueline tilefish landings (numbers of fish and whole weight in pounds) for charterboat, headboat, private boat, and shore modes (MRFSS, NMFS, 1981-2003; MRIP, NMFS, 2004-2011). MRFSS estimates adjusted to MRIP estimates prior to 2004. CH mode adjusted for FHS conversion prior to 2004. After 2004 CH and HB modes are estimated separately in sub-regions 4 and 5. *CVs for CH mode 1981-1985 are unavailable.

	Estimated PR Landings			Estimated SH Landings			ALL MODES Landings		
YEAR	Number	CV*	Pounds	Number	CV	Pounds	Number	CV	Pounds
1981	0	0.00	0	0	0.00	0	0	0.00	0
1982	1,348	0.97	6,651	0	0.00	0	1,348	0.97	6,651
1983	0	0.00	0	820	1.04	4,050	820	1.04	4,050
1984	2,210	0.84	10,918	0	0.00	0	2,488	0.74	12,292
1985	0	0.00	0	0	0.00	0	0	0.00	0
1986	0	0.00	0	0	0.00	0	0	0.00	0
1987	2,197	0.81	10,852	0	0.00	0	2,404	0.75	11,829
1988	0	0.00	0	0	0.00	0	0	0.00	0
1989	156	0.57	768	0	0.00	0	156	0.57	768
1990	0	0.00	0	0	0.00	0	0	0.00	0
1991	0	0.00	0	0	0.00	0	0	0.00	0
1992	0	0.00	0	0	0.00	0	0	0.00	0
1993	970	0.75	4,643	0	0.00	0	2,714	0.68	13,260
1994	0	0.00	0	0	0.00	0	0	0.00	0
1995	0	0.00	0	0	0.00	0	5,241	1.12	25,890
1996	0	0.00	0	0	0.00	0	735	1.30	3,630
1997	0	0.00	0	0	0.00	0	15,791	1.27	77,927
1998	0	0.00	0	0	0.00	0	0	0.00	0
1999	0	0.00	0	0	0.00	0	776	0.41	3,662
2000	0	0.00	0	0	0.00	0	79	0.93	387
2001	0	0.00	0	0	0.00	0	4,787	1.25	23,615
2002	277	0.96	1,366	0	0.00	0	392	0.72	1,921
2003	4,535	0.96	22,402	0	0.00	0	7,319	0.66	36,017
2004	0	0.00	0	0	0.00	0	2,596	0.64	12,724
2005	0	0.00	0	0	0.00	0	7,791	0.61	31,510
2006	19,269	0.58	92,245	0	0.00	0	56,369	0.32	245,555
2007	13,598	0.71	71,455	0	0.00	0	82,737	0.32	422,746
2008	23,548	0.55	108,949	0	0.00	0	74,026	0.27	332,850
2009	12,111	0.44	68,295	0	0.00	0	23,509	0.28	133,230
2010	5,822	0.36	33,377	0	0.00	0	11,821	0.22	70,107
2011	1,738	0.80	8,611	0	0.00	0	8,295	0.41	45,403

Table 4.10.2. Estimated headboat landings of blueline tilefish in the South Atlantic 1974-2011. Due to headboat area definitions and confidentiality issues, Georgia and East Florida landings must be combined.

	NC		SC		GA/FLE	
Year	Number	Weight (lbs)	Number	Weight (lbs)	Number	Weight (lbs)
1974	1,215	3,871	2,174	12,701	481	1,947
1975	185	933	1,382	9,279	223	900
1976	1,016	5,090	2,125	12,796	414	1,674
1977	936	4,451	331	2,090	167	675
1978	368	1,241	1,082	7,533	191	773
1979	185	877	175	935	47	192
1980	107	437	3,409	16,477	565	2,135
1981	205	940	740	3,393	676	2,923
1982	57	57	2,447	8,998	62	228
1983	25	112	2,322	10,295	668	2,998
1984	47	140	292	958	50	212
1985	5	19	613	2,465	31	112
1986	6	21	621	1,966	52	192
1987	28	127	356	1,614	91	412
1988	2	10	389	1,067	45	123
1989	14	14	247	247	171	171
1990	30	167	78	442	101	148
1991	4	21	79	433	236	348
1992	-	-	66	242	1,327	2,540
1993	3	11	-	-	148	238
1994	-	-	11	46	87	100
1995	-	-	1	2	253	574
1996	-	-	12	55	2,522	11,621
1997	8	32	3	14	129	223
1998	35	122	2	7	57	130
1999	8	20	1	3	22	33
2000	-	-	6	8	17	24
2001	-	-	1	1	165	220
2002	-	-	7	108	150	1,323
2003	-	-	-	-	57	105
2004	13	54	1	4	41	31
2005	6	23	1	4	216	812
2006	299	848	-	-	60	108
2007	95	180	-	-	7	12
2008	26	50	4	8	4	7
2009	2,389	4,603	4	8	10	19
2010	2,052	5,952	-	-	-	-
2011	1,732	4,579	-	-	2,223	1,797

Table 4.10.3. Atlantic (ME-FLE) blueline tilefish discards for the recreational fishing modes by year (MRFSS, NMFS, 1981-2003; MRIP, NMFS, 2004-2011). 2011 data is preliminary and through October. CH and CH/HB mode adjusted for FHS conversion prior to 2004. CH/HB mode landings are from the Mid-Atlantic and North Atlantic (sub-regions 4 and 5) through 2003. After 2004 CH and HB modes are estimated separately in these sub-regions. HB mode estimates from 1981-1983 are from the South Atlantic (sub-region 6).

	Estimated CH Discards		Estimated HB Discards		Estimated PR Discards		Estimated SH Discards		ALL MODES Discards	
YEAR	Number	CV*	Number	CV	Number	CV	Number	CV	Number	CV
1981	0				0	0.00	0	0.00	0	0.00
1982	0				0	0.00	0	0.00	0	0.00
1983	0				0	0.00	4,756	0.82	4,756	0.82
1984	0				0	0.00	0	0.00	0	0.00
1985	0				0	0.00	0	0.00	0	0.00
1986	0	0.00			0	0.00	0	0.00	0	0.00
1987	0	0.00			0	0.00	0	0.00	0	0.00
1988	0	0.00			0	0.00	0	0.00	0	0.00
1989	0	0.00			0	0.00	0	0.00	0	0.00
1990	0	0.00			0	0.00	0	0.00	0	0.00
1991	0	0.00			3,556	4.17	0	0.00	3,556	4.17
1992	75	0.00			254	1.54	0	0.00	329	1.21
1993	0	0.00			0	0.00	0	0.00	0	0.00
1994	0	0.00			0	0.00	0	0.00	0	0.00
1995	0	0.00			0	0.00	0	0.00	0	0.00
1996	0	0.00			0	0.00	0	0.00	0	0.00
1997	0	0.00			0	0.00	0	0.00	0	0.00
1998	26	0.81			0	0.00	0	0.00	26	0.81
1999	329	0.49			530	0.49	572	0.59	1,431	0.32
2000	15	0.81			0	0.00	135	0.82	150	0.75
2001	0	0.00			0	0.00	0	0.00	0	0.00
2002	19	0.81			129	0.82	0	0.00	148	0.73
2003	473	1.23			746	0.54	0	0.00	1,219	0.58
2004	7	0.00	0	0.00	67	1.01	0	0.00	74	0.92
2005	1,601	1.01	0	0.00	3,123	0.60	0	0.00	4,724	0.52
2006	977	0.84	0	0.00	118	1.01	0	0.00	1,095	0.75
2007	32,426	0.93	0	0.00	4,912	0.97	0	0.00	37,338	0.81
2008	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
2009	38	1.12	0	0.00	724	0.54	0	0.00	762	0.52
2010	1,837	0.94	0	0.00	0	0.00	0	0.00	1,837	0.94
2011	317	0.86	0	0.00	0	0.00	0	0.00	317	0.86

Table 4.10.4. Estimated South Atlantic blueline tilefish discards for SRHS by year and state.† Due to headboat area definitions and confidentiality issues, Georgia and East Florida data must be combined.

Year	NC	SC	GA/FLE	South Atlantic
1974				
1975				
1976				
1977				
1978				
1979				
1980				
1981				
1982				
1983				
1984				
1985				
1986				
1987				
1988				
1989				
1990				
1991				
1992				
1993				
1994				
1995				
1996				
1997				
1998				
1999				
2000				
2001				
2002				
2003				
2004	-	-	-	-
2005	-	-	-	-
2006	-	-	2	2
2007	-	-	-	-
2008	-	-	8	8
2009	2	-	3	5
2010	6	-	8	14
2011	44	-	26	70

†1974-2003 Assume no discards prior to 2004.

Table 4.10.5. Number of blueline tilefish measured in the Atlantic (ME-FLE) in the MRFSS/MRIP by year, state, and mode.

	Charter							Headboat		Private				Total
YEAR	FL Keys	FLE	SC	NC	VA	DE	All	NJ	All	FL Keys	FLE	NC	All	
1981														
1982														
1983														
1984														
1985														
1986														
1987														
1988														
1989														
1990														
1991														
1992														
1993		2					2			1			1	3
1994														
1995				2			2							2
1996				7			7							7
1997	5			15			20							20
1998														
1999	19						19							19
2000	2		1				3							3
2001	4			15			19							19
2002	1	2					3							3
2003	10			15			25				10		10	35
2004	3	1		5			9							9
2005	6			30			36							36
2006	1			108			109					56	56	165
2007	16			256	12		284					27	27	311
2008	4	3		326			333	1	1			6	6	340
2009	1	22		114		1	138	10	10	2		8	10	158
2010	15	6		93			114					2	2	116
2011		19		40			59				4	2	6	65

Table 4.10.6. Number of blueline tilefish measured and number of trips with measured blueline tilefish in the SRHS by year and state.

	Fish (N)				Trips (N)			
YEAR	NC	SC	GA/FLE	Total	NC	SC	GA/FLE	Total
1972	111	30	-	141	26	12	-	38
1973	108	29	-	137	23	18	-	41
1974	15	76	-	91	4	23	-	27
1975	48	30	-	78	13	16	-	29
1976	152	35	-	187	30	14	-	44
1977	54	12	-	66	13	5	-	18
1978	4	28	-	32	3	11	-	14
1979	-	29	32	61	-	7	3	10
1980	5	19	21	45	5	8	5	18
1981	4	6	26	36	3	3	6	12
1982	-	18	-	18	-	9	-	9
1983	3	40	-	43	1	18	-	19
1984	-	26	3	29	-	10	3	13
1985	3	16	1	20	3	11	1	15
1986	-	29	1	30	-	10	1	11
1987	1	8	-	9	1	7	-	8
1988	1	5	2	8	1	2	2	5
1989	-	-	10	10	-	-	3	3
1990	-	1	5	6	-	1	1	2
1991	-	-	2	2	-	-	2	2
1992	-	-	-	-	-	-	-	-
1993	-	-	-	-	-	-	-	-
1994	-	-	-	-	-	-	-	-
1995	-	-	-	-	-	-	-	-
1996	-	43	-	43	-	6	-	6
1997	-	31	30	61	-	6	6	12
1998	-	30	6	36	-	5	4	9
1999	-	-	-	-	-	-	-	-
2000	-	-	36	36	-	-	4	4
2001	-	-	15	15	-	-	2	2
2002	0	0	0	0	0	0	0	0
2003	0	0	6	6	0	0	4	4
2004	0	0	7	7	0	0	2	2
2005	0	0	0	0	0	0	0	0
2006	0	0	0	0	0	0	0	0
2007	0	0	0	0	0	0	0	0
2008	0	0	2	2	0	0	2	2
2009	0	0	0	0	0	0	0	0
2010	42	0	0	42	6	0	0	6
2011	37	0	8	45	4	0	2	6

Table 4.10.7. Mean weight (kg) of blueline tilefish measured in the SRHS by year and state, 1972-2011.

	NC				SC				FLE/GA			
Year	N	Mean(kg)	Min(kg)	Max(kg)	N	Mean(kg)	Min(kg)	Max(kg)	N	Mean(kg)	Min(kg)	Max(kg)
1972	111	2.11	0.27	4.81	30	3.36	1.54	5.54	-	-	-	-
1973	108	2.17	0.36	5.54	29	3.19	0.86	5.22	-	-	-	-
1974	15	1.75	0.82	3.86	77	2.58	0.55	5.72	-	-	-	-
1975	48	2.73	0.45	6.58	30	2.77	1.00	5.13	-	-	-	-
1976	153	2.27	0.82	5.13	35	2.78	1.20	5.90	-	-	-	-
1977	54	2.11	0.67	4.27	12	2.87	1.36	4.77	-	-	-	-
1978	4	2.70	1.40	3.40	28	3.07	1.60	5.55	-	-	-	-
1979	-	-	-	-	29	2.42	0.54	5.50	32	0.68	0.26	2.50
1980	5	2.63	1.45	4.00	19	2.47	0.97	7.75	21	1.08	0.47	2.70
1981	4	1.59	1.05	2.45	6	2.41	1.20	4.90	26	1.92	0.45	7.03
1982	-	-	-	-	18	1.67	0.41	3.25	-	-	-	-
1983	3	1.32	0.60	2.00	40	2.07	0.43	3.80	-	-	-	-
1984	-	-	-	-	26	1.97	0.70	4.90	3	1.69	0.67	3.00
1985	3	0.92	0.57	1.60	16	1.82	0.77	4.15	1	0.43	0.43	0.43
1986	-	-	-	-	29	1.61	0.61	3.60	1	3.51	3.51	3.51
1987	1	1.50	1.50	1.50	8	2.13	1.40	3.20	-	-	-	-
1988	1	0.22	0.22	0.22	5	1.41	0.43	2.30	2	0.77	0.14	1.40
1989	-	-	-	-	-	-	-	-	10	0.45	0.10	1.08
1990	-	-	-	-	1	3.90	3.90	3.90	5	0.33	0.21	0.42
1991	-	-	-	-	-	-	-	-	2	0.17	0.08	0.25
1992	-	-	-	-	-	-	-	-	-	-	-	-
1993	-	-	-	-	-	-	-	-	-	-	-	-
1994	-	-	-	-	-	-	-	-	-	-	-	-
1995	-	-	-	-	-	-	-	-	-	-	-	-
1996	-	-	-	-	43	2.11	0.73	4.05	-	-	-	-
1997	-	-	-	-	31	1.92	0.95	3.98	30	0.68	0.16	1.40
1998	-	-	-	-	30	1.64	0.50	2.99	6	0.36	0.26	0.53
1999	-	-	-	-	-	-	-	-	-	-	-	-
2000	-	-	-	-	-	-	-	-	36	0.60	0.19	2.81
2001	-	-	-	-	-	-	-	-	15	0.60	0.25	0.93
2002	-	-	-	-	-	-	-	-	-	-	-	-
2003	-	-	-	-	-	-	-	-	6	0.73	0.15	1.19
2004	-	-	-	-	-	-	-	-	7	1.10	0.71	1.58
2005	-	-	-	-	-	-	-	-	-	-	-	-
2006	-	-	-	-	-	-	-	-	-	-	-	-
2007	-	-	-	-	-	-	-	-	-	-	-	-
2008	-	-	-	-	-	-	-	-	2	0.31	0.27	0.35
2009	-	-	-	-	-	-	-	-	-	-	-	-
2010	42	1.10	0.15	3.70	-	-	-	-	-	-	-	-
2011	37	1.16	0.37	3.44	-	-	-	-	8	0.74	0.24	1.63

Table 4.10.8. Number of blueline tilefish measured in the ODU study by year (2007-2011). Trip information was not recorded for these data.

Year	Fish (N)
2007	47
2008	64
2009	72
2010	257
2011	570
Total	1010

Table 4.10.9. Atlantic (ME-FLE) estimated number of angler trips for charter boat mode, headboat mode, and charterboat/headboat mode (MRFSS, NMFS, 1981-2003; MRIP, NMFS, 2004-2011). CH and CH/HB mode adjusted for FHS conversion prior to 2004. CH/HB mode estimates are from the Mid-Atlantic and North Atlantic (sub-regions 4 and 5) from 1981-2003. After 2004 CH and HB modes are estimated separately in sub-regions 4 and 5. MRIP headboat effort from the South Atlantic has been separated from the combined Cbt/Hbt mode and removed. MRIP effort from the Florida Keys is included. *CVs for CH mode 1981-1985 are unavailable.

	Estimated CH Angler Trips		Estimated CH/HB Angler Trips		Estimated HB Angler Trips	
YEAR	Trips	CV*	Trips	CV	Trips	CV
1981	702,010		5,127,985	0.07		
1982	766,866		6,448,699	0.16		
1983	1,334,693		5,695,547	0.08		
1984	858,441		3,947,943	0.09		
1985	1,000,384		5,152,262	0.16		
1986	1,128,589	0.15	4,808,719	0.08		
1987	816,316	0.14	3,517,564	0.08		
1988	1,078,777	0.11	2,892,058	0.07		
1989	864,145	0.12	2,400,947	0.07		
1990	596,793	0.10	2,531,303	0.06		
1991	684,455	0.08	2,993,819	0.07		
1992	764,014	0.08	2,071,191	0.07		
1993	1,056,635	0.07	3,666,103	0.07		
1994	1,267,497	0.06	3,198,441	0.07		
1995	1,507,150	0.06	2,986,512	0.07		
1996	1,560,075	0.06	2,080,684	0.07		
1997	1,596,206	0.06	2,680,613	0.07		
1998	1,229,179	0.06	1,680,101	0.07		
1999	1,000,898	0.07	1,535,047	0.07		
2000	797,740	0.08	1,987,412	0.06		
2001	833,305	0.08	2,216,717	0.06		
2002	807,064	0.07	1,660,987	0.06		
2003	777,444	0.08	2,026,445	0.06		
2004	1,426,898	0.04			674,070	0.08
2005	1,662,619	0.07			616,961	0.04
2006	1,491,721	0.04			886,331	0.03
2007	1,917,784	0.03			937,197	0.04
2008	1,398,972	0.03			814,575	0.02
2009	1,330,537	0.03			774,156	0.01
2010	1,126,273	0.03			562,826	0.01
2011	1,334,364	0.02			596,969	0.01

Table 4.10.9 (continued). Atlantic (ME-FLE) estimated number of angler trips for private/rental boat mode and shore mode (MRFSS, NMFS, 1981-2003; MRIP, NMFS, 2004-2011). MRIP effort from the Florida Keys is included.

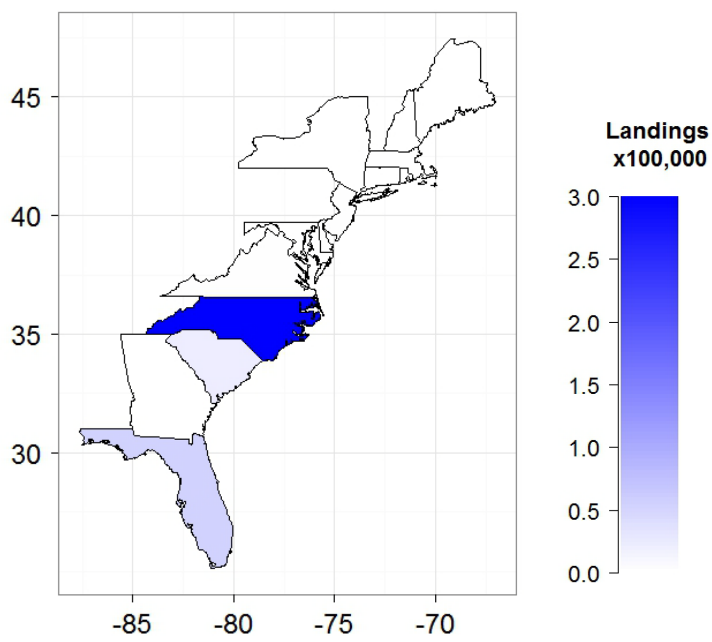
	Estimated PR Angler Trips		Estimated SH Angler Trips		ALL MODES Angler Trips	
YEAR	Trips	CV	Trips	CV	Trips	CV
1981	13,684,143	0.09	13,119,148	0.06	32,633,286	0.05
1982	14,281,195	0.04	16,820,621	0.06	38,317,382	0.04
1983	17,522,441	0.04	20,179,678	0.07	44,732,358	0.04
1984	18,146,102	0.04	17,480,861	0.05	40,433,347	0.03
1985	16,877,411	0.04	15,911,284	0.05	38,941,340	0.03
1986	20,669,710	0.03	16,561,685	0.04	43,168,703	0.02
1987	20,507,255	0.02	15,772,932	0.04	40,614,067	0.02
1988	20,279,058	0.02	16,877,695	0.03	41,127,588	0.02
1989	17,359,378	0.02	14,891,530	0.04	35,515,999	0.02
1990	17,663,168	0.02	13,573,672	0.03	34,364,937	0.02
1991	20,419,927	0.02	19,321,279	0.03	43,419,480	0.02
1992	17,783,844	0.02	16,477,154	0.02	37,096,203	0.02
1993	19,497,811	0.02	17,375,976	0.02	41,596,525	0.02
1994	21,118,885	0.02	19,639,094	0.02	45,223,917	0.01
1995	19,777,894	0.02	19,560,606	0.02	43,832,161	0.01
1996	20,117,710	0.02	18,928,861	0.02	42,687,330	0.01
1997	22,329,740	0.02	19,544,728	0.02	46,151,288	0.01
1998	19,895,505	0.02	17,066,719	0.02	39,871,505	0.02
1999	18,471,997	0.02	15,309,658	0.03	36,317,601	0.02
2000	25,550,773	0.02	21,314,273	0.02	49,650,198	0.01
2001	26,707,144	0.02	23,690,798	0.02	53,447,964	0.01
2002	22,509,418	0.02	19,134,357	0.02	44,111,826	0.01
2003	26,064,529	0.02	22,316,012	0.02	51,184,430	0.01
2004	26,257,681	0.02	21,287,755	0.03	49,646,405	0.02
2005	27,156,157	0.02	22,239,376	0.03	51,675,112	0.02
2006	26,730,425	0.02	22,794,602	0.03	51,903,079	0.02
2007	29,432,245	0.02	22,231,673	0.03	54,518,899	0.02
2008	28,216,819	0.02	22,559,871	0.03	52,990,238	0.02
2009	22,373,114	0.02	19,017,595	0.03	43,495,403	0.02
2010	23,244,450	0.02	18,502,636	0.03	43,436,185	0.02
2011	20,569,565	0.02	17,721,130	0.03	40,222,029	0.02

Table 4.10.10. South Atlantic headboat estimated angler days by year and state, 1981-2011.

Year	NC	SC	FLE/GA
1981	19,372	59,030	298,525
1982	26,939	67,539	293,133
1983	23,830	65,713	277,863
1984	28,865	67,313	288,994
1985	31,346	66,001	280,844
1986	31,187	67,227	317,061
1987	35,261	78,806	333,041
1988	42,421	76,468	301,774
1989	38,678	62,708	316,864
1990	43,240	57,151	322,895
1991	40,936	67,982	280,022
1992	41,177	61,790	264,524
1993	42,785	64,457	236,972
1994	36,693	63,231	242,780
1995	40,294	61,739	201,611
1996	35,142	54,929	199,853
1997	37,189	60,147	173,266
1998	37,399	61,342	155,341
1999	31,596	55,499	163,812
2000	31,323	40,291	182,249
2001	31,779	49,263	163,387
2002	27,601	42,467	151,546
2003	22,998	36,556	145,011
2004	27,255	48,763	175,400
2005	31,573	34,036	172,839
2006	25,730	56,070	175,550
2007	28,997	60,725	157,144
2008	17,156	47,285	123,931
2009	19,463	40,916	136,413
2010	21,066	44,947	123,655
2011	18,453	44,640	124,036

4.11 Figures

a) Blueline Tilefish Landings by State 1974-2011



b) Blueline Tilefish Landings by State and Year 1974-2011

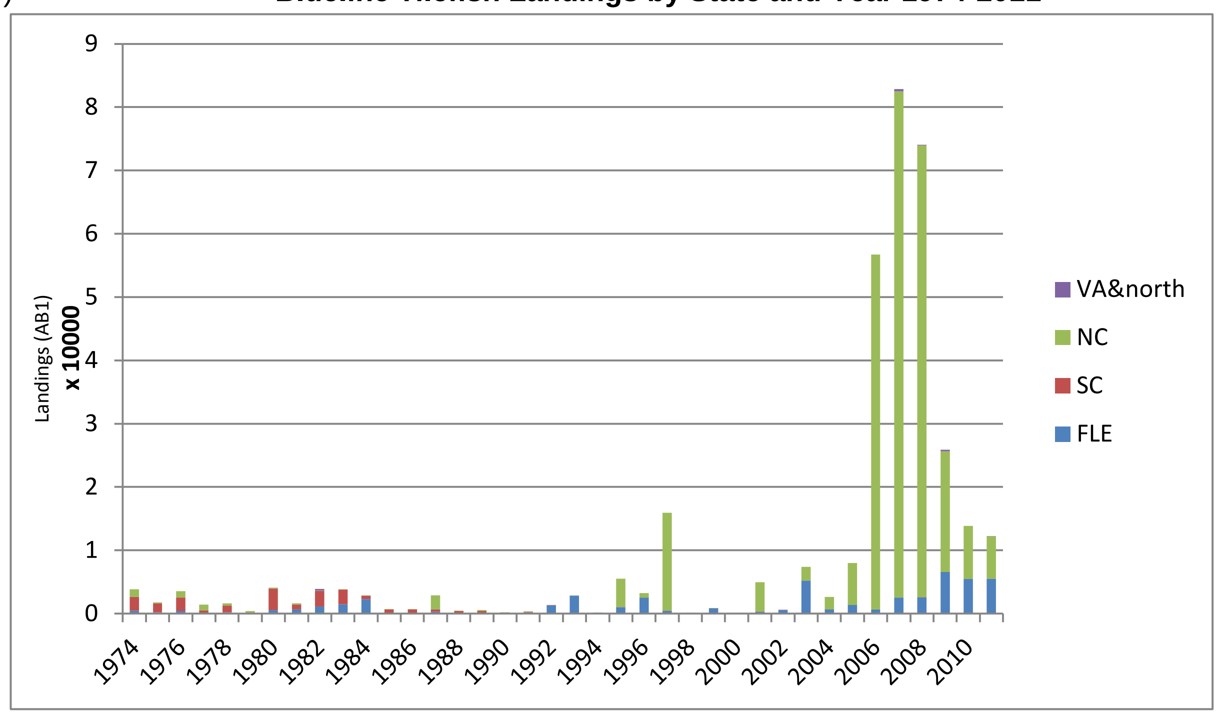
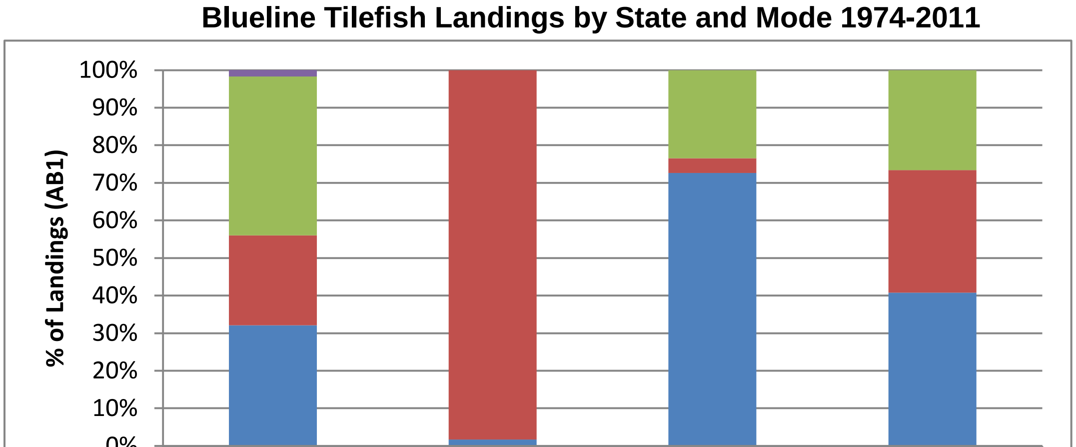


Figure 4.11.1. Estimated number of Atlantic blueline tilefish landings from MRFSS/MRIP (1981-2011) and SRHS (1974-2011) by state (a), by state and year (b), and by state and mode (c). Florida landings from east coast only, including Florida Keys. Due to confidentiality concerns SRHS landings for GA and FLE are grouped and shown as FLE.

c)



Landings (AB1)	FLE	SC	NC	VA&north
Shore	820	0	0	0
Priv	20,819	0	66,676	282
Hbt	11,766	18,982	11,101	345
Cbt	15,806	335	206,678	432

Figure 4.11.1. (continued) Estimated number of Atlantic blueline tilefish landings from MRFSS/MRIP (1981-2011) and SRHS (1974-2011) by state (a), by state and year (b), and by state and mode (c). Florida landings from east coast only, including Florida Keys. Due to confidentiality concerns SRHS landings for GA and FLE are grouped and shown as FLE (continued).

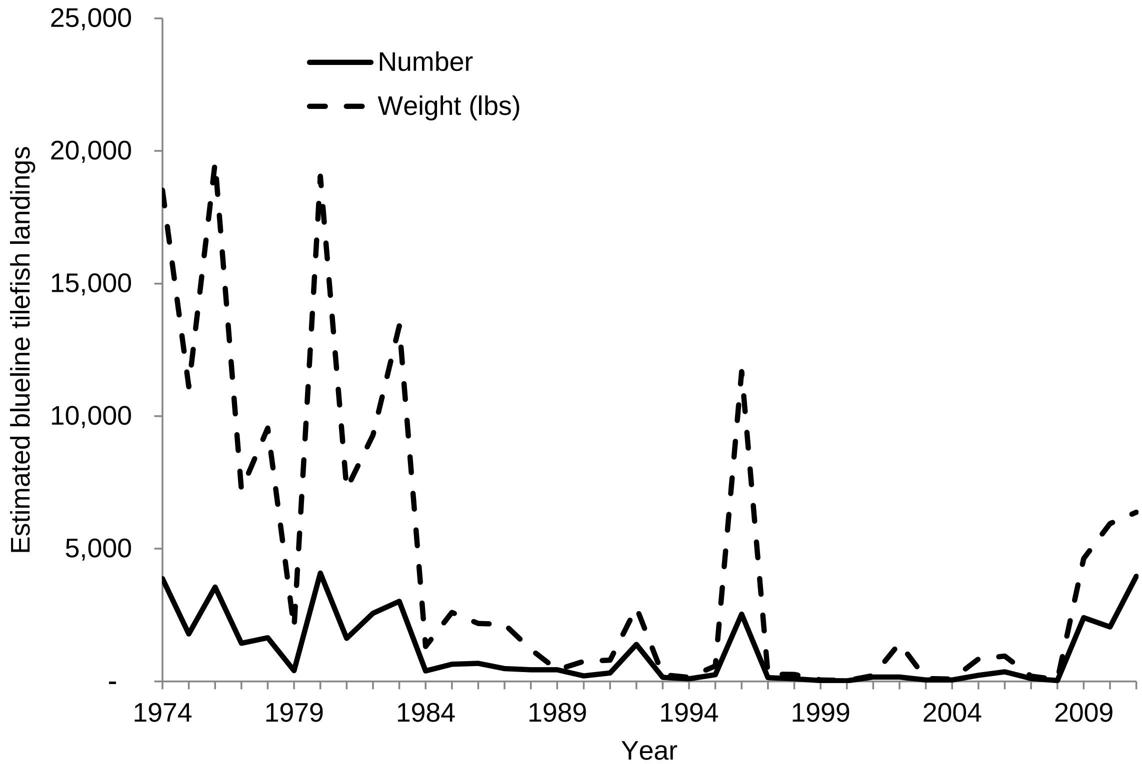
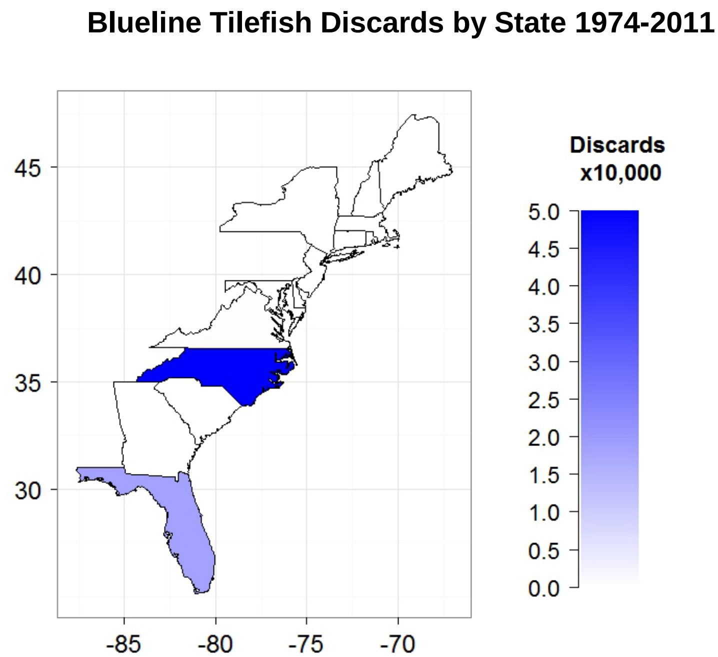


Figure 4.11.2. South Atlantic estimated blueline tilefish landings (number and pounds) for the headboat fishery, 1974-2011.

a)



b)

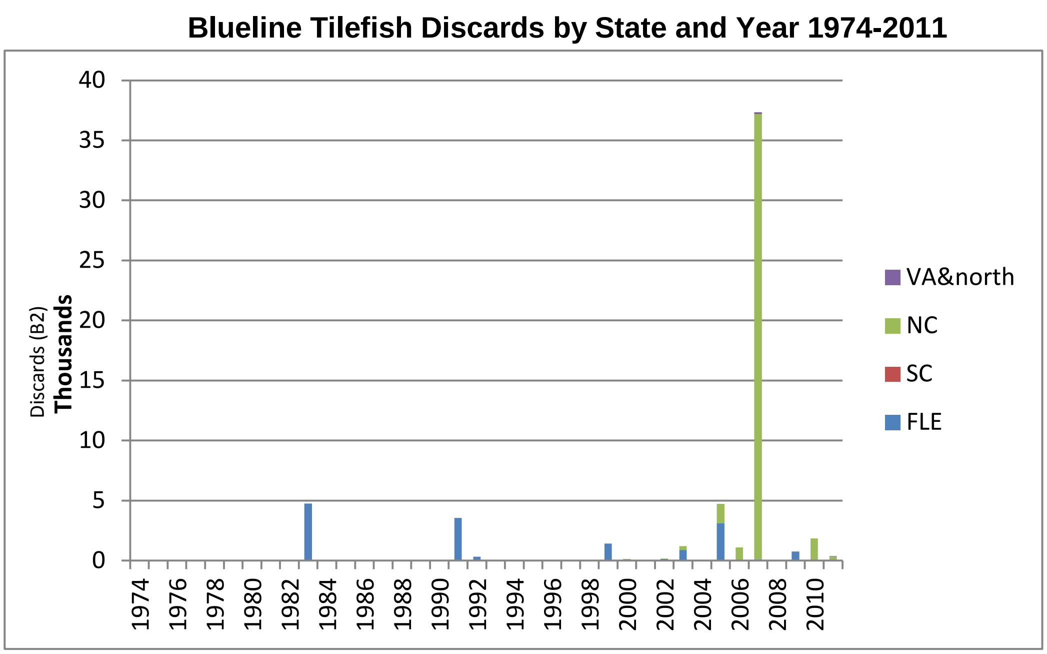


Figure 4.11.3. Estimated number of Atlantic blueline tilefish discards from MRFSS/MRIP (1981-2011) and SRHS (1974-2011) by state (a), by state and year (b), and by state and mode (c). Florida landings from east coast only, including Florida Keys. Due to confidentiality concerns SRHS discards for GA and FLE are grouped and shown as FLE.

c)

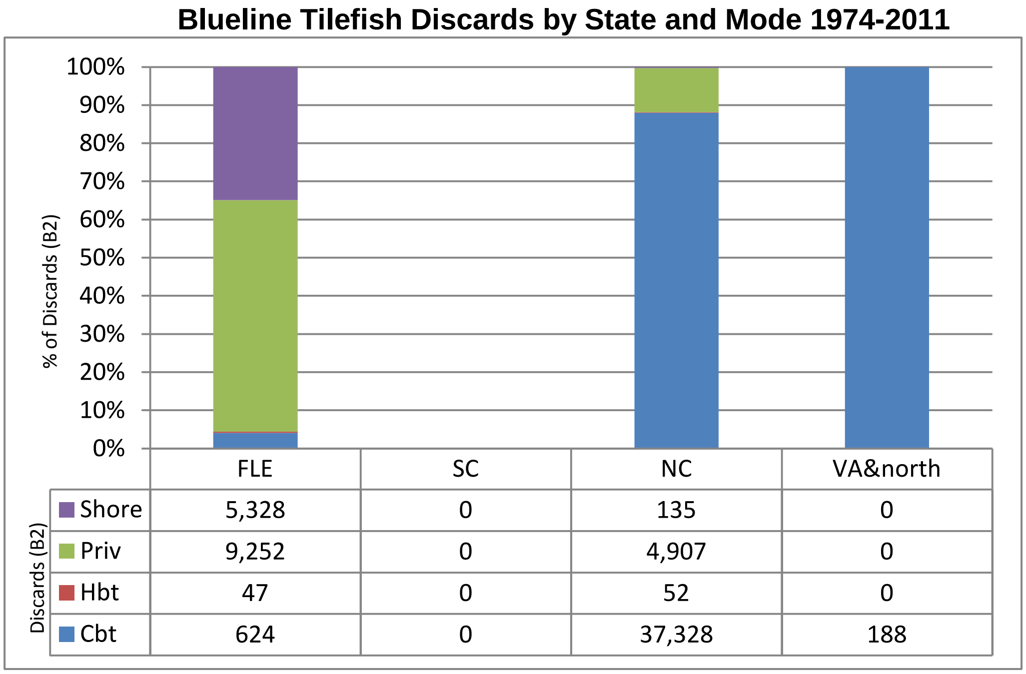


Figure 4.11.3. (continued) Estimated number of Atlantic blueline tilefish discards from MRFSS/MRIP (1981-2011) and SRHS (1974-2011) by state (a), by state and year (b), and by state and mode (c). Florida landings from east coast only, including Florida Keys. Due to confidentiality concerns SRHS discards for GA and FLE are grouped and shown as FLE (continued).

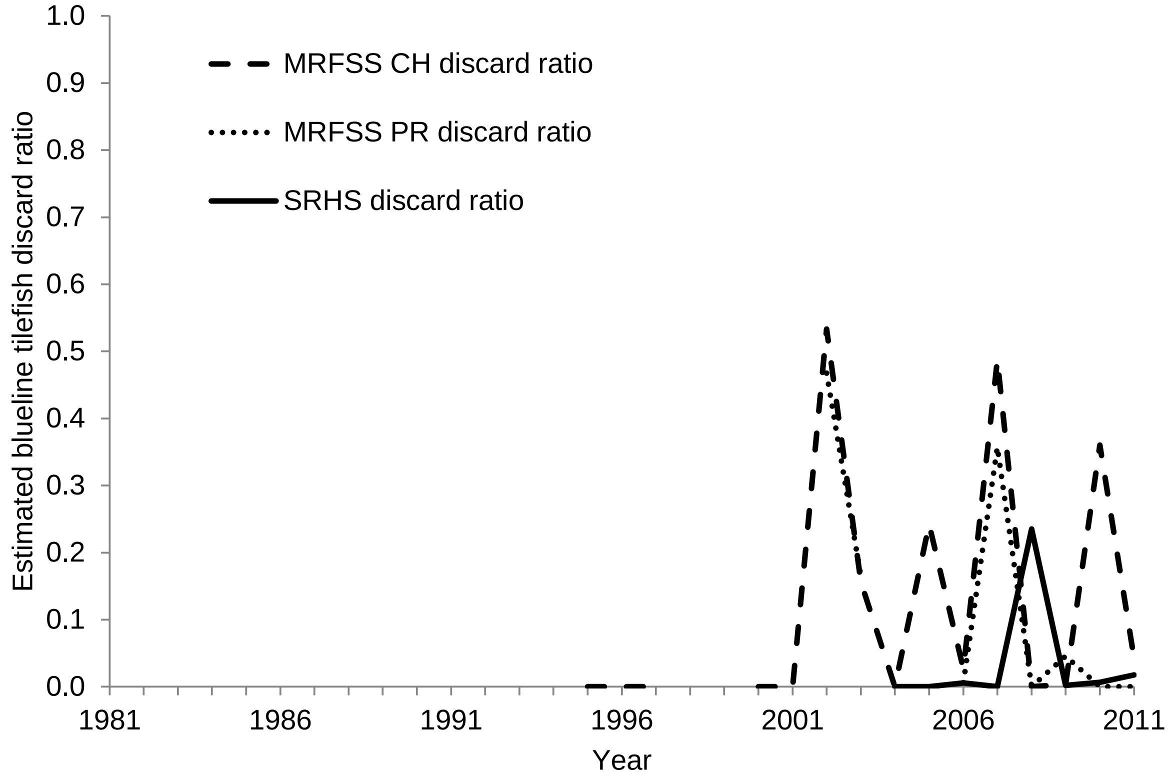


Figure 4.11.4. Percentage of blueline tilefish discards in the recreational fishery, 1981-2011.

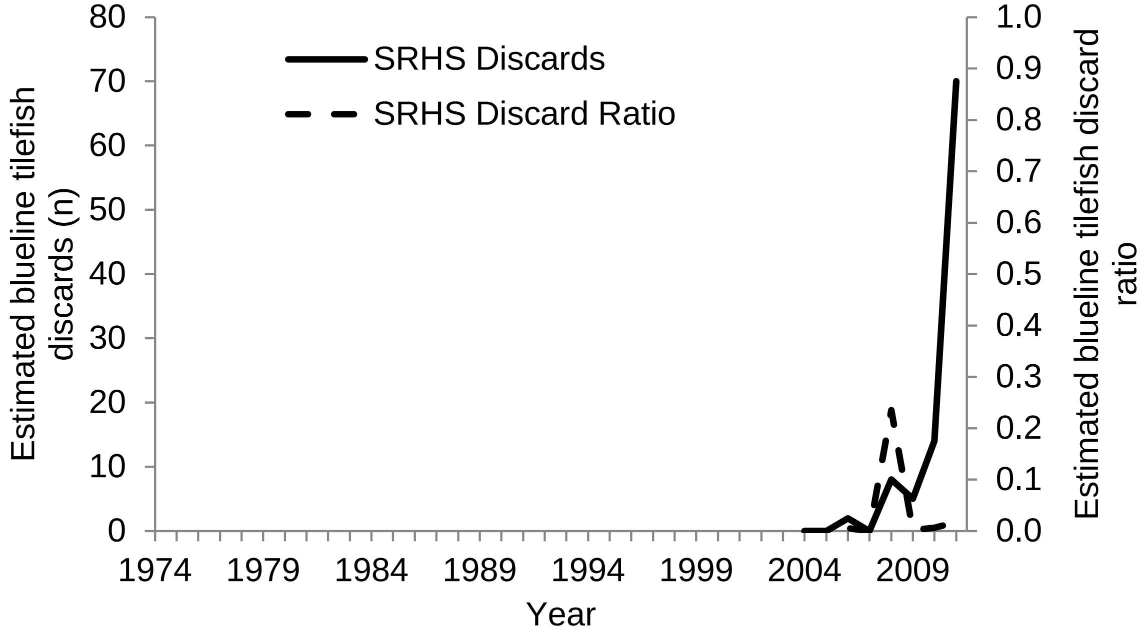


Figure 4.11.5. South Atlantic estimated blueline tilefish discards and discard ratio for the headboat fishery (assume zero discards 1974-2003; SRHS 2004-2011).

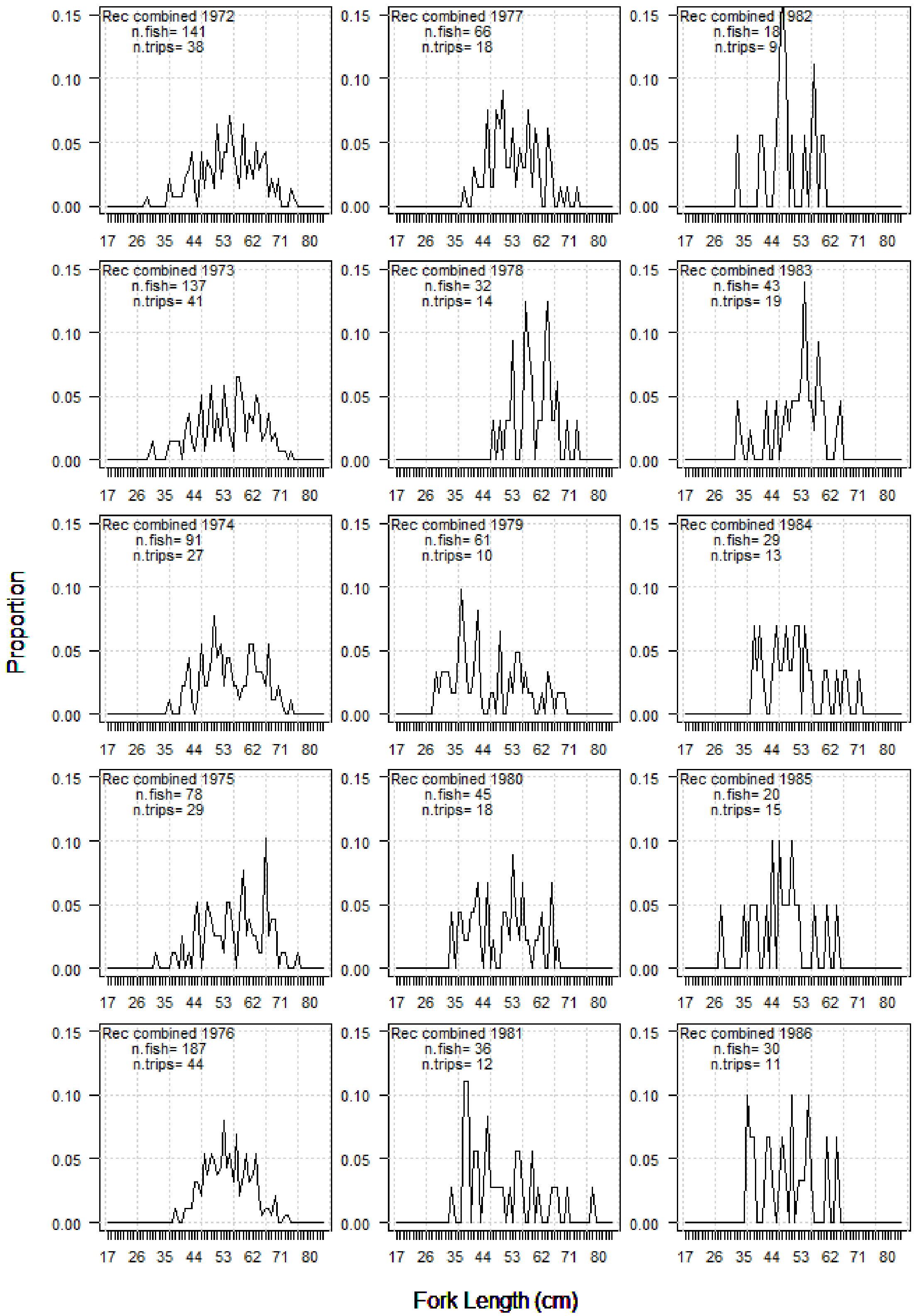


Figure 4.11.6. Nominal length composition from the MRFSS (1981-2011), ODU (2007-2011), and SRHS (1972-2011).

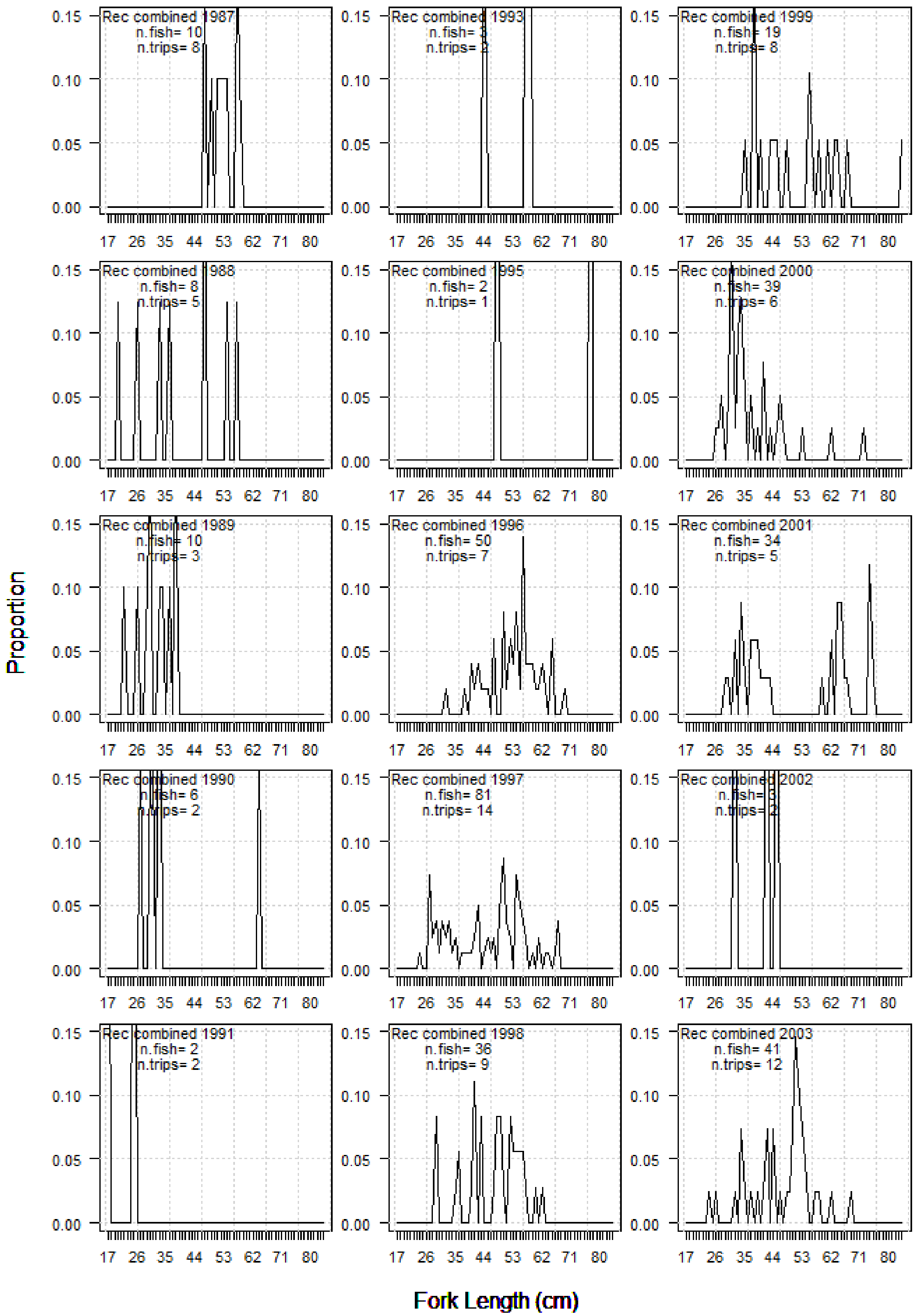


Figure 4.11.6. Nominal length composition from the MRFSS (1981-2011), ODU (2007-2011), and SRHS (1972-2011) (continued).

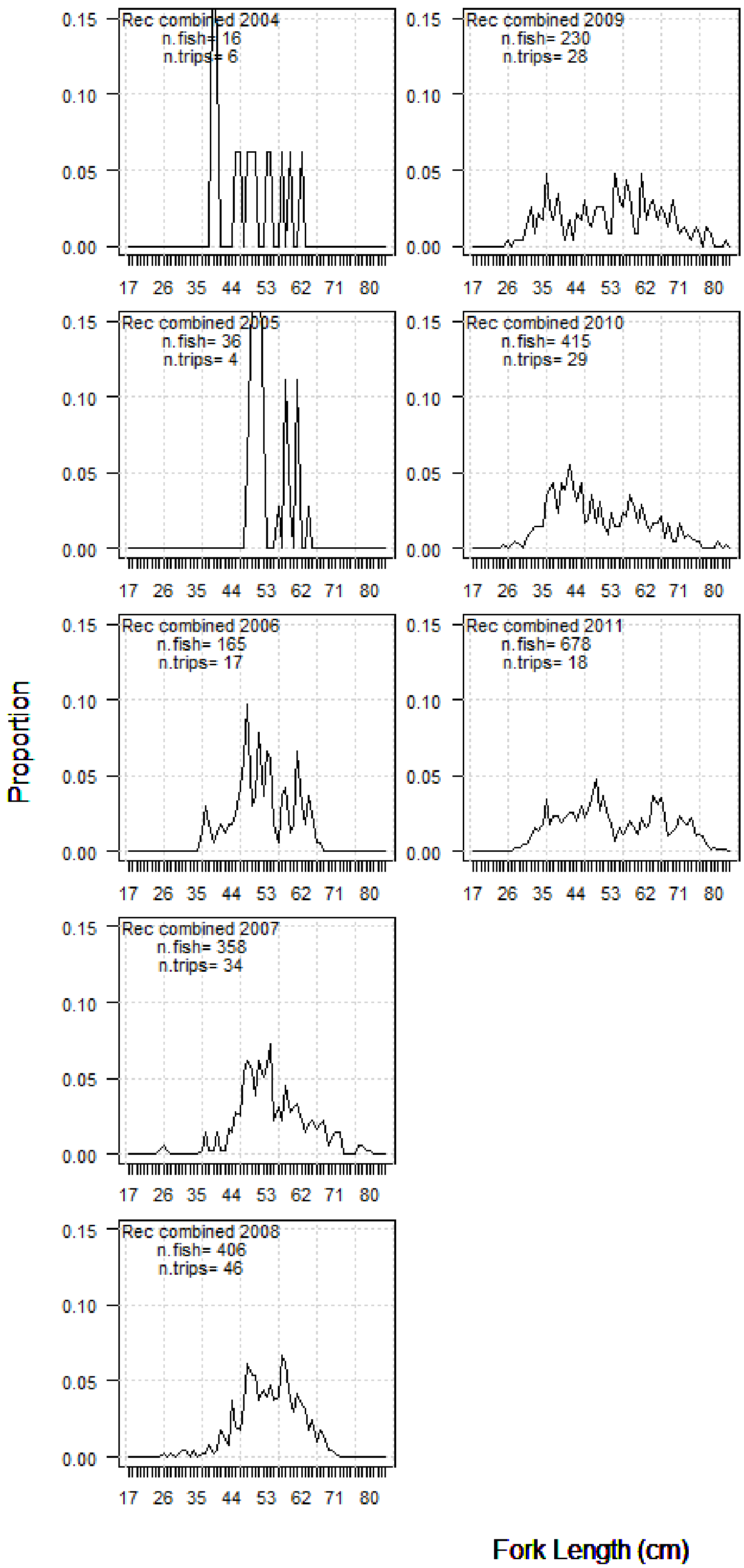
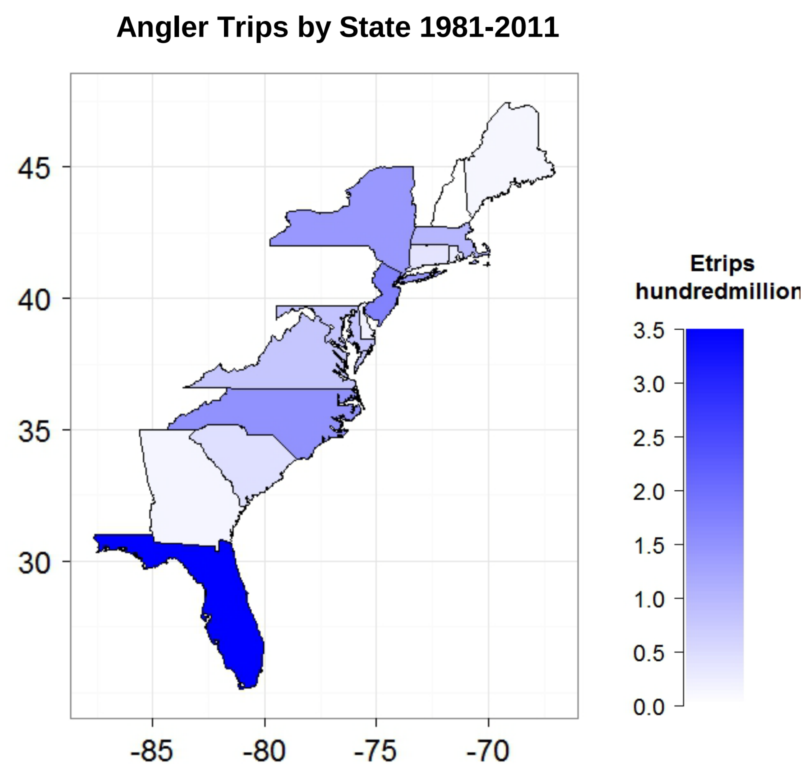


Figure 4.11.6. Nominal length composition from the MRFSS (1981-2011), ODU (2007-2011), and SRHS (1972-2011) (continued).

a)



b)

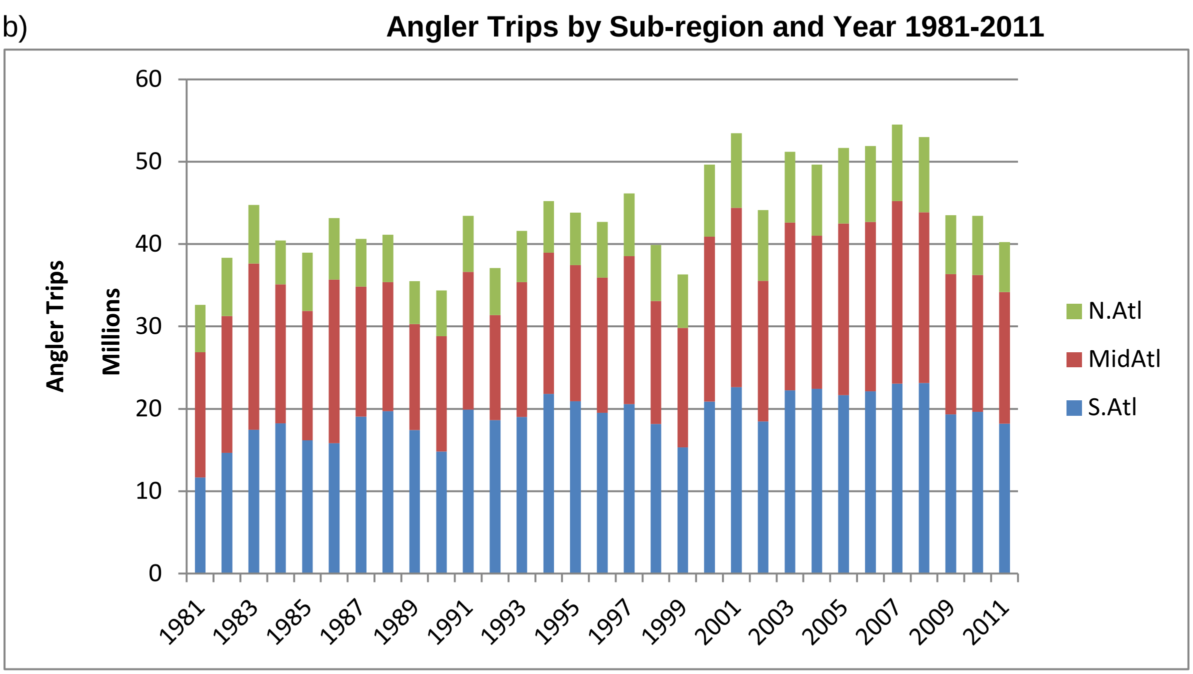
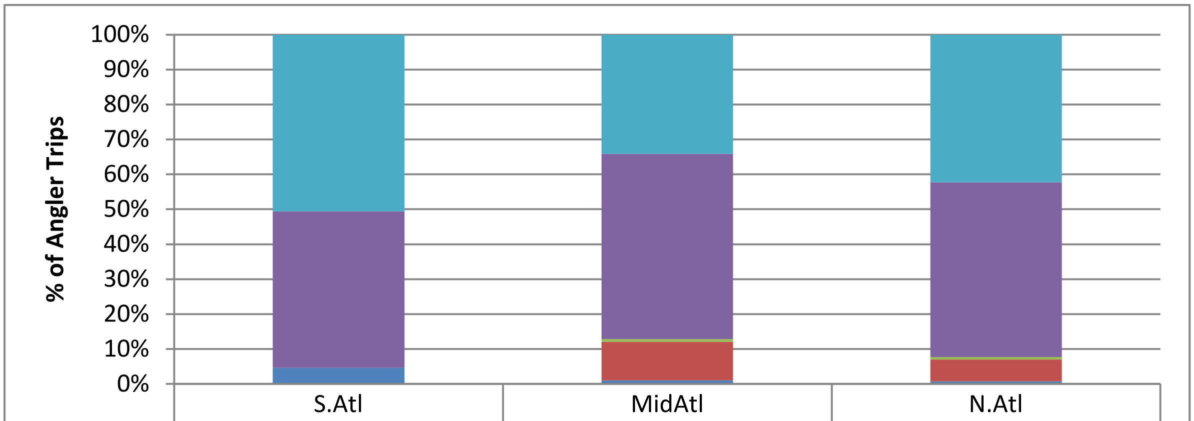


Figure 4.11.7. Atlantic estimated number of angler trips from MRFSS/MRIP (1981-2011) by state (a), by sub-region and year (b), and by sub-region and mode (c). MRFSS/MRIP data from ME to FLE, including the Florida Keys. North Atlantic states include CT through ME. Mid-Atlantic states include VA through NY. South Atlantic states include FLE through NC. MRIP headboat effort has been removed from the South Atlantic.

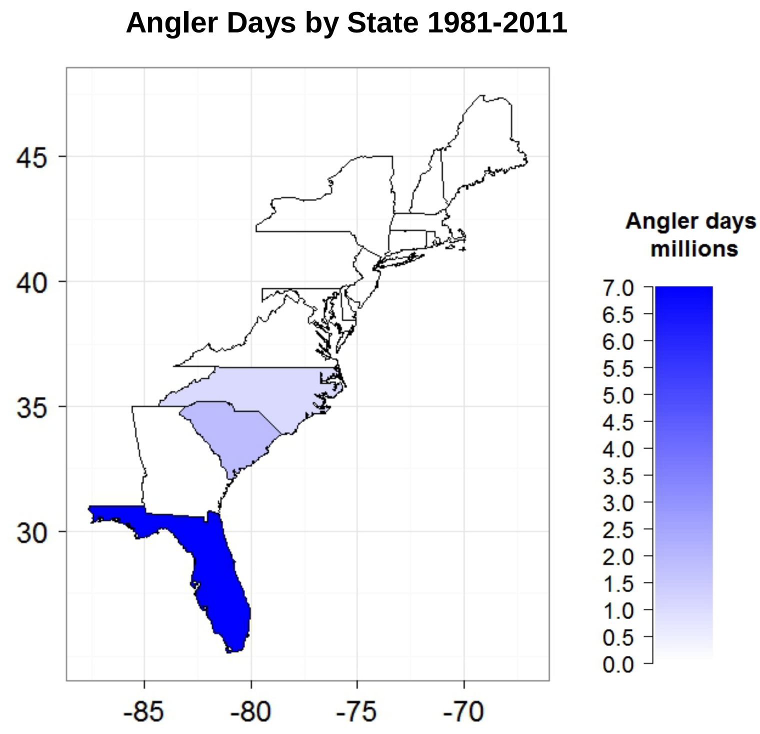
c) **Angler Trips by Sub-region and Mode 1981-2011**



Angler Trips	S.Atl	MidAtl	N.Atl
Shore	300,046,191	183,253,242	93,923,827
Priv	265,069,157	285,306,882	110,839,460
Hbt	0	4,105,244	1,757,842
Cbt/Hbt	0	59,425,341	13,881,760
Cbt	27,648,884	5,445,086	1,623,872

Figure 4.11.7. (continued) Atlantic estimated number of angler trips from MRFSS/MRIP (1981-2011) by state (a), by sub-region and year (b), and by sub-region and mode (c). MRFSS/MRIP data from ME to FLE, including the Florida Keys. North Atlantic states include CT through ME. Mid-Atlantic states include VA through NY. South Atlantic states include FLE through NC. MRIP headboat effort has been removed from the South Atlantic (continued).

a)



b)

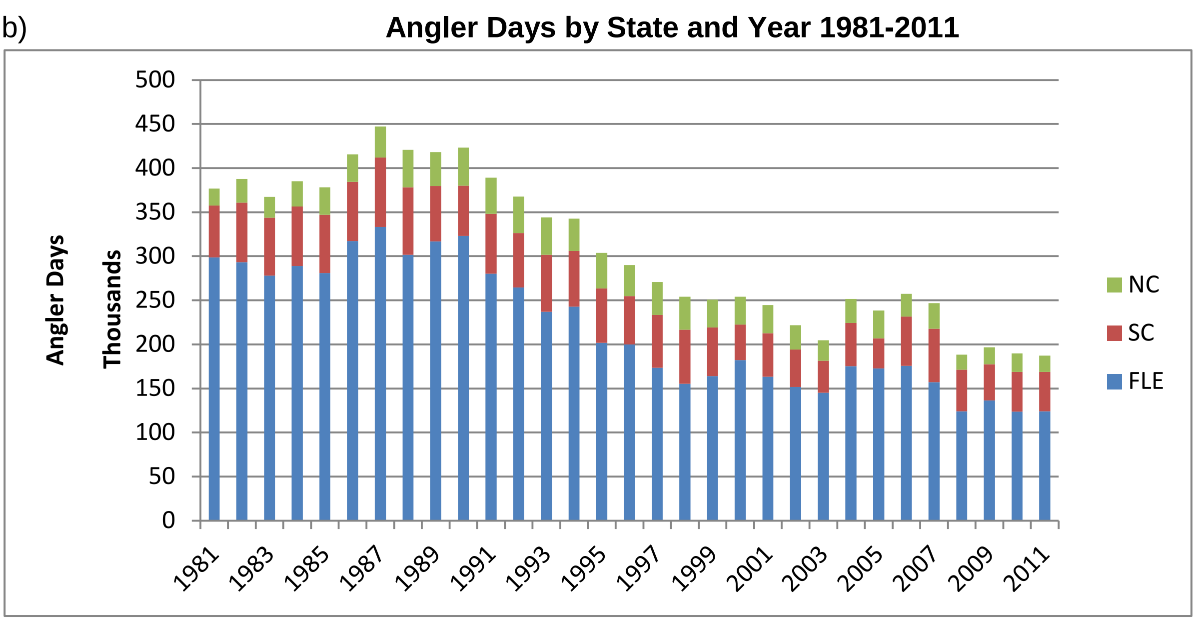


Figure 4.11.8. South Atlantic estimated number of headboat angler days from SRHS (1981-2011) by state (a) and by state and year (b). Due to confidentiality concerns, effort from Georgia has been grouped together with East Florida. SRHS data from NC to FLE, including Atlantic side of the Florida Keys.

5. Measures of Populations Abundance

5.1 Overview

Several data sources were considered for developing indices of abundance (Table 5.1). Two fishery independent data sets were available (MARMAP/SEAMAP-SA/SEFIS chevron traps and MARMAP short bottom longline), but samples sizes for both were inadequate to support meaningful indices. Seven fishery dependent data sets were considered during pre-DW webinars; four had inadequate sample sizes for index development, and three were recommended for further consideration at the DW. Ultimately, the DW recommended the three fishery dependent indices for potential use in the assessment model: recreational headboat, commercial handline, and commercial logbook. These indices are listed in Table 5.1, with pros and cons of each in Table 5.2.

Group membership

Membership of this DW Index Working Group (IWG) included Joey Ballenger, Carolyn Belcher, Rob Cheshire, Lew Coggins, Kevin Craig (IWG co-leader), Mike Errigo, Eric Fitzpatrick, Kevin McCarthy, and Kyle Shertzer (IWG co-leader). Several other DW panelists and observers (Julie DeFilippi, Michelle Duval, David Grubbs, Dewey Hemilright, Rusty Hudson, Robert Johnson) contributed to the IWG discussions throughout the week.

5.2 Review of Working Papers

The relevant working papers describing index construction are SEDAR32-DW13 (headboats), SEDAR32-DW16 (commercial handlines), and SEDAR32-DW17 (commercial longlines). For each of these indices, initial (pre-DW) modeling attempts were revised throughout the DW, based on discussions and recommendations of the IWG. The working papers were constructed after the DW, and therefore reflect decisions made during the workshop.

The index working papers provide information on sample sizes, diagnostics of model fits, and in some cases, maps of catch and effort. Index report cards for all indices considered at the DW can be found in SEDAR32-DW15. A summary of each index is provided below.

5.3 Fishery Independent Indices

No fishery independent program sampled sufficient numbers of blueline tilefish to support construction of a meaningful index of abundance.

5.4 Fishery Dependent Indices

5.4.1 Recreational Headboat Index

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 5.1). 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.

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. Blueline tilefish represent a small fraction of the overall catch in the South Atlantic headboat fleet (~1%).

The IWG discussed the years over which to compute this index. Starting in 1980, blueline tilefish was included on the list of species in catch record forms in all South Atlantic states. Prior to 1980, blueline tilefish would have been reported as write-in species, which was not done consistently across vessels. After 1992, the sample sizes, both in terms of numbers of trips and numbers of fish, were inadequate to support index creation. Thus, this index was created for the years 1980–1992. This is the only index for blueline tilefish that spans the 1980s.

5.4.1.1 Methods of Estimation

Data Filtering

Several methods were considered during the DW to subset trips for effective effort (SEDAR32-DW13). These attempts included the Stephens and MacCall (2004) approach, use of core vessels, and use of co-occurring species (e.g., red porgy, snowy grouper, yellowedge grouper). None of these approaches proved useful for this data set, in large part because sample sizes of blueline tilefish, a deep-water species, are small relative to other snapper-grouper species caught by headboats. Thus, the IWG recommended basing this index only on trips that landed blueline tilefish (positive trips).

Model Description

Response and explanatory variables

CPUE – catch per unit effort (CPUE) has units of fish/angler-hour and was calculated as the number of blueline tilefish caught divided by effort, with effort defined as the product of the number of anglers and the number of trip hours.

Year – Because year is the explanatory variable of interest, it was necessarily included in the analysis. Years included in this analysis were 1980–1992.

Trip Type – Trip types were half and full day trips.

Area – These areas were pooled into two regions of North Carolina and South Carolina (NCSC=2,3,4,5,9,10), Georgia and Florida (GNFL=6,7,8,11,12,17).

Season – Months were pooled into two seasons, season one (January, February, March, April, May, June) and season two (July, August, September, October, November, December).

Party – Two categories for the party size (number of anglers per boat) were considered in the standardization process. The categories were <=30 anglers and >30 anglers.

Standardization

CPUE was modeled using the GLM approach (Lo *et al*. 1992; Dick 2004; Maunder and Punt 2004). In particular, fits of lognormal and gamma models were compared using AIC. Also, the combination of predictor variables was examined to best explain CPUE patterns. All analyses were performed in the R programming language (R Development Core Team 2012), with much of the code adapted from Dick (2004).

To determine predictor variables important for predicting CPUE, the model was fitted with all main effects using both the lognormal and gamma distributions. Stepwise AIC (Venables and Ripley 1997) with a backwards selection algorithm was then used to eliminate those that did not improve model fit. All predictor variables were modeled as factors rather than continuous variables.

Based on AIC, the lognormal distribution outperformed the gamma distribution. For lognormal, the factors year, area, and party were retained. Thus, the final GLM used the lognormal distribution to predict CPUE as a function of year, area, and party.

5.4.1.2 Sampling Intensity

The annual numbers of trips used to compute the index are shown in Table 5.3.

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 the DW report).

5.4.1.4 Catch Rates
Standardized catch rates and associated error bars are shown in Figure 5.2 and are tabulated in Table 5.3. The units on catch rates were number of fish landed per angler-hour.

5.4.1.5 Uncertainty and Measures of Precision
Measures of precision were computed using the jackknife procedure of Dick (2004). Annual CVs of catch rates are tabulated in Table 5.3.

5.4.1.6 Comments on Adequacy for Assessment
The index of abundance created from the headboat data was considered by the IWG to be adequate for use in the assessment. The data cover a wide geographic range relative to most of the stock, and logbooks represent a census of the headboats. For the duration of the index, sampling was consistent over time, and some of the data were verified by port samplers and observers. Furthermore, this index spans a time period (1980–1992) not covered by other indices.

The two primary caveats concerning this index are that sample sizes are small relative to other species caught by headboats, and that the index was derived from fishery dependent data. 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 more effectively.

5.4.2 Commercial Handline Index
Landings and fishing effort of commercial vessels operating in the southeast US Atlantic have been monitored by the NMFS Southeast Fisheries Science Center through the Coastal Fisheries Logbook Program (CFLP). The program collects information about each fishing trip from all vessels holding federal permits to fish in waters managed by the Gulf of Mexico and South Atlantic Fishery Management Councils. Initiated in the Gulf in 1990, the CFLP began collecting logbooks from Atlantic commercial fishers in 1992, when 20% of Florida vessels were targeted. Beginning in 1993, sampling in Florida was increased to require reports from all vessels permitted in coastal fisheries, and since then has maintained the objective of a complete census of federally permitted vessels in the southeast US.

Catch per unit effort (CPUE) from the logbooks was used to develop an index of abundance for blueline tilefish landed with vertical lines (manual handline and electric reel). The time series used for construction of the index spanned 1993−2010, when all vessels with federal snapper-grouper permits were required to submit logbooks on each fishing trip. A 2011 deep-water closure (≥240 ft) prevented inclusion of 2011 data for an abundance index of this stock.

5.4.2.1 Methods of Estimation

Data Treatment

For each fishing trip, the CFLP database included a unique trip identifier, the landing date, fishing gear deployed, areas fished, number of days at sea, number of crew, gear-specific fishing effort, species caught, and weight of the landings. Fishing effort data available for vertical line gear included number of lines fished, hours fished, and number of hooks per line.

For this stock, areas initially considered were those between 24 and 37 degrees latitude, inclusive of the boundaries (Figure 5.3). However, the IWG recommended excluding the northernmost and southernmost areas, because recent fishing trends there called into question the relationship between CPUE and abundance. North of Cape Hatteras NC, blueline tilefish have increasingly and effectively been targeted by commercial fishermen in recent years. South of Cape Canaveral FL, blueline tilefish are more typically a bycatch of snowy grouper trips, and regulations on snowy grouper since the mid-2000s have likely de-coupled blueline CPUE and abundance. Thus, for this analysis, areas were limited to those between Cape Hatteras, NC and Cape Canaveral, FL (28-35 degrees latitude).

Data were restricted to include only those trips with landings and effort data reported within 45 days of the completion of the trip. Reporting delays beyond 45 days likely resulted in less reliable effort data (landings data may be reliable even with lengthy reporting delays if trip ticket reports were referenced by the reporting fisher). Also excluded were records reporting multiple areas or gears fished, which prevents designating catch and effort to specific locations or gears. Therefore, only those trips that reported one area and one gear fished were included in the analyses.

Clear outliers (>99.5 percentile) in the data were also excluded from the analyses. These outliers were identified for manual handlines as records reporting more than 20 lines fished, 15 hooks per line fished, 16 days at sea, or 4 crew members, and they were identified for electric reels as records reporting more than 7 lines fished, 13 hooks per line fished, 16 days at sea, or 6 crew members. Records with greater than 4.07 pounds/hook-hr were excluded.

Subsetting of trips was initially attempted by applying the Stephens and MacCall method, with the intent to apply a delta-GLM for standardization. However, the Stephens and MacCall method removed many of positive trips from an already relatively low sample size. Thus, the IWG recommended against using Stephens and MacCall, and instead standardizing only the positive catches.

Standardization

The response variable, CPUE, was calculated for each trip as,

CPUE = pounds of blueline tilefish/hook-hour

where hook-hours is the product of number of lines fished, number of hooks per line, and total hours fished. Explanatory variables, all categorical, are described below. All analyses were programmed in R (R Development Core Team 2012), with much of the code adapted from Dick (2004).

The explanatory variables considered were year, season, area, crew size, and days at sea, each described below:

Year — Year was necessarily included, as standardized catch rates by year are the desired outcome. Years modeled were 1993−2010.

Season — Four seasons were considered in the model with the months pooled as Jan-Mar, Apr-Jun, Jul-Sep, and Oct-Nov.

Area — Areas reported in the logbook (Figure 5.3) were pooled into the broader geographic levels: NC, SC, and GA/North FL combined.

Crew size — Crew size (crew) was pooled into two levels: one or two, and three or more.

Days at sea — Days at sea (sea days) were pooled into three levels: one or two days, two or three days, and five or more days.

Two parametric distributions were considered for modeling positive values of CPUE, lognormal and gamma. For both distributions, all explanatory variables were initially included as main effects, and then stepwise AIC with a backwards selection algorithm was used to eliminate those variables that did not improve model fit (Venables and Ripley 1997). For both lognormal and gamma distributions, the best model fit included all explanatory variables except season. The two distributions, each with their best set of explanatory variables, were compared using AIC: lognormal outperformed gamma and was therefore applied in the final GLM. Diagnostics suggested reasonable fits of the lognormal model.

5.4.2.2 Sampling Intensity

The annual numbers of trips used to compute the index is typically between 150 and 200, as shown in Table 5.4.

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

5.4.2.4 Catch Rates
Standardized catch rates and associated error bars are shown in Figure 5.4 and are tabulated in Table 5.4. The units on catch rates were pounds of fish landed per hook-hour.

5.4.2.5 Uncertainty and Measures of Precision
Estimates of variance were based on 1000 bootstrap runs where trips were chosen randomly with replacement (Efron and Tibshirani 1994). Annual CVs of catch rates are tabulated in Table 5.4 and applied to the estimated index to develop error estimates.

5.4.2.6 Comments on Adequacy for Assessment
The index of abundance created from the commercial handline data was considered by the IWG to be adequate for use in the assessment. The data cover a wide geographic range relative to that of the stock, and logbooks represent a census of the fleet. The data set has an adequate sample size and a long enough time series to provide potentially meaningful information for the assessment.

The primary caveat concerning this index was that it was derived from fishery dependent data. Fishery dependent effects on CPUE appeared most pronounced north of Cape Hatteras, where fishermen have increasingly targeted blueline tilefish in recent years, and south of Cape Canaveral, where regulations on snowy grouper have likely de-coupled blueline CPUE from abundance. These potential effects were addressed by focusing the analysis on areas between the two capes.

5.4.3 Commercial Longline Index
Landings and fishing effort of commercial vessels operating in the southeast US Atlantic have been monitored by the NMFS Southeast Fisheries Science Center through the Coastal Fisheries Logbook Program (CFLP). The program collects information about each fishing trip from all vessels holding federal permits to fish in waters managed by the Gulf of Mexico and South Atlantic Fishery Management Councils. Initiated in the Gulf in 1990, the CFLP began collecting logbooks from Atlantic commercial fishers in 1992, when 20% of Florida vessels were targeted. Beginning in 1993, sampling in Florida was increased to require reports from all vessels permitted in coastal fisheries, and since then has maintained the objective of a complete census of federally permitted vessels in the southeast US.

Catch per unit effort (CPUE) from the logbooks was used to develop an index of abundance for blueline tilefish landed with longlines. The time series used for construction of the index spanned 1993−2004, when all vessels with federal snapper-grouper permits were required to submit logbooks on each fishing trip. The years after 2004 were excluded because of a shift in effort to almost entirely north of Cape Hatteras, NC, where blueline tilefish can be more effectively targeted by this gear. Additionally, a 2011 deep-water closure (≥240 ft) prevented inclusion of 2011 data for an abundance index of this stock.

5.4.3.1 Methods of Estimation

Data Treatment

For each fishing trip, the CFLP database included a unique trip identifier, the landing date, fishing gear deployed, areas fished, number of days at sea, number of crew, gear-specific fishing effort, species caught, and weight of the landings. Fishing effort data available for longline gear included number of lines fished and number of hooks per line. The number of hours fished is reported inconsistently for longline gear, and it is therefore not recommended for calculating effort. The number of trips reporting blueline tilefish dropped rapidly after 2004 in areas south of Cape Hatteras, and increased substantially in approximately 2006 north of Cape Hatteras. Because of the drop in sample size, the index used a terminal year of 2004.

For this stock, areas initially considered were those between 24 and 37 degrees latitude, inclusive of the boundaries (Figure 5.3). However, the IWG recommended excluding the northernmost and southernmost areas, in part for consistency with the commercial handline index. North of Cape Hatteras NC, blueline tilefish can be more effectively targeted by commercial fishermen than in southern areas. South of Cape Canaveral FL, blueline tilefish are not commonly caught on longlines, likely because of the Oculina Banks closure off southeast Florida. The Oculina Habitat Area of Particular Concern was established in 1984 to protect fragile corals from bottom longlines, among other gears. In 1994, this area became the Oculina Experimental Closed Area (92 square miles), when it prohibited fishing for and possession of snapper-grouper species, in an effort to protect deepwater species. In 2000, it expanded from 92 to 300 square miles. Thus, for this analysis, areas were limited to those between Cape Hatteras, NC and Cape Canaveral, FL (28-35 degrees latitude).

Data were restricted to include only those trips with landings and effort data reported within 45 days of the completion of the trip. Reporting delays beyond 45 days likely resulted in less reliable effort data (landings data may be reliable even with lengthy reporting delays if trip ticket reports were referenced by the reporting fisher). Also excluded were records reporting multiple areas or gears fished, which prevents designating catch and effort to specific locations or gears. Therefore, only those trips that reported one area and one gear fished were included in the analyses.

Clear outliers (>99.5 percentile) in the data were also excluded from the analyses. These outliers were identified for commercial longline as records reporting more than 40 lines fished, 4000 hooks per line fished, 16 days at sea, or 7 crew members. Trips with greater than 0.8 pounds/hook were excluded.

Subsetting of trips was initially attempted by applying the Stephens and MacCall method, with the intent to apply a delta-GLM for standardization. However, the Stephens and MacCall method removed many positive trips from an already relatively low sample size. Thus, the IWG recommended against using Stephens and MacCall, and instead standardizing only the positive catches.

Standardization

The response variable, CPUE, was calculated for each trip as,

CPUE = pounds of blueline tilefish/hook

where hooks is the product of the number of lines fished and the number of hooks per line. Explanatory variables, all categorical, are described below. All analyses were programmed in R (R Development Core Team 2012), with much of the code adapted from Dick (2004).

The explanatory variables considered were year, season, region, crew size, and days at sea, each described below:

Year — Year was necessarily included, as standardized catch rates by year are the desired outcome. Years modeled were 1993−2004.

Season — Four seasons were considered in the model with the months pooled as Jan-Mar, Apr-Jun, Jul-Sep, and Oct-Nov.

Region — Areas reported in the logbook (Figure 5.3) were pooled into two geographic regions: NC, SC–FL.

Crew size — Crew size (crew) was pooled into two levels: one or two, and three or more.

Days at sea — Days at sea (sea days) were pooled into four levels: one to three days, four to six days, seven to nine days, and ten or more days.

Two parametric distributions were considered for modeling positive values of CPUE, lognormal and gamma. The gamma model did not converge. For the lognormal distribution, all explanatory variables were initially included as main effects, and then stepwise AIC (Venables and Ripley,

1997) with both a forward and backward selection algorithm was used to eliminate those variables that did not improve model fit. The best model fit included year, crew size and days at sea. Diagnostics suggested reasonable fits of the lognormal model.

5.4.3.2 Sampling Intensity

The annual numbers of trips used to compute the index is typically between 50 and 100, as shown in Table 5.5.

5.4.3.3 Size/Age data

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

5.4.3.4 Catch Rates

Standardized catch rates and associated error bars are shown in Figure 5.5 and are tabulated in Table 5.5. The units on catch rates were pounds of fish landed per hook.

5.4.3.5 Uncertainty and Measures of Precision

Estimates of variance were based on 1000 bootstrap runs where trips each year were chosen randomly with replacement from that year's samples, and sample size each year was maintained at the level of the original data set (Efron and Tibshirani 1994). Annual CVs of catch rates are tabulated in Table 5.5 and applied to the estimated index to develop error estimates.

5.4.3.6 Comments on Adequacy for Assessment

The index of abundance created from the commercial longline data was considered by the IWG to be adequate for use in the assessment. The data cover a wide geographic range relative to that of the stock, and logbooks represent a census of the fleet.

The primary caveat concerning this index was that it was derived from fishery dependent data. Fishery dependent effects were potentially minimized by focusing the analysis on areas between Cape Hatteras and Cape Canaveral. Additional caveats are that the data set has a relative small sample size and that the computation of effort for longline data has coarse resolution (does not include trip duration).

5.5 Consensus Recommendations and Survey Evaluations

The DW recommended the three fishery dependent indices (headboat, commercial handline, and commercial longline) for potential use in the blueline tilefish stock assessment. All recommended indices and their CVs are tabulated in Table 5.6, and the indices are compared graphically in Figure 5.6. Pearson correlation between the two commercial indices is 0.36, with a p-value of 0.26 (H0: correlation=0).

The IWG discussed relative ranking of the ability of each index to represent true population abundance. Based on these discussions, the indices recommended for the assessment were ranked as follows, with a bulleted list of discussion points below each index (drawn mostly from Table 5.2). Note that these rankings were made during the DW and are based solely on *a priori* information about each index. Therefore, the rankings should be considered preliminary, as they do not benefit from viewing them for consistency with other data sets (e.g., age comp data). The assessment panel, with all data in hand, will be in a better position to judge the indices for use in the assessment.

1. Headboat index
    - 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
    - Small sample sizes relative to other species in the headboat data set; most samples from SC and FL
    - Fishery dependent
2. Commercial handline index
    - Years of index near end of assessment period
    - Commercial fishermen more skillful than general recreational fishermen at targeting focal species
    - Fishery dependent
3. Commercial longline index
    - Commercial fishermen more skillful than general recreational fishermen at targeting focal species
    - Effort only to level of trip or hook, does not include trip duration
    - Effort limited to 50+ fathoms (excludes some blueline habitat)
    - Fishery dependent

5.6 Literature Cited

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

Efron, B. and R. J. Tibshirani. 1994. Modern An Introduction to the bootstrap. Chapnam & Hall/CRC, Boca Raton, FL.

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Stephens, A. and A. MacCall. 2004. A multispecies approach to subsetting logbook data for purposes of estimating CPUE. Fish. Res. 70:299−310.

Venables, W.N. and B.D. Ripley. 1997. Modern Applied Statistics with S-Plus, 2nd Edition. Springer-Verlag, New York.

R Development Core Team (2012). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, URL http://www.R-project.org.

5.7 Tables

Table 5.1. Table of the data sources considered for indices of abundance.

Fishery Type	Data Source	Area	Years	Units	Standardization Method	Issues	Use?
Recreational	Headboat	NC-FL	1980-1992	num kept/ angler-hour	GLM	Fishery dependent, self reported	Yes
Commercial	Commercial Logbook Handline	Cape Hatteras – Cape Canaveral	1993-2010	lb kept/ hook-hour	GLM	Fishery dependent, self reported	Yes
Commercial	Commercial Logbook Longline	Cape Hatteras – Cape Canaveral	1993-2004	lb kept/ hook	GLM	Fishery dependent, self reported, effort unit to level of trip	Yes
Recreational	MRFSS	NC-FL	1982-2010			Few samples (several years with no blueline). Fishery dependent.	No
Independent	MARMAP/ SEAMAP-SA/ SEFIS: chevron traps	SC	1990-2011			Few samples (0-11 fish per yr, typically 1 or 2)	No
Independent	MARMAP: short bottom longline	SC	1996-2011			Few samples (0-12 fish per yr), small geographic coverage	No
Commercial	Shark longline observers					Only one blueline observed	No
Recreational	Headboat-at-sea-observer	NC-FL	2005-2011			No bluelines observed	No
Recreational	SCDNR Charterboat logbook	SC	1993-2011			No bluelines observed	No

Table 5.2. Table of the pros and cons for each data set considered at the data workshop. Note that several data sources were considered (Table 5.1), but discarded, prior to the DW.

<u>Fishery independent index</u>
None

<u>Fishery dependent indices</u>
Recreational Headboat (*Recommended for use*)
Pros:

- Complete census
- Spans the management area
- Some data are verified by port samplers and observers
- Non-targeted for focal species, which should minimize changes in catchability relative to fishery dependent indices that target specific species

Cons:

- Fishery dependent
- Small sample size relative to other species in headboat data set
- Mostly SC and FL
- No information on discard rates
- Catchability may vary over time or with abundance
- Standardization based only on trips successful for blueline tilefish

Commercial Logbook – Handline (*Recommended for use*)
Pros:

- Complete census
- Covers nearly the entire management area
- Continuous, 18-year time series near end of assessment period
- Large sample size relative to other blueline indices

Cons:

- Fishery dependent
- Data are self-reported and largely unverified
- Catchability may vary over time or with abundance
- Potential shifts in species targeted; commercial fishermen more skillful than general recreational fishermen at targeting focal species
- Standardization based only on trips successful for blueline tilefish

Commercial Logbook – Longline (*Recommended for use*)
Pros:

- Complete census
- Covers nearly the entire management area

- Continuous, 18-year time series near end of assessment period

Cons:

- Fishery dependent
- Data are self-reported and largely unverified
- Catchability may vary over time or with abundance
- Effort only to level of trip or hook, does not include trip duration
- Effort limited to 50+ fathoms (excludes some blueline habitat)
- Potential shifts in species targeted; commercial fishermen more skillful than general recreational fishermen at targeting focal species
- Standardization based only on trips successful for blueline tilefish

Table 5.3. The relative nominal CPUE, number of trips (N), standardized index, and CV for blueline tilefish from headboat logbook data.

Year	Relative nominal CPUE	N	Standardized index	CV
1980	2.51	192	1.92	0.10
1981	1.82	77	1.79	0.16
1982	1.33	119	1.20	0.12
1983	1.43	143	1.39	0.11
1984	0.74	52	0.72	0.16
1985	0.80	73	0.67	0.14
1986	0.60	94	0.64	0.12
1987	0.47	77	0.92	0.13
1988	0.42	91	0.70	0.13
1989	0.68	71	0.75	0.14
1990	0.31	49	0.42	0.16
1991	0.58	42	0.67	0.16
1992	1.32	62	1.19	0.16

Table 5.4. The number of trips (N), relative nominal CPUE, standardized index, and CV for blueline tilefish from commercial handline data.

Year	N	Relative nominal	Standardized CPUE	CV
1993	65	0.838	1.125	0.170
1994	93	0.991	0.672	0.146
1995	155	1.434	0.638	0.103
1996	117	0.919	0.935	0.125
1997	198	0.937	0.983	0.094
1998	184	0.814	1.163	0.101
1999	167	1.081	0.796	0.111
2000	156	1.014	1.020	0.122
2001	165	0.940	0.910	0.123
2002	196	0.633	0.756	0.101
2003	176	0.571	0.741	0.108
2004	183	1.029	0.875	0.100
2005	214	1.112	1.138	0.100
2006	178	1.112	1.487	0.109
2007	246	0.836	1.182	0.094
2008	200	1.019	1.415	0.102
2009	170	0.901	0.994	0.102
2010	194	1.819	1.169	0.107

Table 5.5. The number of trips (N), relative nominal CPUE, standardized index, and CV for blueline tilefish from commercial longline data.

Year	N	Relative nominal	Standardized CPUE	CV
1993	72	2.052	2.254	0.171
1994	89	1.188	1.024	0.177
1995	65	1.485	0.974	0.199
1996	41	0.605	0.711	0.234
1997	83	1.075	1.530	0.145
1998	45	0.734	1.032	0.235
1999	52	1.181	0.709	0.232
2000	61	0.790	0.501	0.202
2001	61	0.826	0.766	0.204
2002	50	0.900	1.025	0.204
2003	50	0.549	0.891	0.205
2004	42	0.614	0.584	0.201

Table 5.6. Blueline tilefish indices of abundance and annual CVs recommended for potential use in the stock assessment. HB=headboats, CHL=commercial handline, and CLL=commercial longline. Each index is scaled to its mean.

Year	HB	CHL	CLL	CV HB	CV CHL	CV CLL
1980	1.92			0.10		
1981	1.79			0.16		
1982	1.20			0.12		
1983	1.39			0.11		
1984	0.72			0.16		
1985	0.67			0.14		
1986	0.64			0.12		
1987	0.92			0.13		
1988	0.70			0.13		
1989	0.75			0.14		
1990	0.42			0.16		
1991	0.67			0.16		
1992	1.19			0.16		
1993		1.13	2.25		0.17	0.17
1994		0.67	1.02		0.15	0.18
1995		0.64	0.97		0.10	0.20
1996		0.94	0.71		0.13	0.23
1997		0.98	1.53		0.09	0.15
1998		1.16	1.03		0.10	0.24
1999		0.80	0.71		0.11	0.23
2000		1.02	0.50		0.12	0.20
2001		0.91	0.77		0.12	0.20
2002		0.76	1.03		0.10	0.20
2003		0.74	0.89		0.11	0.21
2004		0.88	0.58		0.10	0.20
2005		1.14			0.10	
2006		1.49			0.11	
2007		1.18			0.09	
2008		1.42			0.10	
2009		0.99			0.10	
2010		1.17			0.11	

5.8 Figures

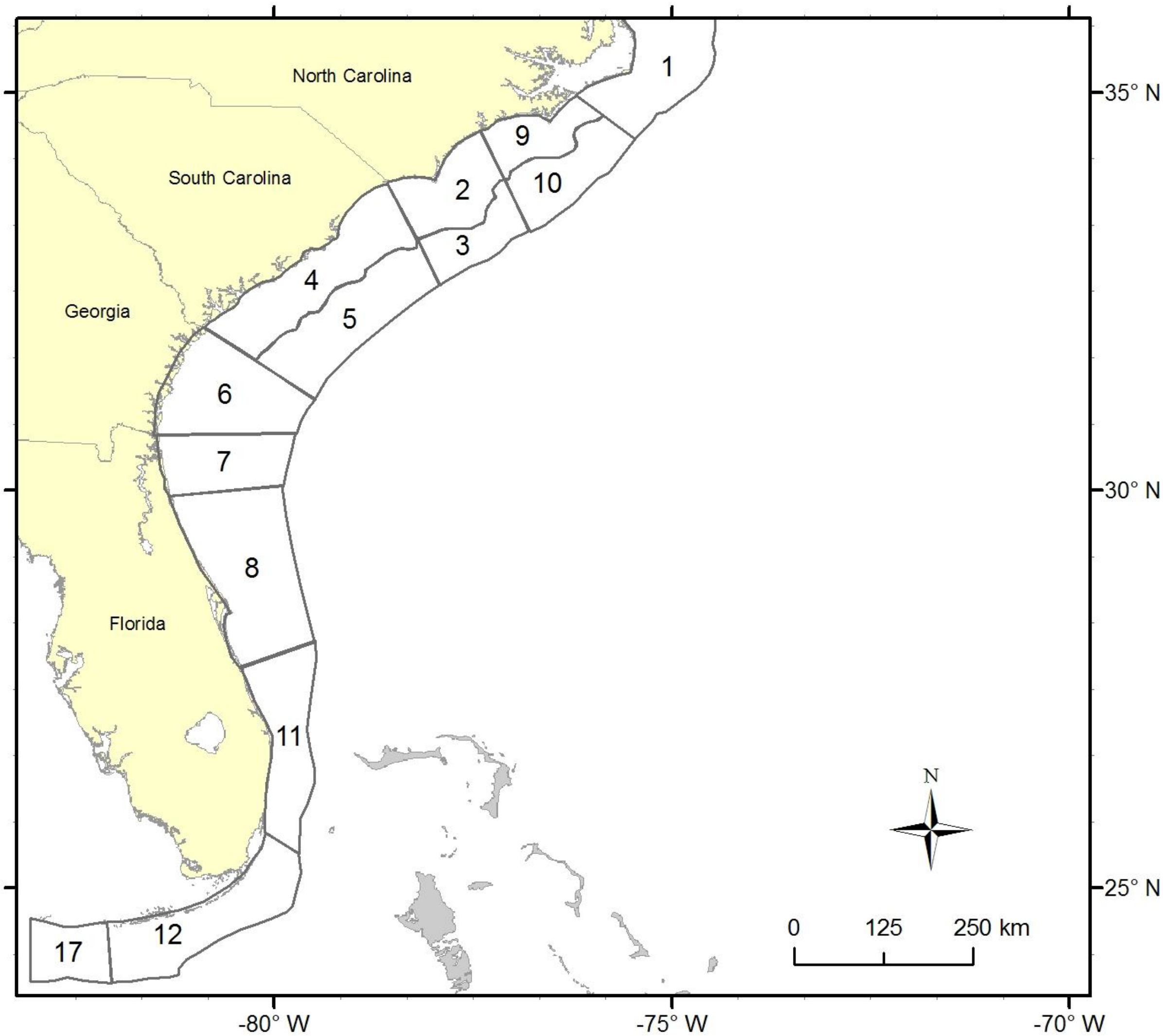

Figure 5.1. Map of headboat sampling area definitions. For analysis, areas were pooled as described in the text.

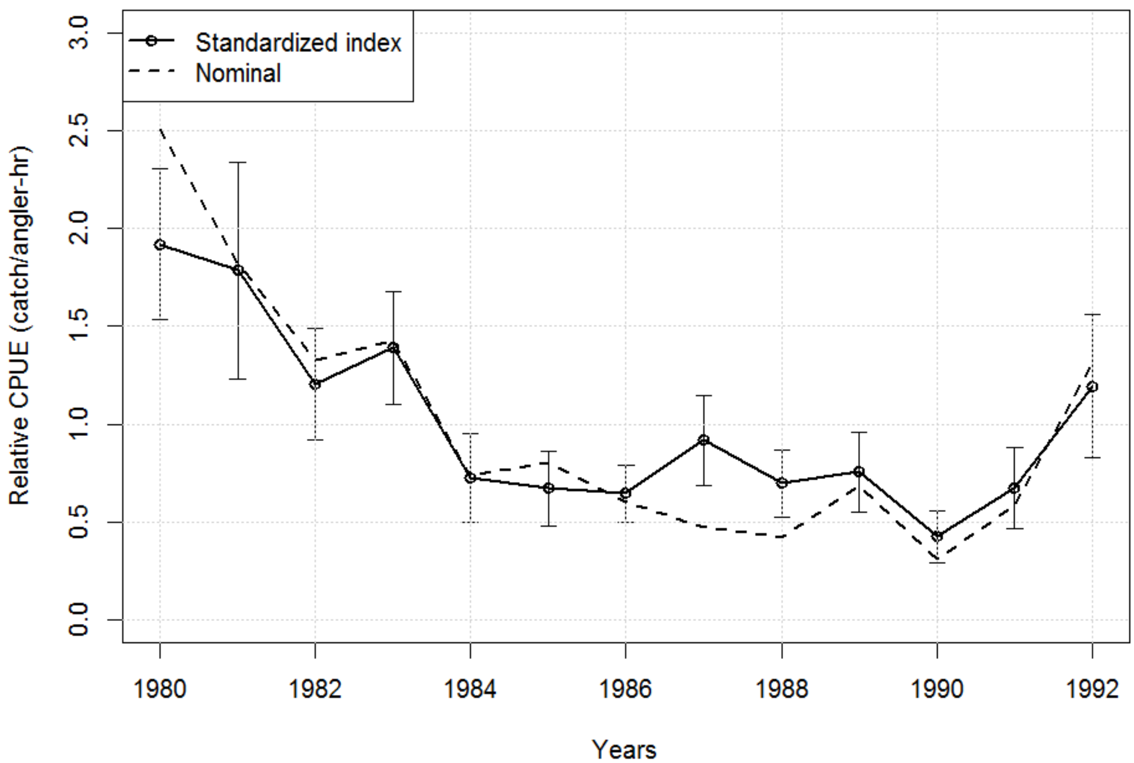

Figure 5.2. The nominal and standardized index for blueline tilefish computed from headboat data. Error bars represent approximate 95% confidence intervals.

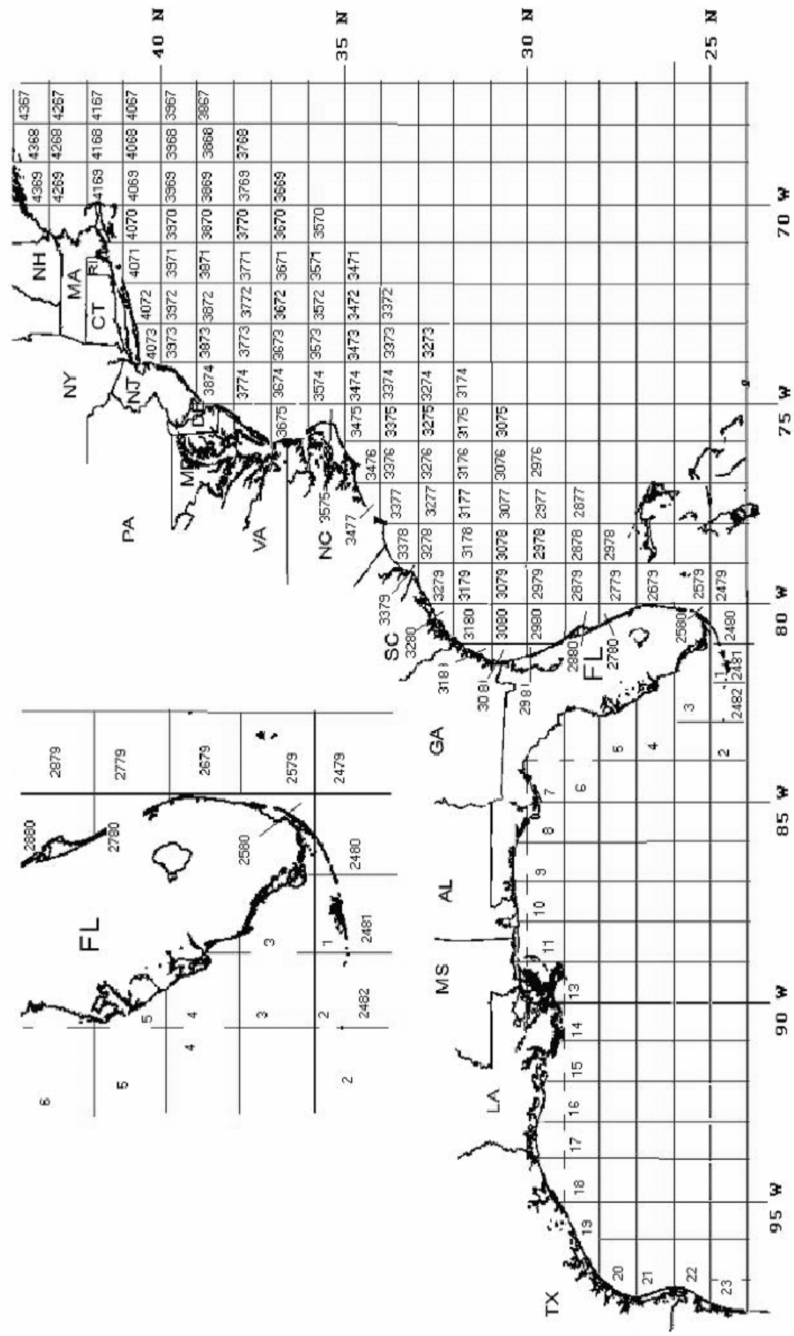

Figure 5.3. Areas reported in commercial logbooks. First two digits signify degrees latitude, second two degrees longitude.

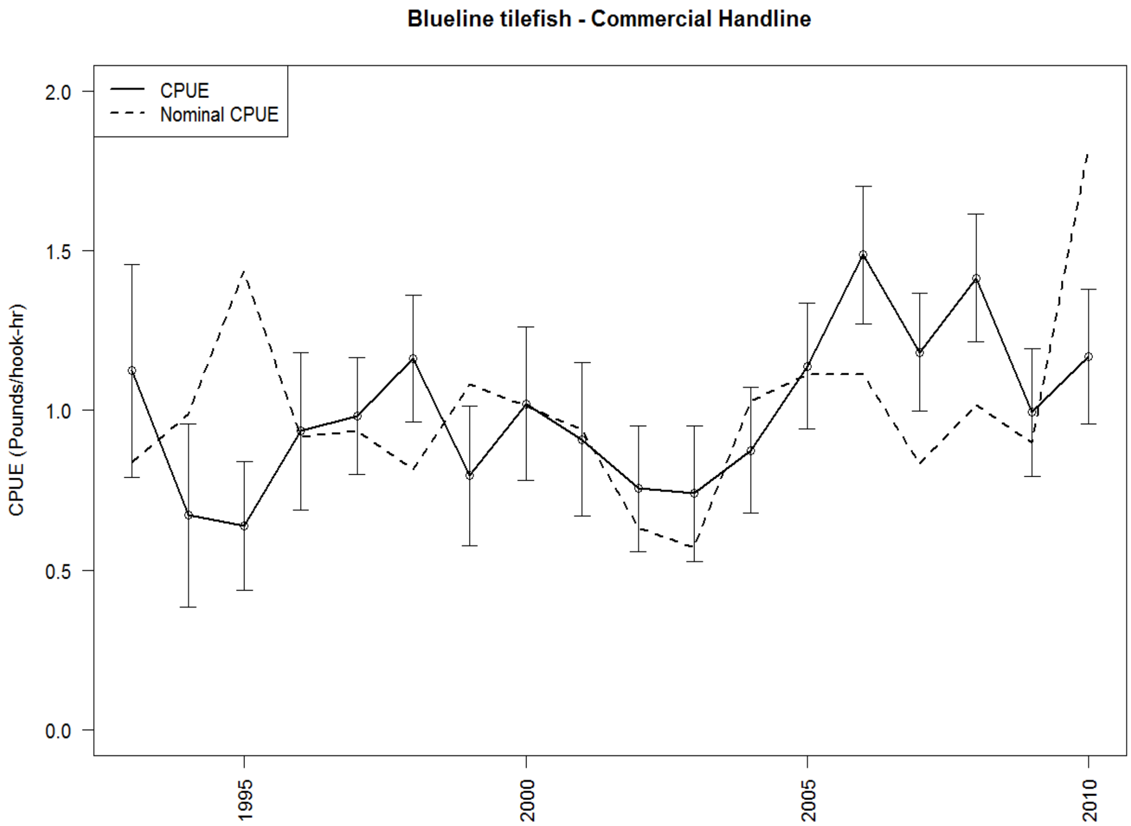

Figure 5.4. The nominal and standardized index for blueline tilefish computed from commercial handline data. Error bars represent approximate 95% confidence intervals.

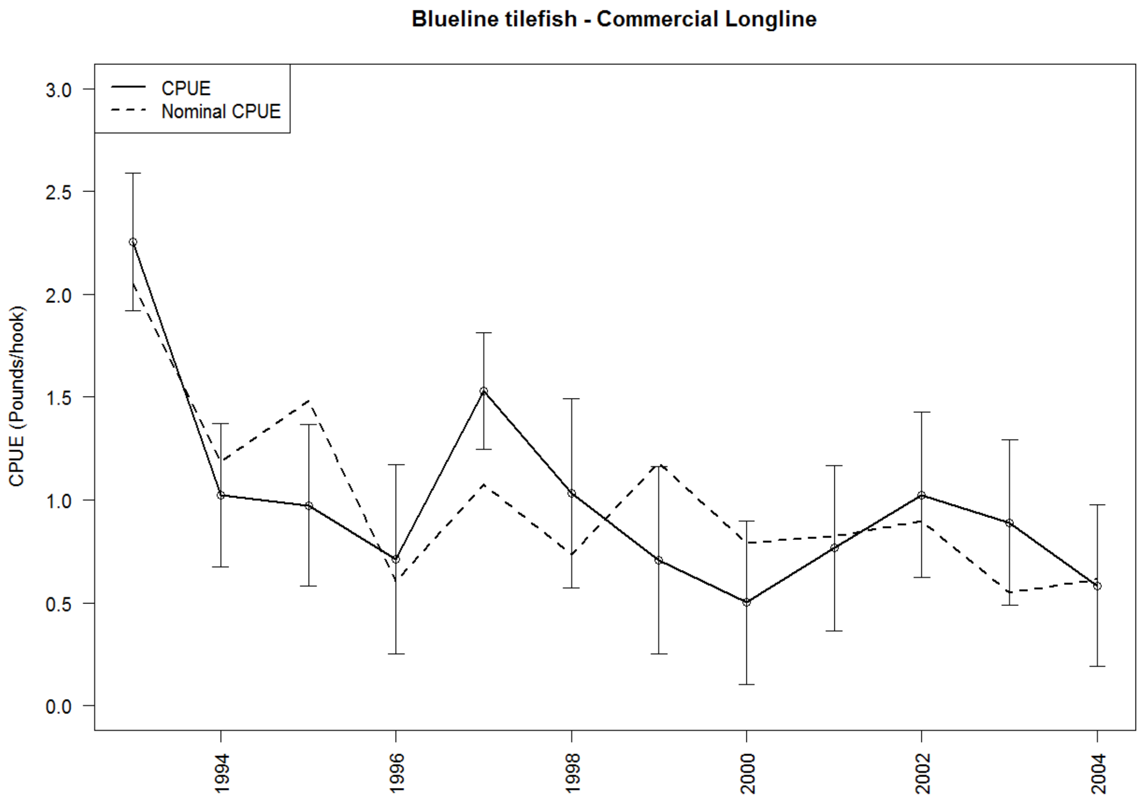

Figure 5.5. The nominal and standardized index for blueline tilefish computed from commercial longline data. Error bars represent approximate 95% confidence intervals.

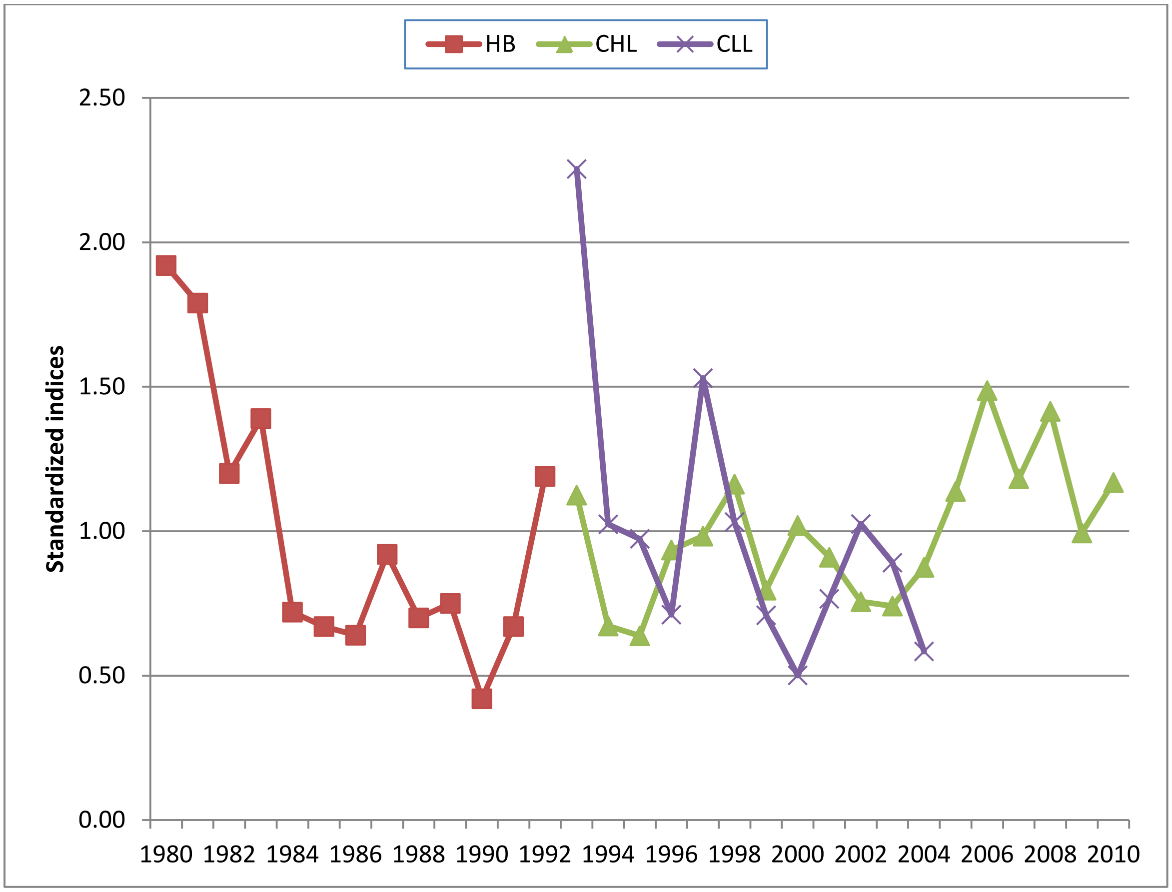

Figure 5.6. All indices (scaled to respective means) recommended for potential use in the blueline tilefish stock assessment at the SEDAR32 Data Workshop. HB=Headboat, CHL=commercial handline, and CLL=commercial longline.

6. Analytic Approach

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

7. Research Recommendations

7.1 Life History

- Stock Structure
  - Blueline tilefish stock definition needs to be investigated further. Genetic study or some other form of stock identification study needs to be undertaken with samples (muscle, fin clips, etc.) collected from several locations within the Gulf of Mexico and the northwestern Atlantic.
  - Habitat studies of deep water sites in the mid-Atlantic, specifically Norfolk Canyon, Balitmore Canyon, and Hudson Canyon need to be undertaken. Temperature data from research conducted in the 1970s in Norfolk Canyon can be used for comparison purposes.
- Age Data
  - Age readings of blueline tilefish need to be validated. Within and between lab variability in readings is large and needs to be addressed. The potential bias in age readings between laboratories also needs to be addressed with another age workshop and exchange of calibration sets of samples.
  - Marginal increment analysis needs to be undertaken in order to convert increment counts to calendar ages. Samples processed and read in older studies will need to be re-examined and margin codes recorded for each.
  - More recreational fishery age samples need to be collected.
- Reproductive Biology Data
  - Overall, more reproductive samples need to be collected. Because small, young fish were lacking from the biological collections, specimens under 18 inches will be needed to address age and size at maturity. Whole gonads will need to be collected for a fecundity study. Specimens collected from throughout the species range and covering all months of the year are needed to better describe spawning season and spawning periodicity.
- Ad-hoc Discard Mortality Sub-group
  - Future research is needed to examine discard mortality rates for this species, as well as factors that affect survival (e.g., gear type, temperature, depth).

7.2 Commercial Fishery Statistics

- Discard
    - Investigate the validity and magnitude of "no discard" trips. This may include fisher interviews throughout the region.
    - Examine potential impacts on "no discard" trips, including:
        - Trip length
        - Trip dates in relation to fishery regulations
        - Trip targeting
        - Trip area fished
    - Improve discard logbook data collections via program expansion or more detailed reporting (e.g. more detailed logbook, electronic reporting)
    - Develop an observer program that is representative of the fishery in the South Atlantic.
- Biosampling
    - Standardize TIP sampling protocol to get representative samples at the species level.
    - Develop an observer program that is representative of the fishery in the South Atlantic.
    - Increase untargeted sampling in NE and Mid-Atlantic observer programs.
    - Increase untargeted dockside sampling in NE and Mid-Atlantic.

7.3 Recreational Fishery Statistics

- Continued research efforts to incorporate/require logbook reporting from recreational anglers.
- Quantify historical fishing photos for use in future SEDARs.
- Fund research efforts to collect discard length and age data from the private sector.
- Improve metadata collection in the recreational fishery.
- Pre-stratify MRIP Keys, N-S Canaveral, N – S Hatteras.
- Research possibility of implementing private recreational reef fish stamp to determine universe and reporting strategies.
- At-sea observers collect surface and bottom temperature.
- At-sea observer protocols should include all fields currently used in FL i.e., condition and depth of released fish.

7.4 Indices

- Evaluate various sub-setting methods to identify effective effort. Methods that have been applied or considered include in this and previous SEDAR assessments include the Jaccard statistic, Stephens and MacCall approach, variations of Stephens and MacCall approach (e.g., using amount of catch rather than presence-absence), and other multivariate statistical approaches (e.g., cluster analysis).

- Evaluate various standardization methods to handle zeros in the catch, e.g., delta-GLM, zero-inflated Poisson, zero-inflated negative binomial, hurdle models, etc.
- Evaluate possible effects of circle hooks on catchability of reef fishes.
- Need fishery independent sampling of deep-water species, including blueline tilefish. Need funding to support these efforts.

SEDAR

Southeast Data, Assessment, and Review

SEDAR 32

South Atlantic Blueline Tilefish

SECTION III: Assessment Workshop Report

August 9, 2013*

*Revised September 20, 2013

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

Table of Contents

1. Introduction

1.1 Workshop Time and Place

The SEDAR 32 Assessment Process was held via a series of webinars from April through July 2013. The pre-assessment webinar was held April 17, 2013. Specific assessment webinar dates were May 8, May 23, June 5, June 19, July 10, and July 24, 2013.

1.2 Terms of Reference

Panel responses are italicized.

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 population assessment models that are compatible with available data and document input data, model assumptions and configuration, and equations for each model considered.

   A catch-age model and a surplus production model (ASPIC) are described in section 3 of the AW report. The BAM was considered the most reliable for providing management advice. Input data are documented in the DW report and in section 2 of the AW report. Model assumptions and equations of BAM are documented in SEDAR 32-RW01 and those of ASPIC in Prager (2005).

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

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

Measures of uncertainty are described in section 3 of the AW report.

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

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

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

   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 are described in section 3 of the AW report.

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

   A) If stock is overfished:
      F=0, F=current, F=Fmsy, Ftarget
      F=Frebuild (max that rebuild in allowed time)

   B) If stock is overfishing
      F=Fcurrent, F=Fmsy, F= Ftarget

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

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

   Projections are described in section 3 of the AW report.

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

    Research recommendations are described in section 3 of the AW report.

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

    This report was prepared within the specified time frame.

1.3 List of Participants

Assessment Panelists

Kate Andrews, NMFS/SEFSC
Rob Cheshire, NMFS/SEFSC
Chip Collier, SSC
Lew Coggins, NMFS/SEFSC
Kevin Craig, NMFS/SEFSC
Eric Fitzpatrick, NMFS/SEFSC
Marcel Reichert, SSC
Kyle Shertzer, NMFS/SEFSC
George Sedberry, SSC
Erik Williams, NMFS/SEFSC

Appointed Observers

Robert Johnson, FL Charter/Headboat
Dewey Hemilright, NC Commercial

Council Representative

Michelle Duval, SAFMC

Council and Agency Staff

Julia Byrd, SEDAR Coordinator
Michael Errigo, SAFMC Staff
Andrea Grabman, SEDAR
Brian Langseth, NMFS/SEFSC
Myra Brower, SAFMC Staff
John Carmichael, SEDAR/SAFMC Staff
Jessica Stephen, SERO

Assessment Webinar Observers

Joey Ballenger, SCDNR
Peter Barile
Carolyn Belcher, GADNR
Rusty Hudson, DSF, Inc.
Kevin Kolmos, SCDNR
Stephanie McInerny, NCDMF
David Nelson
Tracey Smart, SCDNR

1.4 List of Assessment Workshop Working Papers

South Atlantic blueline tilefish and gray triggerfish data workshop document list.

Document #	Title	Authors
	Documents Prepared for the Assessment Workshop	
SEDAR32-AW01	Age and length composition weighting for U.S. blueline tilefish (*Caulolatilus microps*)	Sustainable Fisheries Branch, NMFS 2013
SEDAR32-AW02	Age and length composition weighting for U.S. gray triggerfish (*Balistes Capriscus*)	Sustainable Fisheries Branch, NMFS 2013
SEDAR32-AW03	Development of an ageing error matrix for U.S. blueline tilefish (*Caulolatilus microps*)	Sustainable Fisheries Branch, NMFS 2013
SEDAR32-AW04	Development of an ageing error matrix for U.S. gray triggerfish (*Balistes Capriscus*)	Sustainable Fisheries Branch, NMFS 2013
SEDAR32-AW05	The Beaufort Assessment Model (BAM) with application to cobia[1]: mathematical description, implementation details, and computer code	Sustainable Fisheries Branch, NMFS 2013
SEDAR32-AW06	The Beaufort Assessment Model (BAM) with application to black sea bass[1]: mathematical description, implementation details, and computer code	Sustainable Fisheries Branch, NMFS 2013
	Reference Documents	
SEDAR32-RD01	List of documents and working papers for SEDAR 4 (Caribbean – Atlantic Deepwater Snapper Grouper) – all documents available on the SEDAR website.	SEDAR 4
SEDAR32-RD02	Comparison of Reef Fish Catch per Unit Effort and Total Mortality between the 1970s and 2005–2006 in Onslow Bay, North Carolina	Rudershausen et al. 2008
SEDAR32-RD03	Source document for the snapper-grouper fishery of the South Atlantic region.	SAFMC 1983
SEDAR32-RD04	FMP, regulatory impact review, and final environmental impact statement for the SG fishery of the South Atlantic region	SAFMC 1983
SEDAR32-RD05	Age, growth and reproductive biology of blueline tilefish along the southeastern coast of the United States, 1982-99	Harris et al. 2004
SEDAR32-RD06	List of documents and working papers for SEDAR 9 (Gulf of Mexico Gray Triggerfish, Greater Amberjack, and Vermillion Snapper)	SEDAR 9
SEDAR32-RD07	Estimated Conversion Factors for Adjusting MRFSS Gulf of Mexico Red Snapper Catch Estimates and Variances in 1981-2003 to MRIP Estimates and Variances	Rios et al. 2012

SEDAR32-RD08	Estimates of Historic Recreational Landings of Spanish Mackerel in the South Atlantic Using the FHWAR Census Method	Brennan and Fitzpatrick 2012
SEDAR32-RD09	Excerpt from ASMFC Atlantic Croaker Stock Assessment & Peer Review Reports 2003 – Information on Jacquard Index	ASMFC 2003
SEDAR32-RD10	Survival estimates for demersal reef fishes released by anglers	Collins 1994
SEDAR32-RD11	Indirect estimation of red snapper (Lutjanus campechanus) and gray triggerfish (Balistes capriscus) release mortality	Patterson et al. 2002
SEDAR32-RD12	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
SEDAR32-RD13	Commercial catch composition with discard and immediate release mortality proportions off the southeastern coast of the United States	Stephen and Harris 2010
SEDAR32-RD14	Migration and Standing Stock of Fishes Associated with Artificial and Natural Reefs on Georgia's Outer Continental Shelf	Ansley & Harris 1981
SEDAR32-RD15	Age, Growth, and Reproductive Biology of the Gray Triggerfish (*Balistes capriscus*) from the Southeastern United States, 1992-1997	Moore 2001
SEDAR32-RD16	Size, growth, temperature, and the natural mortality of marine fish	Gislason et al. 2010
SEDAR32-RD17	Evolutionary assembly rules for fish life histories	Charnov et al. 2012
SEDAR32-RD18	A Review for Estimating Natural Mortality in Fish Populations	Siegfried & Sansó

2 Data Review and Update

Processing of data for the assessment is described in the SEDAR 32 South Atlantic Blueline tilefish 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 2.1-2.14.

2.1 Additional Data

Several data elements were discussed and recommended at the SEDAR 32 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

An age-specific maturity vector was developed using length-specific maturity and the von Bertalannfy growth curve (female only) that was provided at the DW. During the assessment workshop process an alternative method was developed. The proportion of active females was multiplied by the proportion of mature females (Table 2.4).

Using AGEMAT software (Punt et al. 2008), an aging error matrix was developed for blueline tilefish. The details concerning the methods can be found in working paper SEDAR 32-AW03. The aging error matrix for blueline tilefish is presented in Table 2.5.

2.3 Commercial Landings and Discards

Total commercial landings (lbs whole weight) and commercial discards (number of fish) are shown in Table 2.6.

2.4 Commercial Length and Age Composition

Blueline tilefish commercial weighted length compositions are presented in Table 2.7 and Table 2.8. Details regarding the methods can be found in working paper SEDAR 32 AW01. Weighted age compositions are provided in Table 2.9 and Table 2.10. Age zero blueline tilefish were omitted and ages greater than 15 were pooled as a plus group (15+, Table 2.9 and Table 2.10). Details regarding the methods can be found in working paper SEDAR 32 AW01.

2.5 Recreational Landings and Discards

Recreational landings and discards (number of fish) are provided in Table 2.11.

2.6 Recreational Length and Age composition

Blueline tilefish recreational length compositions are presented in Table 2.12. Details regarding the methods can be found in working paper SEDAR 32 AW01. Recreational age compositions are provided in Table 2.13. Details regarding the methods can be found in working paper SEDAR 32 AW01.

2.7 Indices

All indices for potential use in the blueline tilefish stock assessment and associated CVs are in Table 2.14.

2.8 References

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

Punt, A.E., Smith, D.C., KrusicGolub, K. and Robertson, S. 2008. Quantifying age-reading error for use in fisheries stock assessments, with application to species in Australia's Southern and Eastern Scalefish and Shark Fishery. *Can. J. Fish. Aquat. Sci.* 65:1991-2005.

2.9 Tables

Table 2.1. Meristic conversions for blueline tilefish caught off the U. S. South Atlantic.

	Length - length					
Source	Equation	Units	n	R^2	SE	Range of X
Headboat Survey, TIP, FWC, MARMAP, VA	**FL = 1.32 + 0.94*TL**	**mm**	**1335**	**0.996**	**0.875, 0.002**	**267 -884**

	Ln(Weight) = a + b*Ln(Length)							Converted Power Equation: $W = a L^b$
Source	a (SE)	b (SE)	MSE	Units	n	R^2	Range of length	
Headboat Survey, TIP, FWC, MARMAP, VA	**-18.85 (0.095)**	**3.11 (0.015)**	**0.009**	**WW, kg FL, mm**	**1113**	**0.97**	**220 - 833**	**$W = 6.54 \times 10^{-9} L^{3.11}$**

Table 2.2. Von Bertalanffy growth model parameter estimates for blueline tilefish in the south Atlantic.

Model	**t0**	**L_∞ (S.E.)**	**K (S.E.)**	**t_0 (S.E.)**	**CV**
Popn-all fish	t0 estimated	609.3 (3.396)	.281 (.01065)	-1.112 (0.14683)	.1555 (0.00161)
Popn-all fish	**t0 fixed**	**600.3 (2.541)**	**.3296 (.00528)**	**-0.5**	**.15596 (.001610)**
Popn-female	t0 estimated	615.7 (10.296)	.1113 (.01020)	-5.082 (0.007094)	.13853(.003197)
Popn-female	t0 fixed	554.9(4.346)	.2581 (.007272)	-0.5	.15103 (.003497)
Fishery-all fish	t0 estimated	621.3 (4.287)	.28152 (.012385)	-1.2473 (0.17607)	.15151 (.001697)

Table 2.3. Age-specific natural mortality blueline tilefish from the south Atlantic for all data combined.

Age	Scaled Charnov base
1	0.29
2	0.20
3	0.16
4	0.14
5	0.12
6	0.12
7	0.11
8	0.11
9	0.10
10	0.10
11	0.10
12	0.10
13	0.10
14	0.10
15	0.10

Table 2.4. SEDAR 32 South Atlantic blueline tilefish age specific percent active and percent mature (females only).

AGE	%Active	%Mature	Active x Mature
1	0.00	0.10	0.00
2	0.00	0.25	0.00
3	0.00	0.50	0.00
4	0.22	1.00	0.22
5	0.34	1.00	0.34
6	0.46	1.00	0.46
7	0.58	1.00	0.58
8	0.70	1.00	0.70
9	0.82	1.00	0.82
10	0.94	1.00	0.94
11	0.97	1.00	0.97
12	0.97	1.00	0.97
13	0.97	1.00	0.97
14	0.97	1.00	0.97
15+	0.97	1.00	0.97

Table 2.5. SEDAR 32 South Atlantic blueline tilefish aging error matrix.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1	0.833	0.165	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.210	0.580	0.202	0.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.020	0.226	0.507	0.226	0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	0.002	0.036	0.239	0.446	0.239	0.036	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	0.005	0.056	0.242	0.395	0.242	0.056	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	0.000	0.001	0.011	0.074	0.238	0.352	0.238	0.074	0.011	0.001	0.000	0.000	0.000	0.000	0.000
7	0.000	0.000	0.002	0.019	0.091	0.230	0.314	0.230	0.091	0.019	0.002	0.000	0.000	0.000	0.000
8	0.000	0.000	0.001	0.005	0.030	0.103	0.220	0.283	0.220	0.103	0.030	0.005	0.001	0.000	0.000
9	0.000	0.000	0.000	0.002	0.010	0.041	0.112	0.208	0.255	0.208	0.112	0.041	0.010	0.002	0.000
10	0.000	0.000	0.000	0.001	0.004	0.016	0.051	0.118	0.195	0.231	0.195	0.118	0.051	0.016	0.004
11	0.000	0.000	0.000	0.000	0.002	0.007	0.023	0.060	0.120	0.183	0.210	0.183	0.120	0.060	0.032
12	0.000	0.000	0.000	0.000	0.001	0.003	0.011	0.030	0.068	0.121	0.170	0.191	0.170	0.121	0.113
13	0.000	0.000	0.000	0.000	0.000	0.002	0.006	0.016	0.038	0.074	0.119	0.159	0.175	0.159	0.254
14	0.000	0.000	0.000	0.000	0.000	0.001	0.003	0.009	0.021	0.044	0.077	0.116	0.148	0.160	0.420
15	0.000	0.000	0.000	0.000	0.000	0.001	0.002	0.005	0.013	0.027	0.050	0.080	0.112	0.137	0.573

Table 2.6. SEDAR 32 South Atlantic blueline tilefish commercial landings and discards.

	Weight (Whole fish - Pounds)			Numbers	
	Landings			Discards	Kept for bait
Year	Handline	Longline	Other	Handline	Handline
1974	33000	0	0		
1975	56456	0	0		
1976	55755	19	0		
1977	30898	0	97		
1978	68763	0	13950		
1979	52174	5891	1734		
1980	83565	34461	238		
1981	293139	107641	2825		
1982	774072	406280	265		
1983	338780	317818	92		
1984	166296	339574	602		
1985	58207	333759	89		
1986	112750	107255	8673		
1987	94468	49017	1585		
1988	62440	43252	1391		
1989	66580	44450	1582		
1990	111891	60300	2934		
1991	119674	70784	4396		
1992	125046	151578	2905		
1993	54962	133940	11302	0	21
1994	70982	112901	4355	1	26
1995	65079	103386	2416	1	26
1996	116976	31270	*	1	25
1997	140236	76508	3244	1	27
1998	64982	41413	1259	0	20
1999	78708	36428	1107	0	17
2000	73615	35245	3573	0	18
2001	89113	36604	2107	0	18
2002	140673	124815	70	0	17
2003	78996	34954	5129	0	14
2004	42415	27003	7291	0	13
2005	59083	18364	6489	0	12
2006	110545	47358	15099	0	13
2007	68717	6904	9482	0	15
2008	210865	186846	14467	0	15
2009	260283	199873	14688	0	15
2010	137744	291514	8791	0	12
2011	19904	114343	7255	0	12

Table 2.7. Weighted length composition (FL in cm) for commercial handline blueline tilefish.

Year	N(fish)	N(trips)	21	22	23	24	25	26	27	28	29	30	31
1983	22	5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1984	404	49	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0028	0.0000	0.0000	0.0028
1985	560	75	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1986	278	46	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1987	232	37	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0054	0.0000
1988	134	26	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0095	0.0165
1989	136	31	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0054	0.0217
1990	396	40	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0020	0.0000	0.0041
1991	169	39	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1992	190	29	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0058	0.0000	0.0058	0.0128
1993	339	41	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0030
1994	281	32	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0039	0.0077
1995	375	46	0.0000	0.0000	0.0000	0.0000	0.0000	0.0023	0.0023	0.0000	0.0000	0.0114	0.0000
1996	209	24	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0017	0.0000	0.0000
1997	62	20	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1998	156	17	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0042	0.0000	0.0042
1999	342	34	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0040	0.0000
2000	462	52	0.0000	0.0000	0.0000	0.0000	0.0000	0.0050	0.0000	0.0025	0.0025	0.0021	0.0025
2001	334	48	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0041	0.0041	0.0000
2002	121	33	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0008	0.0000
2003	337	43	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0008	0.0000
2004	624	46	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0023	0.0045	0.0116
2005	463	45	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0015	0.0015	0.0015
2006	909	50	0.0047	0.0000	0.0000	0.0000	0.0000	0.0000	0.0010	0.0010	0.0030	0.0030	0.0010
2007	329	67	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0031	0.0000	0.0000
2008	211	64	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0079	0.0000	0.0000	0.0000
2009	361	76	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2010	210	70	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0069	0.0000	0.0000
2011	136	41	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0075	0.0000	0.0000

Table 2.7 (Continued).

Year	32	33	34	35	36	37	38	39	40	41	42	43	44
1983	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0909	0.0000	0.0000	0.0455
1984	0.0028	0.0000	0.0033	0.0000	0.0206	0.0127	0.0056	0.0290	0.0295	0.0318	0.0305	0.0458	0.0407
1985	0.0000	0.0000	0.0022	0.0022	0.0022	0.0044	0.0098	0.0142	0.0153	0.0251	0.0087	0.0120	0.0164
1986	0.0000	0.0000	0.0043	0.0000	0.0082	0.0028	0.0043	0.0096	0.0206	0.0113	0.0113	0.0249	0.0142
1987	0.0054	0.0000	0.0054	0.0200	0.0200	0.0116	0.0347	0.0246	0.0124	0.0361	0.0139	0.0124	0.0493
1988	0.0095	0.0315	0.0395	0.0190	0.0300	0.0095	0.0380	0.0285	0.0095	0.0110	0.0380	0.0260	0.0245
1989	0.0109	0.0054	0.0163	0.0109	0.0271	0.0054	0.0109	0.0380	0.0163	0.0217	0.0617	0.0163	0.0326
1990	0.0090	0.0176	0.0131	0.0413	0.0398	0.0365	0.0635	0.0403	0.0314	0.0685	0.0435	0.0534	0.0357
1991	0.0000	0.0000	0.0154	0.0125	0.0154	0.0154	0.0256	0.0432	0.0882	0.0563	0.0409	0.0256	0.0422
1992	0.0122	0.0116	0.0058	0.0180	0.0122	0.0244	0.0064	0.0366	0.0302	0.0302	0.0196	0.0295	0.0667
1993	0.0000	0.0029	0.0086	0.0086	0.0118	0.0029	0.0086	0.0178	0.0204	0.0320	0.0352	0.0377	0.0411
1994	0.0000	0.0116	0.0231	0.0039	0.0000	0.0077	0.0100	0.0146	0.0370	0.0254	0.0524	0.0400	0.0385
1995	0.0068	0.0134	0.0114	0.0180	0.0155	0.0203	0.0248	0.0136	0.0544	0.0385	0.0360	0.0205	0.0383
1996	0.0087	0.0017	0.0138	0.0366	0.0208	0.0034	0.0225	0.0346	0.0366	0.1186	0.0907	0.0645	0.0296
1997	0.0095	0.0000	0.0095	0.0000	0.0000	0.0000	0.0311	0.0596	0.0000	0.0406	0.0501	0.0285	0.0000
1998	0.0212	0.0254	0.0127	0.0169	0.0085	0.0254	0.0339	0.0296	0.0254	0.0423	0.0254	0.0495	0.0339
1999	0.0000	0.0040	0.0095	0.0079	0.0199	0.0119	0.0254	0.0532	0.0508	0.0850	0.0459	0.0468	0.0413
2000	0.0046	0.0025	0.0167	0.0067	0.0088	0.0117	0.0125	0.0368	0.0343	0.0485	0.0459	0.0748	0.0810
2001	0.0015	0.0096	0.0178	0.0167	0.0086	0.0156	0.0268	0.0349	0.0248	0.0681	0.0334	0.0644	0.0482
2002	0.0084	0.0084	0.0084	0.0084	0.0084	0.0357	0.0084	0.0084	0.0530	0.0589	0.0770	0.0337	0.0344
2003	0.0000	0.0031	0.0035	0.0004	0.0221	0.0163	0.0314	0.0442	0.0532	0.0815	0.0966	0.0706	0.0364
2004	0.0035	0.0138	0.0175	0.0233	0.0280	0.0231	0.0241	0.0151	0.0559	0.0505	0.0300	0.0486	0.0726
2005	0.0015	0.0059	0.0284	0.0133	0.0162	0.0328	0.0285	0.0298	0.0654	0.1024	0.0601	0.0303	0.0344
2006	0.0090	0.0170	0.0351	0.0391	0.0513	0.0373	0.0428	0.0453	0.0481	0.0655	0.0511	0.0493	0.0650
2007	0.0000	0.0061	0.0061	0.0031	0.0215	0.0338	0.0307	0.0276	0.0399	0.0399	0.0411	0.0461	0.0798
2008	0.0000	0.0000	0.0158	0.0158	0.0158	0.0000	0.0000	0.0316	0.0160	0.0237	0.0632	0.0319	0.0316
2009	0.0000	0.0000	0.0000	0.0000	0.0113	0.0000	0.0075	0.0038	0.0150	0.0376	0.0226	0.0189	0.0603
2010	0.0000	0.0000	0.0000	0.0000	0.0000	0.0076	0.0277	0.0069	0.0143	0.0277	0.0216	0.0000	0.0691
2011	0.0000	0.0000	0.0000	0.0000	0.0150	0.0150	0.0299	0.0150	0.0000	0.0223	0.0075	0.0374	0.0448

Table 2.7 (Continued).

Year	45	46	47	48	49	50	51	52	53	54	55	56	57
1983	0.0000	0.0455	0.0000	0.0000	0.0909	0.0000	0.1364	0.0455	0.0455	0.0000	0.0000	0.0000	0.0455
1984	0.0399	0.0412	0.0389	0.0249	0.0732	0.0437	0.0368	0.0328	0.0406	0.0413	0.0317	0.0132	0.0596
1985	0.0218	0.0296	0.0538	0.0548	0.0449	0.0218	0.0470	0.0273	0.0405	0.0635	0.0383	0.0459	0.1030
1986	0.0263	0.0221	0.0314	0.0277	0.0831	0.0399	0.0410	0.0449	0.0531	0.0356	0.0560	0.0370	0.0642
1987	0.0370	0.0231	0.0417	0.0362	0.0592	0.0406	0.0531	0.0361	0.0246	0.0254	0.0330	0.0699	0.0646
1988	0.0110	0.0095	0.0205	0.0355	0.0505	0.0245	0.0554	0.0190	0.0559	0.0499	0.0220	0.0479	0.0464
1989	0.0346	0.0163	0.0475	0.0346	0.0475	0.0625	0.0400	0.0163	0.0387	0.0000	0.0054	0.0183	0.0700
1990	0.0217	0.0312	0.0430	0.0079	0.0357	0.0271	0.0521	0.0553	0.0370	0.0128	0.0157	0.0119	0.0418
1991	0.0307	0.0716	0.0371	0.0594	0.0422	0.0450	0.0287	0.0307	0.0240	0.0309	0.0236	0.0154	0.0420
1992	0.0353	0.0417	0.0353	0.0469	0.0727	0.0423	0.0312	0.0469	0.0583	0.0248	0.0196	0.0498	0.0294
1993	0.0501	0.0530	0.0294	0.0776	0.0732	0.0684	0.0563	0.0479	0.0270	0.0290	0.0296	0.0469	0.0325
1994	0.0362	0.0531	0.0639	0.0654	0.0747	0.0500	0.0377	0.0446	0.0577	0.0469	0.0254	0.0246	0.0408
1995	0.0629	0.0585	0.0447	0.0519	0.0587	0.0356	0.0407	0.0335	0.0492	0.0337	0.0199	0.0136	0.0178
1996	0.0500	0.0605	0.0346	0.0467	0.0417	0.0309	0.0346	0.0259	0.0225	0.0138	0.0154	0.0121	0.0400
1997	0.0812	0.0622	0.0000	0.0933	0.0406	0.0190	0.0622	0.0380	0.0380	0.0285	0.0380	0.0000	0.0501
1998	0.0311	0.0296	0.0537	0.0537	0.0664	0.0438	0.0085	0.0169	0.0679	0.0947	0.0169	0.0127	0.0552
1999	0.0691	0.0380	0.0404	0.0371	0.0673	0.0313	0.0141	0.0141	0.0337	0.0117	0.0321	0.0282	0.0307
2000	0.0518	0.0414	0.0710	0.0622	0.0606	0.0401	0.0284	0.0200	0.0238	0.0109	0.0242	0.0305	0.0305
2001	0.0442	0.0523	0.0574	0.0283	0.0538	0.0278	0.0584	0.0270	0.0474	0.0289	0.0330	0.0123	0.0589
2002	0.0602	0.0433	0.0946	0.0589	0.0589	0.0252	0.0446	0.0433	0.0176	0.0252	0.0265	0.0084	0.0446
2003	0.0598	0.0329	0.0691	0.0469	0.0481	0.0190	0.0350	0.0306	0.0070	0.0046	0.0132	0.0194	0.0264
2004	0.0315	0.0578	0.0498	0.0467	0.0475	0.0607	0.0341	0.0489	0.0128	0.0322	0.0116	0.0271	0.0171
2005	0.0265	0.0236	0.0213	0.0391	0.0177	0.0186	0.0191	0.0270	0.0193	0.0191	0.0269	0.0302	0.0227
2006	0.0421	0.0339	0.0368	0.0424	0.0250	0.0130	0.0192	0.0274	0.0237	0.0167	0.0219	0.0276	0.0169
2007	0.0361	0.0583	0.0369	0.0369	0.0344	0.0327	0.0405	0.0184	0.0501	0.0282	0.0311	0.0244	0.0269
2008	0.0363	0.0555	0.0476	0.0479	0.0585	0.0561	0.0418	0.0243	0.0419	0.0809	0.0207	0.0274	0.0577
2009	0.0265	0.0849	0.0566	0.0455	0.0645	0.0491	0.0238	0.0318	0.0200	0.0266	0.0220	0.0358	0.0516
2010	0.0219	0.0226	0.0154	0.0424	0.0501	0.0640	0.0444	0.0302	0.0449	0.0508	0.0813	0.0640	0.0359
2011	0.0449	0.0524	0.0449	0.0521	0.0373	0.0075	0.0060	0.0374	0.0674	0.0357	0.0269	0.0209	0.0150

Table 2.7 (Continued).

Year	58	59	60	61	62	63	64	65	66	67	68	69	70
1983	0.0000	0.0455	0.0455	0.0000	0.0455	0.0000	0.0000	0.0000	0.0909	0.0455	0.0909	0.0000	0.0000
1984	0.0432	0.0170	0.0249	0.0226	0.0137	0.0137	0.0244	0.0193	0.0117	0.0086	0.0061	0.0000	0.0132
1985	0.0285	0.0372	0.0482	0.0362	0.0340	0.0154	0.0142	0.0207	0.0175	0.0099	0.0099	0.0077	0.0076
1986	0.0531	0.0274	0.0043	0.0613	0.0314	0.0410	0.0096	0.0314	0.0218	0.0000	0.0028	0.0150	0.0203
1987	0.0285	0.0415	0.0339	0.0161	0.0115	0.0162	0.0000	0.0084	0.0108	0.0053	0.0053	0.0108	0.0000
1988	0.0369	0.0369	0.0505	0.0245	0.0220	0.0110	0.0000	0.0300	0.0000	0.0000	0.0000	0.0000	0.0000
1989	0.0129	0.0387	0.0292	0.0000	0.0646	0.0313	0.0346	0.0109	0.0000	0.0163	0.0129	0.0000	0.0054
1990	0.0131	0.0050	0.0143	0.0082	0.0217	0.0038	0.0050	0.0082	0.0041	0.0000	0.0020	0.0143	0.0009
1991	0.0420	0.0051	0.0143	0.0143	0.0143	0.0102	0.0143	0.0000	0.0092	0.0000	0.0000	0.0000	0.0000
1992	0.0139	0.0236	0.0149	0.0149	0.0058	0.0033	0.0064	0.0081	0.0074	0.0097	0.0058	0.0091	0.0000
1993	0.0240	0.0328	0.0121	0.0149	0.0148	0.0088	0.0089	0.0116	0.0029	0.0059	0.0030	0.0000	0.0000
1994	0.0000	0.0185	0.0185	0.0154	0.0039	0.0177	0.0062	0.0000	0.0069	0.0000	0.0031	0.0000	0.0069
1995	0.0176	0.0157	0.0176	0.0155	0.0112	0.0174	0.0112	0.0023	0.0000	0.0087	0.0217	0.0000	0.0043
1996	0.0312	0.0067	0.0034	0.0067	0.0121	0.0121	0.0000	0.0121	0.0034	0.0000	0.0000	0.0000	0.0000
1997	0.0311	0.0406	0.0596	0.0190	0.0000	0.0095	0.0406	0.0000	0.0095	0.0000	0.0000	0.0000	0.0000
1998	0.0226	0.0226	0.0184	0.0269	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1999	0.0221	0.0187	0.0377	0.0078	0.0046	0.0069	0.0159	0.0079	0.0070	0.0015	0.0023	0.0000	0.0030
2000	0.0205	0.0175	0.0150	0.0109	0.0046	0.0067	0.0021	0.0000	0.0042	0.0021	0.0025	0.0046	0.0000
2001	0.0086	0.0223	0.0123	0.0101	0.0111	0.0082	0.0108	0.0030	0.0041	0.0000	0.0000	0.0000	0.0000
2002	0.0265	0.0181	0.0265	0.0084	0.0084	0.0000	0.0000	0.0084	0.0000	0.0000	0.0000	0.0000	0.0000
2003	0.0132	0.0163	0.0397	0.0268	0.0039	0.0031	0.0031	0.0000	0.0031	0.0000	0.0031	0.0093	0.0000
2004	0.0103	0.0218	0.0144	0.0156	0.0035	0.0033	0.0012	0.0035	0.0023	0.0098	0.0012	0.0000	0.0098
2005	0.0302	0.0149	0.0269	0.0185	0.0152	0.0427	0.0286	0.0181	0.0000	0.0029	0.0000	0.0000	0.0000
2006	0.0170	0.0086	0.0170	0.0100	0.0145	0.0043	0.0045	0.0010	0.0000	0.0068	0.0000	0.0000	0.0000
2007	0.0221	0.0213	0.0313	0.0104	0.0165	0.0146	0.0109	0.0011	0.0129	0.0056	0.0073	0.0000	0.0056
2008	0.0194	0.0570	0.0276	0.0176	0.0100	0.0006	0.0001	0.0000	0.0079	0.0081	0.0001	0.0015	0.0000
2009	0.0573	0.0283	0.0575	0.0358	0.0458	0.0145	0.0078	0.0121	0.0000	0.0114	0.0039	0.0002	0.0008
2010	0.0078	0.0284	0.0157	0.0212	0.0415	0.0419	0.0214	0.0357	0.0143	0.0014	0.0069	0.0138	0.0000
2011	0.0267	0.0628	0.0822	0.0299	0.0449	0.0150	0.0150	0.0075	0.0225	0.0134	0.0000	0.0000	0.0000

Table 2.7 (Continued).

Year	71	72	73	74	75	76	77	78	79	80
1983	0.0000	0.0000	0.0909	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1984	0.0056	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1985	0.0022	0.0011	0.0022	0.0000	0.0011	0.0011	0.0011	0.0000	0.0000	0.0000
1986	0.0068	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1987	0.0107	0.0000	0.0054	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1988	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1989	0.0000	0.0054	0.0000	0.0054	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1990	0.0020	0.0000	0.0020	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1991	0.0000	0.0143	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1992	0.0000	0.0017	0.0058	0.0081	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1993	0.0000	0.0000	0.0030	0.0000	0.0000	0.0000	0.0059	0.0000	0.0000	0.0000
1994	0.0062	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1995	0.0043	0.0000	0.0043	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1996	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1997	0.0000	0.0000	0.0000	0.0095	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1998	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1999	0.0000	0.0000	0.0000	0.0022	0.0037	0.0037	0.0007	0.0007	0.0000	0.0000
2000	0.0021	0.0021	0.0021	0.0021	0.0000	0.0021	0.0042	0.0000	0.0000	0.0000
2001	0.0015	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2003	0.0062	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2004	0.0012	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2005	0.0000	0.0195	0.0000	0.0090	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2006	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2007	0.0056	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2008	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2009	0.0038	0.0045	0.0000	0.0000	0.0000	0.0007	0.0000	0.0000	0.0000	0.0000
2010	0.0000	0.0000	0.0004	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2011	0.0000	0.0000	0.0150	0.0000	0.0075	0.0150	0.0000	0.0000	0.0000	0.0000

Table 2.7 (Continued).

Year	81	82	83	84
1983	0.0000	0.0000	0.0000	0.0000
1984	0.0000	0.0000	0.0000	0.0000
1985	0.0000	0.0000	0.0000	0.0000
1986	0.0000	0.0000	0.0000	0.0000
1987	0.0000	0.0000	0.0000	0.0000
1988	0.0000	0.0000	0.0000	0.0000
1989	0.0000	0.0000	0.0000	0.0000
1990	0.0000	0.0020	0.0000	0.0000
1991	0.0000	0.0000	0.0000	0.0000
1992	0.0000	0.0000	0.0000	0.0000
1993	0.0000	0.0000	0.0000	0.0000
1994	0.0000	0.0000	0.0000	0.0000
1995	0.0000	0.0000	0.0000	0.0000
1996	0.0000	0.0000	0.0000	0.0000
1997	0.0000	0.0000	0.0000	0.0000
1998	0.0000	0.0000	0.0000	0.0000
1999	0.0000	0.0000	0.0000	0.0000
2000	0.0000	0.0000	0.0000	0.0000
2001	0.0000	0.0000	0.0000	0.0000
2002	0.0000	0.0000	0.0000	0.0000
2003	0.0000	0.0000	0.0000	0.0000
2004	0.0000	0.0000	0.0000	0.0000
2005	0.0090	0.0000	0.0000	0.0000
2006	0.0000	0.0000	0.0000	0.0000
2007	0.0000	0.0000	0.0000	0.0011
2008	0.0000	0.0000	0.0000	0.0000
2009	0.0000	0.0000	0.0000	0.0000
2010	0.0000	0.0000	0.0000	0.0000
2011	0.0000	0.0000	0.0000	0.0000

Table 2.8. Weighted length composition (FL in cm) for commercial longline blueline tilefish.

Year	N(fish)	N(trips)	26	27	28	29	30	31	32	33	34	35	36
1984	638	17	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1985	1023	24	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001
1986	430	15	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1987	95	9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1988	155	8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0042	0.0000	0.0000
1989	73	6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1990	315	9	0.0018	0.0000	0.0000	0.0030	0.0000	0.0030	0.0000	0.0000	0.0000	0.0030	0.0048
1991	354	14	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0015	0.0000	0.0038	0.0015
1992	1550	42	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0001	0.0001
1993	3663	73	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0008	0.0010	0.0010	0.0006
1994	345	24	0.0000	0.0000	0.0000	0.0000	0.0019	0.0009	0.0028	0.0000	0.0000	0.0000	0.0009
1995	372	23	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0010	0.0067	0.0067
1996	383	13	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0019	0.0000	0.0067
1997	137	6	0.0000	0.0000	0.0000	0.0103	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0103
1998	123	5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1999	72	9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0044	0.0044
2000	118	9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0060
2001	400	17	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0046	0.0000	0.0000	0.0018	0.0056
2002	509	28	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0024	0.0024
2003	248	19	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0052	0.0000	0.0052	0.0000	0.0412
2004	290	18	0.0000	0.0000	0.0000	0.0000	0.0000	0.0025	0.0000	0.0000	0.0042	0.0042	0.0167
2005	87	7	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2006	571	15	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0059	0.0000
2007	35	5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2008	342	13	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2009	890	57	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0011	0.0000	0.0011	0.0034
2010	924	57	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0011	0.0023	0.0011
2011	596	38	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0017	0.0000	0.0000

Table 2.8 (Continued).

Year	37	38	39	40	41	42	43	44	45	46	47	48	49	50
1984	0.0000	0.0000	0.0005	0.0009	0.0016	0.0005	0.0016	0.0048	0.0044	0.0037	0.0078	0.0074	0.0102	0.0126
1985	0.0018	0.0001	0.0038	0.0038	0.0111	0.0111	0.0132	0.0268	0.0377	0.0397	0.0356	0.0591	0.0377	0.0367
1986	0.0000	0.0000	0.0113	0.0051	0.0062	0.0113	0.0031	0.0154	0.0112	0.0357	0.0162	0.0255	0.0491	0.0469
1987	0.0000	0.0000	0.0000	0.0000	0.0000	0.0421	0.0188	0.0000	0.0094	0.0376	0.0000	0.0094	0.0421	0.0282
1988	0.0042	0.0000	0.0000	0.0108	0.0000	0.0000	0.0365	0.0000	0.0000	0.0042	0.0042	0.0342	0.0533	0.0407
1989	0.0000	0.0000	0.0137	0.0411	0.0274	0.0274	0.0411	0.0000	0.0000	0.0137	0.0411	0.0274	0.0685	0.0000
1990	0.0126	0.0126	0.0018	0.0018	0.0251	0.0120	0.0156	0.0156	0.0174	0.0180	0.0216	0.0258	0.0342	0.0336
1991	0.0030	0.0152	0.0015	0.0068	0.0294	0.0241	0.0271	0.0321	0.0533	0.0401	0.0347	0.0377	0.0545	0.0646
1992	0.0002	0.0024	0.0026	0.0113	0.0176	0.0244	0.0135	0.0275	0.0374	0.0420	0.0578	0.0565	0.0577	0.0717
1993	0.0030	0.0049	0.0082	0.0127	0.0168	0.0228	0.0270	0.0274	0.0379	0.0339	0.0340	0.0486	0.0534	0.0620
1994	0.0009	0.0113	0.0150	0.0263	0.0244	0.0244	0.0178	0.0310	0.0583	0.0291	0.0282	0.0535	0.0489	0.0657
1995	0.0010	0.0106	0.0039	0.0139	0.0106	0.0178	0.0452	0.0453	0.0712	0.0415	0.0448	0.0367	0.0701	0.0294
1996	0.0067	0.0163	0.0067	0.0106	0.0393	0.0403	0.0379	0.0635	0.0553	0.0586	0.1037	0.0720	0.0538	0.0640
1997	0.0103	0.0000	0.0103	0.0206	0.0000	0.0026	0.0437	0.0309	0.0257	0.0257	0.0643	0.0720	0.1311	0.1054
1998	0.0000	0.0000	0.0000	0.0000	0.0081	0.0000	0.0081	0.0000	0.0081	0.0244	0.0081	0.0325	0.0325	0.0325
1999	0.0088	0.0132	0.0044	0.0130	0.0088	0.0086	0.0000	0.0130	0.0044	0.0130	0.0169	0.0908	0.0130	0.0088
2000	0.0120	0.0060	0.0000	0.0179	0.0120	0.0179	0.0060	0.0120	0.0359	0.0239	0.0120	0.0642	0.0658	0.0500
2001	0.0036	0.0000	0.0085	0.0234	0.0075	0.0082	0.0398	0.0224	0.0378	0.0278	0.0357	0.0534	0.0396	0.0586
2002	0.0024	0.0098	0.0000	0.0103	0.0049	0.0122	0.0196	0.0152	0.0242	0.0490	0.0419	0.0397	0.0375	0.0547
2003	0.0103	0.0258	0.0155	0.0309	0.0155	0.0412	0.0464	0.0464	0.0267	0.0052	0.0361	0.0319	0.0295	0.0628
2004	0.0000	0.0167	0.0134	0.0217	0.0159	0.0566	0.0514	0.0548	0.0642	0.0376	0.0526	0.0634	0.0634	0.0325
2005	0.0000	0.0000	0.0338	0.0000	0.0338	0.0338	0.0508	0.0677	0.0846	0.0508	0.0508	0.0338	0.0677	0.0514
2006	0.0000	0.0023	0.0057	0.0124	0.0275	0.0124	0.0377	0.0230	0.0460	0.0356	0.0388	0.0517	0.0521	0.0441
2007	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1077	0.0000	0.0000	0.0000	0.0000	0.0088	0.1077	0.1077
2008	0.0000	0.0064	0.0064	0.0000	0.0032	0.0097	0.0199	0.0489	0.0586	0.0650	0.0631	0.0656	0.0431	0.0109
2009	0.0034	0.0103	0.0000	0.0103	0.0126	0.0023	0.0046	0.0103	0.0034	0.0264	0.0195	0.0539	0.0524	0.0424
2010	0.0011	0.0023	0.0011	0.0068	0.0056	0.0034	0.0045	0.0096	0.0096	0.0225	0.0332	0.0405	0.0501	0.0703
2011	0.0000	0.0000	0.0000	0.0034	0.0034	0.0117	0.0117	0.0067	0.0117	0.0117	0.0235	0.0285	0.0185	0.0235

Table 2.8 (Continued).

Year	51	52	53	54	55	56	57	58	59	60	61	62	63	64
1984	0.0109	0.1545	0.0252	0.1569	0.1539	0.0135	0.0245	0.0095	0.0046	0.1436	0.0079	0.0047	0.0073	0.1450
1985	0.0383	0.0446	0.0479	0.0444	0.0370	0.0621	0.0902	0.0610	0.0573	0.0350	0.0427	0.0296	0.0277	0.0143
1986	0.0696	0.0774	0.0620	0.0767	0.0650	0.0499	0.0777	0.0348	0.0378	0.0213	0.0194	0.0306	0.0174	0.0195
1987	0.0376	0.1079	0.0609	0.0465	0.0703	0.0232	0.0559	0.1018	0.0326	0.0188	0.0138	0.0094	0.0421	0.0421
1988	0.0449	0.0772	0.1371	0.0552	0.0594	0.0491	0.0889	0.0403	0.0318	0.0360	0.0449	0.0234	0.0150	0.0000
1989	0.0822	0.0000	0.0411	0.0822	0.0822	0.0959	0.0822	0.0548	0.0548	0.0137	0.0548	0.0000	0.0000	0.0137
1990	0.0270	0.0708	0.0480	0.0617	0.0605	0.0611	0.0658	0.1168	0.0192	0.0197	0.0509	0.0521	0.0144	0.0155
1991	0.0665	0.0666	0.0499	0.0647	0.0678	0.0499	0.0366	0.0083	0.0188	0.0391	0.0138	0.0206	0.0114	0.0159
1992	0.0680	0.0508	0.0740	0.0599	0.0777	0.0486	0.0759	0.0196	0.0172	0.0107	0.0144	0.0112	0.0077	0.0025
1993	0.0674	0.0726	0.0615	0.0625	0.0583	0.0565	0.0482	0.0336	0.0211	0.0217	0.0212	0.0184	0.0124	0.0114
1994	0.0601	0.0808	0.0479	0.0460	0.0732	0.0629	0.0441	0.0394	0.0056	0.0178	0.0160	0.0094	0.0066	0.0207
1995	0.0451	0.0821	0.0955	0.0620	0.0716	0.0615	0.0278	0.0216	0.0155	0.0116	0.0078	0.0049	0.0106	0.0134
1996	0.0467	0.0375	0.0419	0.0356	0.0313	0.0294	0.0274	0.0346	0.0159	0.0048	0.0034	0.0019	0.0000	0.0096
1997	0.0437	0.0823	0.0745	0.0488	0.0205	0.0334	0.0257	0.0488	0.0026	0.0154	0.0103	0.0000	0.0180	0.0026
1998	0.0407	0.0407	0.0488	0.0894	0.0894	0.0732	0.0488	0.0732	0.0244	0.0732	0.0407	0.0244	0.0081	0.0163
1999	0.0213	0.0778	0.1512	0.0818	0.0778	0.0000	0.0042	0.0251	0.0042	0.0209	0.0000	0.0000	0.0042	0.0084
2000	0.0783	0.0261	0.0500	0.0179	0.0403	0.0321	0.0522	0.0142	0.0686	0.0060	0.0909	0.0484	0.0283	0.0201
2001	0.0442	0.0573	0.0504	0.0334	0.0322	0.0558	0.0249	0.0249	0.0306	0.0303	0.0347	0.0255	0.0337	0.0229
2002	0.0373	0.0530	0.0410	0.0783	0.0394	0.0405	0.0612	0.0247	0.0364	0.0188	0.0277	0.0310	0.0280	0.0231
2003	0.0272	0.0670	0.0398	0.0267	0.0370	0.0469	0.0623	0.0370	0.0202	0.0408	0.0440	0.0080	0.0061	0.0080
2004	0.0284	0.0652	0.0097	0.0430	0.0258	0.0362	0.0403	0.0208	0.0231	0.0358	0.0206	0.0042	0.0167	0.0097
2005	0.0683	0.1028	0.0514	0.0514	0.0006	0.0169	0.0338	0.0169	0.0000	0.0345	0.0006	0.0182	0.0026	0.0013
2006	0.0406	0.0394	0.0579	0.0693	0.0413	0.0507	0.0560	0.0470	0.0353	0.0296	0.0136	0.0298	0.0068	0.0079
2007	0.0000	0.2154	0.0000	0.0000	0.0088	0.2242	0.0264	0.0264	0.0176	0.0176	0.0351	0.0176	0.0176	0.0351
2008	0.0238	0.0064	0.0238	0.0212	0.0167	0.0592	0.0959	0.0592	0.0431	0.0341	0.0495	0.0322	0.0541	0.0129
2009	0.0436	0.0463	0.0292	0.0226	0.0173	0.0172	0.0288	0.0249	0.0441	0.0536	0.0463	0.0646	0.0639	0.0727
2010	0.0477	0.0533	0.0535	0.0293	0.0186	0.0191	0.0128	0.0196	0.0096	0.0264	0.0287	0.0450	0.0518	0.0591
2011	0.0352	0.0654	0.0839	0.1057	0.0789	0.0520	0.0503	0.0285	0.0168	0.0134	0.0117	0.0168	0.0185	0.0185

Table 2.8 (Continued).

Year	65	66	67	68	69	70	71	72	73	74	75	76	77	78
1984	0.0085	0.0135	0.0114	0.0099	0.0087	0.0092	0.0060	0.0059	0.0062	0.0006	0.0009	0.0003	0.0005	0.0003
1985	0.0238	0.0052	0.0052	0.0020	0.0027	0.0043	0.0011	0.0020	0.0004	0.0007	0.0000	0.0000	0.0000	0.0001
1986	0.0246	0.0073	0.0182	0.0061	0.0122	0.0153	0.0000	0.0041	0.0081	0.0020	0.0000	0.0020	0.0000	0.0020
1987	0.0138	0.0094	0.0138	0.0000	0.0094	0.0421	0.0138	0.0094	0.0188	0.0094	0.0000	0.0000	0.0000	0.0000
1988	0.0234	0.0192	0.0257	0.0000	0.0126	0.0042	0.0000	0.0000	0.0150	0.0000	0.0000	0.0000	0.0042	0.0000
1989	0.0137	0.0137	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0137	0.0000	0.0000	0.0000	0.0000
1990	0.0096	0.0036	0.0000	0.0036	0.0000	0.0347	0.0018	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1991	0.0083	0.0015	0.0000	0.0105	0.0053	0.0015	0.0030	0.0038	0.0015	0.0038	0.0000	0.0000	0.0000	0.0000
1992	0.0068	0.0071	0.0008	0.0078	0.0004	0.0025	0.0025	0.0018	0.0024	0.0023	0.0023	0.0023	0.0000	0.0000
1993	0.0075	0.0089	0.0057	0.0044	0.0023	0.0028	0.0010	0.0014	0.0008	0.0008	0.0004	0.0002	0.0002	0.0002
1994	0.0009	0.0009	0.0216	0.0009	0.0019	0.0009	0.0009	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1995	0.0106	0.0020	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1996	0.0082	0.0029	0.0019	0.0154	0.0010	0.0067	0.0000	0.0000	0.0058	0.0000	0.0000	0.0000	0.0010	0.0000
1997	0.0000	0.0103	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1998	0.0244	0.0325	0.0163	0.0325	0.0081	0.0081	0.0081	0.0000	0.0163	0.0000	0.0081	0.0000	0.0000	0.0000
1999	0.0778	0.0000	0.0000	0.0000	0.0000	0.0000	0.1468	0.0000	0.0000	0.0000	0.0000	0.0734	0.0000	0.0000
2000	0.0142	0.0142	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0142	0.0142	0.0142	0.0000	0.0142	0.0000
2001	0.0417	0.0224	0.0193	0.0203	0.0169	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2002	0.0174	0.0163	0.0277	0.0266	0.0147	0.0049	0.0098	0.0103	0.0000	0.0054	0.0000	0.0000	0.0000	0.0000
2003	0.0009	0.0028	0.0103	0.0019	0.0019	0.0206	0.0000	0.0019	0.0052	0.0019	0.0000	0.0000	0.0000	0.0052
2004	0.0042	0.0039	0.0025	0.0042	0.0042	0.0042	0.0042	0.0083	0.0025	0.0025	0.0042	0.0000	0.0000	0.0000
2005	0.0026	0.0013	0.0019	0.0006	0.0176	0.0006	0.0000	0.0000	0.0000	0.0000	0.0169	0.0000	0.0000	0.0000
2006	0.0059	0.0011	0.0090	0.0079	0.0183	0.0147	0.0090	0.0102	0.0000	0.0023	0.0000	0.0000	0.0011	0.0000
2007	0.0088	0.0088	0.0000	0.0000	0.0088	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2008	0.0097	0.0103	0.0032	0.0064	0.0064	0.0000	0.0032	0.0006	0.0064	0.0097	0.0032	0.0000	0.0006	0.0032
2009	0.0619	0.0298	0.0195	0.0080	0.0080	0.0034	0.0057	0.0046	0.0023	0.0069	0.0023	0.0011	0.0011	0.0000
2010	0.0822	0.0529	0.0585	0.0343	0.0135	0.0079	0.0045	0.0011	0.0017	0.0000	0.0011	0.0000	0.0006	0.0006
2011	0.0201	0.0285	0.0470	0.0621	0.0235	0.0168	0.0117	0.0084	0.0084	0.0034	0.0050	0.0034	0.0017	0.0000

Table 2.8 (Continued).

Year	79	80	81	82	83	84	85	86	87	88	89	90
1984	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1985	0.0000	0.0000	0.0000	0.0000	0.0000	0.0018	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1986	0.0000	0.0000	0.0020	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1987	0.0000	0.0094	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1988	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1989	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1990	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1991	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1992	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1993	0.0004	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1994	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1995	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1996	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1997	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1998	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1999	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2003	0.0000	0.0000	0.0000	0.0009	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2004	0.0000	0.0000	0.0000	0.0000	0.0042	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2005	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	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2007	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2008	0.0000	0.0032	0.0000	0.0006	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2009	0.0011	0.0046	0.0000	0.0000	0.0011	0.0023	0.0000	0.0011	0.0000	0.0000	0.0011	0.0011
2010	0.0000	0.0000	0.0000	0.0000	0.0006	0.0000	0.0000	0.0011	0.0000	0.0000	0.0000	0.0000
2011	0.0000	0.0000	0.0034	0.0017	0.0000	0.0034	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table 2.9. Weighted age composition for commercial handline blueline tilefish with ages 16-36 pooled to the 15-plus bin.

Year	(N) Fish	(N) Trips	1	2	3	4	5	6	7
2003	1	1	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000
2005	30	11	0.0000	0.0000	0.0964	0.3086	0.1139	0.1824	0.1837
2006	16	8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0194	0.0097
2007	87	30	0.0000	0.0236	0.0659	0.1972	0.2469	0.1313	0.1075
2008	107	48	0.0000	0.0000	0.0336	0.1790	0.1709	0.2584	0.1645
2009	122	53	0.0000	0.0000	0.0269	0.1255	0.3926	0.2295	0.1250
2010	180	68	0.0000	0.0000	0.0205	0.1613	0.2893	0.1589	0.1754
2011	105	32	0.0000	0.0000	0.0730	0.1042	0.2932	0.2310	0.0761

Year	8	9	10	11	12	13	14	15
2003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2005	0.0575	0.0028	0.0420	0.0028	0.0000	0.0000	0.0000	0.0099
2006	0.6096	0.1952	0.0717	0.0835	0.0055	0.0000	0.0000	0.0055
2007	0.0962	0.0277	0.0559	0.0123	0.0238	0.0088	0.0008	0.0022
2008	0.0898	0.0624	0.0099	0.0000	0.0026	0.0000	0.0002	0.0288
2009	0.0599	0.0279	0.0109	0.0000	0.0000	0.0000	0.0000	0.0018
2010	0.1034	0.0477	0.0196	0.0043	0.0065	0.0011	0.0054	0.0066
2011	0.0733	0.0437	0.0231	0.0058	0.0377	0.0000	0.0035	0.0355

Table 2.10. Weighted age composition for commercial longline blueline tilefish with ages 16-27 pooled to the 15-plus bin.

Year	(N) Fish	(N) Trips	1	2	3	4	5	6	7
2003	5	1	0.0000	0.0000	0.0000	0.0000	0.5154	0.4496	0.0000
2004	2	1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2005	21	2	0.0000	0.0000	0.0000	0.0000	0.1483	0.2294	0.2574
2006	30	8	0.0000	0.0000	0.0000	0.0000	0.1105	0.1336	0.2398
2007	24	5	0.0000	0.0000	0.0000	0.1819	0.0560	0.2957	0.1418
2008	35	5	0.0000	0.0000	0.0503	0.0624	0.1224	0.4124	0.1511
2009	516	48	0.0005	0.0010	0.0067	0.0106	0.0756	0.3570	0.3251
2010	771	53	0.0000	0.0001	0.0061	0.0435	0.1164	0.2663	0.2929
2011	571	38	0.0000	0.0042	0.0197	0.0664	0.1985	0.2499	0.2466

Year	8	9	10	11	12	13	14	15
2003	0.0000	0.0000	0.0000	0.0351	0.0000	0.0000	0.0000	0.0000
2004	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000
2005	0.2569	0.0000	0.0000	0.1081	0.0000	0.0000	0.0000	0.0000
2006	0.0796	0.1457	0.0000	0.0197	0.0300	0.0409	0.0833	0.1169
2007	0.3106	0.0000	0.0000	0.0140	0.0000	0.0000	0.0000	0.0000
2008	0.0934	0.0672	0.0048	0.0000	0.0000	0.0359	0.0000	0.0001
2009	0.1259	0.0597	0.0096	0.0119	0.0004	0.0063	0.0052	0.0043
2010	0.1334	0.0860	0.0331	0.0077	0.0050	0.0015	0.0037	0.0044
2011	0.1444	0.0353	0.0226	0.0009	0.0058	0.0033	0.0013	0.0010

Table 2.11. SEDAR 32 South Atlantic blueline tilefish recreational landings and discards (number of fish).

Year	Landings	Discards	Total Removals
1974	3870.3		3870.3
1975	1789.5		1789.5
1976	3554.7		3554.7
1977	1433.9		1433.9
1978	1641.0		1641.0
1979	407.4		407.4
1980	4081.0		4081.0
1981	1621.0	0.0	1621.0
1982	3913.7	0.0	3913.7
1983	3834.9	4755.6	8590.5
1984	2877.4	0.0	2877.4
1985	649.0	0.0	649.0
1986	679.0	0.0	679.0
1987	2878.9	0.0	2878.9
1988	436.0	0.0	436.0
1989	587.6	0.0	587.6
1990	209.0	0.0	209.0
1991	319.0	3556.1	3875.1
1992	1393.0	329.1	1722.1
1993	2865.1	0.0	2865.1
1994	98.0	0.0	98.0
1995	5495.3	0.0	5495.3
1996	3268.8	0.0	3268.8
1997	15930.8	0.0	15930.8
1998	94.0	26.0	120.0
1999	806.7	1431.1	2237.8
2000	102.4	149.9	252.3
2001	4953.0	0.0	4953.0
2002	549.4	148.2	697.6
2003	7375.7	1218.9	8594.5
2004	2650.9	73.6	2724.5
2005	8013.8	4724.4	12738.2
2006	56728.1	1097.3	57825.4
2007	82839.2	37338.0	120177.3
2008	74060.4	8.0	74068.4
2009	25911.5	766.7	26678.3
2010	13872.8	1850.8	15723.6
2011	12249.8	387.4	12637.1

Table 2.12. Weighted length composition (FL in cm) for recreational blueline tilefish (SRHS, MRFSS/MRIP, and ODU samples).

Year	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1974	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1975	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1976	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1977	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1978	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1979	-	-	-	-	-	-	-	-	-	-	-	-	0.0328	0.0164
1980	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1984	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1985	-	-	-	-	-	-	-	-	-	-	-	0.0500	-	-
1986	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1987	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1988	-	-	-	0.1250	-	-	-	-	-	0.1250	-	-	-	-
1989	-	-	-	-	-	0.1000	-	-	-	0.1000	-	-	0.1000	0.2000
1990	-	-	-	-	-	-	-	-	-	-	0.1667	-	-	0.1667
1991	0.5000	-	-	-	-	-	-	-	0.5000	-	-	-	-	-
1992	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1993	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1994	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1995	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	-	-	-	-	-	-	-	0.0001	-	-	0.0003	0.0001	0.0002	0.0001
1998	-	-	-	-	-	-	-	-	-	-	-	-	0.0833	-
1999	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2000	-	-	-	-	-	-	-	-	-	0.0021	0.0021	0.0042	-	0.0042
2001	-	-	-	-	-	-	-	-	-	-	-	-	0.0006	0.0006
2002	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2003	-	-	-	-	-	-	-	0.0005	-	0.0005	-	-	-	-
2004	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2005	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2006	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2007	-	-	-	-	-	-	-	-	0.0033	0.0067	0.0033	-	-	-
2008	-	-	-	-	-	-	-	-	-	0.0000	-	0.0001	-	0.0000
2009	-	-	-	-	-	-	-	-	-	0.0067	-	0.0067	0.0067	0.0067
2010	-	-	-	-	-	-	-	-	0.0018	-	0.0018	0.0001	0.0000	-
2011	-	-	-	-	-	-	-	-	-	-	-	0.0161	0.0268	0.0295

Table 2.12 (continued). Weighted length composition (FL in cm) for recreational blueline tilefish (SRHS, MRFSS/MRIP, and ODU samples).

Year	31	32	33	34	35	36	37	38	39	40	41	42	43
1974	-	-	-	-	-	0.0110	-	-	-	0.0220	0.0220	0.0440	0.0110
1975	-	0.0128	-	-	-	-	0.0128	0.0128	-	0.0256	-	0.0128	-
1976	-	-	-	-	-	-	-	0.0107	-	-	0.0107	0.0107	0.0107
1977	-	-	-	-	-	-	-	0.0152	-	-	0.0303	0.0152	0.0152
1978	-	-	-	-	-	-	-	-	-	-	-	-	-
1979	0.0328	0.0328	0.0328	0.0164	0.0164	0.0492	0.0984	0.0656	0.0164	0.0164	0.0328	0.0820	0.0164
1980	-	-	-	0.0444	-	0.0444	0.0444	0.0222	0.0222	0.0444	0.0444	0.0667	0.0222
1981	-	-	-	0.0278	-	-	-	0.1111	0.1111	-	0.0556	0.0556	-
1982	-	-	0.0556	-	-	-	-	-	-	0.0556	0.0556	-	-
1983	-	-	0.0465	0.0233	-	-	0.0233	-	-	-	-	0.0465	-
1984	-	-	-	-	-	-	-	0.0690	0.0345	0.0690	0.0345	-	-
1985	-	-	-	-	0.0500	-	0.0500	0.0500	0.0500	-	-	0.0500	-
1986	-	-	-	-	-	0.1000	0.0667	0.0667	-	-	-	0.0667	0.0667
1987	-	-	-	-	-	-	-	-	-	-	-	-	-
1988	-	-	0.1250	-	-	0.1250	-	-	-	-	-	-	-
1989	-	-	0.1000	0.1000	-	0.1000	-	0.2000	-	-	-	-	-
1990	0.1667	-	0.3333	-	-	-	-	-	-	-	-	-	-
1991	-	-	-	-	-	-	-	-	-	-	-	-	-
1992	-	-	-	-	-	-	-	-	-	-	-	-	-
1993	-	-	-	-	-	-	-	-	-	-	-	-	-
1994	-	-	-	-	-	-	-	-	-	-	-	-	-
1995	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	-	0.0339	-	-	-	-	-	0.0177	-	0.0516	0.0177	0.0516	0.0339
1997	0.0002	0.0001	0.0002	0.0001	0.0499	-	0.0001	0.0001	0.0001	0.0498	0.0499	0.0500	-
1998	-	-	-	-	0.0278	0.0556	-	-	-	0.0278	0.1111	-	0.0833
1999	-	-	-	-	0.0526	-	-	0.2105	-	0.0526	-	-	0.0526
2000	0.0146	0.0021	0.0084	0.0105	0.0042	-	0.0042	-	0.0021	-	0.0063	-	0.0021
2001	-	0.0012	-	0.0534	0.0521	-	0.0528	0.0012	0.0012	0.0006	0.0006	0.0006	0.0006
2002	-	0.3333	-	-	-	-	-	-	-	-	-	0.3333	-
2003	-	0.0285	-	0.0855	0.0285	-	0.0285	-	0.0005	-	0.0005	0.0855	-
2004	-	-	-	-	-	-	-	-	0.1133	0.2207	-	-	-
2005	-	-	-	-	-	-	-	-	-	-	-	-	-
2006	-	-	-	-	-	0.0121	0.0303	0.0182	0.0061	0.0121	0.0182	0.0121	0.0182
2007	-	-	-	-	-	0.0033	0.0167	0.0033	0.0033	0.0069	0.0001	0.0001	0.0102
2008	0.0000	0.0030	-	0.0030	-	0.0029	0.0029	0.0059	0.0029	0.0059	0.0206	0.0147	0.0059
2009	0.0070	0.0205	0.0135	0.0073	0.0071	0.0081	0.0008	0.0004	0.0142	0.0071	0.0001	0.0071	0.0067
2010	0.0037	0.0038	0.0039	0.0039	0.0003	0.0025	0.0217	0.0009	0.0023	0.0027	0.0157	0.0107	0.0062
2011	0.0268	0.0028	0.0484	0.0217	0.0271	0.0592	0.0001	0.0190	0.0324	0.0485	0.0163	0.0324	0.0324

Table 2.12 (continued). Weighted length composition (FL in cm) for recreational blueline tilefish (SRHS, MRFSS/MRIP, and ODU samples).

Year	44	45	46	47	48	49	50	51	52	53	54	55
1974	-	0.0110	0.0549	0.0220	0.0220	0.0440	0.0769	0.0440	0.0549	0.0220	0.0440	0.0440
1975	0.0385	0.0513	-	0.0256	0.0513	0.0385	0.0256	0.0256	0.0256	0.0128	0.0513	0.0513
1976	0.0321	0.0321	0.0214	0.0535	0.0374	0.0535	0.0481	0.0374	0.0428	0.0802	0.0428	0.0535
1977	0.0152	0.0758	0.0152	0.0152	0.0758	0.0606	0.0909	0.0303	0.0303	0.0606	0.0152	0.0455
1978	-	-	-	0.0313	-	0.0313	-	0.0313	0.0313	0.0938	-	-
1979	-	-	0.0164	0.0164	-	0.0656	-	-	0.0328	0.0164	0.0492	0.0492
1980	-	0.0667	-	0.0222	-	-	0.0444	0.0444	0.0222	0.0889	0.0444	0.0222
1981	0.0278	0.0833	0.0278	0.0278	0.0278	0.0278	0.0278	-	0.0278	-	0.0556	0.0556
1982	-	0.0556	0.1111	0.1667	0.1111	-	0.0556	-	-	-	0.0556	-
1983	-	0.0465	-	0.0233	0.0465	0.0233	0.0465	0.0465	0.0465	0.0698	0.1395	0.0465
1984	0.0345	0.0690	0.0345	0.0345	0.0690	0.0345	0.0345	0.0690	0.0690	-	0.0690	0.0345
1985	0.1000	-	0.1000	0.0500	0.0500	0.0500	0.1000	0.0500	0.0500	-	-	-
1986	0.0333	-	0.0333	0.0667	0.0333	-	0.1000	-	0.0333	0.0333	0.0333	0.1000
1987	-	-	-	0.0342	-	0.0171	-	0.0171	0.0171	0.8460	0.0171	-
1988	-	-	-	0.2500	-	-	-	-	-	-	0.1250	-
1989	-	-	-	-	-	-	-	-	-	-	-	-
1990	-	-	-	-	-	-	-	-	-	-	-	-
1991	-	-	-	-	-	-	-	-	-	-	-	-
1992	-	-	-	-	-	-	-	-	-	-	-	-
1993	0.3333	-	-	-	-	-	-	-	-	-	-	-
1994	-	-	-	-	-	-	-	-	-	-	-	-
1995	-	-	-	-	0.5000	-	-	-	-	-	-	-
1996	0.0177	0.0177	-	0.0532	-	-	0.0710	0.0177	0.0532	0.0355	0.1032	0.0177
1997	0.0001	0.0001	0.0001	0.0499	-	0.0501	0.1497	0.0997	0.0001	-	0.1497	0.0998
1998	-	-	-	0.0278	0.0833	0.0833	0.0278	-	0.0833	0.0556	0.0556	0.0556
1999	0.0526	0.0526	-	-	0.0526	-	-	-	-	-	-	0.1053
2000	-	0.0021	0.0042	0.3082	-	-	-	-	-	0.3082	-	-
2001	-	-	-	-	-	-	-	-	-	-	-	-
2002	-	0.3333	-	-	-	-	-	-	-	-	-	-
2003	0.0295	-	0.0285	-	0.0285	0.0285	0.0855	0.1709	0.1140	0.0855	0.0570	-
2004	-	0.1103	0.0010	-	0.0010	0.0010	0.0010	-	-	0.1103	0.1103	-
2005	-	-	-	-	0.0556	0.1667	0.1667	0.2222	0.0833	-	-	-
2006	0.0182	0.0242	0.0424	0.0606	0.0970	0.0303	0.0364	0.0788	0.0364	0.0667	0.0606	0.0182
2007	0.0134	0.0105	0.0202	0.0535	0.0635	0.0568	0.0466	0.0668	0.0534	0.0569	0.0801	0.0234
2008	0.0383	0.0236	0.0206	0.0325	0.0561	0.0472	0.0297	0.0266	0.0355	0.0471	0.0501	0.0383
2009	0.0205	0.0135	0.0338	0.0203	0.0202	0.0271	0.0271	0.0272	0.0069	0.0135	0.0741	0.0405
2010	0.0138	0.0279	0.0117	0.0022	0.0103	0.0255	0.0432	0.0315	0.0314	0.0527	0.0393	0.0471
2011	0.0056	0.0191	0.0163	0.0324	0.0164	0.0165	0.0029	0.0164	0.0190	0.0296	0.0001	0.0269

Table 2.12 (continued). Weighted length composition (FL in cm) for recreational blueline tilefish (SRHS, MRFSS/MRIP, and ODU samples).

Year	56	57	58	59	60	61	62	63	64	65	66	67
1974	0.0220	0.0220	0.0110	0.0220	0.0220	0.0549	0.0549	0.0330	0.0330	0.0330	0.0220	0.0549
1975	0.0256	-	0.0385	0.0769	0.0256	0.0385	0.0256	0.0256	0.0128	0.0128	0.1026	0.0256
1976	0.0321	0.0695	0.0214	0.0374	0.0535	0.0321	0.0374	0.0535	0.0214	0.0053	0.0107	0.0107
1977	0.0303	0.0303	0.0758	0.0152	0.0606	0.0455	-	-	0.0606	0.0303	-	-
1978	0.0313	0.1250	0.0938	0.0625	-	0.0313	0.0313	0.0938	0.1250	0.0313	0.0313	0.0625
1979	0.0164	0.0328	0.0164	0.0164	-	-	0.0164	-	0.0328	0.0164	-	0.0164
1980	0.0667	0.0222	0.0222	-	0.0222	0.0222	0.0444	-	-	0.0667	-	0.0222
1981	0.0278	-	-	0.0556	-	0.0278	-	-	-	0.0278	0.0278	0.0278
1982	0.0556	0.1111	-	0.0556	0.0556	-	-	-	-	-	-	-
1983	0.0465	0.0233	0.0930	0.0465	0.0465	-	-	-	0.0233	0.0465	-	-
1984	0.0345	-	-	-	0.0345	0.0345	-	-	0.0345	-	0.0345	0.0345
1985	-	0.0500	-	-	-	0.0500	-	-	0.0500	-	-	-
1986	0.0333	-	-	-	-	0.0667	-	-	0.0667	-	-	-
1987	-	0.0342	0.0171	-	-	-	-	-	-	-	-	-
1988	-	0.1250	-	-	-	-	-	-	-	-	-	-
1989	-	-	-	-	-	-	-	-	-	-	-	-
1990	-	-	-	-	-	-	-	-	0.1667	-	-	-
1991	-	-	-	-	-	-	-	-	-	-	-	-
1992	-	-	-	-	-	-	-	-	-	-	-	-
1993	-	0.3333	0.3333	-	-	-	-	-	-	-	-	-
1994	-	-	-	-	-	-	-	-	-	-	-	-
1995	-	-	-	-	-	-	-	-	-	-	-	-
1996	0.1242	0.0355	0.0355	0.0516	0.0177	0.0177	0.0355	0.0177	-	0.0532	-	-
1997	0.0002	0.0001	-	0.0001	-	0.0499	-	0.0001	0.0001	-	0.0498	0.0997
1998	0.0556	0.0278	-	-	0.0278	-	0.0278	-	-	-	-	-
1999	0.0526	-	0.0526	-	-	0.0526	-	0.0526	0.0526	-	-	0.0526
2000	-	-	-	-	-	-	0.0021	-	-	-	-	-
2001	-	-	-	0.0521	-	-	0.1043	-	0.1564	0.1564	0.0521	0.0521
2002	-	-	-	-	-	-	-	-	-	-	-	-
2003	-	0.0285	0.0285	-	-	-	0.0285	-	-	-	-	-
2004	-	0.1103	-	0.1103	-	-	0.1103	-	-	-	-	-
2005	0.0278	-	0.1111	0.0278	-	0.1111	-	-	0.0278	-	-	-
2006	0.0061	0.0364	0.0424	0.0121	0.0182	0.0667	0.0303	0.0182	0.0364	0.0242	0.0061	0.0061
2007	0.0366	0.0169	0.0435	0.0203	0.0236	0.0367	0.0266	0.0167	0.0233	0.0201	0.0167	0.0233
2008	0.0413	0.0795	0.0678	0.0442	0.0295	0.0413	0.0354	0.0354	0.0177	0.0295	0.0118	0.0206
2009	0.0338	0.0607	0.0473	0.0003	0.0069	0.0741	0.0203	0.0272	0.0471	0.0202	0.0404	0.0337
2010	0.0257	0.0472	0.1021	0.0473	0.0315	0.0552	0.0471	0.0314	0.0471	0.0351	0.0394	0.0079
2011	0.0162	0.0135	0.0403	0.0135	0.0001	0.0136	0.0056	0.0002	0.0137	0.0538	0.0270	0.0136

Table 2.12 (continued). Weighted length composition (FL in cm) for recreational blueline tilefish (SRHS, MRFSS/MRIP, and ODU samples).

Year	68	69	70	71	72	73	74	75	76	77	78	79	80
1974	0.0110	0.0110	0.0220	0.0110	-	-	0.0110	-	-	-	-	-	-
1975	0.0385	0.0385	-	0.0128	0.0128	-	-	-	0.0128	-	-	-	-
1976	0.0053	0.0214	-	-	0.0053	0.0053	-	-	-	-	-	-	-
1977	0.0152	-	0.0152	-	-	0.0152	-	-	-	-	-	-	-
1978	-	-	0.0313	-	-	0.0313	-	-	-	-	-	-	-
1979	0.0164	0.0164	-	-	-	-	-	-	-	-	-	-	-
1980	-	-	-	-	-	-	-	-	-	-	-	-	-
1981	-	-	0.0278	-	-	-	-	-	-	-	0.0278	-	-
1982	-	-	-	-	-	-	-	-	-	-	-	-	-
1983	-	-	-	-	-	-	-	-	-	-	-	-	-
1984	-	-	-	0.0345	-	-	-	-	-	-	-	-	-
1985	-	-	-	-	-	-	-	-	-	-	-	-	-
1986	-	-	-	-	-	-	-	-	-	-	-	-	-
1987	-	-	-	-	-	-	-	-	-	-	-	-	-
1988	-	-	-	-	-	-	-	-	-	-	-	-	-
1989	-	-	-	-	-	-	-	-	-	-	-	-	-
1990	-	-	-	-	-	-	-	-	-	-	-	-	-
1991	-	-	-	-	-	-	-	-	-	-	-	-	-
1992	-	-	-	-	-	-	-	-	-	-	-	-	-
1993	-	-	-	-	-	-	-	-	-	-	-	-	-
1994	-	-	-	-	-	-	-	-	-	-	-	-	-
1995	-	-	-	-	-	-	-	-	-	0.5000	-	-	-
1996	-	0.0177	-	-	-	-	-	-	-	-	-	-	-
1997	-	-	-	-	-	-	-	-	-	-	-	-	-
1998	-	-	-	-	-	-	-	-	-	-	-	-	-
1999	-	-	-	-	-	-	-	-	-	-	-	-	-
2000	-	-	-	-	0.3082	-	-	-	-	-	-	-	-
2001	-	-	-	-	-	-	0.2086	0.0521	-	-	-	-	-
2002	-	-	-	-	-	-	-	-	-	-	-	-	-
2003	0.0285	-	-	-	-	-	-	-	-	-	-	-	-
2004	-	-	-	-	-	-	-	-	-	-	-	-	-
2005	-	-	-	-	-	-	-	-	-	-	-	-	-
2006	-	-	-	-	-	-	-	-	-	-	-	-	-
2007	0.0234	0.0034	0.0133	0.0167	0.0167	-	-	-	-	0.0067	0.0067	0.0033	0.0033
2008	0.0177	0.0059	0.0059	0.0029	-	-	-	-	-	-	-	-	-
2009	0.0070	0.0405	0.0070	0.0135	0.0070	0.0069	0.0067	0.0202	0.0069	-	0.0136	0.0069	-
2010	0.0081	0.0079	0.0001	0.0159	0.0157	0.0002	0.0001	0.0079	0.0001	-	-	-	-
2011	0.0001	0.0269	0.0403	0.0403	0.0135	0.0135	0.0002	0.0001	0.0135	0.0001	0.0000	0.0000	0.0000

Table 2.12 (continued). Weighted length composition (FL in cm) for recreational blueline tilefish (SRHS, MRFSS/MRIP, and ODU samples).

Year	81	82	83	84
1974	-	-	-	-
1975	-	-	-	-
1976	-	-	-	-
1977	-	-	-	-
1978	-	-	-	-
1979	-	-	-	-
1980	-	-	-	-
1981	-	-	-	-
1982	-	-	-	-
1983	-	-	-	-
1984	-	-	-	-
1985	-	-	-	-
1986	-	-	-	-
1987	-	-	-	-
1988	-	-	-	-
1989	-	-	-	-
1990	-	-	-	-
1991	-	-	-	-
1992	-	-	-	-
1993	-	-	-	-
1994	-	-	-	-
1995	-	-	-	-
1996	-	-	-	-
1997	-	-	-	-
1998	-	-	-	-
1999	-	-	-	0.0526
2000	-	-	-	-
2001	-	-	-	-
2002	-	-	-	-
2003	-	-	-	-
2004	-	-	-	-
2005	-	-	-	-
2006	-	-	-	-
2007	-	-	-	-
2008	-	-	-	-
2009	-	-	0.0001	-
2010	0.0079	-	0.0000	-
2011	0.0000	0.0000	0.0000	-

Table 2.13. SEDAR 32 South Atlantic blueline tilefish recreational age compositions.

	n.fish	n.trips	1	2	3	4	5	6	7	8	9	10	11	12
weight n.fish	96	20	0.0833	0.1667	0.1667	0.2396	0.1562	0.0521	0.0625	0.0104	0.0313	0.0104	0.0104	0.0104
weight n.trips	**96**	**20**	**0.0483**	**0.0966**	**0.1599**	**0.2511**	**0.1337**	**0.0341**	**0.1314**	**0.0250**	**0.0450**	**0.0250**	**0.0250**	**0.0250**
nominal	96	20	0.0833	0.1667	0.1667	0.2396	0.1563	0.0521	0.0625	0.0104	0.0313	0.0104	0.0104	0.0104

Table 2.14. SEDAR 32 South Atlantic blueline tilefish indices and associated CVs recommended for potential use. Each index is scaled to its mean value.

Year	HB	CHL	CLL	CV HB	CV CHL	CV CLL
1980	1.92			0.10		
1981	1.79			0.16		
1982	1.20			0.12		
1983	1.39			0.11		
1984	0.72			0.16		
1985	0.67			0.14		
1986	0.64			0.12		
1987	0.92			0.13		
1988	0.70			0.13		
1989	0.75			0.14		
1990	0.42			0.16		
1991	0.67			0.16		
1992	1.19			0.16		
1993		1.13	2.25		0.17	0.17
1994		0.67	1.02		0.15	0.18
1995		0.64	0.97		0.10	0.20
1996		0.94	0.71		0.13	0.23
1997		0.98	1.53		0.09	0.15
1998		1.16	1.03		0.10	0.24
1999		0.80	0.71		0.11	0.23
2000		1.02	0.50		0.12	0.20
2001		0.91	0.77		0.12	0.20
2002		0.76	1.03		0.10	0.20
2003		0.74	0.89		0.11	0.21
2004		0.88	0.58		0.10	0.20
2005		1.14			0.10	
2006		1.49			0.11	
2007		1.18			0.09	
2008		1.42			0.10	
2009		0.99			0.10	
2010		1.17			0.11	

3 Stock Assessment Models and Results

Several stock assessment models of blueline tilefish were discussed during the Assessment Workshop (AW) including a catch-age model (the Beaufort assessment model, BAM), an age-structured surplus production model, an age-aggregated surplus production model (ASPIC), and stock reduction analysis (SRA).

The BAM was selected by the AW panelists to be the primary assessment model and an age-aggregated surplus production model was selected as the secondary model. Abbreviations used herein 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 (Fournier et al. 2012), and its structure and equations are detailed in SEDAR-32-RW-01. In essence, a statistical catch-age 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 population 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 in the U.S. South Atlantic, such as red porgy, black seabass, snowy grouper, gag grouper, greater amberjack, vermilion snapper, Spanish mackerel, red grouper, red snapper, golden tilefish, and cobia.

3.1.1.2 Data Sources The catch-age model included data from three fishery dependent surveys, and from both recreational and commercial fisheries that caught southeastern U.S. blueline tilefish. The model was fitted to data on annual combined recreational landings and discards (1974-2011), annual combined commercial landings and discards from the handline fleet (1974-2011), annual commercial landings from the longline fleet (1979-2011), a combined age composition of recreational landings (2003, 2008, 2009-2011), annual age compositions from the longline fleet (2006-2011), annual age compositions from the handline fleet (2005-2011), and three fishery-dependent indices of abundance (the South Atlantic Regional Headboat Survey index (SRHS, 1980-1992), the handline commercial fishery index (1993-2010), and the longline commercial fishery index (1993-2004)). Discards were a small proportion of landings and no information on size or age of discards was available to estimate discard selectivity; therefore, discards were combined with landings. Not all of the above data sources were available for all fleets that caught blueline tilefish in all years. Data used in the model are tabulated in the DW report and in §II of this assessment report.

The recreational landings estimates include headboat landings, developed by the headboat survey, and the general recreational landings for private recreational, charterboat, and shore modes of the Marine Recreational Information Program (MRIP). This sampling program began in 1981 under the name Marine Recreational Fishing Statistical Survey (MRFSS). In 2004 the sampling and estimation methodology changed, and calibration factors were developed to adjust prior landings under MRFSS (1981-2003) to the new MRIP methodology.

3.1.1.3 **Model Configuration and Equations** Model structure and equations of the BAM are detailed in SEDAR-32-RW01, along with AD Model Builder code for implementation. The assessment time period was 1974–2011. 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 $1 - 15^{+}$, where the oldest age class (15^{+}) allowed for the accumulation of fish (i.e., plus group). The age to start the plus group (15) was chosen based on inspection of age composition data and where estimates of life history parameters (size-at-age and age-based natural mortality) approached an asymptote.

Initialization Initial (1974) abundance at age was computed in the model assuming an equilibrium age structure and an initial fishing mortality rate. The equilibrium age structure was computed for ages $1 - 15^{+}$ based on natural and fishing mortality (F), where the initial F was estimated by the model. This was based on the assumption by the AW panel that the stock was lightly exploited prior to the 1970s.

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 Charnov et al. (2013). The Charnov et al. (2013) 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. As in previous SEDAR assessments, the estimates of M_a were rescaled to provide the same fraction of fish surviving from age-1 through the oldest observed age (43 yr) as would occur with constant $M = 0.10$ from the DW. This approach using cumulative mortality is consistent with the findings of Hoenig (1983) and Hewitt and Hoenig (2005).

Growth Mean size at age of the population (fork length, FL) was modeled with the von Bertalanffy equation, and weight at age (whole weight, WW) was modeled as a function of fork length (Figure 3.1, Table 3.1). Parameters of growth and conversions (FL-WW) were estimated by the DW and were treated as input to the assessment model. The von Bertalanffy parameter estimates from the DW were $L_\infty = 600.3$ mm, $k = 0.33$, and $t_0 = -0.50$ yr. To convert age of landed fish to mean size, mean size at age of the fishery was modeled using a power function $\mathrm{FL}_a{=}\alpha Age_a^{\beta}$, where α is a scale parameter and β is a shape parameter. A single power function was used to match landings in the commercial handline and longline fisheries because length at age was similar between these two fisheries, and a second power function was used for the recreational fishery which landed smaller, younger fish.

Female maturity Females were modeled to be fully mature at age 4 and the proportion mature at ages 1, 2, and 3 were assumed to be 0.1, 0.25, and 0.5 respectively (Table 3.1).

Spawning stock Spawning stock (units of mt) was modeled using total mature female biomass measured at the time of peak spawning. For blueline tilefish, peak spawning was considered to occur in May. In cases when reliable estimates of fecundity are unavailable, spawning biomass is commonly used as a proxy for population fecundity.

Recruitment Expected recruitment of age-1 fish was predicted from spawning stock using the Beverton–Holt spawner-recruit model. Annual variation in recruitment was assumed to occur with lognormal deviations for the years 1974–2009. These deviations were constrained to sum to 1.0. The ending year of estimated recruitment residuals (2009) was based on the selectivity curves for the recreational and commercial fisheries and the final year that age composition data were available (2011). Because the age at near full selection for blueline tilefish generally occurs at age 5 or 6 with some selection for age 3 and older, and the last year of composition data in the model is 2011, the AW panel agreed that this was a reasonable period over which to estimate recruitment deviations. The effects of alternative periods over which to estimate recruitment deviations was assessed via sensitivity analysis.

Landings and Discards The model included three time series of combined landings plus discards from 1974-2011: a general recreational fleet, the commercial handline fleet, and the commercial longline fleet. Historically, there has been little directed recreational harvest of blueline tilefish. Therefore, recreational landings were pooled across all recreational gears in the model. Discards were a small proportion of landings (mean: 0.0001 for recreational discards, none reported from the longline fleet, and a mean of 18 fish per year reported from the handline fleet) and no information was available to estimate discard selectivity. The DW recommended a discard mortality rate of 1.0 given that blueline tilefish are harvested from deep water. Therefore, discards were combined with landings as total recreational removals (landings plus discards) and total commercial handline removals (landings plus discards). Data on commercial discards were available from 1993-2011 and were assumed neglible prior to 1993 (the number of fish discarded over this time frame ranged from 12 to 27 fish per year). Data on recreational discards were available from 1981-2011, with no discards reported in half of these years. Recreational discards were assumed negligible prior to 1981.

The combined landings and discards were modeled with the Baranov catch equation (Baranov 1918) and were fitted in units of weight (1000 lb whole weight, commercial) or numbers of fish (1000 fish, recreational). The DW provided observed commercial landings back to the first assessment year (1974).

Fishing Mortality For each time series of landings, 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 CPUE series were estimated using a parametric approach. This approach applies plausible structure on the shape of the curves, and achieves greater parsimony than occurs with unique parameters for each age. Selectivity of landings from the commerical and recreational fleets were modeled as flat-topped, using a two parameter logistic function. Recreationally landed fish were typically younger and smaller than commerically landed fish, suggesting they may have been harvested from shallower water. Therefore, dome-shaped selectivity for the recreational fleet was investigated via sensitivity analysis. Selectivities of the fishery dependent indices (Headboat, longline, and handline) were assumed the same as the respective fisheries.

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 regulation. Recreational age data were only sufficient to develop a single pooled age composition (pooled over 2003, 2008, 2009-2011). For the commercial fleets, sufficient data were available to develop annual age compositions for the handline fishery (2005-2011) and the longline fishery (2006-2011). Therefore, the AW panel recommended assuming constant selectivities for the recreational and commercial fleets. Commercial length compositions were available from 1984-2011 and recreational length composition data were available from 1974-2011 (excluding 1992 and 1994). Preliminary model runs indicated the length composition data was in conflict with the commercial indices and the recreational age composition. Therefore, the AW panel recommended removing all length composition data. Because there is no indication that fishing methodologies have changed for blueline over time, the AW panel also recommended assuming constant selectivity over time.

Indices of abundance The model was fit to three fishery-dependent indices of relative abundance: the headboat survey (1980-1992), the commercial handline index (1993-2010), and the commercial longline index (1993-2004). Predicted indices were conditional on selectivities, which were assumed constant over time, and were computed from abundance at the midpoint of the year.

Catchability In the BAM, catchability scales indices of relative abundance to estimated population abundance. 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. The AW agreed that time-varying catchability was unlikely to be an issue for blueline tilefish, and recommended that catchability be assumed constant over time for each index. As a sensitivity run, linearly increasing catchability with a slope of 2% up to 2003 and assumed constant thereafter was conducted. 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). Another sensitivity run applied a random walk approach to estimate catchability, where catchability for a particular year was a function of that in the previous year and a random component.

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 ($\mathrm{SSB}_{\mathrm{MSY}}$). In this assessment, spawning stock measures total biomass 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 estimated as the full F averaged over the last three years of the assessment.

Fitting criterion The fitting criterion was a penalized log-likelihood approach in which combined landings and discards were fit closely, and observed composition data and abundance indices were fit to the degree that they were compatible. Landings and indices were fitted using lognormal likelihoods. Age composition data were fitted using robust multinomial likelihoods.

For the observed recreational age compositions annual age compositions were pooled over multiple years and weighted by the annual number of trips due to low sample sizes. The model predicted an annual age composition for each year of observed data. These predicted annual age compositions were then combined over years and weighted by the observed effective sample size in the same manner as the data prior to fitting.

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 blueline tilefish, CVs of combined landings and discards (in arithmetic space) were assumed equal to 0.05, to achieve a close fit to these time series yet allow 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 and 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. For the pooled recreational age composition, effective sample sizes were set to the average number of trips over the years sampled. These initial weights were then adjusted until standard deviations of normalized residuals (SDNRs) were near 1.0 (SEDAR25-RW04, SEDAR25-RW06). The method used was identical to that of (Francis 2011) and used the method of computing SDNRs that accounts for potential correlations in the composition data (TA1.8 in Table A1 of (Francis 2011)). Because recreational age compositions were pooled over years due to limited sample sizes, this approach could not be used to derive weights for this data source. Therefore, weights on recreational age compositions were assumed to be the same as those for the commercial handline fishery age compositions because both use similar gear and fish in a comparable manner. As a sensitivity run, weights on the indices were adjusted upward to a value of 2.5 (SEDAR25-RW06), in accordance with the principle that abundance data should be given primacy (Francis 2011). Upweighting of the abundance indices was not recommended for the base run because they were not developed from fishery-independent data. An additional sensitivity run did not adjust the weights on data sources so that they remained at their empirically determined initial values.

In addition, the compound objective function included several penalties or prior distributions, applied to CV of growth (based on the empirical estimate), the slope of selectivity parameters, 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. Uncertainty in parameter estimates and management quantities was evaluated through sensitivity analyses and a Monte-Carlo/bootstrap approach (described below). Steepness could not be estimated for blueline tilefish. When the model was allowed to estimate steepness under a variety of conditions, it consistently reached the upper bound (0.99). When a prior was used, the prior had to be highly informative ($CV < 0.1$) for the estimate to be pulled downward from the upper bound. Therefore, the assessment panel agreed to fix steepness at 0.84. This value is based on the modal value for species with a similar life history reported in Myers et al. (2002), a meta analysis of steepness for several demersal fish stocks including southeast U.S. Atlantic species (Shertzer and Conn 2012), and the value assumed in prior assessments of similar species (e.g., SEDAR 25, golden tilefish).

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 (Charnov estimates rescaled so as to provide the same cumulative survival through the oldest observed age as would constant $M = 0.05$)
- S2: High M at age (Charnov estimates rescaled so as to provide the same cumulative survival through the oldest observed age as would constant $M = 0.185$)
- S3: Constant $M = 0.10$ across ages
- S4: Steepness $h = 0.70$
- S5: Steepness $h = 0.95$
- S6: Alternative maturity vector
- S7: Model component weights unadjusted (e.g. all weight multipliers set to 1.0)
- S8: Upweight index weights to 2.50 from those based on iterative reweighting
- S9: Linearly increasing catchability with slope of 2% until 2003 and constant thereafter
- S10: Random walk catchability
- S11: Ageing error matrix
- S12: Handline index only
- S13: Headboat index only
- S14: Longline index only
- S15: Recruitment deviation estimated from 1977-2009
- S16: Recruitment deviation estimated from 1982-2009
- S17: Recruitment deviation estimated from 1987-2009
- S18: Recruitment deviation estimated from 1992-2009
- S19: Recruitment deviation estimated from 1997-2009
- S20: Recruitment deviation estimated from 2002-2009
- S21: Dome-shaped selectivity for recreational fishery
- S22: Retrospective run with data through 2010

- S23: Retrospective run with data through 2009
- S24: Retrospective run with data through 2008
- S25: Retrospective run with data through 2007
- S26: Retrospective run with data through 2006

Retrospective analyses should be interpreted with caution because several data sources and changes in sampling effort appear only near the end of the full time series. In particular, annual age compositions for the handline and longline fleets were available beginning in 2005 and 2006, respectively, and sampling intensity increased considerably in 2008 and 2009. Further, the terminal year of the handline index was 2010 while the terminal year of the model was 2011.

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-32-RW01.

3.1.1.5 **Per Recruit and Equilibrium Analyses** Static spawning potential ratio (static SPR) of each year was computed as the asymptotic spawners per recruit given that year's fishery-specific Fs and selectivities, divided by spawners per recruit that would be obtained in an unexploited stock. In this form, static SPR ranges between zero and one, and 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 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 three years (2009–2011).

3.1.1.6 **Benchmark/Reference Point Methods** In this assessment of blueline tilefish, the quantities F_{MSY}, SSB_{MSY}, B_{MSY}, and MSY were estimated by the method of Shepherd (1982). In this 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. 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,

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

where R_0 is virgin recruitment, h is steepness, and Φ_F is spawning potential ratio (ϕ_F/ϕ_0) given growth, maturity, and total mortality at age (including natural and fishing 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 and the estimate of MSY is that ASY. The estimate of $\mathrm{SSB}_{\mathrm{MSY}}$ follows from the corresponding equilibrium age structure.

Estimates of MSY and related benchmarks are conditional on selectivity patterns. 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 three years (2009–2011). 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 $\mathrm{MSST} = (1 - M)\mathrm{SSB}_{\mathrm{MSY}}$ (Restrepo et al. 1998), with constant M here equal to 0.10. Overfishing is defined as $F >$ MFMT and overfished as SSB $<$ MSST. Current status of the stock is represented by SSB in the latest assessment year (2011), and current status of the fishery is represented by the geometric mean of F from the latest three years (2009–2011).

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 Fs 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_{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 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 n=3200 trials that differed from the original inputs by bootstrapping on data sources, and by Monte Carlo sampling of several key input parameters. The value of 3200 was chosen because at least 3000 runs were desired to characterize variability in input dat and parameters, and not all runs were likely to be valid. Of the 3200 trials, 157 were discarded because of unusually high estimates of R_0 or high estimates of F_{MSY}. This left 3043 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 plus 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 ($\hat{O}_{s,y}$),

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

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 pooled landings and discards were assumed to be 0.05, and CVs of indices of abundance were those provided by the DW (tabulated in §III(2) of this assessment report).

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

Steepness The steepness stock–recruit parameter was fixed at 0.84 in the base run. Uncertainty in this parameter was characterized by drawing random values from a truncated beta distribution (range [0.32, 0.99]) with mean equal to 0.84 and standard deviation=0.19 estimated from meta analysis (Shertzer and Conn 2012). The upper and lower bounds were based on inspection of a profile over steepness that suggested this range as plausible values and the upper and lower values of empirical data used in the meta analysis (Shertzer and Conn 2012).

Natural mortality A point estimate of natural mortality ($M = 0.10$) was 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 uniform distribution (range [0.046, 0.154]). This range was calculated assuming a CV of 0.54 based on recommendations in Brodziak et al. (2011). Each realized value of M was used to scale the age-specific Charnov M, as in the base run.

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, 2012–2016. The structure of the projection model was the same as that of the assessment model, and parameter estimates were those from the assessment. Fully selected F was apportioned between landings according to the selectivity curves averaged across fisheries, using geometric mean F from the last three years of the assessment period.

Central tendencies of SSB (time of peak spawning), F, recruits, and landings 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 2012), other than at age 1, were taken to be the 2011 estimates from the assessment, discounted by 2011 natural and fishing mortalities. The initial abundance at age 1 was computed using the estimated spawner-recruit model and a 2011 estimate of SSB. In the assessment, the terminal three years of recruitment did not deviate from the spawner-recruit curve, which influenced the abundances of ages 1–3 (N_{1-3}) in 2011. In the projections, lognormal stochasticity was applied to these abundances based on recruitment variation σ_R. Thus, the initial abundance in year one (2012) of the projections included this variability in N_{2-4}, as well as in the SSB_{2011} used to compute initial recruits, N_1.

Because the assessment period ended in 2011, the projections required an initialization period (2012). The fully selected fishing mortality rate during the initialization period was taken to be the geometric mean of fully selected F from 2009-2011. Any changes in fishing effort were assumed to begin in 2013.

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, steepness, and historical recreational landings, as well as in estimated quantities such as spawner-recruit parameters, selectivity curves, and in initial (start of 2012) 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 the recruitment deviations estimated for that chosen MCB run.

Because the base run model assumed no recruitment deviation for years 2009–2012, the initial projection year (start of 2012) ages 1–4 included additional variability in recruitment following the same method for subsequent years as age–1.

The procedure generated 10,000 replicate projections of MCB model fits drawn at random (with replacement) from the MCB runs. In cases where the same MCB run was drawn, projections 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 the results of this assessment, blueline tilefish is currently overfished with overfishing occurring and a rebuilding plan is necessary. Rebuilding is defined by the criterion that 50% of projection replicates achieve stock recovery (i.e., $\text{SSB}_{2022} \geq \text{SSB}_{\text{MSY}}$) within 10 years. The value of 0.5 probability of success was chosen based on prior rebuilding plans for other species.

Projection scenarios Four constant-F projection scenarios were considered.

- Scenario 1: $F = 0$
- Scenario 2: $F = F_{\text{rebuild}}$
- Scenario 3: $F = F_{\text{MSY}}$
- Scenario 4: $F = F_{\text{current}}$ as the geometric mean F from 2009-2011

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 age compositions were fit reasonably well in most years (Figure 3.2) for both the recreational fishery (Figure 3.3) and the commercial handline (Figure 3.4) and longline (Figure 3.5) fisheries .

The model was configured to fit observed commercial and recreational removals closely (Figure 3.6-3.8).

Fits to indices of abundance captured the general trends but not all annual fluctuations (Figures 3.9–3.11). The model fits suggested a decline in abundance of blueline tilefish following a period of high landings in the early 1980s, relatively stable abundance through the 1990s and early 2000s, followed by an increase and then decrease in abundance during the mid to late 2000s.

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.

Estimated abundance at age showed a truncation of the oldest ages in the 1970s and early 1980s (Figure 3.12, Table 3.2). Total estimated abundance has varied about two-fold since the 1970s with a decline in the early 1980s and since the mid 2000s. Annual number of recruits is shown in Table 3.2 (age-1 column) and in Figure 3.13. Below average recruitment was predicted through the 1990s with several strong year classes predicted to have occurred in early 2000s.

3.1.2.3 Total and Spawning Biomass Estimated biomass at age follows the same general pattern as estimated abundance at age (Figure 3.14; Table 3.3). Total biomass and spawning biomass showed similar trends–high biomass in the 1970s followed by low but stable biomass during the 1980s and 1990s, with a second peak in biomass in the mid 2000s (Figure 3.15, Table 3.4).

3.1.2.4 Selectivity Selectivity estimates of the commercial handline and longline fleets were very similar, while the general recreational fishery had higher selectivity on younger fish (Figure 3.16). Fish were estimated to be near fully selected by age 5 (recreational) or 8 (commercial). Average selectivities of landings were computed from F-weighted selectivities in the most recent years (Figure 3.17). 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.

3.1.2.5 Fishing Mortality The estimated time series of fishing mortality rates (F) from BAM was highly variable (Figure 3.18). There was a drop in F in the mid 1980s and 1990s following by an increase in the mid 2000s. The commercial longline and handline fleets have made similar contributions to total F throughout the time series, while F from the recreational fleet was generally low until the mid 2000s when it was comparable in magnitude to the commercial fisheries (Table 3.6, Figure 3.18).

Estimates of total F at age are shown in Table 3.7.

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 commercial handline and longline fleets (Figures 3.19, 3.20; Tables 3.10, 3.11).

3.1.2.6 **Spawner-Recruitment Parameters** The estimated Beverton–Holt spawner-recruit curve is shown in Figure 3.21, along with the effect of density dependence on recruitment, depicted graphically by recruits per spawner as a function of spawners. Values of recruitment-related parameters were as follows: assumed steepness $h = 0.84$, unfished age-1 recruitment $\widehat{R_0} = 128,215$, unfished spawning biomass (mt) per recruit $\phi_0 = 6.086e{-3}$, and standard deviation of recruitment residuals in log space $\sigma = 0.37$ (which resulted in bias correction $\varsigma = 1.07$). The empirical standard deviation of recruitment residuals in log space was $\widehat{\sigma} = 0.38$. Uncertainty in these quantities was estimated through the Monte Carlo/bootstrap (MCB) analysis (Figure 3.22).

3.1.2.7 **Per Recruit and Equilibrium Analyses** Static spawning potential ratio (static SPR) showed a rapid decline in the late 1970s, followed by a relatively stable period in the 1980s and 1990s, and a decline since the early to mid 2000s (Figure 3.23, 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 are below the MSY level.

Yield per recruit and spawning potential ratio were computed as functions of F (Figure 3.24). As in computation of MSY-related benchmarks, per recruit analyses applied the most recent selectivity patterns averaged across fisheries, weighted by F from the last three assessment years (2009–2011). The yield per recruit curve peaked at $F_{max} = 0.301$, but a wide range of F provided nearly identical yield per recruit. The Fs that provide 30%, 40%, and 50% SPR are 0.36, 0.20, and 0.13, respectively.

As in per recruit analyses, equilibrium landings and spawning biomass were computed as functions of F (Figure 3.25). By definition, the F that maximizes equilibrium landings is F_{MSY}, and the corresponding landings and spawning biomass are MSY and $\mathrm{SSB_{MSY}}$. Equilibrium landings and discards could also be viewed as functions of biomass B, which itself is a function of F (Figure 3.26).

3.1.2.8 **Benchmarks / Reference Points** As described in §3.1.1.6, biological reference points (benchmarks) were derived assuming equilibrium dynamics, corresponding to the expected spawner-recruit curve (Figure 3.21). This approach is consistent with methods used in rebuilding projections (i.e., fishing at F_{MSY} yields MSY from a stock size of $\mathrm{SSB_{MSY}}$). Reference points estimated were F_{MSY}, MSY, B_{MSY} and $\mathrm{SSB_{MSY}}$. Based on F_{MSY}, three possible values of F at optimum yield (OY) were considered—$F_{\mathrm{OY}} = 65\%F_{\mathrm{MSY}}$, $F_{\mathrm{OY}} = 75\%F_{\mathrm{MSY}}$, and $F_{\mathrm{OY}} = 85\%F_{\mathrm{MSY}}$—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 from the base run and median values from the MCB analysis are summarized in Table 3.12. Point estimates of MSY-related quantities were $F_{\mathrm{MSY}} = 0.302$ y^{-1}, MSY = 226.5 klb, $B_{\mathrm{MSY}} = 679.5$ mt, and $\mathrm{SSB_{MSY}} = 246.6$ mt. Distributions of these benchmarks are shown in Figure 3.27.

3.1.2.9 **Status of the Stock and Fishery** Estimated time series of stock status (SSB/MSST, $\mathrm{SSB/SSB_{MSY}}$) showed a rapid decline in the late 1970s, a stable trend in the 1990s and early 2000s and an increase and then decrease since the mid 2000s (Figure 3.28, Table 3.4). The decline in stock status in the 1980s may have been driven by the rapid increase and decrease in landings in the early to mid 1980s (Figure 3.13). Base run estimates of spawning biomass have been below MSST except for during the 1970s and 80s and several years in the mid 2000s. Current stock status in the base run was estimated to be $\mathrm{SSB_{2011}/MSST} = 0.909$ (Table 3.12), indicating that the stock is overfished. The MCB analysis suggests that the estimate of a stock that is not overfished (i.e., SSB > MSST) is highly uncertain (Figures 3.29, 3.30). Age structure estimated from the base run shows more older fish than the (equilibrium) age structure expected at MSY during the 1980s and fewer than the equilibrium age structure since the 1990s (Figure 3.31).

The estimated time series of F/F_{MSY} from the base run suggests that overfishing has been occurring over most of the assessment period but with considerable uncertainty, particularly since the mid 2000s, as demonstrated by the MCB analysis (Figure 3.28, Table 3.4). Current fishery status, with current F represented by the geometric mean from 2009–2011, is estimated by the base run to be $F_{2009-2011}/F_{\text{MSY}} = 2.37$ (Table 3.12), but with much uncertainty in that estimate (Figures 3.29, 3.30).

3.1.2.10 Sensitivity and Retrospective Analyses

Sensitivity analysis, described in §3.1.1.3, can be useful for evaluating the consequences of assumptions made 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 $\text{SSB}/\text{SSB}_{\text{MSY}}$ are plotted to demonstrate sensitivity to natural mortality (Figure 3.32), steepness (Figure 3.33), an alternative maturity schedule (Figure 3.34), model component weights (Figure 3.35), catchability assumptions (Figure 3.36), ageing error (Figure 3.37), exclusion of indices (Figure 3.38), years over which recruitment deviations were estimated (Figure 3.39), and selectivity (domed vs. flat-topped) for the recreational fishery (Figure 3.40). Status indicators were most sensitive to natural mortality, index weights, and ageing error. The qualitative results on terminal stock status were similar across most sensitivity runs, with the exception of natural mortality, generally indicated that the stock is overfished ($\text{SSB}/\text{SSB}_{\text{MSY}} > 1$) and that overfishing is occurring ($F/F_{\text{MSY}} < 1$) (Table 3.13, Figure 3.41). Sensitivity analyses were in general agreement with the results of the MCB analysis.

Retrospective analyses suggested some patterns in F, B, SSB, recruits, $\text{SSB}/\text{SSB}_{\text{MSY}}$, or F/F_{MSY} but this was likely due to changes in available datasets and sampling intensity over the most recent 5 years of the assessment (Figures 3.42 – 3.46). The handline index was only available through 2010 and sampling intensity for commercial age compositions did not begin until 2005-06, with increases in sampling intensity in 2008-09.

3.1.2.11 Projections

Projection scenarios differed in whether and over what time period the stock could recover with various fishing mortality rates (Figures 3.48–3.51 and Tables 3.14–3.17). With zero fishing mortality the stock would be predicted to recover by 2014. Frebuild was estimated at 0.30 which would result in stock recover by 2022. At current fishing mortality rates the stock is predicted to decline. The $F_{current}$ projection maintained SSB below SSB_{MSY} and landings slightly above landings at MSY (Table 3.15 and Figure 3.51).

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 a logistic population model.

A logistic age-aggregated surplus production model, implemented in ASPIC (Prager 2005), was developed for blueline tilefish. Qualitative results from the production model were similar to those from the catch-age model, with predicted declines in biomass in the early 1980s when the fishery first developed, relatively stable biomass from the late 1980s to early 2000s, and a decline in the mid 2000s. The data sources and model structure relevant to production modeling are described below and in Appendix C.

3.2.1.2 **Data Sources** The surplus production model was fit using a single time series of removals, which included commercial and recreational landings and dead discards, and three abundance indices, the headboat index, the commercial handline index, and the commercial longline index. The time series of removals was based on the same input data used for the catch-age model, converted from numbers to biomass where appropriate.

Landings and Dead Discards All landings and dead discards were combined into a single times series in units of pounds. Where landings or discards were provided in numbers, they were converted to biomass by multiplying numbers by an annual mean weight as described previously.

Indices of Abundance Three indices of abundance, the headboat index, the commercial handline index, and the commercial longline index, were provided by the DW. The headboat index was converted from units of number of fish per angler-hour to pounds per angler-hour using annual estimates of individual mean weight and re-scaling to the mean.

The data input to the production model run is provided in Table 3.18.

3.2.1.3 **Model Configuration and Equations** Production modeling used the model formulation and ASPIC software of Prager (1994; 2005). This is an observation-error estimator of the continuous-time form of the Schaefer (logistic) production model (Schaefer 1954; 1957). 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). When written in terms of stock biomass, this model specifies that

$$\frac{dB_t}{dt} = rB_t - \frac{r}{K}B_t^2, \tag{3}$$

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

$$\frac{dB_t}{dt} = (r - F_t)B_t - \frac{r}{K}B_t^2. \tag{4}$$

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

3.2.2 Model 2 Results

3.2.2.1 **Model Fit** Estimated B_1/K for the production model was high (1.12), suggesting the stock was at near virgin condition in the early 1970s. Therefore, the AW panel recommended fixing B_1/K at 1.0. The model captured the general trends in the indices but not the annual variability (Figure 3.52).

3.2.2.2 **Status of the Stock and Fishery** Estimates of stock status based on the production model were similar to those from the catch-age model (Figure 3.53). SSB/SSB$_{\text{MSY}}$ has been decreasing and F/F_{MSY} increasing in recent years. Sensitivity of these results to assumptions about B_1/K are shown (Figure 3.54). SSB/SSB$_{\text{MSY}}$ was less than 1.0 for B_1/K ranging from 0.5 to 1.0. F/F_{MSY} averaged over the last three years of the assessment ranged from 1.91 to 2.64. The large drop in F/F_{MSY} in the terminal year (2011) was associated with a decrease in landings across fisheries, in particular the commercial longline fishery.

3.2.2.3 **Discussion — Surplus Production Model** The surplus production model, because it omits population age and size structure, does not make use of data for those characteristics. Because such data are available for blueline tilefish, a model that uses them would normally be preferred for a detailed assessment on which to base management. Even so, the production model gave similar trends in status indicators to the catch-age model.

3.3 Discussion

3.3.1 Comments on Assessment Results

Estimated benchmarks played a central role in this assessment. Values of SSB$_{\text{MSY}}$ and F_{MSY} were used to gauge the status of the stock and fishery. 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 Beaufort assessment model (BAM) indicated that the stock is overfished (SSB$_{2011}$/MSST = 0.909), and that overfishing is occurring ($F_{2009-2011}/F_{\text{MSY}}$ = 2.37). These qualitative conclusions were consistent across most model configurations used in sensitivity runs. It should be noted that the sensitivity runs and the mode of the MCB runs tended toward values that were similar to the base run in terms of overfished and overfishing indicators.

There is no fishery independent index of abundance for blueline tilefish, and the three available indices were developed from fishery dependent sampling programs that often target other species. This can be an advantage in that changes in targeting and fishing practices are less likely to effect the use of the index as an indicator of blueline tilefish abundance. Even so, these indices were highly variable and did not overlap considerably so evaluating correlations among the indices was not possible.

Perhaps the greatest uncertainty in this assessment was the spawner-recruit relationship. Steepness could not be estimated reliably (tended toward the upper bound), and, therefore, had to be fixed at a value agreed on by the AW (h = 0.84). Hence, MSY-based management quantities are conditional on this particular value of steepness. An alternative approach would be to choose a proxy for F_{MSY}, most likely $F_{X\%}$ (such as $F_{30\%}$ or $F_{40\%}$). However, such proxies do not provide biomass-based benchmarks. If managers wish to gauge stock status, further assumptions about equilibrium recruitment levels would be necessary. Furthermore, choice of X% implies an underlying steepness, as described by Brooks et al. (2009). Thus, choosing a proxy equates to choosing steepness. Given the two alternative approaches, it seems preferable to focus on steepness, as its value is less arbitrary, and can be evaluated relative to other species by comparison to previous meta-analysis (Myers et al. 2002; Shertzer and Conn 2012).

Of the sensitivity runs conducted with the BAM, results were least sensitive to assumptions about catchability, the maturity schedule, and dome-shaped selectivity for the recreational fleet. Results were most sensitive to natural mortality and aging error, with moderate sensitivity to steepness, model component weights, exclusion of indices, and the years over which recruitment deviations were estimated. Sensitivity to natural mortality is common in stock assessment. Ageing error suggests a less robust stock than in the base run. Upweighting indices suggests a more robust stock compared to that in the base run. Effects of data weighting were most pronounced at the end of the assessment period.

The assessment predicted relatively high abundance in the late 1970s and a rapid decline following a large increase in landings in the early to mid 1980s. Abundance was relatively stable until the mid to late 2000s when predicted biomass increased and then decreased in association with a rapid increase in landings in the late 2000s. The model explained these short (3-5 yr) periods of high landings either by high initial biomass (early increase in landings) or high recruitment (late increase in landings). Discovery of new fishing grounds not previously harvested are an alternative explanation for the rapid increase and decrease in landings during these periods. If so, then distinct subcomponents of the stock may be experiencing very different levels of fishing pressure with possible consequences for population productivity. While MCB and sensitivity analyses indicate stock status (in terms of biomass) is highly uncertain, fishery status (in terms of fishing mortality) suggests overfishing has been occurring. These estimates are conditional on assumptions about steepness with a higher value of steepness implying greater resilience to fishing mortality.

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. The model predicted high recruitments in the early 2000s prior to a rapid increase in landings in the mid to late 2000s. The effect of these high recruitments extend through the projection period and may account for the predicted rapid rebuilding time frame. If these recruitment dynamics are not representative of the entire South Atlantic stock, then the rebuilding time frame may actually be longer than projected

3.4 Research Recommendations

The assessment panel made the following recommendations.

- Develop a fishery independent sampling program for abundance of the deepwater snapper-grouper complex (including blueline tilefish). Fishery dependent abundance indices used in this assessment were uncertain in part due to the lack of an effective sampling methodology.

- Implement a systematic age sampling program and systematic evaluation of aging errror. Age samples were important in this assessment but reasonable sample sizes were only available for the last 3-4 years of the assessment.
- Better characterize reproductive parameters including age at maturity, batch fecundity, spawning seasonality, and spawning frequency.
- Better characterize the genetic structure of the stock and evaluate the possibility of local population structure.
- Better characterize the inshore-offshore migratory dynamics of the stock and the degree of fidelity to spawning areas. Portions of the stock may be further offshore in some years and hence not available to the fishery.
- Age-dependent natural mortality was estimated by indirect methods for this assessment of blueline tilefish. Tag-recapture programs may prove useful for estimating mortality.

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), and proportion females mature.

Age	Total length (mm)	Total length (in)	CV length	Whole weight (kg)	Whole weight (lb)	Female maturity
1	290.0	11.4	0.16	0.30	0.66	0.10
2	377.2	14.9	0.16	0.67	1.49	0.25
3	439.9	17.3	0.16	1.09	2.40	0.50
4	485.0	19.1	0.16	1.47	3.25	1.00
5	517.4	20.4	0.16	1.80	3.97	1.00
6	540.7	21.3	0.16	2.07	4.55	1.00
7	557.5	21.9	0.16	2.27	5.01	1.00
8	569.5	22.4	0.16	2.43	5.35	1.00
9	578.2	22.8	0.16	2.54	5.61	1.00
10	584.4	23.0	0.16	2.63	5.80	1.00
11	588.9	23.2	0.16	2.69	5.94	1.00
12	592.1	23.3	0.16	2.74	6.04	1.00
13	594.4	23.4	0.16	2.77	6.11	1.00
14	596.0	23.5	0.16	2.80	6.17	1.00
15	597.2	23.5	0.16	2.81	6.20	1.00

Table 3.2. Estimated total abundance at age (1000 fish) at start of year.

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1974	115.33	76.47	62.95	54.71	49.33	45.68	43.23	42.03	41.36	40.89	40.55	40.31	40.14	40.06	40.02
1975	114.43	85.81	62.49	53.44	47.40	43.16	40.13	38.06	37.11	36.58	36.23	35.97	35.79	35.67	71.17
1976	114.70	85.17	70.23	53.20	46.43	41.54	37.88	35.22	33.48	32.69	32.29	32.01	31.81	31.68	94.58
1977	115.07	85.35	69.62	59.63	46.09	40.57	36.36	33.15	30.89	29.40	28.77	28.44	28.23	28.08	111.45
1978	115.15	85.66	69.87	59.31	51.89	40.51	35.82	32.17	29.42	27.46	26.19	25.65	25.38	25.22	124.64
1979	113.38	85.71	70.11	59.49	51.54	45.44	35.48	31.33	28.19	25.82	24.15	23.05	22.59	22.38	132.14
1980	110.77	84.41	70.21	59.81	51.82	45.27	39.95	31.19	27.61	24.88	22.83	21.37	20.42	20.04	137.04
1981	108.57	82.41	68.96	59.56	51.70	44.99	39.01	34.25	26.76	23.72	21.41	19.66	18.43	17.62	135.57
1982	103.05	80.80	67.42	58.61	51.35	43.88	36.40	30.55	26.61	20.77	18.43	16.65	15.31	14.36	119.39
1983	98.89	76.63	65.87	56.70	48.93	38.72	26.44	18.98	15.28	13.19	10.29	9.13	8.26	7.60	66.39
1984	98.21	73.53	62.44	55.38	47.53	37.43	24.03	14.48	10.07	8.05	6.95	5.42	4.82	4.36	39.09
1985	99.53	73.04	59.95	52.58	46.45	35.68	21.67	12.10	7.07	4.89	3.91	3.38	2.64	2.35	21.17
1986	95.24	74.08	59.75	50.84	44.44	34.45	19.35	10.09	5.48	3.19	2.21	1.77	1.53	1.20	10.66
1987	90.47	70.87	60.57	50.61	43.05	34.58	22.06	11.03	5.58	3.01	1.76	1.22	0.97	0.84	6.54
1988	86.15	67.27	57.74	50.97	42.78	34.58	24.62	14.53	7.11	3.58	1.93	1.13	0.78	0.63	4.75
1989	84.11	64.12	55.06	49.09	43.84	35.70	26.64	18.04	10.52	5.14	2.59	1.40	0.82	0.57	3.90
1990	97.27	62.60	52.47	46.80	42.24	36.70	27.77	19.79	13.26	7.71	3.77	1.90	1.03	0.60	3.29
1991	125.43	72.40	51.24	44.60	40.08	34.58	26.96	19.02	13.29	8.87	5.17	2.53	1.28	0.69	2.61
1992	120.68	93.23	58.90	43.00	37.57	32.04	24.41	17.58	12.14	8.45	5.64	3.29	1.61	0.81	2.11
1993	88.75	89.77	76.09	49.70	36.18	28.70	19.57	13.11	9.15	6.28	4.37	2.92	1.70	0.84	1.52
1994	73.46	65.99	73.16	64.11	41.99	28.31	18.64	11.53	7.57	5.27	3.62	2.52	1.69	0.98	1.36
1995	78.40	54.68	54.03	62.17	54.63	33.07	18.48	10.96	6.62	4.33	3.01	2.07	1.44	0.97	1.34
1996	81.81	58.24	44.35	45.07	51.94	42.52	21.74	11.05	6.42	3.86	2.53	1.76	1.21	0.85	1.35
1997	76.60	60.81	47.39	37.23	37.94	41.50	30.19	14.21	7.04	4.07	2.45	1.60	1.12	0.77	1.40
1998	70.65	56.61	48.21	37.71	29.25	27.36	24.82	16.00	7.27	3.58	2.07	1.24	0.82	0.57	1.10
1999	83.02	52.59	46.35	41.01	32.40	24.21	20.63	17.63	11.20	5.07	2.50	1.44	0.87	0.57	1.17
2000	116.71	61.75	42.92	39.16	34.93	26.54	18.04	14.44	12.13	7.68	3.48	1.72	0.99	0.60	1.20
2001	124.81	86.88	50.56	36.51	33.67	29.05	20.30	13.05	10.29	8.63	5.47	2.48	1.22	0.71	1.28
2002	180.69	92.72	70.49	42.22	30.67	27.19	21.35	14.01	8.85	6.96	5.84	3.70	1.68	0.83	1.35
2003	285.52	134.45	75.77	59.59	35.43	22.98	15.79	10.63	6.70	4.20	3.30	2.77	1.76	0.80	1.04
2004	360.19	211.92	108.67	62.76	49.50	28.09	16.32	10.43	6.88	4.32	2.71	2.13	1.79	1.14	1.19
2005	243.03	267.96	173.06	92.01	53.85	41.63	22.30	12.50	7.93	5.22	3.28	2.06	1.62	1.36	1.77
2006	169.92	180.47	217.07	144.17	77.48	44.62	32.90	17.06	9.48	6.00	3.96	2.49	1.56	1.23	2.38
2007	194.74	125.22	141.32	168.75	111.39	57.57	30.29	21.04	10.73	5.95	3.77	2.49	1.57	0.98	2.28
2008	154.95	141.83	93.06	98.97	116.16	75.86	38.23	19.73	13.64	6.96	3.86	2.45	1.62	1.02	2.12
2009	122.82	113.49	108.08	68.36	70.65	74.82	39.07	17.20	8.57	5.88	3.00	1.67	1.06	0.70	1.36
2010	124.70	90.77	89.99	85.86	52.94	47.34	36.63	15.76	6.57	3.24	2.22	1.13	0.63	0.40	0.78
2011	121.21	92.36	72.68	72.91	67.74	34.41	19.85	12.13	4.94	2.04	1.00	0.69	0.35	0.20	0.37
2012	120.23	89.87	74.29	59.67	60.03	52.47	22.84	12.23	7.38	3.01	1.24	0.61	0.42	0.22	0.34

Table 3.3. Estimated biomass at age (1000 lb) at start of year

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1974	75.6	113.8	151.0	177.7	196.0	208.1	216.5	224.9	231.9	237.2	240.7	243.4	245.4	246.9	248.2
1975	75.2	127.6	149.9	173.5	188.3	196.7	201.1	203.7	208.1	212.1	215.2	217.2	218.7	220.0	441.6
1976	75.2	126.5	168.4	172.8	184.3	189.2	189.6	188.5	187.8	189.6	191.8	193.3	194.4	195.3	586.9
1977	75.6	127.0	166.9	193.8	183.0	184.7	182.1	177.5	173.3	170.4	170.9	171.7	172.6	173.1	691.6
1978	75.6	127.4	167.6	192.7	206.1	184.5	179.5	172.2	165.1	159.2	155.4	155.0	155.2	155.4	773.4
1979	74.5	127.4	168.2	193.1	204.6	207.0	177.7	167.8	158.1	149.7	143.3	139.1	138.0	138.0	819.9
1980	72.8	125.4	168.4	194.2	205.9	206.1	200.2	166.9	154.8	144.2	135.6	129.0	124.8	123.5	850.3
1981	71.2	122.6	165.3	193.3	205.3	204.8	195.3	183.4	150.1	137.6	127.2	118.8	112.7	108.7	841.3
1982	67.7	120.2	161.6	190.5	203.9	200.0	182.3	163.6	149.3	120.4	109.3	100.5	93.7	88.6	740.8
1983	64.8	114.0	157.9	184.1	194.2	176.4	132.5	101.6	85.8	76.5	61.1	55.1	50.5	47.0	411.8
1984	64.4	109.3	149.7	179.9	188.7	170.4	120.4	77.6	56.4	46.7	41.2	32.8	29.5	26.9	242.5
1985	65.3	108.7	143.7	170.9	184.5	162.5	108.5	64.8	39.7	28.4	23.1	20.5	16.1	14.6	131.4
1986	62.6	110.2	143.3	165.1	176.4	157.0	97.0	54.0	30.6	18.5	13.2	10.6	9.3	7.3	66.1
1987	59.3	105.4	145.3	164.5	171.1	157.4	110.5	59.1	31.3	17.4	10.4	7.3	6.0	5.3	40.6
1988	56.4	100.1	138.5	165.6	170.0	157.4	123.2	77.8	39.9	20.7	11.5	6.8	4.9	4.0	29.5
1989	55.1	95.2	132.1	159.4	174.2	162.5	133.4	96.6	59.1	29.8	15.4	8.4	5.1	3.5	24.3
1990	63.9	93.0	125.9	151.9	167.8	167.1	139.1	105.8	74.3	44.8	22.5	11.5	6.4	3.7	20.5
1991	82.2	107.6	122.8	144.8	159.2	157.4	134.9	101.9	74.5	51.4	30.6	15.2	7.7	4.2	16.3
1992	79.1	138.7	141.3	139.6	149.3	145.9	122.4	94.1	68.1	48.9	33.5	19.8	9.9	5.1	13.0
1993	58.2	133.4	182.5	161.4	143.7	130.7	98.1	70.1	51.4	36.4	26.0	17.6	10.4	5.1	9.5
1994	48.3	98.1	175.5	208.1	166.7	129.0	93.5	61.7	42.5	30.6	21.4	15.2	10.4	6.2	8.4
1995	51.4	81.4	129.6	201.9	216.9	150.6	92.6	58.6	37.0	25.1	17.9	12.6	8.8	6.0	8.4
1996	53.8	86.6	106.3	146.4	206.4	193.8	108.9	59.1	35.9	22.5	15.0	10.6	7.5	5.3	8.4
1997	50.3	90.4	113.5	120.8	150.6	188.9	151.2	76.1	39.5	23.6	14.6	9.7	6.8	4.9	8.6
1998	46.3	84.2	115.5	122.6	116.2	124.6	124.3	85.5	40.8	20.7	12.3	7.5	5.1	3.5	6.8
1999	54.5	78.3	111.1	133.2	128.7	110.2	103.4	94.4	62.8	29.3	14.8	8.8	5.3	3.5	7.3
2000	76.5	91.7	103.0	127.2	138.7	120.8	90.4	77.4	68.1	44.5	20.7	10.4	6.2	3.7	7.5
2001	82.0	129.2	121.3	118.6	133.6	132.3	101.6	69.9	57.8	50.0	32.4	15.0	7.5	4.4	7.9
2002	118.6	137.8	169.1	137.1	121.7	123.9	106.9	75.0	49.6	40.3	34.6	22.3	10.4	5.1	8.4
2003	187.4	200.0	181.7	193.6	140.7	104.7	79.1	56.9	37.5	24.3	19.6	16.8	10.8	4.9	6.4
2004	236.3	315.0	260.6	203.9	196.7	127.9	81.8	55.8	38.6	25.1	16.1	12.8	11.0	7.1	7.3
2005	159.6	398.4	414.9	298.9	213.8	189.6	111.8	67.0	44.5	30.2	19.4	12.3	9.9	8.4	11.0
2006	111.6	268.3	520.5	468.3	307.8	203.3	164.7	91.3	53.1	34.8	23.6	15.0	9.5	7.5	14.8
2007	127.9	186.1	338.9	548.1	442.5	262.1	151.7	112.7	60.2	34.4	22.5	15.0	9.5	6.2	14.1
2008	101.6	210.8	223.1	321.4	461.4	345.5	191.4	105.6	76.5	40.3	22.9	14.8	9.9	6.4	13.2
2009	80.7	168.7	259.3	222.0	280.6	340.8	195.6	92.2	48.1	34.2	17.9	10.1	6.4	4.4	8.4
2010	81.8	134.9	215.8	278.9	210.3	215.6	183.4	84.2	36.8	18.7	13.2	6.8	3.7	2.4	4.9
2011	79.6	137.3	174.4	236.8	269.0	156.7	99.4	64.8	27.8	11.9	6.0	4.2	2.2	1.1	2.2
2012	78.9	133.6	178.1	193.8	238.3	239.0	114.4	65.5	41.4	17.4	7.5	3.7	2.6	1.3	2.2

Table 3.4. Estimated time series and status indicators. Fishing mortality rate is apycal F, which includes discard mortalities. Total biomass (B, mt) is at the start of the year, and spawning biomass (SSB, female gonad weight, mt) at the end of July (time of peak spawning). The MSST *is defined by* $\text{MSST} = (1 - M)\text{SSB}_{\text{MSY}}$, *with constant* $M = 0.10$. *SPR is static spawning potential ratio.*

Year	F	F/F_{MSY}	B	B/B_{unfished}	SSB	SSB/SSB$_{\text{MSY}}$	SSB/MSST	SPR
1974	0.0179	0.0595	1387	0.735	611	2.478	2.753	0.850
1975	0.0219	0.0728	1383	0.732	604	2.449	2.721	0.836
1976	0.0248	0.0823	1376	0.729	598	2.425	2.695	0.812
1977	0.0128	0.0424	1367	0.724	596	2.419	2.687	0.895
1978	0.0258	0.0855	1372	0.726	596	2.416	2.684	0.816
1979	0.0201	0.0667	1364	0.722	594	2.407	2.674	0.853
1980	0.0472	0.1566	1362	0.721	587	2.382	2.647	0.706
1981	0.1493	0.4953	1332	0.706	556	2.254	2.504	0.478
1982	0.6004	1.9915	1221	0.647	439	1.778	1.976	0.252
1983	0.5380	1.7844	868	0.460	312	1.267	1.407	0.263
1984	0.6190	2.0530	697	0.369	243	0.984	1.093	0.248
1985	0.6917	2.2942	582	0.308	197	0.797	0.885	0.240
1986	0.4949	1.6415	509	0.269	177	0.718	0.798	0.278
1987	0.3408	1.1303	495	0.262	177	0.720	0.800	0.322
1988	0.2210	0.7331	502	0.266	187	0.759	0.843	0.403
1989	0.2059	0.6831	523	0.277	199	0.806	0.895	0.415
1990	0.2981	0.9886	543	0.288	202	0.821	0.912	0.352
1991	0.3499	1.1604	549	0.291	197	0.798	0.886	0.315
1992	0.5568	1.8468	548	0.290	182	0.738	0.820	0.261
1993	0.4484	1.4872	515	0.273	174	0.706	0.785	0.283
1994	0.4557	1.5113	506	0.268	180	0.728	0.809	0.290
1995	0.4347	1.4416	498	0.264	183	0.741	0.823	0.279
1996	0.3533	1.1717	484	0.256	180	0.729	0.810	0.315
1997	0.5748	1.9066	476	0.252	164	0.665	0.739	0.219
1998	0.2561	0.8494	416	0.220	153	0.621	0.690	0.378
1999	0.2735	0.9072	429	0.227	158	0.641	0.712	0.359
2000	0.2373	0.7871	448	0.237	163	0.659	0.733	0.392
2001	0.2884	0.9566	482	0.256	167	0.677	0.753	0.338
2002	0.6445	2.1378	527	0.279	162	0.657	0.730	0.248
2003	0.3354	1.1126	573	0.304	172	0.697	0.774	0.308
2004	0.1719	0.5701	724	0.383	212	0.858	0.953	0.444
2005	0.1734	0.5752	903	0.478	278	1.127	1.252	0.419
2006	0.3631	1.2044	1041	0.551	343	1.390	1.544	0.245
2007	0.3289	1.0910	1058	0.560	367	1.489	1.655	0.186
2008	0.7391	2.4513	973	0.515	322	1.304	1.449	0.160
2009	0.8728	2.8948	802	0.425	257	1.042	1.158	0.187
2010	1.0669	3.5386	677	0.358	212	0.859	0.955	0.183
2011	0.3928	1.3029	578	0.306	202	0.818	0.909	0.276
2012	.	.	598	0.317	.	.	.	.

Table 3.5. Selectivity at age (end-of-assessment time period) for pooled commercial (cA), pooled recreational (mrip), and selectivity of landings averaged across fisheries (L.avg). TL is total length.

Age	TL(mm)	TL(in)	cHL	cLL	mrip	L.avg
1	290.0	11.4	0.001	0.000	0.092	0.008119284
2	377.2	14.9	0.004	0.001	0.409	0.036188630
3	439.9	17.3	0.018	0.005	0.825	0.078015960
4	485.0	19.1	0.073	0.038	0.970	0.127338000
5	517.4	20.4	0.254	0.249	0.995	0.313915400
6	540.7	21.3	0.598	0.737	0.999	0.716267700
7	557.5	21.9	0.866	0.959	1.000	0.934220900
8	569.5	22.4	0.966	0.995	1.000	0.986472500
9	578.2	22.8	0.992	0.999	1.000	0.997169800
10	584.4	23.0	0.998	1.000	1.000	0.999388100
11	588.9	23.2	1.000	1.000	1.000	0.999864600
12	592.1	23.3	1.000	1.000	1.000	0.999969800
13	594.4	23.4	1.000	1.000	1.000	0.999993400
14	596.0	23.5	1.000	1.000	1.000	0.999998800
15	597.2	23.5	1.000	1.000	1.000	1.000000000

Table 3.6. Estimated time series of fully selected fishing mortality rates for commercial handline (F.cHL),commercial longline (F.cLL), pooled recreational (F.mrip), 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.cHL	F.cLL	F.mrip	Apical F
1974	0.011	0.000	0.007	0.018
1975	0.019	0.000	0.003	0.022
1976	0.018	0.000	0.006	0.025
1977	0.010	0.000	0.003	0.013
1978	0.023	0.000	0.003	0.026
1979	0.017	0.002	0.001	0.020
1980	0.028	0.012	0.007	0.047
1981	0.108	0.039	0.003	0.149
1982	0.391	0.201	0.009	0.600
1983	0.275	0.252	0.011	0.538
1984	0.204	0.405	0.010	0.619
1985	0.105	0.584	0.003	0.692
1986	0.258	0.234	0.003	0.495
1987	0.220	0.108	0.012	0.341
1988	0.132	0.087	0.002	0.221
1989	0.125	0.079	0.002	0.206
1990	0.197	0.101	0.001	0.298
1991	0.214	0.120	0.016	0.350
1992	0.255	0.295	0.007	0.557
1993	0.131	0.306	0.012	0.448
1994	0.180	0.276	0.000	0.456
1995	0.163	0.248	0.023	0.435
1996	0.271	0.068	0.015	0.353
1997	0.330	0.168	0.077	0.575
1998	0.160	0.096	0.001	0.256
1999	0.184	0.081	0.008	0.274
2000	0.164	0.073	0.001	0.237
2001	0.192	0.074	0.022	0.288
2002	0.346	0.295	0.003	0.645
2003	0.214	0.090	0.032	0.335
2004	0.101	0.063	0.008	0.172
2005	0.112	0.034	0.027	0.173
2006	0.179	0.075	0.109	0.363
2007	0.083	0.008	0.238	0.329
2008	0.307	0.258	0.174	0.739
2009	0.465	0.332	0.076	0.873
2010	0.337	0.678	0.053	1.067
2011	0.054	0.294	0.045	0.393

Table 3.7. Estimated instantaneous fishing mortality rate (per yr) at age, including discard mortality

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1974	0.001	0.003	0.006	0.007	0.010	0.013	0.016	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018
1975	0.000	0.001	0.003	0.004	0.008	0.014	0.019	0.021	0.022	0.022	0.022	0.022	0.022	0.022	0.022
1976	0.001	0.003	0.006	0.007	0.011	0.017	0.022	0.024	0.025	0.025	0.025	0.025	0.025	0.025	0.025
1977	0.000	0.001	0.002	0.003	0.005	0.009	0.011	0.012	0.013	0.013	0.013	0.013	0.013	0.013	0.013
1978	0.000	0.001	0.003	0.004	0.009	0.017	0.023	0.025	0.026	0.026	0.026	0.026	0.026	0.026	0.026
1979	0.000	0.000	0.001	0.002	0.006	0.013	0.018	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020
1980	0.001	0.003	0.007	0.010	0.017	0.033	0.043	0.046	0.047	0.047	0.047	0.047	0.047	0.047	0.047
1981	0.000	0.002	0.005	0.012	0.040	0.096	0.133	0.145	0.148	0.149	0.149	0.149	0.149	0.149	0.149
1982	0.001	0.005	0.015	0.045	0.158	0.390	0.540	0.586	0.597	0.600	0.600	0.600	0.600	0.600	0.600
1983	0.001	0.006	0.015	0.040	0.144	0.361	0.491	0.527	0.536	0.537	0.538	0.538	0.538	0.538	0.538
1984	0.001	0.005	0.014	0.040	0.163	0.430	0.575	0.610	0.617	0.619	0.619	0.619	0.619	0.619	0.619
1985	0.000	0.002	0.007	0.032	0.175	0.496	0.654	0.685	0.691	0.691	0.692	0.692	0.692	0.692	0.692
1986	0.001	0.002	0.008	0.030	0.127	0.330	0.451	0.485	0.493	0.494	0.495	0.495	0.495	0.495	0.495
1987	0.001	0.006	0.014	0.032	0.095	0.224	0.307	0.333	0.339	0.340	0.341	0.341	0.341	0.341	0.341
1988	0.000	0.001	0.004	0.015	0.057	0.145	0.200	0.216	0.220	0.221	0.221	0.221	0.221	0.221	0.221
1989	0.000	0.002	0.005	0.014	0.054	0.135	0.186	0.201	0.205	0.206	0.206	0.206	0.206	0.206	0.206
1990	0.000	0.001	0.005	0.019	0.076	0.192	0.268	0.291	0.296	0.298	0.298	0.298	0.298	0.298	0.298
1991	0.002	0.007	0.017	0.035	0.100	0.232	0.316	0.342	0.348	0.349	0.350	0.350	0.350	0.350	0.350
1992	0.001	0.004	0.012	0.037	0.145	0.377	0.511	0.547	0.555	0.556	0.557	0.557	0.557	0.557	0.557
1993	0.001	0.006	0.013	0.033	0.121	0.315	0.418	0.442	0.447	0.448	0.448	0.448	0.448	0.448	0.448
1994	0.000	0.001	0.005	0.024	0.115	0.311	0.420	0.448	0.454	0.455	0.456	0.456	0.456	0.456	0.456
1995	0.002	0.010	0.023	0.044	0.127	0.304	0.403	0.428	0.433	0.434	0.435	0.435	0.435	0.435	0.435
1996	0.002	0.007	0.017	0.036	0.100	0.226	0.314	0.344	0.351	0.353	0.353	0.353	0.353	0.353	0.353
1997	0.007	0.033	0.070	0.105	0.203	0.398	0.524	0.563	0.572	0.574	0.575	0.575	0.575	0.575	0.575
1998	0.000	0.001	0.004	0.016	0.065	0.167	0.231	0.250	0.255	0.256	0.256	0.256	0.256	0.256	0.256
1999	0.001	0.004	0.011	0.025	0.075	0.178	0.246	0.267	0.272	0.273	0.273	0.274	0.274	0.274	0.274
2000	0.000	0.001	0.004	0.015	0.060	0.152	0.212	0.231	0.236	0.237	0.237	0.237	0.237	0.237	0.237
2001	0.002	0.010	0.022	0.039	0.090	0.192	0.260	0.281	0.287	0.288	0.288	0.288	0.288	0.288	0.288
2002	0.001	0.003	0.010	0.039	0.165	0.427	0.586	0.631	0.642	0.644	0.644	0.645	0.645	0.645	0.645
2003	0.003	0.014	0.030	0.050	0.108	0.226	0.303	0.328	0.334	0.335	0.335	0.335	0.335	0.335	0.335
2004	0.001	0.004	0.008	0.017	0.049	0.115	0.156	0.168	0.171	0.172	0.172	0.172	0.172	0.172	0.172
2005	0.003	0.012	0.025	0.036	0.064	0.119	0.157	0.169	0.173	0.173	0.173	0.173	0.173	0.173	0.173
2006	0.010	0.046	0.094	0.122	0.173	0.271	0.336	0.357	0.362	0.363	0.363	0.363	0.363	0.363	0.363
2007	0.022	0.098	0.198	0.237	0.260	0.293	0.318	0.326	0.328	0.329	0.329	0.329	0.329	0.329	0.329
2008	0.016	0.073	0.151	0.201	0.316	0.548	0.688	0.727	0.736	0.738	0.739	0.739	0.739	0.739	0.739
2009	0.007	0.033	0.072	0.120	0.276	0.598	0.797	0.855	0.869	0.872	0.873	0.873	0.873	0.873	0.873
2010	0.005	0.023	0.052	0.101	0.307	0.753	0.994	1.052	1.064	1.066	1.067	1.067	1.067	1.067	1.067
2011	0.004	0.019	0.039	0.058	0.132	0.294	0.374	0.389	0.392	0.393	0.393	0.393	0.393	0.393	0.393

Table 3.8. Estimated total landings at age in numbers (1000 fish)

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1974	0.06	0.20	0.34	0.38	0.44	0.58	0.67	0.69	0.69	0.69	0.69	0.68	0.68	0.68	0.68
1975	0.03	0.11	0.17	0.22	0.35	0.58	0.73	0.76	0.76	0.75	0.75	0.74	0.74	0.74	1.47
1976	0.06	0.20	0.36	0.37	0.48	0.68	0.79	0.80	0.77	0.76	0.75	0.75	0.74	0.74	2.21
1977	0.02	0.08	0.15	0.18	0.22	0.33	0.39	0.39	0.37	0.35	0.35	0.34	0.34	0.34	1.35
1978	0.03	0.10	0.18	0.25	0.42	0.63	0.76	0.75	0.71	0.66	0.63	0.62	0.61	0.61	3.02
1979	0.01	0.03	0.06	0.11	0.27	0.54	0.59	0.57	0.53	0.49	0.46	0.44	0.43	0.42	2.51
1980	0.07	0.24	0.43	0.53	0.84	1.38	1.59	1.34	1.20	1.09	1.00	0.94	0.90	0.88	6.02
1981	0.04	0.13	0.29	0.68	1.91	3.89	4.62	4.40	3.51	3.13	2.83	2.60	2.44	2.33	17.92
1982	0.11	0.39	0.94	2.40	7.08	13.44	14.45	12.92	11.42	8.95	7.95	7.19	6.61	6.20	51.54
1983	0.11	0.41	0.93	2.10	6.18	11.12	9.76	7.41	6.04	5.23	4.09	3.63	3.28	3.02	26.40
1984	0.10	0.34	0.79	2.03	6.73	12.41	10.00	6.31	4.42	3.55	3.06	2.39	2.13	1.93	17.26
1985	0.03	0.12	0.37	1.56	7.02	13.23	9.90	5.72	3.37	2.33	1.87	1.61	1.26	1.12	10.12
1986	0.04	0.16	0.44	1.42	4.98	9.16	6.68	3.69	2.03	1.19	0.82	0.66	0.57	0.45	3.98
1987	0.11	0.38	0.81	1.49	3.68	6.56	5.54	2.97	1.53	0.83	0.48	0.34	0.27	0.23	1.80
1988	0.02	0.08	0.23	0.69	2.23	4.41	4.23	2.68	1.33	0.68	0.37	0.21	0.15	0.12	0.90
1989	0.02	0.09	0.23	0.65	2.16	4.26	4.29	3.13	1.85	0.91	0.46	0.25	0.15	0.10	0.69
1990	0.02	0.07	0.22	0.82	2.91	6.08	6.19	4.75	3.24	1.89	0.93	0.47	0.25	0.15	0.81
1991	0.18	0.48	0.82	1.45	3.59	6.78	6.94	5.24	3.72	2.49	1.45	0.71	0.36	0.19	0.74
1992	0.10	0.35	0.64	1.45	4.79	9.53	9.29	7.06	4.93	3.44	2.30	1.34	0.66	0.33	0.86
1993	0.09	0.45	0.94	1.49	3.89	7.35	6.36	4.46	3.14	2.16	1.51	1.01	0.59	0.29	0.52
1994	0.01	0.06	0.32	1.41	4.29	7.16	6.08	3.96	2.63	1.84	1.26	0.88	0.59	0.34	0.47
1995	0.16	0.51	1.15	2.50	6.12	8.20	5.82	3.63	2.22	1.45	1.01	0.70	0.49	0.33	0.45
1996	0.11	0.37	0.69	1.50	4.66	8.16	5.57	3.06	1.81	1.09	0.72	0.50	0.34	0.24	0.38
1997	0.49	1.80	2.98	3.48	6.56	12.92	11.71	5.83	2.93	1.70	1.02	0.67	0.47	0.32	0.58
1998	0.01	0.05	0.17	0.55	1.73	3.97	4.85	3.37	1.56	0.77	0.44	0.27	0.18	0.12	0.24
1999	0.07	0.20	0.45	0.93	2.21	3.74	4.26	3.93	2.54	1.16	0.57	0.33	0.20	0.13	0.27
2000	0.02	0.05	0.15	0.55	1.93	3.54	3.27	2.83	2.43	1.54	0.70	0.35	0.20	0.12	0.24
2001	0.24	0.79	1.03	1.29	2.72	4.79	4.41	3.05	2.44	2.06	1.30	0.59	0.29	0.17	0.31
2002	0.10	0.24	0.65	1.52	4.39	8.97	9.01	6.25	4.00	3.16	2.65	1.68	0.76	0.38	0.61
2003	0.77	1.68	2.10	2.70	3.43	4.39	3.92	2.83	1.81	1.14	0.90	0.75	0.48	0.22	0.28
2004	0.25	0.68	0.84	1.00	2.23	2.87	2.23	1.53	1.03	0.65	0.41	0.32	0.27	0.17	0.18
2005	0.55	2.81	3.89	3.03	3.15	4.43	3.07	1.85	1.19	0.79	0.50	0.31	0.25	0.21	0.27
2006	1.50	7.29	18.00	15.50	11.60	10.04	8.92	4.87	2.74	1.74	1.15	0.72	0.45	0.36	0.69
2007	3.68	10.60	23.56	33.43	24.07	13.86	7.82	5.57	2.86	1.59	1.01	0.67	0.42	0.26	0.61
2008	2.18	9.03	12.05	16.90	29.69	30.36	18.10	9.73	6.79	3.47	1.93	1.22	0.81	0.51	1.06
2009	0.79	3.34	6.96	7.22	16.09	31.99	20.46	9.45	4.76	3.28	1.67	0.93	0.59	0.39	0.76
2010	0.56	1.89	4.26	7.73	13.20	23.82	22.04	9.81	4.12	2.03	1.40	0.71	0.40	0.25	0.49
2011	0.44	1.55	2.59	3.87	7.86	8.29	5.88	3.72	1.53	0.63	0.31	0.21	0.11	0.06	0.11

Table 3.9. Estimated total landings at age in whole weight (1000 lb)

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1974	0.08	0.41	0.98	1.38	1.93	2.91	3.81	4.40	4.83	5.22	5.59	5.96	6.33	6.70	7.07
1975	0.04	0.23	0.49	0.81	1.54	2.94	4.17	4.82	5.29	5.70	6.10	6.49	6.89	7.28	15.34
1976	0.07	0.43	1.04	1.35	2.08	3.41	4.52	5.06	5.39	5.75	6.14	6.52	6.91	7.30	23.02
1977	0.03	0.18	0.43	0.65	0.97	1.67	2.23	2.46	2.58	2.68	2.84	3.01	3.18	3.36	14.07
1978	0.04	0.21	0.53	0.91	1.85	3.17	4.34	4.78	4.91	5.02	5.17	5.43	5.73	6.04	31.51
1979	0.01	0.06	0.17	0.41	1.19	2.71	3.36	3.64	3.69	3.69	3.73	3.82	3.99	4.19	26.15
1980	0.08	0.50	1.24	1.95	3.67	6.96	9.07	8.47	8.38	8.25	8.17	8.20	8.36	8.70	62.81
1981	0.04	0.27	0.85	2.48	8.34	19.62	26.33	27.92	24.43	23.66	23.07	22.72	22.69	23.02	187.03
1982	0.13	0.83	2.75	8.77	30.94	67.85	82.40	81.90	79.48	67.72	64.88	62.84	61.59	61.27	538.03
1983	0.14	0.86	2.70	7.69	26.98	56.13	55.64	47.00	42.06	39.61	33.36	31.75	30.60	29.87	275.62
1984	0.12	0.73	2.31	7.42	29.39	62.63	57.04	39.98	30.80	26.85	25.01	20.93	19.83	19.03	180.12
1985	0.04	0.25	1.08	5.72	30.67	66.75	56.49	36.30	23.44	17.65	15.25	14.12	11.76	11.09	105.61
1986	0.05	0.34	1.29	5.21	21.77	46.24	38.08	23.41	14.14	8.99	6.72	5.77	5.32	4.41	41.50
1987	0.13	0.81	2.35	5.45	16.07	33.10	31.57	18.83	10.63	6.27	3.95	2.93	2.50	2.30	18.81
1988	0.03	0.17	0.66	2.54	9.76	22.26	24.11	17.01	9.29	5.11	2.98	1.86	1.38	1.17	9.38
1989	0.03	0.19	0.67	2.39	9.43	21.51	24.45	19.82	12.90	6.88	3.75	2.17	1.35	0.99	7.23
1990	0.03	0.14	0.65	3.00	12.69	30.68	35.30	30.11	22.53	14.32	7.56	4.09	2.36	1.46	8.45
1991	0.22	1.02	2.38	5.31	15.70	34.23	39.59	33.22	25.90	18.88	11.87	6.23	3.35	1.93	7.69
1992	0.12	0.74	1.85	5.29	20.92	48.09	52.96	44.74	34.31	26.05	18.78	11.73	6.13	3.29	8.98
1993	0.11	0.95	2.74	5.44	16.99	37.09	36.27	28.29	21.88	16.36	12.30	8.81	5.48	2.85	5.46
1994	0.02	0.13	0.94	5.18	18.73	36.15	34.68	25.14	18.33	13.90	10.31	7.70	5.49	3.40	4.96
1995	0.19	1.08	3.35	9.13	26.72	41.39	33.19	23.02	15.43	11.00	8.27	6.10	4.53	3.22	4.72
1996	0.14	0.79	2.02	5.50	20.37	41.16	31.74	19.39	12.60	8.28	5.86	4.37	3.21	2.38	4.02
1997	0.60	3.79	8.69	12.75	28.65	65.19	66.79	36.95	20.38	12.84	8.35	5.86	4.36	3.18	6.10
1998	0.02	0.10	0.49	2.02	7.58	20.05	27.68	21.34	10.83	5.82	3.63	2.34	1.64	1.21	2.48
1999	0.08	0.42	1.31	3.40	9.67	18.86	24.31	24.89	17.66	8.74	4.65	2.88	1.85	1.29	2.79
2000	0.03	0.11	0.43	2.02	8.42	17.88	18.67	17.97	16.89	11.68	5.72	3.02	1.86	1.19	2.52
2001	0.30	1.66	3.00	4.72	11.87	24.19	25.13	19.31	17.01	15.57	10.65	5.18	2.73	1.67	3.21
2002	0.12	0.50	1.88	5.56	19.15	45.26	51.41	39.66	27.85	23.88	21.63	14.70	7.12	3.73	6.41
2003	0.94	3.55	6.10	9.88	14.96	22.18	22.36	17.92	12.59	8.61	7.31	6.58	4.45	2.15	2.94
2004	0.30	1.45	2.44	3.65	9.73	14.50	12.73	9.72	7.16	4.91	3.32	2.80	2.51	1.69	1.86
2005	0.67	5.93	11.34	11.09	13.75	22.34	17.52	11.73	8.31	5.98	4.06	2.73	2.29	2.04	2.80
2006	1.83	15.40	52.43	56.71	50.67	50.67	50.86	30.87	19.08	13.18	9.39	6.33	4.24	3.54	7.23
2007	4.48	22.39	68.63	122.34	105.12	69.96	44.61	35.30	19.90	12.02	8.22	5.82	3.90	2.60	6.35
2008	2.66	19.08	35.10	61.84	129.66	153.23	103.25	61.71	47.29	26.29	15.75	10.71	7.55	5.04	11.09
2009	0.96	7.06	20.28	26.41	70.26	161.46	116.71	59.91	33.12	24.79	13.65	8.12	5.50	3.86	7.91
2010	0.68	4.00	12.39	28.27	57.64	120.21	125.71	62.22	28.70	15.39	11.39	6.23	3.69	2.49	5.11
2011	0.53	3.27	7.53	14.16	34.34	41.83	33.53	23.61	10.64	4.79	2.54	1.87	1.02	0.60	1.19

Table 3.10. Estimated time series of landings in numbers (1000 fish) for commercial handline (L.cHL), commercial longline (L.cLL) and pooled recreational (L.mrip)

Year	L.cHL	L.cLL	L.mrip	Total
1974	4.27	0.00	3.87	8.14
1975	7.11	0.00	1.79	8.90
1976	6.90	0.00	3.56	10.45
1977	3.78	0.00	1.43	5.21
1978	8.35	0.00	1.64	9.99
1979	6.33	0.72	0.41	7.45
1980	10.16	4.20	4.08	18.44
1981	35.88	13.19	1.62	50.69
1982	96.90	50.78	3.91	151.59
1983	44.32	41.56	3.84	89.72
1984	23.19	47.37	2.88	73.44
1985	8.78	50.22	0.65	59.65
1986	18.32	17.28	0.68	36.28
1987	15.93	8.19	2.88	27.00
1988	10.61	7.28	0.44	18.33
1989	11.21	7.44	0.59	19.24
1990	18.61	9.97	0.21	28.79
1991	19.70	11.59	3.87	35.16
1992	20.58	24.74	1.72	47.05
1993	9.20	22.18	2.87	34.25
1994	12.16	19.07	0.10	31.33
1995	11.38	17.85	5.50	34.73
1996	20.49	5.45	3.27	29.22
1997	24.32	13.20	15.94	53.46
1998	11.13	7.03	0.12	18.28
1999	13.24	6.06	1.67	20.97
2000	12.20	5.61	0.12	17.93
2001	14.66	5.86	4.96	25.48
2002	23.27	20.39	0.70	44.36
2003	13.17	5.62	8.60	27.39
2004	7.34	4.59	2.72	14.66
2005	10.41	3.16	12.73	26.29
2006	19.77	8.24	57.57	85.58
2007	10.37	0.98	118.65	130.00
2008	37.55	32.94	73.35	143.85
2009	46.67	35.42	26.59	108.67
2010	25.00	52.00	15.71	92.70
2011	3.72	20.81	12.64	37.17

Table 3.11. Estimated time series of landings in whole weight (1000 lb) for commercial handline (L.cHL), commercial longline (L.cLL) and pooled recreational (L.mrip)

Year	L.cHL	L.cLL	L.mrip	Total
1974	33.06	0.00	24.53	57.59
1975	56.57	0.00	11.55	68.12
1976	55.87	0.00	23.13	78.99
1977	30.96	0.00	9.37	40.32
1978	68.91	0.00	10.73	79.64
1979	52.28	5.89	2.66	60.83
1980	83.75	34.47	26.59	144.81
1981	294.32	107.73	10.42	412.47
1982	780.15	407.57	23.67	1211.39
1983	340.46	318.77	20.77	680.00
1984	166.96	341.14	14.07	522.18
1985	58.35	335.00	2.89	396.23
1986	113.04	107.34	2.85	223.23
1987	94.70	49.03	11.96	155.69
1988	62.59	43.27	1.84	107.70
1989	66.74	44.47	2.55	113.76
1990	112.14	60.31	0.92	173.37
1991	119.83	70.77	16.91	207.51
1992	125.25	151.55	7.19	283.99
1993	55.12	134.37	11.54	201.02
1994	71.29	113.38	0.40	185.06
1995	65.20	103.39	22.76	191.35
1996	116.72	31.24	13.86	161.83
1997	140.16	76.45	67.89	284.50
1998	65.25	41.49	0.51	107.25
1999	79.16	36.48	7.17	122.81
2000	73.79	34.13	0.50	108.42
2001	89.42	35.92	20.85	146.20
2002	141.11	125.00	2.75	268.86
2003	77.48	33.71	31.34	142.53
2004	42.22	27.02	9.55	78.78
2005	59.11	18.37	45.11	122.59
2006	110.91	47.43	214.09	372.43
2007	57.63	5.53	468.48	531.64
2008	208.39	184.81	297.04	690.24
2009	257.17	197.30	105.54	560.01
2010	135.82	287.95	60.36	484.13
2011	19.82	113.04	48.58	181.45

Table 3.12. Estimated status indicators, benchmarks, and related quantities from the Beaufort catch-age model, conditional on estimated current selectivities averaged across fisheries. Rate estimates (F) are in units of y^{-1}*; status indicators are dimensionless; and biomass estimates are in units of metric tons or pounds, as indicated. Spawning stock biomass (SSB) and minimum stock size threshold (MSST) are measured by total biomass of mature females. Symbols, abbreviations, and acronyms are listed in Appendix A.*

Quantity	Units	Estimate	SE	MCB median
F_{MSY}	y^{-1}	0.302	0.262	0.229
85% F_{MSY}	y^{-1}	0.256	0.223	0.194
75% F_{MSY}	y^{-1}	0.226	0.196	0.171
65% F_{MSY}	y^{-1}	0.196	0.170	0.149
$F_{30\%}$	y^{-1}	0.356	0.213	0.356
$F_{40\%}$	y^{-1}	0.203	0.101	0.200
$F_{50\%}$	y^{-1}	0.126	0.056	0.124
B_{MSY}	mt	679.5	341.4	785.3
$\mathrm{SSB}_{\mathrm{MSY}}$	mt	246.6	165.0	298.7
[1]MSST	mt	221.9	157.0	268.9
MSY	klb	226.5	27.2	234.4
R_{MSY}	1000 age-1 fish	124.0	46.3	129.4
Y at 85% F_{MSY}	1000 lb	225.8	26.8	233.4
Y at 75% F_{MSY}	1000 lb	224.1	25.9	231.4
Y at 65% F_{MSY}	1000 lb	221.0	24.6	227.6
$F_{2009-2011}/F_{\mathrm{MSY}}$	—	2.37	2.15	3.34
$F_{2011}/F_{\mathrm{MSY}}$	—	1.30		
$\mathrm{SSB}_{2011}/\mathrm{MSST}$	—	0.909	0.378	0.801

[1]Correction to previous version of document

Table 3.13. Results from sensitivity runs of the Beaufort catch-age model. Current F represented by geometric mean of last three assessment years. Spawning stock was based on total biomass (mt) of mature females. See text for full description of sensitivity runs.

Run	Description	F_{MSY}	$\mathrm{SSB}_{\mathrm{MSY}}$ (mt)	B_{MSY} (mt)	MSY(1000 lb)	$F_{2009-2011}/F_{\mathrm{MSY}}$	$\mathrm{SSB}_{2011}/\mathrm{SSB}_{\mathrm{MSY}}$	$\mathrm{SSB}_{2011}/\mathrm{MSST}$	steep	R0(1000)
Base	—	0.302	247	679	227	2.37	0.91	0.82	0.84	128
S1	M=0.05	0.132	386	902	232	5.47	0.48	0.54	0.84	65
S2	M=0.15	0.739	181	622	247	0.89	1.31	1.45	0.84	228
S3	constant M=0.10	0.274	255	666	228	2.6	0.77	0.85	0.84	84
S4	h=0.7	0.208	310	814	225	3.29	0.68	0.75	0.7	142
S5	h=0.95	0.454	199	584	231	1.6	1	1.11	0.95	120
S6	alternative maturity	0.308	251	673	226	2.33	0.83	0.92	0.84	128
S7	Unweighted	0.328	253	696	232	2.23	1.06	1.17	0.84	123
S8	upweight indices	0.524	272	775	284	1.47	1.76	1.96	0.84	84
S9	q 0.02	0.306	248	683	228	2.37	0.83	0.93	0.84	128
S10	RW q	0.302	247	679	227	2.37	0.82	0.91	0.84	128
S11	Aging error matrix	0.425	252	694	231	6.34	0.66	0.73	0.84	120
S12	HL index only	0.3	246	678	226	2.38	0.81	0.9	0.84	128
S13	HB index only	0.3	237	654	218	3.75	0.52	0.57	0.84	126
S14	LL index only	0.3	237	654	218	3.71	0.53	0.58	0.84	126
S15	rec devs 1977	0.302	242	667	222	2.35	0.83	0.93	0.84	125
S16	rec devs 1982	0.302	239	659	220	2.33	0.82	0.91	0.84	121
S17	rec devs 1987	0.295	227	627	210	2.43	0.71	0.79	0.84	114
S18	rec devs 1992	0.284	219	607	204	2.46	0.58	0.64	0.84	112
S19	rec devs 1997	0.302	204	566	194	2.46	0.59	0.66	0.84	93
S20	rec devs 2002	0.33	164	462	166	2.21	0.73	0.82	0.84	57
S21	no rec devs	0.242	244	672	222	3.09	0.5	0.55	0.84	139
S22	rec dome selectivity	0.304	244	674	226	2.37	0.82	0.92	0.84	127

*Table 3.14. Projection results with fishing mortality rate fixed at $F = 0$ starting in 2013. F = fishing mortality rate (per year), Pr(*SSB > SSB$_{\mathrm{MSY}}$*) = proportion of stochastic projection replicates exceeding* SSB$_{\mathrm{MSY}}$*, SSB = spawning stock (mt) at peak spawning time, R = recruits (1000 age-1 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* $F_{\mathrm{MSY}} = 0.302$ *(per yr),* $\mathrm{SSB}_{\mathrm{MSY}} = 246.6$ *(mt), and* $\mathrm{MSY} = 226.5$ *(1000 lb). Expected values presented are from deterministic projections.*

Year	F(per yr)	Pr(SSB > SSB$_{\mathrm{MSY}}$)	SSB(mt)	R(1000)	D(1000)	D(1000 lb)	L(1000)	L(1000 lb)	Sum L(1000 lb)
2012	0.349	0.34	211.7	129	0	0	36	181	181
2013	0	0.59	236.7	121	0	0	0	0	181
2014	0	0.87	279.7	123	0	0	0	0	181
2015	0	0.97	321.6	126	0	0	0	0	181
2016	0	0.99	360	128	0	0	0	0	181

Table 3.15. Projection results with fishing mortality rate fixed at $F = F_{\text{rebuild}}$ starting in 2013. F = fishing mortality rate (per year), Pr(SSB > SSB_{MSY}) = proportion of stochastic projection replicates exceeding SSB_{MSY}, SSB = spawning stock (mt) at peak spawning time, R = recruits (1000 age-1 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 $F_{\text{MSY}} = 0.302$ (per yr), $\text{SSB}_{\text{MSY}} = 246.6$ (mt), and MSY = 226.5 (1000 lb). Expected values presented are from deterministic projections.

Year	F(per yr)	Pr(SSB > SSB_{MSY})	SSB(mt)	R(1000)	D(1000)	D(1000 lb)	L(1000)	L(1000 lb)	Sum L(1000 lb)
2012	0.349	0.34	211.7	129	0	0	36	181	181
2013	0.3	0.45	221.3	121	0	0	34	178	360
2014	0.3	0.51	229.2	122	0	0	36	193	552
2015	0.3	0.52	235.3	123	0	0	37	202	754
2016	0.3	0.52	238.5	123	0	0	37	209	963
2017	0.3	0.52	240.6	123	0	0	38	215	1178
2018	0.3	0.51	242	124	0	0	38	218	1396
2019	0.3	0.5	243.1	124	0	0	38	220	1616
2020	0.3	0.51	244	124	0	0	39	221	1837
2021	0.3	0.5	244.7	124	0	0	39	223	2060

*Table 3.16. Projection results with fishing mortality rate fixed at $F = F_{\mathrm{MSY}}$ starting in 2013. F = fishing mortality rate (per year), Pr(*SSB > $\mathrm{SSB}_{\mathrm{MSY}}$*) = proportion of stochastic projection replicates exceeding* $\mathrm{SSB}_{\mathrm{MSY}}$*, SSB = spawning stock (mt) at peak spawning time, R = recruits (1000 age-1 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} =* 0.302 *(per yr),* $\mathrm{SSB}_{\mathrm{MSY}}$ = 246.6 *(mt), and* MSY = 226.5 *(1000 lb). Expected values presented are from deterministic projections.*

Year	F(per yr)	Pr(SSB > $\mathrm{SSB}_{\mathrm{MSY}}$)	SSB(mt)	R(1000)	D(1000)	D(1000 lb)	L(1000)	L(1000 lb)	Sum L(1000 lb)
2012	0.349	0.34	211.7	129	0	0	36	181	181
2013	0.302	0.44	221.2	121	0	0	34	179	360
2014	0.302	0.51	229	122	0	0	36	193	554
2015	0.302	0.52	234.9	123	0	0	37	203	756
2016	0.302	0.52	238.1	123	0	0	38	209	966

Table 3.17. Projection results with fishing mortality rate fixed at $F = F_{\text{current}}$ starting in 2013. F = fishing mortality rate (per year), Pr($\text{SSB} > \text{SSB}_{\text{MSY}}$*) = proportion of stochastic projection replicates exceeding* SSB_{MSY}*, SSB = spawning stock (mt) at peak spawning time, R = recruits (1000 age-1 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* $F_{\text{MSY}} = 0.302$ *(per yr),* $\text{SSB}_{\text{MSY}} = 246.6$ *(mt), and* MSY = 226.5 *(1000 lb). Expected values presented are from deterministic projections.*

Year	F(per yr)	Pr(SSB > SSB_{MSY})	SSB(mt)	R(1000)	D(1000)	D(1000 lb)	L(1000)	L(1000 lb)	Sum L(1000 lb)
2012	0.349	0.34	211.7	129	0	0	36	181	181
2013	0.715	0.29	202.4	121	0	0	71	368	550
2014	0.715	0.15	180.8	120	0	0	61	311	861
2015	0.715	0.08	169.2	118	0	0	54	274	1134
2016	0.715	0.05	161.9	117	0	0	51	253	1387

Table 3.18. Input for Surplus–production model runs. Total removals in metric tons. The indices are in units of pounds per angler hour.

Year	Removals	Headboat	Handline	Longline
1974	26.2			
1975	32.4			
1976	37.2			
1977	18.5			
1978	43.4			
1979	28.4			
1980	65.3	2.0		
1981	186.6	1.8		
1982	543.4	1.2		
1983	306.1	1.5		
1984	236.0	0.7		
1985	179.1	0.7		
1986	104.8	0.7		
1987	72.2	0.9		
1988	49.2	0.7		
1989	51.7	0.7		
1990	79.9	0.3		
1991	88.9	0.6		
1992	128.8	1.2		
1993	97.0		1.1	2.3
1994	85.5		0.7	1.0
1995	89.6		0.6	1.0
1996	75.5		0.9	0.7
1997	135.3		1.0	1.5
1998	49.0		1.2	1.0
1999	56.2		0.8	0.7
2000	50.2		1.0	0.5
2001	68.4		0.9	0.8
2002	122.2		0.8	1.0
2003	69.6		0.7	0.9
2004	38.3		0.9	0.6
2005	61.5		1.1	
2006	191.2		1.5	
2007	312.8		1.2	
2008	334.4		1.4	
2009	275.8		1.0	
2010	233.8		1.2	
2011	85.2			

3.7 Figures

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

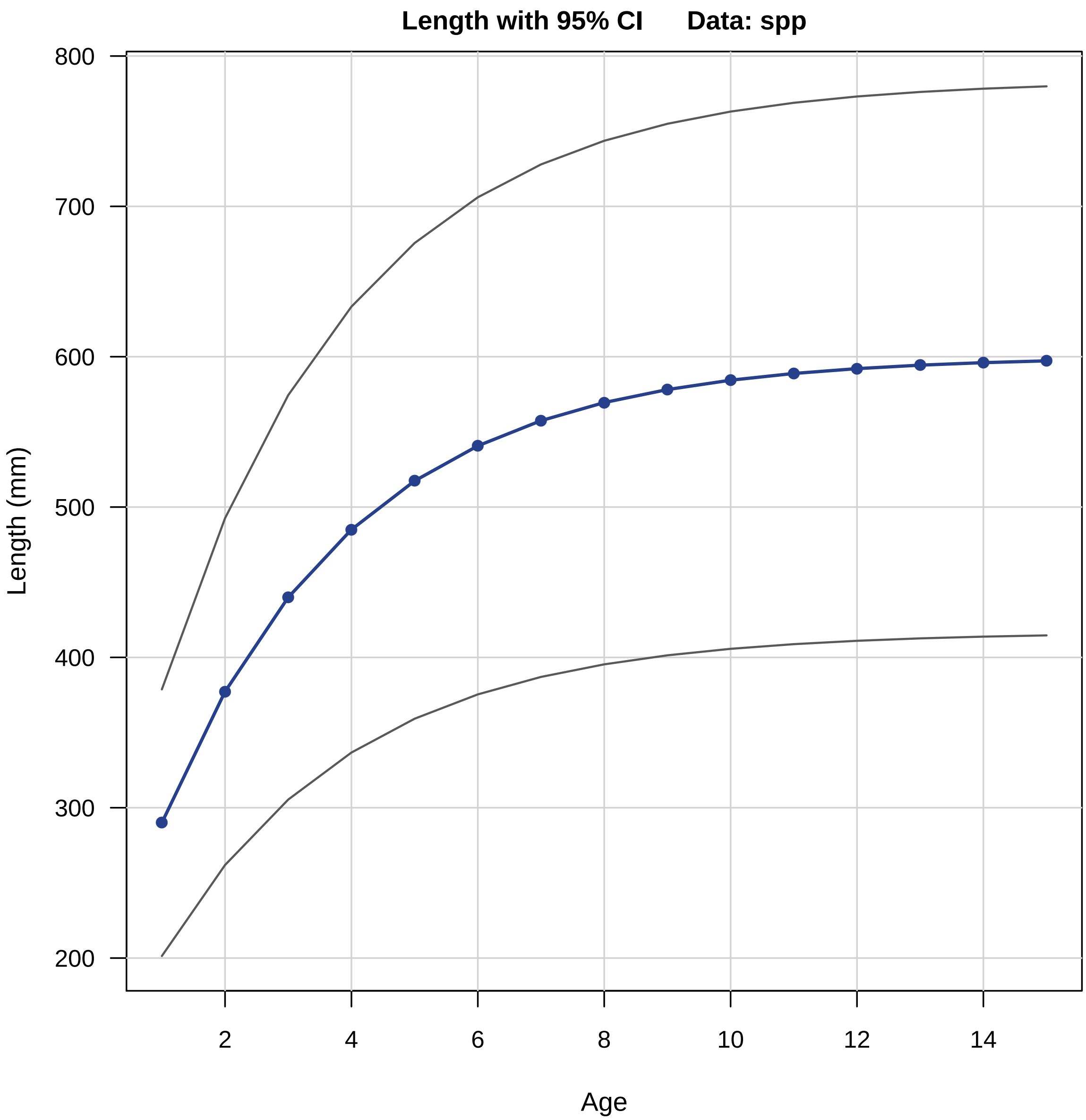


Figure 3.2. Observed (open circles) and estimated (solid line) annual age compositions by fleet or survey. In panels indicating the data set, acomp to age compositions, mrip to pooled recreational landings and discards, cHL to pooled commercial handline landings and discards, and CLL to commercial longline landings. N indicates the number of trips from which individual fish samples were taken.

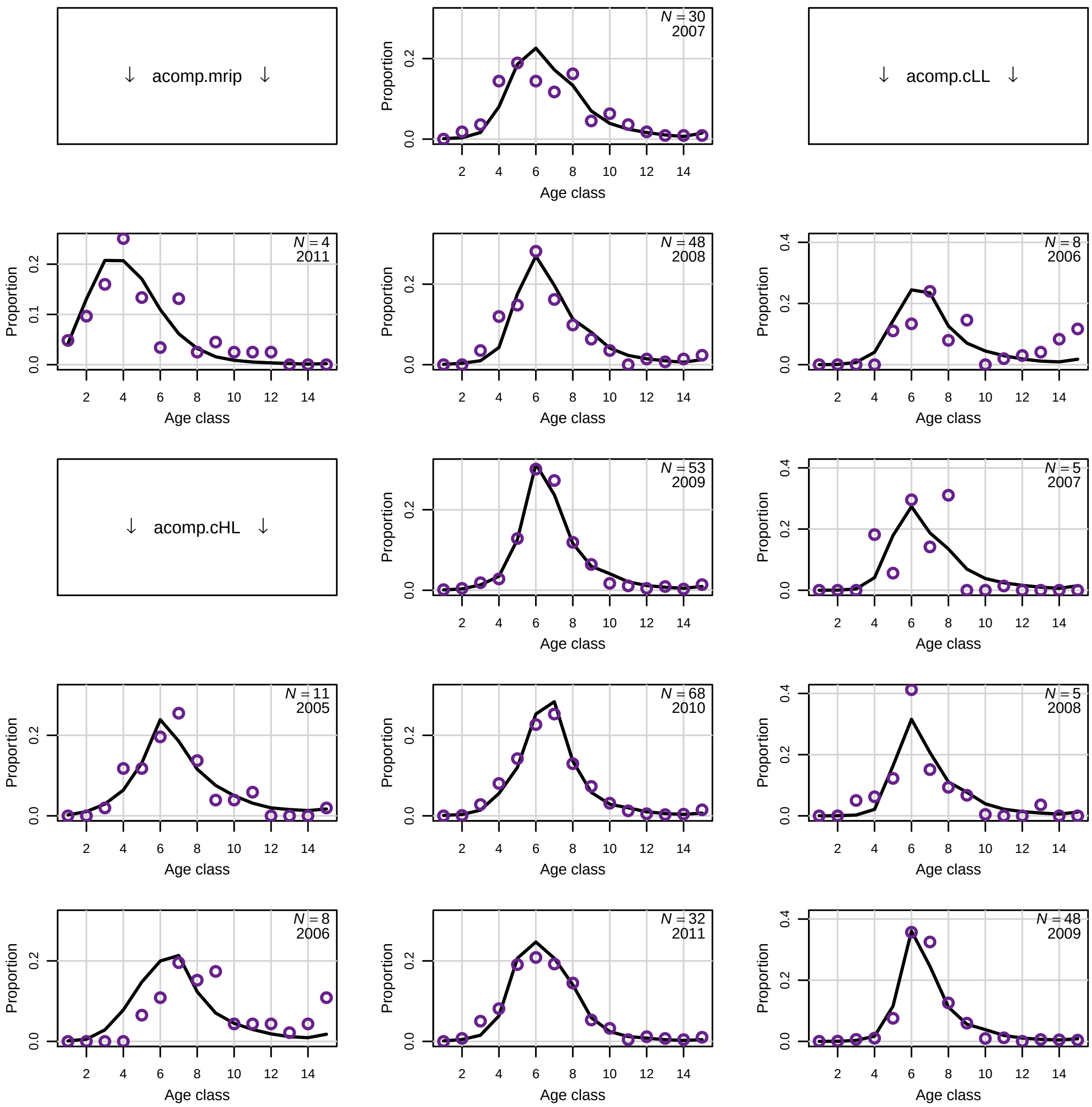


Figure 3.2. (cont.) Observed (open circles) and estimated (solid line) annual age compositions by fleet or survey.

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

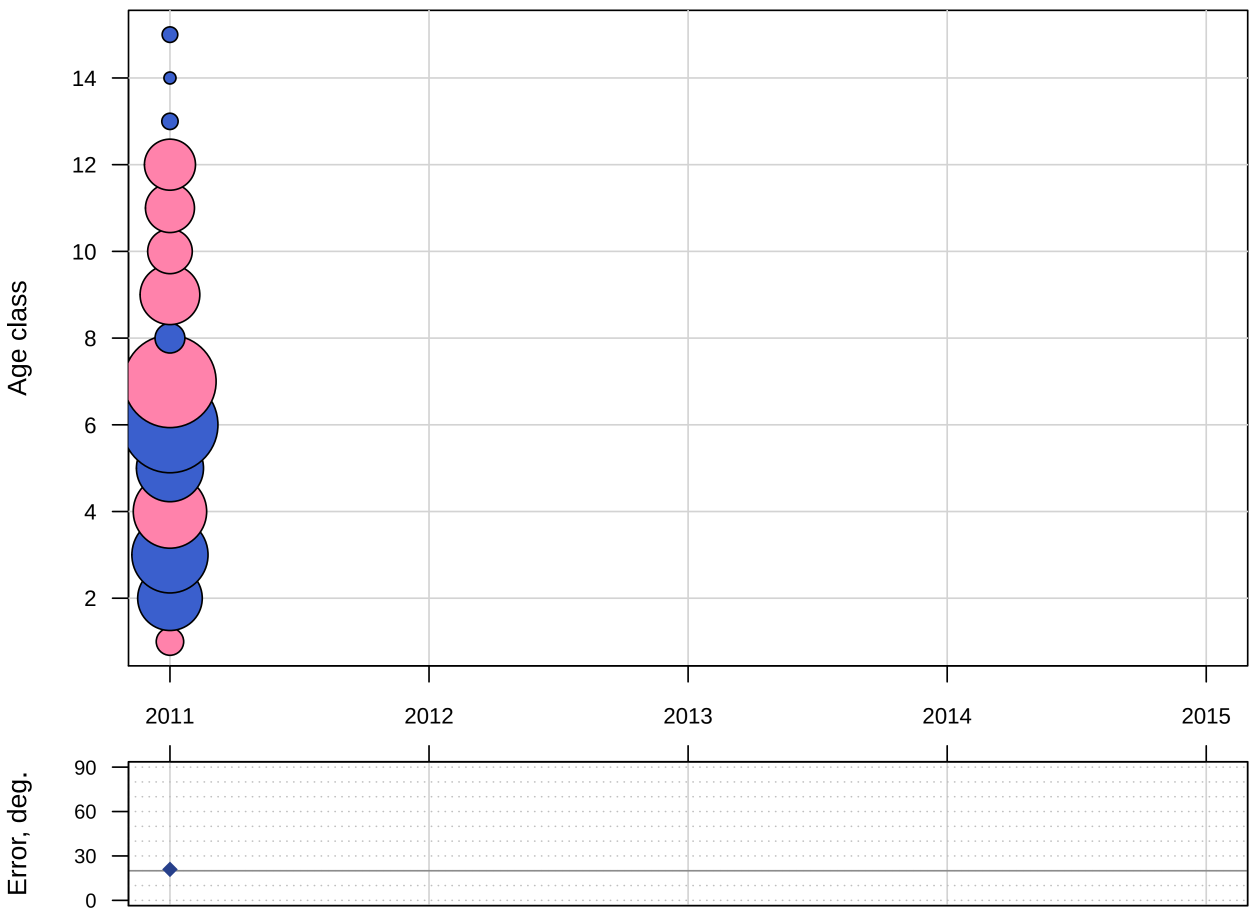


Figure 3.4. Top panel is a bubble plot of age composition residuals from the commercial handline fishery. Dark represents overestimates and light indicates underestimates. Bottom panel shows the angle (in degrees) between vectors of observations and estimates, with a reference line at 20 degrees. Error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

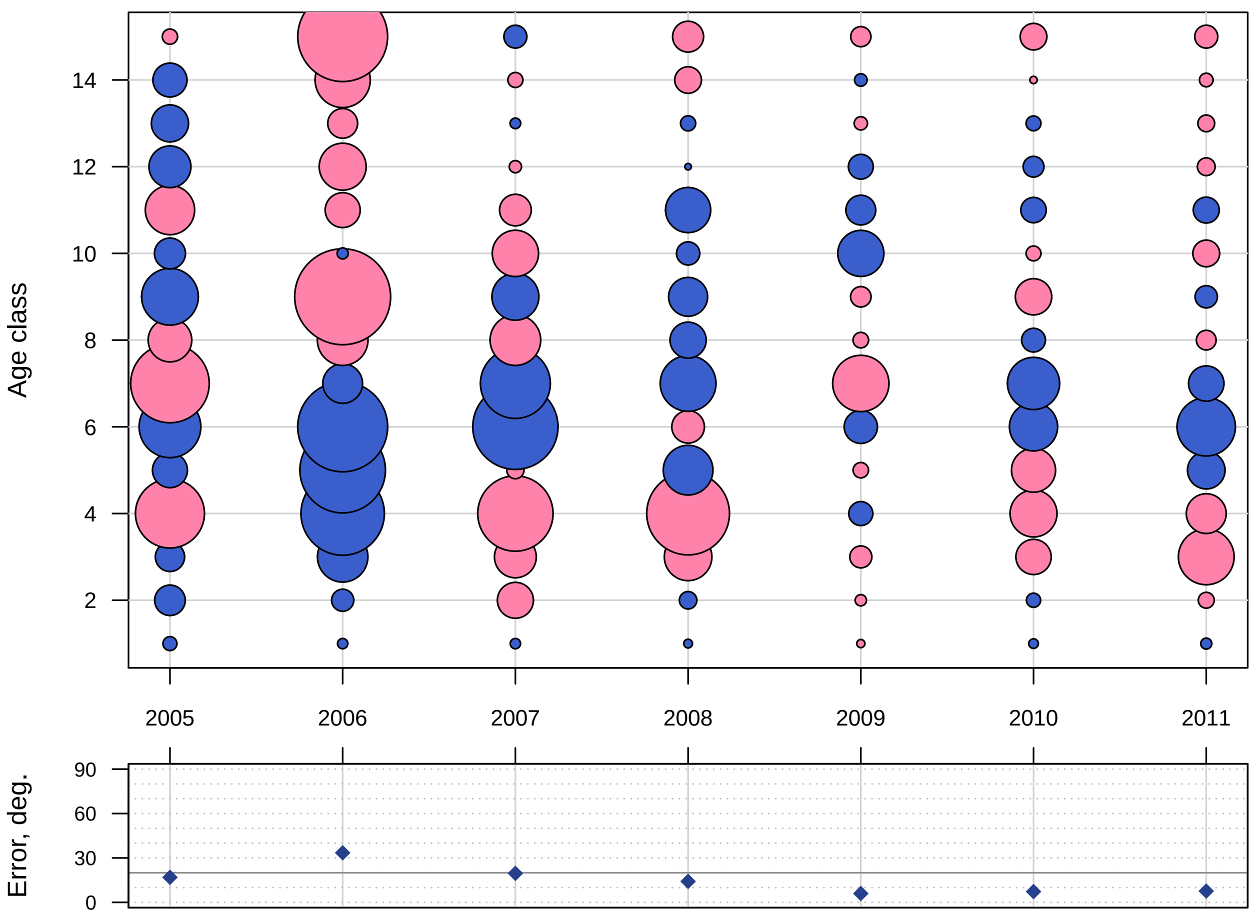


Figure 3.5. Top panel is a bubble plot of age composition residuals from the commercial longline fishery. Dark represents overestimates and light indicates underestimates. Bottom panel shows the angle (in degrees) between vectors of observations and estimates, with a reference line at 20 degrees. Error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

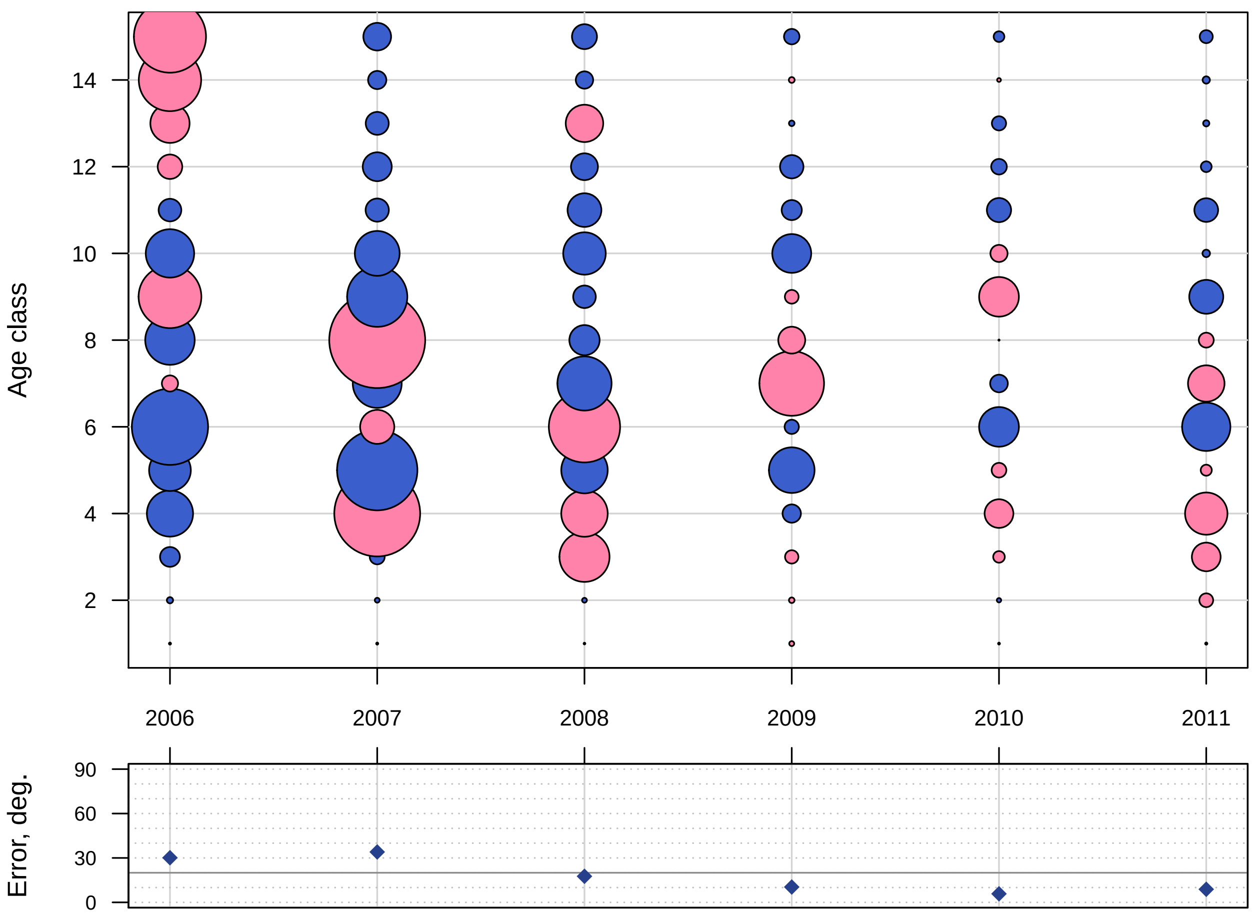


Figure 3.6. Observed (open circles) and estimated (line, solid circles) combined commercial handline landings and discards (1000 lb whole weight).

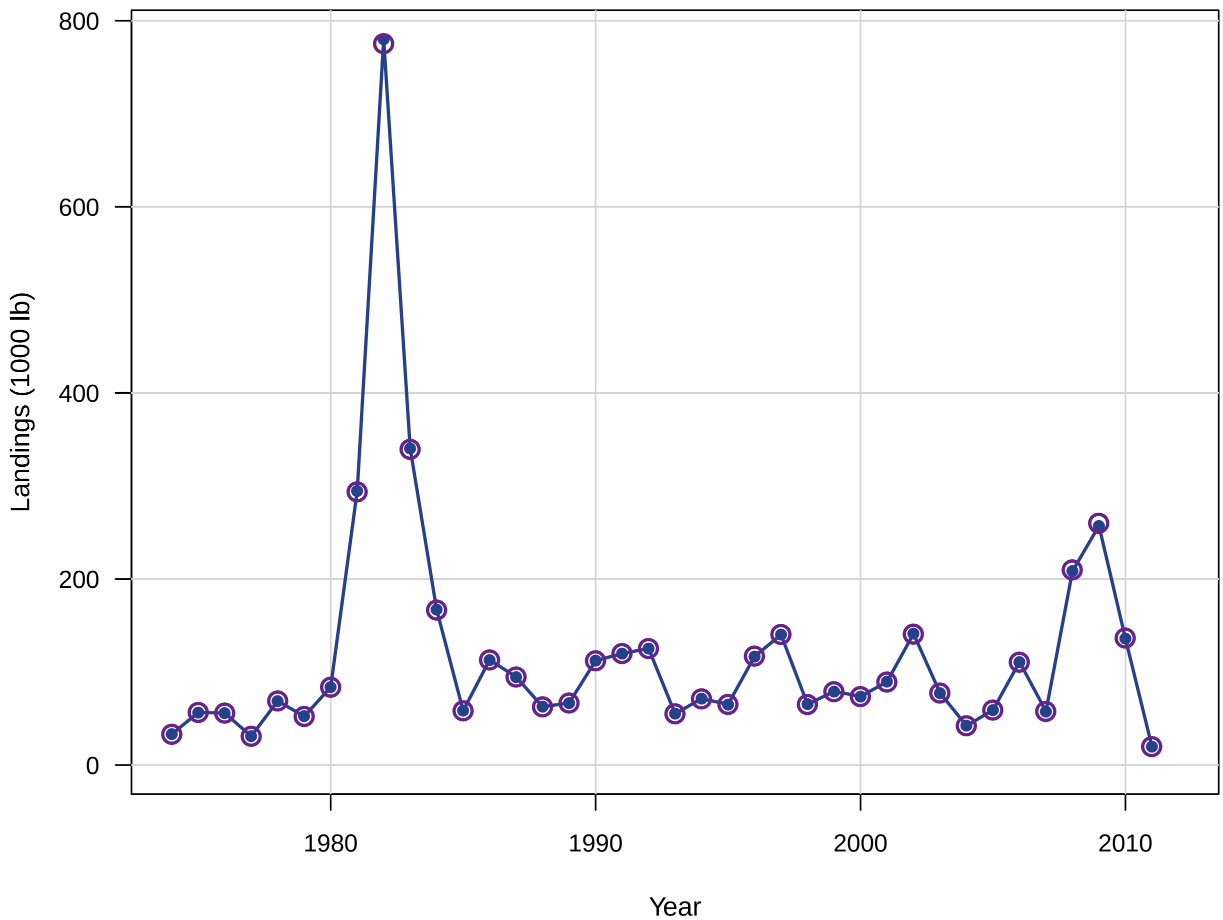


Figure 3.7. Observed (open circles) and estimated (line, solid circles) commercial longline landings (1000 lb whole weight).

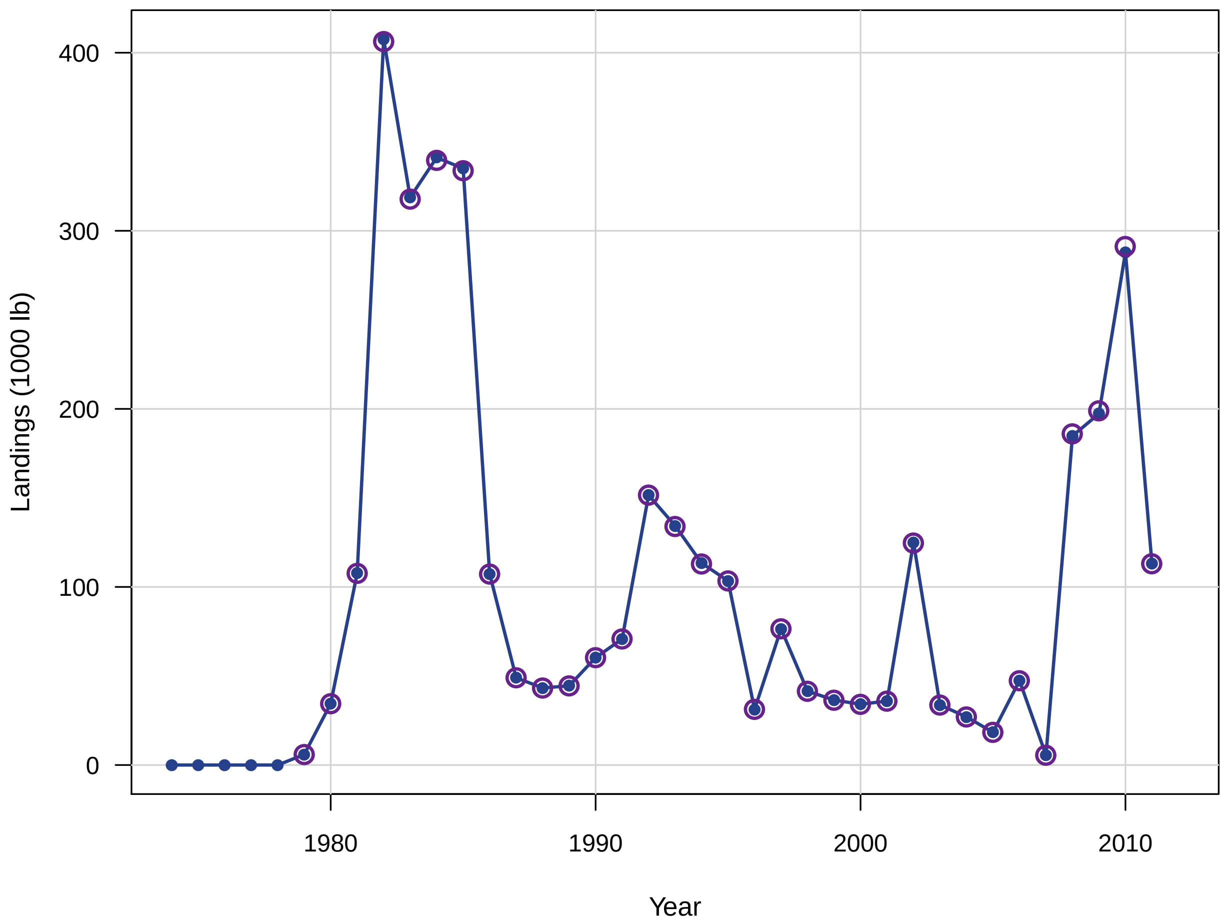


Figure 3.8. Observed (open circles) and estimated (line, solid circles) combined recreational landings and discards (1000 fish).

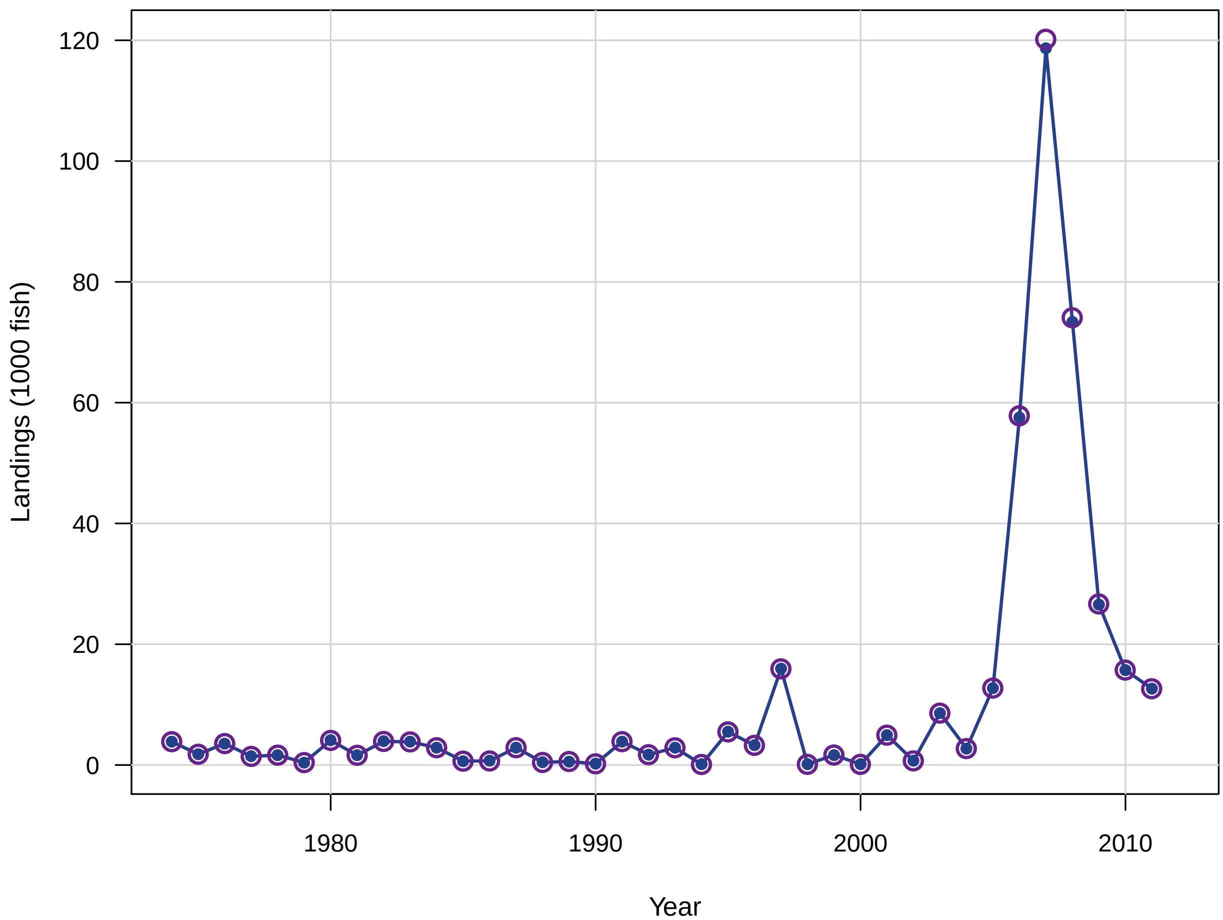


Figure 3.9. Observed (open circles) and estimated (line, solid circles) index of abundance- headboat.

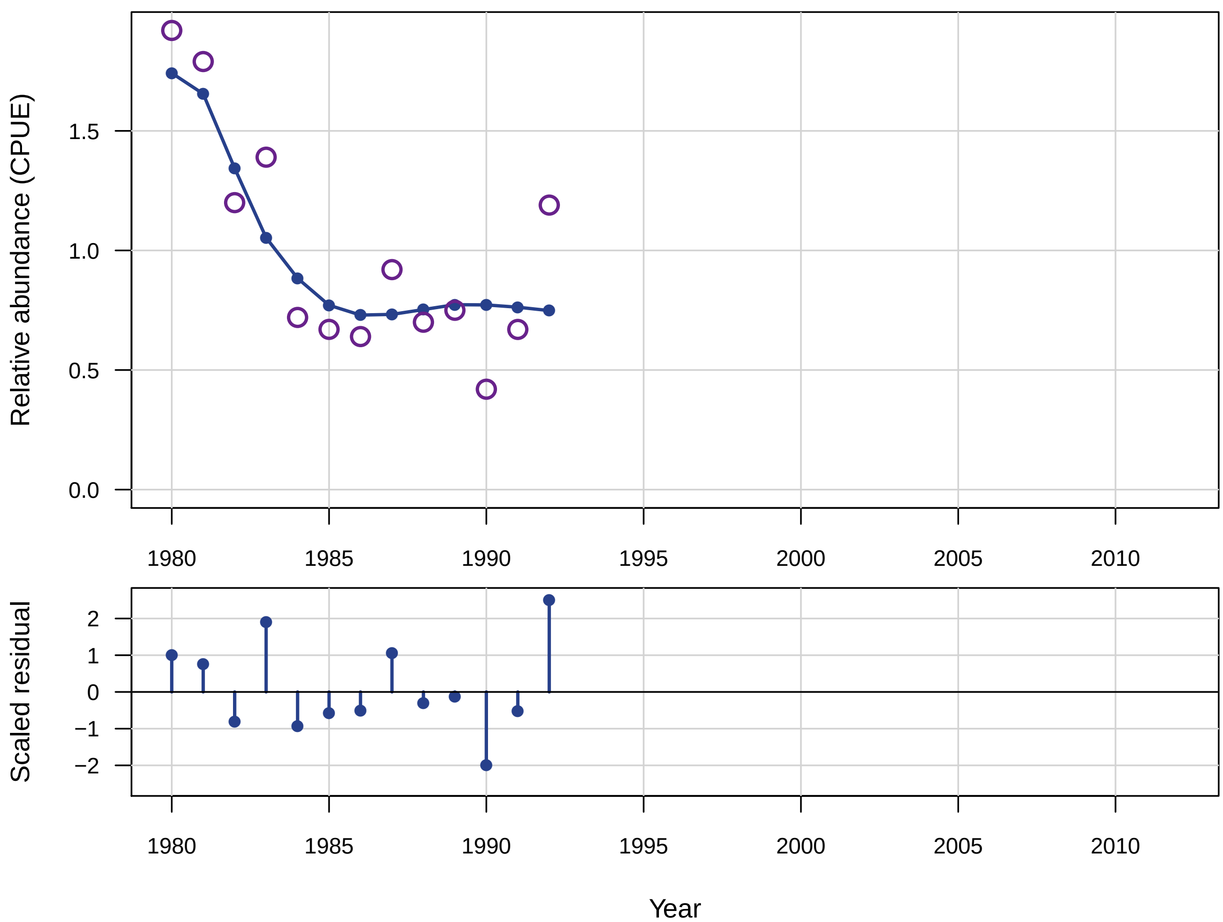


Figure 3.10. Observed (open circles) and estimated (line, solid circles) index of abundance- Commercial longline.

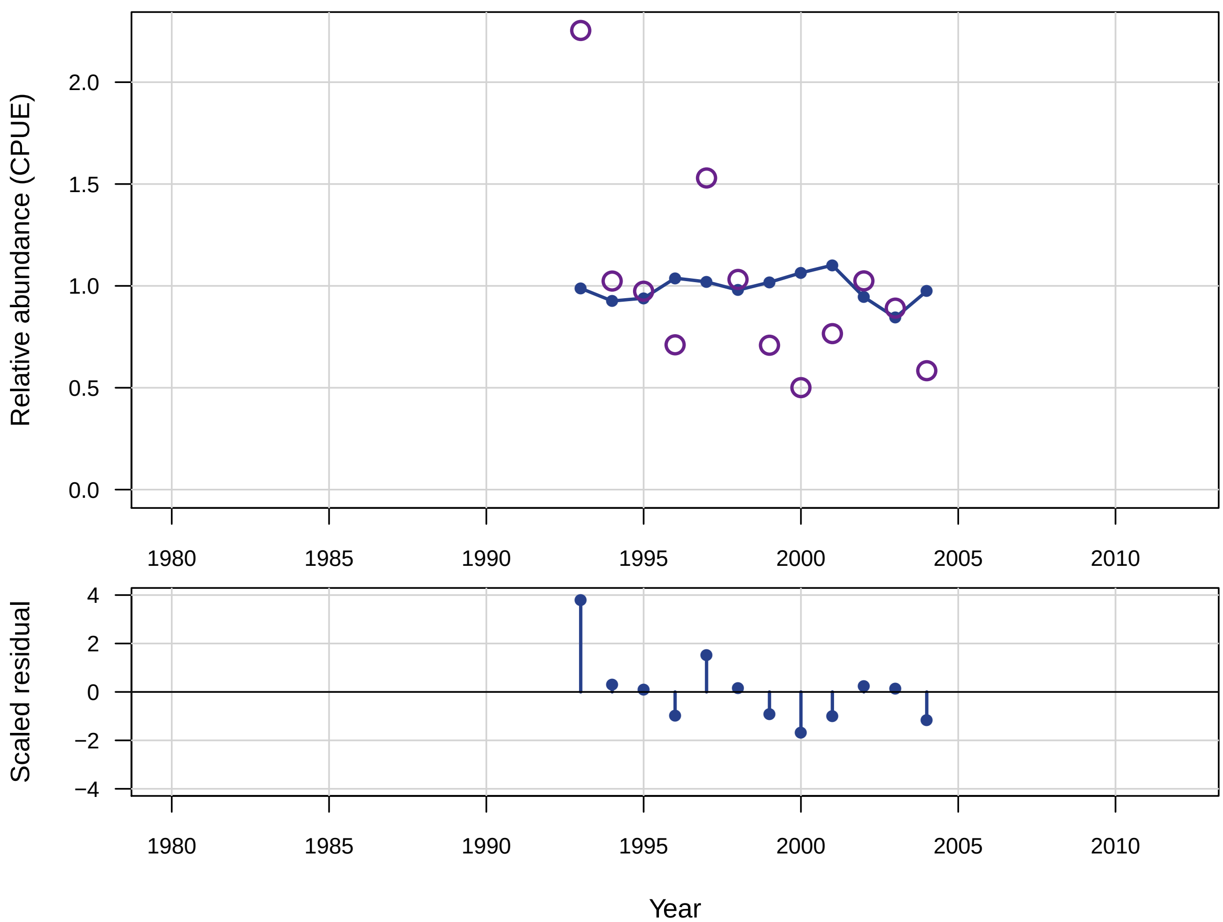


Figure 3.11. Observed (open circles) and estimated (line, solid circles) index of abundance- Commercial handline.

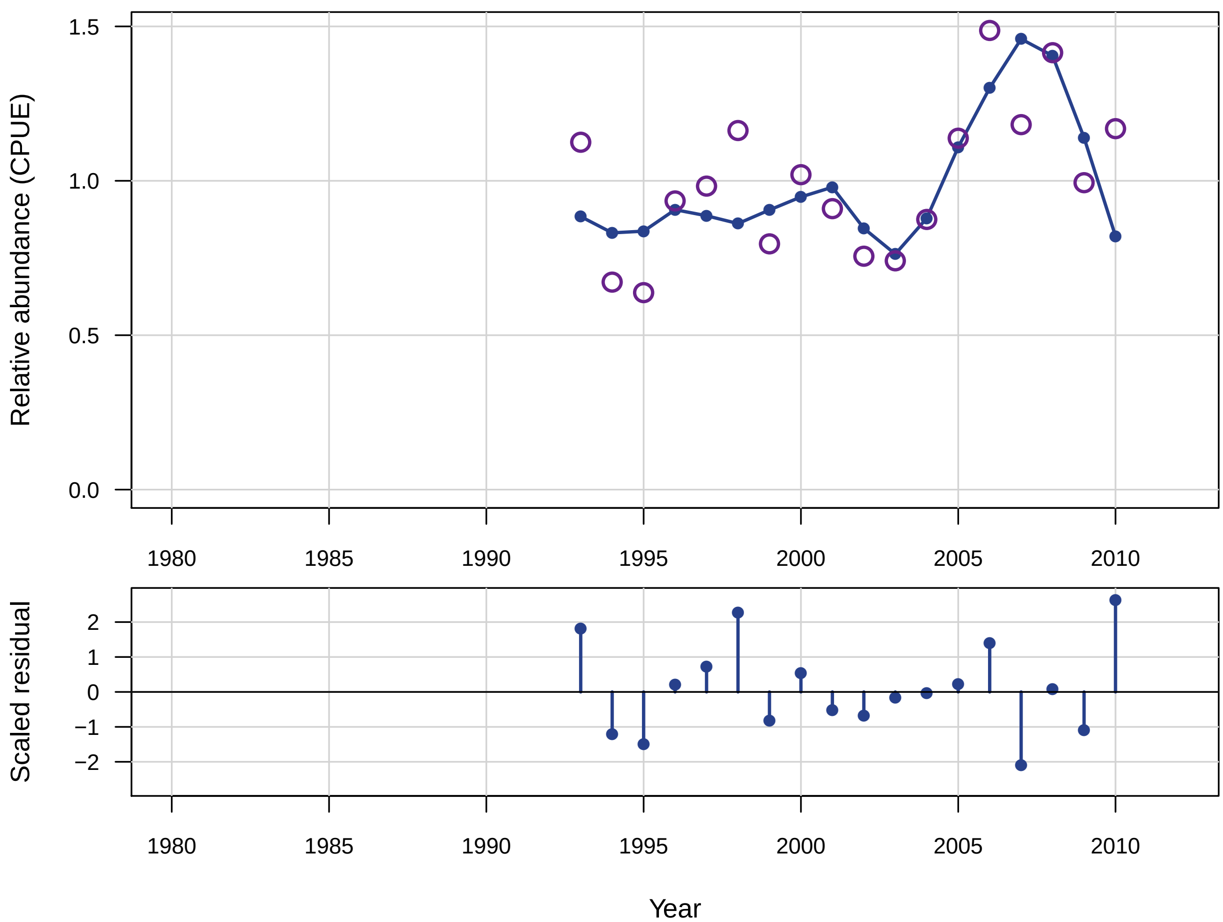


Figure 3.12. Estimated abundance at age at start of year.

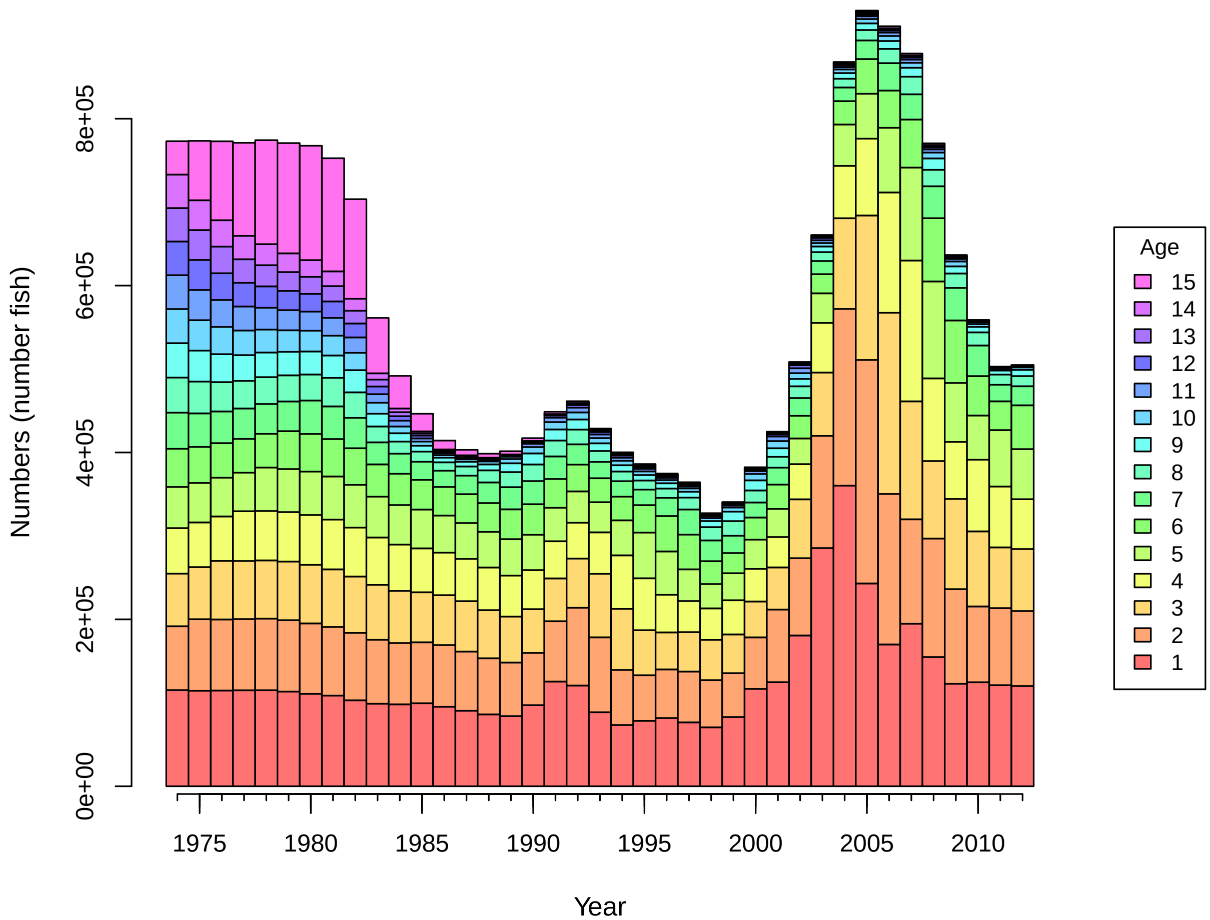


Figure 3.13. Top panel: Estimated recruitment of age-1 fish. Horizontal dashed line indicates R_{MSY}. Bottom panel: log recruitment residuals.

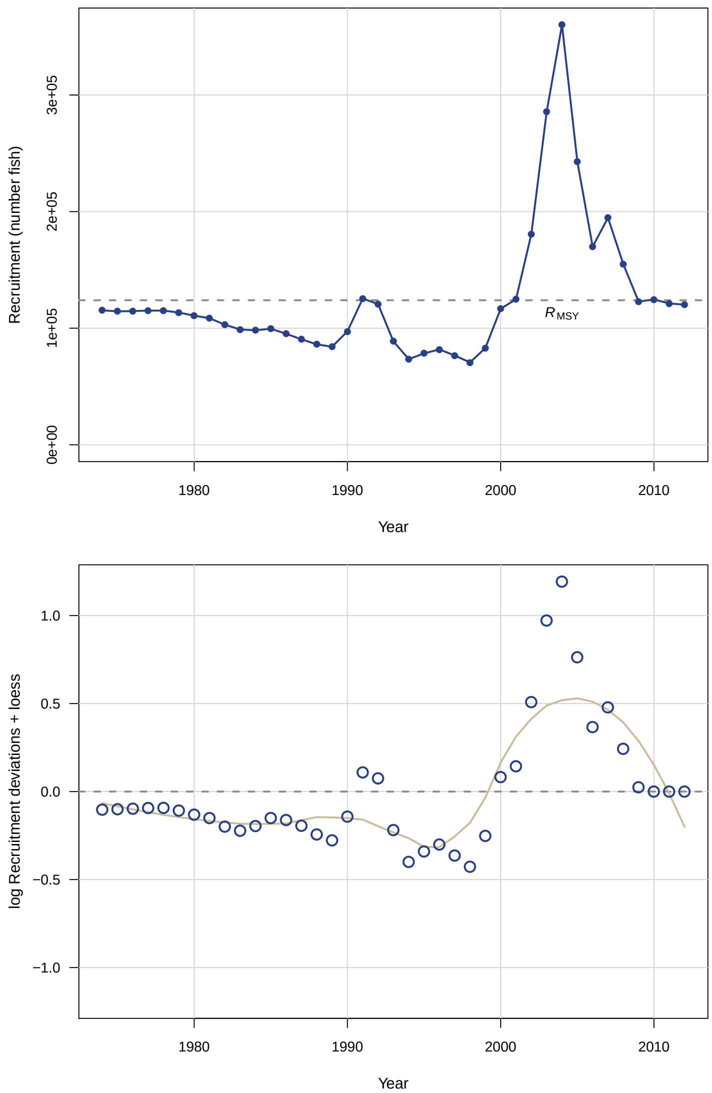


Figure 3.14. Estimated biomass at age at start of year.

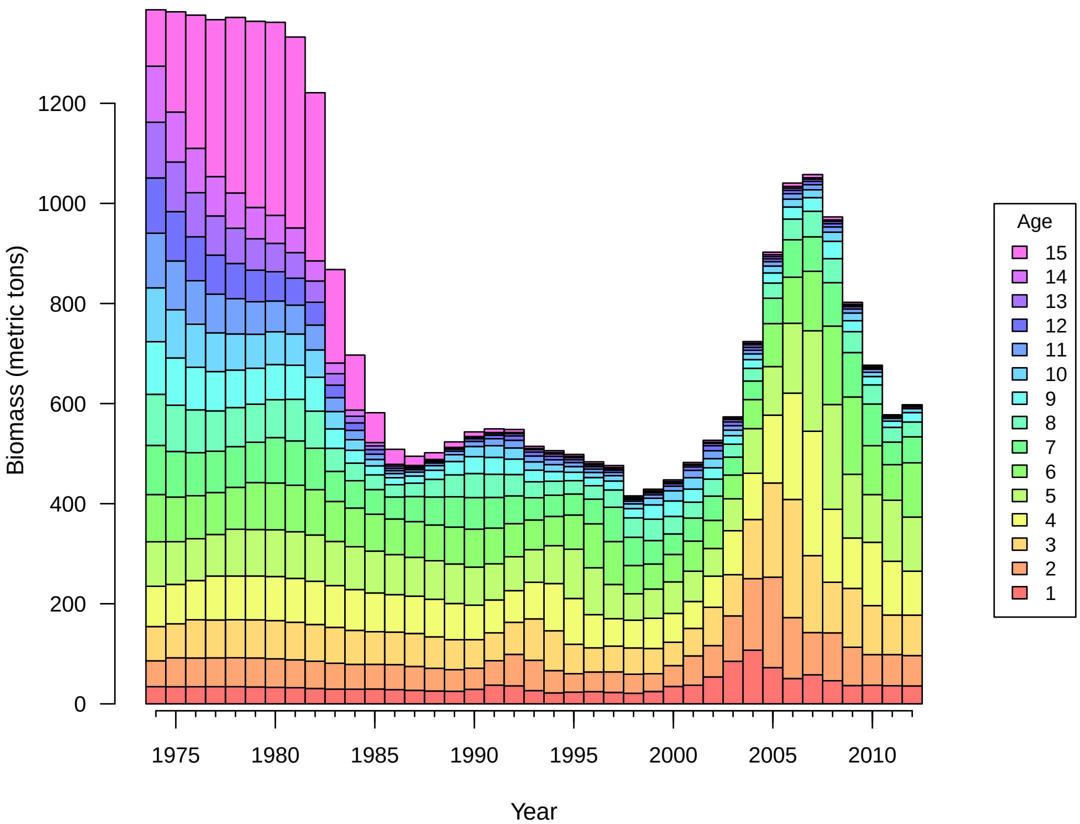


Figure 3.15. Top panel: Estimated total biomass (metric tons) at start of year. Horizontal dashed line indicates B_{MSY}*. Bottom panel: Estimated spawning stock (mature female biomass) at time of peak spawning.*

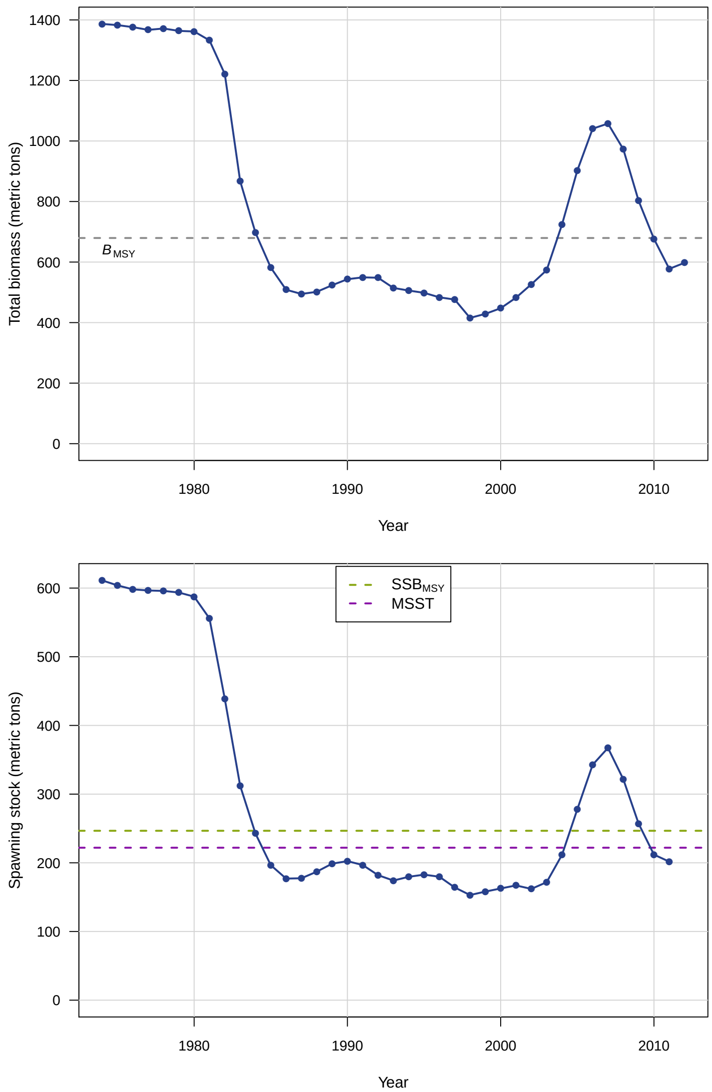


Figure 3.16. Selectivities of fleets 1974–2011. Top panel: recreational including landings and discards. Second panel: commercial handline including landings and discards. Third panel: commercial longline.

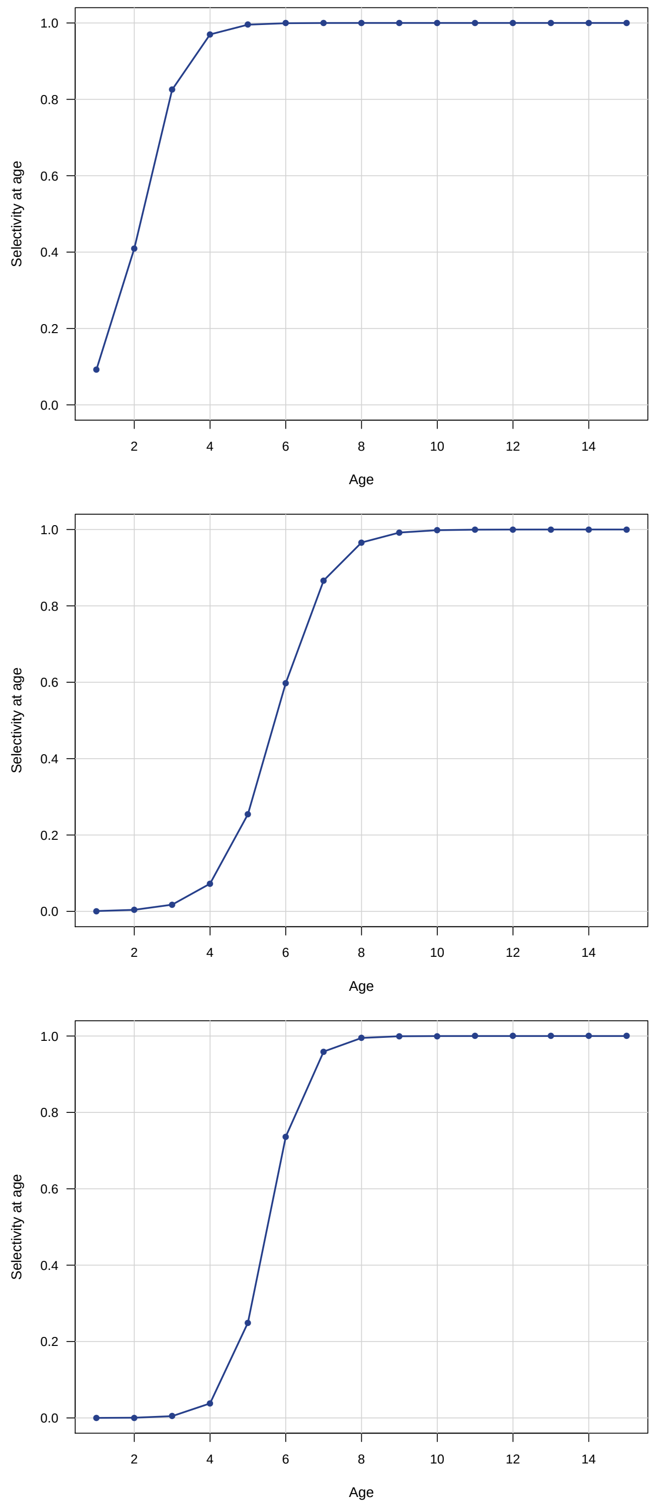


Figure 3.17. Average selectivity from the terminal assessment year weighted by geometric mean Fs from the last three assessment years, and used in computation of benchmarks and central-tendency projections.

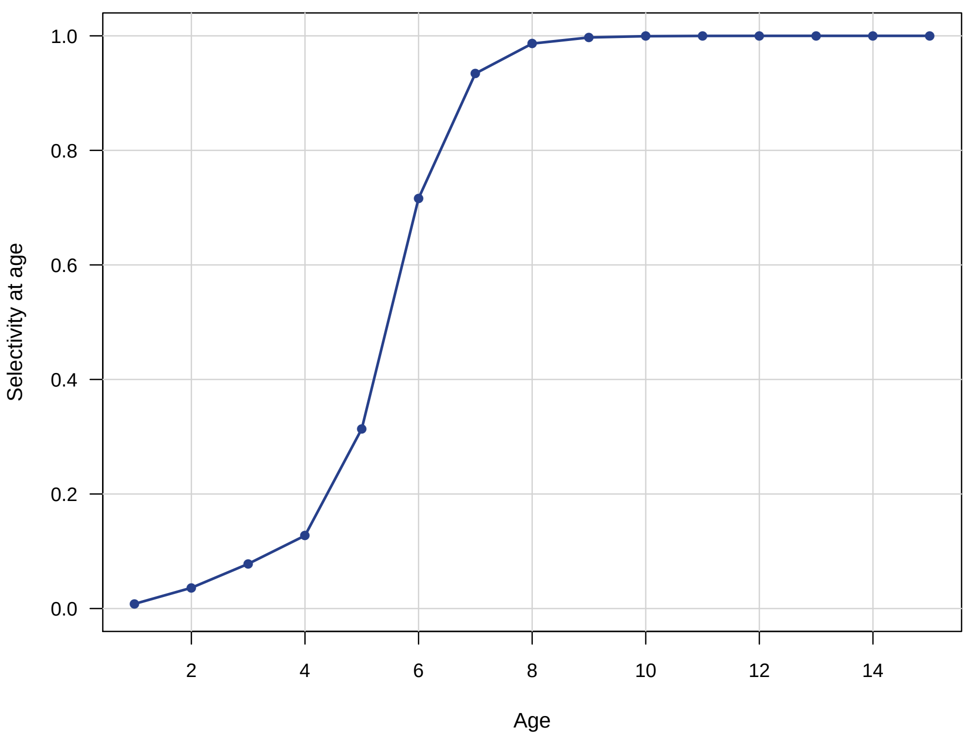


Figure 3.18. Estimated fully selected fishing mortality rate (per year) by fishery. cHL refers to commercial handline, cLL to commercial longline, and mrip to recreational; discards included.

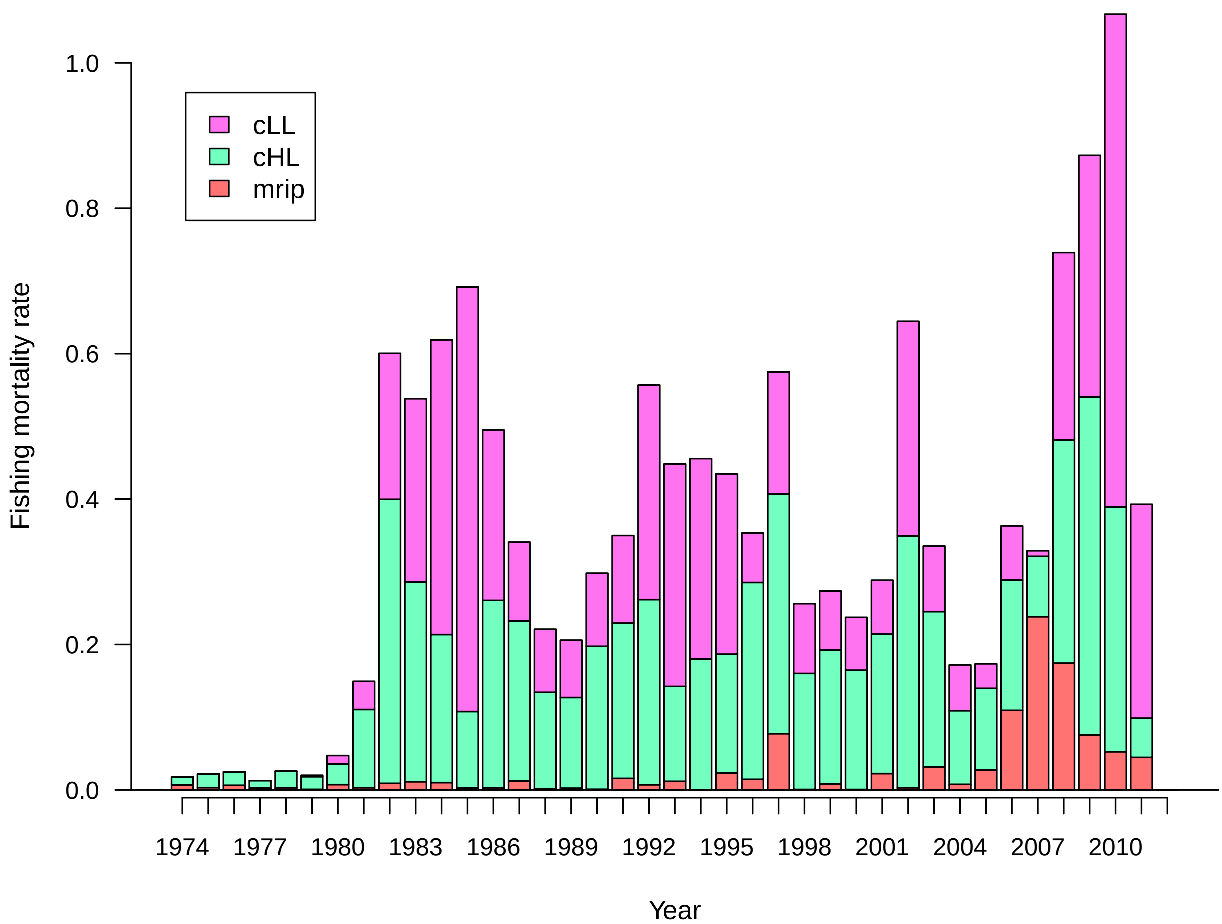


Figure 3.19. Estimated removals in numbers by fishery from the catch-age model. cLL refers to commercial longline, cHL to commercial handline, and mrip is the recreational fleet.

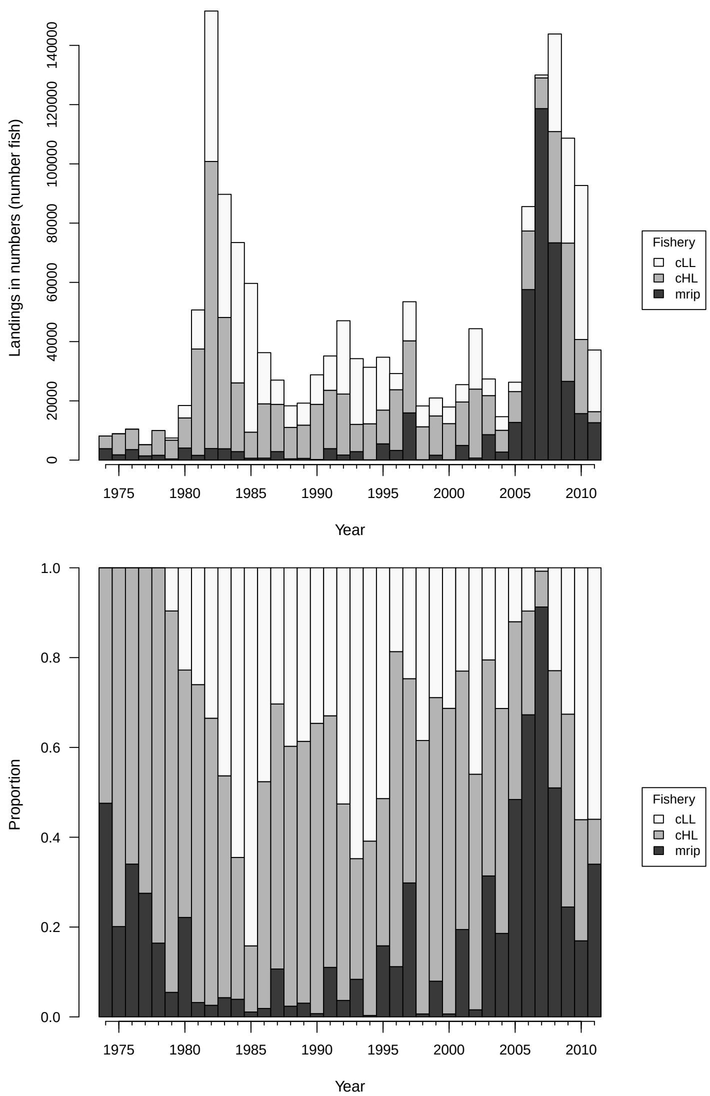


Figure 3.20. Estimated removals in whole weight by fishery from the catch-age model. cHL refers to commercial handline, cLL to commercial longline, and mrip is the recreational fleet.

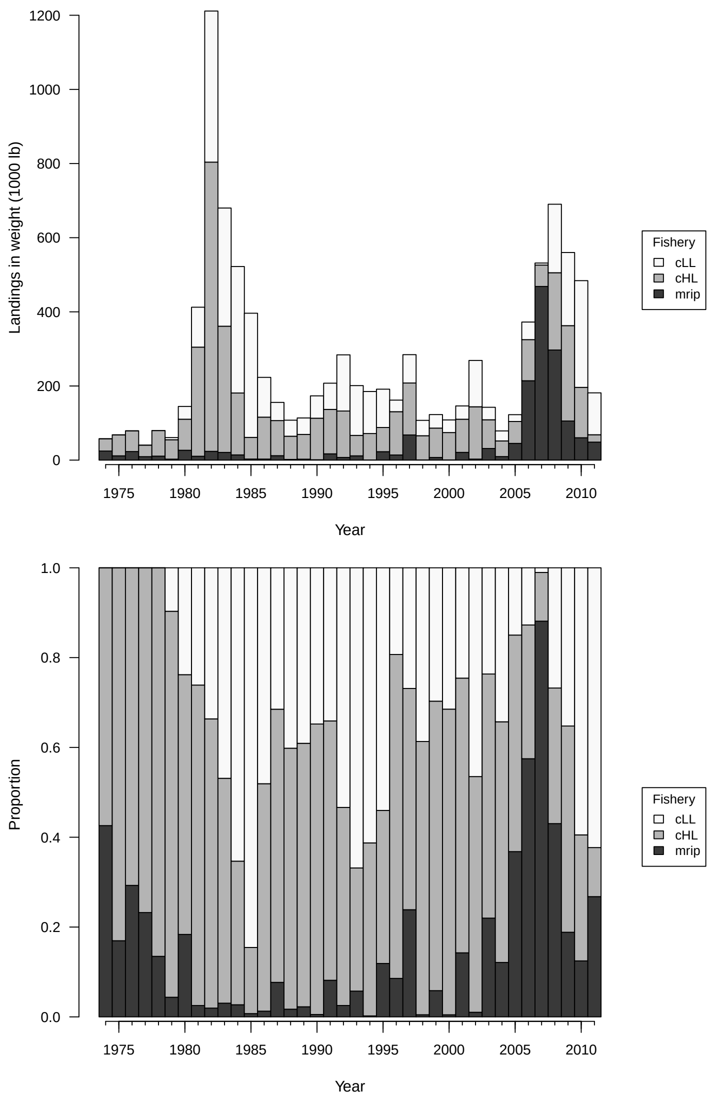


Figure 3.21. Top panel: Beverton–Holt spawner-recruit curves, with and without lognormal bias correction. The expected (upper) curve was used for computing management benchmarks. Years within panel indicate year of recruitment generated from spawning biomass one year prior. Bottom panel: log of recruits (number age-1 fish) per spawner (biomass of mature females) as a function of spawners.

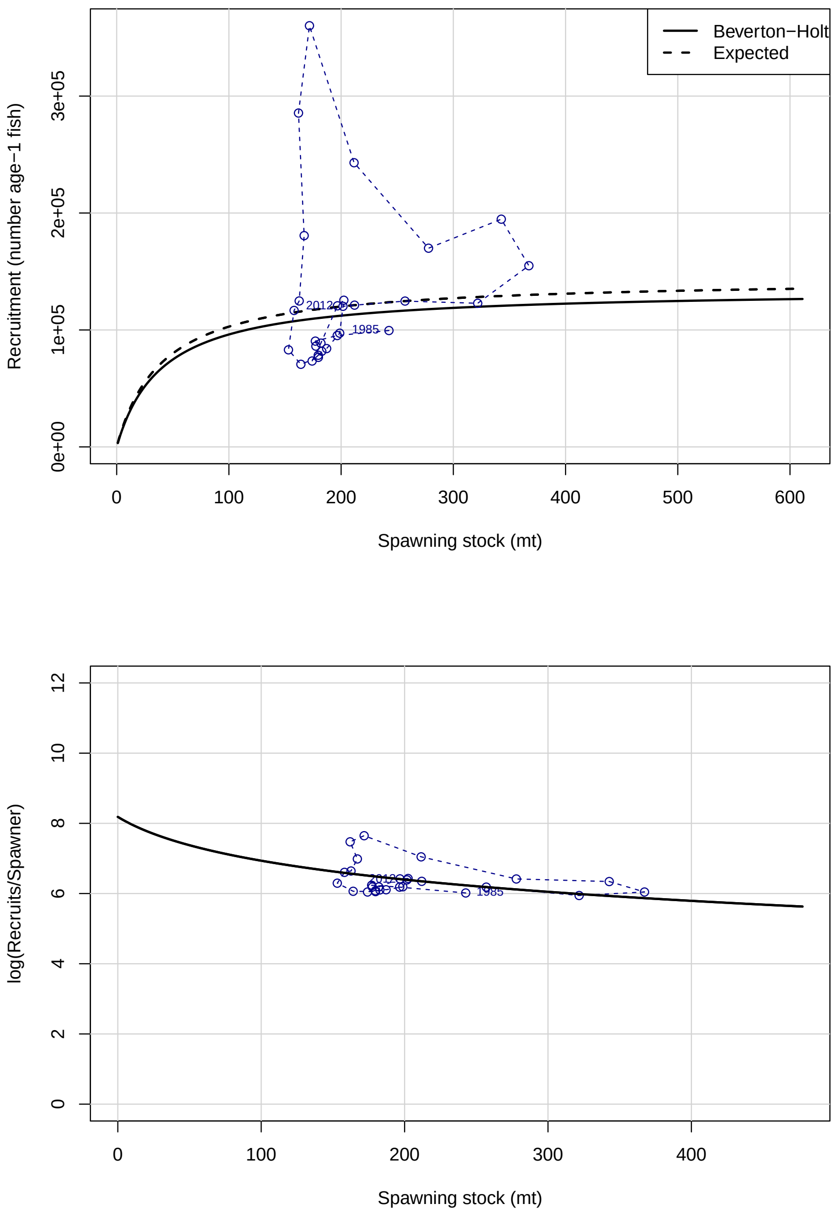


Figure 3.22. Probability densities of spawner-recruit quantities R0 (unfished recruitment of age-1 fish), steepness, unfished spawners per recruit, and standard deviation of recruitment residuals in log space. Vertical lines represent point estimates or values from the base run of the Beaufort Assessment Model.

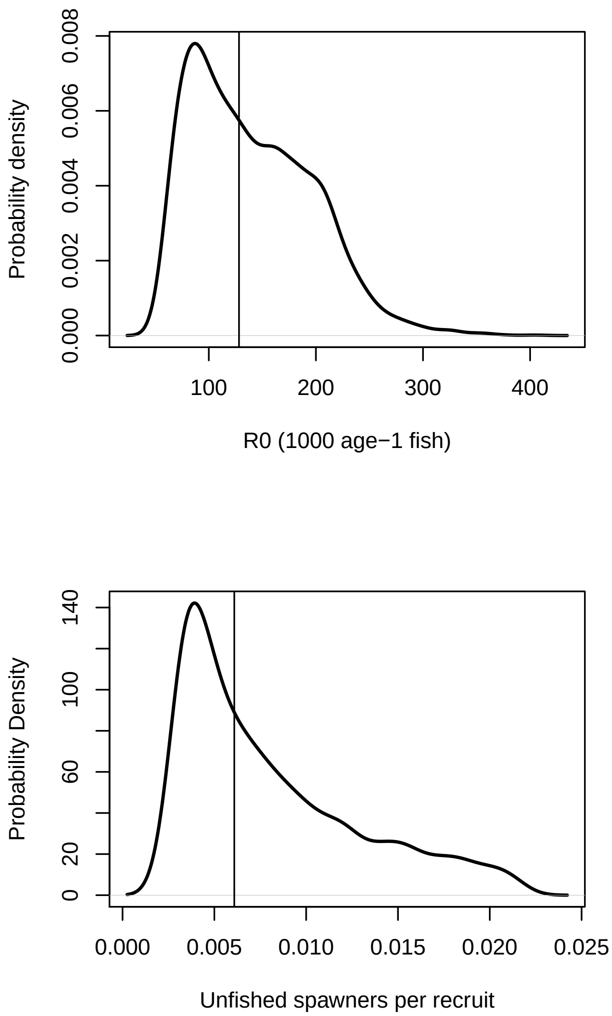


Figure 3.23. Estimated time series of static spawning potential ratio, the annual equilibrium spawners per recruit relative to that at the unfished level. Horizontal dashed line indicates the equilibrium MSY level.

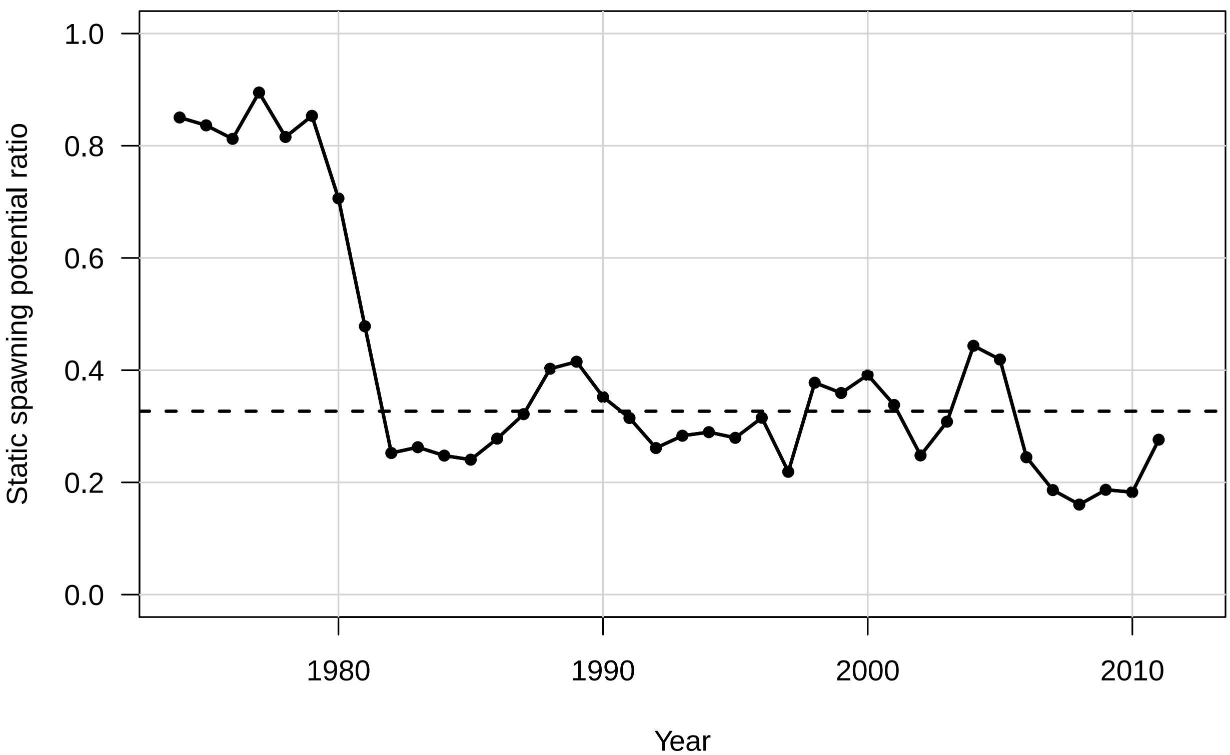


Figure 3.24. Top panel: yield per recruit. Bottom panel: spawning potential ratio (spawning biomass per recruit relative to that at the unfished level), from which the x% levels provide $F_{x\%}$. Both curves are based on average selectivity from the end of the assessment period.

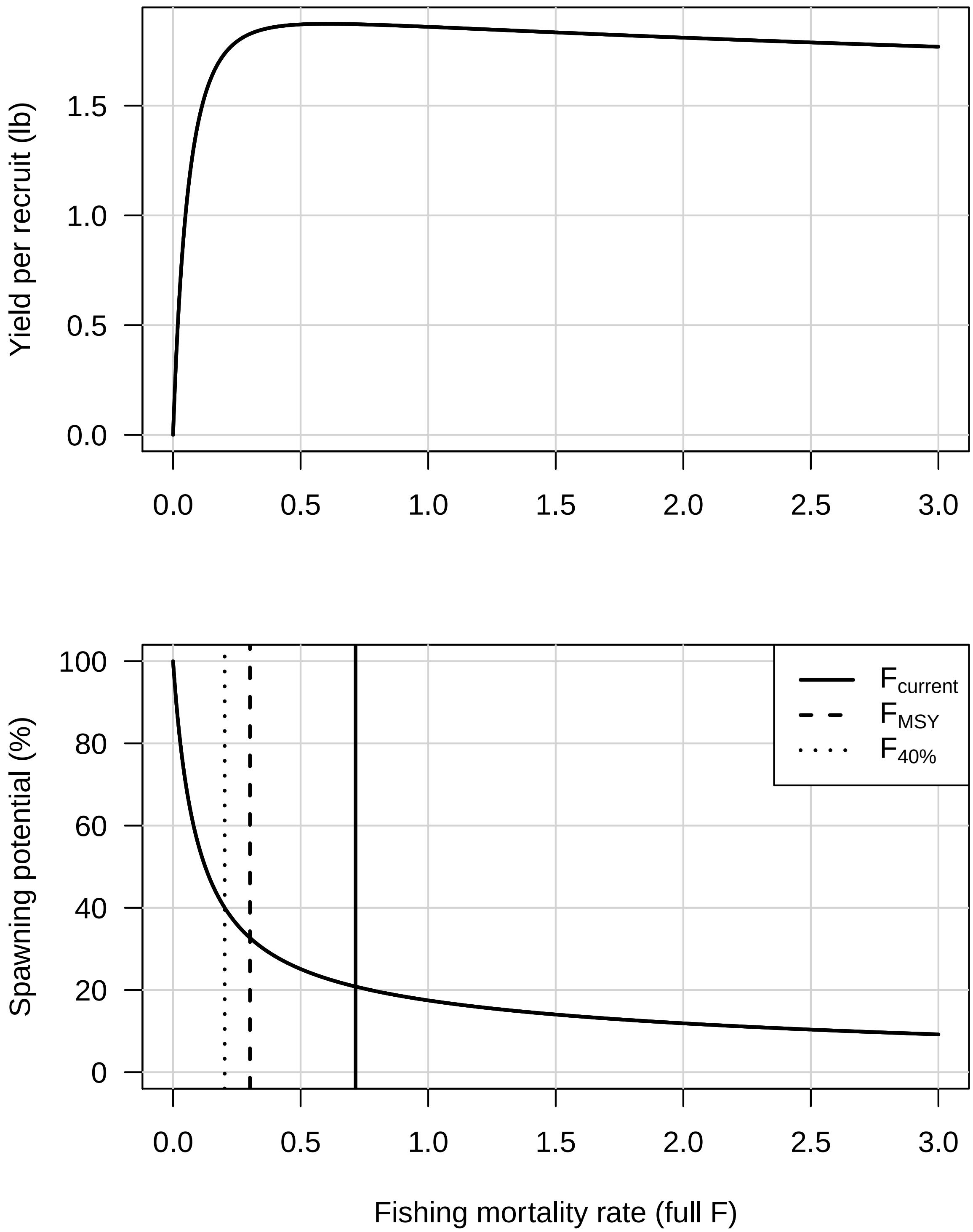


Figure 3.25. Top panel: equilibrium landings. The peak occurs where fishing rate is $F_{\mathrm{MSY}} = 0.302$ *and equilibrium landings are* $\mathrm{MSY} = 226.5$ *(1000 lb). Bottom panel: equilibrium spawning biomass. Both curves are based on average selectivity from the end of the assessment period.*

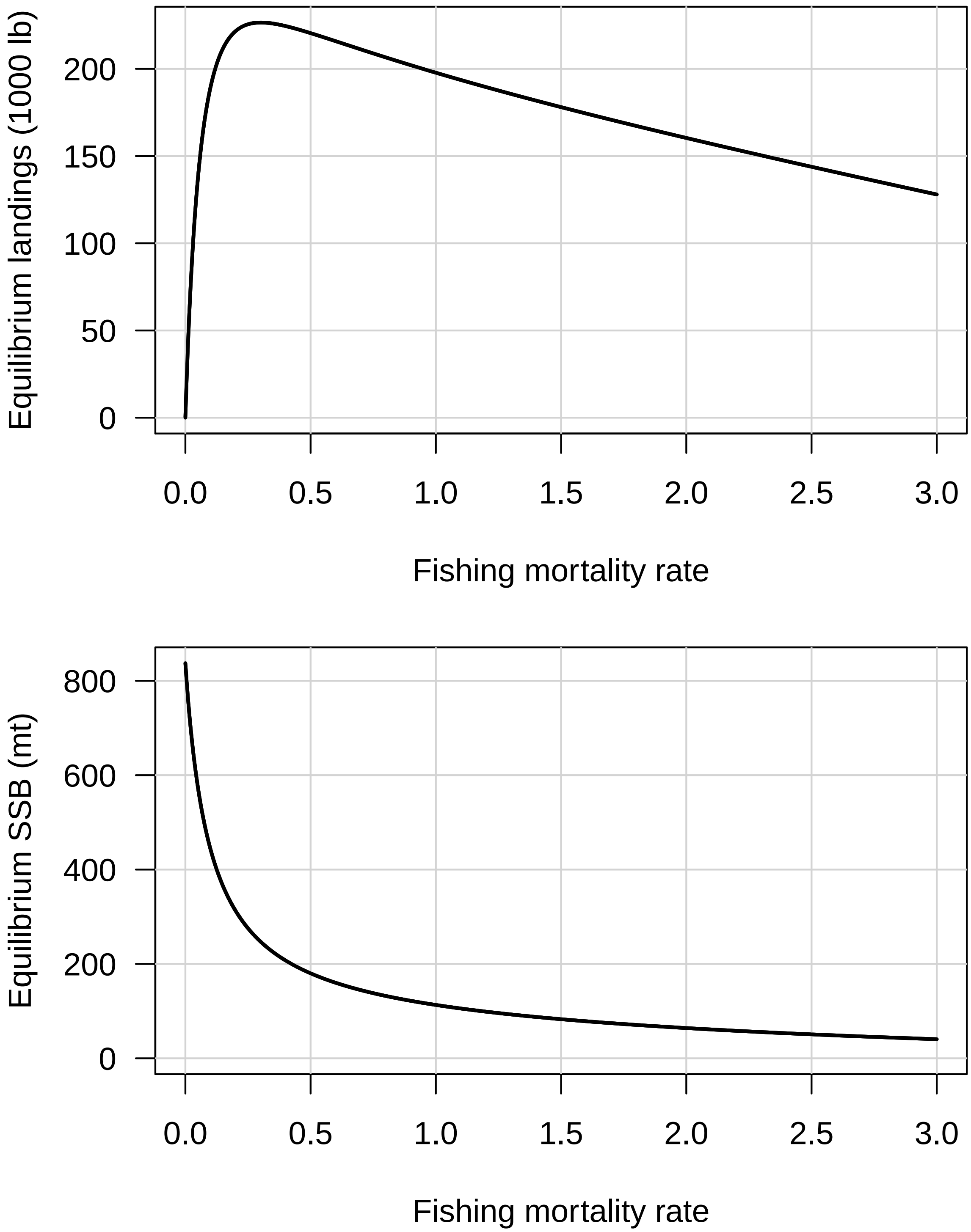


Figure 3.26. Equilibrium landings as a function of equilibrium biomass, which itself is a function of fishing mortality rate. The peak occurs where equilibrium biomass is B_{MSY} = 679.5 *mt and equilibrium landings are* MSY = 226.5 *(1000 lb).*

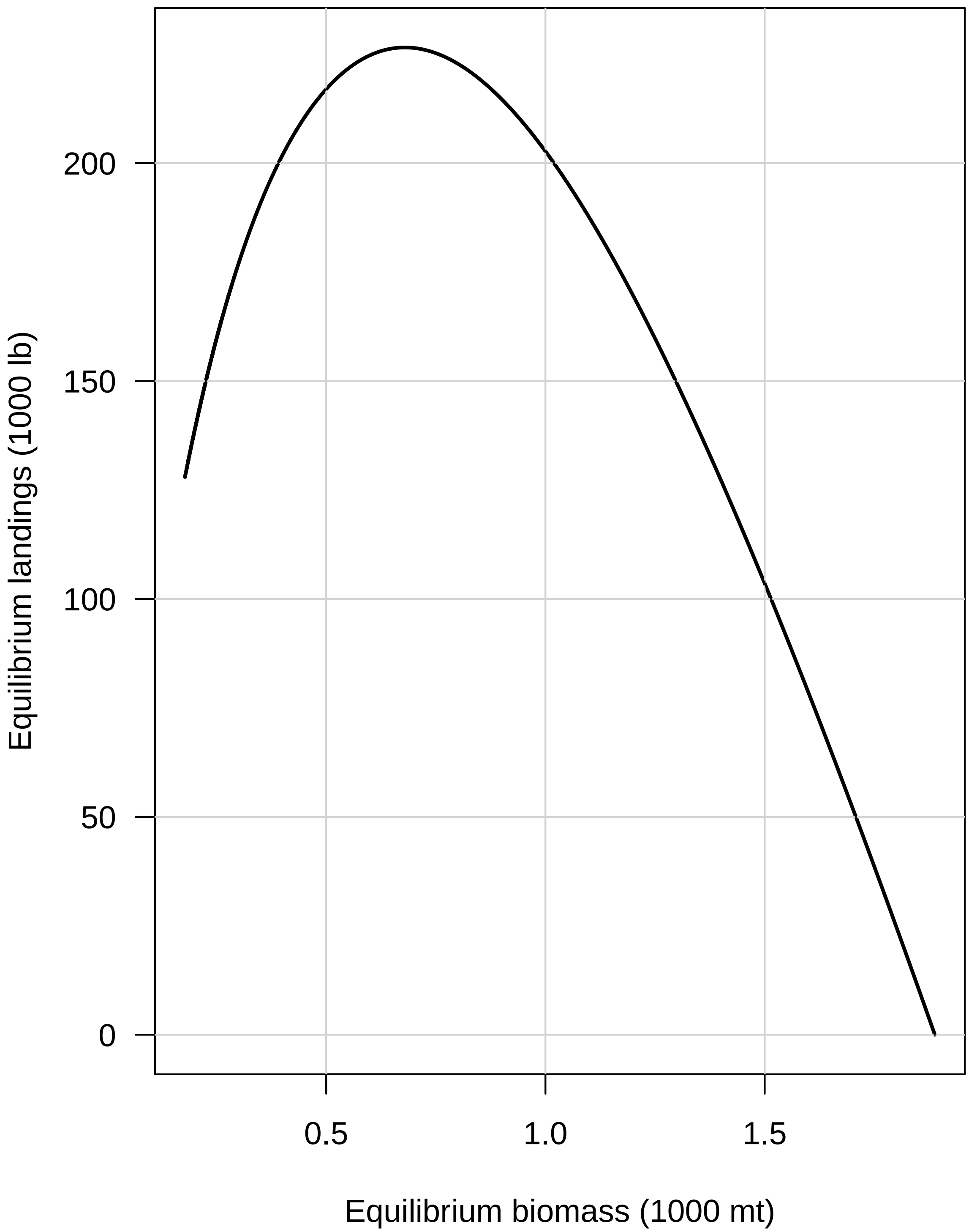


Figure 3.27. Probability densities of MSY*-related benchmarks from MCB analysis of the Beaufort Assessment Model. Vertical lines represent point estimates from the base run.*

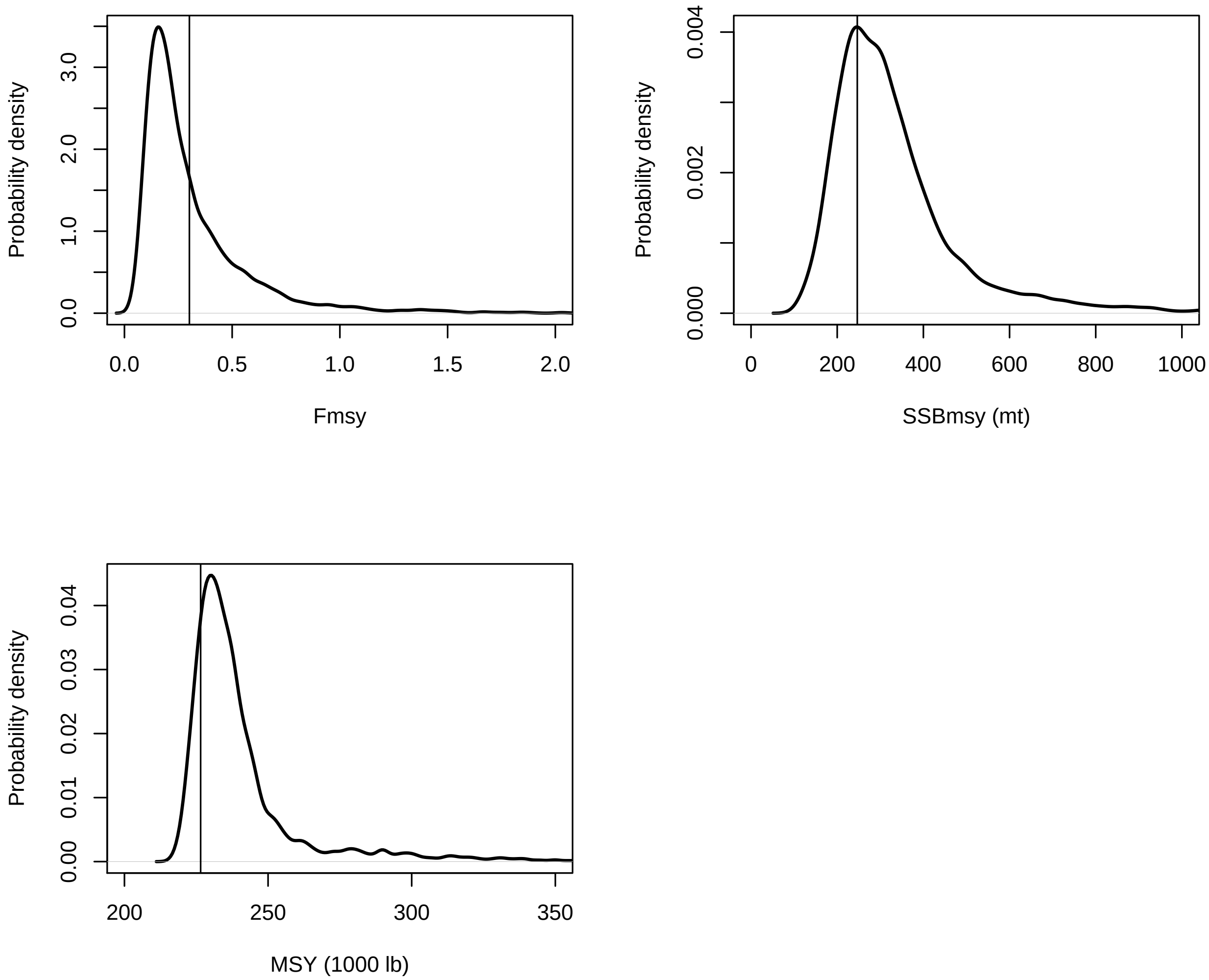


Figure 3.28. Estimated time series relative to benchmarks. Solid line indicates estimates from base run of the Beaufort Assessment Model; gray error bands indicate 5^{th} *and* 95^{th} *percentiles of the MCB trials. Top panel: spawning biomass relative to the minimum stock size threshold (*MSST*). Middle panel: spawning biomass relative to SSBmsy. Bottom panel: F relative to* F_{MSY}.

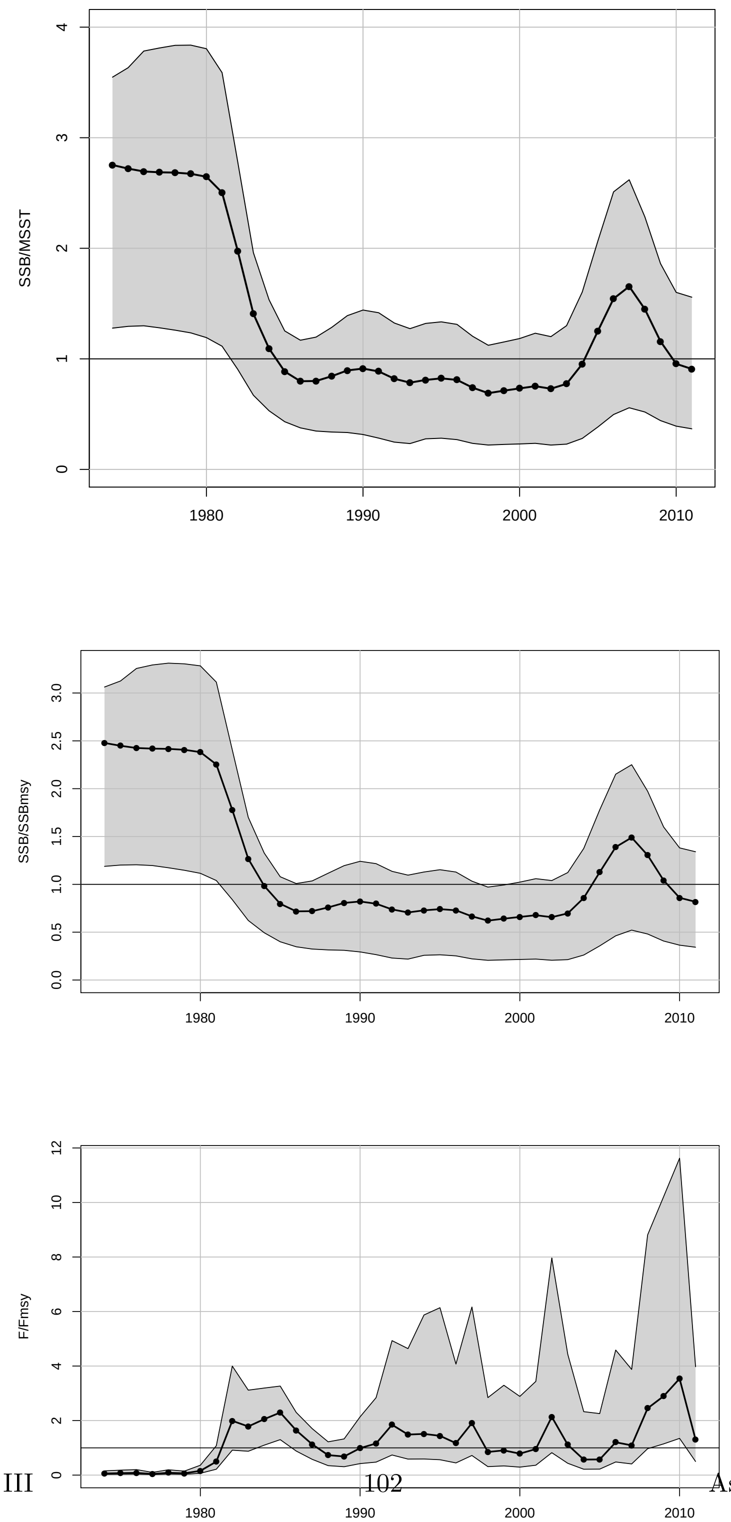


Figure 3.29. Probability densities of terminal status estimates from MCB analysis of the Beaufort Assessment Model. Vertical lines represent point estimates from the base run.

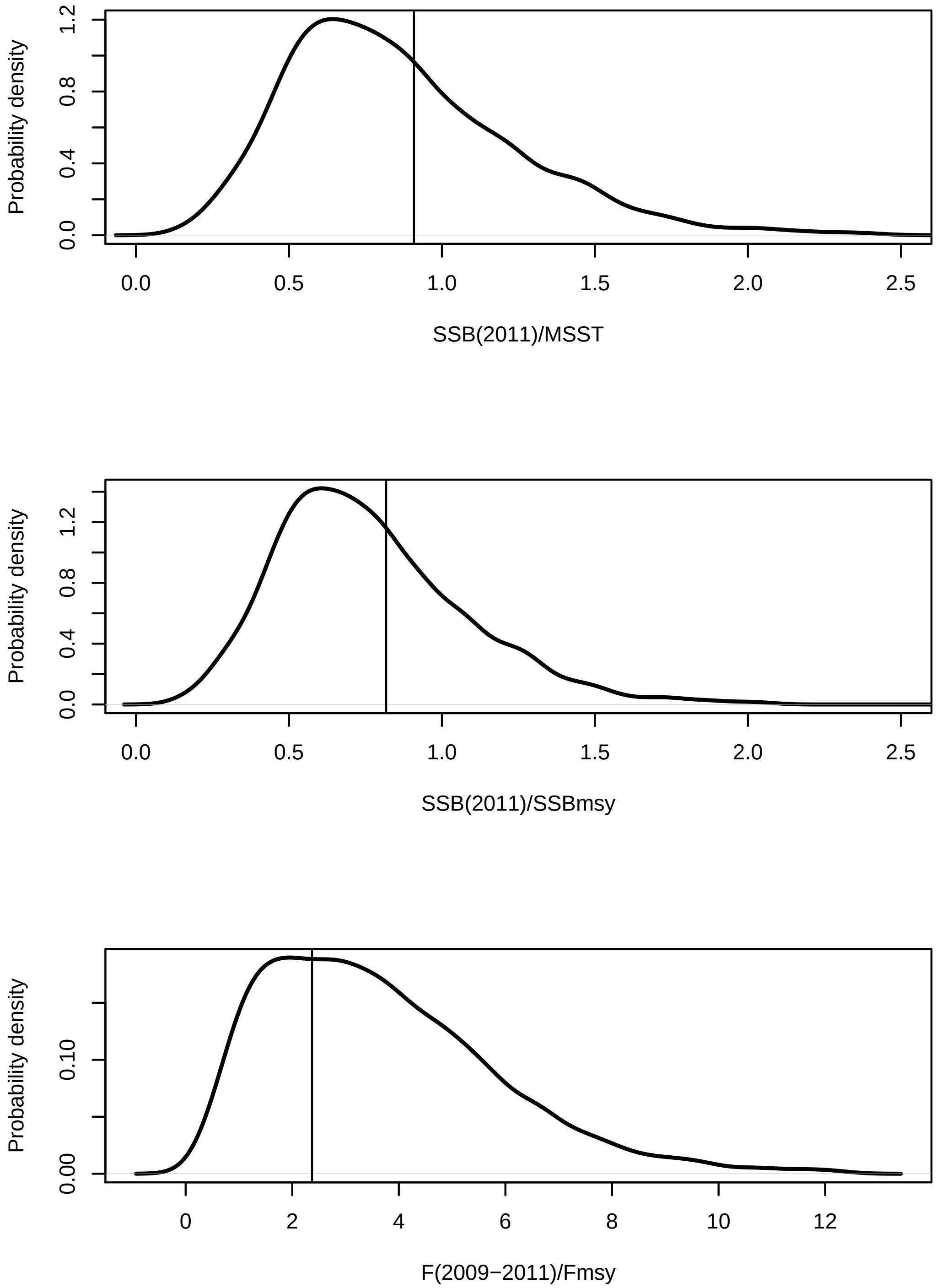
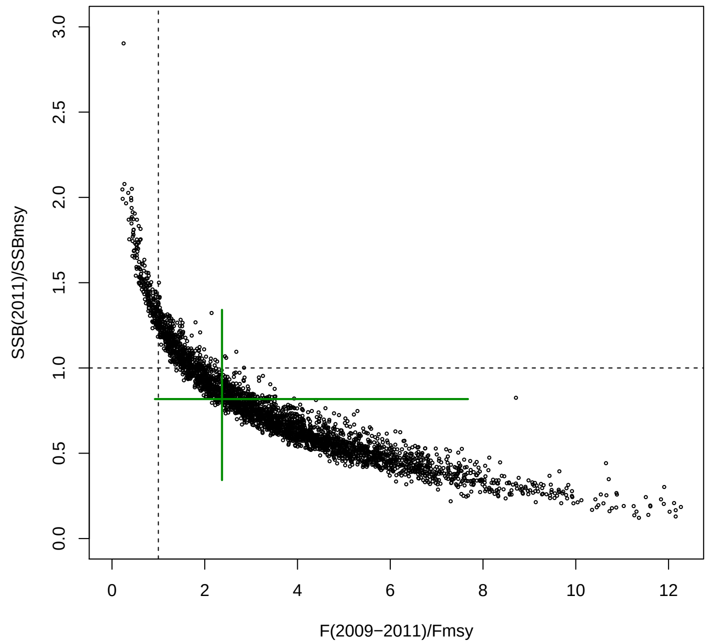


Figure 3.30. Phase plot of terminal status estimates from MCB analysis of the Beaufort Assessment Model. The intersection of crosshairs indicates estimates from the base run; lengths of crosshairs defined by 5^{th} and 95^{th} percentiles.



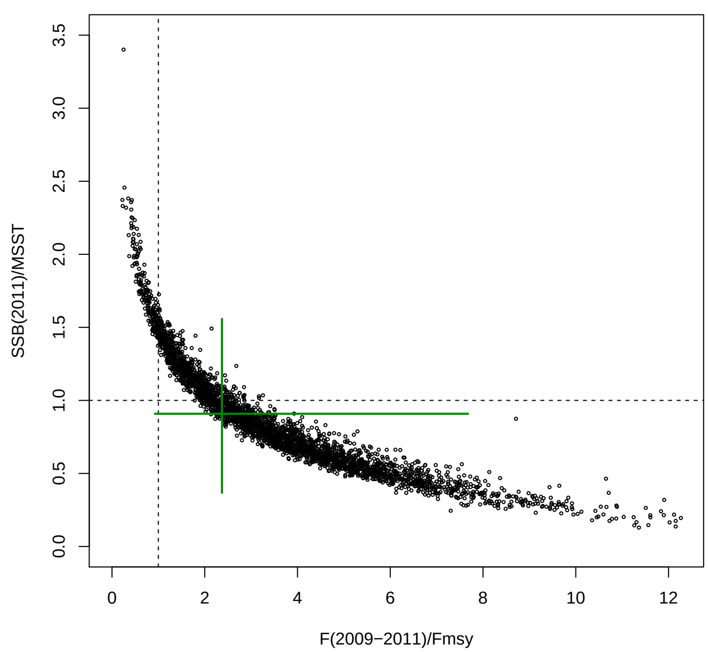


Figure 3.31. Age structure relative to the equilibrium expected at MSY*.*

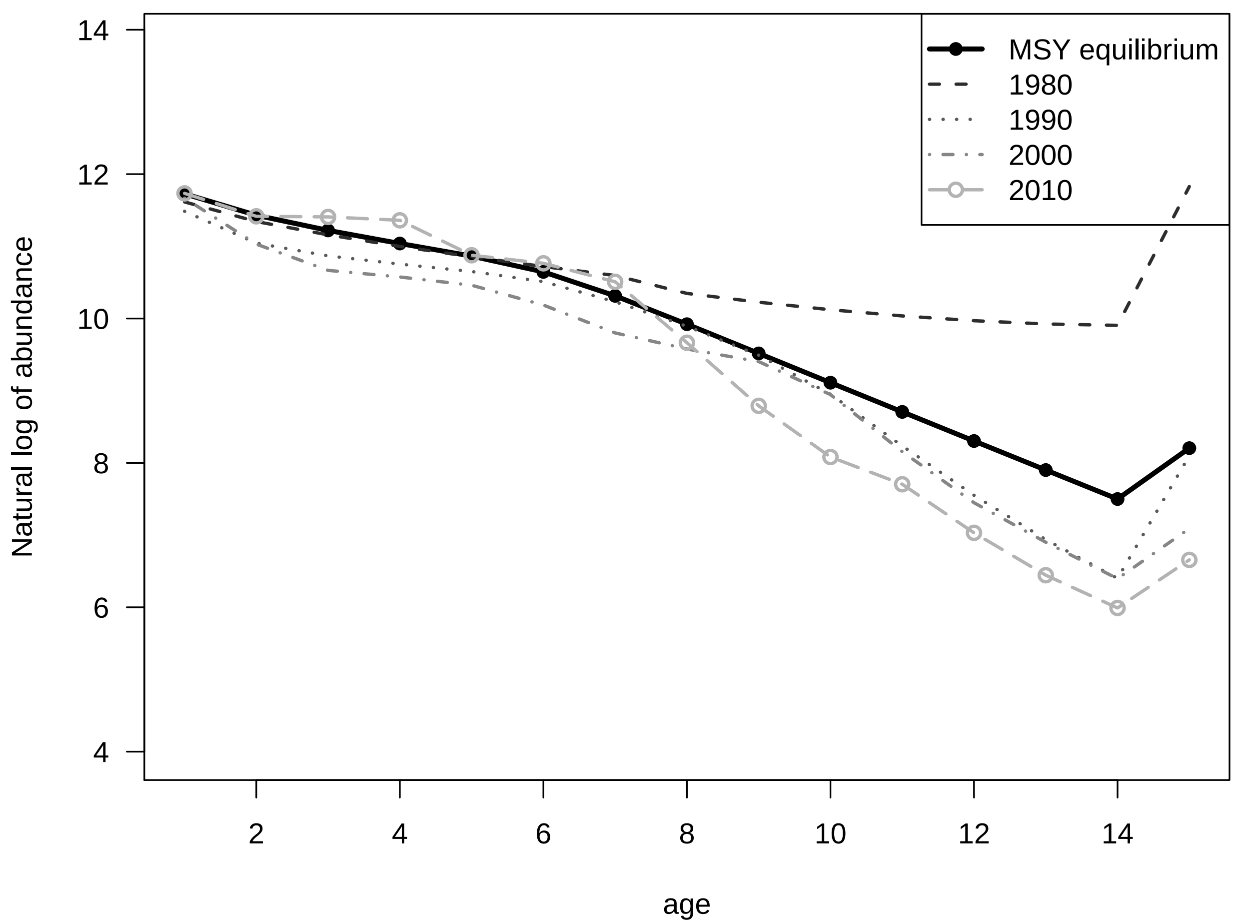


Figure 3.32. Sensitivity to changes in natural mortality (sensitivity runs S1–S3). Top panel: Ratio of F to F_{MSY}. Bottom panel: Ratio of SSB *to* $\mathrm{SSB}_{\mathrm{MSY}}$*. Any lines not visible overlap results of the base run.*

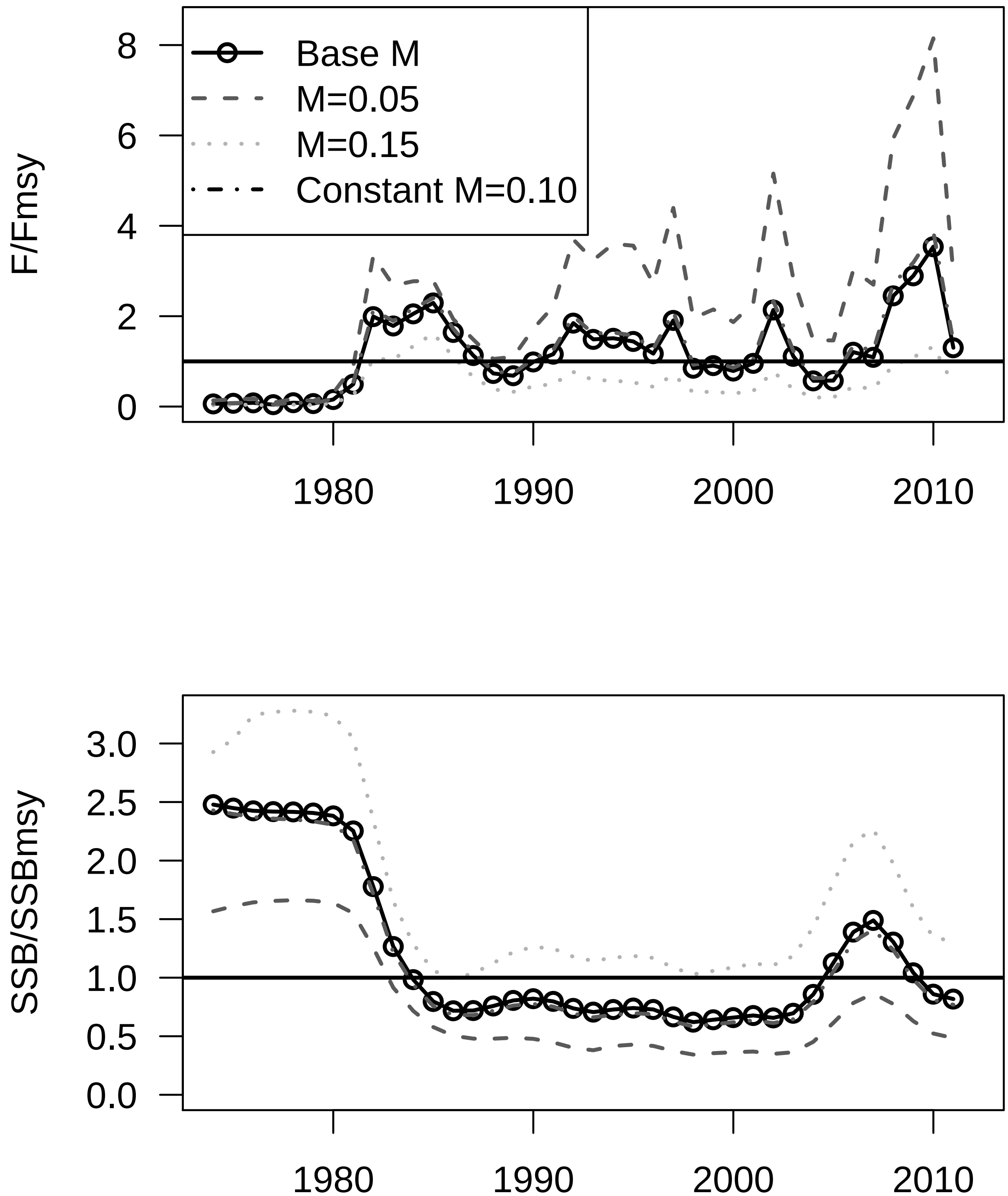


Figure 3.33. Sensitivity to steepness (sensitivity runs S4–S5). Top panel: Ratio of F to F_{MSY}*. Bottom panel: Ratio of* SSB *to* $\mathrm{SSB}_{\mathrm{MSY}}$*. Any lines not visible overlap results of the base run.*

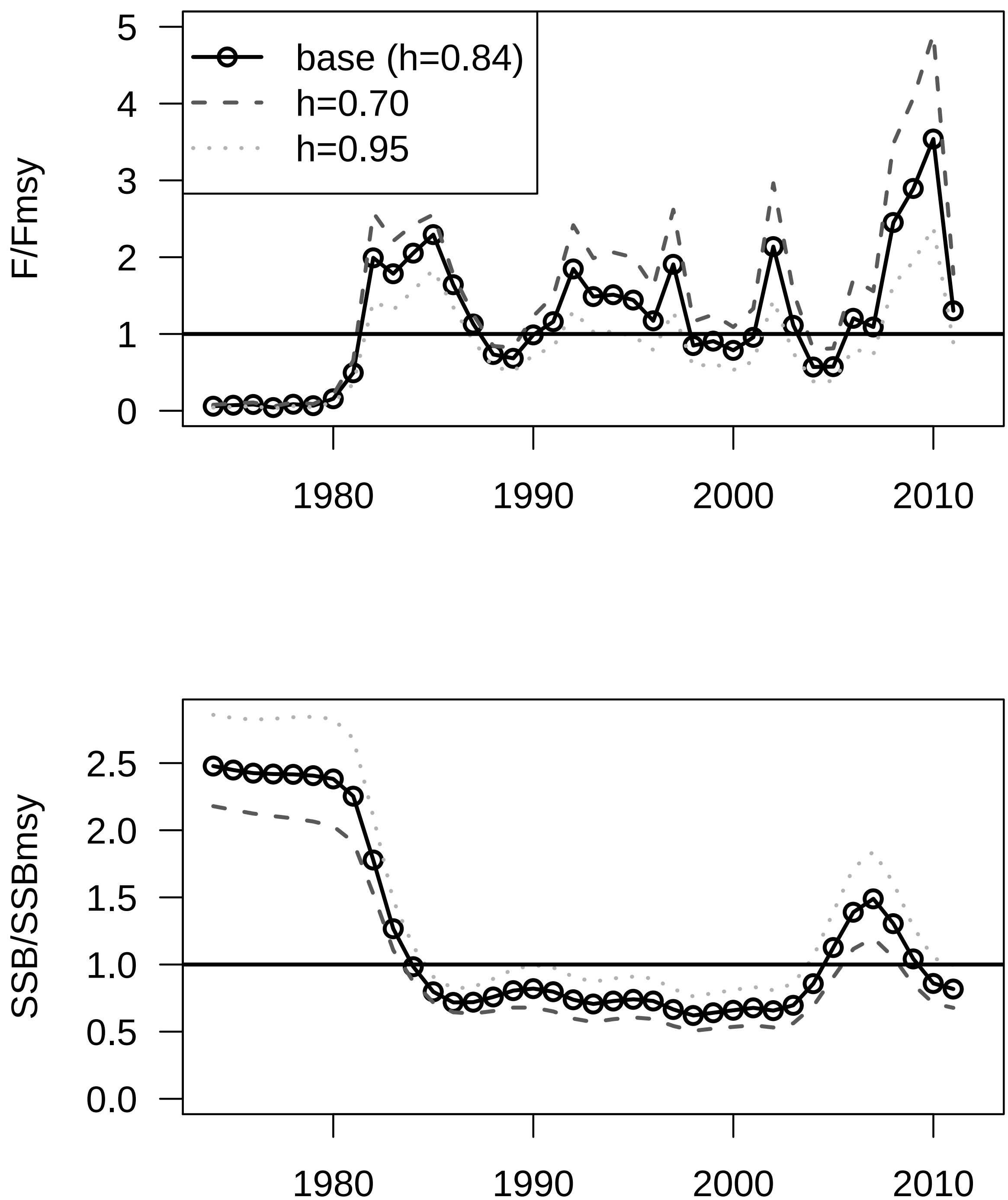


Figure 3.34. Sensitivity to maturity vector (sensitivity runs S6). Top panel: Ratio of F to F_{MSY}. Bottom panel: Ratio of SSB *to* $\mathrm{SSB}_{\mathrm{MSY}}$. *Any lines not visible overlap results of the base run.*

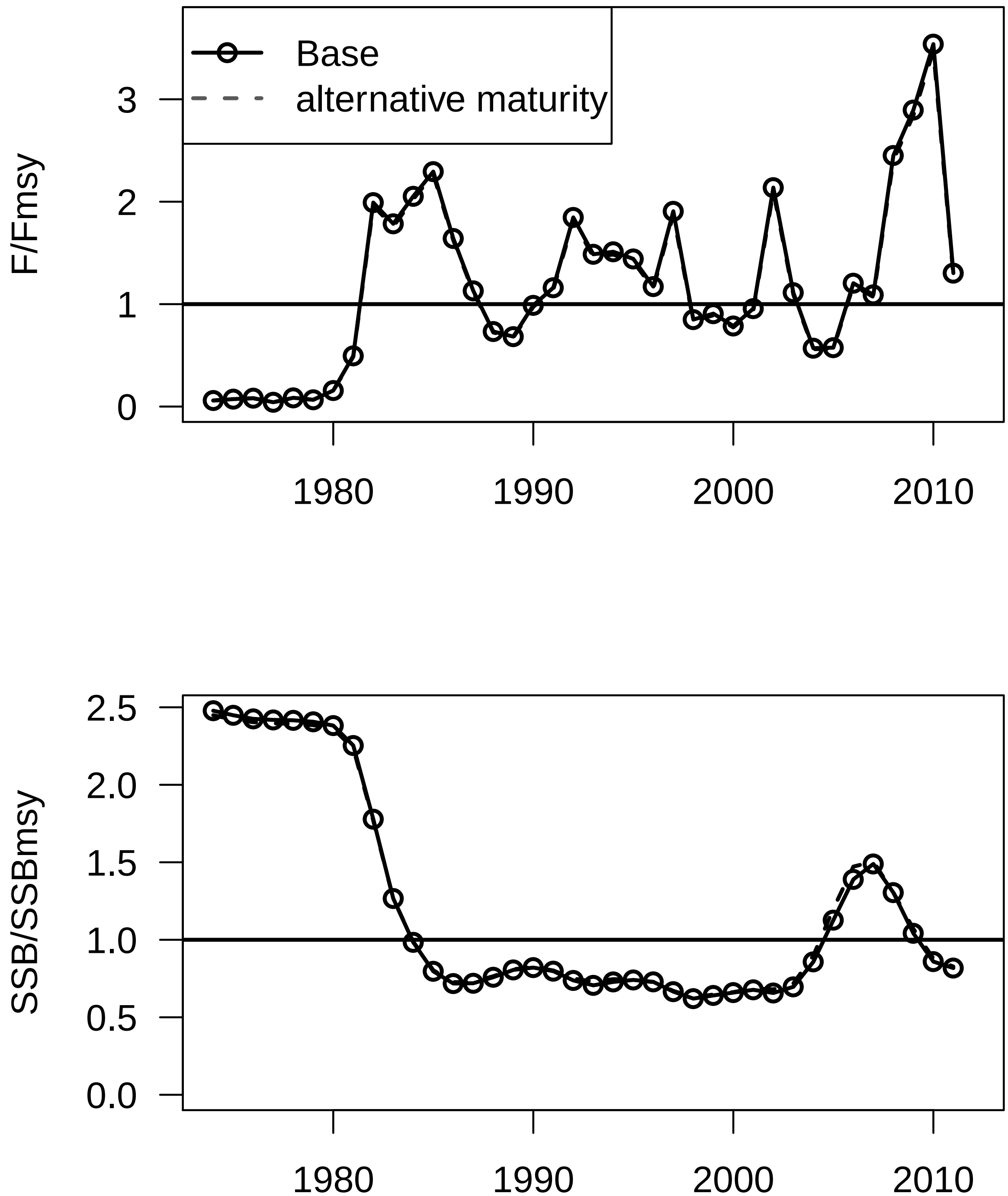


Figure 3.35. Sensitivity to model component weights (sensitivity runs S7–S8). Top panel: Ratio of F to F_{MSY}. Bottom panel: Ratio of SSB to SSB_{MSY}. Any lines not visible overlap results of the base run.

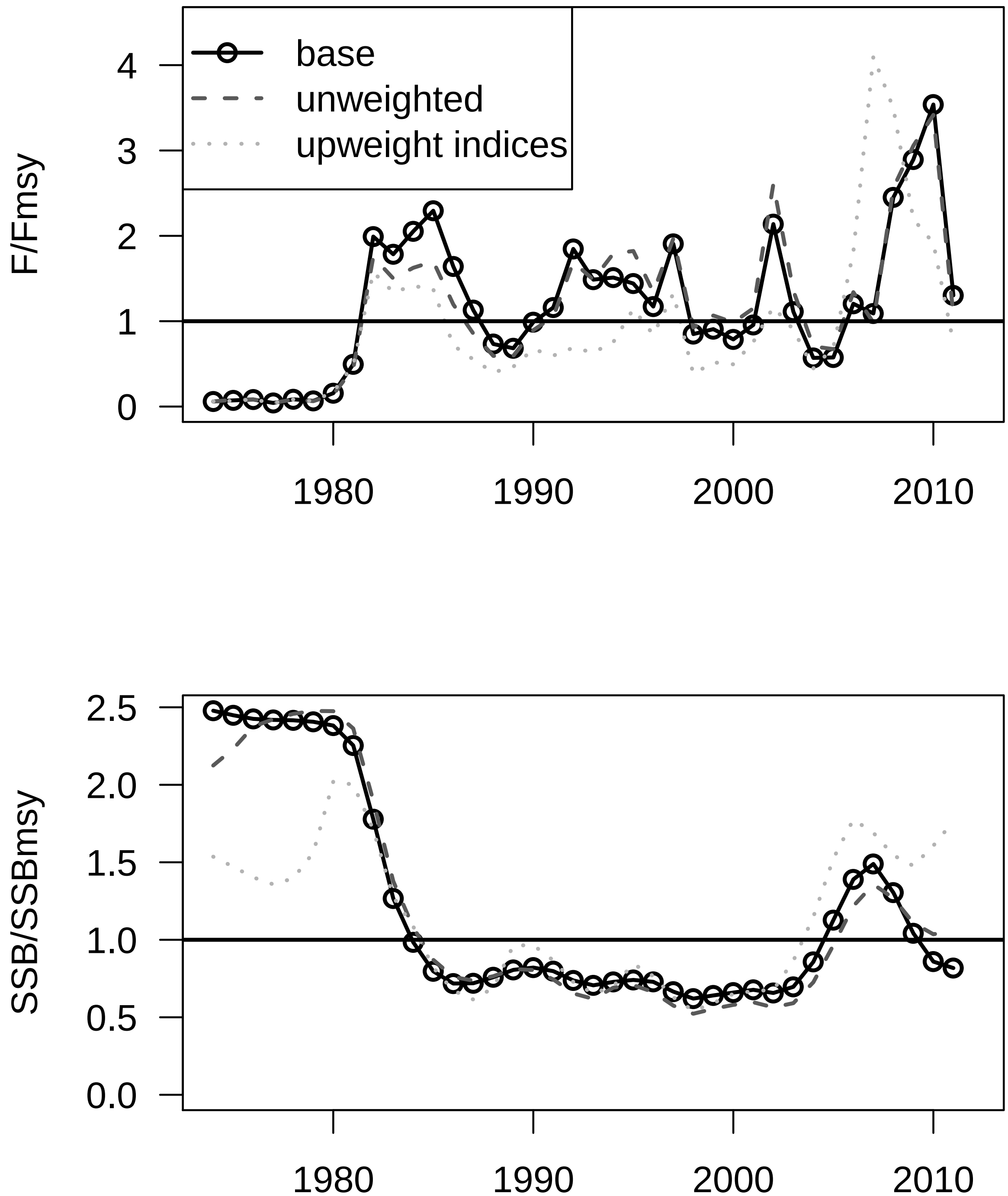


Figure 3.36. Sensitivity to catchability assumptions (sensitivity run S9–S10). Top panel: Ratio of F to F_{MSY}. *Bottom panel: Ratio of* SSB *to* $\mathrm{SSB}_{\mathrm{MSY}}$. *Any lines not visible overlap results of the base run.*

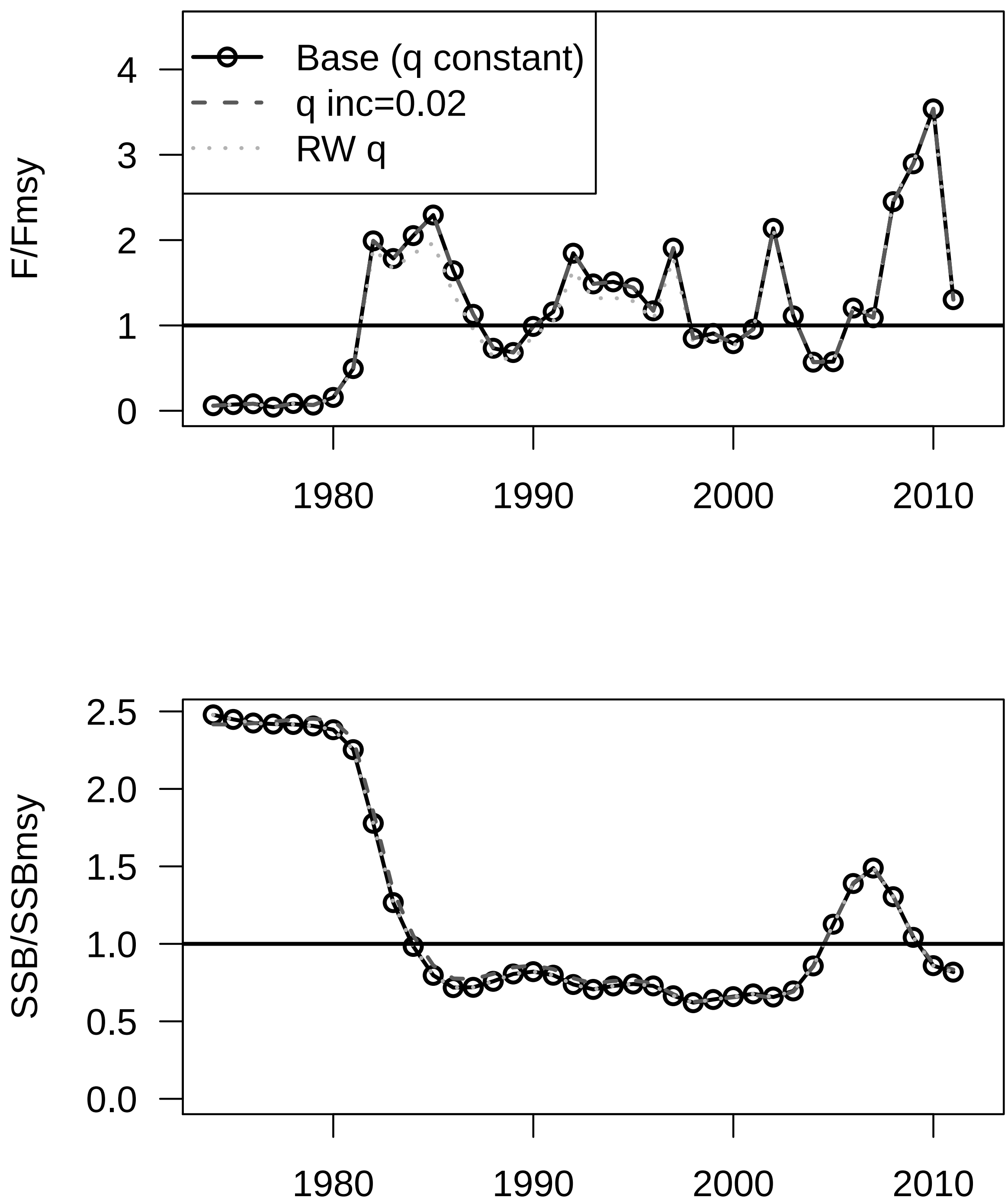
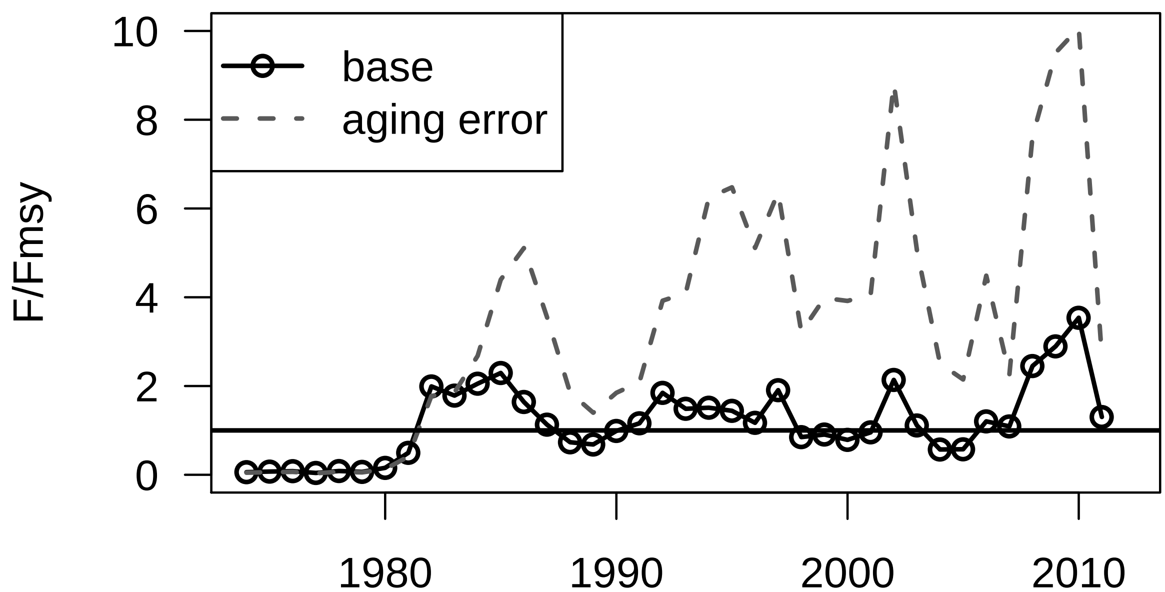


Figure 3.37. Sensitivity to ageing error (sensitivity run S11). Top panel: Ratio of F to F_{MSY}*. Bottom panel: Ratio of* SSB *to* $\mathrm{SSB}_{\mathrm{MSY}}$*. Any lines not visible overlap results of the base run.*



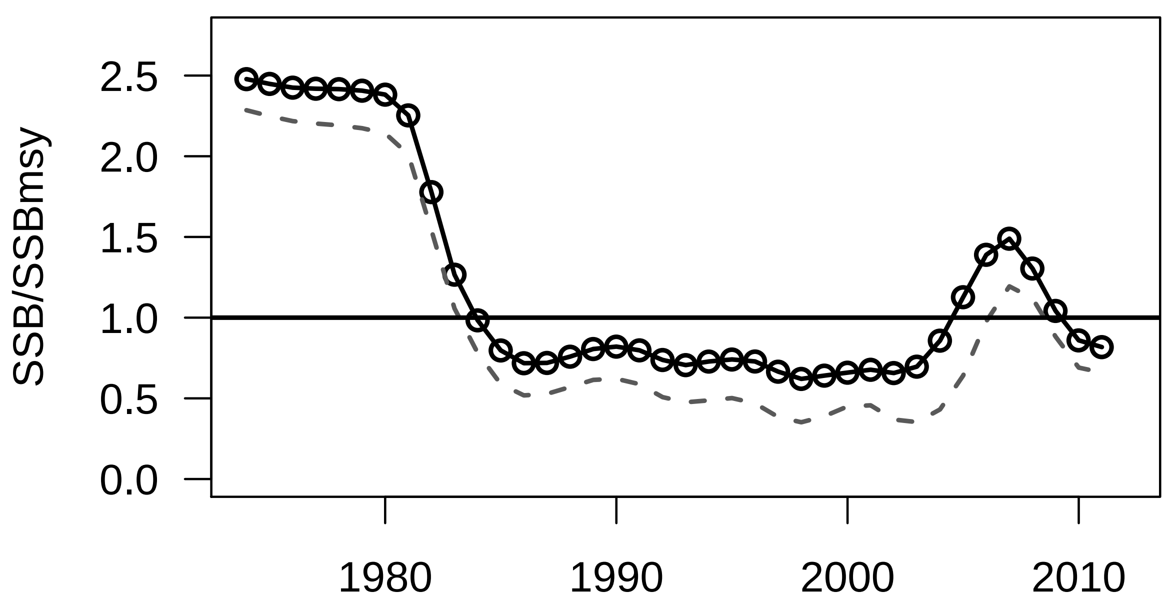


Figure 3.38. Sensitivity to indices (sensitivity runs S12–S14). Top panel: Ratio of F to F_{MSY}*. Bottom panel: Ratio of* SSB *to* $\mathrm{SSB}_{\mathrm{MSY}}$*. Any lines not visible overlap results of the base run.*

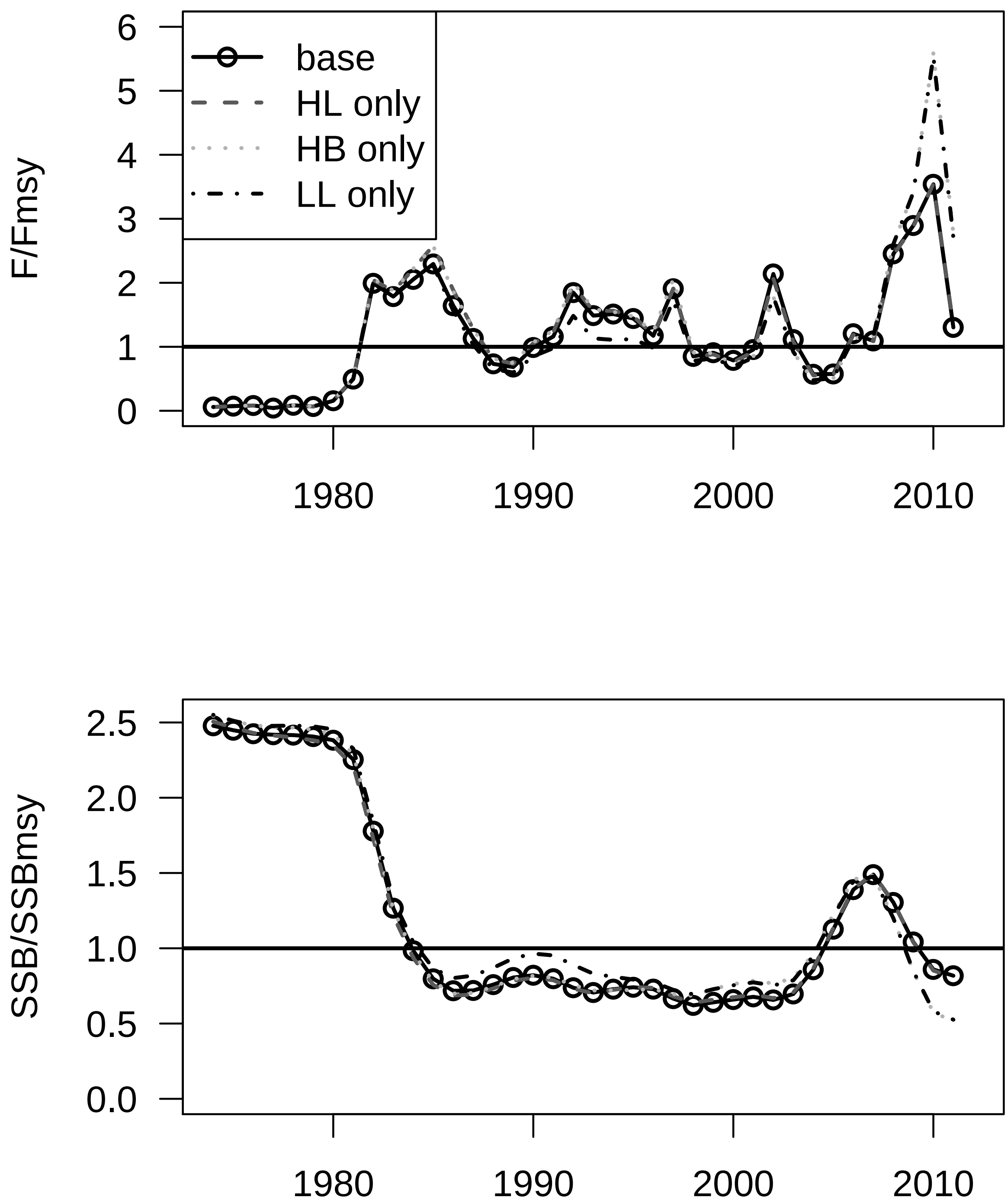


Figure 3.39. Sensitivity to years recruitment deviations estimated (sensitivity run S15–21). Top panel: Ratio of F to F_{MSY}. Bottom panel: Ratio of SSB *to* $\mathrm{SSB}_{\mathrm{MSY}}$*. Any lines not visible overlap results of the base run.*

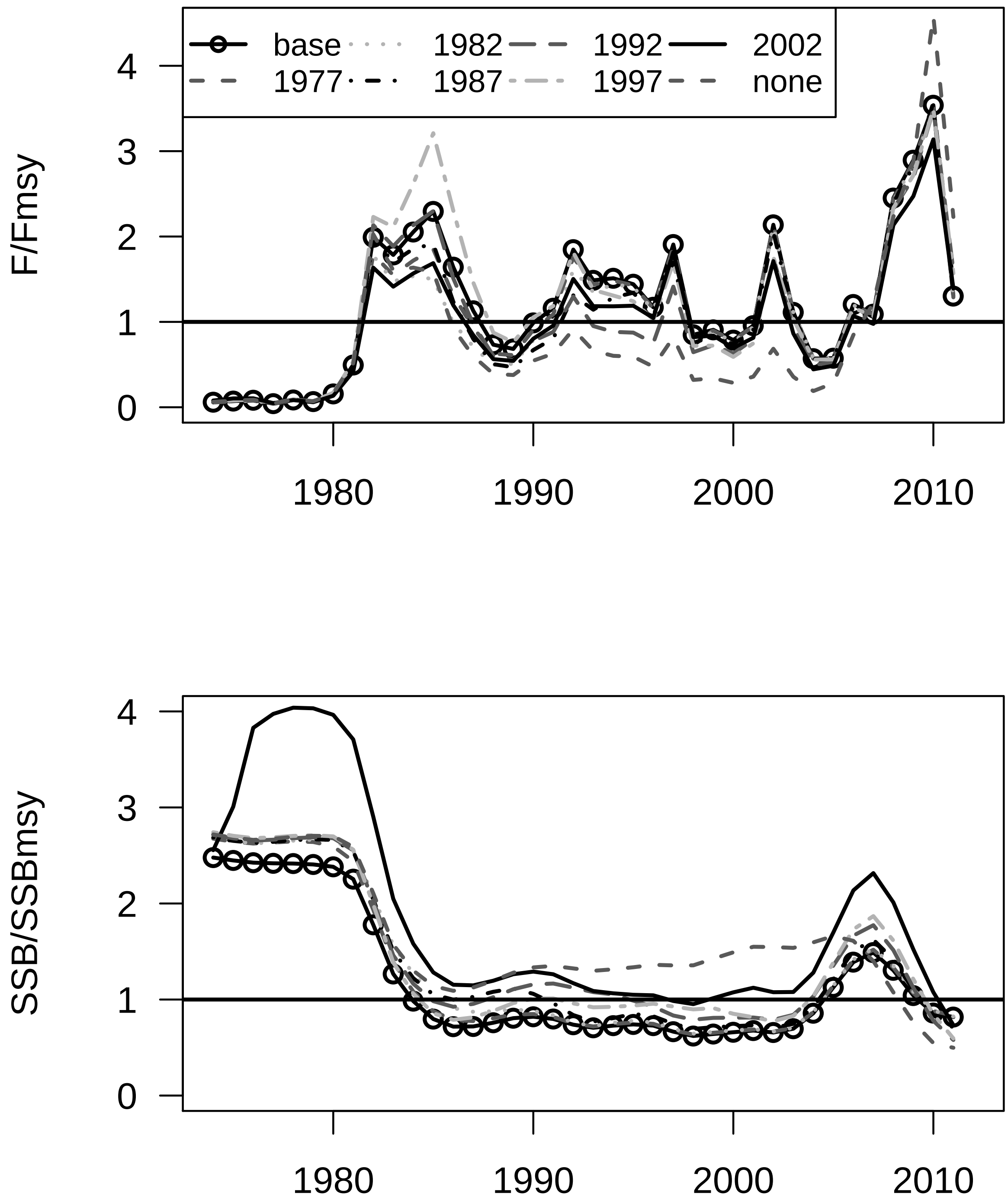
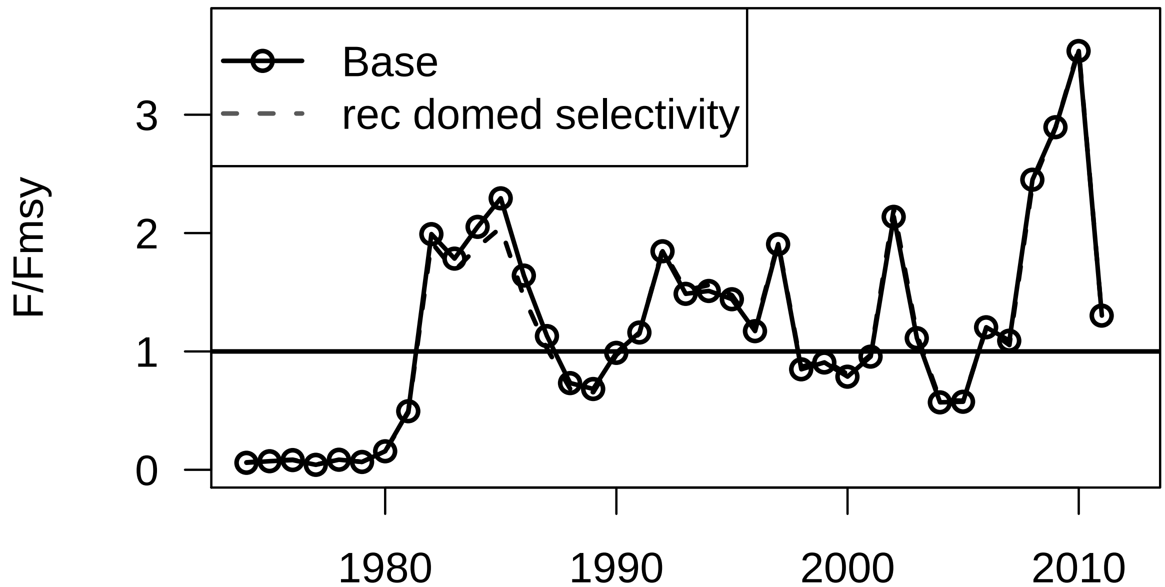


Figure 3.40. Sensitivity to dome-shaped recreational selectivity (sensitivity run S16). Top panel: Ratio of F to F_{MSY}. Bottom panel: Ratio of SSB *to* $\mathrm{SSB}_{\mathrm{MSY}}$*. Any lines not visible overlap results of the base run.*



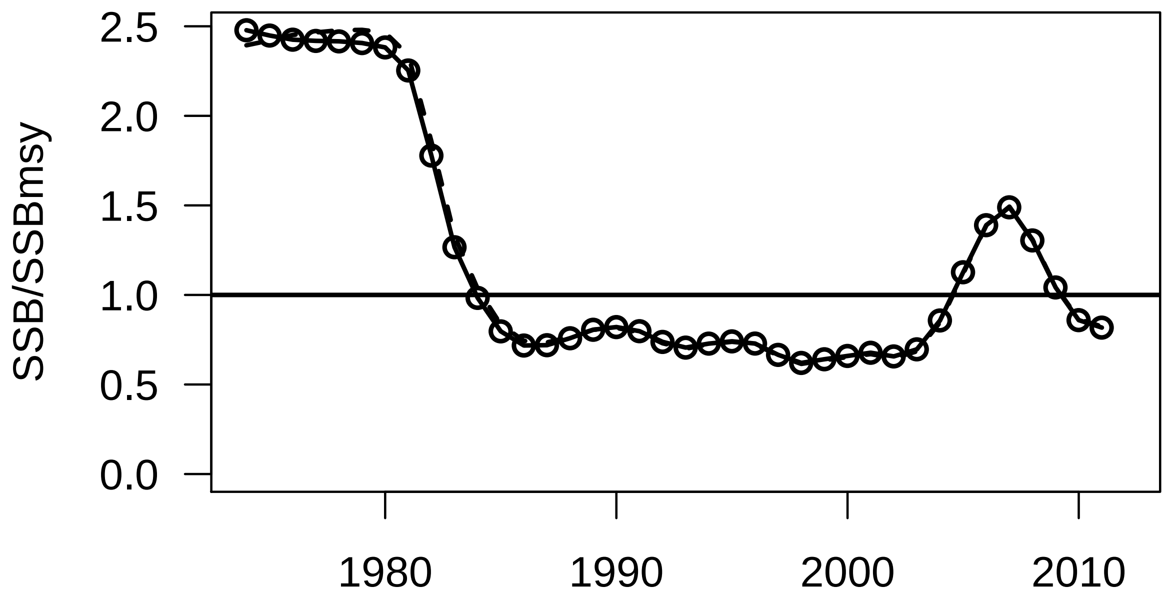


Figure 3.41. Phase plot of terminal status estimates from sensitivity runs of the Beaufort Assessment Model.

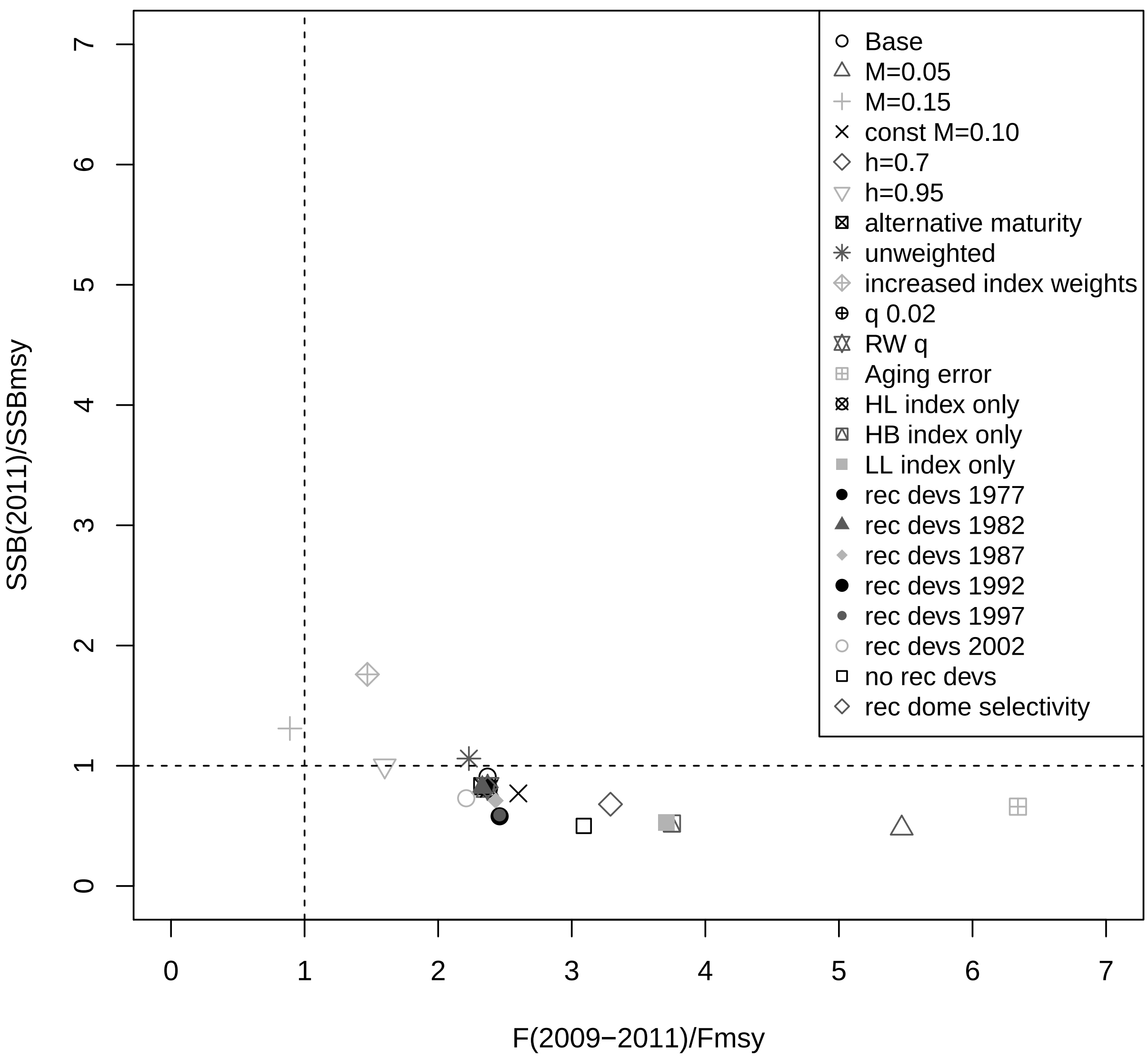


Figure 3.42. Retrospective analyses. Sensitivity to terminal year of data (sensitivity runs S17–S23). Fishing mortality rate, where solid circles show geometric mean of terminal three years, as used to compute fishing status.

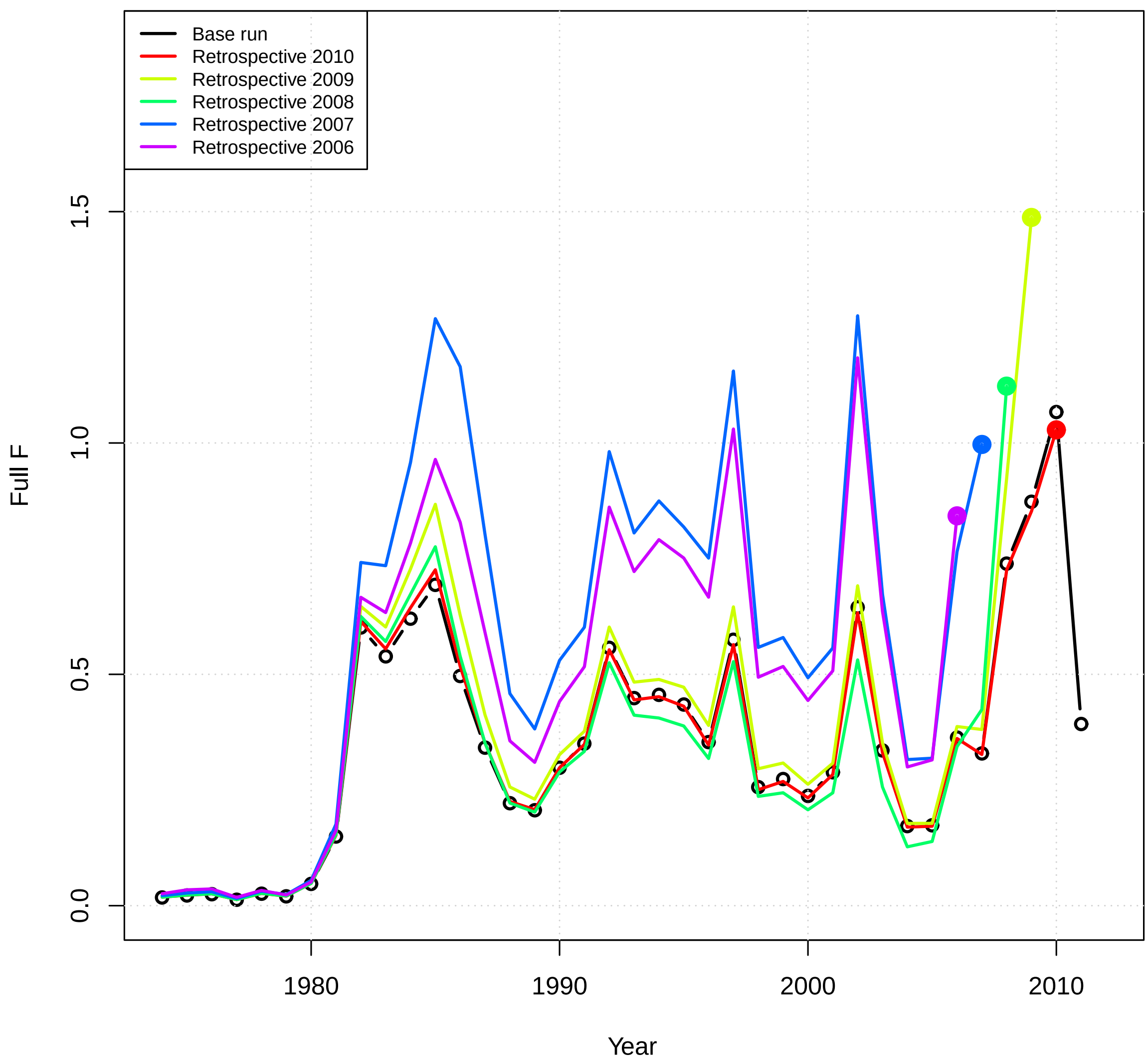


Figure 3.43. Retrospective analyses. Sensitivity to terminal year of data (sensitivity runs S17–S23). Biomass time series.

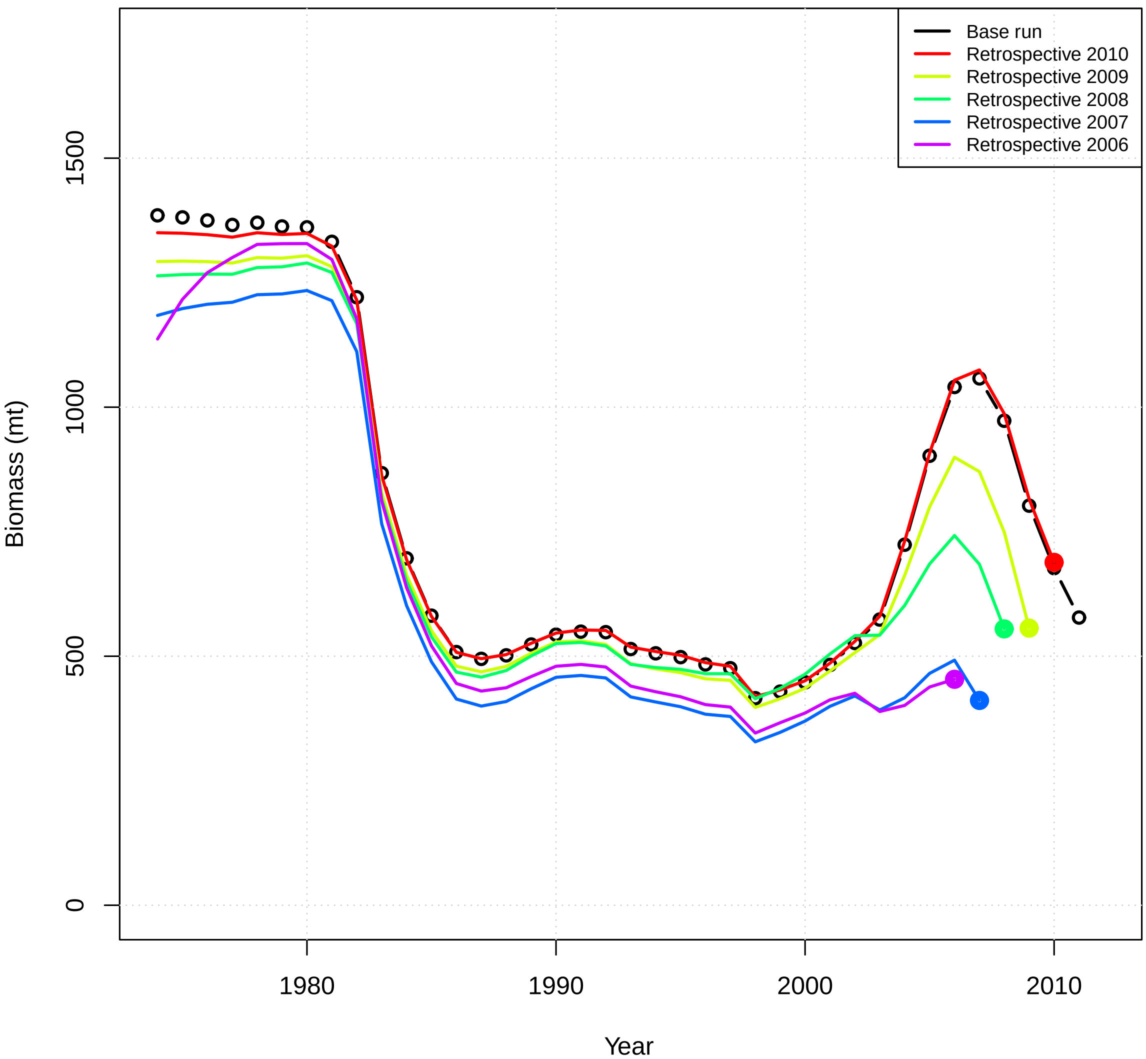


Figure 3.44. Retrospective analyses. Sensitivity to terminal year of data (sensitivity runs S17–S23). Spawning stock biomass time series.

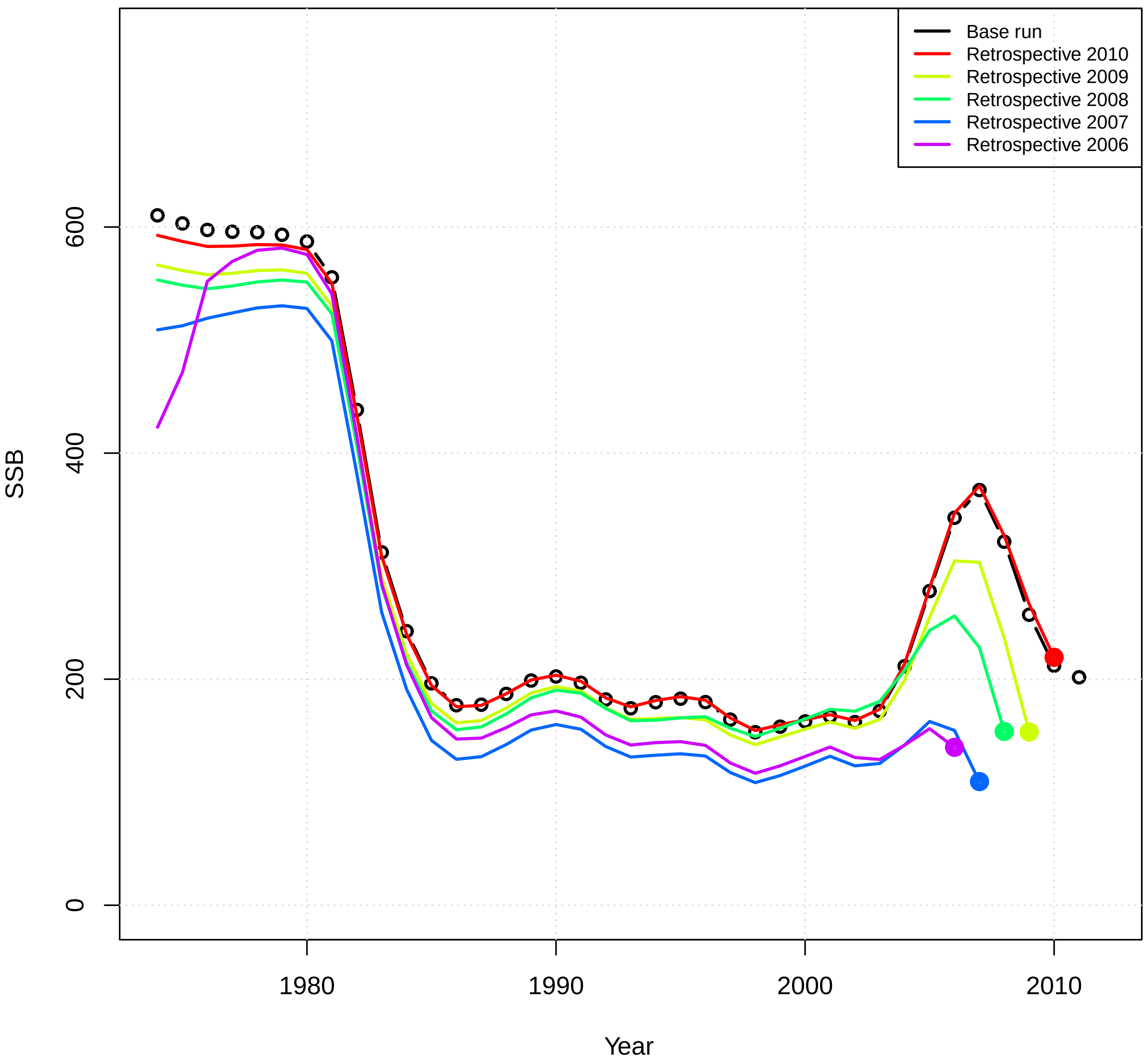


Figure 3.45. Retrospective analyses. Sensitivity to terminal year of data (sensitivity runs S17–S23). Recruitment time series.

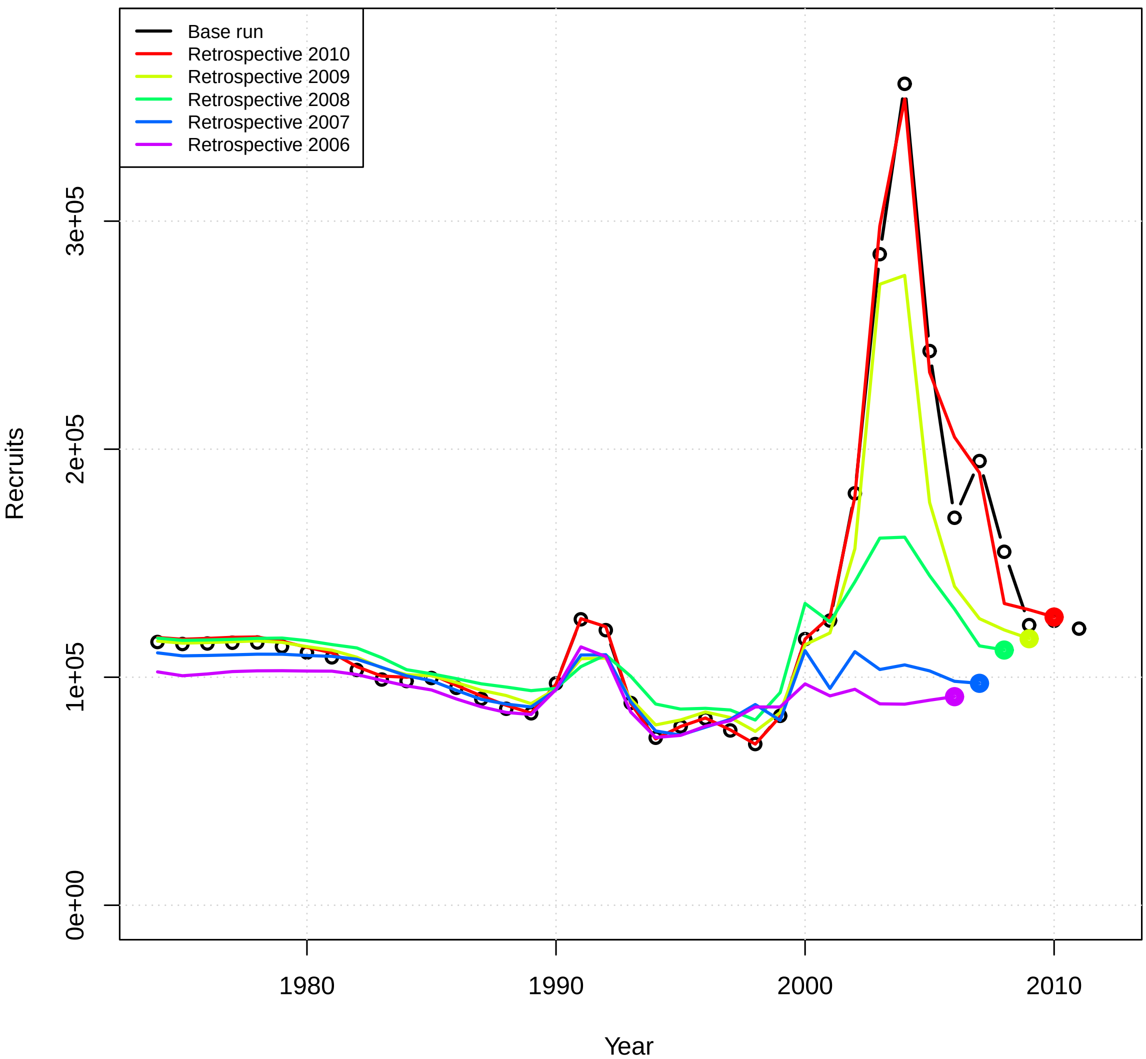


Figure 3.46. Retrospective analyses. Sensitivity to terminal year of data (sensitivity runs S17–S23). Relative spawning stock biomass time series.

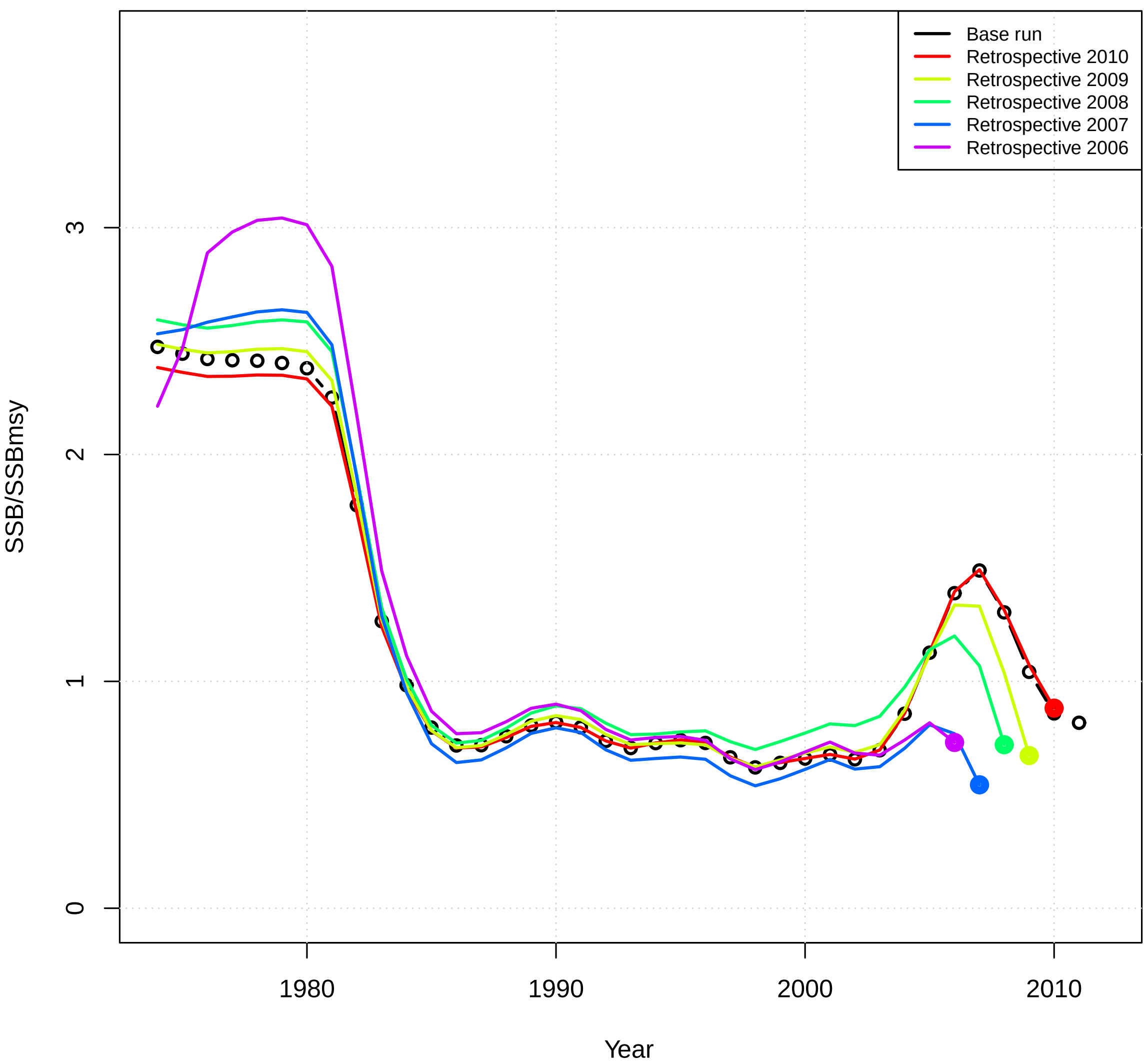


Figure 3.47. Retrospective analyses. Sensitivity to terminal year of data (sensitivity runs S17–S23). Relative fishing mortality rate time series.

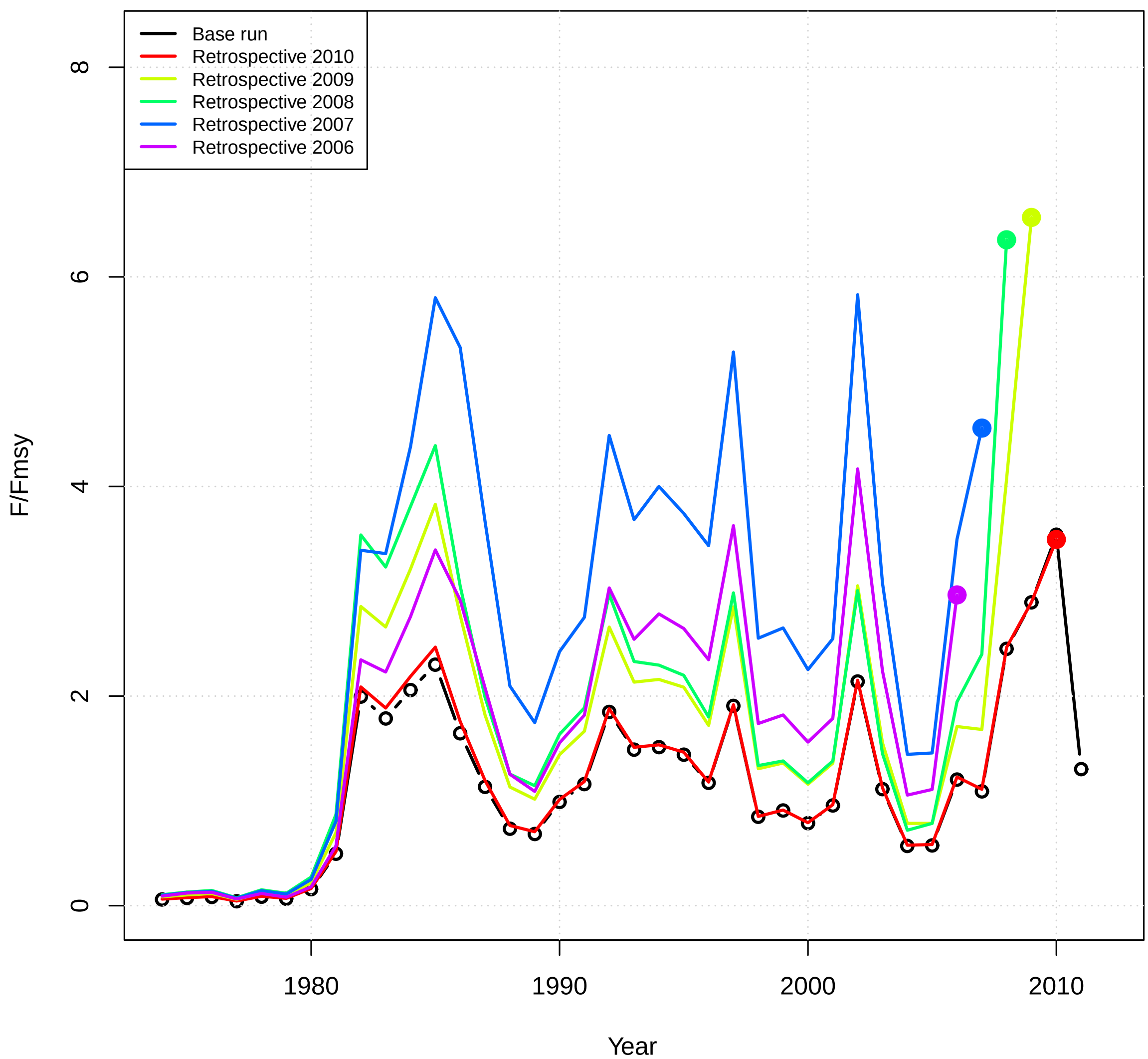


Figure 3.48. Projection results under scenario 1—fishing mortality rate fixed at $F = 0$. Expected values represented by dotted solid lines, and uncertainty represented by thin lines corresponding to 5^{th} and 95^{th} percentiles of replicate projections. Horizontal lines mark MSY*-related quantities. Spawning stock (SSB) is at time of peak spawning.*

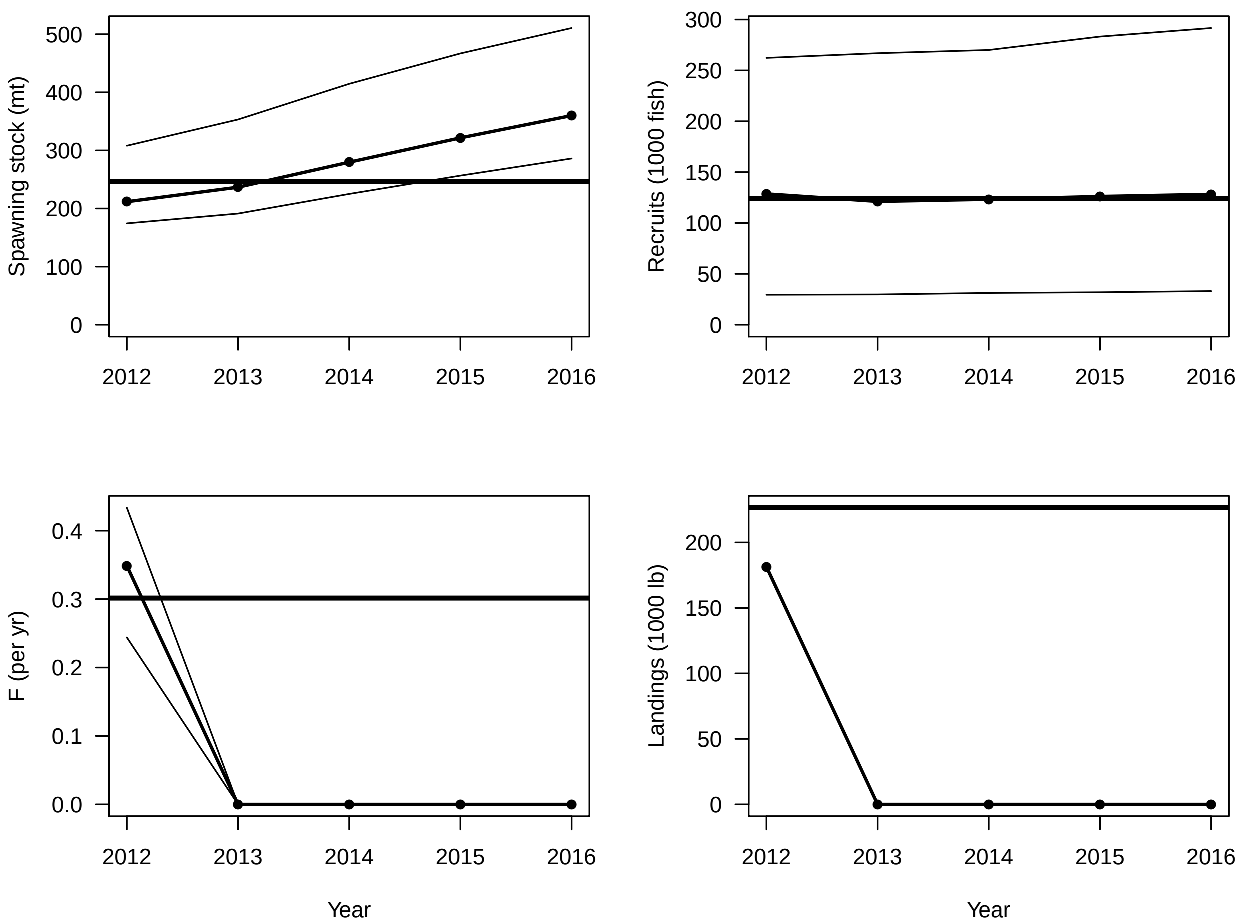


Figure 3.49. Projection results under scenario 2—fishing mortality rate fixed at $F = F_{\text{rebuild}} = 0.30$. *Expected values represented by dotted solid lines, and uncertainty represented by thin lines corresponding to* 5^{th} *and* 95^{th} *percentiles of replicate projections. Horizontal lines mark* MSY*-related quantities. Spawning stock (SSB) is at time of peak spawning.*

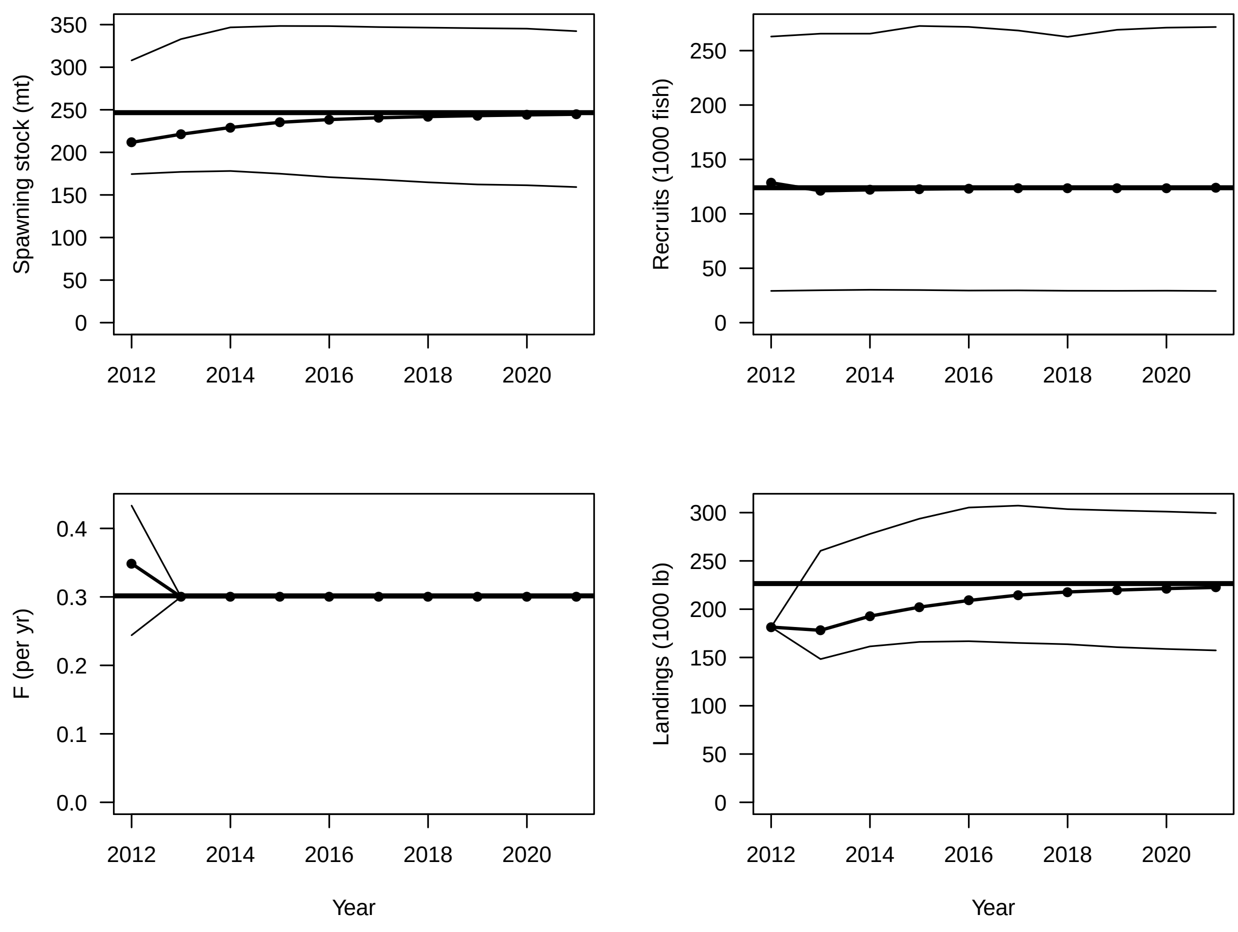


Figure 3.50. Projection results under scenario 3—fishing mortality rate fixed at $F = F_{\mathrm{MSY}}$. Expected values represented by dotted solid lines, and uncertainty represented by thin lines corresponding to 5^{th} and 95^{th} percentiles of replicate projections. Horizontal lines mark MSY*-related quantities. Spawning stock (SSB) is at time of peak spawning.*

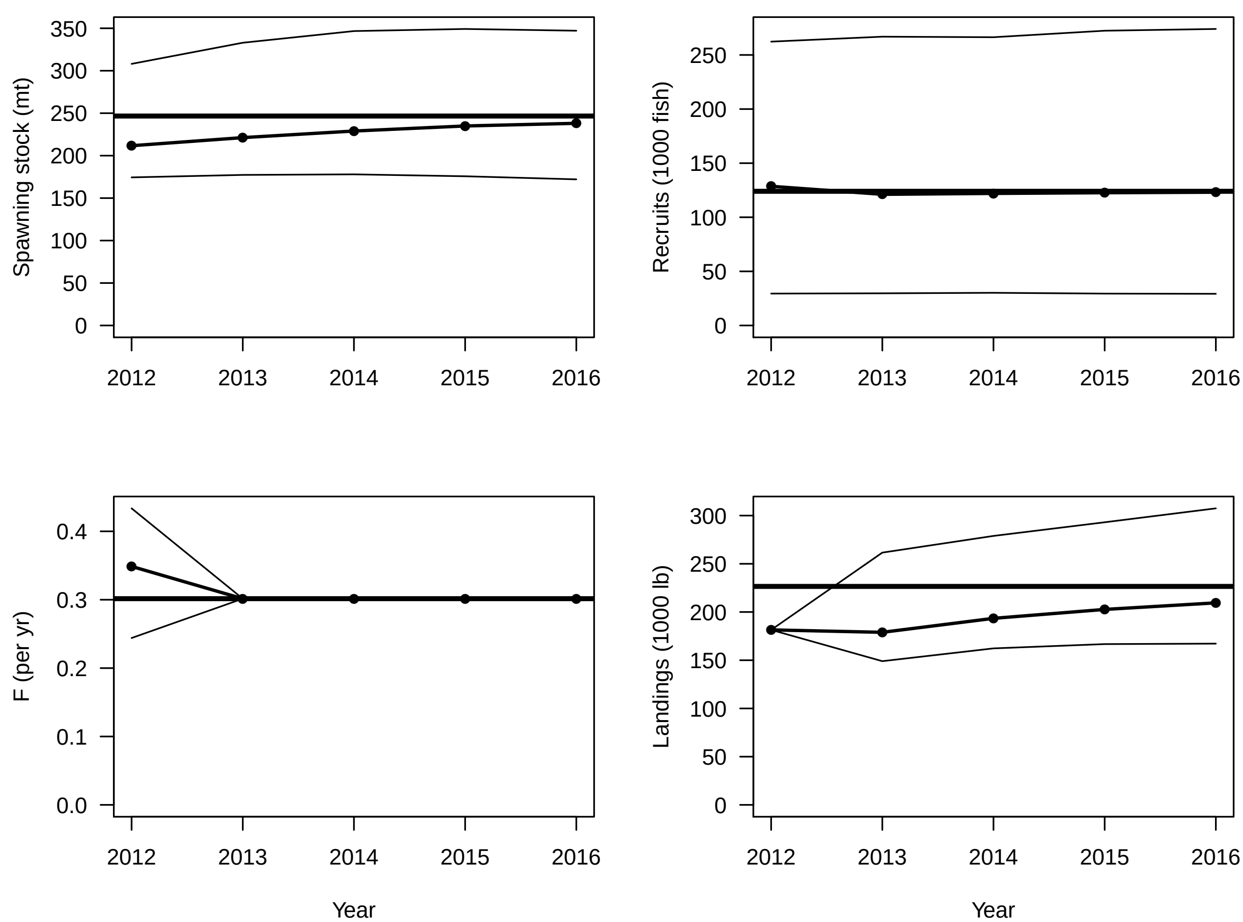


Figure 3.51. Projection results under scenario 4—fishing mortality rate fixed at $F = F_{\text{current}}$. Expected values represented by dotted solid lines, and uncertainty represented by thin lines corresponding to 5^{th} and 95^{th} percentiles of replicate projections. Horizontal lines mark MSY*-related quantities. Spawning stock (SSB) is at time of peak spawning.*

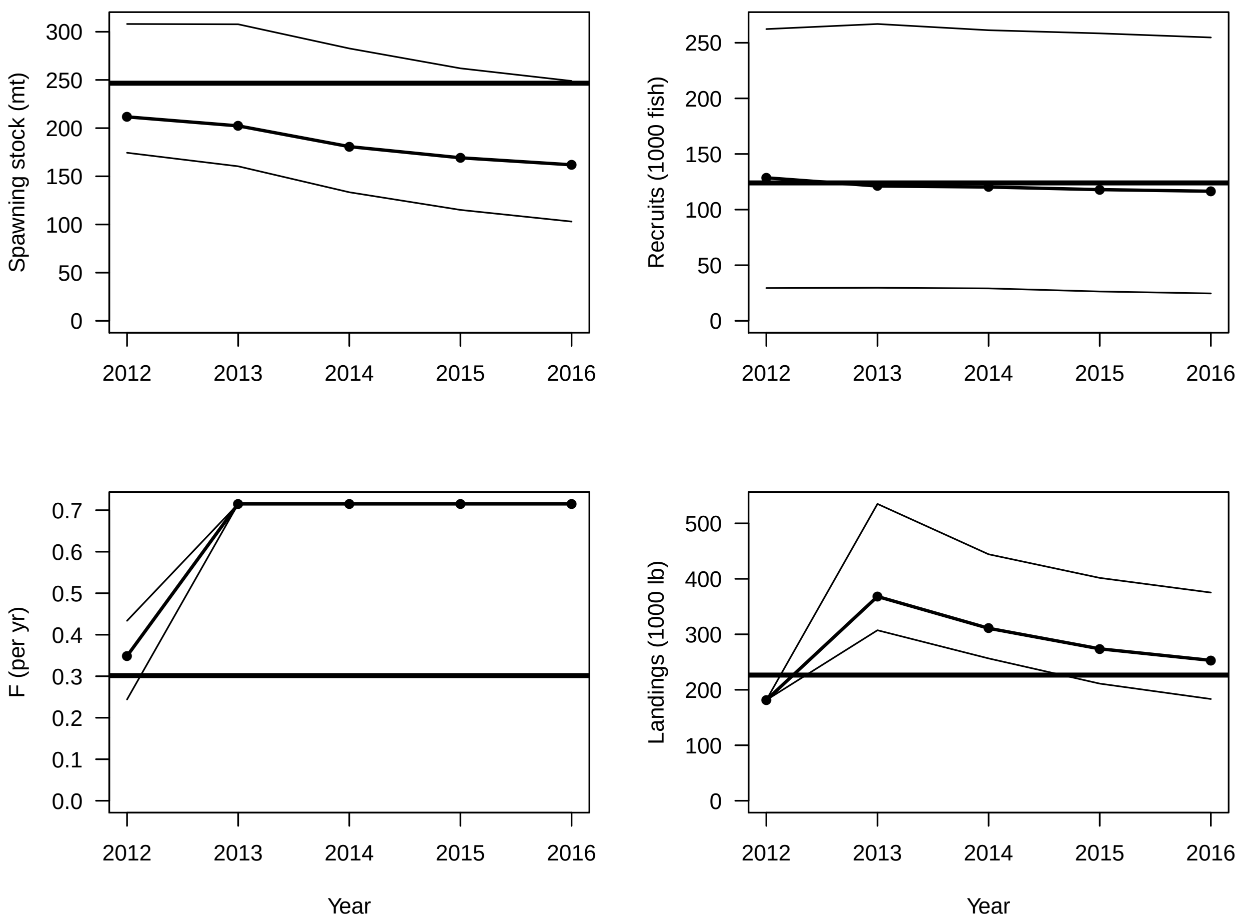


Figure 3.52. Blueline tilefish production model: Observed (closed circles) and model fit (open diamonds) for three fishery-dependent (headboat, commercial longline, and commercial handline) indices of abundance.

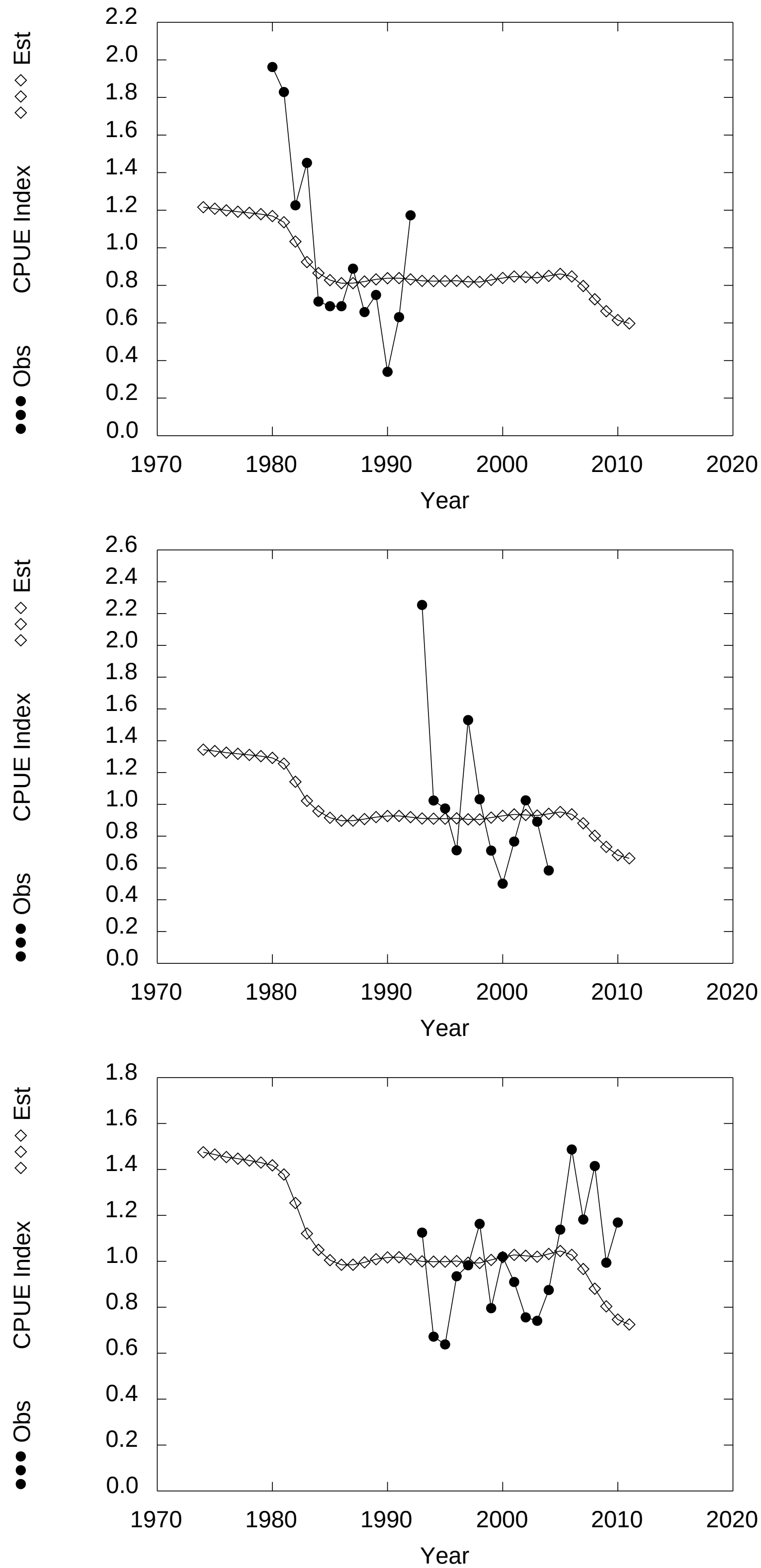


Figure 3.53. Blueline tilefish production model: Trends in relative fishing mortality (F/F_{MSY}, top panel) and relative biomass (B/B_{MSY}, bottom panel) estimated by the production model.

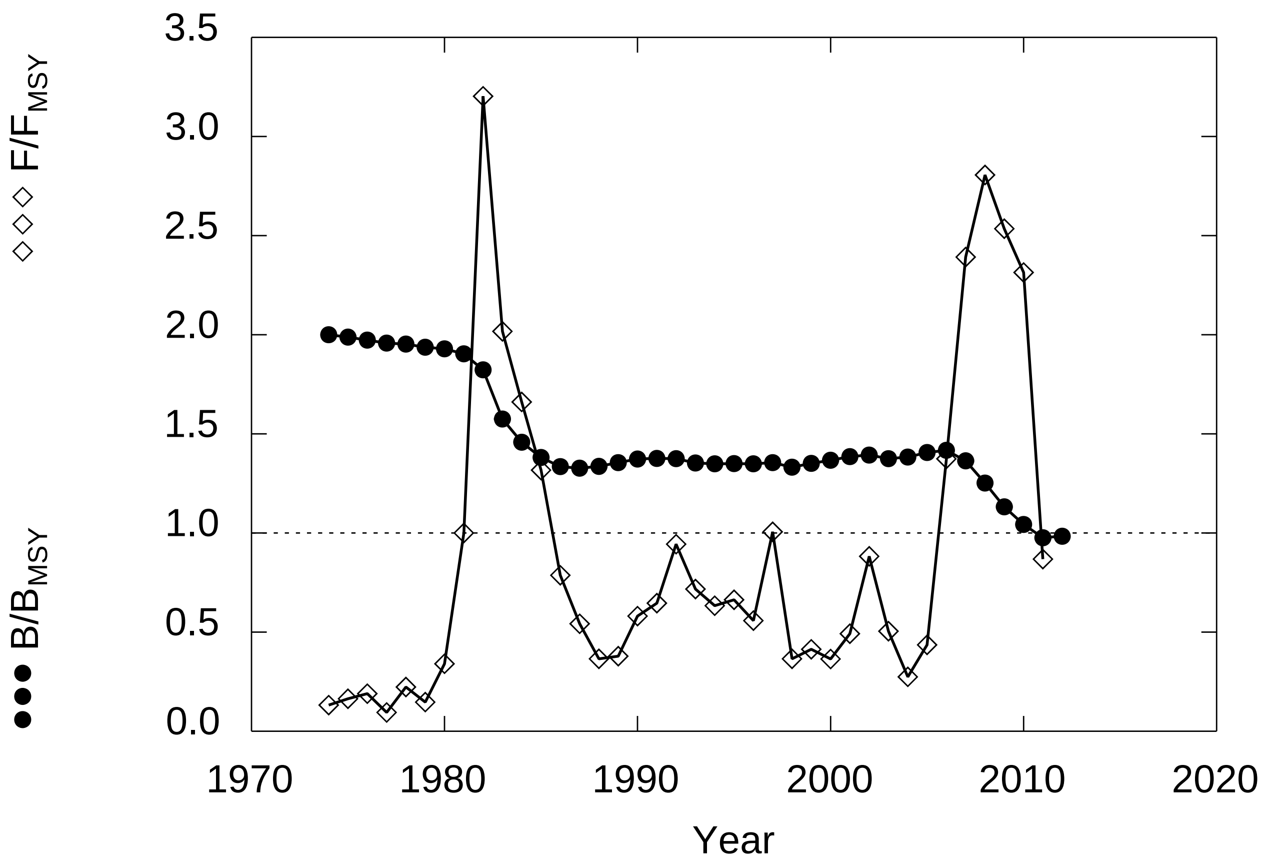
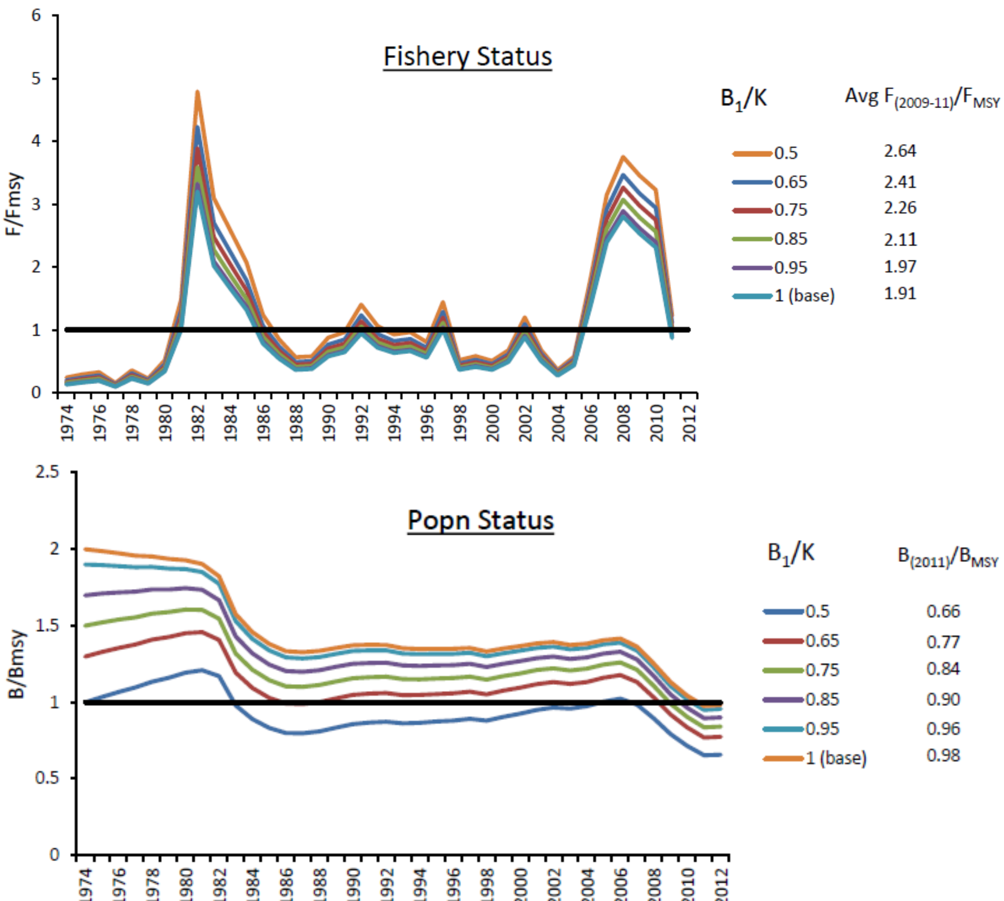


Figure 3.54. Blueline tilefish production model: Trends in relative fishing mortality (F/F_{MSY}, top panel) and relative biomass (B/B_{MSY}, bottom panel) estimated by the production model for different values of B1/K.



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 blueline tilefish)
ASY	Average Sustainable Yield
B	Total biomass of stock, conventionally on January 1
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 blueline tilefish)
F	Instantaneous rate of fishing mortality
F_{MSY}	Fishing mortality rate at which MSY can be attained
FL	State of Florida
GA	State of Georgia
GLM	Generalized linear model
K	Average size of stock when not exploited by man; carrying capacity
kg	Kilogram(s); 1 kg is about 2.2 lb.
klb	Thousand pounds; thousands of pounds
lb	Pound(s); 1 lb is about 0.454 kg
m	Meter(s); 1 m is about 3.28 feet.
M	Instantaneous rate of natural (non-fishing) mortality
MARMAP	Marine Resources Monitoring, Assessment, and Prediction Program, a fishery-independent data collection program of SCDNR
MCB	Monte Carlo/Boostrap, an approach to quantifying uncertainty in model results
MFMT	Maximum fishing-mortality threshold; a limit reference point used in U.S. fishery management; often based on F_{MSY}
mm	Millimeter(s); 1 inch = 25.4 mm
MRFSS	Marine Recreational Fisheries Statistics Survey, a data-collection program of NMFS, predecessor of MRIP
MRIP	Marine Recreational Information Program, a data-collection program of NMFS, descended from MRFSS
MSST	Minimum stock-size threshold; a limit reference point used in U.S. fishery management. The SAFMC has defined MSST for blueline tilefish as $(1 - M)\mathrm{SSB}_{\mathrm{MSY}} = 0.7\mathrm{SSB}_{\mathrm{MSY}}$.
MSY	Maximum sustainable yield (per year)
mt	Metric ton(s). One mt is 1000 kg, or about 2205 lb.
N	Number of fish in a stock, conventionally on January 1
NC	State of North Carolina
NMFS	National Marine Fisheries Service, same as "NOAA Fisheries Service"
NOAA	National Oceanic and Atmospheric Administration; parent agency of NMFS
OY	Optimum yield; SFA specifies that OY $\leq$ MSY.
PSE	Proportional standard error
R	Recruitment
SAFMC	South Atlantic Fishery Management Council (also, Council)
SC	State of South Carolina
SCDNR	Department of Natural Resources of SC
SDNR	Standard deviation of normalized residuals
SEDAR	SouthEast Data Assessment and Review process
SFA	Sustainable Fisheries Act; the Magnuson–Stevens Act, as amended
SL	Standard length (of a fish)
SPR	Spawning potential ratio
SSB	Spawning stock biomass; mature biomass of males and females
$\mathrm{SSB}_{\mathrm{MSY}}$	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 = 175  Objective function value = -339.463  Maximum gradient component = 8.95255e-005
# Linf:
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# K:
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# t0:
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# len_cv_val:
0.156000000000
# agepar_a_F:
353.900000000
# agepar_b_F:
0.255000000000
# len_cv_val_F:
0.117000000000
# agepar_a_mrip:
256.700000000
# agepar_b_mrip:
0.380000000000
# len_cv_val_mrip:
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# steep:
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# rec_sigma:
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# log_rec_dev:
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 -0.107867016447 -0.130977568046 -0.150348402384 -0.198850770780 -0.222247947721
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-0.251563756755 0.0824894161757 0.143882478396 0.508626005361 0.972167440893
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# log_Nage_dev:
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# selpar_slope_mrip:
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# selpar_L50_cHL:
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# selpar_slope_cHL:
1.47262967952
# selpar_L50_cLL:
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# selpar_slope_cLL:
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# log_q_cLL:
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# log_q_hb:
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# log_q_cHL:
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# M_constant:
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# log_avg_F_mrip:
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# log_F_dev_mrip:
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-1.05270552002 0.389718655881 -1.52424650416 -1.25181494775 -2.28597955531 0.645773892978
-0.149007909203 0.351084499190 -3.02938313769 1.03441731288 0.561010103261 2.23407189222
-2.60568181193 0.00912996591360 -2.68219000577 0.997849275201 -1.01818200156 1.34187700925
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# log_F_dev_cHL:
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0.305471174608 0.810568871809 1.00707556008 0.281786041853 0.424658515463 0.309819254624 0.467897924465
1.05717526640 0.573373940619 -0.171674083514 -0.0678416740218 0.397538928241 -0.372069122149 0.936726551494
1.35077167634 1.02845184769 -0.801749902011
# log_avg_F_cLL:
-2.19447243557
# log_F_dev_cLL:
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0.743368972185 -0.0280259892874 -0.249529010730 -0.345420096871 -0.102306128776 0.0771870913477 0.973829580475
1.01045781960 0.905822631704 0.800027328716 -0.493598356250 0.410428344964 -0.149723722425 -0.317517638312
-0.427617354029 -0.412370523714 0.973978461662 -0.211491487430 -0.572169385027 -1.19482795825 -0.401259381930
-2.67344283383 0.838071133263 1.09335208558 1.80548173926 0.970837463033
# F_init:
0.00507448000762
```

Appendix C ASPIC Output: Results of production model run for blueline tilefish.

```
BLT SEDAR32 (landings and discards) April 2013                                                          Page 1
                                                                                  Tuesday, 20 Aug 2013 at 14:34:37
ASPIC -- A Surplus-Production Model Including Covariates (Ver. 5.47)
                                                                                                FIT program mode
Author:     Michael H. Prager                                                               LOGISTIC model mode
            Prager Consulting                                                               YLD conditioning
            mike.prager@mhprager.com                                                        SSE optimization

Reference:  Prager, M. H. 1994. A suite of extensions to a nonequilibrium              ASPIC User's Manual is available
            surplus-production model.  Fishery Bulletin 92: 374-389.                          gratis from the author.

CONTROL PARAMETERS (FROM INPUT FILE)           Input file: C:/...32/AW/ASPIC/indices/blt-landings&discards_74-11_38.inp
------------------------------------------------------------------------------------------------------------------------
Operation of ASPIC:  Fit logistic (Schaefer) model by direct optimization.
Number of years analyzed:                     38           Number of bootstrap trials:                              0
Number of data series:                         3           Bounds on MSY (min, max):       5.000E+01     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:            10
Maximum F allowed in fitting:              8.000


PROGRAM STATUS INFORMATION (NON-BOOTSTRAPPED ANALYSIS)                                              error code   0
------------------------------------------------------------------------------------------------------------------------
Normal convergence
Number of restarts required for convergence:     32


CORRELATION AMONG INPUT SERIES EXPRESSED AS CPUE (NUMBER OF PAIRWISE OBSERVATIONS BELOW)
------------------------------------------------------------------------------------------------------------------------
                                      |
 1  Com HL Index                      |   1.000
                                      |      18
                                      |
 2  Com Longline Index                |   0.356   1.000
                                      |      12      12
                                      |
 3  Rec Headboat                      |   0.000   0.000   1.000
                                      |       0       0      13
                                      --------------------------------------------------
                                              1       2       3


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                        1.702E-20     1          N/A    1.000E+00          N/A
Loss(1)   Com HL Index                              1.347E+00    18    8.421E-02    1.000E+00    1.454E+00      -0.326
Loss(2)   Com Longline Index                        1.917E+00    12    1.917E-01    1.000E+00    6.384E-01      -0.058
Loss(3)   Rec Headboat                              1.908E+00    13    1.734E-01    1.000E+00    7.058E-01       0.343
..........................................................................................
TOTAL OBJECTIVE FUNCTION, MSE, RMSE:           5.17204683E+00          1.361E-01    3.689E-01
Estimated contrast index (ideal = 1.0):                0.5121          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 1974)       1.000E+00          1.000E+00    7.296E-01             0            1
```

MSY	Maximum sustainable yield	1.001E+02	2.700E+02	1.053E+02	1	1
K	Maximum population size	3.974E+03	1.000E+04	1.000E+07	1	1
phi	Shape of production curve (Bmsy/K)	0.5000	0.5000	----	0	1

--------- Catchability Coefficients by Data Series ---------------

q(1)	Com HL Index	3.725E-04	1.450E-04	1.586E-03	1	1
q(2)	Com Longline Index	3.394E-04	1.210E-04	1.150E-02	1	1
q(3)	Rec Headboat	3.070E-04	8.500E-04	8.075E-02	1	1

MANAGEMENT and DERIVED PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter		Estimate	Logistic formula	General formula
MSY	Maximum sustainable yield	1.001E+02	----	----
Bmsy	Stock biomass giving MSY	1.987E+03	K/2	K*n**(1/(1-n))
Fmsy	Fishing mortality rate at MSY	5.039E-02	MSY/Bmsy	MSY/Bmsy
n	Exponent in production function	2.0000	----	----
g	Fletcher's gamma	4.000E+00	----	[n**(n/(n-1))]/[n-1]
B./Bmsy	Ratio: B(2012)/Bmsy	9.834E-01	----	----
F./Fmsy	Ratio: F(2011)/Fmsy	8.682E-01	----	----
Fmsy/F.	Ratio: Fmsy/F(2011)	1.152E+00	----	----
Y.(Fmsy)	Approx. yield available at Fmsy in 2012	9.850E+01	MSY*B./Bmsy	MSY*B./Bmsy
	...as proportion of MSY	9.838E-01	----	----
Ye.	Equilibrium yield available in 2012	1.001E+02	4*MSY*(B/K-(B/K)**2)	g*MSY*(B/K-(B/K)**n)
	...as proportion of MSY	9.997E-01	----	----

--------- Fishing effort rate at MSY in units of each CE or CC series ---------

fmsy(1)	Com HL Index	1.353E+02	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	1974	0.007	3.974E+03	3.961E+03	2.625E+01	2.625E+01	1.275E+00	1.315E-01	2.000E+00
2	1975	0.008	3.949E+03	3.934E+03	3.240E+01	3.240E+01	3.936E+00	1.634E-01	1.988E+00
3	1976	0.010	3.920E+03	3.905E+03	3.723E+01	3.723E+01	6.823E+00	1.892E-01	1.973E+00
4	1977	0.005	3.890E+03	3.885E+03	1.847E+01	1.847E+01	8.748E+00	9.434E-02	1.958E+00
5	1978	0.011	3.880E+03	3.864E+03	4.337E+01	4.337E+01	1.079E+01	2.227E-01	1.953E+00
6	1979	0.007	3.848E+03	3.840E+03	2.838E+01	2.838E+01	1.304E+01	1.467E-01	1.937E+00
7	1980	0.017	3.832E+03	3.807E+03	6.528E+01	6.528E+01	1.607E+01	3.402E-01	1.929E+00
8	1981	0.050	3.783E+03	3.701E+03	1.866E+02	1.866E+02	2.557E+01	1.000E+00	1.904E+00
9	1982	0.161	3.622E+03	3.367E+03	5.434E+02	5.434E+02	5.133E+01	3.203E+00	1.823E+00
10	1983	0.102	3.130E+03	3.011E+03	3.061E+02	3.061E+02	7.342E+01	2.017E+00	1.575E+00
11	1984	0.084	2.898E+03	2.819E+03	2.360E+02	2.360E+02	8.251E+01	1.661E+00	1.458E+00
12	1985	0.066	2.744E+03	2.697E+03	1.791E+02	1.791E+02	8.730E+01	1.317E+00	1.381E+00
13	1986	0.040	2.652E+03	2.644E+03	1.048E+02	1.048E+02	8.916E+01	7.864E-01	1.335E+00
14	1987	0.027	2.637E+03	2.645E+03	7.222E+01	7.222E+01	8.913E+01	5.418E-01	1.327E+00
15	1988	0.018	2.654E+03	2.673E+03	4.917E+01	4.917E+01	8.817E+01	3.650E-01	1.336E+00
16	1989	0.019	2.693E+03	2.710E+03	5.168E+01	5.168E+01	8.685E+01	3.784E-01	1.355E+00
17	1990	0.029	2.728E+03	2.731E+03	7.987E+01	7.987E+01	8.609E+01	5.804E-01	1.373E+00
18	1991	0.033	2.734E+03	2.732E+03	8.892E+01	8.892E+01	8.603E+01	6.458E-01	1.376E+00
19	1992	0.048	2.731E+03	2.710E+03	1.288E+02	1.288E+02	8.687E+01	9.434E-01	1.375E+00
20	1993	0.036	2.689E+03	2.684E+03	9.698E+01	9.698E+01	8.778E+01	7.169E-01	1.353E+00
21	1994	0.032	2.680E+03	2.681E+03	8.551E+01	8.551E+01	8.790E+01	6.329E-01	1.349E+00
22	1995	0.033	2.682E+03	2.681E+03	8.957E+01	8.957E+01	8.789E+01	6.629E-01	1.350E+00
23	1996	0.028	2.681E+03	2.687E+03	7.551E+01	7.551E+01	8.770E+01	5.577E-01	1.349E+00
24	1997	0.051	2.693E+03	2.669E+03	1.353E+02	1.353E+02	8.832E+01	1.006E+00	1.355E+00
25	1998	0.018	2.646E+03	2.666E+03	4.904E+01	4.904E+01	8.844E+01	3.651E-01	1.332E+00
26	1999	0.021	2.685E+03	2.701E+03	5.621E+01	5.621E+01	8.719E+01	4.130E-01	1.351E+00
27	2000	0.018	2.716E+03	2.734E+03	5.016E+01	5.016E+01	8.596E+01	3.640E-01	1.367E+00
28	2001	0.025	2.752E+03	2.760E+03	6.842E+01	6.842E+01	8.495E+01	4.919E-01	1.385E+00

29	2002	0.044	2.769E+03	2.750E+03	1.222E+02	1.222E+02	8.536E+01	8.821E-01	1.393E+00
30	2003	0.025	2.732E+03	2.740E+03	6.964E+01	6.964E+01	8.575E+01	5.044E-01	1.375E+00
31	2004	0.014	2.748E+03	2.771E+03	3.828E+01	3.828E+01	8.452E+01	2.741E-01	1.383E+00
32	2005	0.022	2.794E+03	2.805E+03	6.155E+01	6.155E+01	8.315E+01	4.354E-01	1.406E+00
33	2006	0.069	2.816E+03	2.761E+03	1.912E+02	1.912E+02	8.488E+01	1.374E+00	1.417E+00
34	2007	0.121	2.709E+03	2.595E+03	3.128E+02	3.128E+02	9.063E+01	2.392E+00	1.364E+00
35	2008	0.141	2.487E+03	2.365E+03	3.344E+02	3.344E+02	9.638E+01	2.806E+00	1.252E+00
36	2009	0.128	2.249E+03	2.159E+03	2.758E+02	2.758E+02	9.931E+01	2.535E+00	1.132E+00
37	2010	0.117	2.073E+03	2.004E+03	2.338E+02	2.338E+02	1.001E+02	2.314E+00	1.043E+00
38	2011	0.044	1.939E+03	1.946E+03	8.516E+01	8.516E+01	1.001E+02	8.682E-01	9.759E-01
39	2012		1.954E+03						9.834E-01

RESULTS FOR DATA SERIES # 1 (NON-BOOTSTRAPPED) Com HL Index

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	1974	*	1.475E+00	0.0066	2.625E+01	2.625E+01	0.00000	1.000E+00
2	1975	*	1.465E+00	0.0082	3.240E+01	3.240E+01	0.00000	1.000E+00
3	1976	*	1.454E+00	0.0095	3.723E+01	3.723E+01	0.00000	1.000E+00
4	1977	*	1.447E+00	0.0048	1.847E+01	1.847E+01	0.00000	1.000E+00
5	1978	*	1.439E+00	0.0112	4.337E+01	4.337E+01	0.00000	1.000E+00
6	1979	*	1.430E+00	0.0074	2.838E+01	2.838E+01	0.00000	1.000E+00
7	1980	*	1.418E+00	0.0171	6.528E+01	6.528E+01	0.00000	1.000E+00
8	1981	*	1.378E+00	0.0504	1.866E+02	1.866E+02	0.00000	1.000E+00
9	1982	*	1.254E+00	0.1614	5.434E+02	5.434E+02	0.00000	1.000E+00
10	1983	*	1.121E+00	0.1016	3.061E+02	3.061E+02	0.00000	1.000E+00
11	1984	*	1.050E+00	0.0837	2.360E+02	2.360E+02	0.00000	1.000E+00
12	1985	*	1.005E+00	0.0664	1.791E+02	1.791E+02	0.00000	1.000E+00
13	1986	*	9.849E-01	0.0396	1.048E+02	1.048E+02	0.00000	1.000E+00
14	1987	*	9.852E-01	0.0273	7.222E+01	7.222E+01	0.00000	1.000E+00
15	1988	*	9.956E-01	0.0184	4.917E+01	4.917E+01	0.00000	1.000E+00
16	1989	*	1.009E+00	0.0191	5.168E+01	5.168E+01	0.00000	1.000E+00
17	1990	*	1.017E+00	0.0292	7.987E+01	7.987E+01	0.00000	1.000E+00
18	1991	*	1.018E+00	0.0325	8.892E+01	8.892E+01	0.00000	1.000E+00
19	1992	*	1.009E+00	0.0475	1.288E+02	1.288E+02	0.00000	1.000E+00
20	1993	1.125E+00	9.998E-01	0.0361	9.698E+01	9.698E+01	-0.11801	1.000E+00
21	1994	6.720E-01	9.985E-01	0.0319	8.551E+01	8.551E+01	0.39603	1.000E+00
22	1995	6.380E-01	9.987E-01	0.0334	8.957E+01	8.957E+01	0.44807	1.000E+00
23	1996	9.350E-01	1.001E+00	0.0281	7.551E+01	7.551E+01	0.06785	1.000E+00
24	1997	9.830E-01	9.940E-01	0.0507	1.353E+02	1.353E+02	0.01114	1.000E+00
25	1998	1.163E+00	9.928E-01	0.0184	4.904E+01	4.904E+01	-0.15824	1.000E+00
26	1999	7.960E-01	1.006E+00	0.0208	5.621E+01	5.621E+01	0.23402	1.000E+00
27	2000	1.020E+00	1.018E+00	0.0183	5.016E+01	5.016E+01	-0.00164	1.000E+00
28	2001	9.100E-01	1.028E+00	0.0248	6.842E+01	6.842E+01	0.12197	1.000E+00
29	2002	7.560E-01	1.024E+00	0.0445	1.222E+02	1.222E+02	0.30356	1.000E+00
30	2003	7.410E-01	1.020E+00	0.0254	6.964E+01	6.964E+01	0.31994	1.000E+00
31	2004	8.750E-01	1.032E+00	0.0138	3.828E+01	3.828E+01	0.16507	1.000E+00
32	2005	1.138E+00	1.045E+00	0.0219	6.155E+01	6.155E+01	-0.08559	1.000E+00
33	2006	1.487E+00	1.028E+00	0.0692	1.912E+02	1.912E+02	-0.36869	1.000E+00
34	2007	1.182E+00	9.666E-01	0.1205	3.128E+02	3.128E+02	-0.20116	1.000E+00
35	2008	1.415E+00	8.808E-01	0.1414	3.344E+02	3.344E+02	-0.47408	1.000E+00
36	2009	9.940E-01	8.040E-01	0.1278	2.758E+02	2.758E+02	-0.21210	1.000E+00
37	2010	1.169E+00	7.465E-01	0.1166	2.338E+02	2.338E+02	-0.44848	1.000E+00
38	2011	*	7.249E-01	0.0438	8.516E+01	8.516E+01	0.00000	1.000E+00

* Asterisk indicates missing value(s).

UNWEIGHTED LOG RESIDUAL PLOT FOR DATA SERIES # 1

```
                   -1      -0.75     -0.5     -0.25      0       0.25      0.5      0.75      1
                    |   .    |   .    |   .    |   .    |    .    |    .   |    .   |    .   |
Year   Residual    -------------------------------------------------------------------------------------
1974     0.0000                                         |
1975     0.0000                                         |
```

```
1976     0.0000                                             |
1977     0.0000                                             |
1978     0.0000                                             |
1979     0.0000                                             |
1980     0.0000                                             |
1981     0.0000                                             |
1982     0.0000                                             |
1983     0.0000                                             |
1984     0.0000                                             |
1985     0.0000                                             |
1986     0.0000                                             |
1987     0.0000                                             |
1988     0.0000                                             |
1989     0.0000                                             |
1990     0.0000                                             |
1991     0.0000                                             |
1992     0.0000                                             |
1993    -0.1180                                        =====|
1994     0.3960                                             |================
1995     0.4481                                             |==================
1996     0.0679                                             |===
1997     0.0111                                             |
1998    -0.1582                                       ======|
1999     0.2340                                             |=========
2000    -0.0016                                             |
2001     0.1220                                             |=====
2002     0.3036                                             |============
2003     0.3199                                             |=============
2004     0.1651                                             |=======
2005    -0.0856                                          ===|
2006    -0.3687                               ===============|
2007    -0.2012                                     ========|
2008    -0.4741                           ===================|
2009    -0.2121                                     ========|
2010    -0.4485                            ==================|
2011     0.0000                                             |
                   ------------------------------------------------------------------------------------
```

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RESULTS FOR DATA SERIES # 2 (NON-BOOTSTRAPPED) Com Longline Index

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	1974	0.000E+00	0.000E+00	--	*	1.344E+00	0.00000	1.000E+00
2	1975	0.000E+00	0.000E+00	--	*	1.335E+00	0.00000	1.000E+00
3	1976	0.000E+00	0.000E+00	--	*	1.325E+00	0.00000	1.000E+00
4	1977	0.000E+00	0.000E+00	--	*	1.318E+00	0.00000	1.000E+00
5	1978	0.000E+00	0.000E+00	--	*	1.311E+00	0.00000	1.000E+00
6	1979	0.000E+00	0.000E+00	--	*	1.303E+00	0.00000	1.000E+00
7	1980	0.000E+00	0.000E+00	--	*	1.292E+00	0.00000	1.000E+00
8	1981	0.000E+00	0.000E+00	--	*	1.256E+00	0.00000	1.000E+00
9	1982	0.000E+00	0.000E+00	--	*	1.142E+00	0.00000	1.000E+00
10	1983	0.000E+00	0.000E+00	--	*	1.022E+00	0.00000	1.000E+00
11	1984	0.000E+00	0.000E+00	--	*	9.567E-01	0.00000	1.000E+00
12	1985	0.000E+00	0.000E+00	--	*	9.154E-01	0.00000	1.000E+00
13	1986	0.000E+00	0.000E+00	--	*	8.974E-01	0.00000	1.000E+00
14	1987	0.000E+00	0.000E+00	--	*	8.976E-01	0.00000	1.000E+00
15	1988	0.000E+00	0.000E+00	--	*	9.072E-01	0.00000	1.000E+00
16	1989	0.000E+00	0.000E+00	--	*	9.197E-01	0.00000	1.000E+00
17	1990	0.000E+00	0.000E+00	--	*	9.267E-01	0.00000	1.000E+00
18	1991	0.000E+00	0.000E+00	--	*	9.273E-01	0.00000	1.000E+00
19	1992	0.000E+00	0.000E+00	--	*	9.196E-01	0.00000	1.000E+00
20	1993	1.000E+00	1.000E+00	--	2.254E+00	9.110E-01	0.90596	1.000E+00
21	1994	1.000E+00	1.000E+00	--	1.024E+00	9.098E-01	0.11821	1.000E+00
22	1995	1.000E+00	1.000E+00	--	9.740E-01	9.099E-01	0.06802	1.000E+00
23	1996	1.000E+00	1.000E+00	--	7.110E-01	9.118E-01	-0.24870	1.000E+00

24	1997	1.000E+00	1.000E+00	--	1.530E+00	9.057E-01	0.52430	1.000E+00
25	1998	1.000E+00	1.000E+00	--	1.032E+00	9.046E-01	0.13176	1.000E+00
26	1999	1.000E+00	1.000E+00	--	7.090E-01	9.165E-01	-0.25674	1.000E+00
27	2000	1.000E+00	1.000E+00	--	5.010E-01	9.279E-01	-0.61629	1.000E+00
28	2001	1.000E+00	1.000E+00	--	7.660E-01	9.367E-01	-0.20121	1.000E+00
29	2002	1.000E+00	1.000E+00	--	1.025E+00	9.332E-01	0.09388	1.000E+00
30	2003	1.000E+00	1.000E+00	--	8.910E-01	9.297E-01	-0.04257	1.000E+00
31	2004	1.000E+00	1.000E+00	--	5.840E-01	9.404E-01	-0.47637	1.000E+00
32	2005	0.000E+00	0.000E+00	--	*	9.518E-01	0.00000	1.000E+00
33	2006	0.000E+00	0.000E+00	--	*	9.371E-01	0.00000	1.000E+00
34	2007	0.000E+00	0.000E+00	--	*	8.808E-01	0.00000	1.000E+00
35	2008	0.000E+00	0.000E+00	--	*	8.025E-01	0.00000	1.000E+00
36	2009	0.000E+00	0.000E+00	--	*	7.326E-01	0.00000	1.000E+00
37	2010	0.000E+00	0.000E+00	--	*	6.802E-01	0.00000	1.000E+00
38	2011	0.000E+00	0.000E+00	--	*	6.605E-01	0.00000	1.000E+00

* Asterisk indicates missing value(s).

BLT SEDAR32 (landings and discards) April 2013 Page 7

UNWEIGHTED LOG RESIDUAL PLOT FOR DATA SERIES # 2

```
                   -1       -0.75     -0.5      -0.25       0        0.25      0.5       0.75       1
                    |    .    |    .    |    .    |    .    |    .    |    .    |    .    |    .    |
Year   Residual    -------------------------------------------------------------------------------------
1974     0.0000                                             |
1975     0.0000                                             |
1976     0.0000                                             |
1977     0.0000                                             |
1978     0.0000                                             |
1979     0.0000                                             |
1980     0.0000                                             |
1981     0.0000                                             |
1982     0.0000                                             |
1983     0.0000                                             |
1984     0.0000                                             |
1985     0.0000                                             |
1986     0.0000                                             |
1987     0.0000                                             |
1988     0.0000                                             |
1989     0.0000                                             |
1990     0.0000                                             |
1991     0.0000                                             |
1992     0.0000                                             |
1993     0.9060                                             |====================================
1994     0.1182                                             |=====
1995     0.0680                                             |===
1996    -0.2487                                   ==========|
1997     0.5243                                             |=====================
1998     0.1318                                             |=====
1999    -0.2567                                   ==========|
2000    -0.6163                    =========================|
2001    -0.2012                                     ========|
2002     0.0939                                             |====
2003    -0.0426                                           ==|
2004    -0.4764                          ===================|
2005     0.0000                                             |
2006     0.0000                                             |
2007     0.0000                                             |
2008     0.0000                                             |
2009     0.0000                                             |
2010     0.0000                                             |
2011     0.0000                                             |
                   -------------------------------------------------------------------------------------
```

BLT SEDAR32 (landings and discards) April 2013 Page 8

RESULTS FOR DATA SERIES # 3 (NON-BOOTSTRAPPED) Rec Headboat

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	1974	0.000E+00	0.000E+00	--	*	1.216E+00	0.00000	1.000E+00
2	1975	0.000E+00	0.000E+00	--	*	1.208E+00	0.00000	1.000E+00
3	1976	0.000E+00	0.000E+00	--	*	1.199E+00	0.00000	1.000E+00
4	1977	0.000E+00	0.000E+00	--	*	1.192E+00	0.00000	1.000E+00
5	1978	0.000E+00	0.000E+00	--	*	1.186E+00	0.00000	1.000E+00
6	1979	0.000E+00	0.000E+00	--	*	1.179E+00	0.00000	1.000E+00
7	1980	1.000E+00	1.000E+00	--	1.962E+00	1.169E+00	0.51818	1.000E+00
8	1981	1.000E+00	1.000E+00	--	1.829E+00	1.136E+00	0.47636	1.000E+00
9	1982	1.000E+00	1.000E+00	--	1.226E+00	1.033E+00	0.17098	1.000E+00
10	1983	1.000E+00	1.000E+00	--	1.452E+00	9.241E-01	0.45186	1.000E+00
11	1984	1.000E+00	1.000E+00	--	7.140E-01	8.653E-01	-0.19216	1.000E+00
12	1985	1.000E+00	1.000E+00	--	6.890E-01	8.279E-01	-0.18363	1.000E+00
13	1986	1.000E+00	1.000E+00	--	6.890E-01	8.116E-01	-0.16379	1.000E+00
14	1987	1.000E+00	1.000E+00	--	8.890E-01	8.119E-01	0.09076	1.000E+00
15	1988	1.000E+00	1.000E+00	--	6.580E-01	8.205E-01	-0.22068	1.000E+00
16	1989	1.000E+00	1.000E+00	--	7.490E-01	8.319E-01	-0.10492	1.000E+00
17	1990	1.000E+00	1.000E+00	--	3.400E-01	8.382E-01	-0.90227	1.000E+00
18	1991	1.000E+00	1.000E+00	--	6.310E-01	8.387E-01	-0.28450	1.000E+00
19	1992	1.000E+00	1.000E+00	--	1.173E+00	8.317E-01	0.34386	1.000E+00
20	1993	0.000E+00	0.000E+00	--	*	8.239E-01	0.00000	1.000E+00
21	1994	0.000E+00	0.000E+00	--	*	8.229E-01	0.00000	1.000E+00
22	1995	0.000E+00	0.000E+00	--	*	8.230E-01	0.00000	1.000E+00
23	1996	0.000E+00	0.000E+00	--	*	8.246E-01	0.00000	1.000E+00
24	1997	0.000E+00	0.000E+00	--	*	8.192E-01	0.00000	1.000E+00
25	1998	0.000E+00	0.000E+00	--	*	8.182E-01	0.00000	1.000E+00
26	1999	0.000E+00	0.000E+00	--	*	8.290E-01	0.00000	1.000E+00
27	2000	0.000E+00	0.000E+00	--	*	8.392E-01	0.00000	1.000E+00
28	2001	0.000E+00	0.000E+00	--	*	8.472E-01	0.00000	1.000E+00
29	2002	0.000E+00	0.000E+00	--	*	8.440E-01	0.00000	1.000E+00
30	2003	0.000E+00	0.000E+00	--	*	8.409E-01	0.00000	1.000E+00
31	2004	0.000E+00	0.000E+00	--	*	8.505E-01	0.00000	1.000E+00
32	2005	0.000E+00	0.000E+00	--	*	8.609E-01	0.00000	1.000E+00
33	2006	0.000E+00	0.000E+00	--	*	8.476E-01	0.00000	1.000E+00
34	2007	0.000E+00	0.000E+00	--	*	7.966E-01	0.00000	1.000E+00
35	2008	0.000E+00	0.000E+00	--	*	7.258E-01	0.00000	1.000E+00
36	2009	0.000E+00	0.000E+00	--	*	6.626E-01	0.00000	1.000E+00
37	2010	0.000E+00	0.000E+00	--	*	6.152E-01	0.00000	1.000E+00
38	2011	0.000E+00	0.000E+00	--	*	5.974E-01	0.00000	1.000E+00

* Asterisk indicates missing value(s).

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```
UNWEIGHTED LOG RESIDUAL PLOT FOR DATA SERIES # 3
                   -1       -0.75     -0.5      -0.25       0        0.25      0.5       0.75       1
                    |    .    |    .    |    .    |    .    |    .    |    .    |    .    |    .    |
Year   Residual    ------------------------------------------------------------------------------------
1974     0.0000                                             |
1975     0.0000                                             |
1976     0.0000                                             |
1977     0.0000                                             |
1978     0.0000                                             |
1979     0.0000                                             |
1980     0.5182                                             |=====================
1981     0.4764                                             |===================
1982     0.1710                                             |=======
1983     0.4519                                             |==================
1984    -0.1922                                     ========|
1985    -0.1836                                      =======|
1986    -0.1638                                      =======|
1987     0.0908                                             |====
1988    -0.2207                                    =========|
1989    -0.1049                                         ====|
1990    -0.9023         ====================================|
1991    -0.2845                                  ===========|
1992     0.3439                                             |==============
1993     0.0000                                             |
1994     0.0000                                             |
```

```
1995     0.0000                                             |
1996     0.0000                                             |
1997     0.0000                                             |
1998     0.0000                                             |
1999     0.0000                                             |
2000     0.0000                                             |
2001     0.0000                                             |
2002     0.0000                                             |
2003     0.0000                                             |
2004     0.0000                                             |
2005     0.0000                                             |
2006     0.0000                                             |
2007     0.0000                                             |
2008     0.0000                                             |
2009     0.0000                                             |
2010     0.0000                                             |
2011     0.0000                                             |
                   -------------------------------------------------------------------------------------

BLT SEDAR32 (landings and discards) April 2013                                                                  Page 10

                Observed (O) and Estimated (*) CPUE for Data Series # 1 -- Com HL Index
           :
      1.6 -:
           :
           :
           :        * *                                                             O
           :            * * * *
      1.4 -:                    *                                                       O
           :                      *
           :
           :
           :                        *
      1.2 -:                                                                          O
           :                                                        O                       O
           :                          *                   O                       O
           :
           :                            *                               O * * * * * *
      1.0 -:                              * * * * * * * * * * * * 2 * * *                 O
           :                                                                          *
           :                                                    O         O
           :                                                                    O       *
           :
      0.8 -:                                                          O                   *
           :                                                                O O             *
           :                                                                                  *
           :                                                O
           :                                                  O
      0.6 -:
           :
           :
           :
           :
      0.4 -:
           :........................................................................................................
            :         :         :         :         :         :         :         :         :         :         :
         1970.     1975.     1980.     1985.     1990.     1995.     2000.     2005.     2010.     2015.     2020.


                Observed (O) and Estimated (*) CPUE for Data Series # 2 -- Com Longline Index
           :
      2.4 -:
           :
           :                                              O
           :
           :
      2.0 -:
           :
           :
           :
```

```
           :
      1.6 -:
           :                                                      O
           :
           :        * * *
           :              * * * * *
      1.2 -:                        *
           :                          *
           :                                                O       O       O
           :                            *           * *       O         * * * * * * *
           :                              * * * * *     * * * * * * * *       O       *
      0.8 -:                                                              O             *
           :                                                    O     O                   * *
           :                                                                                  *
           :                                                                    O
           :                                                            O
      0.4 -:
           :
           :
           :
           :
      0.0 -:
           :........................................................................................................
            :         :         :         :         :         :         :         :         :         :         :
         1970.     1975.     1980.     1985.     1990.     1995.     2000.     2005.     2010.     2015.     2020.
```

```
BLT SEDAR32 (landings and discards) April 2013                                                                  Page 11

                Observed (O) and Estimated (*) CPUE for Data Series # 3 -- Rec Headboat
           :
      2.4 -:
           :
           :
           :
           :
      2.0 -:                    O
           :                      O
           :
           :
      1.6 -:
           :
           :                          O
           :
           :
      1.2 -:        * * * * * * *   O                   O
           :                      *
           :                        *
           :                          *
           :                            *     O                           * * * * * *
      0.8 -:                              * * * * * * * * * * * * * * * *             *
           :                            O O O     O                                     *
           :                                    O     O                                   * *
           :                                                                                  *
           :
      0.4 -:
           :                                        O
           :
           :
           :
      0.0 -:
           :........................................................................................................
            :         :         :         :         :         :         :         :         :         :         :
         1970.     1975.     1980.     1985.     1990.     1995.     2000.     2005.     2010.     2015.     2020.


                                   Time Plot of Estimated F/Fmsy and B/Bmsy (dashed line = 1.0)
           :
      3.6 -:
           :
```

```
          :
          :                        F
          :
     3.0 -:
          :
          :                                                                            F
          :
          :                                                                              F
     2.4 -:                                                                          F
          :                                                                                F
          :
          :        B B               F
          :            B B B B B B
     1.8 -:                        B
          :                            F
          :                          B
          :                            B B                               B B   B B B
          :                              F B B B B B B B B B B B B B B B     B     F B
     1.2 -:                                                                            B
          :                                                                              B B
          :- - - - - - - - - - - 2 - - - - - - - - - - 2 - - - - 2 - - - - - - - - - - - - - 2 2 - - - - - - - -
          :                                F                               F                 F
          :                                              F   F
     0.6 -:                                  F     F F     F   F
          :                                                              F   F   F
          :                    F               F F                 F F F
          :            F   F                                                   F
          :        F F   F   F
     0.0 -:
          :........................................................................................................
           :         :         :         :         :         :         :         :         :         :         :
        1970.     1975.     1980.     1985.     1990.     1995.     2000.     2005.     2010.     2015.     2020.
```

Elapsed time: 0 hours, 0 minutes, 3 seconds.

SEDAR

Southeast Data, Assessment, and Review

SEDAR 32

South Atlantic Blueline Tilefish

SECTION IV: Research Recommendations

September 2013

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

Section IV. Research Recommendations

Contents

Data Workshop Research Recommendations

Life History

- Stock Structure
  - Blueline tilefish stock definition needs to be investigated further. Genetic study or some other form of stock identification study needs to be undertaken with samples (muscle, fin clips, etc.) collected from several locations within the Gulf of Mexico and the northwestern Atlantic.
  - Habitat studies of deep water sites in the mid-Atlantic, specifically Norfolk Canyon, Balitmore Canyon, and Hudson Canyon need to be undertaken. Temperature data from research conducted in the 1970s in Norfolk Canyon can be used for comparison purposes.
- Age Data
  - Age readings of blueline tilefish need to be validated. Within and between lab variability in readings is large and needs to be addressed. The potential bias in age readings between laboratories also needs to be addressed with another age workshop and exchange of calibration sets of samples.
  - Marginal increment analysis needs to be undertaken in order to convert increment counts to calendar ages. Samples processed and read in older studies will need to be re-examined and margin codes recorded for each.
  - More recreational fishery age samples need to be collected.
- Reproductive Biology Data
  - Overall, more reproductive samples need to be collected. Because small, young fish were lacking from the biological collections, specimens under 18 inches will be needed to address age and size at maturity. Whole gonads will need to be collected for a fecundity study. Specimens collected from throughout the species range and covering all months of the year are needed to better describe spawning season and spawning periodicity.
- Ad-hoc Discard Mortality Sub-group
  - Future research is needed to examine discard mortality rates for this species, as well as factors that affect survival (e.g., gear type, temperature, depth).

Commercial Statistics

- Discard
  - Investigate the validity and magnitude of “no discard” trips. This may include fisher interviews throughout the region.
  - Examine potential impacts on “no discard” trips, including:
    - Trip length
    - Trip dates in relation to fishery regulations
    - Trip targeting

        - Trip area fished
    - Improve discard logbook data collections via program expansion or more detailed reporting (e.g. more detailed logbook, electronic reporting)
    - Develop an observer program that is representative of the fishery in the South Atlantic.
- Biosampling
    - Standardize TIP sampling protocol to get representative samples at the species level.
    - Develop an observer program that is representative of the fishery in the South Atlantic.
    - Increase untargeted sampling in NE and Mid-Atlantic observer programs.
    - Increase untargeted dockside sampling in NE and Mid-Atlantic.

Recreational Statistics

- Continued research efforts to incorporate/require logbook reporting from recreational anglers.
- Quantify historical fishing photos for use in future SEDARs.
- Fund research efforts to collect discard length and age data from the private sector.
- Improve metadata collection in the recreational fishery.
- Pre-stratify MRIP Keys, N-S Canaveral, N – S Hatteras.
- Research possibility of implementing private recreational reef fish stamp to determine universe and reporting strategies.
- At-sea observers collect surface and bottom temperature.
- At-sea observer protocols should include all fields currently used in FL i.e., condition and depth of released fish.

Indices

- Evaluate various sub-setting methods to identify effective effort. Methods that have been applied or considered include in this and previous SEDAR assessments include the Jaccard statistic, Stephens and MacCall approach, variations of Stephens and MacCall approach (e.g., using amount of catch rather than presence-absence), and other multivariate statistical approaches (e.g., cluster analysis).
- Evaluate various standardization methods to handle zeros in the catch, e.g., delta-GLM, zero-inflated Poisson, zero-inflated negative binomial, hurdle models, etc.
- Evaluate possible effects of circle hooks on catchability of reef fishes.
- Need fishery independent sampling of deep-water species, including blueline tilefish. Need funding to support these efforts.

Assessment Workshop Research Recommendations

The assessment panel made the following recommendations.

- Develop a fishery independent sampling program for abundance of the deepwater snapper-grouper complex (including blueline tilefish). Fishery dependent abundance indices used in this assessment were uncertain in part due to the lack of an effective sampling methodology.
- Implement a systematic age sampling program and systematic evaluation of aging error. Age samples were important in this assessment but reasonable sample sizes were only available for the last 3-4 years of the assessment.
- Better characterize reproductive parameters including age at maturity, batch fecundity, spawning seasonality, and spawning frequency.
- Better characterize the genetic structure of the stock and evaluate the possibility of local population structure.
- Better characterize the inshore-offshore migratory dynamics of the stock and the degree of fidelity to spawning areas. Portions of the stock may be further offshore in some years and hence not available to the fishery.
- Age-dependent natural mortality was estimated by indirect methods for this assessment of blueline tilefish. Tag-recapture programs may prove useful for estimating mortality.

Review Workshop Research Recommendations

Research recommendations for blueline tilefish were provided in the data and assessment working group documents. The Panel noted that many of these recommendations reflected concerns across a range of deep-water species and therefore confined their attention to those specific to the stock assessment of blueline tilefish.

While the panel supports work on stock structure, we recommend starting with the available information on describing the differences in demographics/life history characteristics over the range of the management area. Additionally, the available information on habitat in the areas listed should be evaluated before initiating any new studies.

Given that this is an age-based assessment, the comparison and calibration studies for the age determination should receive high priority along with the marginal increment analysis to determine if the opaque zone is formed annually. Many species would probably benefit from expanding the MRIP program to include age sampling.

The collection of information to better describe spawning season and spawning periodicity could probably start with fishery-dependent sources, but will need data from fishery-independent programs to cover the range of the species. The latter program would probably have to be tailored to provide samples across the deep-water snapper/grouper complex.

Studies of discard mortality should be low priority given the current negligible discard rate in the commercial fishery. The collection of additional information on discards and catch (e.g, lengths, ageing material) is important especially for the areas north of Hatteras, but would likely require an observer program developed for all fisheries focusing on the deep-water snapper/grouper complex.

The BAM model is reliant on historical information and any data on size compositions, maximum size, etc., that can be obtained from historical recreational fishing photos could be quite useful. One of the main issues raised about the recreational fishery concerned the high landings in the mid-late 2000s, especially the high landing and discard estimates for 2007. Closer scrutiny of these estimates requires data at higher resolution than was apparently available for this stock assessment.

With respect to developing a fishery-independent survey, sampling of deep-water habitats may elucidate habitat characteristics, and spatial distributions of blueline tilefish and other deep-water reef fishes. If a sufficient time series is developed, then a fishery-independent index may be developed.

SEDAR

Southeast Data, Assessment, and Review

SEDAR 32

South Atlantic Blueline Tilefish

SECTION V: Review Workshop Report

September 2013

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

Table of Contents

1. Introduction

1.1 Workshop Time and Place

The SEDAR 32 Review Workshop for South Atlantic blueline tilefish (*Caulolatilus microps*) was held August 27-30 in Morehead City, NC. It was held in conjunction with the Review Workshop for SEDAR 32A for Gulf of Mexico menhaden (*Brevortia patronus*).

1.2 Terms of Reference

1. Evaluate the data used in the assessment, addressing the following:
    a) Are data decisions made by the DW and AW sound and robust?
    b) Are data uncertainties acknowledged, reported, and within normal or expected levels?
    c) Are data applied properly within the assessment model?
    d) Are input data series reliable and sufficient to support the assessment approach and findings?
2. Evaluate the methods used to assess the stock, taking into account the available data.
    a) Are methods scientifically sound and robust?
    b) Are assessment models configured properly and used consistent with standard practices?
    c) Are the methods appropriate for the available data?
3. Evaluate the assessment findings with respect to the following:
    a) Are abundance, exploitation, and biomass estimates reliable, consistent with input data and population biological characteristics, and useful to support status inferences?
    b) Is the stock overfished? What information helps you reach this conclusion?
    c) Is the stock undergoing overfishing? What information helps you reach this conclusion?
    d) Is there an informative stock recruitment relationship? Is the stock recruitment curve reliable and useful for evaluation of productivity and future stock conditions?
    e) Are the quantitative estimates of the status determination criteria for this stock reliable? If not, are there other indicators that may be used to inform managers about stock trends and conditions?
4. Evaluate the stock projections, addressing the following:
    a) Are the methods consistent with accepted practices and available data?
    b) Are the methods appropriate for the assessment model and outputs?
    c) Are the results informative and robust, and useful to support inferences of probable future conditions?
    d) Are key uncertainties acknowledged, discussed, and reflected in the projection results?

5. Consider how uncertainties in the assessment, and their potential consequences, are addressed.
    - Comment on the degree to which methods used to evaluate uncertainty reflect and capture the significant sources of uncertainty in the population, data sources, and assessment methods.
    - Ensure that the implications of uncertainty in technical conclusions are clearly stated.
6. Consider the research recommendations provided by the Data and Assessment workshops and make any additional recommendations or prioritizations warranted.
    - Clearly denote research and monitoring that could improve the reliability of, and information provided by, future assessments.
    - Provide recommendations on possible ways to improve the SEDAR process.
7. Provide guidance on key improvements in data or modeling approaches which should be considered when scheduling the next assessment.
8. Prepare a Peer Review Summary summarizing the Panel's evaluation of the stock assessment and addressing each Term of Reference. Develop a list of tasks to be completed following the workshop. Complete and submit the Peer Review Summary Report in accordance with the project guidelines.

1.3 List of Participants

Review Workshop Panelists

Steve Cadrin	Review Panel Chair	SAFMC SSC
Churchill Grimes	Reviewer	SAFMC SSC
Will Patterson	Reviewer	GSMFC Appointee
Gary Melvin	Reviewer	CIE
Stephen Smith	Reviewer	CIE
Kevin Stokes	Reviewer	CIE

Analytical Team

Kevin Craig	Lead analyst, SA BLT	NMFS Beaufort
Amy Scheuller	Lead analyst, GoM menhaden	NMFS Beaufort
Kyle Shertzer	Assessment Team	NMFS Beaufort
Erik Williams	Assessment Team	NMFS Beaufort
Katie Andrew	Assessment Team	NMFS Beaufort
Rob Cheshire	Assessment Team	NMFS Beaufort
Robert Leaf	Assessment Team	USM

Observers

Dewey Hemilright	Fishing Industry	Commercial, NC
Robert Johnson	Fishing Industry	Charter/Headboat, FL

GSMFC Menhaden Advisory Committee

John Mareska, ADCNR-MRD
Behzad Mahmoudi, FL FWC
Jerry Mambretti, TPWD
Borden Wallace, Daybrook Fisheries
Ron Lukens, Omega Protein, Inc.
Matt Hill, MDMR
Harry Blanchet, LDWF

Council Representative

Michelle Duval	Council Member	SAFMC

Council and Agency Staff

Julia Byrd	SEDAR Coordinator	SEDAR
Julie O'Dell	Administration	SEDAR/SAFMC
Michael Errigo	Fishery Biologist	SAFMC Staff
Steve VanderKooy	IJF Program Coordinator	GSMFC
Jessica Stephen	Fishery Biologist	SERO
Brian Langseth	Observer	SEFSC Beaufort
Joe Smith	Observer	NOAA

Data workshop observers

Tony Austin
Doug Vaughan
Mike Prager
Robert O'Boyle

1.4 List of Data Workshop Working Papers

South Atlantic blueline tilefish and gray triggerfish reference workshop document list.

Document #	Title	Authors
	Documents Prepared for the Review Workshop	
SEDAR32-RW01	The Beaufort Assessment Model (BAM) with application to blueline tilefish: mathematical description, implementation details, and computer code	NMFS-SFB 2013
SEDAR32-RW02	Catch Curves for blueline tilefish from the commercial handline and longline fleets	NMFS-SFB 2013
	Reference Documents	
SEDAR32-RD01	List of documents and working papers for SEDAR 4 (Caribbean – Atlantic Deepwater Snapper Grouper) – all documents available on the SEDAR website.	SEDAR 4
SEDAR32-RD02	Comparison of Reef Fish Catch per Unit Effort	Rudershausen et al.

	and Total Mortality between the 1970s and 2005–2006 in Onslow Bay, North Carolina	2008
SEDAR32-RD03	Source document for the snapper-grouper fishery of the South Atlantic region.	SAFMC 1983
SEDAR32-RD04	FMP, regulatory impact review, and final environmental impact statement for the SG fishery of the South Atlantic region	SAFMC 1983
SEDAR32-RD05	Age, growth and reproductive biology of blueline tilefish along the southeastern coast of the United States, 1982-99	Harris et al. 2004
SEDAR32-RD06	List of documents and working papers for SEDAR 9 (Gulf of Mexico Gray Triggerfish, Greater Amberjack, and Vermillion Snapper)	SEDAR 9
SEDAR32-RD07	Estimated Conversion Factors for Adjusting MRFSS Gulf of Mexico Red Snapper Catch Estimates and Variances in 1981-2003 to MRIP Estimates and Variances	Rios et al. 2012
SEDAR32-RD08	Estimates of Historic Recreational Landings of Spanish Mackerel in the South Atlantic Using the FHWAR Census Method	Brennan and Fitzpatrick 2012
SEDAR32-RD09	Excerpt from ASMFC Atlantic Croaker Stock Assessment & Peer Review Reports 2003 – Information on Jacquard Index	ASMFC 2003
SEDAR32-RD10	Survival estimates for demersal reef fishes released by anglers	Collins 1994
SEDAR32-RD11	Indirect estimation of red snapper (Lutjanus campechanus) and gray triggerfish (Balistes capriscus) release mortality	Patterson et al. 2002
SEDAR32-RD12	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
SEDAR32-RD13	Commercial catch composition with discard and immediate release mortality proportions off the southeastern coast of the United States	Stephen and Harris 2010
SEDAR32-RD14	Migration and Standing Stock of Fishes Associated with Artificial and Natural Reefs on Georgia's Outer Continental Shelf	Ansley & Harris 1981
SEDAR32-RD15	Age, Growth, and Reproductive Biology of the Gray Triggerfish (*Balistes capriscus*) from the Southeastern United States, 1992-1997	Moore 2001

SEDAR32-RD16	Size, growth, temperature, and the natural mortality of marine fish	Gislason et al. 2010
SEDAR32-RD17	Evolutionary assembly rules for fish life histories	Charnov et al. 2012
SEDAR32-RD18	A Review for Estimating Natural Mortality in Fish Populations	Siegfried & Sansó

2. Review Panel Report

Executive Summary

The stock assessment presented by the SEDAR 32 Assessment Workshop (AW) provided the Review Panel with outputs and results from two statistical assessment models and a catch curve analysis. The primary model was the Beaufort Assessment Model (BAM), while a secondary, surplus-production model (ASPIC), provided a comparison of model results. The Review Panel endorses the AW recommendation to determine stock status using the BAM base configuration. Fishing mortality in 2011 is estimated as 0.39, which is greater than the estimate of Fmsy (0.302), so overfishing is estimated to be occurring. Spawning biomass in 2011 is estimated as 445,000 lb, which is 91% of the estimate of Minimum Stock Size Threshold (489 ,000 lb), so the stock is estimated to be overfished.

2.1. Response to Terms of Reference

1. Evaluate the data used in the assessment, addressing the following:

- Stock area

The management area was defined such that landings from Rhode Island to Florida were used for this stock assessment. There are no genetics or tagging data available for this species to define biological stocks or the management area, but many species exhibit a stock boundary along the US east coast at Cape Hatteras. Blueline tilefish are pelagic spawners and as a consequence, it was suggested that larvae would be wide-ranging. However, previous work on the confamilial golden tilefish indicate a stock break north and south of Cape Hatteras (Katz, et al.1983). There was concern expressed that the stock area may be too broad given that the fishery appears to be focused in a few small areas, and because this species is known to be highly residential, occupying scour depressions in carbonate substratum and burrows in soft bottom (Able, et al.1987). Such an aggregated species may be subject to local depletion.

Research Recommendation: Further research on stock structure would help align landings and the indices being used to monitor annual changes in stock size.

- Natural mortality

Natural mortality at age was estimated using the methods of Charnov et al. (2012) which are based on estimates of K and L_∞ from von Bertalanffy growth curves, and therefore highly dependent upon the quality of the age data. Considerable uncertainty in age determination for blueline tilefish was documented by Harris et al. (2004).

Scaling the mean rate over the older ages to 0.1 was reasonable given the Hoenig estimate based on maximum age. Values of 0.15 and 0.05 were used for sensitivity training based upon a CV of

54% from the Hoenig method. However, the lack of fish of age 15 years and older in the landings suggests that either M may be higher because the maximum age of 43 is questionable due to the uncertainty in ageing or Fishing mortality was much higher than assumed. This suggests that the higher M alternative should receive more attention in the sensitivity analysis than the lower M and perhaps M estimates higher than 0.15 might also be considered.

- Maturity at age

Maturity-at-age was based upon estimates for golden tilefish with 50% mature at age 3 and 100% mature at age 4. While these results indicated a relatively younger maturity than might be expected for such a long-lived fish, similar results have been reported for other long-lived species in the region. However, maturity studies of golden tilefish, a confamilial species, suggest that functional maturity may occur at ages older than histological maturity because of territoriality, dominance and mate choice (Grimes et al. 1988 and McBride et al. 2013). If this is also true for blueline tilefish, then the apparent truncation of age composition due to harvesting may result in a decline in the size of males that gain access to the females for spawning.

- Ageing

The von Bertalanffy growth curve indicated that 98% of total growth is completed by age 15 yrs., and therefore ages 15 yrs. and older were adopted as a plus group. The underlying growth data were obtained from sampling recent landings for fisheries that appeared to target a very narrow range of ages (3-5 yrs. for recreational and 5-8 yrs. for commercial fisheries). There were no age composition data for landings in the earlier part of the series when it was expected that larger/older fish should have been a higher proportion of the population given the assumption of maximum age of 43 yrs. As noted above, the reliability of the underlying assumptions of the initial age composition raises issues about the current estimates of M and F, as well the assumption of flat-topped selectivity. Industry comments during the meeting suggested that there may be differing spatial distribution by size/age class. The available age composition data do not appear to track year-classes, even though high recruitment was estimated to have occurred prior to the period that the bulk of these data were collected.

Age and growth information used in the assessment was extracted from Harris et al. 2004. This study did not rigorously validate putative ages and reported low aging precision, e.g., ~ 60% within 2 yrs.

An ageing error matrix was developed at NMFS Beaufort comparing the results of two agers. Due to the small sample sizes, ageing errors were assumed to follow normal distributions. A symmetric distribution of errors was questioned as experience suggests that older ages tend to be more likely to be underestimated as annuli tend to pack at the otolith margin as the fish approach the asymptotic length. However, uncertainty in age determination as measured by the ageing error matrix was considered to be relatively small in comparison to other sources of uncertainty that had been identified.

While the age compositions were fitted by the model, the length compositions were removed from the analysis due to preliminary results indicating lack of fit. In light of the uncertainties associated with the ageing data, it seemed strange that the length composition data would not be better fitted by the model.

- Quality of commercial and recreational landings data

The landing data were considered to be reliable since 1974 and discarding for the commercial fishery was assumed to be negligible and consistent with there being no regulatory reasons for discarding (e,g., size limits). The recreational catch was sporadic and low relative to the commercial catch until 2006. There was considerable discussion about the reliability of the recreational landings estimate for 2006 to 2008 including the very high discard estimates in 2007. Most of these landings appeared to have occurred in North Carolina waters and there was a suggestion that the development of a "deep-drop" fishery may have driven the increase with the decrease in 2011 due to the implementation of a deep water closure. Examination of the MRIP data indicated that CVs for 2006 to 2011 decreased relative to the period before and the number of sample intercepts increased, both indicative of increased fishing activity. However, magnitude of the landings relative to the commercial landings in those same years still seemed to be unprecedented and industry participants questioned the reliability of the recreational estimates.

- Abundance indices:

The commercial and recreational catch rate information was key data for both the BAM and ASPIC models. These were the only annual abundance indices available and were developed using standard approaches, i.e., fit delta-GLM models to filter out annual trends from other factors associated with these data. The recreational index represents the earlier period when the SSB was being fished down but this index actually represents very low levels of catch. There was no overlap between this index and the two commercial indices.

- Landings, catch at age and CPUE

Landings and catch-at-age were estimated for the entire geographic domain of the fishery, including those that came from north of 35N. However, CPUE was only computed for areas north of 28 N and south of 35N. When we examined nominal CPUE by latitude, regardless of fishery it was higher north of 35N than the standardized composite CPUE used as an abundance index in the assessment. Therefore, increased landings north of 35N are not being fully indexed. One implication of this is the BAM model fits this increase in landings as an increase in recruitment, thus the greatest positive recruitment deviations in the model (see assessment document Fig. 3.13). This clearly has implications for projected future stock productivity.

2. Evaluate the methods used to assess the stock, taking into account the available data.

The Beaufort Assessment Model (BAM) was used as the principal assessment tool. The BAM, implemented in AD Model Builder software (Fournier et al, 2012), is structured to allow implementation of forward projecting, statistical catch-at-age assessment models. Use of the BAM permitted the inclusion of all available types of data, including total annual removals from commercial and recreational fleets (landings and discards), age and length compositions, and indices of biomass abundance, with appropriate error distributions and use of priors on parameters. Decisions on a priori data inclusion and exclusion are considered at ToR 1.

The specified assessment model used standard approaches to predicting landings and modeling growth and recruitment BAM also allowed an exploration of catchability and selectivity options.

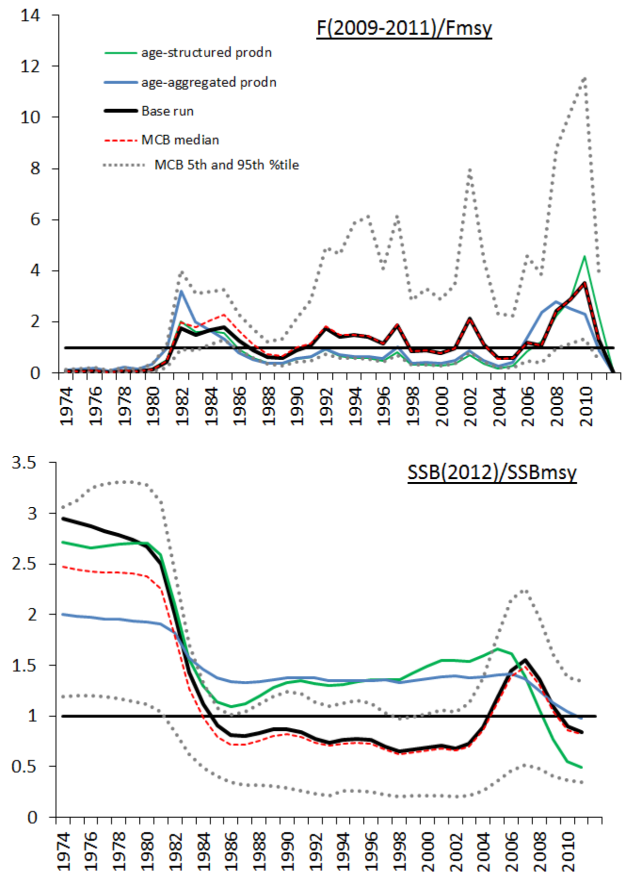
The base case model and rationale for modeling decisions are well described in the AW report (section 3) and were further explored during the Review Workshop. The base case run included commercial and recreational landings, age composition data and three indices of abundance (recreational head boats, commercial long line and hand line). There was some concern that the recreational and commercial indices do not overlap, but this was explored during the RW and the general patterns seem to be consistent. Length compositions were excluded by the AW due to concerns about inconsistent sampling and conflicts in fitting. The AW concluded that length composition data help to inform selectivity estimates but conflict with information in abundance indices, do not track year classes well, and add unnecessary noise. The RW panel was concerned at this exclusion and the issue was explored further during the RW by looking at shadow fits comparing the base case predicted (but not fit) length compositions with the data and by examining models fits to the length composition data. The RW concluded that the residual patterns in indices were not acceptable from the model that included length compositions, and the results could not be considered as a viable base case (or sensitivity run). The decision by the AW to exclude length composition data was therefore upheld. Natural mortality was assumed constant through time but age-specific based on the method of Charnov (2013) and scaled consistent with maximum observed age. Steepness was fixed at 0.84 based on meta-analyses (Myers et al., 2002; Shertzer and Conn, 2012). Selectivities and catchabilities were all estimated as constant for the full assessment period (1974-2011).

The model was fit to the data using appropriate methods, consistent with standard practice. Analysis included iterative reweighting using the method of Francis (2011) and exploration of a variety of data configurations and parameterizations. The modeling processes and decision making resulting in a proposed base case run and sensitivity testing are well described in the AW Report and AW WDs and were further elaborated during the SEDAR 32 Review Workshop where additional diagnostics (Likelihood components, weights, likelihood profiles) were made available. The modeling procedures adopted appear to be robust. Landings and discards were fit closely, and age composition data and abundance indices were fit to the degree that they are compatible and as indicated using the reweighting procedures. Landings and indices were fit using lognormal likelihoods. Age composition data were fit using robust multinomial likelihoods.

The treatment of the data and the relative importance given to the various components were well explored by the AW and at the RW and appear appropriate. The model structure is adequate to capture the main patterns in the data.

In addition to the catch-at-age primary assessment, two biomass dynamics stock assessments were carried out using the ASPIC software, one fully age-aggregated and the other age structured. The biomass dynamics models were considered as complementary rather than alternative analyses, because the catch-at-age model makes fuller use of composition data and represents a more detailed investigation of population dynamics. The biomass dynamics models provide a useful comparison with the catch-at-age model results (see Figure below), which they broadly support, showing the similar status of the stock in relation to MSY benchmarks (ToR 3). The biomass dynamics models and methods used are well known and were appropriately configured and implemented.

Monte Carlo Bootstrapping (MCB) was used to portray uncertainty around model outputs, including status estimates. MCB combines parametric bootstrapping to landings and indices data and resampling from the age composition data. The Monte Carlo component entails drawing values of M and steepness from specified pdf’s. Outputs provided are the quantiles of the distribution resulting from application of the MCB simulations. Each simulation applies a single BAM model using the weights developed for the vase case run. No reweighting procedures are used for individual realizations.



Trajectories of status benchmarks for the catch-at-age base case model, two biomass dynamics model runs, and the MCB analysis. Refer to key for explanation.

The MCB generates a stochastic version of the BAM model by introducing process error to the model components of natural mortality and steepness. Means of management quantities (MSY, BMSY, FMSY) from the MCB runs do not equal estimates from the base run. The direction of the differences observed between the MCB based estimates and those of the base run are in the direction predicted by Bousquet et al (2008). FMSY from the MCB runs will be less than the deterministic estimates from the BAM base run, estimates of MSY will be slightly higher and those for BMSY slightly lower. The size of the differences will be a function of the amount of stochastic error in the model. Of course, these differences will not be apparent when looking only at ratio benchmarks as in the figure above. It is important to note that for consistency, if MCB is used for projections, the MCB estimates of the management quantities should also be used for evaluating stock status.

3. Evaluate the assessment findings with respect to the following:

a) Are abundance, exploitation, and biomass estimates reliable, consistent with input data and population biological characteristics, and useful to support status inferences?

The review panel examined the consistency of input data and population biological characteristics with abundance, exploitation and biomass estimates. The Review Panel agreed with the AW that the base run provided the best representation of stock status, and the MCB should be used for projection estimates. The base rune outputs are generally consistent the inputs, given assumptions and weighting choices.

b) Is the stock overfished? What information helps you reach this conclusion?

The RW Panel endorses the AW recommendation to determine stock status using the BAM base configuration. Based on the base run estimates of SSB, the South Atlantic Blueline tilefish is overfished. Spawning biomass in 2011 is estimated as 445 thousand lb, which is 91 per cent of the estimate of Minimum Stock Size Threshold (489 thousand lb), so the stock is overfished. SSB has been below the MSST for the past two years (2010-2011). The majority of viable sensitivity runs indicate that the SSB2011 was < SSBmsy. The only exception is if M is higher, in which case SSB may be estimated greater than SSBmsy. The RP initially had some concerns about the assumed M value and suggested that a higher value might be credible. However, likelihood profiles presented during the meeting supported the use of the assumed value (0.1).Production model outputs of population status generally agree with the BAM base run and indicate a B/Bmsy of less than 1 in 2011.

c) Is the stock undergoing overfishing? What information helps you reach this conclusion?

Based on the BAM base run fishing mortality (F) estimates, overfishing is occurring for the South Atlantic blueline tilefish. The ratio of the geometric mean F over the past 3 years to Fmsy was greater (2.37) than 1.0 and has been for the past several years. The decrease in $F_{(2011)}$ was primarily the result of a fishery closure, which no longer exists. Production model outputs all indicate an average F/Fmsy well in excess of 1.0.

4. Evaluate the stock projections, addressing the following:

a) Are the methods consistent with accepted practices and available data?

The methods used by the AW are consistent with accepted practices in the region and elsewhere, and the available data. Initially the review panel had several concerns regarding the use of Monte Carlo and bootstrap (MCB) approach as a measure of precision and to compute uncertainty. The MCB analysis is considered an approximation of uncertainty for an individual run. Unconverged and unrealistic runs were removed (3200 reduced to 3043) from the analysis, however, there was still the possibility of including nonsense variable inputs that individually could occur within the established parameter bounds, but combined (biologically)could not, resulting in unrealistic outputs of R0 and Fmsy. All unfiltered runs were given equal weight and were included in the estimate of uncertainty. These limitations were identified in the assessment report. In addition, there was the mixing of deterministic and stochastic parameters, the latter introducing process error. The Review Panel concluded that although the MCB approach is a common approach used in SEDAR assessments to estimate uncertainty, the results may be different if a true Bayesian approach was applied.

The panel questioned if the assumed F in 2012 and 2013 was overestimated because of changes in regulations and closures. However, examination of the preliminary 2012 landings showed a substantial increase from 2011, thereby justifying the assumed F. The Panel recommends that projections of future catch should be based on direct estimates of past catch when available rather than assumed F.

b) Are the methods appropriate for the assessment model and outputs?

Five-year projections were made using the MCB model to capture uncertainty in data and parameter inputs. The assumed error structures on data are as used for fitting the BAM base run. The pdf on M is effectively uniform from 0.05 to 0.15, consistent with the sensitivity tests using the BAM and covering the central assumption. The pdf for h has a mean of 0.84, consistent with the BAM base run and is based on a published meta-analysis (Shertzer and Conn, 2012). Numbers in 2012 are based on 2011 estimates for ages 2 to 15+, discounted by estimated Z. Initial recruits are computed from the spawning-recruit model with h drawn from the pdf at each realization. Consistent with the F used to determine status, F2012 is calculated as F2009-2011. A total of 10,000 projected time series were made in the MCB and four alternative F scenarios were investigated (F0, Frebuild, Fmsy, and Fcurrent).

The method used for projections are appropriate but the RP noted that because the estimates of Fmsy, Bmsy and Msy are different between the MCB and BAM (due to inclusion, and dependent on the degree, of process error in the BAM) then it would make sense also to use the MCB to determine stock status. This needs further consideration generally.

c) Are the results informative and robust, and useful to support inferences of probable future conditions?

Projection results are informative and robust within the range of observations and inputs from the MCB. Currently F is estimated as the mean of the 3 previous years, one of which (2011) was subject to lower F due to a closure. Given the observed rapid changes in F and the preliminary landings estimates for 2012 and 2013, consideration might be given to using actual landings for future projections or drop the 2011 from estimate of F for 2013 and 14.

d) Are key uncertainties acknowledged, discussed, and reflected in the projection results?

The assessment report identified and evaluated uncertainties associated with the assessment through the MCB. The report identifies the degree of uncertainty associated with M, ageing error, steepness, model component weights, indices and recruitment deviations. Some concern was expressed by the Review Panel on the appropriateness of using the mean F (high relative to the time series) for the previous 3 years given the high F's of 2009 and 2010 and the low value for 2011 for projections. However, examination of the preliminary landings for 2012 and 2013 support the use of a large F.

5. Consider how uncertainties in the assessment, and their potential consequences, are addressed.

Uncertainty was explored in the assessment modeling using extensive sensitivity runs and likelihood profiling, retrospective analyses and Monte Carlo Bootstrapping (MCB). All of the methods used are standard and much used. The AW reported widely on the various analyses and more materials were provided and used in discussion at the RW. The application of methods appears to be comprehensive and appropriately focused. Sensitivity runs as variants of the base case run are numerous and good information was provided on the impacts on fits (through detailed likelihood components and also weighting diagnostics, SDNRs, likelihood profiles, etc.). Such runs can only look at what the model structure accommodates and cannot consider, for example, processes such as fishery or environmentally induced geographic changes in distribution of the stock or fishery induced local depletion. There was much discussion at the RW on these issues and on data inclusion or exclusion in indices to represent stock abundance. Ultimately, the stock assessment assumes a single dynamic pool of fish and there are insufficient data at this time to support investigating alternative hypotheses. With the exception of this structural uncertainty, the other uncertainties in the assessment and its outputs have been appropriately and comprehensively considered.

Issues considered in sensitivity runs include variations in M and steepness, alternative maturity vector, adjustment of model weights and exclusion of each series of indices, allowing catchability to vary, inclusion of ageing error, and allowing recreational selectivity to be dome shaped. Issues of uncertainty not covered explicitly in sensitivity tests include the quantum of landings assigned to recreational landings and especially discards in 2007-9 (see ToR 1).

The MCB is alluded to at ToR 2. A total of 3200 realizations were made using M and h values drawn from specified pdf's and with the landings, indices and age composition data bootstrapped. Each realization of the BAM model was run using the iteratively reweighted weights from the base case (it would have been impossible to automate this process for each of the 3200 realizations). However, it should be noted that reweighting can have major implications for fitting and parameter estimation and that each realization may not be feasible. The degree to which this may or may not matter is model and data specific. As all realizations are afforded equal weight in determining distributions of outputs there is in general need for care in interpreting MCB results. For blueline tilefish, the SDNRs for all sensitivity tests are surprisingly good when runs are made using the base case weights. This is encouraging, however, is no guarantee that for specific M and h combinations drawn from the pdfs, which may be incompatible, the base case weights would in any way be appropriate.

Notwithstanding, the RW was comfortable that the AW had fully explored uncertainty to the extent possible and that the characterization of benchmark trajectories (Figure above) and hence stock status (ToR 3) and projections (ToR 4) are suitable for informing management decisions.

6. Consider the research recommendations provided by the Data and Assessment workshops and make any additional recommendations or prioritizations warranted.

Research recommendations for blueline tilefish were provided in the data and assessment working group documents (see below). The Panel noted that many of these recommendations reflected concerns across a range of deep-water species and therefore confined their attention to those specific to the stock assessment of blueline tilefish.

While the panel supports work on stock structure, we recommend starting with the available information on describing the differences in demographics/life history characteristics over the range of the management area. Additionally, the available information on habitat in the areas listed should be evaluated before initiating any new studies.

Given that this is an age-based assessment, the comparison and calibration studies for the age determination should receive high priority along with the marginal increment analysis to determine if the opaque zone is formed annually. Many species would probably benefit from expanding the MRIP program to include age sampling.

The collection of information to better describe spawning season and spawning periodicity could probably start with fishery-dependent sources, but will need data from fishery-independent programs to cover the range of the species. The latter program would probably have to be tailored to provide samples across the deep-water snapper/grouper complex.

Studies of discard mortality should be low priority given the current negligible discard rate in the commercial fishery. The collection of additional information on discards and catch (e.g, lengths, ageing material) is important especially for the areas north of Hatteras, but would likely require an observer program developed for all fisheries focusing on the deep-water snapper/grouper complex.

The BAM model is reliant on historical information and any data on size compositions, maximum size, etc., that can be obtained from historical recreational fishing photos could be quite useful. One of the main issues raised about the recreational fishery concerned the high landings in the mid-late 2000s, especially the high landing and discard estimates for 2007. Closer scrutiny of these estimates requires data at higher resolution than was apparently available for this stock assessment.

With respect to developing a fishery-independent survey, sampling of deep-water habitats may elucidate habitat characteristics, and spatial distributions of blueline tilefish and other deep-water reef fishes. If a sufficient time series is developed, then a fishery-independent index may be developed.

Research Recommendations from the Data and Assessment Working Groups

7.1 Life History

- Stock Structure
    - Blueline tilefish stock definition needs to be investigated further. Genetic study or some other form of stock identification study needs to be undertaken with samples (muscle, fin clips, etc.) collected from several locations within the Gulf of Mexico and the northwestern Atlantic.
    - Habitat studies of deep water sites in the mid-Atlantic, specifically Norfolk Canyon, Baltimore Canyon, and Hudson Canyon need to be undertaken. Temperature data from research conducted in the 1970s in Norfolk Canyon can be used for comparison purposes.
- Age Data
    - Age readings of blueline tilefish need to be validated. Within and between lab variability in readings is large and needs to be addressed. The potential bias in age readings between laboratories also needs to be addressed with another age workshop and exchange of calibration sets of samples.
    - Marginal increment analysis needs to be undertaken in order to convert increment counts to calendar ages. Samples processed and read in older studies will need to be re-examined and margin codes recorded for each.
    - More recreational fishery age samples need to be collected.
- Reproductive Biology Data
    - Overall, more reproductive samples need to be collected. Because small, young fish were lacking from the biological collections, specimens under 18 inches will be needed to address age and size at maturity. Whole gonads will need to be

collected for a fecundity study. Specimens collected from throughout the species range and covering all months of the year are needed to better describe spawning season and spawning periodicity.

- Ad-hoc Discard Mortality Sub-group
  - Future research is needed to examine discard mortality rates for this species, as well as factors that affect survival (e.g., gear type, temperature, depth).

7.2 Commercial Fishery Statistics

- Discard
  - Investigate the validity and magnitude of "no discard" trips. This may include fisher interviews throughout the region.
  - Examine potential impacts on "no discard" trips, including:
    - Trip length
    - Trip dates in relation to fishery regulations
    - Trip targeting
    - Trip area fished
  - Improve discard logbook data collections via program expansion or more detailed reporting (e.g. more detailed logbook, electronic reporting)
  - Develop an observer program that is representative of the fishery in the South Atlantic.
- Biosampling
  - Standardize TIP sampling protocol to get representative samples at the species level.
  - Develop an observer program that is representative of the fishery in the South Atlantic.
  - Increase untargeted sampling in NE and Mid-Atlantic observer programs.
  - Increase untargeted dockside sampling in NE and Mid-Atlantic.

7.3 Recreational Fishery Statistics

- Continued research efforts to incorporate/require logbook reporting from recreational anglers.
- Quantify historical fishing photos for use in future SEDARs.
- Fund research efforts to collect discard length and age data from the private sector.
- Improve metadata collection in the recreational fishery.
- Pre-stratify MRIP Keys, N-S Canaveral, N – S Hatteras.
- Research possibility of implementing private recreational reef fish stamp to determine universe and reporting strategies.

- At-sea observers collect surface and bottom temperature.
- At-sea observer protocols should include all fields currently used in FL i.e., condition and depth of released fish.

7.4 Indices

- Evaluate various sub-setting methods to identify effective effort. Methods that have been applied or considered include in this and previous SEDAR assessments include the Jaccard statistic, Stephens and MacCall approach, variations of Stephens and MacCall approach (e.g., using amount of catch rather than presence-absence), and other multivariate statistical approaches (e.g., cluster analysis).
- Evaluate various standardization methods to handle zeros in the catch, e.g., delta-GLM, zero-inflated Poisson, zero-inflated negative binomial, hurdle models, etc.
- Evaluate possible effects of circle hooks on catchability of reef fishes.
- Need fishery independent sampling of deep-water species, including blueline tilefish. Need funding to support these efforts.

7. Provide guidance on key improvements in data or modeling approaches which should be considered when scheduling the next assessment.

The Atlantic blueline tilefish assessment relies upon fishery dependent indexes of abundance to inform theBAM. No fishery independent indices are available for this stock. As such the geographic distribution, seasonal movement, spawning, and consistency of the fishery over time all have an impact on the indices and contribute to the uncertainty associated with the assessment. Whether or not the stock is truly a single spawning population distributed throughout the stock range or a series of multiple spawning components is unknown given its broad spatial occurrence along the Atlantic coast. Changes in the state proportional contribution to total landings and catches from the commercial handline and longline fisheries implies a divergence from a more southerly dominated (Florida and South Carolina) fishery during the 1980's to a northern (North Carolina, especially above Cape Hatteras) focused fishery in more recent years. The reason(s) for these observed changes in landings are unknown. The changes in catch and subsequent catch rates used as indices of abundance may be a function of population dynamics, serial depletion, or a northerly migration in response to environmental variability. Further investigation of this issue should be undertaken before the next assessment to insure the current commercial indices represent changes in abundance and not the adaption of the fishing fleets to availability. Development of a fishery independent index of abundance would help to resolve some of these issues.

While the size of this fishery may not by itself warrant the cost of implementing such a survey, there may be broader advantages in designing a survey for the complex of deep-water species.

During the initial review and presentation of the stock assessment it was unclear that the commercial CPUE indices were being truncated or trimmed at Cape Hatteras, thereby excluding the catch and effort data north of this area. The landings data used in the assessment model included all reported catches taken throughout the entire range of the stock. Given a large portion of recent landings are being reported north of Cape Hatteras are not included in the commercial CPUE indices the effects on the abundance indices are unknown. The review panel suggests the increased catches be addressed and that this apparent inconsistency between the indices and the fishery be resolved before the next assessment.

The blueline tilefish assessment uses 3 CPUE indices based on information from the headboat (1980-1992), handline (1993-2010) and longline (1993-2004), with no data for 2011 due to a commercial and recreational closure. The headboat time series was terminated due to the low number of trips/catches. No overlapping years between the headboat and the other two indices were used in the assessment suggesting uncertainty in the scaling of the indices. Limited information was available for the headboat over the entire time series. During the review the panel requested additional analysis on the headboat time series to investigate if there were consistencies in CPUE patterns. When the headboat data were binned into 3 year averages the data generally tracked the ups and downs of the other indices. The headboat data should be investigated further to see if the times series can be extended, especially given the recent increases in headboat catches since 2008.

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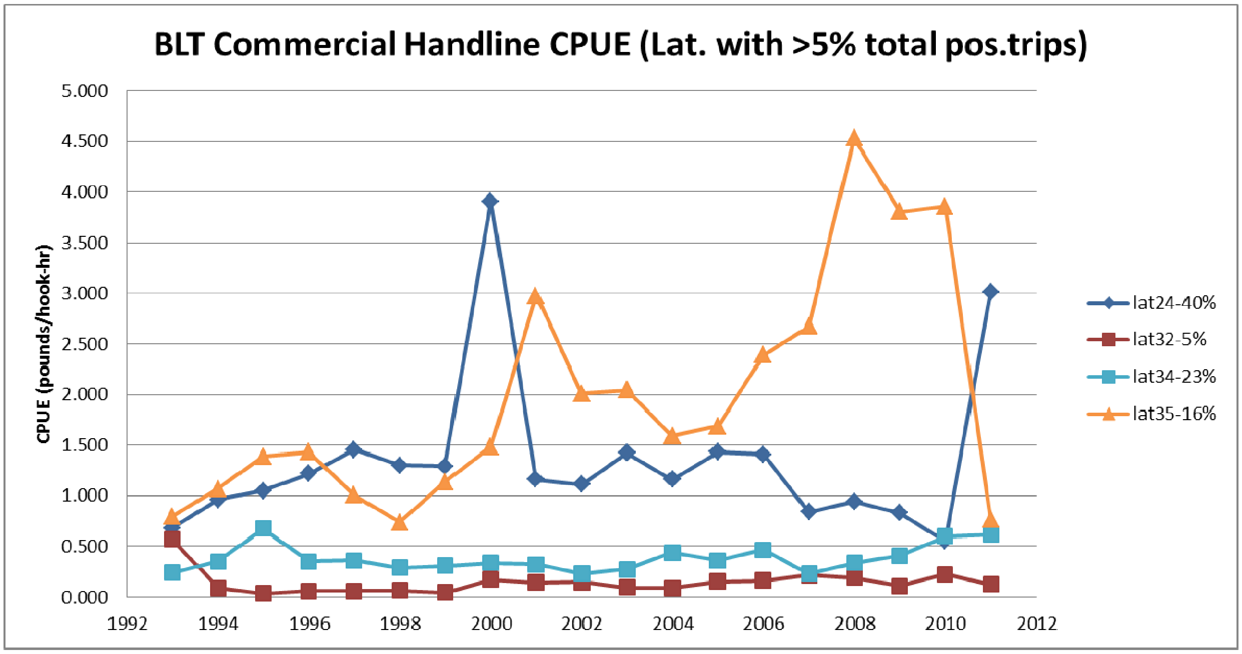
2.2 Summary Results of Analytical Requests

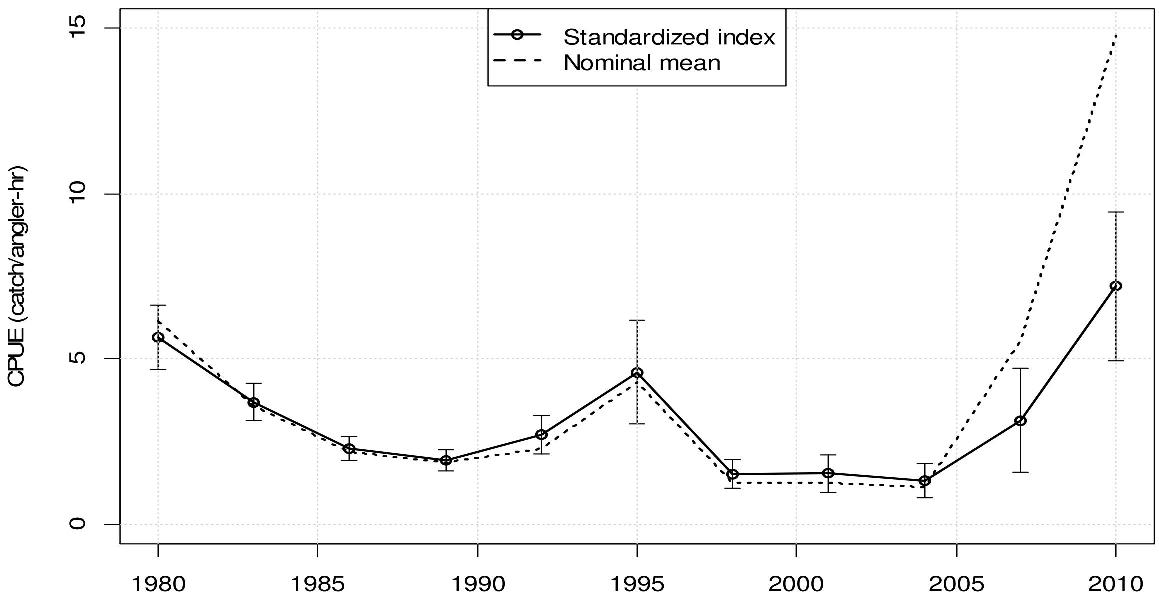
- The review panel requested geographic plots of the fishery to evaluate the extent of the spatial distribution of the fishery.

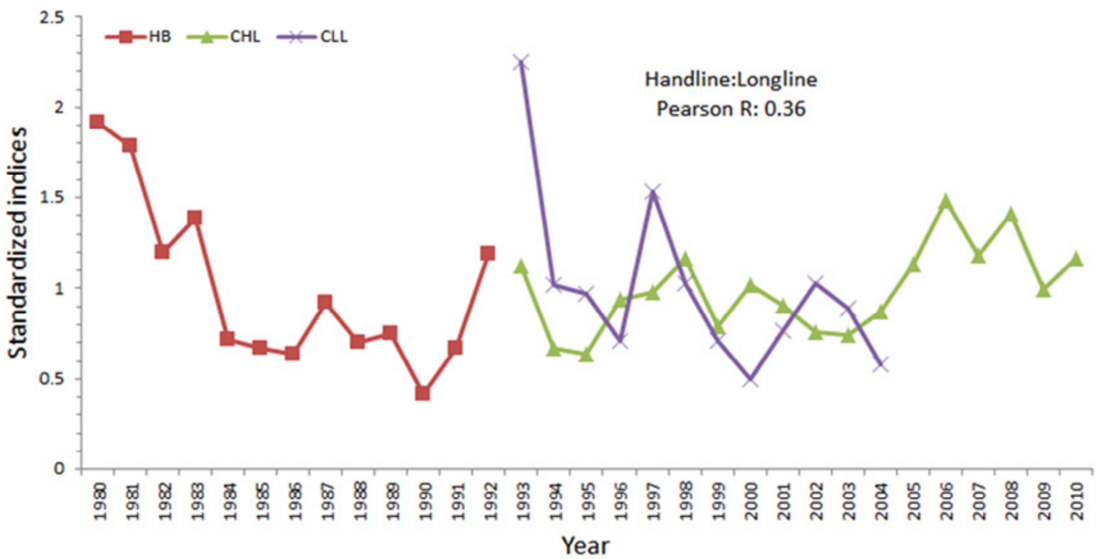
Landings and catch-at-age were estimated including those that came from north of 35N. However, CPUE was only computed for areas north of 28N and south of 35N. When we examined nominal CPUE by latitude, regardless of fishery it was higher north of 35N than the standardized composite CPUE used as an index in the assessment. Therefore, resource trends associated with increased landings north of 35 are not being indexed fully. One implication of this is the BAM model fits this increase in landings as an increase in recruitment, thus the greatest positive recruitment deviations (assessment document Fig. 3.13). This clearly has implications for projected future stock productivity.



- The Panel requested the results of the model fit to the length compositions from the base-model. The results illustrate the data conflicts and support the AW decision to exclude length compositions from the objective function.

- The review panel requested further exploration of the data to examine any period of potential overlap between the recreational and commercial indices to detect similar or dissimilar trends. When the headboat data were binned into 3 year averages (top panel in following figure) the data generally tracked the ups and downs of the other indices (commercial handline and longline, bottom panel in following figure).


Standardized index
Nominal mean
CPUE (catch/angler-hr)
0
5
10
15
1980
1985
1990
1995
2000
2005
2010


HB
CHL
CLL
Handline:Longline
Pearson R: 0.36
Standardized indices
Year

SEDAR

Southeast Data, Assessment, and Review

SEDAR 32

South Atlantic Blueline Tilefish

SECTION VI: Addendum

November 2013

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

Projections and Associated Analyses for South Atlantic Blueline Tilefish SEDAR 32 Stock Assessment

Sustainable Fisheries Branch, National Marine Fisheries Service,
Southeast Fisheries Science Center,
101 Pivers Island Rd, Beaufort, NC 28516
November 25, 2013

Introduction

This document responds to requests for revised stochastic projections, P* projections, and related information from the SEDAR 32 South Atlantic blueline tilefish stock assessment following the October 2013 meeting of the SSC.

Stochastic Projections

Four constant F projection scenarios were provided in the SEDAR 32 blueline tilefish assessment report:
1. F=0

2. $F=F_{rebuild}$ (F at which 50% of projection replicates achieve stock recovery in 10 yrs (i.e., $SSB_{2023} \geq SSB_{msy}$)

3. $F=F_{msy}$

4. $F=F_{current}$ (geometric mean F from 2009-2011)

In the original report, each scenario was run as a 5-year projection (2012-2016) with 2012 as an interim year, and management first applied in 2013. These projections only included data through 2011 and F in 2012 was taken as the geometric mean F from 2009-2011. Details of the projection methodology and results can be found in the SEDAR 32 blueline tilefish assessment report (SEDAR 2013).

At the SEDAR 32 review workshop (RW) it was noted that blueline landings in 2011 were unusally low compared to 2009 and 2010. This was attributed to a deepwater closure that was only in effect for 2011. As a result, the convention of using the geometric mean of the fishing mortality over the terminal three years of the assessment (2009-2011) for projections was questioned. A request was made at the RW to update the projections using actual 2012 landings data. The 2012 landings were similar in magnitude to those in 2009 and 2010 (and higher than 2011), supporting the conclusion that the low 2011 landings were a result of the temporary management regulation.

All projections were re-done including 2012 landings data. 2012-2014 were considered interim years and management was first applied in 2015 as described in the blueline tilefish management overview. The terminal year of the projections was 2023. The original four projection scenarios described above were re-run including these changes. An additional request was made for a rebuilding projection at 72.5% probability of successful rebuilding at $F_{rebuild}$. Hence, a fifth projection was run in an identical manner to those described above:

5. $F=F_{rebuild}$ (F at which 72.5% of projection replicates achieve stock recovery in 10 yrs (i.e., $SSB_{2023} \geq SSB_{msy}$)

Total blueline removals in 2012 were constructed from commercial (handline, longline, other gear) and recreational (headboat, MRIP) landings and discard estimates (Table 1). Landings were provided in pounds whole weight. Discards were converted from numbers to pounds whole weight assuming a mean weight of 5.06 pounds. A 1-yr projection was run with the 2012 landings data to generate a value for fishing mortality (F) in 2012 given the 2012 landings. The geometric mean fishing mortality over

2009, 2010, and 2012 (excluding 2011) was then used as current F for the interim years in the constant F projection scenarios described below.

In the SEDAR 32 blueline assessment, discards were not modeled separate from landings. This was due to the small amount of dead discards relative to landings and the lack of size or age information of discards needed to estimate discard selectivity. This decision was approved by the assessment panel during the assessment workshop and subsequent webinars. Because there were not separate discard and landings data streams in the assessment model, separate fishing mortality rates (Fs) were not estimated for landings and discards and, hence, all projected ABCs reflect combined landings and discards.

To separate the combined ABCs into those for landings and discards a posthoc analysis was conducted using the ratio of dead discards to landings available in the data. Recreational landings and discards were available from 1981 – 2011. Commercial discards were available from 1993 – 2011. Discard mortality was assumed to be 100% as recommended by the SEDAR 32 DW. Dead discards represented on average 0.0108% of total removals (landings + dead discards). Projected ABCs were partitioned between landings and discards using this ratio.

Results of the 5 projection scenarios are shown in Table 2-6 and Fig. 1-5.

P Analysis*

Acceptable biological catch (ABC) was computed using the sequential PASCL approach of Shertzer et al. (2010), a refinement of the probability-based approach described in Shertzer et al. (2008). This approach solves for annual levels of projected landings that are consistent with a preset acceptable probability of overfishing (P*) in any year of the projection time period. The method considers uncertainty in F_{MSY} as characterized by the MCB analysis described in the SEDAR 32 South Atlantic blueline tilefish stock assessment report (SEDAR 2013). No implementation uncertainty is included so that annual catch targets are considered to be centered on the ABC. Two 5-yr projections were run with P* = 0.5 and P* = 0.3. These values were recommended by the SSC following review of the assessment.

Projections were run for the six years following the terminal year of the assessment (2012-2017). The structure of the projection model is described in SEDAR (2013). The first year of new management is assumed to be 2015. Point estimates of initial abundance at age in the projection (start of 2012), other than at age 1, were taken to be the 2011 estimates from the assessment, discounted by 2011 natural and fishing mortalities. The initial abundance at age 1 was computed using the estimated spawner-recruit model and a 2011 estimate of SSB. In the assessment, the terminal two years of recruitment did not deviate from the spawner-recruit curve, which influenced the abundances of ages 1-2 (N_{1-2}) in 2011. In the projections, lognormal stochasticity was applied to these abundances based on recruitment variation (σ_R). Thus, the initial abundance in year one (2012) of the projections included this variability in N_{2-3}, as well as in the SSB_{2011} used to compute initial recruits, N_1. Because the assessment ended in 2011, the projections required an initialization period (2012). As for the stochastic projections described above, the fully selected fishing mortality rate during the initialization period was taken to be the geometric mean of fully selected F for 2009, 2010, and 2012. Any changes in fishing effort were assumed to begin in 2015.

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 steepness, as well as in estimated quantities such as spawner-recruit parameters, selectivity curves, and in initial (2012) 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. Variability was added to the mean values by choosing multiplicative deviations at random from the recruitment deviations estimated for that chosen MCB run.

The procedure generated 10,000 replicate projections of MCB model fits drawn at random (with replacement) from the MCB runs. In cases where the same MCB run was drawn, projections would still differ as a result of stochasticity in projected recruitment streams. Precision of projections was represented graphically by the 5th and 95th percentiles of the replicate projections.

Annual ABC (landings plus discard mortalities in 1000 lb whole weight and 1000s fish) was computed for the years 2013-2017. In general, ABC increased with a higher acceptable probability of overfishing (P*) while spawning stock biomass decreased. Because implementation uncertainty was considered zero, these ABC values should be considered possible catch limits. Implementation uncertainty could be included in which case these values would be adjusted downward in setting annual catch targets (ACTs).

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

Results of P* analysis (in weight and numbers) are shown in Table 7-10 and Fig. 6-7.

Comments on Projections:

- Both stochastic projections and P* analysis show a predicted spike in fishing mortality in 2014. The assumed F during the interim years (2012-2014) prior to management in 2015 is about three times F_{msy}. This high F drives down the predicted spawning biomass. In addition, the large recruitments in the early to mid-2000's predicted by the assessment model have pass through the fishery by 2013. The combination of low spawning biomass and a more typical (rather than elevated) recruitment pattern likely account for this spike in fishing mortality.

- In general, projections of fish stocks are highly uncertain, particularly in the long-term (> 3-5 years).

- Although these projections included many 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 fishing effort, using the estimated current selectivity patterns. New management regulations that alter those proportions or selectivities would likely affect projection results.

- These projections did not consider any error in implementing regulations (e.g., landings in excess of the ABC). If implementation error were included the projections would be altered.

- The projections assume that the estimated spawner-recruit relationship applies in the future and that past residuals reflect future uncertainty in recruitment. If future recruitment changes, due to environment or harvest effects, then stock trajectories will be altered.

References

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Table 1. 2012 landings and discard removals (pounds whole weight) of South Atlantic blueline tilefish.

Fishery	Removals
Com Handline landings	32,726
Com Longline landings	309,320
Com 'Other' landings	25,197
Com Discards	197
MRIP landings	91,421
MRIP discards	7,458
Headboat landings	18,462
Headboat discards	86
Total:	**484,867**

Table 2. Scenario 1: F=0. Acceptable biological catch (ABC) in units of 1000 lb whole weight and 1000s fish. F = fishing mortality rate (per yr), SSB = mid-year spawning stock biomass (mature female biomass in metric tons whole weight), Pr(SSB > SSB_{MSY}) = proportion of replicates where SSB was above the point estimate of SSB_{MSY} = 246.6 mt, R = recruits (1000 age-1 fish). Annual ABCs are a single quantity while other values presented are medians.

Year	F	SSB	Pr(SSB > SSBmsy)	R	ABC landings (1000 lb)	ABC discards (1000 lb)	ABC landings (1000 fish)	ABC discards (1000 fish)
2012	1.216	178.97	0.14	128.615	484.815	0.0524	97.811	0.0106
2013	2.084	125.48	0.05	117.750	484.815	0.0524	104.953	0.0113
2014	5.363	71.44	0.03	109.205	484.815	0.0524	125.174	0.0135
2015	0	76.24	0.03	92.260	0	0	0	0
2016	0	113.78	0.08	94.403	0	0	0	0
2017	0	152.41	0.19	106.545	0	0	0	0
2018	0	188.59	0.33	114.100	0	0	0	0
2019	0	224.85	0.47	118.864	0	0	0	0
2020	0	262.44	0.60	122.333	0	0	0	0
2021	0	300.26	0.69	125.052	0	0	0	0
2022	0	337.50	0.77	127.182	0	0	0	0
2023	0	373.66	0.82	128.862	0	0	0	0

Table 3. Scenario 2: F=Frebuild with 50% probability. Acceptable biological catch (ABC) in units of 1000 lb whole weight and 1000s fish. F = fishing mortality rate (per yr), SSB = mid-year spawning stock biomass (mature female biomass in metric tons whole weight), Pr(SSB > SSB_{MSY}) = proportion of replicates where SSB was above the point estimate of SSB_{MSY} = 246.6 mt, R = recruits (1000 age-1 fish). Annual ABCs are a single quantity while other values presented are medians.

Year	F	SSB	Pr(SSB > SSBmsy)	R	ABC landings (1000 lb)	ABC discards (1000 lb)	ABC landings (1000 fish)	ABC discards (1000 fish)
2012	1.216	178.97	0.14	128.615	484.815	0.0524	97.811	0.0106
2013	2.084	125.48	0.05	117.750	484.815	0.0524	104.953	0.0113
2014	5.363	71.44	0.03	109.205	484.815	0.0524	125.173	0.0135
2015	0.185	75.02	0.03	92.260	15.996	0.0017	4.254	0.0005
2016	0.185	107.95	0.06	93.874	31.101	0.0034	7.279	0.0008
2017	0.185	138.32	0.10	105.063	50.792	0.0055	10.889	0.0012
2018	0.185	162.42	0.16	111.724	71.950	0.0078	14.492	0.0016
2019	0.185	183.09	0.23	115.589	91.444	0.0099	17.552	0.0019
2020	0.185	202.47	0.30	118.240	107.108	0.0116	19.790	0.0021
2021	0.185	220.47	0.37	120.315	120.384	0.0130	21.627	0.0023
2022	0.185	236.82	0.44	121.965	133.132	0.0144	23.422	0.0025
2023	0.185	251.29	0.50	123.279	145.395	0.0157	25.145	0.0027

Table 4. Scenario 3: $F=F_{msy}$. Acceptable biological catch (ABC) in units of 1000 lb whole weight and 1000s fish. F = fishing mortality rate (per yr), SSB = mid-year spawning stock biomass (mature female biomass in metric tons whole weight), Pr(SSB > SSB_{MSY}) = proportion of replicates where SSB was above the point estimate of SSB_{MSY} = 246.6 mt, R = recruits (1000 age-1 fish). Annual ABCs are a single quantity while other values presented are medians.

Year	F	SSB	Pr(SSB > SSBmsy)	R	ABC landings (1000 lb)	ABC discards (1000 lb)	ABC landings (1000 fish)	ABC discards (1000 fish)
2012	1.216	178.97	0.14	128.615	484.815	0.0524	97.811	0.0106
2013	2.084	125.48	0.05	117.750	484.815	0.0524	104.953	0.0113
2014	5.363	71.44	0.03	109.205	484.815	0.0524	125.174	0.0135
2015	0.302	74.27	0.03	92.260	25.592	0.0028	6.827	0.0007
2016	0.302	104.57	0.05	93.544	47.836	0.0052	11.295	0.0012
2017	0.302	130.70	0.07	104.147	74.855	0.0081	16.271	0.0018
2018	0.302	149.31	0.09	110.274	101.639	0.0110	20.871	0.0023
2019	0.302	163.77	0.12	113.608	123.962	0.0134	24.408	0.0026
2020	0.302	176.81	0.15	115.778	139.585	0.0151	26.658	0.0029
2021	0.302	188.76	0.18	117.487	151.690	0.0164	28.398	0.0031
2022	0.302	199.43	0.22	118.883	163.315	0.0176	30.168	0.0033
2023	0.302	208.54	0.25	120.011	174.399	0.0188	31.869	0.0034

Table 5. Scenario 4: $F=F_{current}$ (geometric mean F 2009, 2010, 2012). Acceptable biological catch (ABC) in units of 1000 lb whole weight and 1000s fish. F = fishing mortality rate (per yr), SSB = mid-year spawning stock biomass (mature female biomass in metric tons whole weight), Pr(SSB > SSB_{MSY}) = proportion of replicates where SSB was above the point estimate of SSB_{MSY} = 246.6 mt, R = recruits (1000 age-1 fish). Annual ABCs are a single quantity while other values presented are medians.

Year	F	SSB	Pr(SSB > SSBmsy)	R	ABC landings (1000 lb)	ABC discards (1000 lb)	ABC landings (1000 fish)	ABC discards (1000 fish)
2012	1.216	178.97	0.14	128.615	484.815	0.0524	97.811	0.0106
2013	2.084	125.48	0.05	117.750	484.815	0.0524	104.953	0.0113
2014	5.363	71.44	0.03	109.205	484.815	0.0524	125.174	0.0135
2015	1.064	69.67	0.02	92.260	80.772	0.0087	21.984	0.0024
2016	1.064	86.65	0.01	91.424	121.080	0.0131	30.152	0.0033
2017	1.064	96.10	0.01	98.488	153.015	0.0165	36.111	0.0039
2018	1.064	98.25	0.00	101.660	172.250	0.0186	39.498	0.0043
2019	1.064	98.26	0.00	102.318	179.166	0.0194	40.566	0.0044
2020	1.064	99.48	0.00	102.321	177.927	0.0192	40.291	0.0044
2021	1.064	101.66	0.00	102.687	178.585	0.0193	40.575	0.0044
2022	1.064	103.57	0.00	103.328	182.755	0.0197	41.492	0.0045
2023	1.064	104.71	0.00	103.870	186.665	0.0202	42.262	0.0046

Table 6. Scenario 5: $F=F_{rebuild}$ with 72.5% probability. Acceptable biological catch (ABC) in units of 1000 lb whole weight and 1000s fish. F = fishing mortality rate (per yr), SSB = mid-year spawning stock biomass (mature female biomass in metric tons whole weight), $Pr(SSB > SSB_{MSY})$ = proportion of replicates where SSB was above the point estimate of SSB_{MSY} = 246.6 mt, R = recruits (1000 age-1 fish). Annual ABCs are a single quantity while other values presented are medians.

Year	F	SSB	Pr(SSB > SSBmsy)	R	ABC landings (1000 lb)	ABC discards (1000 lb)	ABC landings (1000 fish)	ABC discards (1000 fish)
2012	1.216	178.97	0.14	128.615	484.815	0.0524	97.811	0.0106
2013	2.084	125.48	0.05	117.750	484.815	0.0524	104.953	0.0113
2014	5.363	71.44	0.03	109.205	484.815	0.0524	125.174	0.0135
2015	0.075	75.74	0.03	92.260	6.601	0.0007	1.750	0.0002
2016	0.075	111.35	0.07	94.188	13.343	0.0014	3.097	0.0003
2017	0.075	146.37	0.15	105.940	22.754	0.0025	4.813	0.0005
2018	0.075	177.07	0.25	113.126	33.690	0.0036	6.661	0.0007
2019	0.075	205.94	0.37	117.519	44.767	0.0048	8.383	0.0009
2020	0.075	234.54	0.49	120.651	54.818	0.0059	9.808	0.0011
2021	0.075	262.17	0.58	123.105	64.177	0.0069	11.068	0.0012
2022	0.075	288.31	0.66	125.035	73.528	0.0079	12.312	0.0013
2023	0.075	312.60	0.73	126.562	82.872	0.0090	13.529	0.0015

Table 7. Acceptable biological catch (ABC) in units of 1000 lb whole weight based on the annual probability of overfishing P* = 0.5. F = fishing mortality rate (per yr), SSB = mid-year spawning stock biomass (mature female biomass in metric tons whole weight), Pr(SSB > SSB_{MSY}) = proportion of replicates where SSB was above the point estimate of SSB_{MSY} = 246.6 mt, R = recruits (1000 age-1 fish). Annual ABCs are a single quantity while other values presented are medians.

Year	F	Pr(F > Fmsy)	P*	SSB	Pr(SSB > SSBmsy)	R	ABC landings (1000 lb)	ABC discards (1000 lb)
2013	1.54	0.99	NA	150.285	0.03	106.423	NA	NA
2014	3.17	1.00	NA	101.240	0.02	96.623	NA	NA
2015	0.238	0.50	0.5	102.593	0.02	83.011	32.854	0.00355
2016	0.234	0.50	0.5	132.846	0.05	83.213	54.548	0.00589
2017	0.231	0.50	0.5	158.401	0.10	90.402	77.379	0.00836

Table 8. Acceptable biological catch (ABC) in units of 1000s of fish based on the annual probability of overfishing P* = 0.5. F = fishing mortality rate (per yr), SSB = mid-year spawning stock biomass (mature female biomass in metric tons whole weight), Pr(SSB > SSB_{MSY}) = proportion of replicates where SSB was above the point estimate of SSB_{MSY} = 246.6 mt, R = recruits (1000 age-1 fish). Annual ABCs are a single quantity while other values presented are medians.

Year	F	Pr(F > Fmsy)	P*	SSB	Pr(SSB > SSBmsy)	R	ABC landings (1000 fish)	ABC discards (1000 fish)
2013	1.54	0.99	NA	150.285	0.03	106.423	NA	NA
2014	3.17	1.00	NA	101.240	0.02	96.623	NA	NA
2015	0.238	0.50	0.5	102.593	0.02	83.011	7.782	0.00084
2016	0.234	0.50	0.5	132.846	0.05	83.213	11.787	0.00127
2017	0.231	0.50	0.5	158.401	0.10	90.402	15.664	0.00169

Table 9. Acceptable biological catch (ABC) in units of 1000 lb whole weight based on the annual probability of overfishing P* = 0.3. F = fishing mortality rate (per yr), SSB = mid-year spawning stock biomass (mature female biomass in metric tons whole weight), Pr(SSB > SSB_{MSY}) = proportion of replicates where SSB was above the point estimate of SSB_{MSY} = 246.6 mt, R = recruits (1000 age-1 fish). Annual ABCs are a single quantity while other values presented are medians.

Year	F	Pr(F > Fmsy)	P*	SSB	Pr(SSB > SSBmsy)	R	ABC landings (1000 lb)	ABC discards (1000 lb)
2013	1.54	0.99	NA	150.285	0.03	106.423	NA	NA
2014	3.17	1.00	NA	101.240	0.02	96.623	NA	NA
2015	0.151	0.30	0.3	103.566	0.02	83.011	21.192	0.00229
2016	0.152	0.30	0.3	136.680	0.05	83.562	37.483	0.00405
2017	0.152	0.30	0.3	166.063	0.12	91.495	55.608	0.00601

Table 10. Acceptable biological catch (ABC) in units of 1000s fish based on the annual probability of overfishing P* = 0.3. F = fishing mortality rate (per yr), SSB = mid-year spawning stock biomass (mature female biomass in metric tons whole weight), Pr(SSB > SSB_{MSY}) = proportion of replicates where SSB was above the point estimate of SSB_{MSY} = 246.6 mt, R = recruits (1000 age-1 fish). Annual ABCs are a single quantity while other values presented are medians.

Year	F	Pr(F > Fmsy)	P*	SSB	Pr(SSB > SSBmsy)	R	ABC landings (1000 fish)	ABC discards (1000 fish)
2013	1.54	0.99	NA	150.285	0.03	106.423	NA	NA
2014	3.17	1.00	NA	101.240	0.02	96.623	NA	NA
2015	0.151	0.30	0.3	103.566	0.02	83.011	5.004	0.000540
2016	0.152	0.30	0.3	136.680	0.05	83.562	8.036	0.000868
2017	0.152	0.30	0.3	166.063	0.12	91.495	11.1224	0.00120

Figure 1. Scenario 1: F=0. For this assessment, discards were combined with landings so the ABC reflects both landings and dead discards (landings and dead discards are separated in the associated Tables). Annual ABCs are a single quantity while other values presented are medians. Error bars represent the 5th and 95th percentiles of the 10,000 projection runs.

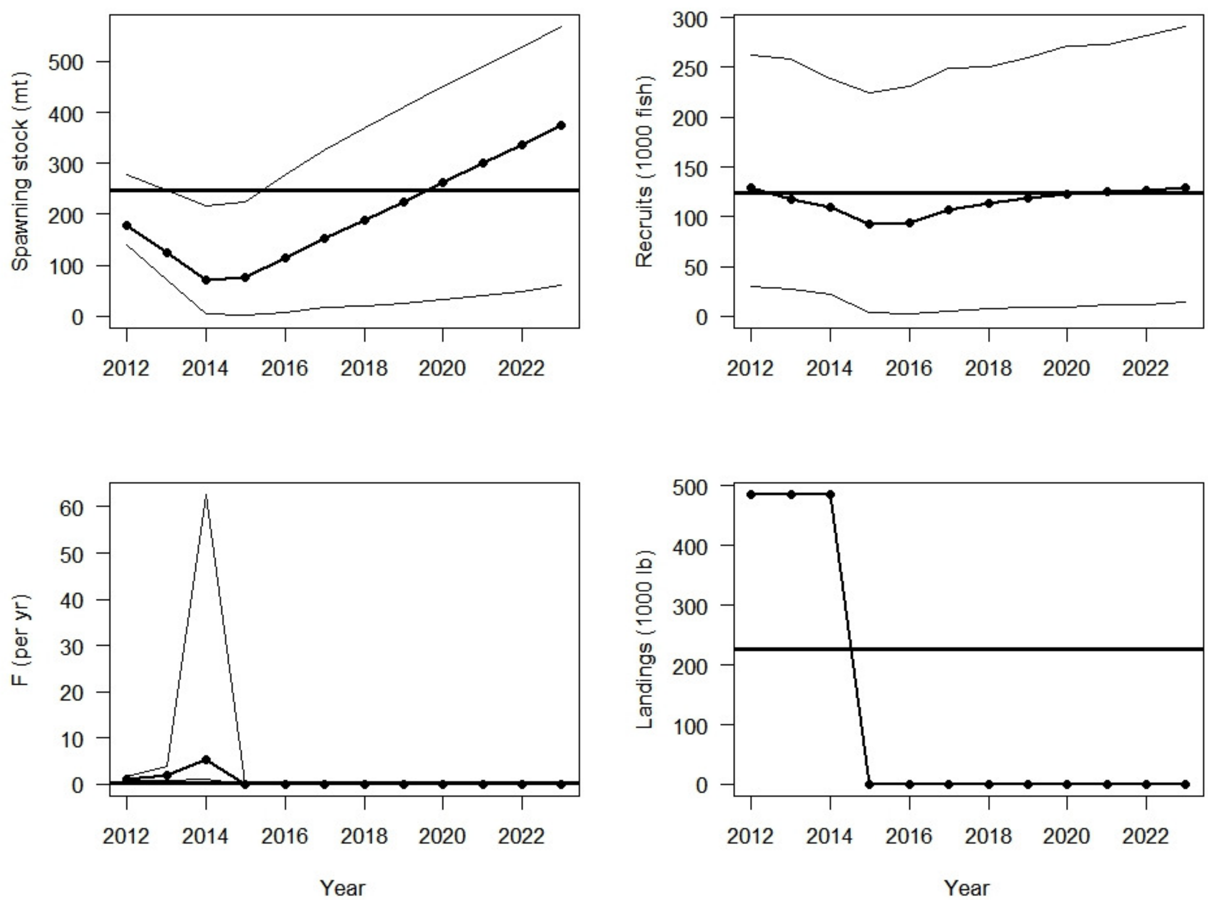

Figure 2. Scenario 1: F=$F_{rebuild}$ with 50% probability. For this assessment, discards were combined with landings so the ABC reflects both landings and dead discards (landings and dead discards are separated in the associated Tables). Annual ABCs are a single quantity while other values presented are medians. Error bars represent the 5th and 95th percentiles of the 10,000 projection runs.

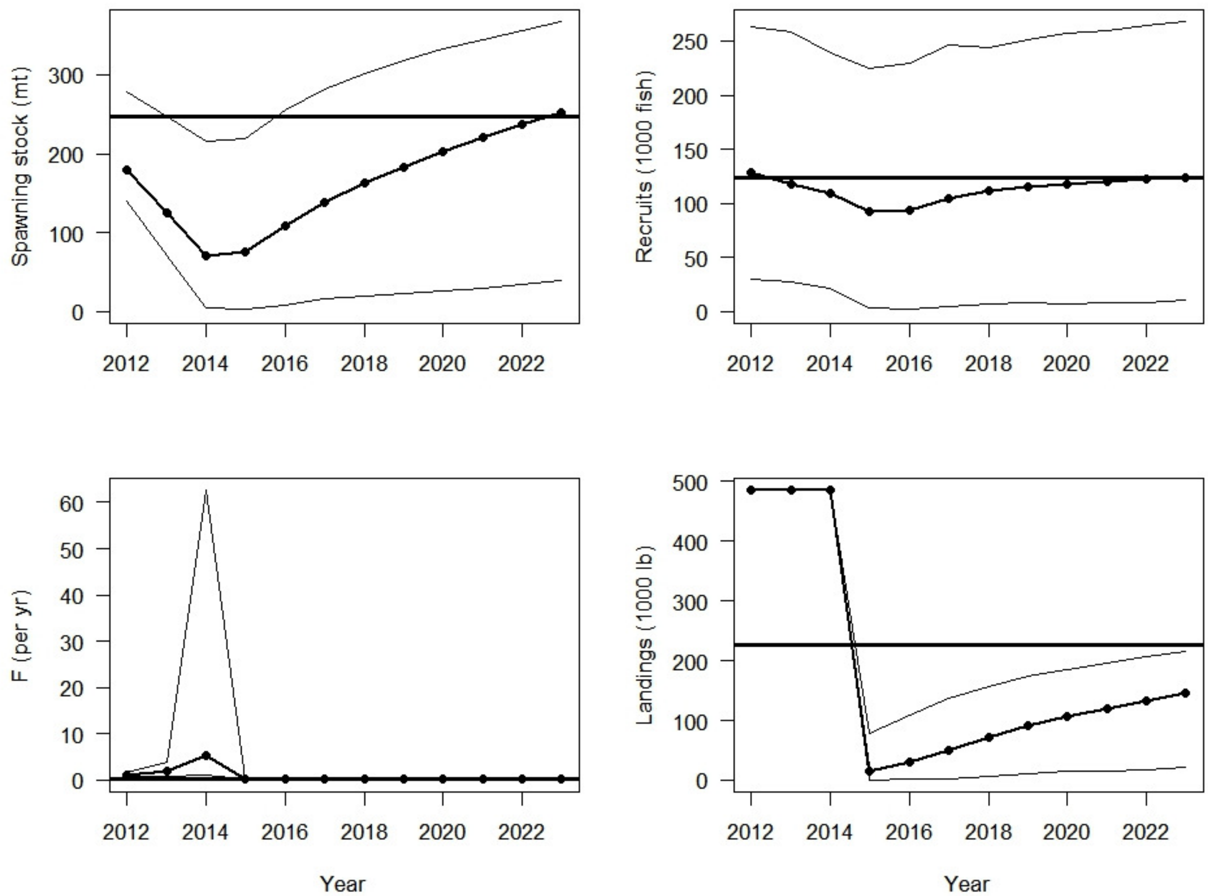

Figure 3. Scenario 1: F=F_{msy}. For this assessment, discards were combined with landings so the ABC reflects both landings and dead discards (landings and dead discards are separated in the associated Tables). Annual ABCs are a single quantity while other values presented are medians. Error bars represent the 5^{th} and 95^{th} percentiles of the 10,000 projection runs.

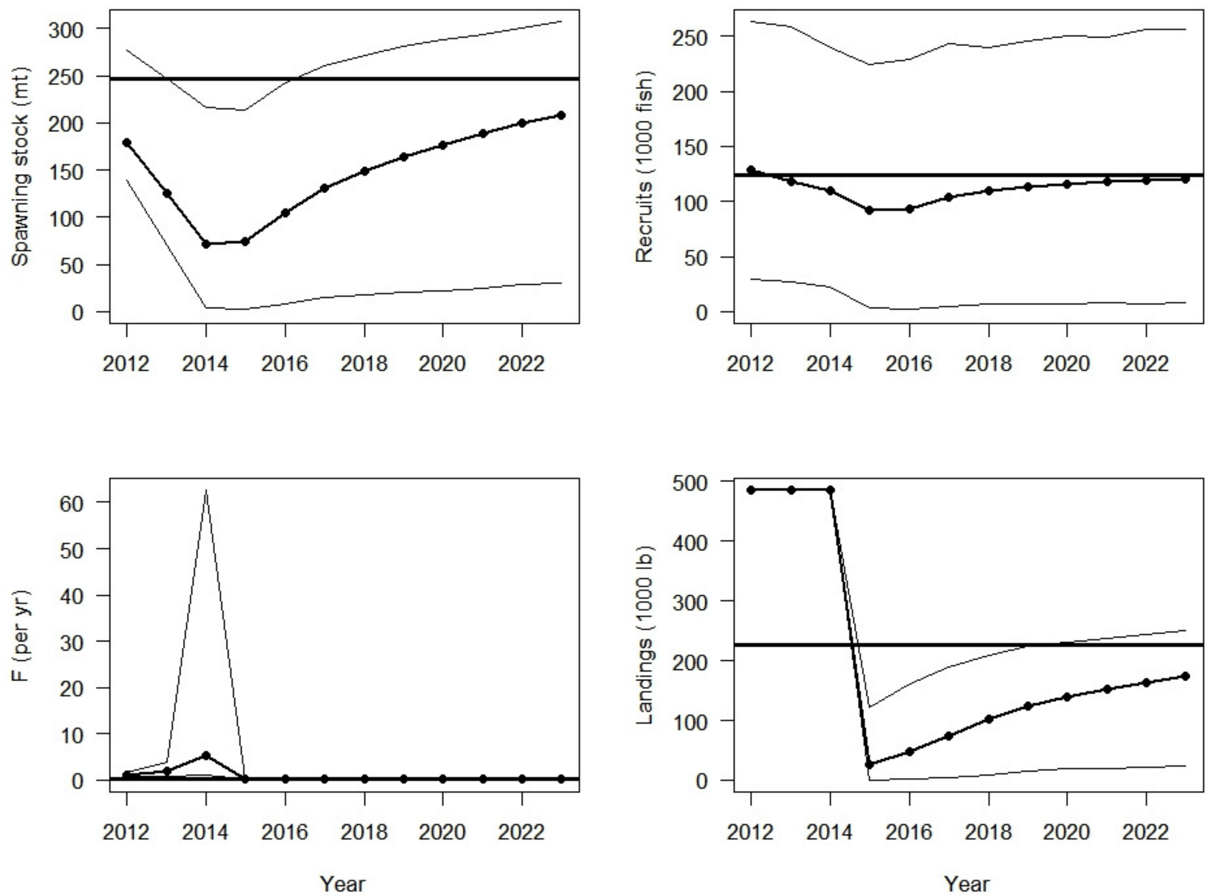

Figure 4. Scenario 1: F=$F_{current}$ (geometric mean F from 2009, 2010, and 2012). For this assessment, discards were combined with landings so the ABC reflects both landings and dead discards (landings and dead discards are separated in the associated Tables). Annual ABCs are a single quantity while other values presented are medians. Error bars represent the 5th and 95th percentiles of the 10,000 projection runs.

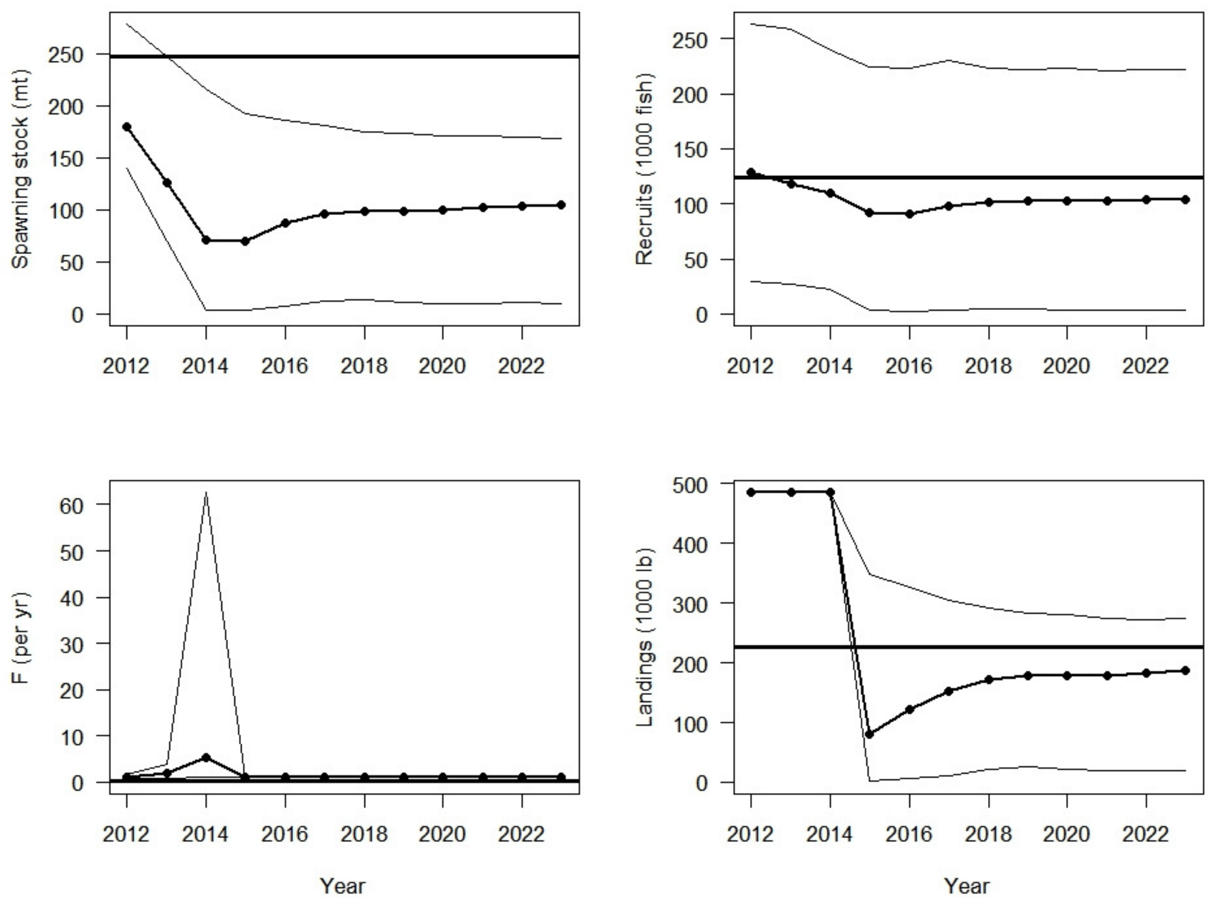

Figure 5. Scenario 1: F=$F_{rebuild}$ with 72.5% probability. For this assessment, discards were combined with landings so the ABC reflects both landings and dead discards (landings and dead discards are separated in the associated Tables). Annual ABCs are a single quantity while other values presented are medians. Error bars represent the 5th and 95th percentiles of the 10,000 projection runs.

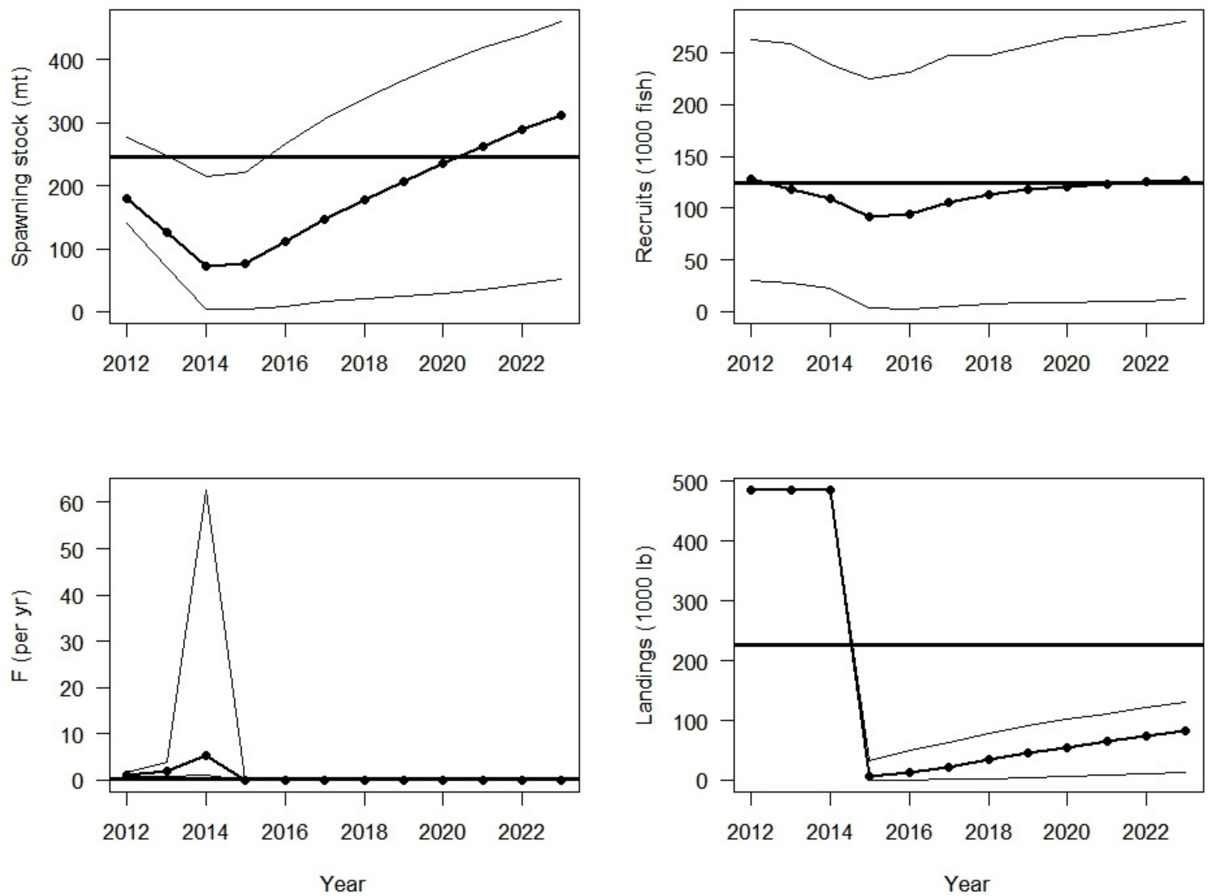

Figure 6. P* = 0.5 projection results. For this assessment, discards were combined with landings so the ABC reflects both landings and dead discards (i.e., Landings = Catch). Annual ABCs (panel E) are a single quantity while other values presented are medians. Error bars represent the 5th and 95th percentiles of the 10,000 projection runs.

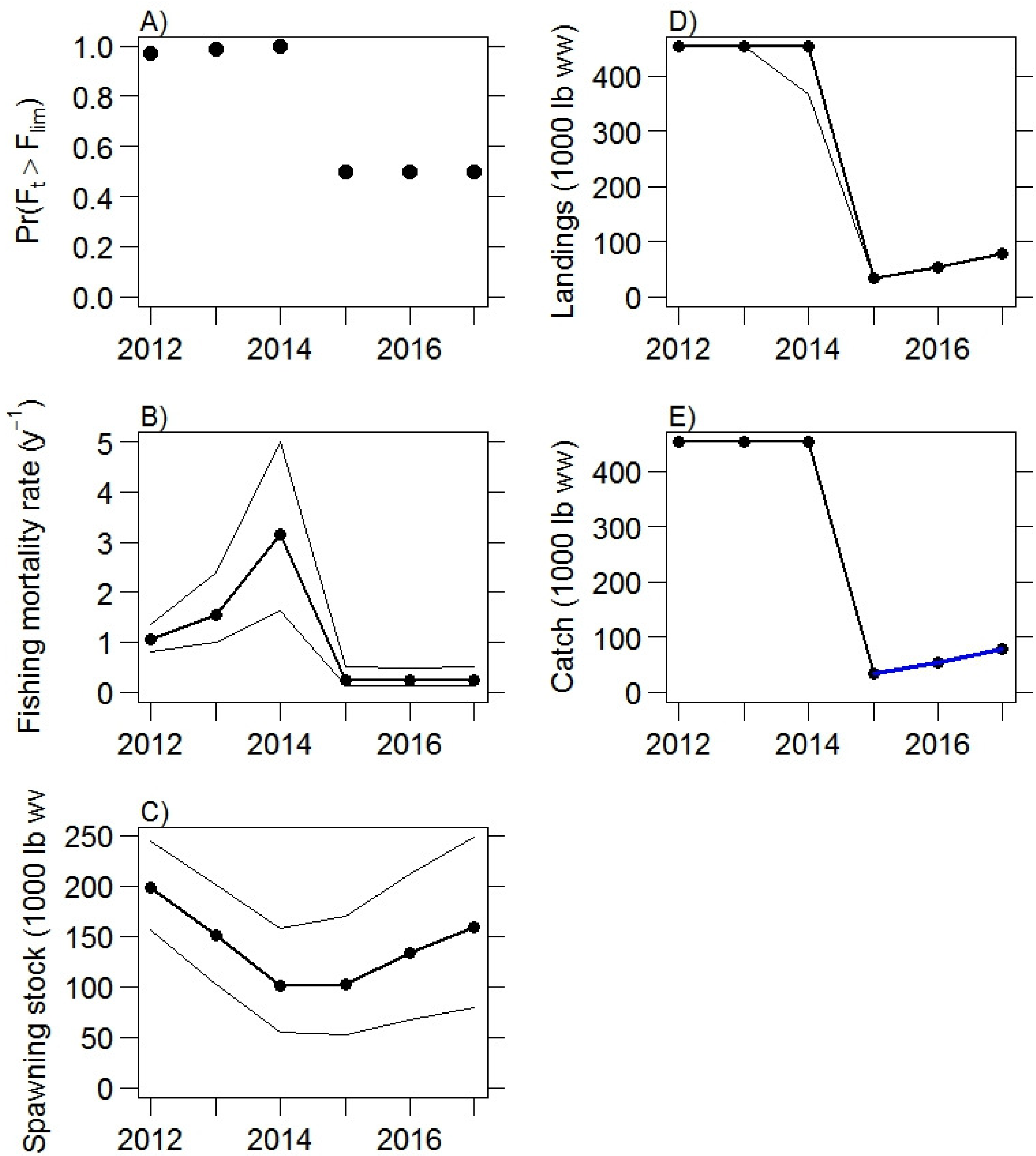

Figure 7. P* = 0.3 projection results. For this assessment, discards were combined with landings so the ABC reflects both landings and dead discards (i.e., landings = catch). Annual ABCs (panel E) are a single quantity while other values presented are medians. Error bars represent the 5th and 95th percentiles of the 10,000 projection runs.