SEDAR

Southeast Data, Assessment, and Review

SEDAR 68
Stock Assessment Report

Atlantic Scamp Grouper

September 2021

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

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SECTION I: Introduction

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Overview

SEDAR 68 addressed the stock assessments for Atlantic and Gulf of Mexico Scamp Snapper. The process consisted of a series of webinars. The Data Workshop was originally scheduled for March 2020, but due to the COVID-19 pandemic, was cancelled. The Data Process transitioned to webinars, which were held between March and September 2020. The Assessment Process was conducted via webinars December 2020 - May 2021, and the Review Workshop was held virtually August 31-September 3, 2021.

The first stage of the Data Process was a Stock ID review. This process was conducted via a series of webinars. The primary findings of the Stock ID Workshop were twofold. First, there is no evidence in support of biological substructure of the Scamp population off the Southeastern United States. Second, Scamp are very difficult to distinguish from Yellowmouth Grouper, even for trained biologists, and thus much of the assessment data likely represent both species in unknown proportions. In line with these findings, the Stock ID Workshop recommended that two stock assessments be conducted, separated by the default boundary between the Gulf of Mexico and Atlantic waters, as defined by the Councils' jurisdictions. Further, the Stock ID Workshop recommended that each assessment (Gulf of Mexico, Atlantic) be conducted on both Scamp and Yellowmouth Grouper jointly, with the two species treated as a single complex.

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

The final Stock Assessment Reports (SAR) for Atlantic scamp was disseminated to the public in September 2021. The Gulf of Mexico and South Atlantic Council's Scientific and Statistical Committee (SSC) will review the SAR. The SSCs are tasked with recommending whether the assessments represent Best Available Science, whether the results presented in the SARs are useful for providing management advice and developing fishing level recommendations for the Council. An SSC may request additional analyses be conducted or may use the information provided in the SAR as the basis for their Fishing Level Recommendations (e.g., Overfishing Limit and Acceptable Biological Catch). A review of the assessment will be conducted by the Gulf of Mexico Fishery Management Council's SSC in January 2022. The South Atlantic Fishery Management Council's SSC will review the assessment at its October 2021 meeting, followed by the Council receiving that information at its December 2021. Documentation on SSC recommendations are not part of the SEDAR process and is handled through each Council.

1 SEDAR PROCESS DESCRIPTION

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

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

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

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

2 SCAMP MANAGEMENT OVERVIEW

2.1 Fishery Management Plans and Amendments

The following summary describes only those management actions that likely affect Scamp and Yellowmouth Grouper 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 83º W longitude. Regulations apply only to federal waters.

Note that this management overview focuses on management measures directly affecting scamp. There may be management of other species that indirectly affects scamp due to changes in the behavior of fishermen that cannot be reliably predicted.

SAFMC FMP Amendments affecting scamp

Description of Action	FMP/Amendment	Effective Date

-4” trawl mesh size -Gear limitations (poisons, explosives, fish traps, trawls) -Designated modified habitats or artificial reefs as Special Management Zones	Snapper Grouper FMP	8/31/1983
-Prohibit trawls to harvest snapper grouper species south of Cape Hatteras, NC and north of Cape Canaveral, FL -Defined directed fishery as vessel with trawl gear and at least 200 pounds of snapper grouper species on board	Amendment 1	1/12/1989
-Prohibited gear: fish traps except black sea bass pots north of Cape Canaveral, FL; entanglement nets; longlines inside 50 fathoms; powerheads in designated SMZs off SC -Required offloading of SG species with heads and fins intact -Scamp minimum size limit = 20 inches total length -Aggregate grouper bag limit (including scamp) = 5 per person per day -Allowance for multiple bag limits per trip on charter vessels and headboats for trips over 24 hours. -Defined overfishing/overfished and established rebuilding timeframe for overfished species. Groupers = 15 years (1991 is year 1). -Required permits (commercial and for-hire) and specified data collection regulations	Amendment 4	1/1/1992
-Required dealer, charter, and headboat federal permits -Restricted sale and purchase of SG species -Specified allowable gear -Modified criteria for possession of multi-day bag limits	Amendment 7	1/23/1995
-Established limited entry for commercial snapper grouper fishery	Amendment 8	12/14/1998
-Established MSY proxy for groupers = 30% static SPR -OY proxy for hermaphroditic groupers = 45% static SPR -Determined scamp no longer overfished (static SPR = 35%) Established overfishing level = F>F30% static SPR MSST = [(1-M) or 0.5, whichever is greater)*B_{MSY} MFMT=F_{MSY}	Amendment 11	12/02/1999
-Prohibited the sale of SG species harvested or possessed in the EEZ under the bag limit and by vessels with a federal charter/headboat permit for SG species, regardless of where harvested	Amendment 15B	12/16/2009
-Established recreational and commercial shallow-water grouper spawning closure annually from January through April -Reduced 5-fish aggregate to 3-fish -Captain and crew on for-hire trips cannot retain species within the 3-grouper aggregate	Amendment 16	7/29/2009

-Specified allocations and directed commercial quota for gag -Prohibited harvest and possession of gag and associated shallow-water groupers (including scamp) when the directed commercial quota of gag was reached		
-Required use of non-stainless-steel circle hooks when fishing for SG species with natural baits in the EEZ north of 28 degrees N Latitude.	Amendment 17A	3/3/2011
-Reorganized FMU into 6 complexes (deep-water, jacks, snappers, grunts, shallow-water groupers, porgies) -Established ABCs, ACLs, allocations, and AMs for SG species not undergoing overfishing. For scamp: commercial ACL = 341,636 lbs ww; recreational ACL = 150,936 lbs ww; allocations = 65.34% comm/34.66% rec For SASWG: commercial SASWG ACL = 49,488 lbs ww; recreational SASWG ACL = 48,329 lbs ww; Allocations (for Yellowmouth) = 1.35% commercial	Amendment 25 (Comprehensive ACL Amendment)	4/16/2012
-Limited harvest of SG species in SC SMZs to the bag limit	Amendment 23 (CE-BA2)	1/30/2012
-Removed restriction on retention of bag limit quantities of grouper aggregate species (including scamp and yellowmouth) by captain and crew on for-hire vessels	Amendment 27	1/27/2014
-Modified ABC Control Rule for SG species to incorporate ORCS methodology -Adjusted ABCs and fishing levels for 14 unassessed SG species. -For scamp: ACL = OY = 90%ABC and 0.5 risk tolerance scalar. New ABC = 373,049 lbs ww. Commercial ACL = 219,375 lbs ww Rec ACL = 116,369 lbs ww -For SASWG: ACL = OY = ABC. Commercial ACL = 55,542 lbs ww Rec ACL = 48,648 lbs ww	Amendment 29	7/1/2015
-Revised accountability measures for SG species (including scamp and yellowmouth)	Amendment 34	2/22/2016

SAFMC Regulatory Amendments affecting scamp

Description of Action	Amendment	Effective Date
-Adjusted ACLs in response to MRIP revisions. Scamp: Comm ACL =333,100 lbs ww; Rec ACL = 176,688 lbs ww Yellowmouth: Comm ACL = 49,776 lbs ww; Rec ACL = 46,656 lbs ww	Regulatory Amendment 13	7/17/2013
-Removed prohibition on harvest and possession of shallow-water groupers	Regulatory Amendment 15	9/12/2013

(including scamp and yellowmouth) when the gag commercial ACL is met or projected to be met.		

2.2 Emergency and Interim Rules (if any)

None affecting scamp or yellowmouth

2.3 Secretarial Amendments (if any)

None affecting scamp or yellowmouth

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.

Notice of Control Date effective June 15, 2016: Fishermen entering federal for-hire snapper grouper recreational fishery off S. Atlantic states after 06/15/16 is not assured of future access if limited entry program is developed.

2.5 Management Program Specifications

Table 2.5.1. General Management Information

Atlantic

Species	Scamp (*Mycteroperca phenax*) Yellowmouth Grouper (*Mycteroperca interstitialis)*
Management Unit	Southeastern U.S.
Management Unit Definition	All waters within South Atlantic Fishery Management Council Boundaries
Management Entity	South Atlantic Fishery Management Council
Management Contacts SERO / Council	SAFMC: Myra Brouwer SERO: Rick DeVictor
Current stock exploitation status	Overfishing not occuring
Current stock biomass status	Unknown

Table 2.5.2. Management Parameters

As Scamp or Yellowmouth have never been formally assessed, most management parameters do not currently exist.

Criteria	Atlantic – Proposed (values from SEDAR 68)		
	Definition	Base Run Values	Median of Base Run MCBs

MSST[1]	(1-M) B_{MSY}		
	0.5 B_{MSY}		
MFMT	F_{MSY}, if available; $F_{30\% SPR}$ proxy [2]		
F_{MSY}	F_{MSY}		
MSY	Yield at F_{MSY}, landings and discards, pounds and numbers		
B_{MSY}[1]	Total or spawning stock, to be defined		
R_{MSY}	Recruits at MSY		
OY	Optimum Yield, landings and discards, pounds and numbers		
F_{OY}	F at OY		
F Target	75% F_{MSY}		
Yield at F_{TARGET} (equilibrium)	Landings and discards, pounds and numbers		
M	Natural mortality, average across ages or point estimate used to scale M at age		
Terminal F	Exploitation, geometric mean of the last 3 years		
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 30% 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.

Table 2.5.3. Stock Rebuilding Information

None

Table 2.5.4. General Projection Specifications

The projection information will be completed when the management history is updated for the Scamp Operational Assessment.

First Year of Management	
Interim basis	
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.

The projection information will be completed when the management history is updated for the Scamp Operational Assessment.

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

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.

Basis	Value	Years to Project	P* applies to

Table 2.5.7. Quota Calculation Details

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

Scamp: Current Acceptable Biological Catch (ABC) and Total Annual Catch Level (ACL) Value for Scamp Yellowmouth ACL (part of SASWG complex):	ABC=373,049 lbs ww Total ACL = 335,744 lbs ww For SASWG: commercial SASWG ACL = 49,488 lbs ww; recreational SASWG ACL = 48,329 lbs ww
Commercial ACL for Scamp	219,375 lbs ww
Recreational ACL for Scamp	116,369 lbs ww
Commercial ACL allocation for yellowmouth	1.35% commercial
Recreational ACL allocation for yellowmouth	98.65% recreational
Next Scheduled Quota Change	upon completion of stock assessment
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 ACL is set at 90% of the ABC, which was established under the Only Reliable Catch Stocks (ORCS) methodology incorporated in the ABC Control Rule in 2015. The methodology includes a catch statistic (highest landings between 1999 and 2007 =596,879 lbs ww), a risk of overexploitation scalar (1.25) and a risk tolerance scalar (0.5).

The sector allocations (65.34% comm/34.66% rec) were set using the formula (0.5 x average catch 1986-2008) + (0.5 x average catch 2006-2008).

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

The quota does not include estimates of discards in it.

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

None

2.6 Federal Management and Regulatory Timeline

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

Table 2.6.1 South Atlantic Scamp and Yellowmouth Recreational Regulatory History prepared by: Myra Brouwer Notes: Regulatory Amendment 30 proposes extending the recreational seasonal closure ONLY OFF THE CAROLINAS AND FOR RED GROUPER ONLY. Regulations are expected to affect the 2020 fishing year

Year	Quota (# fish)	ACL (# fish)	Days Open	fishing season	reason for closure	season start date (first day implemented)	season end date (last day effective)	Size limit	size limit start date	size limit end date	Retention Limit (# fish)	Retention Limit Start Date	Retention Limit End Date	Aggregate Retention Limit[1] (# fish)	Aggregate Retention Limit Start Date	Aggregate Retention Limit End Date
1983	N/A	N/A	123	open	N/A	31-Aug	31-Dec	None	N/A	N/A	None	N/A	N/A	None	N/A	N/A
1984	N/A	N/A	366	open	N/A	1-Jan	31-Dec	None	N/A	N/A	None	N/A	N/A	None	N/A	N/A
1985	N/A	N/A	365	open	N/A	1-Jan	31-Dec	None	N/A	N/A	None	N/A	N/A	None	N/A	N/A
1986	N/A	N/A	365	open	N/A	1-Jan	31-Dec	None	N/A	N/A	None	N/A	N/A	None	N/A	N/A
1987	N/A	N/A	365	open	N/A	1-Jan	31-Dec	None	N/A	N/A	None	N/A	N/A	None	N/A	N/A
1988	N/A	N/A	366	open	N/A	1-Jan	31-Dec	None	N/A	N/A	None	N/A	N/A	None	N/A	N/A
1989	N/A	N/A	365	open	N/A	1-Jan	31-Dec	None	N/A	N/A	None	N/A	N/A	None	N/A	N/A
1990	N/A	N/A	365	open	N/A	1-Jan	31-Dec	None	N/A	N/A	None	N/A	N/A	None	N/A	N/A
1991	N/A	N/A	365	open	N/A	1-Jan	31-Dec	None	N/A	N/A	None	N/A	N/A	None	N/A	N/A
1992	N/A	N/A	366	open	N/A	1-Jan	31-Dec	20 inches	1-Jan	31-Dec	5	1-Jan	31-Dec	5	1-Jan	31-Dec
1993	N/A	N/A	365	open	N/A	1-Jan	31-Dec	20 inches	1-Jan	31-Dec	5	1-Jan	31-Dec	5	1-Jan	31-Dec
1994	N/A	N/A	365	open	N/A	1-Jan	31-Dec	20 inches	1-Jan	31-Dec	5	1-Jan	31-Dec	5	1-Jan	31-Dec
1995	N/A	N/A	365	open	N/A	1-Jan	31-Dec	20 inches	1-Jan	31-Dec	5	1-Jan	31-Dec	5	1-Jan	31-Dec
1996	N/A	N/A	366	open	N/A	1-Jan	31-Dec	20 inches	1-Jan	31-Dec	5	1-Jan	31-Dec	5	1-Jan	31-Dec
1997	N/A	N/A	365	open	N/A	1-Jan	31-Dec	20 inches	1-Jan	31-Dec	5	1-Jan	31-Dec	5	1-Jan	31-Dec
1998	N/A	N/A	365	open	N/A	1-Jan	31-Dec	20 inches	1-Jan	31-Dec	5	1-Jan	31-Dec	5	1-Jan	31-Dec
1999	N/A	N/A	365	open	N/A	1-Jan	31-Dec	20 inches	1-Jan	31-Dec	5	1-Jan	31-Dec	5	1-Jan	31-Dec
2000	N/A	N/A	366	open	N/A	1-Jan	31-Dec	20 inches	1-Jan	31-Dec	5	1-Jan	31-Dec	5	1-Jan	31-Dec
2001	N/A	N/A	365	open	N/A	1-Jan	31-Dec	20 inches	1-Jan	31-Dec	5	1-Jan	31-Dec	5	1-Jan	31-Dec
2002	N/A	N/A	365	open	N/A	1-Jan	31-Dec	20 inches	1-Jan	31-Dec	5	1-Jan	31-Dec	5	1-Jan	31-Dec
2003	N/A	N/A	365	open	N/A	1-Jan	31-Dec	20 inches	1-Jan	31-Dec	5	1-Jan	31-Dec	5	1-Jan	31-Dec
2004	N/A	N/A	366	open	N/A	1-Jan	31-Dec	20 inches	1-Jan	31-Dec	5	1-Jan	31-Dec	5	1-Jan	31-Dec
2005	N/A	N/A	365	open	N/A	1-Jan	31-Dec	20 inches	1-Jan	31-Dec	5	1-Jan	31-Dec	5	1-Jan	31-Dec
2006	N/A	N/A	365	open	N/A	1-Jan	31-Dec	20 inches	1-Jan	31-Dec	5	1-Jan	31-Dec	5	1-Jan	31-Dec
2007	N/A	N/A	365	open	N/A	1-Jan	31-Dec	20 inches	1-Jan	31-Dec	5	1-Jan	31-Dec	5	1-Jan	31-Dec
2008	N/A	N/A	366	open	N/A	1-Jan	31-Dec	20 inches	1-Jan	31-Dec	5	1-Jan	31-Dec	5	1-Jan	31-Dec
2009	N/A	N/A	365	open	N/A	1-Jan	31-Dec	20 inches	1-Jan	31-Dec	5	1-Jan	28-Jul	5	1-Jan	28-Jul
											3	29-Jul	31-Dec	3	29-Jul	31-Dec
2010	N/A	N/A	120	closed	Seasonal	1-Jan	30-Apr	20 inches	1-Jan	31-Dec	3	1-May	31-Dec	3	1-May	31-Dec
			245	open	N/A	1-May	31-Dec									
2011	N/A	N/A	120	closed	Seasonal	1-Jan	30-Apr	20 inches	1-Jan	31-Dec	3	1-May	31-Dec	3	1-May	31-Dec
			245	open	N/A	1-May	31-Dec									
2012	see ACL	150,936 lbs ww	121	closed	Seasonal	1-Jan	30-Apr	20 inches	1-Jan	31-Dec	3	1-May	31-Dec	3	1-May	31-Dec
			245	open	N/A	1-May	31-Dec									
2013	see ACL	150,936 lbs ww	120	closed	Seasonal	1-Jan	30-Apr	20 inches	1-Jan	31-Dec	3	1-May	31-Dec	3	1-May	31-Dec
			245	open	N/A	1-May	31-Dec									
2014	see ACL	150,936 lbs ww	120	closed	Seasonal	1-Jan	30-Apr	20 inches	1-Jan	31-Dec	3	1-May	31-Dec	3	1-May	31-Dec
			245	open	N/A	1-May	31-Dec									
2015	see ACL	150,936 lbs ww	120	closed	Seasonal	1-Jan	30-Apr	20 inches	1-Jan	31-Dec	3	1-May	31-Dec	3	1-May	31-Dec
			61	open	N/A	1-May	30-Jun									
		116,369 lbs ww	184	open	N/A	1-Jul	31-Dec									
2016	see ACL	116,369 lbs ww	121	closed	Seasonal	1-Jan	30-Apr	20 inches	1-Jan	31-Dec	3	1-May	31-Dec	3	1-May	31-Dec
			245	open	N/A	1-May	31-Dec									
2017	see ACL	116,369 lbs ww	120	closed	Seasonal	1-Jan	30-Apr	20 inches	1-Jan	31-Dec	3	1-May	31-Dec	3	1-May	31-Dec
			245	open	N/A	1-May	31-Dec									
2018	see ACL	116,369 lbs ww	120	closed	Seasonal	1-Jan	30-Apr	20 inches	1-Jan	31-Dec	3	1-May	31-Dec	3	1-May	31-Dec
			245	open	N/A	1-May	31-Dec									

Table 2.6.2 South Atlantic Scamp and Yellowmouth Commercial Regulatory History prepared by: Myra Brouwer Notes: Regulatory Amendment 30 proposes extending the commercial seasonal closure ONLY OFF THE CAROLINAS AND FOR RED GROUPER ONLY. Regulations are expected to affect the 2020 fishing year.

Year	Quota (units)	ACL (units)	Days Open	fishing season	reason for closure	season start date (first day implemented)	season end date (last day effective)	Size limit (units and length type, indicate maximum or natural length)	size limit start date	size limit end date	Retention Limit (units)	Retention Limit Start Date	Retention Limit End Date	Aggregate Retention Limit (units)	Aggregate Retention Limit Start Date	Aggregate Retention Limit End Date
1983	N/A	N/A	365	open	N/A	1-Jan	31-Dec	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1984	N/A	N/A	366	open	N/A	1-Jan	31-Dec	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1985	N/A	N/A	365	open	N/A	1-Jan	31-Dec	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1986	N/A	N/A	365	open	N/A	1-Jan	31-Dec	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1987	N/A	N/A	365	open	N/A	1-Jan	31-Dec	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1988	N/A	N/A	366	open	N/A	1-Jan	31-Dec	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1989	N/A	N/A	365	open	N/A	1-Jan	31-Dec	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1990	N/A	N/A	365	open	N/A	1-Jan	31-Dec	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1991	N/A	N/A	365	open	N/A	1-Jan	31-Dec	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1992	N/A	N/A	366	open	N/A	1-Jan	31-Dec	20 inches	1-Jan	31-Dec	N/A	N/A	N/A	N/A	N/A	N/A
1993	N/A	N/A	365	open	N/A	1-Jan	31-Dec	20 inches	1-Jan	31-Dec	N/A	N/A	N/A	N/A	N/A	N/A
1994	N/A	N/A	365	open	N/A	1-Jan	31-Dec	20 inches	1-Jan	31-Dec	N/A	N/A	N/A	N/A	N/A	N/A
1995	N/A	N/A	365	open	N/A	1-Jan	31-Dec	20 inches	1-Jan	31-Dec	N/A	N/A	N/A	N/A	N/A	N/A
1996	N/A	N/A	366	open	N/A	1-Jan	31-Dec	20 inches	1-Jan	31-Dec	N/A	N/A	N/A	N/A	N/A	N/A
1997	N/A	N/A	365	open	N/A	1-Jan	31-Dec	20 inches	1-Jan	31-Dec	N/A	N/A	N/A	N/A	N/A	N/A
1998	N/A	N/A	365	open	N/A	1-Jan	31-Dec	20 inches	1-Jan	31-Dec	N/A	N/A	N/A	N/A	N/A	N/A
1999	N/A	N/A	365	open	N/A	1-Jan	31-Dec	20 inches	1-Jan	31-Dec	N/A	N/A	N/A	N/A	N/A	N/A
2000	N/A	N/A	366	open	N/A	1-Jan	31-Dec	20 inches	1-Jan	31-Dec	N/A	N/A	N/A	N/A	N/A	N/A
2001	N/A	N/A	365	open	N/A	1-Jan	31-Dec	20 inches	1-Jan	31-Dec	N/A	N/A	N/A	N/A	N/A	N/A
2002	N/A	N/A	365	open	N/A	1-Jan	31-Dec	20 inches	1-Jan	31-Dec	N/A	N/A	N/A	N/A	N/A	N/A
2003	N/A	N/A	365	open	N/A	1-Jan	31-Dec	20 inches	1-Jan	31-Dec	N/A	N/A	N/A	N/A	N/A	N/A
2004	N/A	N/A	366	open	N/A	1-Jan	31-Dec	20 inches	1-Jan	31-Dec	N/A	N/A	N/A	N/A	N/A	N/A
2005	N/A	N/A	365	open	N/A	1-Jan	31-Dec	20 inches	1-Jan	31-Dec	N/A	N/A	N/A	N/A	N/A	N/A
2006	N/A	N/A	365	open	N/A	1-Jan	31-Dec	20 inches	1-Jan	31-Dec	N/A	N/A	N/A	N/A	N/A	N/A
2007	N/A	N/A	365	open	N/A	1-Jan	31-Dec	20 inches	1-Jan	31-Dec	N/A	N/A	N/A	N/A	N/A	N/A
2008	N/A	N/A	366	open	N/A	1-Jan	31-Dec	20 inches	1-Jan	31-Dec	N/A	N/A	N/A	N/A	N/A	N/A
2009	N/A	N/A	365	open	N/A	1-Jan	31-Dec	20 inches	1-Jan	31-Dec	N/A	N/A	N/A	N/A	N/A	N/A
2010	N/A	N/A	120	closed	seasonal	1-Jan	30-Apr	20 inches	1-Jan	31-Dec	N/A	N/A	N/A	N/A	N/A	N/A
2010	N/A	N/A	245	open	N/A	1-May	31-Dec									
2011	N/A	N/A	120	closed	seasonal	1-Jan	30-Apr	20 inches	1-Jan	31-Dec	N/A	N/A	N/A	N/A	N/A	N/A
2011	N/A	N/A	245	open	N/A	1-May	31-Dec									
2012	N/A	N/A	121	closed	seasonal	1-Jan	30-Apr	20 inches	1-Jan	31-Dec	N/A	N/A	N/A	N/A	N/A	N/A
	see ACL	341,636 lbs ww	173	open	N/A	1-May	20-Oct									
			23	closed	closure for gag	21-Oct	12-Nov									
			9	open	gag reopened	13-Nov	21-Nov									
			40	closed	closure for gag	22-Nov	31-Dec									
2013	see ACL	341,636 lbs ww	120	closed	seasonal	1-Jan	30-Apr	20 inches	1-Jan	31-Dec	N/A	N/A	N/A	N/A	N/A	N/A
			78	open	N/A	1-May	17-Jul									
		333,100 lbs ww	167	open	N/A	18-Jul	31-Dec									
2014	see ACL	333,100 lbs ww	120	closed	seasonal	1-Jan	30-Apr	20 inches	1-Jan	31-Dec	N/A	N/A	N/A	N/A	N/A	N/A
			245	open	N/A	1-May	31-Dec									
2015	see ACL	333,100 lbs ww	120	closed	seasonal	1-Jan	30-Apr	20 inches	1-Jan	31-Dec	N/A	N/A	N/A	N/A	N/A	N/A
			62	open	N/A	1-May	1-Jul									
		219,375 lbs ww	183	open	N/A	2-Jul	31-Dec									
2016	see ACL	219,375 lbs ww	121	closed	seasonal	1-Jan	30-Apr	20 inches	1-Jan	31-Dec	N/A	N/A	N/A	N/A	N/A	N/A
			245	open	N/A	1-May	31-Dec									
2017	see ACL	219,375 lbs ww	120	closed	seasonal	1-Jan	30-Apr	20 inches	1-Jan	31-Dec	N/A	N/A	N/A	N/A	N/A	N/A
			245	open	N/A	1-May	31-Dec									
2018	see ACL	219,375 lbs ww	120	closed	seasonal	1-Jan	30-Apr	20 inches	1-Jan	31-Dec	N/A	N/A	N/A	N/A	N/A	N/A
			245	open	N/A	1-May	31-Dec									

2.7 Closures in the South Atlantic Due to Meeting Commercial Quota or Commercial/Recreational ACL

Commercial: 10/20/12; reopened 11/13/12 – 11/21/12

2.8 State Regulatory Information

North Carolina:

There are currently no North Carolina state-specific regulations for scamp. North Carolina has complemented federal regulations, including quota and/or annual catch limit closures, for all snapper grouper species via proclamation authority since January 1991, when rule 15A NCAC 03M .0506 was first implemented:

15A NCAC 03M .0506 SNAPPER-GROUPER

The Fisheries Director may, by proclamation, until September 1, 1991, impose any or all of the following restrictions in the fishery for 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:

(1) Specify size;
(2) Specify seasons;
(3) Specify areas;
(4) Specify quantity;
(5) Specify means/methods; and
(6) Require submission of statistical and biological data

History Note: Statutory Authority G.S. 113-134; 113-182; 113-221; 143B-289.4. Eff. January 1, 1991.

The rule was modified slightly to remove the phrase "until September 1, 1991" effective September 1, 1991. The first proclamation (FF-19-94) pertaining to scamp was issued under the authority of this rule effective July 1, 1994 and established a 20-inch total length minimum size limit (both sectors) and included the species in a five-fish aggregate bag limit.

Rule 15A NCAC 03M .0506 remained unchanged until March 1, 1996 when species-specific regulations for all snapper grouper species were added to the proclamation authority contained in the rule. Specific to scamp, the rule was amended to include the minimum size limit initially established in FF-19-94:

15A NCAC 03M .0506 SNAPPER-GROUPER

(h) It is unlawful to possess scamp less than 20 inches total length.

(q) It is unlawful to possess more than five grouper taken in any one day unless fishing aboard a vessel holding a federal vessel permit for snapper-grouper authorizing the bag limit to be exceeded.

History Note: Statutory Authority G.S. 113-134; 113-182; 113-221; 143B-289.4. Eff. January 1, 1991. Amended eff. March 1, 1996; September 1, 1991.

In addition to the above change, rule 15A NCAC 03M .0512 was implemented effective March 1, 1996 and provided supplementary proclamation authority to the Fisheries Director to modify any existing size and harvest limits for species subject to interstate and federal management:

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

In order to comply with management requirements incorporated in Federal Fishery Management Council Management Plans or Atlantic States Marine Fisheries Commission Management Plans, the Fisheries Director may, by proclamation, suspend the minimum size and harvest limits established by the Marine Fisheries Commission, and implement different minimum size and harvest limits. Proclamations issued under this Section 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(e1).

History Note: Authority G.S. 113-134; 113-182; 143B-289.4; Eff. March 1, 1996.

Proclamation FF-20-99 was issued effective September 15, 1999 which prohibited all commercial and recreational harvest and possession, complementing the federal emergency closure of the fishery.

On January 1, 2002 rule 15A NCAC 03M .0506 was amended to remove the combined aggregate bag limit language for grouper. On May 1, 2004, the combined bag limit language was added back into rule. However, there was no regulatory change to the grouper bag limits as the combined bag limit language was consistently maintained in proclamation since Proclamation FF-20-99.

No further modifications to rule 15A NCAC 03M .0506 pertaining to scamp were implemented. In 2002, North Carolina adopted its Inter-Jurisdictional Fishery Management Plan (IJ FMP), which incorporates all Atlantic States Marine Fisheries Commission and council-managed species by reference and adopts all federal regulations as minimum standards for management, as appropriate. In 2007, the statutorily-mandated five-year review of the IJ FMP began, with final adoption of the updated plan in 2008. Changes to the FMP included removal of all species-specific regulations from rule 15A NCAC 03M .0506 effective October 1, 2008, and proclamation authority to implement changes for all species under federal or interstate management was moved to rule 15A NCAC 03M .0512.

Once the changes to rules 15A NCAC 03M .0506 and 03M .0512 described above were implemented, proclamation FF-66-2008 was issued effective October 1, 2008 and contained all relevant commercial and recreational regulations for all snapper grouper species. The portion of the proclamation specific to scamp is excerpted as follows:

III. Other Groupers

C. It is unlawful to possess scamp less than 20 inches total length.

IX. Combined Bag Limits

B. It is unlawful to possess more than five grouper without a valid Federal Commercial Snapper-Grouper permit of which:

1. no more than two may be a gag or black grouper (individually or in combination) per person per day;

2. no more than one per vessel per trip may be a speckled hind;

3. no more than one per vessel per trip may be a warsaw grouper;

4. no more than one per person per day may be a snowy grouper; and

5. no more than one per person per day may be a golden tilefish.

F. It is unlawful for persons in possession of a valid National Marine Fisheries Service Snapper-Grouper Permit for Charter Vessels to exceed the creel restrictions established in Sections (I), (V), (IX), and (X) of this proclamation when fishing with more than three persons (including the captain and mate) on board.

To comply with Amendment 16, Proclamation FF-48-2009 reduced the five-fish aggregate grouper limit to three fish and prohibited possession of "shallow water grouper" from January 1 to April 30. Later that year, Proclamation FF-66-2009 added the prohibition on sale of fish harvested under the recreational bag limit without a federal commercial snapper grouper permit (as per Amendment 15B) to the general regulations for the entire fishery.

An information update to the IJ FMP was completed and approved in November 2015 and contained no additional modifications to rules 15A NCAC 03M .0506 and 15A NCAC 03M .0512. The only procedural modifications that have occurred are starting in 2013, proclamations establishing the size limits, possession limits and seasons for the upcoming calendar year ("season-opening" proclamations) have been issued in December of the preceding year; and beginning in 2015, commercial and recreational regulations have been moved into separate proclamations for ease of use by the public. The most current Snapper Grouper proclamations, as well as previous versions from 2001 onward, can be found online using this link: http://portal.ncdenr.org/web/mf/proclamations. Proclamations issued prior to 2001 are contained in hard copy archives.

Tables 1 and 2 contain a summary of recreational and commercial regulations, respectively. Because many snapper grouper proclamations are issued throughout the year to complement federal management measures, only those proclamations that were issued which affect regulations for scamp in any one year are listed.

The current versions of rules 15A NCAC 03M .0506 and 15A NCAC 03M .0512 are below:

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.

Table 4.1.1. North Carolina recreational scamp regulations in state waters 1991-2019. (TL = total length)

Year	Season	Min. Size (TL)	Daily Possession Limit	Regulation(s)
1991	Year-round	n/a	n/a	15A NCAC 03M .0506
1992	Year-round	n/a	n/a	15A NCAC 03M .0506
1993	Year-round	n/a	n/a	15A NCAC 03M .0506
1994	Year-round	20 inches	n/a	15A NCAC 03M .0506/FF-19-94 (eff. 7/1/1994)
1995	Year-round	20 inches	n/a	15A NCAC 03M .0506/FF-19-94
1996	Year-round	20 inches	n/a	15A NCAC 03M .0506/03M .0512/FF-19-94
1997	Year-round	20 inches	n/a	15A NCAC 03M .0506/03M .0512
1998	Year-round	20 inches	n/a	15A NCAC 03M .0506/03M .0512
1999	Year-round	20 inches	5 fish/person	15A NCAC 03M .0506/03M .0512
2000	Year-round	20 inches	5 fish/person	15A NCAC 03M .0506/03M .0512
2001	Year-round	20 inches	5 fish/person	15A NCAC 03M .0506/03M .0512
2002	Year-round	20 inches	5 fish/person	15A NCAC 03M .0506/03M .0512
2003	Year-round	20 inches	5 fish/person	15A NCAC 03M .0506/03M .0512
2004	Year-round	20 inches	5 fish/person	15A NCAC 03M .0506/03M .0512
2005	Year-round	20 inches	5 fish/person	15A NCAC 03M .0506/03M .0512
2006	Year-round	20 inches	5 fish/person	15A NCAC 03M .0506/03M .0512
2007	Year-round	20 inches	5 fish/person	15A NCAC 03M .0506/03M .0512
2008	Year-round	20 inches	5 fish/person	15A NCAC 03M .0506/03M .0512/FF-66-2008
2009*	Closed January -April	20 inches	5 fish/person; 3 fish/person*	15A NCAC 03M .0506/03M .0512/FF-48-2009
2010	Closed January -April	20 inches	3 fish/person	15A NCAC 03M .0506/03M .0512
2011	Closed January -April	20 inches	3 fish/person	15A NCAC 03M .0506/03M .0512
2012	Closed January -April	20 inches	3 fish/person	15A NCAC 03M .0506/03M .0512
2013	Closed January -April	20 inches	3 fish/person	15A NCAC 03M .0506/03M .0512
2014	Closed January -April	20 inches	3 fish/person	15A NCAC 03M .0506/03M .0512
2015	Closed January -April	20 inches	3 fish/person	15A NCAC 03M .0506/03M .0512
2016	Closed January -April	20 inches	3 fish/person	15A NCAC 03M .0506/03M .0512
2017	Closed January -April	20 inches	3 fish/person	15A NCAC 03M .0506/03M .0512
2018	Closed January -April	20 inches	3 fish/person	15A NCAC 03M .0506/03M .0512
2019	Closed January -April	20 inches	3 fish/person	15A NCAC 03M .0506/03M .0512

*FF-48-2009 (effective July 29, 2009) established a January 1 to April 30 shallow water grouper spawning closure and reduced the aggregate grouper bag limit to three-fish

Table 4.1. 2. North Carolina commercial scamp regulations in state waters 1991-2019. (TL = total length)

Year	Season	Min. Size (TL)	Trip Limit	Regulation(s)
1991	Year-round	n/a	n/a	15A NCAC 03M .0506
1992	Year-round	n/a	n/a	15A NCAC 03M .0506
1993	Year-round	n/a	n/a	15A NCAC 03M .0506
1994	Year-round	20 inches	n/a	15A NCAC 03M .0506/FF-19-94 (eff. 7/1/1994)
1995	Year-round	20 inches	n/a	15A NCAC 03M .0506/FF-19-94
1996	Year-round	20 inches	n/a	15A NCAC 03M .0506/03M .0512/FF-19-94
1997	Year-round	20 inches	n/a	15A NCAC 03M .0506/03M .0512
1998	Year-round	20 inches	n/a	15A NCAC 03M .0506/03M .0512
1999	Year-round	20 inches	n/a	15A NCAC 03M .0506/03M .0512
2000	Year-round	20 inches	n/a	15A NCAC 03M .0506/03M .0512
2001	Year-round	20 inches	n/a	15A NCAC 03M .0506/03M .0512
2002	Year-round	20 inches	n/a	15A NCAC 03M .0506/03M .0512
2003	Year-round	20 inches	n/a	15A NCAC 03M .0506/03M .0512
2004	Year-round	20 inches	n/a	15A NCAC 03M .0506/03M .0512
2005	Year-round	20 inches	n/a	15A NCAC 03M .0506/03M .0512
2006	Year-round	20 inches	n/a	15A NCAC 03M .0506/03M .0512
2007	Year-round	20 inches	n/a	15A NCAC 03M .0506/03M .0512
2008	Year-round	20 inches	n/a	15A NCAC 03M .0506/03M .0512/FF-66-2008
2009*	Closed January -April	20 inches	n/a	15A NCAC 03M .0506/03M .0512/FF-48-2009
2010	Closed January -April	20 inches	n/a	15A NCAC 03M .0506/03M .0512
2011	Closed January -April	20 inches	n/a	15A NCAC 03M .0506/03M .0512
2012	Closed January -April	20 inches	n/a	15A NCAC 03M .0506/03M .0512
2013	Closed January -April	20 inches	n/a	15A NCAC 03M .0506/03M .0512
2014	Closed January -April	20 inches	n/a	15A NCAC 03M .0506/03M .0512
2015	Closed January -April	20 inches	n/a	15A NCAC 03M .0506/03M .0512
2016	Closed January -April	20 inches	n/a	15A NCAC 03M .0506/03M .0512
2017	Closed January -April	20 inches	n/a	15A NCAC 03M .0506/03M .0512
2018	Closed January -April	20 inches	n/a	15A NCAC 03M .0506/03M .0512
2019	Closed January -April	20 inches	n/a	15A NCAC 03M .0506/03M .0512

*FF-48-2009 (effective July 29, 2009) established a January 1 to April 30 shallow water grouper spawning closure

South Carolina:

1992: SC Code of Laws Section 50-17-510(C) adopted the federal minimum size limits automatically for all species managed under the Fishery Conservation and Management Act (PL94-265); and Section 50-17-510(F) adopted the federal catch and possession limits for a number of listed species managed under the Fishery Conservation and Management Act (PL94-265) as the Law of the State of SC, with "all species of snapper grouper" specifically mentioned as being covered as well.

2000: SC Marine Fisheries-related Laws reorganized under SC Code of Laws Title 50 Chapter 5.

SC Code of Laws Section 50-5-2730 reads – "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 scamp–related regulation is pulled directly from the federal regulations as promulgated under Magnuson. No changes have been made to this approach in covering scamp since the Chapter 5 rewrite.

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 East Coast:

Atlantic Scamp Regulation History

Year	Minimum Size Limit	Recreational Daily Harvest Limits	Commercial Daily Harvest Limits	Regulation Changes	Rule Change Effective Date
1980	None	None	None		
1981	None	None	None		
1982	None	None	None		
1983	None	None	None		
1984	None	None	None		
1985	None	None	None		
1986	None	5 per person per day within the 5-fish grouper	None	Established a recreational bag limit. Prohibited use of longline gear by	Dec. 11, 1986

		aggregate bag limit		commercial fishermen. Longline harvesters targeting other species have a bycatch allowance of 5%. Prohibited use of stab nets (or sink nets) to take grouper in Atlantic waters of Monroe County. Required fish to be landed in whole condition.	
1987	None	5 per person per day within the 5-fish grouper aggregate bag limit	None		
1988	None	5 per person per day within the 5-fish grouper aggregate bag limit	None		
1989	None	5 per person per day within the 5-fish grouper aggregate bag limit	None		
1990	20 inches TL	5 per person per day within the 5-fish grouper aggregate bag limit	None	Established a minimum size limit. Designated all grouper as “restricted species.” Designated allowable gear as hook and line, black sea bass trap, spear, gig, or lance (except powerheads, bangsticks, or explosive devices). Prohibited all commercial harvest in state waters when harvest for that species is prohibited	Feb. 1, 1990

				in adjacent federal waters.	
1991	20 inches TL	5 per person per day within the 5-fish grouper aggregate bag limit	None		
1992	20 inches TL	5 per person per day within the 5-fish grouper aggregate bag limit	None		
1993	20 inches TL	5 per person per day within the 5-fish grouper aggregate bag limit	None	Allowed persons who possess either a Gulf of Mexico or South Atlantic federal reef fish permit to commercially harvest snappers and groupers (except red snapper) in all state waters until July 1, 1995.	Oct. 18, 1993
1994	20 inches TL	5 per person per day within the 5-fish grouper aggregate bag limit	None	Allowed a two-day possession limit for reef fish statewide for persons aboard charter and headboats on trips exceeding 24 hours provided the vessel is equipped with a permanent berth for each passenger aboard, and each passenger has a receipt verifying the trip length. Modified rule language to provide the same definitions of Gulf of Mexico and Atlantic Ocean regions.	March 1, 1994
1995	20 inches TL	5 per person per day within the 5-	None	Continued the allowance for persons	July 1, 1995

		fish grouper aggregate bag limit		to possess either the proper South Atlantic or Gulf permit to harvest reef fish for commercial purposes through Dec. 31, 1995.	
1996	20 inches TL	5 per person per day within the 5-fish grouper aggregate bag limit	None	(1) Continued the allowance for persons to possess either the proper South Atlantic or Gulf permit to harvest reef fish for commercial purposes through Dec. 31, 1996. (2) Continued the allowance for persons to possess either the proper South Atlantic or Gulf permit to harvest reef fish for commercial purposes through Dec. 31, 1997.	(1) Jan. 1, 1996 (2) Nov. 27, 1996
1997	20 inches TL	5 per person per day within the 5-fish grouper aggregate bag limit	None		
1998	20 inches TL	5 per person per day within the 5-fish grouper aggregate bag limit	None		
1999	20 inches TL	5 per person per day within the 5-fish grouper aggregate bag limit	None		
2000	20 inches TL	5 per person per day within the 5-fish grouper aggregate bag limit	None	Eliminated the 5-day commercial closure extension.	Jan. 1, 2000

2001	20 inches TL	5 per person per day within the 5-fish grouper aggregate bag limit	None		
2002	20 inches TL	5 per person per day within the 5-fish grouper aggregate bag limit	None		
2003	20 inches TL	5 per person per day within the 5-fish grouper aggregate bag limit	None		
2004	20 inches TL	5 per person per day within the 5-fish grouper aggregate bag limit	None		
2005	20 inches TL	5 per person per day within the 5-fish grouper aggregate bag limit	None		
2006	20 inches TL	5 per person per day within the 5-fish grouper aggregate bag limit	None	Provided that, for purposes of determining the legal size of reef fish species, "total length" means the straight-line distance from the most forward point of the head with the mouth closed, to the farthest tip of the tail with the tail compressed or squeezed, while the fish is lying on its side.	July 1, 2006
2007	20 inches TL	5 per person per day within the 5-fish grouper aggregate bag limit	Consistent with federal waters	Set commercial trip limits in the Atlantic that are the same as trip limits in federal waters.	July 1, 2007

				Prohibited commercial fishermen from harvesting or possessing the recreational bag limit of reef fish species on commercial trips.	
2008	20 inches TL	5 per person per day within the 5-fish grouper aggregate bag limit	Consistent with federal waters		
2009	20 inches TL	5 per person per day within the 5-fish grouper aggregate bag limit	Consistent with federal waters		
2010	20 inches TL	3 per person per day within the 3-fish grouper aggregate bag limit	Consistent with federal waters	Reduced the recreational bag limit. Prohibited the captain and crew of for-hire vessels from retaining any species in the aggregate grouper bag limit. Prohibited all harvest of shallow-water groupers from Jan. 1 – April 30 in Atlantic and Monroe County state waters. Required dehooking tools to be aboard commercial and recreational vessels for anglers to use as needed to remove hooks from Atlantic reef fish.	Jan. 19, 2010
2011	20 inches TL	3 per person per day within the 3-fish grouper aggregate bag limit	Consistent with federal waters		

2012	20 inches TL	3 per person per day within the 3-fish grouper aggregate bag limit	Consistent with federal waters		
2013	20 inches TL	3 per person per day within the 3-fish grouper aggregate bag limit	Consistent with federal waters		
2014	20 inches TL	3 per person per day within the 3-fish grouper aggregate bag limit	Consistent with federal waters	Eliminated language that prohibited captain and crew on for-hire vessels from retaining recreational bag limits of groupers on for-hire trips in state waters of the Atlantic (including Monroe County).	March 23, 2014
2015	20 inches TL	3 per person per day within the 3-fish grouper aggregate bag limit	Consistent with federal waters		
2016	20 inches TL	3 per person per day within the 3-fish grouper aggregate bag limit	Consistent with federal waters		
2017	20 inches TL	3 per person per day within the 3-fish grouper aggregate bag limit	Consistent with federal waters		
2018	20 inches TL	3 per person per day within the 3-fish grouper aggregate bag limit	Consistent with federal waters		
2019	20 inches TL	3 per person per day within the 3-fish grouper aggregate bag limit	Consistent with federal waters		

3 ASSESSMENT HISTORY AND REVIEW

SEDAR 68 is the first formal assessment for both scamp and yellowmouth under the SEDAR process for the South Atlantic. In 1994, a preliminary assessment of scamp was conducted along with six other grouper species in the South Atlantic Fisheries Management Council (SAFMC) jurisdiction from North Carolina to the Florida Keys. Catch data from 1988 were used to develop models of yield per recruit and spawning stock per recruit (SSR) for scamp (Huntsman et al, 1994).

A more in-depth assessment was conducted for scamp in 1998 using data from 1986-1996. Changes in age structure and scamp were studied using landing and size frequency data from the commercial, recreational and headboat fisheries from North Carolina to the Florida Keys. A separable virtual population analysis (SVPA) estimated annual, age-specific fishing mortality using four different levels of natural mortality. The spawning potential ratio ranged between 30-52% (Manooch et al, 1998).

A localized, retrospective assessment was conducted in the Florida Keys for 18 species of reef fish, including scamp and yellowmouth. The average length of the exploitable phase from visual surveys conducted in 1979-1996 were used to develop estimates of spawning potential ratios. From this study, both scamp and yellowmouth were overfished with SPR values of 3% for scamp and 22% for yellowmouth (Ault et al, 1998).

References:

Ault, J.S., Bohnsack, J.A., and Meester, G.A. (1998). Retrospective (1979-1996) multispecies assessment of coral reef fish stocks in the Florida Keys: Fishery Bulletin, vol. 96, no. 3, 395-414.

Huntsman, G.R. and Mays, R. W. and Potts, Jennifer C. (1994). A Preliminary assessment of the populations of seven species of Grouper (Serranidae, Epinephelinae) in the western Atlantic Ocean from Cape Hatteras, North Carolina to the Dry Tortugas, Florida. In: Proceedings of the Gulf and Caribbean Fisheries Institute, 43, pp. 193-216.

Manooch, C.S., III, J.C. Potts, M.L. Burton, and P.J. Harris. (1998). Population assessment of the scamp, *Mycteroperca phenax*, from the southeastern United States. NOAA Technical Memorandum NMFS-SEFSC-410, 57p.

4 REGIONAL MAPS

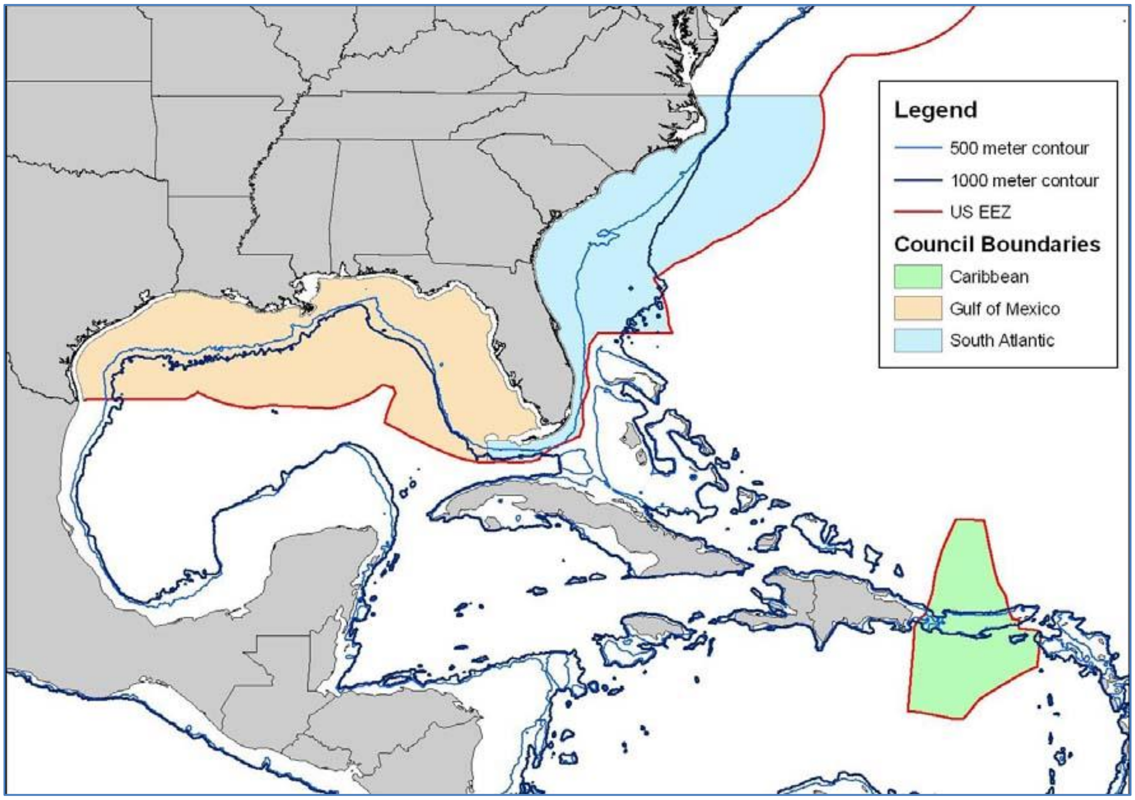

Figure 4.1 Southeast Region including Council and EEZ Boundaries.

5 SEDAR ABBREVIATIONS

ABC	Acceptable Biological Catch
ACCSP	Atlantic Coastal Cooperative Statistics Program
ADMB	AD Model Builder software program
ALS	Accumulated Landings System; SEFSC fisheries data collection program
AMRD	Alabama Marine Resources Division
ASMFC	Atlantic States Marine Fisheries Commission
B	stock biomass level
BAM	Beaufort Assessment Model
BMSY	value of B capable of producing MSY on a continuing basis
CFMC	Caribbean Fishery Management Council
CIE	Center for Independent Experts

CPUE	catch per unit of effort
EEZ	exclusive economic zone
F	fishing mortality (instantaneous)
FMSY	fishing mortality to produce MSY under equilibrium conditions
FOY	fishing mortality rate to produce Optimum Yield under equilibrium
FXX% SPR	fishing mortality rate that will result in retaining XX% of the maximum spawning production under equilibrium conditions
FMAX	fishing mortality that maximizes the average weight yield per fish recruited to the fishery
F0	a fishing mortality close to, but slightly less than, Fmax
FL FWCC	Florida Fish and Wildlife Conservation Commission
FWRI	(State of) Florida Fish and Wildlife Research Institute
GA DNR	Georgia Department of Natural Resources
GLM	general linear model
GMFMC	Gulf of Mexico Fishery Management Council
GSMFC	Gulf States Marine Fisheries Commission
GULF FIN	GSMFC Fisheries Information Network
HMS	Highly Migratory Species
LDWF	Louisiana Department of Wildlife and Fisheries
M	natural mortality (instantaneous)
MARMAP	Marine Resources Monitoring, Assessment, and Prediction
MDMR	Mississippi Department of Marine Resources
MFMT	maximum fishing mortality threshold, a value of F above which overfishing is deemed to be occurring
MRFSS	Marine Recreational Fisheries Statistics Survey
MRIP	Marine Recreational Information Program
MSST	minimum stock size threshold, a value of B below which the stock is deemed to be overfished
MSY	maximum sustainable yield
NC DMF	North Carolina Division of Marine Fisheries
NMFS	National Marine Fisheries Service

NOAA	National Oceanographic and Atmospheric Administration
OY	optimum yield
SAFMC	South Atlantic Fishery Management Council
SC DNR	South Carolina Department of Natural Resources
SEAMAP	Southeast Area Monitoring and Assessment Program
SEDAR	Southeast Data, Assessment and Review
SEFIS	Southeast Fishery-Independent Survey
SEFSC	Fisheries Southeast Fisheries Science Center, National Marine Fisheries Service
SERO	Fisheries Southeast Regional Office, National Marine Fisheries Service
SPR	spawning potential ratio, stock biomass relative to an unfished state of the stock
SSB	Spawning Stock Biomass
SS	Stock Synthesis
SSC	Science and Statistics Committee
TIP	Trip Incident Program; biological data collection program of the SEFSC and Southeast States.
TPWD	Texas Parks and Wildlife Department
Z	total mortality, the sum of M and F

SEDAR

Southeast Data, Assessment, and Review

SEDAR 68

Atlantic Scamp

SECTION II: Data Workshop Report

December 2020

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

1 INTRODUCTION

1.1 WORKSHOP TIME AND PLACE

The SEDAR 68 Data Workshop was scheduled to be held March 16-20, 2020 in Charleston, SC. Due to rising concerns regarding the COVID-19 pandemic, the in-person workshop was cancelled, and a modified process was developed.

- SEDAR 68 Scamp Data Review and Recommendation Process: After the cancellation of the in-person DW, and the mounting evidence that it would be some time before any sort of large gathering would be possible, SEDAR and SEFSC Staff held discussions to determine a path forward, followed by additional discussions with the previously appointed working group leads. The following process is currently underway:
  - Working Groups (Life History, Commercial Statistics, Recreational Statistics, and Indices of Abundance) worked amongst themselves to schedule and held various meetings to review the available data and make pre-decisional recommendations.
  - Several publicly noticed Data Plenary webinars will be held, during which the Working Groups will present the results of the discussions to the entire Data Panel for review and comment.
  - If concerns are raised that require additional analysis, the Working Group will be tasked to complete that request and report back at the next Plenary webinar.
  - Once the Panel is satisfied with the analyses, then the Assessment Development Team (ADT) will make the final decision regarding recommending using the data in the assessment. These recommendations will happen during the Plenary webinars.
  - A Data Process Report will be produced, to document the discussions and decisions of the Panel and the ADT.

1.2 TERMS OF REFERNCE

1. Definition of assessment unit stock will be developed through the Scamp Stock ID process and will be added to TORs once process is complete.
2. Review, discuss, and tabulate available life history information for each stock being assessed.
   - Evaluate age, growth, natural mortality, and reproductive characteristics

   - Explore the validity of age data and methodology across ageing facilities
- Provide appropriate models to describe population and fleet specific (if warranted) growth, maturation, hermaphroditism including age and size at transition, 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.
- Evaluate and discuss the sources of uncertainty and error, and data limitations (such as temporal and spatial coverage) for each data source. Provide estimates or ranges of uncertainty for all life history information.

3. Provide measures of population abundance that are appropriate for stock assessment.
   - Consider 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 independent 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.
   - Document pros and cons of available indices regarding their ability to represent abundance.
      - Consider potential species identification issues between scamp and yellowmouth grouper and, if present, whether the issue was adequately addressed during index development.
   - Categorize the available indices into one of three tiers: Suitable and Recommended, Suitable and Not Recommended, or Not Suitable; *provide justifications for the categorization.*
   - For recommended indices, document any known or suspected temporal patterns in catchability not accounted for by standardization.
   - Provide appropriate measures of uncertainty for the abundance indices to be used in stock assessment models.

4. Provide commercial catch statistics for each stock being assessed, including both landings and discards in both pounds and number. Consider species identification issues between scamp and yellowmouth grouper and correct for these instances as appropriate.
   - Evaluate and discuss the adequacy of available data for accurately characterizing landings and discards by fishery sector or gear.
   - Provide length and age distributions for both landings and discards if feasible.
   - Provide maps of fishery effort and harvest by fishery sector or gear.
   - Provide estimates of uncertainty around each set of landings and discard estimates.
5. Provide recreational catch statistics for each stock being assessed, including both landings and discards in both pounds and number. Consider species identification issues between scamp and yellowmouth grouper and correct for these instances as appropriate.
   - Evaluate and discuss the adequacy of available data for accurately characterizing landings and discards by fishery sector or gear.
   - Provide length and age distributions for both landings and discards if feasible.
   - Provide maps of fishery effort and harvest by fishery sector or gear.
   - Provide estimates of uncertainty around each set of landings and discard estimates.
6. Recommend discard mortality rates.
   - Review available research and published literature.
     - Consider research directed at scamp as well as similar species from the southeastern United States and other areas.
   - Provide estimates of discard mortality rate by fishery, gear type, depth, and other feasible or appropriate strata.
   - Provide estimates of uncertainty around recommended discard mortality rates
   - Document the rationale for recommended rates and uncertainties.
7. Describe any known evidence regarding ecosystem, climate, species interactions, habitat considerations, and/or episodic events *(including red tide and upwelling events)* that would reasonably be expected to affect scamp population dynamics, *and the effectiveness of* biological reference points that might ensue.
   - Review available predation studies and summarize diet composition with respect to ontogeny, seasonality, and habitat, where available.

- Provide species envelopes, i.e. minimum and maximum values of environmental boundaries (e.g. depth, temperature, substrate, relief) based on observations of occurrence.
- Use available survey datasets to determine species that frequently co-occur or are associated with scamp.
- Develop hypotheses to link the ecosystem and climatic events identified in addressing this TOR to population and fishery parameters that can be evaluated and modeled.

8. Provide recommendations for future research in areas such as sampling, fishery monitoring, and stock assessment. Include specific guidance on sampling intensity (number of samples including age and length structures) and appropriate strata and coverage.
9. Prepare a Data Workshop report providing complete documentation of workshop actions and decisions in accordance with project schedule deadlines.

1.3 LIST OF PARTICIPANTS

Assessment Development Team

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1.4 LIST OF DATA WORKSHOP WORKING PAPERS & REFERNCE DOCUMENTS

Document #	Title	Authors	Date Submitted
Documents Prepared for the Stock ID Process			
SEDAR68-SID-01	Brief Summary of FWRI-FDM Tag-Recapture Program	Rachel Germeroth	8 April 2019 Updated: 3 September 2019

SEDAR68-SID-02	Larval dispersal of scamp (*Mycteroperca phenax*) in the waters off the southeastern United States: Connectivity within and between the Gulf of Mexico and Atlantic Ocean	J. R. Brothers, M. Karnauskas, C.B. Paris, and K.W. Shertzer	28 September 2019
SEDAR68-SID-03	Preliminary Genetic Stock Assessment of Scamp (Mycteroperca phenax) in Florida Waters	Elizabeth Wallace	26 July 2019 Updated: 20 September 2019
SEDAR68-SID-04	Population Genetic Analyses of Scamp	Darden, T. and M. Walker	26 July 2019 Updated: 22 August 2019
SEDAR68-SID-05	Gulf of Mexico and Atlantic Scamp Stock ID Process Final Report	Stock ID Panel	31 March 2020
Documents Prepared for the Data Workshop			
SEDAR68-DW-01	Standardized video counts of Southeast U.S. Atlantic scamp and yellowmouth grouper (*Mycteroperca phenax* and *Mycteroperca interstitialis*) from the Southeast Reef Fish Survey	Rob Cheshire and Nathan Bacheler	7 February 2020
SEDAR68-DW-02	Standardized catch rates of scamp and yellowmouth grouper (*Mycteroperca phenax* and *Myteroperca interstitialis*) in the southeast U.S. from headboat logbook data	Sustainable Fisheries Branch	4 March 2020
SEDAR68-DW-03	Standardized catch rates of scamp and yellowmouth grouper (*Mycteroperca phenax* and *Myteroperca interstitialis*) in the southeast U.S. from commercial logbook data	Sustainable Fisheries Branch	2 March 2020 Updated: 9 March 2020; 13 April 2020
SEDAR68-DW-04	Scamp/Yellowmouth Grouper Fishery-Independent Indices of Abundance in US South Atlantic Waters Based on a Chevron Video Trap Survey and a Short Bottom Longline Survey	Walter J. Bubley, Dawn Glasgow, and Tracey I. Smart	20 February 2020

SEDAR68-DW-05	Reproductive Parameters for South Atlantic Scamp and Yellowmouth Grouper in Support of the SEDAR 68 Research Track Assessment	David M. Wyanski, Dawn M. Glasgow, Keilin R. Gamboa-Salazar, and Wally J. Bubley	4 March 2020 Updated: 31 October 2020
SEDAR68-DW-06	Fisheries-independent data for Scamp (*Mycteroperca phenax*) from reef-fish visual surveys in the Florida Keys and Dry Tortugas, 1999-2018	Jessica Keller, Jennifer Herbig, and Alejandro Acosta	19 February 2020
SEDAR68-DW-07	Indices of abundance for Scamp (*Mycteroperca phenax*) using combined data from three independent video surveys	Kevin A. Thompson, Theodore S. Switzer, Mary C. Christman, Sean F. Keenan, Christopher Gardner, Katherine E. Overly, Matt Campbell	19 February 2020 Updated: 21 October 2020
SEDAR68-DW-08	Recreational Survey data for Scamp and Yellowmouth Grouper in the South Atlantic	Vivian M. Matter and Matthew A. Nuttall	2 March 2020 Updated: 11 March 2020 Updated: 25 August 2020 Updated: 27 October 2020
SEDAR68-DW-09	Recreational Survey data for Scamp and Yellowmouth Grouper in the Gulf of Mexico	Vivian M. Matter and Matthew A. Nuttall	2 March 2020 Updated: 11 March 2020 Updated: 25 August 2020 Updated: 27 October 2020
SEDAR68-DW-10	SEFSC computation of variance estimates for custom data aggregations from the Marine Recreational Information Program	Kyle Dettloff, Vivian M. Matter, and Matthew Nuttall	11 March 2020

SEDAR68-DW-11	Estimates of Historic Recreational Landings of Scamp and Yellowmouth Grouper in the South Atlantic Using the FHWAR Census Method	Ken Brennan	25 February 2020 Updated: 29 May 2020
SEDAR68-DW-12	Estimates of Historic Recreational Landings of Scamp and Yellowmouth Grouper in the Gulf of Mexico Using the FHWAR Census Method	Ken Brennan	25 February 2020 Updated: 29 May 2020
SEDAR68-DW-13	Marine Recreational Information Program Metadata for the Atlantic, Gulf of Mexico, and Caribbean regions	Vivian M. Matter and Matthew A. Nuttall	2 March 2020
SEDAR68-DW-14	SEAMAP Reef Fish Video Survey: Relative Indices of Abundance of Scamp	Matthew D. Campbell, Kevin R. Rademacher, Paul Felts, Brandi Noble, Joseph Salisbury, and John Moser	20 February 2020
SEDAR68-DW-15	Scamp (*Mycteroperca phenax*) age comparisons between aging labs in the Gulf of Mexico and South Atlantic	Andrew D. Ostrowski, Jennifer C. Potts, and Eric Fitzpatrick	31 March 2020
SEDAR68-DW-16	Commercial Discard Length Composition for South Atlantic Scamp and Yellowmouth Grouper	Sarina F. Atkinson	5 March 2020 Updated: 27 August 2020
SEDAR68-DW-17	Commercial Discard Length Composition for Gulf of Mexico Scamp and Yellowmouth Grouper	Sarina F. Atkinson	5 March 2020 Updated: 27 August 2020
SEDAR68-DW-18	Standardized Catch Rate Indices for Scamp (*Mycteroperca phenax*) and Yellowmouth Grouper (*Mycteroperca interstitialis*) during 1986-2017 by the U.S. Gulf of Mexico Headboat Recreational Fishery	Gulf and Caribbean Branch	2 March 2020 Updated: 9 June 2020 Updated: 10 December 2020
SEDAR68-DW-19	Scamp grouper reproduction on the West Florida Shelf	Susan Lowerre-Barbieri, Hayden Menendez, Ted	4 March 2020

		Switzer, and Claudia Friess	Updated: 2 April 2020
SEDAR68-DW-20	Summary of preliminary age, length, and reproduction data for U.S. Gulf of Mexico scamp, *Mycteroperca phenax*, submitted for SEDAR68	Veronica Beech, Laura Thornton, Beverly Barnett	3 March 2020
SEDAR68-DW-21	Summary of preliminary age and length data for U.S. Gulf of Mexico yellowmouth grouper, *Mycteroperca interstialis*, submitted for SEDAR68	Laura Thornton, Veronica Beech, Beverly Barnett	3 March 2020
SEDAR68-DW-22	Preliminary Non-Technical Fishery Profile and Limited Data Summary for Scamp, Mycteroperca phenax with Focus on the West Florida Shelf: Application of Electronic Monitoring on Commercial Snapper Grouper Bottom Longline Vessels	Carole L. Neidig, Daniel Roberts, Max Lee, Ryan Schloesser	12 March 2020
SEDAR68-DW-23	Scamp Length Frequency Distributions from At-Sea Headboat Surveys in the South Atlantic, 2005 to 2017	Dominique Lazarre, Chris Wilson, Kelly Fitzpatrick	1 April 2020
SEDAR68-DW-24	A Summary of Observer Data from the Size Distribution and Release Condition of Scamp Discards from Recreational Fishery Surveys in the Eastern Gulf of Mexico	Dominique Lazarre	1 April 2020
SEDAR68-DW-25	Summary of the SAFMC Scamp Release Citizen Science Pilot Project for SEDAR 68	Julia Byrd	16 April 2020 Updated: 26 August 2020
SEDAR68-DW-26	Voluntary reports of Scamp caught by private recreational anglers in MyFishCount for SEDAR 68	Chip Collier	7 April 2020
SEDAR68-DW-27	Assigning fates in telemetry studies using hidden Markov models: an application to deepwater groupers released with descender devices	Brendan J. Runde, Theo Michelot, Nathan M. Bacheler, Kyle W. Shertzer, and Jeffrey A. Buckel	27 February 2020
SEDAR68-DW-28	Scamp grouper reproduction in the Gulf of Mexico	Susan Lowerre-Barbieri, Veronica	22 May 2020

		Beech, and Claudia Friess	Updated: 2 September 2020
SEDAR68-DW-29	Standardized Catch Rate Indices for Scamp (*Mycteroperca phenax*) and Yellowmouth Grouper (*Mycteroperca interstitialis*) during 1993-2017 by the U.S. Gulf of Mexico Vertical Line and Longline Fisheries	Gulf and Caribbean Branch, SFD	11 September 2020
SEDAR68-DW-30	CPUE Expansion Estimation for Commercial Discards of Gulf of Mexico Scamp & Yellowmouth Grouper	Steven G. Smith, Kevin J. McCarthy, Stephanie Martinez	23 September 2020
SEDAR68-DW-31	SEFSC Computation of Uncertainty for Southeast Regional Headboat Survey and Total Recreational Landings Estimates, with Applications to SEDAR 68 Scamp and Yellowmouth Grouper	Matthew A Nuttall, Kyle Dettloff, Kelly E Fitzpatrick, Kenneth Brennan, and Vivian M Matter	27 October 2020
SEDAR68-DW-32	Discards of scamp (*Rhomboplites aurorubens*) for the headboat fishery in the US South Atlantic	Fisheries Ecosystems Branch, National Marine Fisheries Service, Southeast Fisheries Science Center, Beaufort, NC	30 October 2020
SEDAR68-DW-33	Discards of scamp (*Mycteroperca phenax*) for the headboat fishery in the US Gulf of Mexico	Fisheries Ecosystems Branch, National Marine Fisheries Service, Southeast Fisheries Science Center, Beaufort, NC	30 October 2020
SEDAR68-DW-34	South Atlantic U.S. scamp (*Mycteroperca phenax*) age and length composition from the recreational fisheries	Fisheries Ecosystems Branch, National Marine Fisheries Service, Southeast	10 December 2020

		Fisheries Science Center	
SEDAR68-DW-35	Commercial age and length composition weighting for Southeast U.S. scamp and yellowmouth grouper (*Mycteroperca phenax and Mycteroperca interstitialis)*	Sustainable Fisheries Branch, National Marine Fisheries Service, Southeast Fisheries Science Center	12 November 2020
Reference Documents			
SEDAR68-RD01	A retrospective (1979-1996) multispecies assessment of coral reef fish stocks in the Florida Keys	Ault et al. 1997	
SEDAR68-RD02	Spawning Locations for Atlantic Reef Fishes off the Southeastern U.S.	Sedberry et al. 2006	
SEDAR68-RD03	Site Fidelity and Movement of Reef Fishes Tagged at Unreported Artificial Reef Sites off NW Florida	Addis et al. 2007	
SEDAR68-RD04	Implications of reef fish movement from unreported artificial reef sites in the northern Gulf of Mexico	Addis et al. 2013	
SEDAR68-RD05	Comparison of scamp grouper (*Mycteroperca phenax*), growth off of the West Florida shelf and the coast of Louisiana	Bates 2008	
SEDAR68-RD06	Aspects Of The Life History Of The Yellowmouth Grouper, *Mycteroperca interstitialis*, In The Eastern Gulf Of Mexico	Bullock and Murphy, 1994	
SEDAR68-RD07	Memoirs of the Hourglass Cruises: Seabasses (Pisces: Serranidae)	Bullock and Smith, 1991	
SEDAR68-RD08	Groupers on the Edge: Shelf Spawning Habitat in and Around Marine Reserves of the Northeastern Gulf of Mexico	Coleman et al. 2014	
SEDAR68-RD09	Decadal fluctuations in life history parameters of scamp (*Mycteroperca phenax*) collected by commercial hand-line vessels from the west coast of Florida	Lombardi-Carlson et al.	

SEDAR68-RD10	A Description of Age, Growth, and Reproductive Life History Traits of Scamps from the Northern Gulf of Mexico	Lombardi-Carlson et al. 2012
SEDAR68-RD11	Incorporating Mortality from Catch and Release into Yield-per-Recruit Analyses of Minimum-Size Limits	Waters and Huntsman 1986
SEDAR68-RD12	Population genetic analysis of red grouper, *Epinephelus morio*, and scamp, *Mycteroperca phenax*, from the southeastern U.S. Atlantic and Gulf of Mexico	Zatcoff et al. 2004
SEDAR68-RD13	Population Assessment of the Scamp, *Mycteroperca phenax*, from the Southeastern United States	Mancooch et al. 1998
SEDAR68-RD14	A Preliminary Assessment of the Populations of Seven Species of Grouper (Serranidae, Epinephelinae) in the Western Atlantic Ocean from Cape Hatteras, North Carolina to the Dry Tortugas, Florida	Huntsman et al.
SEDAR68-RD15	Color Variation And Associated Behavior In The Epinepheline Groupers, *Mycteroperca microlepis* (Goode And Bean) And *M. Phenax* Jordan And Swain	Gilmore and Jones 1992
SEDAR68-RD16	Age, Growth, and Reproduction of Scamp, *Mycteroperca phenax*, in the Southwestern North Atlantic, 1979 – 1997	Harris et al. 2002
SEDAR68-RD17	Age, Growth, Mortality, Food and Reproduction of the Scamp, *Mycteroperca phenax*, Collected off North Carolina and South Carolina	Matheson et al. 1986
SEDAR68-RD18	Tagging Studies and Diver Observations of Fish Populations on Live-Bottom Reefs of the U.S. Southeastern Coast	Parker 1990
SEDAR68-RD19	Age and growth of the yellowedge grouper, *Epinephelus flavolimbatus*, and the yellowmouth grouper, *Mycteroperca interstitialis*, off Trinidad and Tobago	Manickchand-Heileman and Phillip 2000

SEDAR68-RD20	Multi-decadal decline in reef fish abundance and species richness in the southeast USA assessed by standardized trap catches	Bachelor and Smart 2016
SEDAR68-RD21	Aspects Of The Life History Of The Yellowmouth Grouper, *Mycteroperca interstitialis*, In The Eastern Gulf Of Mexico	Bullock and Murphy 1994
SEDAR68-RD22	Age, Growth, and Mortality of Yellowmouth Grouper from the Southeastern United States	Burton et al. 2014
SEDAR68-RD23	South Carolina Marine Game Fish Tagging Program 1978 -2009	Robert K. Wiggers
SEDAR68-RD24	Decadal-scale decline of scamp (Mycteroperca phenax) abundance along the southeast United States Atlantic coast	Nathan M. Bacheler and Joseph C. Ballenger
SEDAR68-RD25	Timing and locations of reef fish spawning off the southeastern United States	Nicholas A. Farmer, William D. Heyman, Mandy Karnauskas, Shinichi Kobara, Tracey I. Smart, Joseph C. Ballenger, Marcel J. M. Reichert, David M. Wyanski, Michelle S. Tishler, Kenyon C. Lindeman, Susan K. Lowerre-Barbieri, Theodore S. Switzer, Justin J. Solomon, Kyle McCain, Mark Marhefka, George R. Sedberry
SEDAR68-RD26	**Developmental patterns within a multispecies reef fishery: management applications for essential fish habitats and protected areas**	**Kenyon C. Lindeman, Roger Pugliese, Gregg T. Waugh, and Jerald S. Ault**
SEDAR68-RD27	Ingress of postlarval gag, Mycteroperca microlepis (Pisces: Serranidae)	Paula Keener, G. David Johnson, Bruce W Stender, Edward B. Brothers and Howard R. Beatty
SEDAR68-RD28	Survival estimates for demersal reef fishes released by anglers	Mark R. Collins
SEDAR68-RD29	Commercial catch composition with discard and immediate release mortality proportions off the southeastern coast of the United States	Jessica A. Stephen, Patrick J. Harris

SEDAR68-RD30	Discard composition and release fate in the snapper and grouper commercial hook-and-line fishery in North Carolina, USA	P.J. Rudershausen, J.A. Buckel, and E.H. Williams
SEDAR68-RD31	Sink or swim? Factors affecting immediate discard mortality for the Gulf of Mexico commercial reef fish fishery	J.R. Pulver
SEDAR68-RD32	SEDAR 33-DW-19: A meta-data analysis of discard mortality estimates for gag grouper and greater amberjack	Linda Lombardi, Matthew D. Campbell, Beverly Sauls, and Kevin J. McCarthy
SEDAR68-RD33	Potential survival of released groupers caught deeper than 40 m based on shipboard and in-situ observations, and tag-recapture data	Raymond R. Wilson, Jr. and Karen M. Burns
SEDAR68-RD34	Scamp Fishery Performance Report	SAFMC Snapper Grouper Advisory Panel
SEDAR68-RD35	Hierarchical analysis of multiple noisy abundance indices	Paul B. Conn
SEDAR68-RD36	SAFMC SSC MRIP Workshop Report	SAFMC SSC
SEDAR68-RD37	Catch Characterization and Discards within the Snapper Grouper Vertical Hook-and-Line Fishery	Gulf and South Atlantic Fisheries Foundation
SEDAR68-RD38	A Continuation of Catch Characterization and Discards within the Snapper Grouper Vertical Hook-and-Line Fishery	Gulf and South Atlantic Fisheries Foundation
SEDAR68-RD39	Continuation of Catch Characterization and Discards within the Snapper Grouper Vertical Hook-and-Line Fishery	Gulf and South Atlantic Fisheries Foundation
SEDAR68-RD40	Descender Devices are Promising Tools for Increasing Survival in Deepwater Groupers	Brendan J. Runde and Jeffrey A. Buckel
SEDAR68-RD41	Something's Fishy with Scamp Response Summary	GMFMC
SEDAR68-RD42	Application of three-dimensional acoustic telemetry to assess the	Erin Collings Bohaboy, Tristan L. Guttridge, Neil Hammerschlag,

	effects of rapid recompression on reef fish discard mortality	Maurits P. M. Van Zinnicq Bergmann, and William F. Patterson III1
SEDAR68-RD43	Length selectivity of commercial fish traps assessed from in situ comparisons with stereo-video: Is there evidence of sampling bias?	Tim J. Langlois, Stephen J. Newman, Mike Cappo, Euan S. Harvey, Ben M. Rome, Craig L. Skepper, Corey B. Wakefield
SEDAR68-RD44	Changes in Reef Fish Community Structure Following the Deepwater Horizon Oil Spill	Justin P. Lewis, Joseph H. Tarnecki, Steven B. Garner, David D. Chagaris &William F. Patterson III

2 LIFE HISTORY

2.1 OVERVIEW

The Life History Work Group (LHG) was tasked with reviewing all Life history data for Scamp/Yellowmouth Grouper stocks in the U.S. South Atlantic and Gulf of Mexico and providing parameter inputs for the assessment models as appropriate. The LHG evaluated age, growth, and reproductive characteristics for each stock, including age data that could be used to characterize fishery landings, population growth models, maturity schedules, age and size at sexual transition and estimates of fecundity or other measures of reproductive potential. These data were used to inform estimates of natural mortality. The LHG has provided estimates or ranges of uncertainty for all input data parameters.

2.1.1 Work Group members and participants in Life History webinars

Andy Ostrowski	Work Group Co-Lead	NMFS
Jennifer Potts	Work Group Co-Lead	NMFS
Beverly Barnett	Work Group Deputy	NMFS
Laura Thornton	Work Group Deputy and Rapporteur	NMFS
Molly Stevens	Work Group member and Rapporteur	NMFS
Gregg Bray	Work Group member, Data Provider	GSMFC
Veronica Beech	Work Group member, Data Provider	NMFS
Wally Bubley	Work Group member, Data Provider	SCDNR
Dave Wyanski	Work Group member, Data Provider	SCDNR
Claudia Friess	Work Group member, Data Provider	Florida FWC
Nikolai Klibansky	Work Group member	NMFS
Sue Lowerre-Barbieri	Work Group member, Data Provider	Florida FWC
Kyle Shertzer	Lead Analyst*/ADT	NMFS
Skyler Sagarese	Lead Analyst/ADT	NMFS

Kate Siegfried	Work Group member/Lead Analyst*	NMFS
Francesca Forrestal	Assistant Analyst, Observer	NMFS
Will Patterson	ADT	GMFMC SSC
Sean Powers	ADT	GMFMC SSC
Jim Tolan	ADT	GMFMC SSC
Marcel Reichert	ADT	SAFMC SSC
Adyan Rios	Work Group member	NMFS
Tracey Smart	Work Group member	SCDNR
Judd Curtis	Work Group member	GMFMC SSC
Mandy Karnauskas	Work Group member	NMFS
Carole Neidig	Work Group member	Mote Marine Laboratory
Max Lee	Work Group member	Mote Marine Laboratory
Alexandra Smith	Observer	NMFS
Jessica Carroll	Observer, Data Provider	Florida FWC
Tracy McCulloch	Observer	NMFS
Guillermo Diaz	Observer	NMFS
Nancie Cummings	Observer	NMFS
Margaret Finch	Observer, Data Provider	SCDNR
Michelle Willis	Observer, Data Provider	SCDNR
Eric Fitzpatrick	Data compiler, Observer	NMFS
Rob Cheshire	Observer	NMFS
Jamie Clark	Observer	NMFS
Homer Hiers	Observer	
Wiley Sinkus	Observer	SCDNR
Stephen Long	Observer	

2.2 REVIEW OF WORKING PAPERS GREMANE TO LIFE HISTORY

SEDAR68-DW-05: Reproductive Parameters for South Atlantic Scamp and Yellowmouth Grouper in Support of the SEDAR 68 Research Track Assessment

Gonad tissue samples of Scamp and Yellowmouth Grouper were collected from a fishery-independent survey and fishery-dependent port sampling within the US South Atlantic since 1979. Primary gears used to capture the fish were snapper reels (50%) and chevron traps (40%). All gonad tissues were histologically processed. Data recorded included sex of the fish, including transitionals, maturity staging, based on Brown-Peterson et al. (2011), and fecundity estimates. Analyses of the data included sex ratio, age and length at maturity, maturity schedules, age and length at transition, spawning frequency, and batch fecundity. All analyses used recommended SEDAR best practice approaches. Functional maturity for females at calendar age and fork length were estimated by filtering data to include only developing, spawning capable and immature phases from spawning months (Feb–July), with developing and spawning capable phases representing mature females. This definition of maturity included specimens with oocyte development at or beyond the vitellogenic stage. All male specimens were considered sexually mature. Data from all months were used to estimate calendar age and fork length at sex transition. Juvenile females were included in these analyses, whereas transitional specimens were omitted.

Specimens with developing, spawning, regressing, or regenerating gonads were considered sexually mature (Brown-Peterson et al. 2011); however, functional maturity for females at calendar age and fork length was estimated by filtering data to include only developing, spawning capable and immature phases from spawning months (Feb-July), with developing and spawning capable phases representing mature females. This definition of maturity included specimens with oocyte development at or beyond the vitellogenic stage. Spawning frequency, imminent or recent spawning, was modeled on samples collected during spawning months (Feb – July) for ages 2 through 14+. Batch fecundity was modeled with a power function to be consistent with recent SEDARs where fecundity was thought to be a function of volume rather than length.

Recommendation:

The samples that were collected cover the majority of the range of the species in the South Atlantic. By having samples from various gears, they should be representative of the population. Standard procedures for analyzing the data were followed and are current with most up-to-date literature and SEDAR practices. Alternative models for batch fecundity could be explored to find best fit to the data. The reproductive parameters for Scamp/Yellowmouth Grouper complex were updated and further analyses and discussion are included in following report sections. The data and parameters are adequate for stock assessment inputs.

SEDAR68-DW-15: Scamp (*Mycteroperca phenax*) age comparisons between aging labs in the Gulf of Mexico and South Atlantic.

This report compared consistency of Scamp age estimates between labs in the Gulf of Mexico (GOM) and South Atlantic (SA) to ensure no bias would be introduced through these data. A calibration set of 400 samples was split evenly between GOM and SA. Four labs (Florida Fish and Wildlife Conservation Commission Fish and Wildlife Research Institute (FWRI), South Carolina Department of Natural Resources (SCDNR), and NOAA Panama City and Beaufort labs) assigned ages, edge codes, and quality codes for the three analyses (average percent error, age-bias plots, Evans Hoenig & Baker symmetry tests) that calculate precision, illustrate patterns, and evaluate bias. Ranges of APE were satisfactory and there was no clear overaging or underaging bias among labs. Scamp aged 0–10 years were more precise compared to Scamp aged 11+, and represent the bulk of the data. Results indicate high precision among the aging labs within a region submitting data for the assessment.

Recommendation:

The reported analyses were well done and thorough, and the results indicated that readings are consistent with little bias and low average percent error (APE). There was no indication that these data would introduce bias. Therefore, they should be considered for use in the assessment.

SEDAR68-DW-19: Scamp grouper reproduction on the West Florida Shelf
A more comprehensive working paper was submitted (SEDAR68-DW-28).

SEDAR68-DW-20: Summary of preliminary age, length, and reproduction data for U.S. Gulf of Mexico Scamp, *Mycteroperca phenax*, submitted for SEDAR68
This working paper is a preliminary summary of Scamp life history data provided for the Gulf of Mexico by the NOAA Panama City Laboratory. It is broken out by years, mode and gear, sampling program, and state landed/captured. This is a large portion of the complete data set for Scamp in the Gulf of Mexico and will be very useful for any reproductive-based parameters for the assessment.

Recommendation:
Life history data from other sources, specifically FWRI, should be combined with the data summarized in this report for more robust analyses of growth and reproductive parameters (see following report sections). The data are useful as inputs to the GOM stock assessment.

SEDAR-68-DW-21: Summary of preliminary age and length data for U.S. Gulf of Mexico Yellowmouth Grouper, *Mycteroperca interstitialis*, submitted for SEDAR68
This working paper is a preliminary summary of Yellowmouth Grouper life history data provided for the Gulf of Mexico by the NOAA Panama City Laboratory. It is broken out by years, mode and gear, sampling program, and state landed/captured. The data are considered part of the Scamp/Yellowmouth Grouper complex for the GOM, and will be incorporated into the full GOM life history data set for the species.

Recommendation:

These Yellowmouth Grouper life history data should be combined with the GOM Scamp data for more robust analyses of growth and reproductive parameters (see following report sections). The data are useful as inputs to the GOM stock assessment.

SEDAR68-DW-28: Scamp grouper reproduction in the Gulf of Mexico

The document summarizes analyses conducted on a combined dataset from the NMFS Panama City Lab and the Florida Fish & Wildlife Commission (FWC). The authors developed histological indicators for Scamp, assessed timing of reproduction, size and age at maturity and sex transition, spawning frequency, batch fecundity, and other aspects of reproductive biology. Most samples were collected by NMFS during 1972–2017 (*n*=4,105) from fishery-dependent, fishery-independent, and unknown sources, with the remaining samples collected by FWC during 2009–2017 (*n*=459) from fishery-independent and fishery-dependent surveys and a study targeting Gag Grouper along the western coast of Florida. Specimen age has not yet been determined for the FWC samples. The authors developed species-specific histological indicators to assess reproductive state and then used the resulting data to investigate maturity, sex ratio, reproductive timing, and spawning frequency of Scamp in the Gulf of Mexico. Various models were applied to estimate size and calendar age at maturity and at sex transition, spawning season duration, and spawning frequency.

Recommendation:

The methods used in this working paper were sound and often represented thoughtful improvements over standard methods. The overall dataset was large, but the samples were somewhat restricted to the western coast of Florida: 84% of the NMFS-Panama City specimens, and 100% of the FWC specimens. Assessing size and age at maturity in females was based on whether or not females were capable of spawning. Therefore, data were restricted to fish caught during the spawning season for analyses. While the definition “Actively Spawning” varies slightly on pages 2 and 3, it is understood to include those specimens with indicators of imminent or recent spawning. This approach will reduce the number of samples available for regression analysis, but relies on very distinct histological characteristics and reduces observation error. Spawning season duration was estimated with a novel approach, which estimates the average start and end dates of the spawning season with binomial regression and calculates the difference between these dates. This should be much more robust than the standard method, which is based on estimates of the extreme start and end dates of the spawning season, and is very sensitive to sampling early and late in the spawning season. Spawning fraction was estimated from the proportion of all females with spawning indicators, which is different than how it is often calculated as a proportion of mature females. Calculating spawning frequency as a function of all females is an improvement that avoids the need to even estimate "maturity", and eliminates the uncertainty in maturity staging. Spawning frequency (number of spawns per year) was calculated as a function of spawning fraction, spawning season duration, and an assumed duration of spawning indicators. A regression was then run to estimate spawning frequency as a logistic function of age.

Sources of uncertainty that could potentially be of concern in Scamp are assumptions about duration of spawning indicators, and histological criteria that indicate sex transition, and the uncertain duration of transitional characteristics. This is worth nothing, but these are common issues with studies of this type, that may not be problematic. If the assumed duration of spawning indicators is an over/underestimated, spawning events will tend to appear less/more common which will tend to under/overestimate the number of spawns per season. In protogynous fish, individuals may contain varying amounts of male and female tissue in their gonads, and it is often unclear how quickly transition proceeds. Thus, characterizing fish as "transitional" can be of somewhat limited utility since it is not clear when a "transitional" fish will actually function as male. Regardless, this should not compromise sex-at-age functions reported in this paper, which excluded "transitional" individuals.

The analyses were very informative, and novel in the case of spawning duration, and generated very reliable reproductive inputs for the Gulf of Mexico Scamp/Yellowmouth Grouper assessment. The results of this study are recommended for use in the assessment.

2.3 NATURAL MORTALITY

Natural mortality (*M*) of a fish species is often estimated using its life history parameters due to the difficulty in estimating *M* directly. Based on past assessments, the LHG had discussions about maximum age, use of point estimates of *M* and age-varying *M*s based on size at age. Many equations to calculate a point estimate of *M* are available, but the equations using maximum age of the population are preferred (Hoenig, 1983; Then et al., 2015). It is believed that the early life stages of a fish make them more vulnerable to natural mortality than the older, mature fish. For that reason, equations that estimate M as a function of size at age (Lorenzen, 1996; Charnov et al., 2012) were prioritized for this assessment.

The LHG first discussed the maximum age of Scamp in the region. The maximum ages of Scamp in the South Atlantic and the Gulf of Mexico data sets have been recorded as 34 years and 31 years, respectively. A recent bomb radio-carbon study (Pers. comm. Linda Lombardi-Carlson and Beverly Barnett, NMFS Panama City Laboratory) on a limited number of available samples was validated to a maximum age of 25 years (range = 24 – 27 years). However, one sample in the same study was aged 33 years by all four labs engaged in ageing Scamp, but due to an error with samples mixed up during processing, could not be validated. A calibration set shared among the four ageing labs (SEDAR68-DW-15) consistently found a maximum age of 34 years. Due to the potential for uncertainty in consistently ageing the oldest fish in the calibration data set, the LHG proposed a range about the single maximum age of 34 years to be used in uncertainty analyses for both regions. From the calibration set ages recorded by all age readers, the error calculated around the oldest fish was computed. The LHG recommended a range of ± 2 years to be used. This maximum age is plausible because data from the Gulf of Mexico stock had 14 samples aged 30+, while the South Atlantic data contained six samples. The Gulf of Mexico population came from fish caught during more recent years and have survived through a time of heavy exploitation. The LHG thinks that a maximum age of 34 years is reasonable since it was found in multiple data sets and across many years. Max age for Yellowmouth Grouper was similar to that found for Scamp in both stocks.

The LHG decided that *M* as a function of size at age was the most appropriate data input for the stock assessment because smaller fish are more susceptible to predation than older, larger fish. Two age-varying *M* estimates were initially considered from two approaches: (1) Charnov et al. (2012) and (2) Lorenzen (1996). Recent South Atlantic SEDAR assessments have used Charnov et al. calculations, while Gulf of Mexico SEDAR assessments have used Lorenzen. A member of the LHG reached out to both Lorenzen and Charnov to seek their inputs into their respective data sets used for their calculations of *M*. Lorenzen re-analyzed his estimate of size-varying *M* using his original data set and the data set from Charnov et al. (2012). Lorenzen's data set and estimation procedure better addresses the population level natural mortality, whereas Charnov et al.'s estimator works better at a community level. Lorenzen made a strong argument that the new analyses resulted in an equation more similar to his original equation (manuscript in prep). Lorenzen advised that the natural mortality vector be scaled for the species using the Then et al. (2015) point estimate using t_{max}. His reasoning was that, depending on the species, the mortality vector from his equation may not allow for the fish to survive to the maximum age. Then et al. (2015) recommend that, for each species to which their natural mortality estimator is applied, the analyst evaluate the Then et al. (2015) data set (available at https://www.vims.edu/research/departments/fisheries/programs/mort_db/index.php) and rerun the regression on a subset of species with more similar life history strategies to their focal species. Therefore, we calculated a new *M* estimator for Scamp and Yellowmouth Grouper.

The LHG considered the data used in the Then et al. (2015) point estimate of *M* based on t_{max}, which consisted of 227 data points from across multiple species and families and resulted in *M* = 0.1938 for Scamp/Yellowmouth Grouper. Criteria for sub-setting the data suggested by members of the LHG include having a sufficient range in maximum ages and enough data points for the regression to be robust. It was further suggested that species from similar habitats were important, such as tropical/sub-tropical reef fish or demersal species rather than pelagic or cold-water species. With those criteria set out, the full data set was subsetted based on reef fish families to include Serranidae (groupers), Sparidae (porgies), Pomacanthidae (angelfishes), Pomacentridae (damselfishes), Scaridae (parrotfishes), Malacanthidae (tilefishes), Labridae (wrasses), Lutjanidae (snappers), Haemulidae (grunts), Carangidae (jacks), and Acanthuridae (surgeonfishes) (*n* = 67). A few families were excluded immediately due to concern over the ageing methodology (e.g., Balistidae [triggerfishes] and Polyprionidae [wreckfishes]). The regression equation including these reef fish families resulted in *M* = 0.193. Some of the relevant literature cited by Then et al. (2015) was reviewed by various members of the LHG. Many of the studies drew concern over ageing methodology or how *M* was calculated. Many of the *M* values were based on catch-curve analysis of unfished or lightly fished stocks. Concern was also raised about including reef fish species that had very different life history strategies or maximum sizes compared to groupers. One suggestion was made to limit the data points to species in the same family which exhibit similar trophic levels to groupers. Thus, the 12 Serranidae species were chosen to rerun the regression. The Serranids ranged in age from 7 to 85 years and estimates of *M* ranged from 0.078 to 0.68 (Figure 1). The regression based on those 12 data points calculated an *M* of 0.155. The LHG proposed to use the Lorenzen (1996) mortality vector scaled to the Serranids only point estimate of *M* for both the South Atlantic and the Gulf of Mexico stocks (Figure 2 and Table 1). The *M* vector for each stock would use the stock specific growth model (see Section 5) and weight-length equations (see Section 7) in the calculations. Scaling of the *M* vector was based on the survivability of the fully recruited ages, ages 6-34 for both stocks. The LHG group did note that a more thorough review of the literature cited in Then et al. (2015) is needed, as well as investigation in the most appropriate way to subset the data for other SEDAR species.

<u>ADT Recommendation</u>:

1. Maximum age of Scamp/Yellowmouth Grouper is 34 years with a range of ± 2 years for both the South Atlantic and the Gulf of Mexico stocks.

2. Use natural mortality vector as a function of mean size at age using Lorenzen (1996) equation and scaled to Then et al. (2015) point estimate using a re-calculated t_{max} regression based on data gathered for Serranid species. This method will be applied to both the South Atlantic and the Gulf of Mexico stocks.

2.4 AGE DATA

The preferred age structure of Scamp are otoliths, but were considered difficult to interpret; thus, staff from the four laboratories contributing data to this SEDAR met for an age workshop to ensure the consistency in age readings of Scamp. They established the best methodology for sectioning the otoliths and interpreting the macrostructure of the otolith sections to assign ages to the samples. Following the workshop, each lab contributed to a calibration set (n = 400) to be shared that was representative of each lab's processing technique, the full age range of available samples, location of fishing activity or surveys, and all months of the year. Overall average percent error (APE) between each pair of labs ranged from 4.63% to 6.37% and no significant over-ageing or under-ageing bias was found. Within a stock, APE values were 4.24% and 5.14% for the South Atlantic and Gulf of Mexico, respectively. The outcome of the workshop and the exchange of the calibration sets suggested that data sets from the four laboratories could be combined for SEDAR68. Full results of the age comparisons can be found in SEDAR68-DW-15.

NMFS Beaufort and SCDNR labs contributed age data for the South Atlantic stock, (n = 17,410). The data consisted primarily of Scamp records (n = 16,994), but included limited Yellowmouth Grouper records (n = 416). Samples were collected from commercial fishery landings, recreational fishery landings, and fishery-independent surveys or special projects. A breakdown of commercial and recreational individual samples with ages and number of intercepted trips by year, fishery, gear or fishing mode and state of landing is included in Tables 2 and 3. A thorough review of the sampling methodology of each sample collection program was undertaken to include only those samples randomly collected and to be used for characterizing the commercial and recreational landings. Table 4 includes the count of age data by gear of the fishery-independent Southeast Reef Fish Survey (SERFS). Details of how the age data were treated are included.

Generally, the calendar-, or cohort-, ages of the fish are preferred for the assessment model input. Each fish with an age reading included annuli counts and edge type codes. The edge, or margin, codes refer to the presence of an opaque zone on the edge (code = 1) or the amount of translucent zone on the edge. The translucent zone codes include: 2 = narrow translucent zone (<1/3 of previous translucent zone); 3 = Moderate translucent zone (width 34- 66% of previous translucent zone); and 4 = wide translucent zone (>2/3 of previous zone). The analysis of the timing of opaque zone formation was somewhat problematic for Scamp, because of the difficulty with age reading. Data provided by SCDNR showed a pattern of peak opaque zone formation during June and July, with completed zones evident by the end of August indicating that their ages would be bumped through July 31st. Analyses for NOAA-BFT data indicated that the peak opaque zones were through August, indicating that their ages would be bumped through August 31st. The fish in the South Atlantic dataset are predominantly from North Carolina and South Carolina. Otoliths from fish in waters off those states tend to have more clearly defined growth zones than the same species in more southerly latitudes (e.g., Florida). Based on these results, the South Atlantic Scamp life history data set will include calendar ages. The criteria for converting annuli counts to calendar ages is as follows:

1. For all fish landed between January 1 and July 31 (SCDNR) or August 31 (NOAA-BFT) with a large translucent zone on the margin (edge type = 3 or 4), calendar age = annuli count + 1.

2. For all fish landed between January 1 and July 31 (SCDNR) or August 31 (NOAA-BFT) with opaque zone on the margin (edge type = 1) or a narrow translucent zone (edge type = 2), then calendar age = annuli count.

3. All fish landed between August/September 1 and December 31, the calendar age = annuli count.

Once the calendar ages were calculated, fractional (biological) ages were calculated for use in the growth models. The fractional ages were based on the calendar ages and the month of peak spawning, which was May, for the South Atlantic stock (Harris et al., 2002). The equation for calculating fractional age for Scamp is

$A_F = A_C + ((M_C – M_S)/12))$, where

A_F = fractional age (years),

A_C = calendar age (years),

M_C = month of capture, and

M_S = month of peak spawning.

In addition to the age data for Scamp, data for Yellowmouth Grouper was included in the full life history data set. NMFS-BFT contributed 379 ages from fish landed in the commercial and recreational fisheries. Age reading methodology, calendar age and fractional age calculations can be found in Burton et al. (2014). SCDNR provided 38 records, primarily from the SERFS fishery-independent survey with 15 samples from fishery landings. These data were treated as part of the Scamp/Yellowmouth Grouper complex and were included in the sample count tables.

2.5 GROWTH

Growth of Scamp/Yellowmouth Grouper in the U.S. South Atlantic was modelled for the population, fishery only, and separately for each sex. To account for growth of the fish throughout the year, the fractional age of each sample was used in the growth model. For the population growth model, each age data sample was identified to the source of the sample, specifically commercial fishery, recreational fishery, or fishery-independent. These designations were important in the population growth model because the fishery-dependent samples were subject to the minimum size regulations since 1992 (Amendment 4 of the Snapper Grouper FMP), in effect allowing the fastest growers at the youngest ages to be retained in the fishery landings. The population growth model includes a statistical correction for the left-truncated distribution (McGarvey and Fowler, 2002). Due to the increased uncertainty in the age readings of the oldest fish, it was deemed most appropriate for the growth model to assume a constant CV across all ages. To overcome 90% of the South Atlantic age data represented by ages 1-10, each data point was weighted by the inverse of the sample size at each sample's calendar age. Those data were driving the population model and not fitting the size at age of the oldest fish well. The growth model parameter values are included in Table 5.

The value of t_0 (-1.845) in the population growth model caused some concern because it did not seem biologically reasonable and could be an important consideration if the age at maturity was very young. In past SEDARs, the value of t_0 has been fixed at -0.5, a more biologically reasonable value, but by fixing the t_0 value, the risk of incorrectly estimating the other parameters, L_∞ and K increases. To verify the t_0 output from the population growth model, a likelihood profile was run on the value of t_0, which supported the value estimated in the model as having the minimum likelihood value (Figure 4). The LHG felt that the freely estimated model parameters provided the best fit to the data (Figure 4). In the South Atlantic stock, female Scamp are 50% mature at age 2.9 years, and the assessment will be modelling fish starting at age-1. The growth model appeared to capture the size of the fish being modelled and the mature biomass.

A growth model based on length at age data from the fishery was run to characterize the average size at age of the fish landed in the fishery. The correction for the minimum size regulations was not used in the fishery growth model, because the model needs to reflect what fish are in the landings, not the whole population. The minimum size limit was enacted in 1992, leading the LHG to investigate fishery growth models pre and post regulation time-periods. The majority of the age data from the fishery landings for the South Atlantic have been collected since 1992 (n = 13,690), compared to only 121 age samples collected during the pre-regulation period, all of which came from the recreational headboat fishery. The pre-1992 samples were not adequate to characterize the commercial and recreational fishery landings during that time, therefore, the group recommended using the population growth model for the pre-regulation time period. The LHG recommended using the age data from fishery samples during the regulation time period to model growth and estimate length at age for the fish landed in the fisheries from 1992 to present.

The assumption of constant CV across all ages was used in the model estimation procedure. Parameter results are included in Table 5 and Figure 5.

To calculate reproductive potential in the stock, a measure of fecundity or mature biomass (spawning stock biomass [SSB]) in the population is needed. When a reliable measure of fecundity and spawning periodicity are not available, an estimate of all mature adult, mature female only, or in the case of sperm limitation, mature male size at ages can be used. Because Scamp is a protogynous species, growth models of females only and male only in the population were calculated. Only fish that were histologically identified as functional females and males were used in these sex-specific growth models. To reflect length at age of females and males in the population, the correction to account for the bias on size at age introduced by minimum size regulations and assuming constant CV across all ages were incorporated into the growth models (Figure 6). The estimated growth parameters for each sex are included in Table 5.

ADT Recommendation:

1. The ADT approved the use of the population growth model as presented.
2. The ADT approved the use of the population growth model to characterize the fishery landings prior to 1992.
3. The ADT approved the use of the fishery growth model using only fishery-dependent age samples and no correction for minimum size limits to characterize the fishery landings since 1992.
4. The ADT approved the use of the female and male population growth models, which could be used to estimate SSB in a series of sensitivity runs to see the effects of possible sperm limitation on the stock.

2.6 REPRODUCTION

Fishery-independent and fishery-dependent data for Scamp and Yellowmouth Grouper were collected by the Marine Resources Monitoring Assessment and Prediction (MARMAP) program and the Southeast Area Monitoring and Assessment Program, South Atlantic (SEAMAP-SA) at the South Carolina Department of Natural Resources (SCDNR) and the Southeast Fisheries

Independent Survey (SEFIS) at the Southeast Fisheries Science Center (SEFSC), Beaufort. Fishery-independent samples for life history were collected via MARMAP's reef fish survey efforts during 1979 to 2009, and then by the collaborative Southeast Reef Fish Survey (consisting of MARMAP, SEAMAP-SA, and SEFIS) from 2010 to 2017, mostly with chevron traps. Fishery-dependent samples for life history were collected via MARMAP's short-term port sampling efforts or special projects, mostly via snapper reel. Given that the two species are similar in morphology and coloration at smaller sizes, the decision to combine Scamp and Yellowmouth Grouper data was recommended by the SEDAR68 Stock ID Workshop (SEDAR68-SID-05). A total of 5,014 specimens was available for analyses, with 4,546 (mostly Scamp, *n*=4,518, 99%) having both reproductive and age data. Most (54%) specimens with both data types were from fishery-independent samples and the primary gear types irrespective of source were snapper reel (48%) and chevron trap (42%).

<u>Maturity, sex ratio, and spawning frequency</u>: Gonad tissue samples from Scamp and Yellowmouth Grouper collected by MARMAP or SERFS were processed histologically and examined under a microscope by two readers independently via standard procedures (Brown-Peterson et al. 2011; Smart et al., 2015) to determine sex and reproductive phase. Female specimens with developing or spawning capable gonads were considered functionally mature; this definition of maturity included specimens with oocyte development at or beyond the vitellogenic stage. To estimate calendar age and fork length at maturity, data were filtered to include immature and mature (developing or spawning capable) specimens from February through July. All females (i.e., juvenile and adult) were included in analyses to estimate calendar age and fork length at sex transition, but specimens undergoing sex transition were omitted. Fork length data in millimeters were rounded to the nearest cm to create 10 mm bins. A gonadosomatic index (gonad wt/whole fish weight * 100) was calculated for male Scamp to give insight into their mating strategy.

Maturity: The Logit model provided the best fit for estimating female age and size at functional maturity (Tables 6 and 7). The youngest mature female was Age 2 and all females were mature at Age 7. Estimates of female age and length at 50% maturity were 2.9 years and 375.2 mm FL, respectively (Figures 7 and 8).

Sex Ratio: The Probit model provided the best fit for estimating age and size at sex transition (Tables 8 and 9). Sex transition occurred over a wide range of age, as males ranged from Age 4 to Age 34. Estimates of age and length at 50% sex transition (to male) were 10.6 years and 646.9 mm FL, respectively (Figures 9 and 10). To address the potential for sperm limitation in the S. Atlantic population, sex ratio by fork length interval over time was calculated for three decades (1990-1999, 2000-2009, and 2010-2017; Figure 11). Although the proportion of males is smaller in most size classes in the 2010s, comparisons between periods are not appropriate due to: 1) improved sampling coverage relative to depth and latitude since 2010, and 2) small sample sizes in the larger size intervals. The number of specimens > 650 mm FL was only 49 in 1990-1999, 21 in 2000-2009, and 79 in 2010-2017. The consensus among the LHG members was that sex ratio data alone cannot be used to determine sperm limitation. To address this question requires knowledge of mating strategy and fertilization rate under various sex ratio scenarios, both of which are not known for these two species and challenging to investigate.

Spawning frequency: Spawning frequency (SF, number of batches per individual fish) was determined from histological examination of gonad tissue. Females were categorized as actively spawning if there were indicators of imminent (oocyte maturation, including germinal vesicle migration and hydration) or recent (postovulatory follicle complexes, POC) spawning. The total duration of spawning indicators was estimated to be 48 h. Data were filtered to include all females from the spawning season months (February – July; Harris *et al*., 2002). To maintain comparable sample sizes, ages 14-23 were pooled in the 14+ age group. For each calendar age, the SF was obtained by multiplying the proportion of spawning females by the spawning season duration as described in Gamboa-Salazar *et al*. (2019). Spawning frequency had a significant dome-shaped relationship with calendar age, with the best-fit model being a second order polynomial ($y=-4.710+6.148x-0.425x^2$ with $R^2 = 0.608$, $p = 0.002$; Figure 12). Predicted values of SF were highest for ages 6-8 yr and lowest for the oldest females (Table 10).

Batch Fecundity: Batch fecundity was estimated by applying the power function to the data from Harris *et al.* (2002). The specimens were collected in 1996 (*n*=72) and 1998 (*n*=4) and ranged in fork length (FL) from 406 to 657 mm. Batch Fecundity = b * FL^z, with b= 0.0000316 and z= 3.53 (Figure 13).

Measure of reproductive potential: The consensus reached by the LHG prior to Plenary #2 on 26 May 2020 was to recommend the use of total spawning biomass (vs. total egg production, TEP) in the base model for both regions because of: 1) the use of TEP would omit the reproductive value of males, 2) the standing recommendation of Brooks et al. (2008) to use total spawning biomass for protogynous species, 3) the precedence for using total spawning biomass in previous S. Atlantic assessments of grouper (i.e., Gag, Red Grouper, Snowy Grouper), and 4) the limitations of the available batch fecundity data for the S. Atlantic. The size range of specimens examined by Harris et al. (2002) to estimate batch fecundity was 406-657 mm FL; however, 9.1% of 341 adult females in the SERFS 2010-2017 SERFS chevron trap samples were 651-783 mm FL.

During LHG meetings prior to Plenary #3 on 24 September 2020, there was extended discussion about the design of sensitivity runs, much of which focused on how to incorporate a measure of male reproductive value into the sensitivity runs. Observations of reproductive behavior by Gilmore and Jones (1992) suggest that spawning in Scamp "occurs most frequently in pairs or small groups following elaborate courtship displays." The male GSI supports their conclusion because the GSI is < 1% at its peak (Figure 14), indicating that Scamp are not spawning in large aggregations. Members of the LHG, some of which are on the assessment team at NMFS Beaufort, proposed a matrix of 4 sensitivity runs that would explore the effect of varying levels of male contribution to spawning by either down-weighting or up-weighting the ratio of male to female biomass in the model (Table 11). The male only run will test the impact of sperm limitation. This matrix of sensitivity runs was subsequently adopted as consensus at Plenary #3 and will be utilized in the Scamp/Yellowmouth Grouper assessments for both regions to the extent possible.

<u>ADT Recommendations</u>:

1. Use maturity schedule at age and sex ratio at age as presented: 50% maturity of female age and length at were 2.9 years and 375.2 mm FL, respectively, and sex transition (to male) of age and Length at 50% were 10.6 years and 646.9 mm FL, respectively.
2. Use mature biomass of sexes combined as measure of reproductive potential.
3. Conduct sensitivity runs exploring the contribution or limitations of males to spawning success in the population by varying the ratio of female to male biomass as presented in Table 11.

2.7 MERISTIC CONVERSIONS

Fishery-dependent monitoring and fishery-independent surveys collect different measurement types on fish, which may need to be converted to standardized types for consistency in data inputs for SEDAR68 Scamp/Yellowmouth Grouper. The SEDAR 68 panel assigned the length type and fish weight for the biological data inputs to be in fork length (mm) and whole, or round, weight (kg), respectively. Meristic data collected on fish landed or surveyed within the SAFMC jurisdiction with paired length types, weight-length and whole weight – gutted weight data were compiled for the regression analyses. Data included were from TIPS, SRHS, MRIP, SERFS, GulfFIN and Shark Bottom Longline Observer Program (SBLOP). Linear regressions for length-length and LN transformed weight and length were modelled. The weight-length equations were converted to the power equation, $W = aL^b$, adding ½ mean squared error (MSE) for transformation bias. Whole weight – gutted weight measurements were collected during SERFS cruises. All lengths were in mm, and all weights were in kg for the various comparisons. Tables 12a and b provides the parameters, standard errors, sample sizes and ranges of each independent variable.

Comparison of the regression equations from the South Atlantic to those from the Gulf of Mexico revealed similarities and differences. The length – length equations yielded essentially the same results. On the other hand, the weight-length equations were different. Fish from the Gulf of Mexico appeared to be heavier at length than the ones from the South Atlantic after ~700 mm FL. A greater proportion of fish larger than 700 mm FL with accompanying whole weights were recorded in the South Atlantic (18% of 17,614) compared to the Gulf of Mexico (2% of 12,660). The LHG recommended that the conversion equations remain separated by area based on these slight differences.

The LHG reviewed data inputs for the whole weight – gutted weight conversion. The whole weight – gutted weight relationships between the areas were different in the estimated slopes by region: 1.07 for the South Atlantic and 1.03 for the Gulf of Mexico. The data source for the South Atlantic was from SCDNR and was primarily from the fishery-independent survey (SERFS) since 2010, while the majority of the data from the Gulf of Mexico was from FWRI fishery-dependent monitoring in 1979-1980 of the commercial fishery. The range of the data from the South Atlantic was greater than the Gulf of Mexico (Figure 15). The resulting slope of the combined data was 1.05, which is a value more in line with the conversion factor used for other grouper species. Because of the overall range and sources of the data available, the LHG recommended using results of the combined data for the whole weight- gutted weight conversion (Table 12c).

ADT Recommendation**:**

1. Use the meristic conversion equations as presented in Table 12 for the South Atlantic jurisdiction.
2. Use a combined South Atlantic and Gulf of Mexico whole weight – gutted weight equation to be applied to both areas.

2.8 RESEARCH RECOMMENDATIONS

2.8.1 Natural Mortality

- Convene a topical workgroup or other workshop to critically review literature used in Then et al. (2015), discuss recent advancements in ageing approaches (e.g., Gray Triggerfish), and propose best options for selecting species for inclusion in regression analyses for reef fish species in the US Southeast Region to be used in estimating natural mortality.

- Research the Thorson FishLife program for use in natural mortality estimates and measures of uncertainty. https://github.com/James-Thorson-NOAA/FishLife

2.8.2 Reproductive Biology

- Investigate the male contribution to spawning success and the potential for sperm limitation in the population through model simulations and field research that will fill in critical gaps in knowledge (i.e., fertilization rate under various sex ratio scenarios, mating strategy) and continue to monitor sex ratio.
- Additional sampling with better spatial and especially temporal coverage to confirm preliminary results that male gonadosomatic index (GSI) indicates that Scamp are spawning in pairs or small groups. This information is lacking for Yellowmouth Grouper.

- Collect all sizes of Yellowmouth Grouper and larger female Scamp (> 650 mm FL) during the spawning season to assess batch fecundity and thereby fill a data gap that prevents estimating total egg production.
- Given the likely smaller population size of Yellowmouth Grouper, samples with a wide range of size/age, from fishery-dependent and fishery-independent sources, are needed to determine reproductive parameters for this species and to allow comparisons with those of Scamp.

2.9 LITERATURE CITED

Charnov, E. L., H. Gislason, and J. G. Pope. 2012. Evolutionary assembly rules for fish life histories. Fish and Fisheries 14(2): 213 – 224.

Brooks, E. N., K. W. Shertzer, T. Gedamke, and D. S. Vaughan. 2008. Stock assessment of protogynous fish: Evaluating measures of spawning biomass used to estimate biological reference points. Fishery Bulletin 106:12-23.

Brown-Peterson, N.J., D. M. Wyanski, F. Saborido-Rey, B. J. Macewicz, and S. K. Lowerre-Barbieri. 2011. A standardized terminology for describing reproductive development in fishes. Marine and Coastal Fisheries [online serial] 3:52–70. DOI: 10.1080/19425120.2011.555724

Burton, M. L., J. C. Potts and D. R. Carr. 2014. Age, Growth, and Mortality of Yellowmouth Grouper from the Southeastern United States, Marine and Coastal Fisheries, 6:1, 33-42, DOI:10.1080/19425120.2013.866998

Gamboa-Salazar, K. R., D. M. Wyanski, W. J. Bubley, and N. Klibansky. 2019. Effects of age and size on spawning and egg production in gag and Scamp grouper off the southeastern United States. ICES Journal of Marine Science 77: 290-299.

Gilmore R. G., and R. S. Jones. 1992. Color variation and associated behavior in the epinepheline groupers, *Mycteroperca microlepis* (Goode and Bean), and *M. phenax* (Jordan and Swain). Bulletin of Marine Science 51: 83–103.

Harris, P. J., D. M. Wyanski, D. B. White, and J. L. Moore. 2002. Age, growth, and reproduction of Scamp, *Mycteroperca phenax*, in the southwestern north Atlantic, 1979–1997. Bulletin of Marine Science 70: 113–132.

Hoenig, J. 1983. Empirical use of longevity data to estimate mortality rates. Fishery Bulletin 82(1):898 – 903.

Lorenzen, K. 1996. The relationship between body weight and natural mortality in juvenile and adult fish: a comparison of natural ecosystems and aquaculture. Journal of Fish Biology 49(4):627 – 642.

McGarvey, R., and A. J. Fowler. 2002. Seasonal growth of King George whiting (*Sillaginodes punctata*) estimated from length-at-age samples of the legal-size harvest. Fishery Bulletin 100(3):545-558.

Smart, T. I., M. J. M. Reichert, J. C. Ballenger, W. J. Bubley, and D. M. Wyanski. 2015. Overview of sampling gears and standard protocols used by the Southeast Reef Fish Survey and its partners. SEDAR41-RD58.

Then, A. Y., J. M. Hoenig, N. G. Hall, and D. A. Hewitt. 2015. Evaluating the predictive performance of empirical estimators of natural mortality rate using information on over 200 fish species. Journal of Marine Science, doi: 10.1093/icesjms/fsu136.

2.10 TABLES

Table 1. Natural mortality (*M*) vectors based on Lorenzen (1996) and scaled to Then et al. (2015) Serranidae data for maximum age for both stocks of Scamp/Yellowmouth Grouper (*M* = 0.155). Size at Age was calculated on the mid-point of the age (e.g., 0 = 0.5, 1 = 1.5, etc.)

Age	*M* - SA	*M* - GOM
0	0.486	0.567
1	0.382	0.432
2	0.325	0.359
3	0.288	0.314
4	0.264	0.283
5	0.246	0.261
6	0.232	0.244
7	0.222	0.231
8	0.214	0.221
9	0.207	0.213
10	0.202	0.207
11	0.198	0.201
12	0.194	0.197
13	0.191	0.193
14	0.189	0.190
15	0.187	0.187
16	0.185	0.185
17	0.183	0.183
18	0.182	0.181
19	0.181	0.180
20	0.180	0.179
21	0.180	0.177
22	0.179	0.177
23	0.178	0.176
24	0.178	0.175
25	0.177	0.174
26	0.177	0.174
27	0.177	0.174
28	0.177	0.173
29	0.176	0.173
30	0.176	0.172
31	0.176	0.172
32	0.176	0.172
33	0.176	0.172
34	0.176	0.172

Table 2. Number of Scamp/Yellowmouth Grouper age samples (number of trips intercepted) from commercial fishery landings, which were determined to be randomly collected and could be used for generating age composition of the landings. Annual sample sizes are listed by gear group and state.

Gear Group	Vertical Hook and Line			Bottom Longline	Spears			Vertical Longline	
Year/State	FL	NC	SC	FL	FL	NC	SC	NC	SC
1996	75 (10)		6 (4)						
1997	23 (7)		2 (2)	11 (4)					
1998	35 (9)								
1999	18 (5)								
2000	24 (6)								
2001	48 (11)		3 (1)						
2002	17 (7)								
2003	27 (8)								
2004	18 (4)	155 (46)							
2005	36 (7)	313 (86)	109 (24)						
2006	11 (3)	374 (116)	568 (147)				15 (5)		
2007	49 (8)	866 (205)	576 (163)				12 (1)		
2008	12 (2)	664 (180)	613 (165)				16 (2)		
2009	59 (11)	496 (117)	324 (143)				47 (12)		
2010	1 (1)	321 (94)	539 (107)			36 (6)	65 (9)		
2011	20 (5)	383 (116)	557 (109)			25 (3)	116 (16)		
2012		395 (98)	448 (89)			24 (4)	9 (2)	2 (1)	
2013	24 (8)	220 (68)	179 (61)			48 (8)	59 (16)	1 (1)	
2014	27 (10)	323 (62)	176 (62)		2 (1)	119 (18)	27 (9)	1 (1)	
2015	4 (1)	168 (52)	130 (48)		1 (1)	31 (8)	13 (5)		
2016	3 (1)	296 (66)	141 (48)			62 (7)	33 (9)		
2017	11 (3)	167 (45)	94 (35)		3 (1)	90 (13)	14 (7)		5 (1)
2018	9 (5)	288 (62)	87 (36)		6 (1)	59 (13)	17 (7)		

Table 3. Number of Scamp/Yellowmouth Grouper age samples (number of trips intercepted) from recreational fishery landings, which were determined to be randomly collected and could be used for generating age composition of the landings. Annual sample sizes are listed by fishing mode and state.

Mode	Headboat				Charter Boat		Private Boat	
Year/State	FL	GA	NC	SC	FL	NC	FL	NC
1979	5 (3)							
1980	33 (19)		6 (3)	2 (2)				
1981	52 (33)	1 (1)	3 (1)					
1982	3 (3)		2 (2)					
1983	6 (4)			1 (1)				
1984	1 (1)							
1985								
1986								
1987								
1988								
1989				5 (3)				
1990								
1991			1 (1)					
1992								
1993			1 (1)					
1994								
1995	3 (2)			9 (1)				
1996	1 (1)	1 (1)	4 (3)	119 (42)				
1997			2 (1)					
1998								
1999								
2000				1 (1)				
2001	1 (1)				6 (4)			
2002				4 (3)	44 (22)			
2003			1 (1)		60 (33)			
2004			3 (3)		87 (42)			
2005	3 (1)		12 (11)		86 (42)			
2006	4 (4)	3 (3)		26 (26)	59 (17)			
2007	8 (6)	1 (1)	4 (4)	33 (33)	15 (5)			
2008	5 (4)		1 (1)	17 (17)				
2009	15 (12)	2 (2)	2 (1)	40 (22)	9 (3)			
2010	7 (4)	1 (1)	7 (6)	27 (17)	2 (1)	7 (2)		2 (1)
2011	2 (2)	1 (1)		6 (6)	1 (1)			
2012	25 (13)		10 (6)	11 (7)				
2013	19 (10)		17 (11)	25 (13)	2 (1)			
2014	16 (12)	1 (1)	19 (9)	6 (4)			1 (1)	
2015	16 (8)		11 (7)	2 (2)				
2016	43 (19)	1 (1)	5 (5)	6 (6)				2 (1)
2017	14 (9)		6 (4)	5 (4)	3 (3)			
2018	6 (3)		8 (5)	13 (8)				5 (4)

Table 4. Number of Scamp/Yellowmouth Grouper age samples from the fishery-independent portion of SERFS by year and gear.

Year	Chevron trap	Hook and Line	Short-Bottom Longline	Experimental trap	FL Antillean trap	Trawls
1976						2
1977						
1978						
1979						
1980		2				
1981		1				
1982		1			1	
1983		4				
1984		7			1	1
1985					5	
1986		1			1	
1987					4	1
1988	17	9				
1989	4	2				
1990	21	7				
1991	53					
1992	51	2				
1993	74	9				
1994	121	2				
1995	183	3				
1996	132	8	1			
1997	191	3				
1998	122	2				
1999	60		21	8		
2000	61	1	2			
2001	60	1	31			
2002	50		9			
2003	42	1	8			
2004	68		14		3	
2005	67	2	13		3	
2006	24	2	23		1	
2007	59	1	28			
2008	13		4			
2009	17	7	18			
2010	54	11	10			
2011	35	24	25	5		
2012	62	22				
2013	63	18	13			
2014	74	38	9			
2015	72	22	12			
2016	53	14	8			
2017	71	17	10			
2018	42	19	6			

Table 5. Growth model parameters of Scamp/Yellowmouth Grouper in the U.S. South Atlantic.

	L_∞ (FL, mm)	K	t_0	C.V.
Population model (*n*= 16778)	787.36 ± 26.35	0.149 ± 0.027	-1.845 ± 0.711	0.1 ± 2.6815e-005
Fisheries Post 1992 model (*n*= 13690)	919.06 ± 17.48	0.076 ± 0.0042	-5.19 ± 0.288	0.1 ± 7.1679e-008
Females only model (*n* = 3568)	761.51 ± 79.21	0.128 ± 0.051	-2.53 ± 1.42	0.118 ± 0.0199
Males only model (*n* = 333)	765.62 ± 63.11	0.145 ± 0.093	-3.34 ± 4.57	0.1 ± 0.00003

Table 6. Best fit for female age at functional maturity in S. Atlantic Scamp/Yellowmouth Grouper during the period 1979-2017. Female specimens with developing or spawning capable gonads were considered mature.

Distribution	N	A_{50} (yr)		Estimate	Std. Error	z value	Pr(>|z|)
Logit	1011	2.9	**(Intercept)**	-6.1129	0.7237	-8.447	<2e-16
			CalAge	2.0936	0.1998	10.477	<2e-16

Table 7. Best fit for female fork length at functional maturity in S. Atlantic Scamp/Yellowmouth Grouper during the period 1979-2017. Female specimens with developing or spawning capable gonads were considered mature.

Distribution	N	L_{50} (mm)		Estimate	Std. Error	z value	Pr(>|z|)
Logit	1085	375.2	**(Intercept)**	-16.7155	1.6901	-9.89	<2e-16
			Fork Length	0.0446	0.0042	10.74	<2e-16

Table 8. Best fit for female age at sex transition in S. Atlantic Scamp/Yellowmouth Grouper during the period 1979-2017. All females (i.e., juvenile and adult) were included, but specimens undergoing sex transition were omitted.

Distribution	N	A_{50} (yr)		Estimate	Std. Error	z value	Pr(>|z|)
Probit	4357	10.6	**(Intercept)**	-3.07207	0.07969	-38.55	<2e-16
			CalAge	0.28968	0.01014	28.56	<2e-16

Table 10. Predicted values of spawning frequency (SF, number of batches per individual fish) at calendar age for S. Atlantic Scamp/Yellowmouth Grouper during the period 1979-2017 from a second-order polynomial regression model, with sample size (N) at each age. Ages 14-23 were pooled. Predicted value of SF for age 14+ was negative (-1.97), therefore the observed value was provided. Model equation $y = -4.710 + 6.148x - 0.425x^2$

Calendar Age (yr)	SF	N
1	1.01	2
2	5.88	46
3	9.91	145
4	13.08	411
5	15.4	603
6	16.87	507
7	17.49	226
8	17.26	115
9	16.18	94
10	14.25	41
11	11.47	25
12	7.84	25
13	3.36	11
14+	0.03	17

Table 11. Consensus reached during Plenary #3 on 24 September 2020 on sensitivity runs for S. Atlantic and Gulf of Mexico assessments. Ratios of female to male biomass for estimating spawning potential biomass in the model.

	Female Only	Male Biomass at 50%	Female Biomass at 50%	Male Only
Female	1	1	0.5	0
Male	0	0.5	1	1

Table 12. Meristic conversion equations for South Atlantic Scamp/Yellowmouth Grouper.

a. Length – length equations

Model: *Y = a + bX*	**n**	**a**	**SE**	**b**	**SE**	**r^2**	**Units**	**range of Independent variable**
FL = TL	1999	19.72	1.31	0.89	0	0.99	mm, mm	267 - 1003
TL = FL	1999	-15.01	1.51	1.11	0	0.99	mm, mm	252 - 898
TL = maxTL	152	-0.30	3.34	0.98	0	0.99	mm, mm	457 - 922
maxTL = TL	152	2.95	3.37	1.01	0	0.99	mm, mm	453 - 916
FL = maxTL	5213	23.03	0.70	0.88	0	0.99	mm, mm	193 - 922
maxTL = FL	5213	-20.42	0.83	1.13	0	0.99	mm, mm	184 - 847
FL = SL	5111	25.38	0.90	1.12	0	0.98	mm, mm	149 - 720
SL = FL	5111	-15.46	0.83	0.88	0	0.98	mm, mm	184 - 847
TL = SL	183	17.00	10.57	1.14	0.02	0.95	mm, mm	374 - 695
SL = TL	183	11.97	8.34	0.77	0.01	0.95	mm, mm	453 - 916
maxTL = SL	5321	5.90	1.18	1.26	0	0.98	mm, mm	149 - 750
SL = maxTL	5321	5.07	0.92	0.78	0	0.98	mm, mm	193 - 925

b. Whole weight – length equations. LN transformed weight and length for linear regression analyses. Equations converted to power equation including ½ MSE for transformation bias.

Model: $Y = a + bX$	**n**	**a**	**SE**	**b**	**SE**	**r^2**	**Units**	**range of Independent variable**	**MSE**	**Power Equation:** $Y = a(X)^b$
Ln(WW) = Ln(FL)	17614	-16.51	0.04	2.75	0	0.92	kg, mm	178 - 1130	0.04	$WW = 7.03E\text{-}08(FL)^{2.75}$
Ln(FL) = Ln(WW)	17614	6.03	0	0.34	0	0.92	kg, mm	0.083 - 20.98	0.00439	$FL = 417.54(WW)^{0.34}$
Ln(WW) = Ln(TL)	2847	-17.44	0.1	2.87	0.02	0.91	kg, mm	183 - 1003	0.04	$WW = 2.78E\text{-}08(TL)^{2.87}$
Ln(TL) = Ln(WW)	2847	6.09	0	0.32	0	0.91	kg, mm	0.10 - 11.00	0.00427	$TL = 443.31(WW)^{0.32}$
Ln(WW) = Ln(maxTL)	4805	-18.25	0.06	3.00	0.01	0.95	kg, mm	193 - 922	0.0181	$WW = 1.21E\text{-}08(maxTL)^{3.00}$
Ln(maxTL) = Ln(WW)	4805	6.11	0	0.32	0	0.95	kg, mm	0.083 - 15.50	0.0019	$maxTL = 451.20(WW)^{0.32}$
Ln(WW) = Ln(SL)	4749	-17.37	0.06	2.97	0.01	0.94	kg, mm	149 - 750	0.02	$WW = 2.92E\text{-}08(SL)^{2.97}$
Ln(SL) = Ln(WW)	4749	5.86	0	0.32	0	0.94	kg, mm	0.083 - 15.50	0.0021	$SL = 351.46(WW)^{0.32}$

c. Whole weight – gutted weight conversions.

Model: WW = GW (no intercept; $Y = bX$)	**n**	**b**	**SE**	**r^2**	**Units**	**range of Independent variable**
South Atlantic	172	1.07	0	0.9977	kg, kg	0.129 - 7.1
Gulf of Mexico	230	1.03	0	0.9981	Kg, kg	0.19 – 4.75
Southeast Region	402	1.05	0	0.9946	Kg, kg	0.129 – 7.1

2.11 FIGURES

Figure 1. Values of *M* estimated for Serranids (groupers) from Then et. Al (2015) data set and regression line.

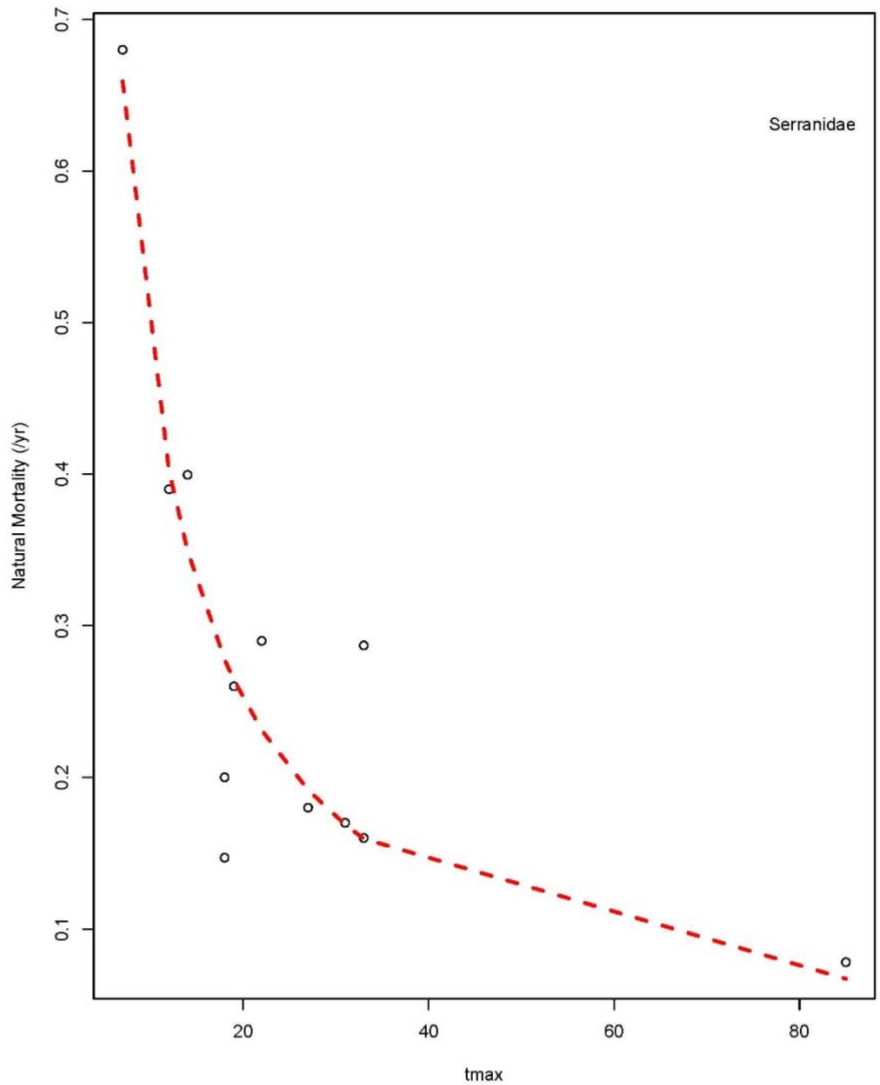
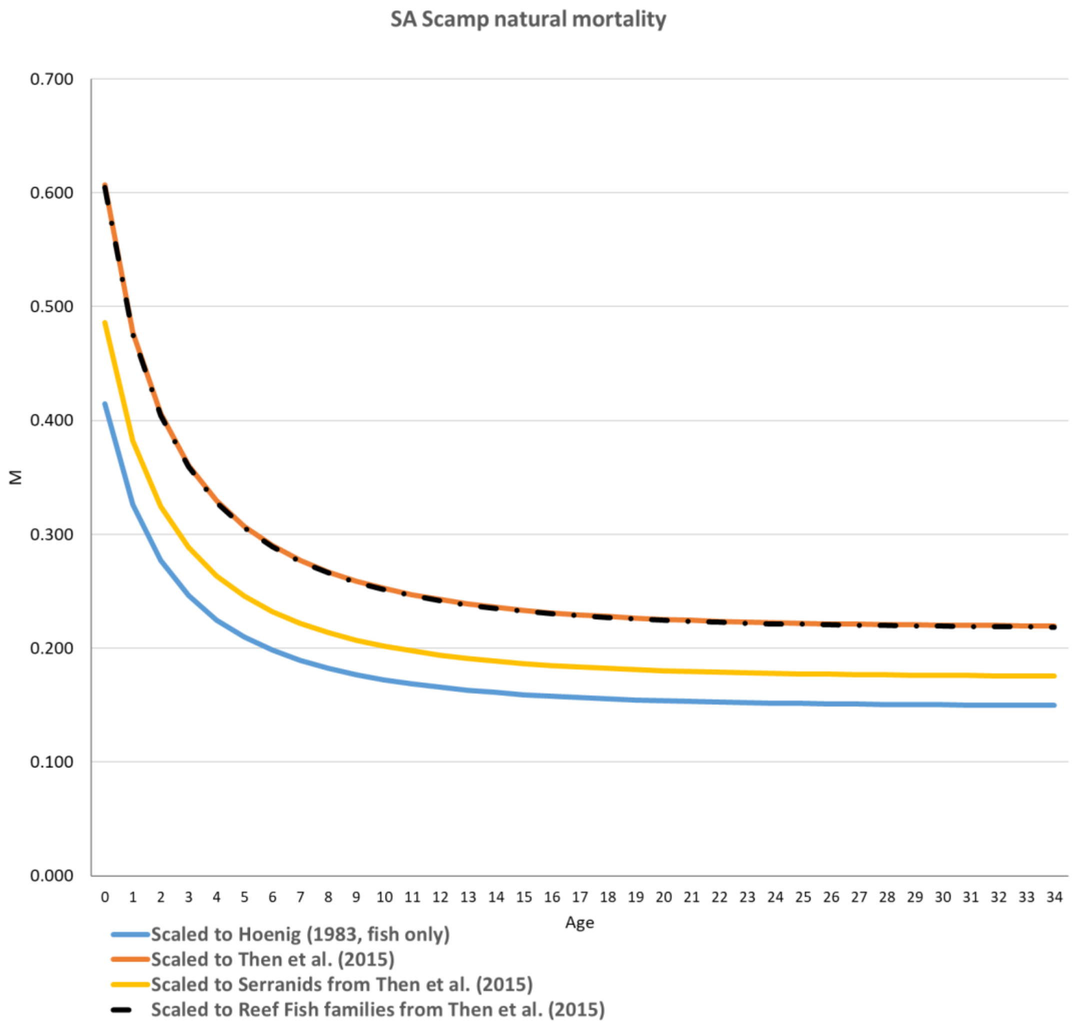


Figure 2. Natural Mortality vector for (a) South Atlantic and (b) Gulf of Mexico stocks. Lorenzen (1996) size-at-age natural mortality scaled to point estimates of *M* based on maximum age in the population, age 34. Recommended values (yellow) are the ones scaled to the point estimate of *M* based on the Serranidae data used in Then et al. (2015).

a.



b.

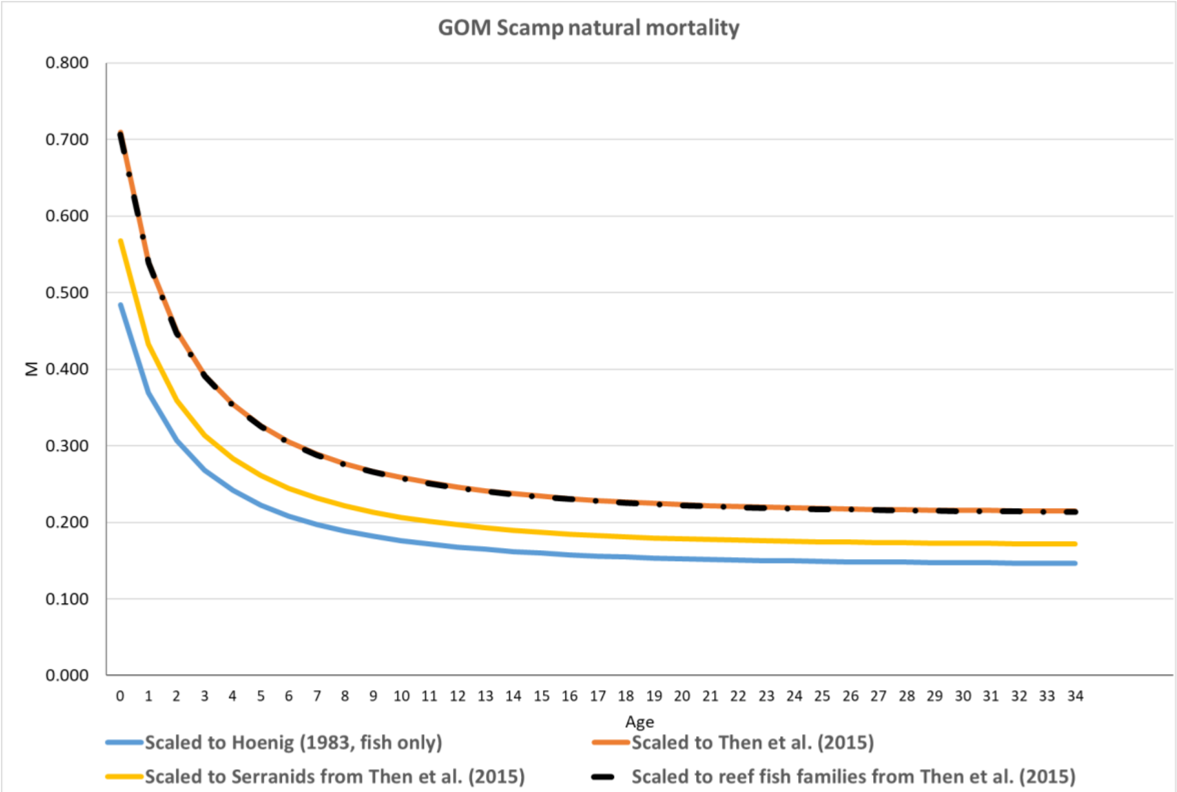

GOM Scamp natural mortality
M
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34
Age
Scaled to Hoenig (1983, fish only)
Scaled to Then et al. (2015)
Scaled to Serranids from Then et al. (2015)
Scaled to reef fish families from Then et al. (2015)

Figure 3. Likelihood profile of the value of t_0 estimated in the population growth model of the South Atlantic Scamp/Yellowmouth Grouper stock.

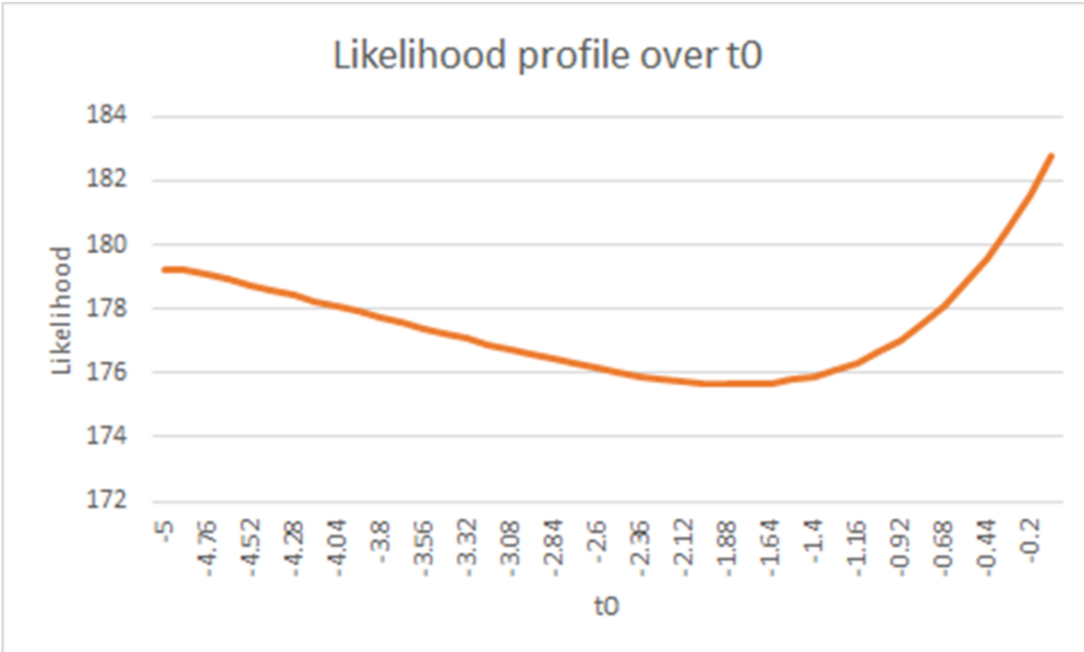


Figure 4. South Atlantic Scamp/Yellowmouth Grouper population growth model using fractional age at length (FL, mm) with correction for left truncated distribution of size at age under minimum size regulations, inverse weighted by sample size at calendar age, and assuming a constant CV across all ages.

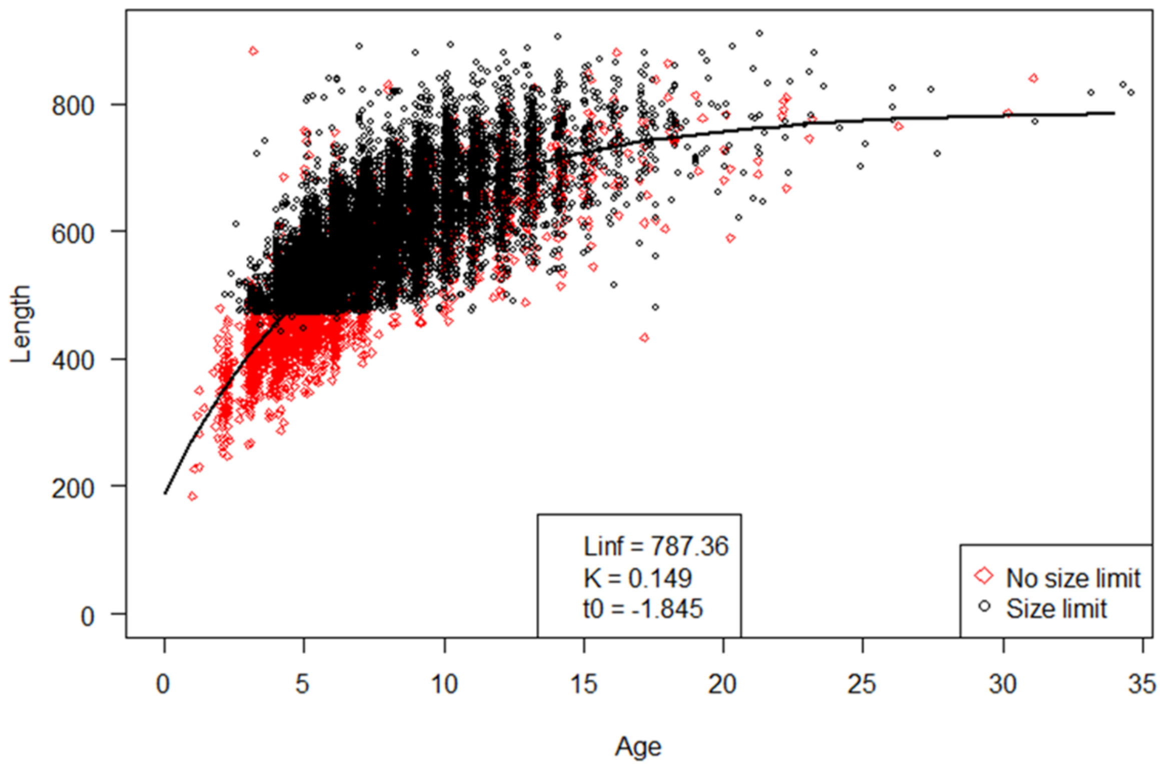


Figure 5. South Atlantic Scamp/Yellowmouth Grouper fishery growth model during minimum size regulations: 1992 – present. Model run on fork length (mm) at fractional age (years) and assuming a constant CV across all ages.

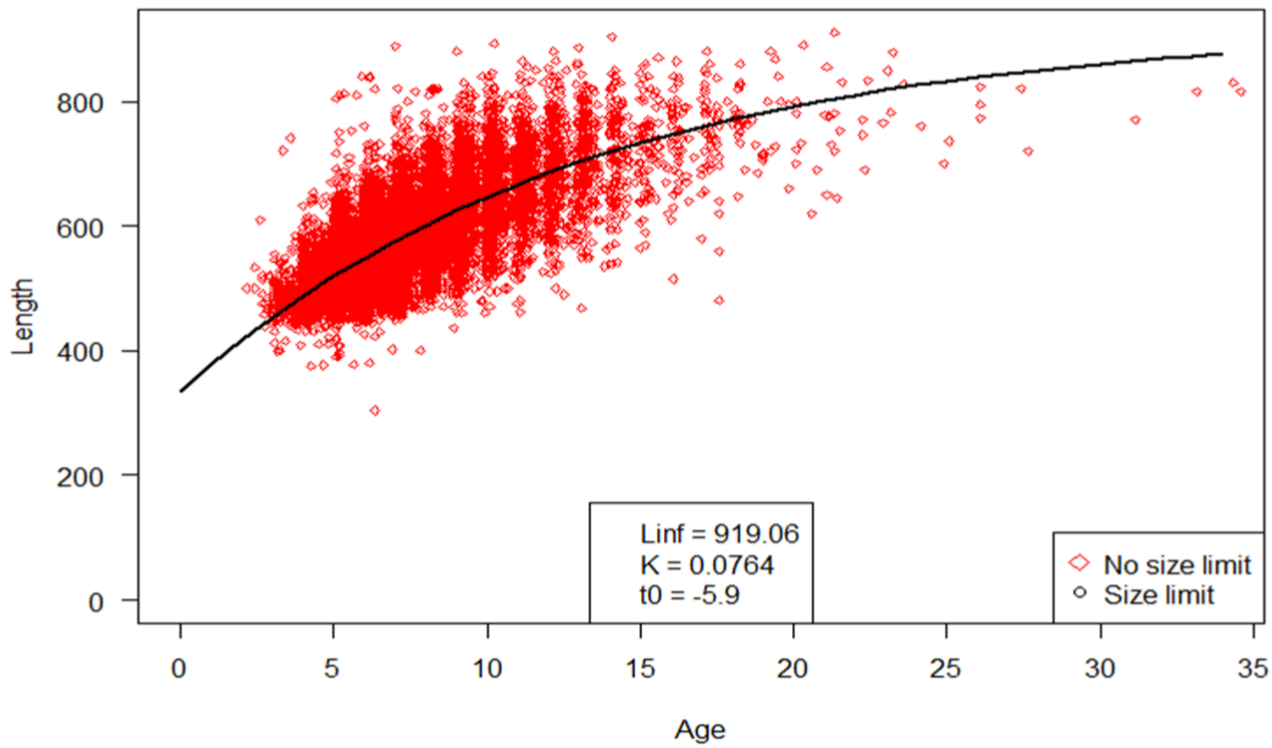
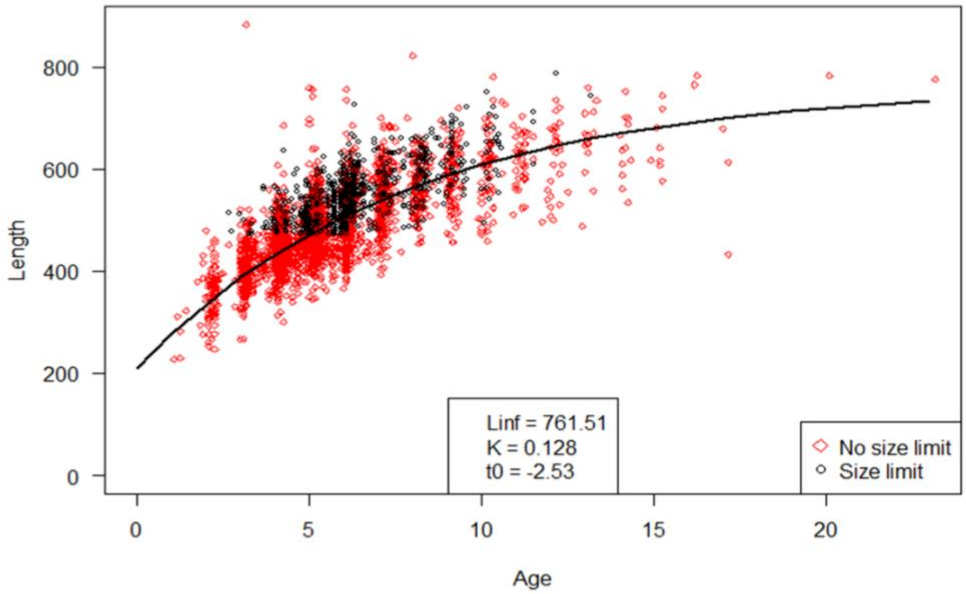


Figure 6. South Atlantic Scamp/Yellowmouth Grouper female only (a) and male only (b) population growth model using fork length (mm) at fractional age with correction for left truncated distribution of size at age under minimum size regulations, inverse weighted by sample size at calendar age, and assuming a constant CV across all ages.

a.



b.

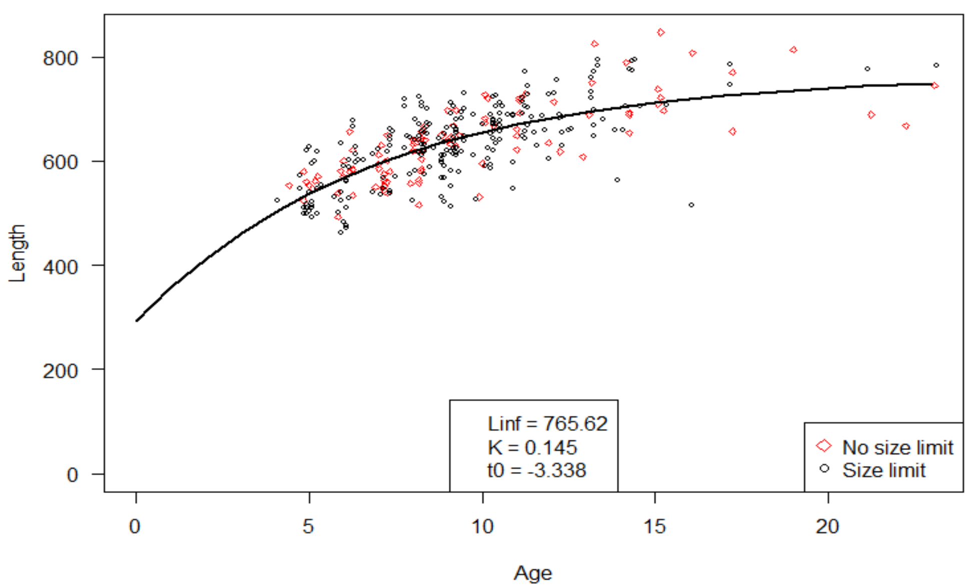


Figure 7. Best fit for female age at functional maturity in S. Atlantic Scamp/Yellowmouth Grouper during the period 1979-2017. Female specimens with developing or spawning capable gonads were considered mature.

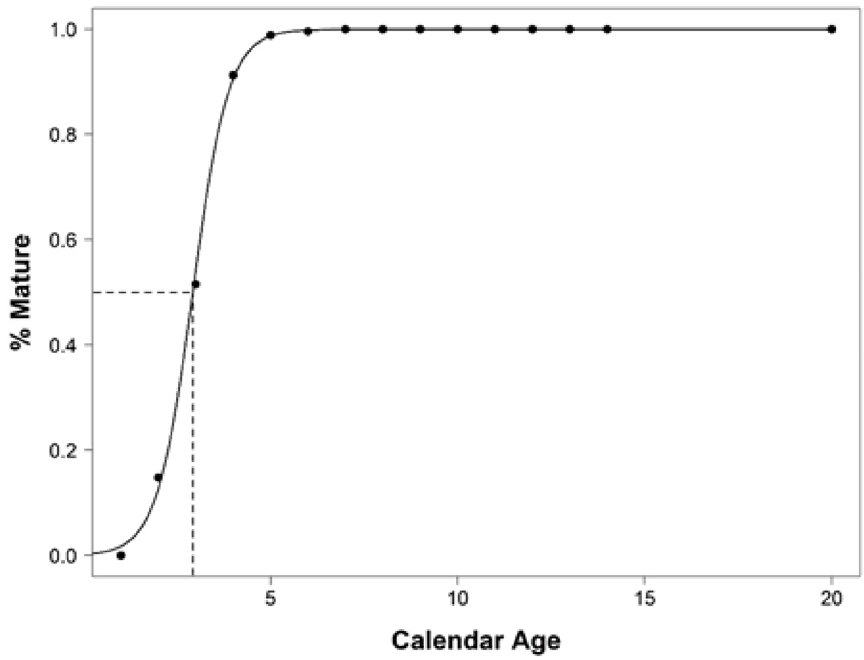


Figure 8. Best fit for female fork length at functional maturity in S. Atlantic Scamp/Yellowmouth Grouper during the period 1979-2017. Female specimens with developing or spawning capable gonads were considered mature.

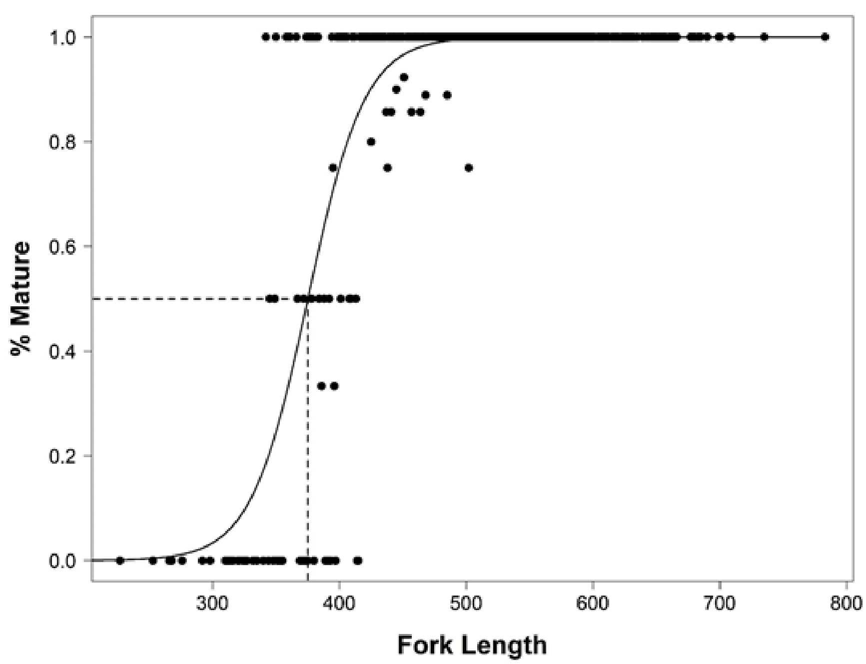


Figure 9. Best fit for female age at sex transition in S. Atlantic Scamp/Yellowmouth Grouper during the period 1979-2017. All females (i.e., juvenile and adult) were included, but specimens undergoing sex transition were omitted.

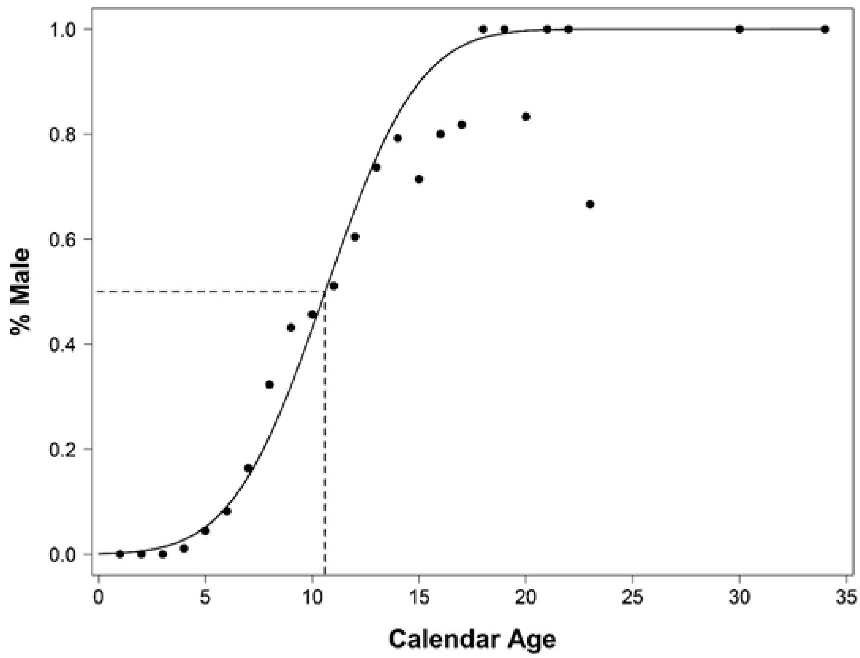


Figure 10. Best fit for female fork length at sex transition in S. Atlantic Scamp/Yellowmouth Grouper during the period 1979-2017. All females (i.e., juvenile and adult) were included, but specimens undergoing sex transition were omitted. [Error in units of length to be corrected to mm]

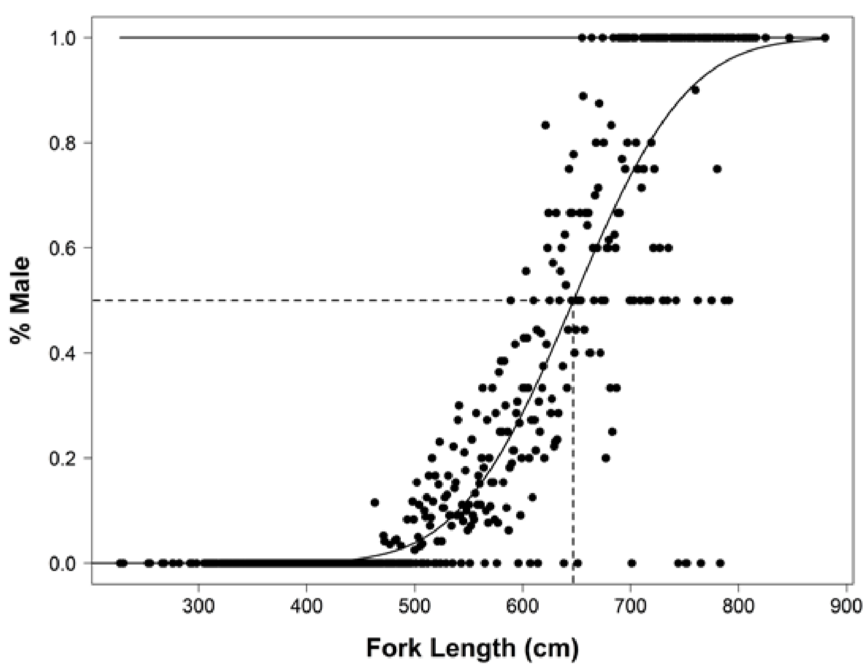


Figure 11. Sex ratio by fork length interval of S. Atlantic Scamp/Yellowmouth Grouper in samples from chevron traps during three decades.

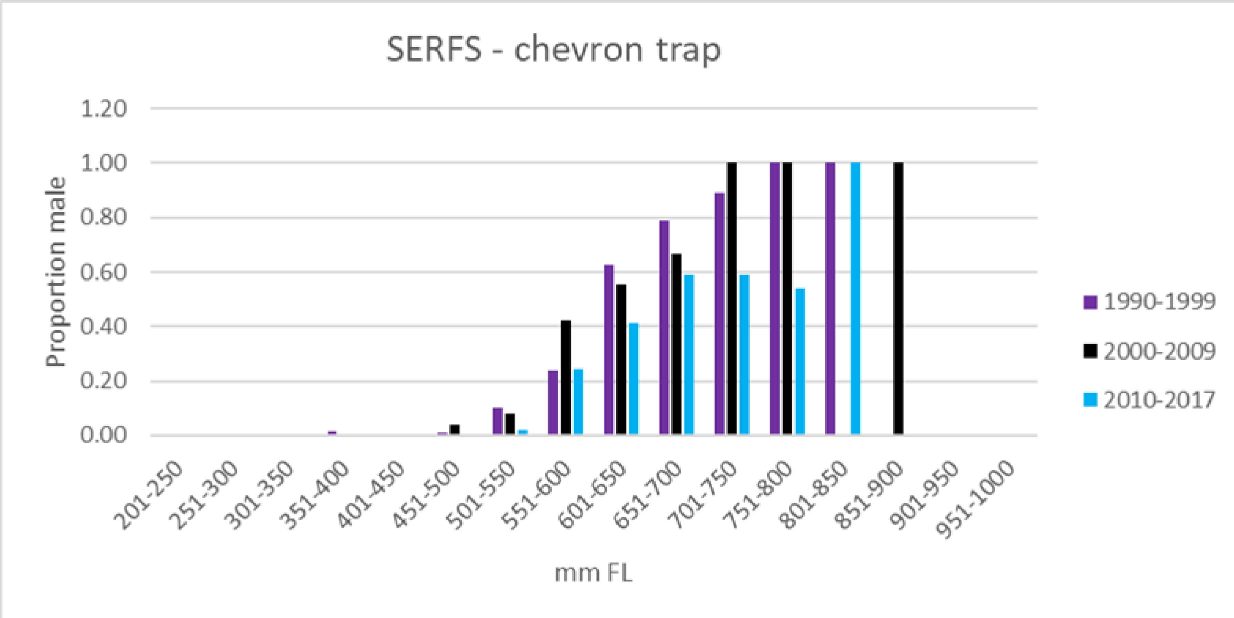


Figure 12. Observed (filled circles) spawning frequency at calendar age for S. Atlantic Scamp/Yellowmouth Grouper during the period 1979-2017. A second-order polynomial regression model was fitted to the data (solid line). Ages 14-23 were pooled. Model equation $y = -4.710 + 6.148x - 0.425x^2$

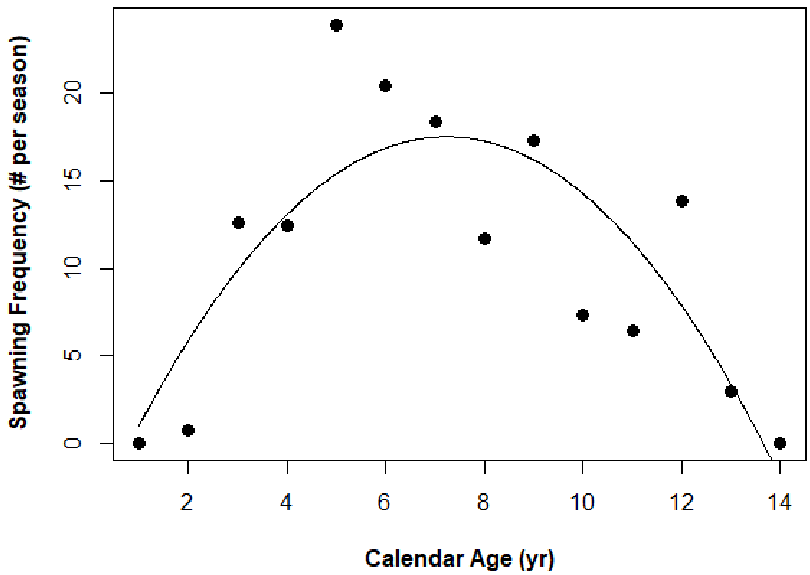


Figure 13. Batch fecundity at fork length (FL) for S. Atlantic Scamp collected during 1996 (n=72) and 1998 (n=4). Batch Fecundity = b * FL^z, with b= 0.0000316 and z= 3.53.

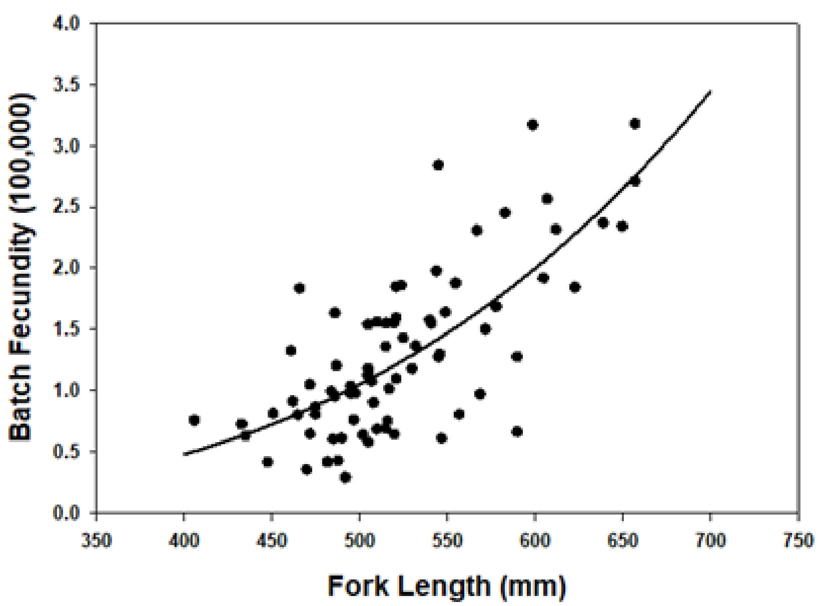


Figure 14. Male gonadosomatic index (GSI) for male Scamp collected by MARMAP during 1979-1998. GSI = (gonad wt/whole fish weight) * 100.

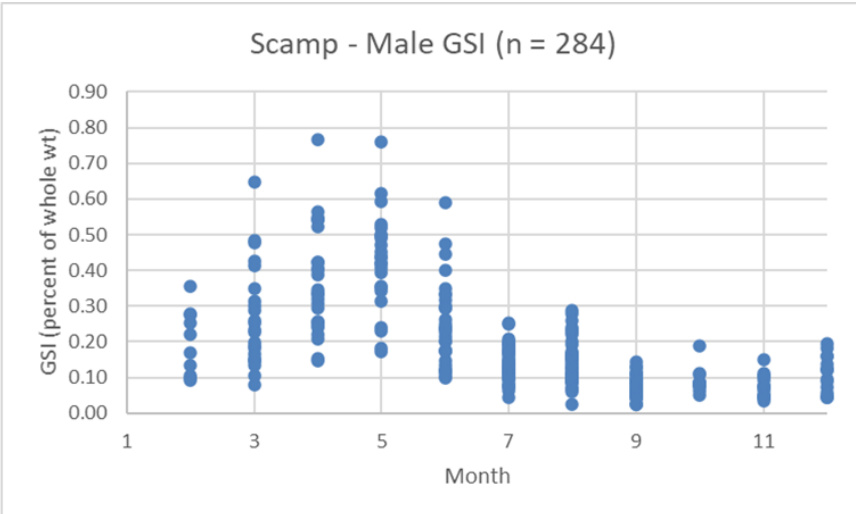
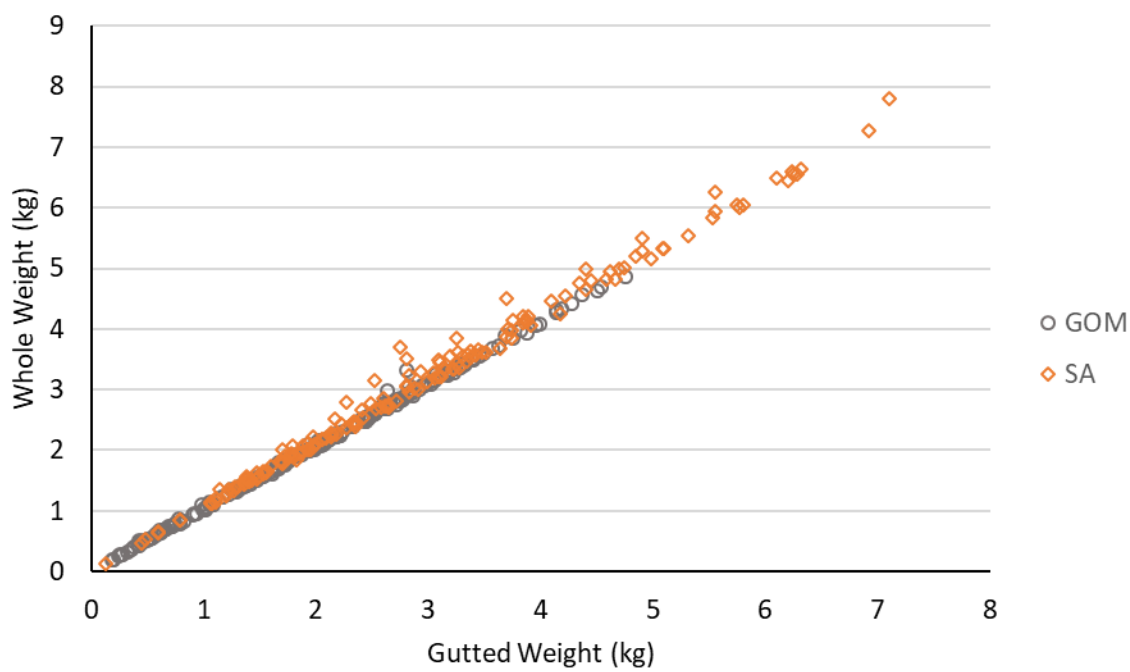


Figure 15. Scamp/Yellowmouth Grouper whole weight – gutted weight data for the entire Southeast region.



3 COMMERCIAL FISHERY STATISTICS

3.1 OVERVIEW

Commercial landings for the US South Atlantic Scamp and Yellowmouth Grouper stock were developed in whole weight pounds for the period 1950-2018 based on federal and state trip ticket databases. The SEDAR 68 Stock ID Workshop established the South Atlantic (SA) and Gulf of Mexico (GoM) Council boundary line as the delimiting stock boundary between SA and GoM stocks.

Scamp and Yellowmouth Grouper discards from the South Atlantic commercial fishery were estimated using two datasets. A discard logbook dataset provided discard rate data and the coastal logbook dataset provided total effort from the fishery. Methods used began with SEDAR 32 and are described in McCarthy, et al. (2020).

3.1.1 Commercial Workgroup Participants

Beth Wrege	Workgroup leader	SEFSC Miami
Julie Defilippi-Simpson	Workgroup leader	ACCSP
Amy Dukes	Data provider	SC DNR
Eric Hiltz	Data provider	SC DNR
Alan Bianchi	Data provider	NC DMF
Julie Califf	Data provider	GA DNR
Steve Brown	Data provider	FWCC
Kevin McCarthy	Data provider	SEFSC Miami
Refik Orhun	Data provider	SEFSC Miami
Sarina Atkinson	Participant	SEFSC Miami
Kyle Shertzer	Participant	NOAA
Molly Stevens	Participant	NOAA
Skyler Sagarese	Participant	NOAA
Carole Neidig	Participant	Mote
Steve Smith	Participant	NOAA
Jay Mullins	Participant	Fisherman
Shannon Calay	Participant	NOAA
Mike Rinaldi	Data provider/rapporteur	ACCSP

*Workshop done via webinar format due to COVID-19 Pandemic

** See Table 3.7 for full list of attendees

3.1.2 Issues Discussed at the Data Workshop

Issues discussed by the commercial workgroup concerning South Atlantic Scamp and Yellowmouth Grouper landings included species identification issues; data sources for commercial landings; commercial effort products; gear groupings of handline, longline, spears & diving, and others; and proportioning unclassified grouper landings.

3.2 REVIEW OF WORKING PAPERS

SEDAR68-DW-22: The group reviewed the working paper on Mote Marine Lab's Scamp data from their participating electronic monitoring (EM) fisheries. C. Neidig presented on the results of linking EM data with observer, dealer, and TIP (dockside) sampling data. The group agreed that EM data may support mortality, and depth of occurrence, but will primarily inform SEDAR from a qualitative perspective.

SEDAR68-DW-16: Commercial Discard Length Composition for South Atlantic Scamp and Yellowmouth Grouper. This working paper provided summary data from the NOAA Fisheries Reef Fish Observer Program (RFOP) and Shark Bottom Longline Observer Program (SBLOP). RFOP data were collected by the South Atlantic Fisheries Foundation on volunteer vessels from the snapper grouper vertical hook-and-line fishery. The SBLOP includes data from the bottom longline and vertical line fisheries in the South Atlantic. Data from both sources were analyzed by year and gear, and length compositions were generated.

SEDAR68-DW-25: This working paper presents a summary of the data collected through the South Atlantic Fishery Management Council's (SAFMC) initial citizen science pilot project, SAFMC Scamp Release. This project focuses on collecting data on released Scamp Grouper through the development and use of a mobile app. The SAFMC Release app is designed to collect data on released fish from commercial, for-hire, and recreational fishermen and is being pilot tested on Scamp Grouper. It will expand to collect information on all shallow water grouper in 2021. The app is open access, meaning that any interested fisherman that encounter Scamp can participate in data collection efforts. Data fields for discarded fish include trip type, date, discard time, location, depth, species name, fork length, photo, hook type and location, and release condition and treatment. There is also a separate 'No Release' form within the app to collect limited information on trips where Scamp were not released. The SAFMC Scamp Release project launched in late June 2019. The information collected through SAFMC Scamp Release was presented to the Recreational Work Group, Commercial Work Group, and Discard Mortality Ad-hoc Group.

3.3 COMMERCIAL LANDINGS

Commercial landings of Scamp and Yellowmouth Grouper were compiled from 1950 through 2018 for the Atlantic Coast from the Florida Keys (South of US Route 1) to North Carolina. Sources for landings in the U.S. South Atlantic included the North Carolina Division of Marine Fisheries (NCDMF), South Carolina Department of Natural Resources (SCDNR), Florida Fish and Wildlife Conservation Commission (FWCC), and the Atlantic Coastal Cooperative Statistics Program. Further discussion of how landings were compiled from the above sources can be found in Section 3.3.4.

3.3.1 Commercial Gears

The workgroup investigated reported gears landing Scamp and all other grouper species. Work group discussion on fleet composition and predominant gears resulted in the final gear groupings of handline, longline, spear and diving, and other for the South Atlantic. The list of gear used in the assessment can be found in Table 3.1. Per best practices, ACCSP (FIN) standard gear codes were used.

3.3.2 Stock Boundaries

***DW ToR #1**: Define the unit stock for the SEDAR 68 Gulf of Mexico and Atlantic Scamp and stock assessment to include the US Atlantic seaboard, using the boundary between the Gulf of Mexico and South Atlantic Councils as the southwestern boundary for the stock unit to assess.*

Per Data Workshop Term of Reference #1, landings along the entire U.S. Atlantic coast were examined. Landings before 1980 were reported as unclassified grouper (family Serranidae), except for Warsaw and Goliath groupers. Historical landings required proportioning in order to estimate the composition of Scamp and Yellowmouth Grouper. Proportions created with South Atlantic and Gulf landings are only appropriate for use in the South Atlantic and Gulf of Mexico regions. They are not representative of grouper species in other regions of the Atlantic. There are no reported Scamp and Yellowmouth Grouper landings from states north of North Carolina, but unclassified grouper landings exist. In alignment with previous assessments, proportions were not applied to unclassified grouper landings north of NC, and these data will not be used in the assessment.

The Commercial Workgroup considered the southwestern boundary, as defined by Data Workshop Term of Reference #1, of the South Atlantic – Gulf of Mexico Council boundary along US Highway 1 in Monroe County, FL as the dividing line between the South Atlantic and Gulf of Mexico stocks (see Figure 3.1). Commercial Fisheries Logbook Program proportions (see Section 3.3.4, Florida), were used to divide landings in Monroe County. A close up of the southern boundary, as determined by the South Atlantic Council boundary, can be seen in Figure 3.2.

3.3.3 Misidentification of Scamp and Yellowmouth Grouper, Unclassified Groupers

Both Scamp and Yellowmouth Grouper are very similar in their external appearances, and the adults of both species reach approximately the same maximum size. Because of the two species similarity, it is reported that Yellowmouth Grouper and Scamp are both marketed as Scamp, though Yellowmouth Grouper's contribution to 'Scamp' landings are low, and exact proportions are unknown. Therefore, Scamp and Yellowmouth Grouper landings will be combined for all sources of data (landings, indices, length comps, age comps, discards) for the assessment.

Before 1980, all grouper landings except for Warsaw and Goliath Grouper were reported as unclassified (family Serranidae). Therefore, consistent with other grouper-complex SEDARs, proportioning was required in order to estimate the Scamp and Yellowmouth Grouper composition of South Atlantic unclassified landings. Based on input from state data providers, unclassified grouper landings were proportioned by year, state, and gear. Supporting information included the implementation of state trip ticket programs, fishermen knowledge, and existing SEDAR best practices. The proportion methodology can be seen below:

$$\mathit{Scamp\ and\ Yellowmouth\ Grouper} \div$$

$$\mathit{All\ identified\ grouper\ species}\ (\mathit{excluding\ Warsaw\ and\ Goliath})$$

Proportions of Scamp and Yellowmouth Grouper landings were created by year, state, and gear and applied to unclassified landings within the same strata. Average proportions for state and gear were created using the years below:

- Florida 1986-1991
- Georgia 1981-1991
- South Carolina 1980-1991
- North Carolina 1981-1991

Average proportions were then applied to unclassified historical grouper landings by state and year.

3.3.4 Commercial Landings by State

Statistics on commercial landings (1950 to present) for all species on the Atlantic coast are maintained in the 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 December 2019 for all grouper landings (annual summaries by gear category) from 1950 to 2018 from Florida through Maine (ACCSP 2019). Data are presented using the gear categories as determined during the Data Workshop. The ACCSP gear types in each category are listed in Table 3.1. Commercial landings in whole weight pounds were developed based on methods defined by each state data provider. Landings are reported in different conditions (gutted, whole, head off, etc), and weight-weight conversions are state-specific. In order to create a uniform data set for the SEDAR process, whole weight landings were converted into gutted weights using state-specific conversion factors. Gutted weights were then converted back into whole weight using a unified South Atlantic and Gulf of Mexico conversion factor of 1.05. The gutted-to-live conversion was provided by the Life History workgroup. Final data are presented in whole weight pounds for the South Atlantic.

<u>Virginia to Maine</u>

No landings were reported at the species level for Scamp or Yellowmouth Grouper above the NC-VA line.

<u>Georgia</u>

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 for the entire time series.

The proportion of Scamp and Yellowmouth Grouper to other grouper species was determined by year and SEDAR gear. These proportions were applied to unclassified landings within the same strata. Proportions from years 1981 to 1991 were averaged. The average proportion was applied to unclassified grouper landings from 1950-1979.

South Carolina

Prior to 1972, commercial landings data were collected by various federal fisheries agents based in South Carolina, either U.S. Fish and 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, vessel and fisherman information.

SCDNR compared trip ticket landings with those from the ACCSP Data Warehouse. Landings were in almost complete alignment from 1950 to 2003, and were sourced from ACCSP. From 2004 to 2018, SCDNR provided landings.

Between 1950 and 1979, non-Warsaw and Goliath Grouper landings were assigned to unclassified grouper landings. In years where both identified and unclassified grouper landings exist, the proportion of Scamp and Yellowmouth Grouper to all other identified grouper (excluding Warsaw and Goliath) were created. These were applied to all years with the same strata. The average proportions by gear from 1980 to 1991 were calculated and applied to unclassified grouper landings from 1950 to 1979.

North Carolina

NCDMF provided North Carolina's landings data from 1928 to 2018. This data set was a collective grouping of historical data collection by the NMFS/NCDMF Cooperative Statistics Program, its predecessors, and the NC Trip Ticket Program. Data collection continuity was sporadic in the earlier years of the dataset prior to 1950. Data continuity and accuracy dramatically increased over time. From 1994 to 2018 landings data collection were provided by the NC Trip Ticket Program and considered the most consistent and inclusive portion of the dataset. In 1999 NCDMF started sharing the landings data with the ACCSP data warehouse.

Final assessment data were provided by the NC Trip Ticket Program due to the need for primary gear reassignments on multi-gear trips. Up to three gears can be listed on a trip ticket therefore, landings were analyzed to look at gear combinations and gear was reassigned where necessary. Data were provided by NCDMF to capture all three gears and contained the most recent edits to the data.

Proportions were applied to unclassified landings within the same strata. Proportions from years 1981 to 1991 were averaged. The average proportion was applied to unclassified grouper landings from 1950-1979.

Florida

Landings from the ACCSP database were used for 1950-1985. Comparisons were made between the commercial Florida Trip Ticket Program and NMFS SEFSC CFLP (Coastal Fisheries Logbook Program) logbook data. Both datasets were very similar in landings trends and level of landings reported for matching years. While no direct comparison was made between Florida Trip Ticket Program (FTT) and ALS General Canvass, it was decided to use the total landings from the Florida Trip Ticket data over the General Canvass and CFLP logbook since General Canvass data are Florida Trip Ticket data since 1997, and the Florida Trip Ticket data are more complete and are of a longer time series than the CFLP logbook data.

Since Scamp have been coded to species since 1986, it was decided to apportion Scamp from unclassified grouper on trips where only unclassified grouper was reported. The rationale was that if grouper were coded to species on trips that also included unclassified grouper, the dealer was probably diligent in reporting major grouper species correctly. To apportion Scamp from unclassified only grouper, Florida Trip Ticket data were used to calculate the ratio of Scamp to total identified grouper which was then applied to unclassified only grouper landings by year and gear from 1950-1985. This was done for both Monroe county and South Atlantic (non-Monroe) landings separately.

From 1993-2018, the calculated proportion of landings by gear from the CFLP logbook data was applied to the corresponding total annual combined landings of Scamp and Yellowmouth in Florida trip ticket for both Monroe county (by region) and the South Atlantic (non-Monroe) landings. Additionally, the average proportion of landings by gear from 1993-2018 was applied to both the annual combined Scamp and Yellowmouth landings for Monroe (by region) as well as the South Atlantic (non-Monroe) landings from 1986-1992. Calculated South Atlantic (non-Monroe) and South Atlantic Monroe County landings were then combined into a total representing Scamp and Yellowmouth landings harvested from Florida South Atlantic waters.

Combined State Results

Landings are presented in whole weight pounds by gear in Table 3.2. The landings in number of fish are presented in Table 3.3.

Commercial landings, and the approach taken in transforming them, have been approved by the commercial workgroup. Commercial data can be summarized by the following:

- Landings should be reported as whole weight in pounds and number of fish
- Final landings data came from the following sources:
    - NC: 1950-2018 (NCDMF)
    - SC: 1950-2003 (ACCSP)
      2004-2018 (SCDNR)
    - GA: 1950-2018 (ACCSP)
    - FL: 1950-1985 (ACCSP)
      1986-2018 (FLTT)

Whole vs. Gutted Weight

Commercial landings are reported in various states of processing. Data providers' state-specific conversion factors are used to convert the landing condition to whole weights. As outlined in Section 3.3.4, landings by state were converted to gutted weight using appropriate state and federal conversion factors. Landings in gutted weight were converted to whole weight using the 1.05 combined South Atlantic and Gulf of Mexico conversion factor provided by the Life History group.

Uncertainty

The commercial workgroup discussed uncertainty in commercial fishery landings. After consultation with assessment biologists, the work group decided to use uncertainty estimates consistent with those from previous assessments. Estimates of uncertainty are not coefficients of variation, but are estimates of possible reporting error; i.e., represent the range in actual commercial landings relative to the reported landings.

In making these uncertainty estimates, the following assumption was made:

Landings may be underreported during all years; however, underreporting was likely highest during early years of the time series and likely less of an issue in recent years. This assumption was based upon the following information and Data Workshop expert testimony: during the period 1950 (beginning of landings time series) to 1961, landings were summarized annually by state and likely did not include landings from small scale dealers. In the years 1962 to 1977, landings data were collected annually, but under a more all-inclusive program (General Canvass). Monthly landings summaries were collected during the period 1978 to the beginning of trip ticket data collection (NC-1994, SC-2004, GA-2001, FL-1986). The most recent landings data, collected through state trip ticket programs, were assumed to be most reliable and inclusive of all commercial landings.

The group agreed, based upon expert opinion, that both an upper and lower bound be used for the period during which unclassified grouper were present in the landings. The workgroup recommended that an upper bound only be set to account for underreported landings during the period when no unclassified grouper were reported. See Table 3.4 for state-specific bounds.

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 year, state, and gear. The landings in pounds were then divided by the mean weight by the same strata to derive landings in number (Table 3.3). The mean weights, or 'meristic conversions', can be viewed in Table 3.5.

3.4 COMMERCIAL DISCARDS

Scamp and Yellowmouth Grouper discards from the South Atlantic commercial fishery were estimated using data from two datasets. A discard logbook dataset provided discard rate data and the coastal logbook dataset provided total effort from the fishery. Methods followed those used beginning with SEDAR 32 and are described in McCarthy, et al. (2020).

Fisher logbook reported data collection programs provided the only available datasets sufficient to estimate commercial discards of Scamp and Yellowmouth Grouper. Available South Atlantic observer data were limited and insufficient to estimate commercial discards. Observer collected data from commercial fishing vessels in the Gulf of Mexico, however, have been used to estimate commercial discards for several recent stock assessments.

Comparison of Gulf of Mexico discards estimated using observer data to those estimated using discard logbook data consistently result in differences in yearly discards. Estimates of discards are usually greater when using discard logbook data than when using observer data. SEDAR reviewers have had higher confidence in observer data than in logbook reported data. In addition, the estimation method using observer data can be validated by estimating landings using a similar approach to that used to estimate discards. Those estimated landings have closely matched the logbook reported landings. South Atlantic discards estimated using discard logbook data were presumed to be an overestimate of actual discards, as has been found in Gulf of Mexico analyses.

A bias correction factor was proposed for use with South Atlantic commercial vertical line discards to correct for the presumed overestimation of those discards (McCarthy, et al., 2020). The bias correction was calculated as:

$$SA\ Discards\ RFOP = GOM\ Discards\ RFOP \times \frac{SA\ Discards\ DLP}{GOM\ Discards\ DLP}$$

where RFOP = Reef fish observer program and DLP = Discard logbook program.

The associated SA discard standard errors (SE) are derived from the DLP estimates,

$$SE(RFOP) = CV(DLP) \times \text{mean estimate}(RFOP),$$

where CV(DLP) is the DLP standard error divided by the DLP mean estimate (i.e., coefficient of variation for the mean estimate). Thus, the method adjusts the mean value of the discard estimates but does not affect the uncertainty.

South Atlantic vertical line discards and bias corrected discards are provided in Table 3.6.

Bottom longline estimated discards were fewer than 80 fish per year prior to bias correction. In most years estimated Scamp were fewer than 50 fish per year. Such low numbers of discards were presumed to have a negligible effect on the stock assessment.

Discard estimation methods were reviewed and accepted by the commercial workgroup.

SAFMC Scamp Release

The South Atlantic Fishery Management Council's (SAFMC) initial citizen science pilot project, SAFMC Scamp Release, focuses on collecting data on released Scamp Grouper through the development and use of a mobile app. The SAFMC Release app is designed to collect data on released fish from commercial, for-hire, and recreational fishermen and is being pilot tested on Scamp Grouper. It will expand to collect information on all shallow water grouper in 2021. The app is open access, meaning that any interested fisherman that encounter Scamp can participate in data collection efforts. Data fields for discarded fish include trip type, date, discard time, location, depth, species name, fork length, photo, hook type and location, and release condition and treatment. There is also a separate 'No Release' form within the app to collect limited information on trips where Scamp were not released.

The SAFMC Scamp Release project launched in late 2019. Multiple avenues were used to promote and recruit fishermen to participate in the project. There are currently 52 SAFMC Release user accounts split among the four South Atlantic states and among fishing sectors. Limited data have been collected through the app thus far. However, staff are continuing to focus on recruitment and retention of commercial, for-hire, and recreational fishermen to participate in the SAFMC Scamp Release project. Released scamp reported through the app were caught in waters from 80-132 feet and ranged in size from 16-22 inches. They were typically hooked in the jaw and fishermen reported use of circle offset, circle non-offset, and j-hooks. Scamp reported as kept through the 'No Release' reports were caught in waters from 80-265 feet.

While recruiting fishermen to participate in the SAFMC Release app, SAFMC staff had conversations with many fishermen who encounter Scamp. Some common themes heard through these discussions include:

- Scamp Grouper releases are not common during the open shallow water grouper season (May – December). The reason for discards during the open season is typically due to undersized fish (size limit in the South Atlantic is 20in TL), not due to possessions limits. However, many indicated they do not typically see undersized fish. Some thought that could potentially be due to where they are fishing (depths and locations) or bait or hook size.
- Several fishermen, in particular for-hire and recreational fishermen, noted they don't fish as much in the winter and typically bottom fish less when the shallow water grouper season is closed (January – April). Some noted they are more likely to release Scamp Grouper in early spring when fishing effort is starting to increase, but the shallow water grouper closure is still in place.
- Several fishermen noted that Scamp Grouper catches have become less common in recent years. Some indicated this could potentially be due to abundance, others noted it was hard to get bait to the bottom where you would typically catch grouper due to large numbers of Red Snapper.
- Scamp Grouper tend to be in deeper water than other shallow water grouper species. This may impact the number of encounters with Scamp compared to other shallow water grouper species.

Currently, data collected through the SAFMC Release app are limited and cannot be used directly within the assessment. However, SEDAR 68 participants found the information collected through the app and provided by SAFMC Release participants useful when interpreting trends found in other data sources. As more trips are reported and sample size increases, additional analyses will be performed to check for potential biases in data including spatial distribution of releases, angler avidity, and representation of fishing sectors (Jiorle et al. 2016, Venturelli et al. 2016, Bradley et al. 2019).

3.5 COMMERCIAL EFFORT

Map products were created that reflected commercial effort along the South Atlantic and Gulf coasts. The data used in map products for the South Atlantic were reported from 1992 to 2019 in the coastal fisheries logbook program data (CFLP – federal only) from Texas to NC. The data represent the total number of trips per fishing area to reflect fishing effort. Total Cumulative Scamp Effort (in Trips) 1990-2019 for both the Gulf of Mexico and South Atlantic (start 1992) is shown in Figure 3.4.

3.6 BIOLOGICAL SAMPLING

Biological sample data were obtained from the TIP database at NMFS/SEFSC. The group reviewed the data, and no known inadequacies were discovered. TIP data were deemed adequate for use in the assessment.

3.6.1 Sampling Intensity

Following the Data Workshop, weighted compositions were developed and minimum sample size cutoffs were explored for both number of fish and number of trips. Details pertaining to these sample sizes can be found in the working paper that will be available following the release of the Data Workshop report and prior to the Assessment Workshop.

3.6.2 Length/Age distributions

Scamp and Yellowmouth Grouper length samples were reviewed for the years 1984-2018 using available TIP length data. Commercial landings length frequency distributions will be provided by year and gear (handline and other (longline, diving and other)). Commercial discard lengths from observer data were provided for 2006-2018. Commercial landings ages were weighted by the length distribution frequency distributions and will be provided by year and gear. Details of these compositions will be provided in a working paper following the Data Workshop.

3.6.3 Adequacy for Characterizing Catch

Adequacy of length data and length sampling fractions will be reported in the Assessment Workshop report.

3.7 ADEQUACY OF DATA FOR ASSESSMENT ANALYSES

Landings data for the assessment analysis are adequate. There is a clear landings history for the available time series. With Scamp and Yellowmouth Grouper combined as one unit, there are no obvious species identification issues. Before the 1980's, all grouper landings (with the exception of Warsaw and Goliath) were reported as unclassified grouper. Grouper landings after 1980 were reported at the species level in state trip ticket programs. These landings have been proportioned according to the specifications of South Atlantic data providers. Uncertainty in landings for the South Atlantic is higher when data represent annual and monthly totals before the implementation of individual state trip ticket programs. Definition of stock boundaries and landed condition (gutted vs. whole) were not an issue.

3.8 RESEARCH RECOMMENDATIONS

- **Recommendation for the use of EM to facilitate the improvement of discard accounting in the South Atlantic**
    - The Center for Electronic Monitoring at Mote (CFEMM) has been applying Electronic Monitoring (EM) in the Gulf of Mexico (GoM) using Saltwater Inc. (SWI) software since 2016. EM is a valuable monitoring tool for researchers to directly observe and permanently document location, identify bycatch hotspots, catch, effort, and discard data to reduce uncertainty in critical finfish and shark fishery data for use by industry and management.
    - In the absence of a robust reef fish observer program in the South Atlantic, the commercial workgroup recognizes EM as a tool to improve discard accounting in the region. Additionally, the COVID-19 pandemic has hampered interactions between the fishing industry and state/federal fisheries data collections. The workgroup recognizes the potential for work pioneered by the CFEMM to advance biological sampling needs without human observers.
    - Continue to explore additional methods, such as citizen science (e.g. SAFMC Scamp Release), to help supplement information to characterize discard size composition
- **Recommendation for South Atlantic and Gulf of Mexico unified methodology in preparation of commercial landings**
    - The SEDAR 68 commercial workgroup has recognized that there are significant differences in the South Atlantic and Gulf of Mexico in the approach to the preparation of commercial landings. These differences were identified specifically in discussions of proportioning, validation, and data provision formats.

  - In order to resolve the issue, the workgroup recommends that SEDAR staff convene and facilitate a joint-regional workshop for commercial workgroup members from both regions in order to follow-up on and confirm the best practices in Procedural Workshop 7.
  - Previous workgroup leaders should be consulted in establishing the TORs for the workshop.
  - The workshop should review past decisions made for various species and summarize best practices, which could greatly simplify the content needed within stock assessment reports (e.g., focus text on details specific to the species being assessed)
- **Recommendation for Expanding Reef Fish Observer Program Coverage to the South Atlantic**
  - Programmatic funding should be allocated to expand existing observer temporal and spatial coverage in the South Atlantic reef fish fishery. Observer coverage should be sufficient to provide for statistically rigorous discard estimation methods and to provide adequate discard size composition data for use in stock assessments.

3.9 LITERATURE CITED

Atlantic Coastal Cooperative Statistics Program. 2020. Annual Landings by Custom Gear Category; generated by Mike Rinaldi using ACCSP Data Warehouse, Arlington, VA: accessed April 2020.

Bradley D, M Merrifield, KM Miller, S Lomonico, JR Wilson, MG Gleason. 2019. Opportunities to improve fisheries management through innovative technology and advanced data systems. Fish and Fisheries 20: 564–583.

Jiorle, RP, RNM Ahrens, MS Allen. 2016. Assessing utility of a smartphone app for recreational fishery catch data. Fisheries 41: 758-766.

McCarthy K., J Diaz, SG Smith. 2020. Estimated discards of Scamp and Yellowmouth Grouper from commercial vertical line fishing vessels in the South Atlantic. SEDAR68-WP-16. SEDAR, North Charleston, SC. 7 pp.

Venturelli, PA, K Hyder, C Skov. 2016. Angler apps as a source of recreational fisheries data: Opportunities, challenges, and proposed standards. Fish and Fisheries 18: 578-595.

3.10 TABLES

Table 3.1 Specific ACCSP gears in each requested gear category for commercial Scamp and Yellowmouth Grouper landings.

	HANDLINE		
GEAR CODE	**GEAR NAME**	**TYPE CODE**	**GEAR TYPE**
300	HOOK AND LINE	7	HOOK AND LINE
301	HOOK AND LINE, MANUAL	7	HOOK AND LINE
302	HOOK AND LINE, ELECTRIC	7	HOOK AND LINE
303	ELECTRIC/HYDRAULIC, BANDIT	7	HOOK AND LINE
304	HOOK AND LINE, CHUM	7	HOOK AND LINE
305	HOOK AND LINE, JIG	7	HOOK AND LINE
306	HOOK AND LINE, TROLL	7	HOOK AND LINE
307	HOOK AND LINE, CAST	7	HOOK AND LINE
308	HOOK AND LINE, DRIFTING EEL	7	HOOK AND LINE
309	HOOK AND LINE, FLY	7	HOOK AND LINE
310	HOOK AND LINE, BOTTOM	7	HOOK AND LINE
320	TROLL LINES	7	HOOK AND LINE
321	TROLL LINE, MANUAL	7	HOOK AND LINE
322	TROLL LINE, ELECTRIC	7	HOOK AND LINE
323	TROLL LINE, HYDRAULIC	7	HOOK AND LINE
324	TROLL LINE, GREEN-STICK	7	HOOK AND LINE
330	HAND LINE	13	HAND LINE
331	TROLL & HAND LINE CMB	13	HAND LINE
340	AUTO JIG	13	HAND LINE
700	HAND LINE	13	HAND LINE
701	TROLL AND HAND LINES CMB	13	HAND LINE
702	HAND LINES, AUTO JIG	13	HAND LINE
	LONGLINE		
GEAR CODE	**GEAR NAME**	**TYPE CODE**	**GEAR TYPE**
400	LONG LINES	8	LONG LINES
401	LONG LINES, VERTICAL	8	LONG LINES
402	LONG LINES, SURFACE	8	LONG LINES
403	LONG LINES, BOTTOM	8	LONG LINES
404	LONG LINES, SURFACE, MIDWA	8	LONG LINES
405	LONG LINES, TROT	8	LONG LINES
406	LONG LINES, TURTLE HOOKS	8	LONG LINES
407	LONG LINES, DRIFT W/HOOOKS	8	LONG LINES
408	BOUY GEAR	8	LONG LINES
	SPEARS/DIVING		
GEAR CODE	**GEAR NAME**	**TYPE CODE**	**GEAR TYPE**
650	HARPOONS	12	SPEARS AND GIGS
660	SPEARS	12	SPEARS AND GIGS
661	SPEARS, DIVING	12	SPEARS AND GIGS
662	GIGS	12	SPEARS AND GIGS
663	POWERHEADS	12	SPEARS AND GIGS
670	HANDHELD HOOKS	12	SPEARS AND GIGS
671	SPONGE HOOKS	12	SPEARS AND GIGS
750	BY HAND, DIVING GEAR	14	BY HAND
760	BY HAND, NO DIVING GEAR	14	BY HAND
761	KNIFE, SEAWEED	14	BY HAND
762	WEEDWACKER, SEAWEED	14	BY HAND
	OTHER		
GEAR CODE	**GEAR NAME**	**TYPE CODE**	**GEAR TYPE**
*	All other gears	*	All other gear types

Table 3.2 South Atlantic Non-Confidential Commercial Scamp and Yellowmouth Grouper Landings by Gear (whole weight pounds)

Year	HANDLINE	LONGLINE	OTHER	SPEARS/DIVING
1950	48,714	677	35	7,937
1951	67,339	990	51	11,599
1952	46,234	680	35	7,964
1953	38,392	564	29	6,613
1954	38,837	571	29	6,690
1955	19,429	286	15	3,347
1956	25,004	297	15	3,478
1957	46,030	514	34	6,020
1958	15,763	169	9	1,977
1959	11,917	146	7	1,707
1960	14,652	192	10	2,252
1961	14,480	195	10	2,289
1962	12,249	179	9	2,101
1963	10,402	152	8	1,783
1964	11,379	163	8	1,908
1965	17,376	175	196	2,046
1966	11,868	158	9	1,849
1967	35,168	280	17	3,282
1968	47,560	498	286	5,833
1969	28,505	397	143	4,654
1970	38,217	483	307	5,661
1971	43,429	504	150	5,900
1972	31,117	391	444	4,584
1973	43,915	343	130	4,015
1974	60,807	449	38	5,260
1975	58,435	689	53	8,077
1976	78,359	568	124	6,657
1977	117,175	611	573	7,161
1978	268,535	739	98	8,565
1979	254,012	676	190	7,918

1980	243,589	690	1,176	7,109
1981	232,638	680	2,990	7,969
1982	369,555	1,420	1,586	6,003
1983	308,116	3,930	2,442	8,341
1984	309,598	3,306	941	6,325
1985	248,842	*	162	5,753
1986	274,753	1,607	3,542	6,496
1987	293,980	20,844	6,531	7,065
1988	323,071	15,068	3,829	6,083
1989	364,002	3,584	*	8,761
1990	429,438	25,532	16,824	12,525
1991	341,481	8,970	37,203	6,505
1992	275,453	2,555	2,728	5,158
1993	304,656	2,671	*	3,372
1994	306,447	450	254	4,179
1995	340,824	*	*	3,079
1996	279,472	*	3,736	3,551
1997	281,187	1,036	*	6,110
1998	256,728	1,465	*	7,724
1999	373,639	319	*	9,369
2000	291,631	302	*	7,535
2001	206,026	*	11,919	8,619
2002	202,813	8,748	14,415	12,375
2003	231,520	3,271	23,092	5,530
2004	246,135		5,192	8,310
2005	265,197	17	*	*
2006	311,410		*	4,049
2007	333,593	25	*	6,495
2008	240,986		*	9,598
2009	238,019	*	18,670	3,950
2010	162,209	24	*	6,131
2011	128,660	3,632	*	6,823
2012	140,493	*	*	*

2013	115,468	930	18,513	6,237
2014	138,640	1,374	13,020	11,501
2015	112,784	2,282	*	5,443
2016	94,402	212	8,041	8,344
2017	87,279	*	11,395	11,424
2018	80,000	*	*	12,904

Table 3.3 South Atlantic Non-Confidential Commercial Scamp and Yellowmouth Grouper Landings by Gear (number of fish)

Year	HANDLINE	LONGLINE	OTHER	SPEARS/DIVING
1950	7,974	171	9	2,008
1951	10,978	250	13	2,934
1952	7,537	172	9	2,015
1953	6,259	143	7	1,673
1954	6,331	144	7	1,692
1955	3,167	72	4	847
1956	4,159	75	4	880
1957	7,694	130	9	1,523
1958	2,643	43	2	500
1959	1,975	37	2	432
1960	2,405	49	2	570
1961	2,374	49	3	579
1962	1,997	45	2	532
1963	1,696	38	2	451
1964	1,860	41	2	483
1965	2,900	44	50	518
1966	1,954	40	2	468
1967	5,739	71	4	830
1968	7,908	126	73	1,476
1969	4,655	100	36	1,177
1970	6,233	122	78	1,432
1971	7,129	127	38	1,493
1972	5,086	99	112	1,160
1973	7,343	87	33	1,016
1974	10,256	114	10	1,331
1975	9,694	174	14	2,043
1976	13,193	144	31	1,684
1977	19,874	155	145	1,812
1978	46,708	187	25	2,167
1979	44,402	171	48	2,003

1980	42,656	175	298	1,798
1981	40,804	172	759	2,016
1982	65,433	361	404	1,519
1983	54,238	1,000	621	2,110
1984	53,551	875	251	1,600
1985	44,369	*	33	1,101
1986	48,741	535	1,008	3,317
1987	56,452	5,413	1,697	1,787
1988	67,271	4,580	1,170	1,539
1989	80,595	1,420	*	2,216
1990	99,481	7,981	5,301	2,706
1991	80,057	3,182	13,056	2,787
1992	53,497	574	629	1,114
1993	58,032	817	*	1,041
1994	55,044	102	43	878
1995	62,398	*	*	760
1996	54,121	*	1,107	1,091
1997	52,067	281	*	1,723
1998	49,783	383	*	2,023
1999	71,245	91	*	2,666
2000	54,560	90	*	2,233
2001	36,423	*	3,027	1,913
2002	36,514	2,255	3,719	3,825
2003	42,638	2,222	16,446	2,154
2004	44,730	0	1,216	1,652
2005	48,460	4	*	*
2006	54,261	0	*	895
2007	59,077	6	*	1,681
2008	41,039	0	*	2,250
2009	39,856	*	4,580	1,533
2010	26,272	6	*	1,535
2011	20,545	1,851	*	3,008
2012	22,419	*	*	*

2013	17,858	225	4,448	1,501
2014	18,409	369	2,693	2,723
2015	16,783	698	*	1,477
2016	14,455	54	2,123	2,177
2017	13,211	*	2,826	2,592
2018	10,984	*	*	2,775

Table 3.4 Uncertainty in commercial landings by year range

Year	NC	SC	GA	FL - EC	Comments
1950-1961	0.25	0.25	0.25	0.25	Annual state summaries, likely missed small scale dealers
1962-1977	0.2	0.2	0.2	0.2	Annual state summaries, more inclusive General Canvas
1978-1985	0.1	0.1	0.1	0.1	Monthly state summaries
1986-1990	0.1	0.1	0.1	0.05	FL starts state trip ticket
1991-1993	0.1	0.1	0.1	0.05	
1994-1995	0.05	0.1	0.1	0.05	NC starts state trip ticket
1996-2000	0.05	0.1	0.1	0.05	
2001-2003	0.05	0.1	0.05	0.05	GA starts state trip ticket
2004-2010	0.05	0.05	0.05	0.05	SC starts state trip ticket
2011- present	0.05	0.05	0.05	0.05	

**The group agreed, based upon expert opinion, that both an upper and lower bound be used for the period during which unclassified grouper were present in the landings. The workgroup recommended that an upper bound only be set to account for underreported landings during the period when no unclassified grouper were reported.*

Table 3.5 Scamp and Yellowmouth Grouper Mean Weights by Gear, Year, and State

Handline					**Other (Longline, Other, Spear/Diving)**			
year	NC	SC	GA	FL	NC	SC	GA	FL
1984	5.649763955	5.7659549	6.1790836	6.1791	3.743317066	3.7433171	3.9528258	3.9528
1985	5.149964072	5.703313	6.9412234	6.9412	3.653223153	3.6532232	5.2278425	5.2278
1986	5.102643416	5.8470656	7.1942509	7.1943	4.337707315	4.3377073	1.9586731	1.9587
1987	4.73912276	5.6242906	5.8530088	5.853	3.847169786	3.8471698	3.9528258	3.9528
1988	4.202464791	5.3851568	6.3906156	6.3906	3.269978823	3.2699788	3.9528258	3.9528
1989	4.022171009	4.8595307	4.6057479	4.6057	2.30263879	2.3026388	3.9528258	3.9528
1990	4.087271498	4.4503878	4.3330454	4.333	3.155798736	3.1557987	4.6278811	4.6279
1991	3.839732077	4.5473469	4.2856386	4.2856	2.871679044	2.871679	2.3342592	2.3343
1992	5.077869793	5.0572425	5.4326855	5.4327	4.228801941	4.2288019	4.6917755	4.6918
1993	4.846820401	5.3833835	5.7622375	5.7622	3.279699986	3.2797	3.2402243	3.2402
1994	5.11044622	5.7121206	5.9978238	5.9978	3.651718519	3.6517185	6.0523324	6.0523
1995	5.331163155	5.3787385	5.7177541	5.7178	3.474591879	3.4745919	4.6357679	4.6358
1996	4.889076696	5.3586144	5.0542055	5.0542	4.457321702	4.4573217	3.2434778	3.2435
1997	5.271236978	5.4620109	5.4042043	5.4042	7.026632649	7.0266326	3.5339737	3.534
1998	5.135414536	5.2266466	5.0283333	5.0283	3.926332122	3.9263321	3.8165381	3.8165
1999	5.047824597	5.3693638	5.0600064	5.06	3.926332122	3.9263321	3.5096184	3.5096
2000	5.286592805	5.4574586	5.1258473	5.1258	3.926332122	3.9263321	3.3551741	3.3552
2001	5.416522062	5.8627942	5.6516872	5.6517	3.926332122	3.9263321	4.6328852	4.6329
2002	5.681450547	5.6762305	5.205533	5.2055	3.926332122	3.9263321	3.1541636	3.1542
2003	5.215532746	5.482357	5.8691182	5.8691	1.397184867	1.3971849	4.2867883	4.2868
2004	5.526174388	5.5645175	5.2866471	5.2866	4.270854442	4.2708544	5.3624789	5.3625
2005	5.4159805	5.5377235	5.306279	5.3063	4.224710688	4.2247107	3.9528258	3.9528
2006	6.082590837	5.5617183	6.0775416	6.0775	3.617204803	3.6172048	4.6066297	4.6066
2007	5.980639972	5.3717967	6.2392404	6.2392	3.642008766	3.6420088	3.8877923	3.8878
2008	5.793891453	5.8367661	6.210561	6.2106	3.697192077	3.6971921	4.4781267	4.4781
2009	5.859105045	5.8469024	6.8775004	6.8775	4.076125268	4.0761253	2.4737566	2.4738
2010	6.367338669	6.0442751	6.610141	6.6101	4.248528437	4.2485284	3.9528258	3.9528
2011	6.286430514	5.9485951	9.9753661	9.9754	4.654515548	4.6545155	1.9464723	1.9465
2012	6.312386067	6.2822057	6.1340396	6.134	4.904432231	4.9044322	5.1039648	5.104

2013	6.778272114	5.9183109	7.9672706	7.9673	4.172158821	4.1721588	4.1353478	4.1353
2014	7.097244795	7.166931	9.2465058	9.2465	4.835089282	4.8350893	3.7233044	3.7233
2015	6.298824834	6.955539	6.7055316	6.7055	4.050032392	4.0500324	3.2713581	3.2714
2016	6.702445654	6.514104	6.3345581	6.3346	3.787459333	3.7874593	3.9528258	3.9528
2017	7.5992396	6.5375132	5.9893542	5.9894	4.031910077	4.0319101	5.8579815	5.858
2018	7.022535017	6.9173042	8.6387977	8.6388	4.880277233	4.8802772	3.5305351	3.5305

Table 3.6 Calculated yearly total discards of Scamp from South Atlantic vertical line vessels using standard estimation methods with discard logbook data and with bias correction applied.

Year	Vertical line calculated discards (1,000s of fish)	Bias corrected vertical line calculated discards (1,000s of fish)	Vertical line calculated discards (pounds)	Bias corrected vertical line calculated discards (pounds)	Discard estimate standard error
1993	12.90	0.971	65,584	4,934	194.2
1994	15.95	0.989	81,077	5,028	197.9
1995	16.66	1.133	84,670	5,756	226.6
1996	16.50	1.267	83,854	6,437	253.4
1997	16.95	1.370	86,126	6,963	274.1
1998	12.95	1.257	65,803	6,387	251.5
1999	11.00	1.308	55,922	6,646	261.6
2000	11.03	1.031	56,036	5,240	206.3
2001	11.92	1.214	60,594	6,172	243.0
2002	21.13	1.345	107,406	6,834	269.0
2003	12.08	1.482	61,421	7,534	296.6
2004	6.77	1.429	34,399	7,263	285.9
2005	4.40	1.264	22,369	6,423	252.9
2006	4.54	1.131	23,068	5,747	226.2
2007	4.51	1.078	22,933	5,479	215.7
2008	4.75	0.962	24,166	4,887	192.4
2009	3.48	1.174	17,671	5,969	235.0
2010	2.52	0.847	12,830	4,307	169.6
2011	1.23	0.957	6,257	4,866	191.6
2012	1.50	1.198	7,645	6,088	239.7
2013	2.43	0.987	12,374	5,019	197.6
2014	1.51	0.930	7,673	4,726	186.0
2015	1.65	0.805	8,408	4,094	161.2
2016	1.31	0.976	6,651	4,963	195.4
2017	0.90	0.739	4,596	3,757	147.9
2018	0.64	0.638	3,255	3,243	127.7

Table 3.7 Workshop Attendees

Name	Organization	Call #1 *4/8*	Call #2 *4/14*	Call #3 *4/15*	Call #4 *4/17*	Call #5 *4/27*	Call #6 *5/4*	Call #7 5/20	Call #8 8/19	Call #9 8/27	Call #10 10/07
Alan Bianchi	NC DMF	X	X	x	x	x	x			x	x
Alexandra Smith	NOAA	X	X	x	x		x	x	x		x
Amy Dukes	SC DNR	X	X	x	x		x		x		
Beth Wrege	NOAA	X	X	x	x	x	x	x	x	x	x
Jay Mullins	Gulf fisherman	X	X	x	x	x		x			
Julia Byrd	SAFMC	X		x	x	x	x	x		x	
Julie Simpon	ACCSP	X	X	X	x	x	x	x	x	x	x
Kenneth Roberts			X								
Kevin McCarthy	NOAA	X	X	x	x	x	x			x	x
Kyle Shertzer	NOAA	X	X	x	x	x	x	x			
Mike Rinaldi	ACCSP	X	X	x	x	x	x	x	x	x	
Molly Stevens	NOAA	X	X	x	x	x	x	x	x		x
Randy Mckinley	NC fisherman										
Refik Orhun	NOAA	X	*X*	*x*	x	x	x	x			x
Skyler Sagarese	NOAA	X	X	x	x		x	x	x	x	x
Stephanie Martinez	NOAA	X	X	x	x	x	x		x		
Steve Brown	FL FWCC	X	X	x	x	x	x	x			x
Steve Smith	NOAA	X	X	x	x	x	x	x	x		
Sarina Atkinson	NOAA	X	X	x	x	x	x	x	x	x	
Shannon Calay	NOAA	X	X								
Skyler Sagarese	NOAA	X	X	X	X	X	X		X	X	
Max Lee	Mote Marine Lab	X	X	X	X		X	X	X	X	
Carole Neidig	Mote Marine Lab	X	X	X	X	X	X				x
Daniel Roberts	Mote Marine Lab	X	X	X	X		X	X			
Guillermo Diaz	NOAA	X	X	X							
Nancie Cummings	NOAA	X	X	X	X		X				
Eric Fitzpatrick	NOAA		X	X	X	X	X				x
Francesca Forrestal	NOAA		X	X	X	X	X		X		x
Jeff Pulver	NOAA		X	X	X	X	X			X	
Mandy Karnauskas	NOAA		X								
Matthew Nuttall	NOAA		X								
Matthew Smith	NOAA		X								
Dave Glockner	NOAA		X								x
Rob Cheshire	NOAA		X		X						
Larry Beerkircher	NOAA			X							
Marcel Reichert	NOAA									X	x
Alan Lowther	NOAA										x

3.11 FIGURES

Figure 3.1 South Atlantic Fisheries Management Council Boundaries

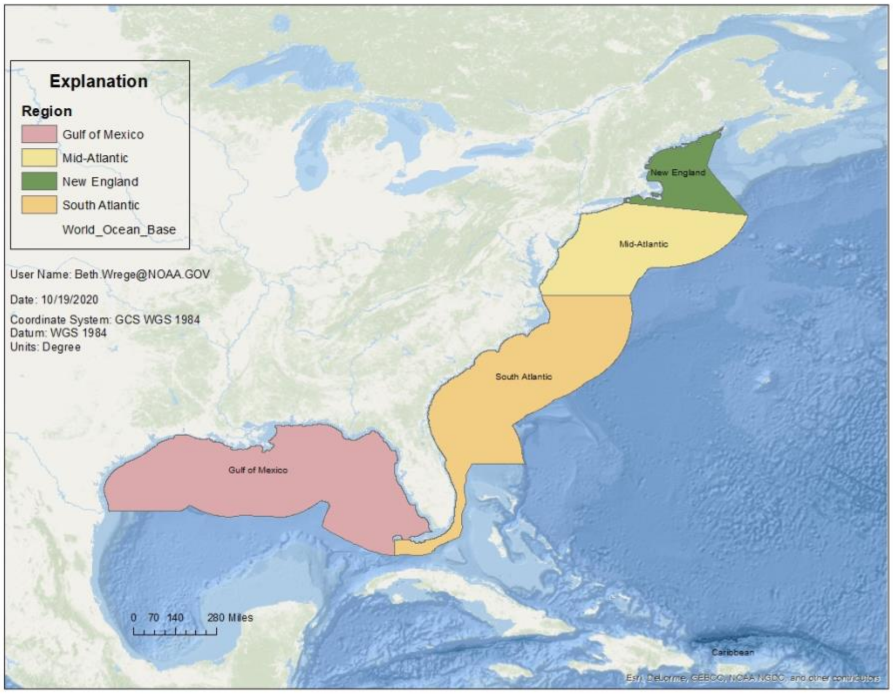


Figure 3.2 Close-up of the southern boundary as defined by the Gulf of Mexico/South Atlantic Council boundary.

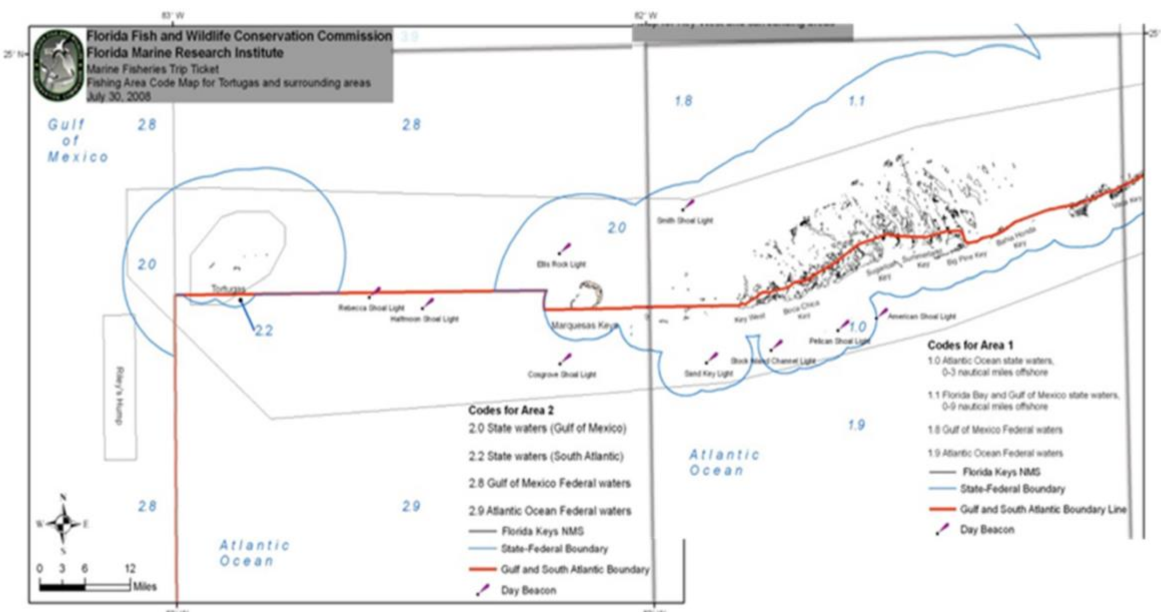


Figure 3.3 ACCSP Data Warehouse Sources and Collection Methodology

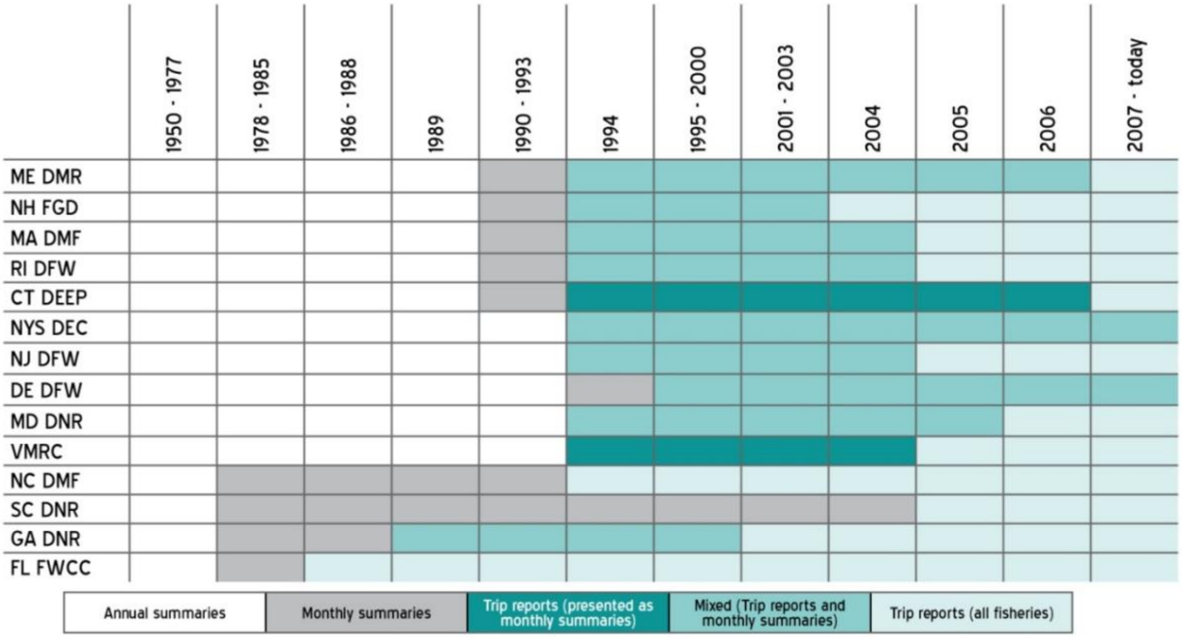
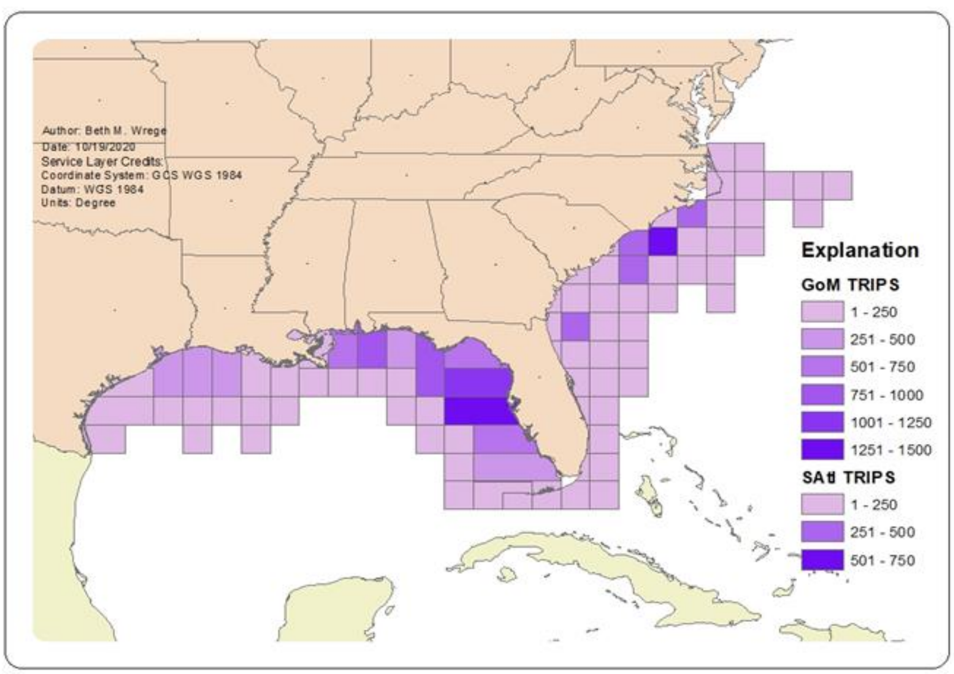


Figure 3.4. Map of Total Cumulative Scamp Effort (Trips) 1990 to 2019 in the Gulf of Mexico and South Atlantic (SATL starts in 1992) as reported to CFLP



4 RECREATIONAL FISHERY STATISTICS

4.1 OVERVIEW

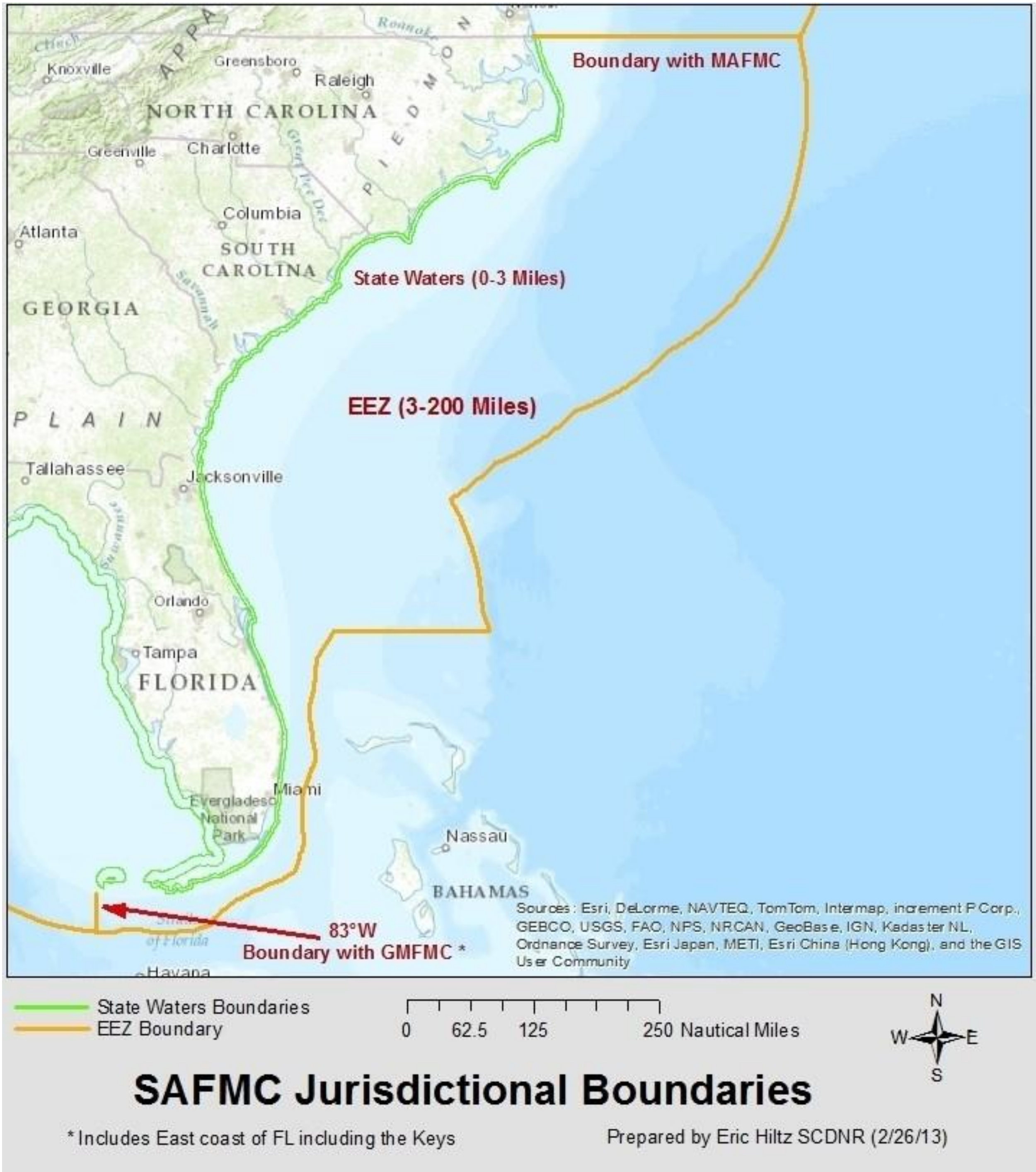
4.1.1 Group Membership

Members - Ken Brennan (Co-leader/NMFS SEFSC Beaufort), Julia Byrd (SAFMC), Kelly Fitzpatrick (NMFS SEFSC Beaufort), Dominique Lazarre (FWCC, FL), Vivian Matter (Co-leader/NMFS SEFSC Miami), Matthew Nuttall (NMFS SEFSC Miami), Alexandra Smith (CIMAS/NMFS SEFSC Miami), Molly Stevens (NMFS SEFSC Miami)

4.1.2 Tasks

1. Identify potential species misidentification issues
2. Review fully calibrated MRIP FES/APAIS/FHS landings and discard estimates
3. Determine whether MRIP catch estimates from Monroe County belong to the Gulf of Mexico or South Atlantic stock
4. Evaluate MRIP catch estimates by mode of fishing to determine appropriate modes for inclusion in the Scamp assessment
5. Determine when Scamp was included in the SRHS universal logbook form
6. Evaluate usefulness of historical data sources such as the Fishing, Hunting, and Wildlife-Associated Recreation Survey (FHWAR) to generate estimates of landings prior to 1981
7. Provide estimates of uncertainty around each set of landings and discard estimates
8. Review whether SRHS discard estimates (2004+) 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
9. Provide nominal length distributions for both landings and discards if feasible
10. Evaluate adequacy of available data
11. Provide research recommendations to improve recreational data

4.1.3 South Atlantic Fishery Management Council Scamp Group Management Boundaries



4.1.4 Stock ID Recommendations

Geographic boundaries

The SEDAR 68 Stock ID Workshop "recommended that two stock assessments be conducted, separated by the default boundary between the Gulf of Mexico and Atlantic waters, as defined by the Councils' jurisdictions" (SEDAR68-SID-05).

Species identification

Task 1: The SEDAR 68 Stock ID Workshop found that "Scamp are very difficult to distinguish from Yellowmouth Grouper, even for trained biologists, and thus much of the assessment data likely represent both species in unknown proportions". It was recommended that the Scamp assessment "be conducted on both Scamp and Yellowmouth Grouper jointly, with the two species treated as a single complex" (SEDAR68-SID-05). As such, the recreational working group included both Scamp and Yellowmouth Grouper when providing recreational data for this stock assessment. Subsequent references to Scamp in this Recreational Data Workshop report include both Scamp and Yellowmouth Grouper.

4.2 ABSTRACTS OF WORKING PAPERS

General Recreational Survey data for Scamp and Yellowmouth Grouper in the South Atlantic (SEDAR 68-DW-08)

General recreational data for Scamp and Yellowmouth Grouper from the Marine Recreational Information Program (MRIP) are summarized from 1981 to 2018 for South Atlantic states from North Carolina to eastern Florida, including the Florida Keys. Charter, private, and shore fishing modes are presented. These fully calibrated MRIP estimates take into account the change in the Fishing Effort Survey, the redesigned Access Point Angler Intercept Survey, and the For-hire Survey. Tables and figures presented include calibration comparisons, landing and discard estimates, associated CVs, sample sizes, fish sizes, and effort estimates.

SEFSC computation of variance estimates for custom data aggregations from the Marine Recreational Information Program (SEDAR 68-DW-10)

Coefficient of variation (CV) estimates for Marine Recreational Information Program (MRIP) survey catch totals are provided for stock assessments by the Southeast Fisheries Science Center (SEFSC). Variances of total catch estimates are computed directly from the raw survey data to obtain CVs appropriate for custom aggregations by year, wave, sub-region, state, and mode using standard survey methods.

Estimates of Historic Recreational Landings of Scamp Grouper and Yellowmouth Grouper in the South Atlantic Using the FHWAR Census Method (SEDAR 68-DW-11)

The National Survey of Fishing, Hunting, and Wildlife-Associated Recreation Survey (FHWAR) has been conducted every 5 years since 1955 and is one of the oldest and most comprehensive recreational surveys. The FHWAR census method utilizes information from these surveys including U.S. angler population estimates and angling effort estimates from 1955–1985 for the South Atlantic region. To obtain historical Scamp landings prior to 1981, estimated saltwater angler trips (1955-1980) are multiplied by average catch rates that are calculated from early years (1981-1985) of recreational data. Interpolation is used to complete time series.

Marine Recreational Information Program Metadata for the Atlantic, Gulf of Mexico, and Caribbean regions (SEDAR 68-DW-13)

The Marine Recreational Information Program (MRIP), formerly the Marine Recreational Fisheries Statistics Survey (MRFSS), is conducted by the NOAA National Marine Fisheries Service (NMFS) to provide estimates of catch per unit effort, total effort, landings, and discards for six two-month periods (waves) per year. MRIP provides estimates for three main recreational fishing modes: shore-based fishing, private and rental boat fishing, and for-hire charter boat and guide boat fishing. MRIP also provides estimates for the headboat mode in the mid and north Atlantic regions and in the early years (1981-1985) in the South Atlantic and Gulf of Mexico. Methodologies through time, spatiotemporal coverage, and field descriptions are summarized in this metadata paper.

Scamp length frequency distributions from At-Sea Headboat Surveys in the South Atlantic (SEDAR 68-DW-23)

This report summarizes available size distribution and release condition data for Scamp and Yellowmouth Grouper captured in the headboat for-hire fleet operating along the South Atlantic coast (North Carolina through East Florida).

Summary of the SAFMC Scamp Release Citizen Science Pilot Project for SEDAR 68 (SEDAR68-DW25)

This working paper presents a summary of the data collected through the South Atlantic Fishery Management Council's (SAFMC) initial citizen science pilot project, SAFMC Scamp Release. This project focuses on collecting data on released Scamp Grouper through the development and use of a mobile app. The SAFMC Release app is designed to collect data on released fish from commercial, for-hire, and recreational fishermen and is being pilot tested on Scamp Grouper. It will expand to collect information on all shallow water grouper in 2021. The app is open access, meaning that any interested fisherman that encounter Scamp can participate in data collection efforts. Data fields for discarded fish include trip type, date, discard time, location, depth, species name, fork length, photo, hook type and location, and release condition and treatment. There is also a separate 'No Release' form within the app to collect limited information on trips where Scamp were not released. The SAFMC Scamp Release project launched in late June 2019. The information collected through SAFMC Scamp Release was presented to the Recreational Work Group, Commercial Work Group, and Discard Mortality Ad-hoc Group.

SEFSC Computation of Uncertainty for Southeast Regional Headboat Survey and Total Recreational Landings Estimates (SEDAR 68-DW-31)

Coefficient of variation (CV) estimates for recreational catch totals are provided as uncertainty measures for use in stock assessments by the Southeast Fisheries Science Center (SEFSC). Variances for landings estimates from the Southeast Region Headboat Survey (SRHS) are calculated at the vessel level from reported logbook landings. Uncertainty in total recreational landings are calculated as the sum total of variances from reported SRHS logbook landings and landings data from the Marine Recreational Information Program.

Discards of Scamp (*Mycteroperca phenax*) for the headboat fishery in the South Atlantic (*SEDAR 68-DW-32)*

The Southeast Region Headboat Survey (SRHS) was modified in 2004 to collect self-reported discards for each reported trip. These self-reported data are currently not validated within the SRHS. The SRHS discard proportions were compared to the MRIP At-Sea Observer program discard proportions for validation purposes and to determine whether the SRHS discard estimates should be used for a full or partial time series (2004-2018). Discard estimates prior to 2004 are calculated using a proxy method. For Scamp, MRIP CH mode, MRIP PR mode, and the mean MRIP CH:SRHS discard ratio method were considered as sources for proxy discard estimates for headboat discards. Due to variability in the MRIP CH mode and PR mode discard and landings estimates, a mean SRHS discard ratio method was also considered, as well as a three year rolling average of the MRIP CH mode and mean MRIP CH:SRHS discard ratio method.

4.3 RECREATIONAL DATA SOURCES

4.3.1 Marine Recreational Information Program (MRIP)

Introduction

The Marine Recreational Information Program (MRIP), formerly the Marine Recreational Fisheries Statistics Survey, conducted by NOAA Fisheries (NMFS) provides estimates of catch per unit effort, total effort, landings, and discards for six two-month periods (waves) each year. MRIP provides estimates for three main recreational fishing modes: shore-based fishing (Shore), private and rental boat fishing (Priv), and for-hire charter and guide fishing (Cbt). MRIP also provides estimates for headboat mode (Hbt) in the mid and north Atlantic regions. MRIP covers coastal Atlantic states from Maine to Florida. When the survey first began in Wave 2 (Mar/Apr) of 1981, headboats were included in the for-hire mode, but were excluded after 1985 to avoid overlap with the Southeast Region Headboat Survey (SRHS), conducted by the NMFS Beaufort laboratory.

Recreational catch, effort, and participation were estimated through a suite of independent but complementary surveys that are described in SEDAR 68-DW-13. Over the years, effort data have been collected from three different surveys: (1) the Coastal Household Telephone Survey (CHTS) which used random digit dialing of coastal households to obtain information about recreational fishing trips, (2) the weekly For-Hire Survey which interviews charter boat operators (captains or owners) to obtain trip information and replaced the CHTS for the charter mode (in 2000 for the Gulf of Mexico and East Florida and 2004 for the Atlantic coast north of Georgia), and (3) the Fishing Effort Survey which is a mail based survey whose sample frame consists of anglers from the National Saltwater Angler Registry and replaced the CHTS for the private and shore modes in 2018. Catch data are collected through dockside angler interviews in the Access Point Angler Intercept Survey (APAIS), which samples recreational fishing trips after they have been completed. In 2013, MRIP implemented a new APAIS to remove sources of potential bias from the sampling process. Catch rates from dockside intercept surveys are combined with estimates of effort 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). Sample sizes in the dockside intercept portion have been increased over time to improve precision of catch estimates.

Task 2: In order to maintain a consistent time series, charter estimates were calibrated on the Atlantic prior to 2004 (SEDAR64-RD-12). CHTS and calibrated FHS charter catch estimates for South Atlantic Scamp from 1981 to 2003 are shown in Figure 1 of SEDAR 68-DW-08. Calibrated APAIS and FES estimates for South Atlantic Scamp from 1981 to 2018 are shown in Figure 2 of SEDAR 68-DW-08.

Monroe County

Monroe County MRIP landings are included in the official West Florida estimates. However, they can be estimated separately 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 (SEDAR68-DW-13). Although Monroe county estimates can be separated using this process, they cannot be partitioned into those from the Atlantic Ocean and those from the Gulf of Mexico (SEDAR-PW-07).

Task 3: For SEDAR 68, MRIP Scamp landings from Monroe County were allocated to the South Atlantic region because it is more likely that this deep-water species would be caught on the Atlantic side of the Florida Keys than the Florida Bay side.

Adjustment to Fishing Modes

Task 4a: Between 1981 and 1985, MRIP charter and headboat modes were combined into a single mode for estimation purposes. Since the NMFS Southeast Region Headboat Survey

(SRHS) began in the Atlantic in 1981, the MRIP combined charter/headboat mode must be split in order to not double the estimated headboat landings in these early years. The MRIP charter/headboat mode (1981-1985) was split by using a ratio of SRHS headboat angler trip estimates to MRIP charter boat angler trip estimates for 1986-1990. In accordance with SEDAR Best Practices, the mean ratio was calculated by state (or state equivalent to match SRHS areas to MRIP states) and then applied to the 1981-1985 estimates to split out the headboat component (SEDAR-PW-07). To avoid duplication of headboat estimates, the MRIP headboat component from this split was deleted for the South Atlantic region (NC to the Florida Keys) and SRHS estimates are used to represent headboat fishing for all years (1981+). In the Florida Keys, headboats primarily operate along the South Atlantic side and are covered by SRHS areas 12 and 17.

Task 4b: The working group also discussed the validity of the MRIP shore mode estimates for South Atlantic Scamp. The working group recommended that all shore mode estimates be excluded because:

- Shore landings are sporadic and generally extremely low compared to other modes or based on only a few intercepts that have expanded the estimates greatly
- Scamp are primarily a deep-water species
- Legal sized fish aren't likely to be caught during a shore trip
- Scamp identified during shore mode trips may be a result of misidentification

Uncertainty

Coefficient of variation (CV) estimates for Marine Recreational Information Program (MRIP) survey catch totals are provided for stock assessments by the Southeast Fisheries Science Center (SEFSC). Variances of total catch estimates are computed directly from the raw survey data to obtain CVs appropriate for custom aggregations by year, wave, sub-region, state, and mode using standard survey methods (SEDAR 68-DW-10).

4.3.2 Southeast Region Headboat Survey (SRHS)

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

The Headboat Survey was started in 1972 but only included vessels from North Carolina and South Carolina until 1975. The survey was expanded to Georgia and northeast Florida (Nassau-Indian River counties) in 1976, followed by southeast Florida (St. Lucie-Monroe counties) in 1978. In 1986 the survey expanded to include west Florida, Alabama, Louisiana, and Texas. Mississippi was added to the survey in 2010. For SEDAR 68, only data from North Carolina through eastern Florida were included. Due to headboat area definitions and confidentiality issues, estimates of SRHS catch are combined for eastern Florida and Georgia. The portion of the SRHS covering the South Atlantic generally includes 70-80 participating in the area annually.

Uncertainty

As an associated measure of uncertainty for landings estimates from the Southeast Region Headboat Survey (SRHS), the variance in reported landings from SRHS logbooks is computed at the vessel level for each area-month strata. Because the SRHS is designed to be a census, this calculation also includes a finite population correction factor where uncertainty equals zero when the entire headboat fleet is covered by the survey (i.e., reported landings = actual landings). Details of this approach are outlined in SEDAR 68-DW-31.

4.3.3 Headboat At-Sea Observer Survey

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. This coverage continued through 2017. Headboat vessels are randomly selected throughout the year in each state. Biologists board selected vessels with permission from the captain and observe anglers as they fish on the recreational trip. Data collected include the species, number, final disposition, and size of landed and discarded fish.

Data are also collected on the length of the trip and area fished (inland, state, and federal waters) (SEDAR68-DW-23).

4.3.4 SAFMC Scamp Release

The South Atlantic Fishery Management Council's (SAFMC) initial citizen science pilot project, SAFMC Scamp Release, focuses on collecting data on released Scamp Grouper through the development and use of a mobile app. The SAFMC Release app is designed to collect data on released fish from commercial, for-hire, and recreational fishermen and is being pilot tested on Scamp Grouper. It was launched in June 2019 and it will expand to collect information on all shallow water grouper in 2021. The app is open access, meaning that any interested fisherman that encounter Scamp can participate in data collection efforts. Data fields for discarded fish include trip type, date, discard time, location, depth, species name, fork length, photo, hook type and location, and release condition and treatment. There is also a separate 'No Release' form within the app to collect limited information on trips where Scamp were not released. There are currently 52 SAFMC Release user accounts split among the four South Atlantic states and among fishing sectors (SEDAR68-DW-25).

4.4 RECREATIONAL LANDINGS

4.4.1 MRIP Landings

Weight Estimation

The Southeast Fisheries Science Center used the MRIP sample data to obtain an average weight by strata using the following hierarchy: species, region, year, state, mode, wave, and area (SEDAR32-DW-02). The minimum number of weights used at each level of substitution is 15 fish, except for the final species level where the minimum is 1 fish (SEDAR67-WP-06). Average weights are then multiplied by the landings estimates in numbers to obtain estimates of landings in weight. These estimates are provided in pounds whole weight.

Landing Estimates

Final MRIP landings estimates and associated coefficients of variation, in numbers of fish, are shown by year and mode in Table 3 of SEDAR 68-DW-08 and by year in Table 5 of SEDAR 68-DW-08. Estimates are provided by year and mode for all South Atlantic states from eastern

Florida to North Carolina, including the Florida Keys. Final MRIP landings estimates in pounds whole weight are shown by year and state in Table 6 of SEDAR 68-DW-08.

The working group investigated the 2014 landings estimate, which is relatively high compared to neighboring years. The estimate of 38,389 fish for that year came primarily from East Florida, wave 3, private mode, and ocean greater than 3 miles. Five trips contributed to the estimate for this strata, each with a harvest of three fish (not seen by an interviewer), resulting in a landings estimate of 35,893 fish.

4.4.2 SRHS Headboat Logbook Landings

The headboat logbook has changed multiple times throughout the history of the SRHS. In the case of Scamp, the logbook form used in the South Atlantic has listed Scamp since 1973. Yellowmouth Grouper was added to the forms used in GA and FLE in 1980 but was not added to the NC and SC forms until 1984. However, due to species identification issues, it is likely that any Yellowmouth Grouper were identified as Scamp. Prior to 1981 grouper landings were calculated at the genus level (*Mycteroperca*) and cannot be separated.

Task 5: The SRHS has had a logbook form that included Scamp in all of the South Atlantic since 1973. However, Yellowmouth Grouper was not listed on all forms in the South Atlantic until 1984.

- Option 1: Begin landings in 1972. From 1972 to 1980 grouper landings were calculated at the family level (*Mycteroperca)* and include several species.
- Option 2: Begin landings in 1981 due to increased geographical survey coverage. Also, both Scamp and Yellowmouth Grouper are recorded at the species level in nearly all areas beginning in 1981.

The recreational working group recommends that SRHS estimates for Scamp will begin in 1981. Scamp has been included on all SRHS logbook forms since 1973. Although Yellowmouth Grouper was not listed on SRHS forms used in NC and SC until 1984, due to species identification issues, it is likely that any Yellowmouth Grouper were identified as Scamp. Landings prior to 1981 will be calculated according to the FHWAR method (section 4.4.3).

Landing Estimates

Final SRHS landings estimates are shown in Table 4.12.1.

4.4.3 Historic Recreational Landings

Introduction

The historic recreational landings time period is defined as pre-1981 for the charter boat, headboat, and private fishing modes, which represents the start of the Marine Recreational Information Program (MRIP) and availability of landings estimates for Scamp. The Recreational Working Group was tasked with evaluating historical sources and methods to compile landings estimates for Scamp prior to 1981.

FHWAR Census Method

The 2001 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (FHWAR) presents summary tables of U.S. population estimates, along with estimates of hunting and fishing participation and effort from surveys conducted by the US Fish and Wildlife Service every 5 years from 1955 to 1985 (SEDAR 68-DW-11). This information was used to develop an alternative method for estimating recreational landings prior to 1981.

The two key components from these FHWAR surveys that were used in this census method were the estimates of U.S. saltwater anglers and U.S. saltwater days. These estimates are used to calculate the historical effort of South Atlantic saltwater anglers. The mean CPUE from the MRIP estimates from 1981 to 1985 for Scamp is then applied to the historical effort estimates for South Atlantic anglers to provide estimates of recreational Scamp landings prior to 1981 (Table 4.12.2).

Task 6: Historical Scamp landings are available from 1955-1980

- Option 1: Use historical Scamp landings from the FHWAR method (Table 4.12.2 1955-1980) and non-historical Scamp landings estimates from the MRIP and SRHS surveys (1981-2018), shown in Figure 1 of SEDAR 68-DW-11.
- Option 2: Use only non-historical Scamp landings estimates (1981-2018)

The SEDAR 68 recreational working group recommended to include historical landings estimates from the FHWAR method (Option 1.) because this method has been accepted as a best practice for SEDARs and is the most representative method available for characterizing recreational landings prior to standardized data collection programs.

4.4.4 Total Recreational Landings

Combined landings estimates (MRIP and SRHS) are shown in Table 4.12.3, Figure 4.13.1, and mapped in Figure 4.13.2. The recreational landings in the South Atlantic are about evenly distributed between private, charter, and headboat modes. Geographically, landings mostly come from North Carolina (about 40%), followed by South Carolina (about 30%) and East Florida (about 20%). Scamp landings estimates steadily increased to about the mid-2000s, with some decline in the mid-1990s, and have generally remained low since about 2008.

Uncertainty

Task 7: To provide an associated measure of uncertainty for total recreational landings estimates, coefficients of variation (CVs) are calculated from the sum total of variance in reported SRHS logbook landings and MRIP landings data. Details of this approach are outlined in SEDAR 68-DW-31.

4.5 RECREATIONAL DISCARDS

4.5.1 MRIP Discards

Fish reported to have been discarded alive are not seen by MRIP interviewers and so neither the identity nor the quantities of discarded fish can be verified. The size and weight of discarded fish are also unknown for all modes of fishing. Final MRIP discard estimates and associated coefficients of variation, in numbers of fish, are shown by year and mode in Table 4 of SEDAR 68-DW-08 and by year in Table 5 of SEDAR 68-DW-08. Estimates are provided by year and mode for all South Atlantic states from eastern Florida to North Carolina, including the Florida Keys.

The working group investigated the 2007 discards estimate, which is relatively high compared to the rest of the time series. The estimate of 47,935 fish for that year came primarily from North Carolina, private mode, and ocean greater than 3 miles during two different waves:

- Wave 2- One trip which released ten live fish and resulted in a discards estimate of 21,388 fish. This trip also landed one fish, seen by an interviewer.
- Wave 3- Three trips resulted in a discards estimate of 12,732 fish
    - One trip released five live fish (and landed one fish, seen by an interviewer)
    - One trip released two live fish (and landed three fish, seen by an interviewer)
    - One trip released one live fish

4.5.2 Headboat At-Sea Observer Survey Discards

Self-reported headboat discards (discussed in 4.5.3) are not currently validated within the SRHS. However, discard information from the At-Sea Observer Survey is used to validate the SRHS discard estimates and determine whether SRHS discards should be used for the entire time series (2004-2018) or for a partial time series. In the SRHS, 10,811 Scamp logbook records were collected in the South Atlantic from 2004-2018. Of these records, 6,692 trips reported discards of Scamp. In the At-Sea Observer Program, only 237 observed trips were positive for Scamp, 172 of which had Scamp discards. Due to the differences in magnitude of the number of trips sampled within the At-Sea Observer Program and SRHS, the discard proportion was compared only for those trips where Scamp were discarded. The SRHS and At-Sea Observer discard proportions exhibit the same pattern and degree of magnitude (SEDAR 68-DW-32, 2020). Therefore, the SEDAR 68 recreational working group recommended using the SRHS discard estimates for 2004-2018.

4.5.3 SRHS 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”. As of Jan 1, 2013, the SRHS began collecting logbook data electronically. Changes to the trip report were also made at this time, one of which removed the condition category for discards (i.e., released alive vs. released dead). The form now collects only the total number of fish released, regardless of condition.

Due to the lack of a Scamp size limit in the South Atlantic, it is assumed that discards were negligible prior to 1992. The MRIP charter mode, MRIP private mode, and mean MRIP CH:SRHS discard ratio method (SEDAR 28 Assessment Workshop Report, 2013) were considered as sources for proxy discard estimates for headboat discards 1992-2003. Due to variability in the MRIP charter mode and private mode discard and landings estimates, a mean SRHS discard ratio method was also considered, as well as a three year rolling average of the MRIP charter mode and mean MRIP CH:SRHS discard ratio method (SEDAR 68-DW-32, 2020).

Task 8: Proxy for estimated headboat discards from 1992-2003

- Option 1: Apply the MRIP private boat discard:landings ratio to estimated headboat landings to estimate headboat discards from 1992-2003.
- Option 2: Apply the MRIP charter boat discard:landings ratio to estimated headboat landings to estimate headboat discards from 1992-2003.
- Option 3: Apply a three year rolling average MRIP charter boat discard:landings ratio to estimated headboat landings to estimate headboat discards (1992-2003).
- Option 4: Mean MRIP CH:SRHS discard ratio method: Calculate the ratio of the mean ratio of SRHS discard:landings (2004-2018) and MRIP CH discard:landings (2004-2018). Apply this ratio to the yearly MRIP charter boat discard:landings ratio (1992-2003) to estimate the yearly SRHS discard:landings ratio (1992-2003). This ratio is then applied to the SRHS landings (1992-2003) to estimate headboat discards (1992-2003).
- Option 5: Apply a three year rolling average of the mean MRIP CH:SRHS discard ratio method to estimated headboat landings to estimate headboat discards (1992-2003).
- Option 6: Apply a mean SRHS discard:landings ratio (2004-2008) to estimated headboat landings to estimate headboat discards (1992-2003).
- Option 7: Apply a mean SRHS discard:landings ratio (2004-2018) to estimated headboat landings to estimate headboat discards (1992-2003).

For years prior to 2004, the working group recommended option 7 as a proxy method for SRHS headboat discards because the MRIP private and charter boat modes showed highly variable discard ratios which did not agree with the SRHS discard ratios and were not recommended for use. The variability within the MRIP charter mode discard ratios in turn affected the mean MRIP CH:SRHS discard ratio method. In an effort to reduce the variability of the MRIP charter boat mode and MRIP CH:SRHS discard ratio methods a three year rolling average discard ratio from each method was applied to the SRHS landings estimates. A mean SRHS discard:landings ratio was also examined, using a mean of years 2004-2008 and 2004-2018. The MRIP charter mode three year rolling average, mean MRIP CH:SRHS discard ratio method three year rolling average, mean SRHS discard ratio (2004-2008), and mean SRHS discard ratio (2004-2018) were compared to the SRHS discard estimates (SEDAR 68-DW-32). The cross correlation analysis was used to first determine if lagging the discard estimates with the landings would identify a stronger relationship (strong year class in one year (discards) could be seen in following years (landings)), and secondly provide an objective approach to identify a preferred recommendation. A lag of zero had the highest correlation for the South Atlantic. The mean SRHS discard ratio (2004-2018) method had the strongest relationship with the landings with a lag of zero for the South Atlantic. Therefore, the mean SRHS discard ratio (2004-2018) method was recommended as the proxy method for SRHS discard estimates.

Discard Estimates

Final SRHS estimated discards (2004-2018) are presented in Table 4.12.4 along with the proxy discard estimates (1992-2003). SRHS discards in FLW/AL vary through time and correspond to fluctuations in the SRHS landings and effort.

4.5.4 SAFMC Scamp Release

While recruiting fishermen to participate in the SAFMC Scamp Release app, SAFMC staff had conversations with many fishermen who encounter Scamp. Some common themes heard through these discussions include: 1) Scamp Grouper releases are not common during the open shallow water grouper season (May – December) and those that are released are a result of the size limit rather than possession limit; 2) Scamp Grouper releases during the shallow water grouper closed season (January-April) are more likely to occur in the early Spring when for-hire and recreational bottom fishing effort begins to increase at the end of winter; 3) Scamp Grouper catches have become less common in recent years, potentially due to abundance or increased numbers of Red Snapper preventing bait from getting to the bottom; and 4) Scamp Grouper tend to be in deeper water than other shallow water grouper species (SEDAR 68-DW-25). Currently, data collected through the SAFMC Scamp Release app are limited and cannot be used directly within the assessment. However, SEDAR 68 participants found the information collected through the app and provided by SAFMC Scamp Release participants useful when interpreting trends found in other data sources.

4.5.5 Total Recreational Discards

Combined discard estimates (MRIP and SRHS) are shown in Table 4.12.5, Figure 4.13.3, and mapped in Figure 4.13.4. The majority of the recreational discards in the South Atlantic come from the private mode (about 50%). The headboat mode contributes about 30% and the charter boat mode makes up the remaining 20% of the recreational discards. Geographically, over half of the discards come from North Carolina (about 60%). Another 30% of the discards come from East Florida and the Florida Keys. Discard estimates for Scamp appear in the early 1990s and generally increased to about the late-2000s, with some decline in the mid-2000s. With the exception of 2007, discussed above, discards have generally remained low since about 2013.

4.6 BIOLOGICAL SAMPLING

4.6.1 Landings

4.6.1.1 MRIP Biological Sampling

The MRIP angler intercept survey includes the collection of fish lengths from the harvested catch (landed, whole condition). Up to 15 of each landed species per angler interviewed are measured to the nearest mm along a centerline (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. 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 fish that have a single, or few, caudal fin rays that extend further. Weights are typically collected for the same fish measured, although weights are preferred when time is constrained. Ageing structures and other biological samples are not collected during MRIP assignments because of concerns over the introduction of bias to survey data collection due to the time required to collect aging structures. Discarded fish size is unknown for all modes of fishing covered by MRIP.

Summaries of fish size for MRIP-sampled Scamp in the South Atlantic by state (1981-2018) are provided in Table 4.12.6 (pounds whole weight) and Table 7 of SEDAR 68-DW-08 (millimeters fork length). Comparable summaries of fish size by mode are provided in Table 10 of SEDAR 68-DW-08 (pounds whole weight) and Table 9 of SEDAR 68-DW-08 (millimeters fork length). These summaries include the number of measured Scamp, number of angler trips from which Scamp were measured, and the minimum, average, and maximum size of all measured Scamp.

4.6.1.2 *SRHS Biological Sampling: Landings*

Lengths were collected by headboat dockside samplers beginning in 1972. From 1972 to 1975, only North Carolina and South Carolina were sampled whereas Georgia and northeast Florida sampling began in 1976. The SRHS conducted dockside sampling throughout the southeast portion of the US (from the NC-VA border to the Florida Keys) beginning in 1978. SRHS dockside sampling has been conducted in all Gulf states since 1986, except for Mississippi where sampling started in 2010. Weights are typically collected for the same fish measured during dockside sampling. Biological samples (scales, otoliths, spines, stomachs, and gonads) are also collected routinely and processed for aging, diet studies, and maturity studies.

Summaries of fish size, in kilograms whole weight, for SRHS-sampled Scamp in the South Atlantic (1972-2018) are provided in Table 4.12.7. These summaries include the annual number of measured Scamp, the number of trips from which Scamp were measured, and the minimum, average, and maximum size of Scamp measured by SRHS dockside samplers.

Any existing total length measurements without an associated fork length measurement were converted using the following equation derived by the Life History Working Group for the South Atlantic stock at the SEDAR 68 Data Workshop:

FL_mm=19.72+0.89*TL_mm

Any existing whole weight measurements without an associated fork length measurement were converted using the following equation derived by the Life History Working Group for the Gulf of Mexico stock at the SEDAR 68 Data Workshop:

$FL\_mm = 417.54(WW\_kg)^{0.34}$

4.6.1.3 Nominal Length Frequency Distributions of Landings

Task 9: Nominal length frequency distributions were generated for the recreational fleet comparing the combined MRIP charter boat/private boat mode and SRHS headboat mode (Figure 4.13.5). There were two management periods in the South Atlantic: South Atlantic: pre-1992, no minimum size limit; and post-1992, 20" TL minimum size limit. These length frequency distributions indicate that the charter boat/private boat fishery and headboat fishery retain similarly sized fish and that the size limit implemented in 1992 caused a shift toward slightly larger fish in both modes (Figure 4.13.6).

4.6.1.4 Aging Data

Age samples are collected as part of the SRHS sampling protocol. Age samples collected from the private/rental boat, charter boat, and shore modes are not typically collected as part of the MRIP sampling protocol. These samples come from a number of sources including state agencies, special projects, and sometimes as add-ons to the MRIP survey. The number of Scamp aged from the recreational fishery (mode unknown) by year and state is summarized in Table 4.12.8. The recreational landings ages will be weighted by the length frequency distributions by year and fleet.

4.6.2 Discards

4.6.2.1 *SAFMC Scamp Release Biological Sampling*

Limited data have been collected through the SAFMC Scamp Release app thus far. However, staff are continuing to focus on recruitment and retention of commercial, for-hire, and recreational fishermen to participate in the SAFMC Scamp Release project. Released scamp reported through the app were caught in waters from 80-132 feet and ranged in size from 16-22 inches. They were typically hooked in the jaw and fishermen reported use of circle offset, circle non-offset, and j-hooks. Scamp reported as kept through the 'No Release' reports were caught in waters from 80-265 feet.

4.6.2.2 Headboat At-Sea Observer Survey Biological Sampling

At-sea sampling of headboat discards was initiated as part of the improved for-hire surveys to characterize the size distribution of live discarded fish in the headboat fishery.

4.6.2.3 Nominal Length Frequency Distributions of Discards

Length measurements from 230 discarded fish from the Headboat at-Sea Observer Survey were used to generate a headboat discard length frequency distribution. The distribution was weighted by region, to account for differences in sampling effort by region. These length data, though sparse, show discarding in the headboat fleet as a function of regulatory discards (Figure 4.13.7). An additional 5 discard lengths from the east Florida charter boat fleet were provided but were not enough to describe the discarding behavior of that fleet. Only the weighted headboat length frequency distribution was recommended for use to describe the size distribution for discarded fish. A full accounting of the weighting procedure applied to the raw length data is provided in SEDAR68-DW-23.

4.7 RECREATIONAL EFFORT

4.7.1 MRIP Effort

MRIP effort estimates are produced via the Fishing Effort Survey (FES) for private/rental boats and shore mode and the For-Hire Survey (FHS) for charter boat mode. MRIP effort is calculated in units of angler trips, which represents a single day of fishing in the specified mode that does not exceed 24 hours and is provided by year and mode in Table 13 of SEDAR 68-DW-08 and by year and state in Table 12 of SEDAR 68-DW-08. These summaries include all South Atlantic states from eastern Florida to North Carolina, including the Florida Keys.

4.7.2 SRHS Effort

Effort data from the SRHS is provided as the number of anglers on a given trip, which is standardized to "angler days" based on the length of the trip (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 any available information. This information is used to provide estimates of total catch by month and area, along with estimates of effort.

In order to summarize recreational fishing effort across the South Atlantic, SRHS effort estimates are also provided in units of angler trips to match that provided by the MRIP survey. Monthly estimates of angler trips are calculated as the product of the reported number of anglers and ratios for the estimated number of total trips to the reported number of total trips (SEDAR 28-DW-12).

SRHS effort estimates (in angler days) are provided in Table 4.12.9. Estimated headboat angler days decreased in both the South Atlantic and Gulf of Mexico beginning in 2008 due to the economic down-turn coupled with the high cost of fuel. South Atlantic fishing effort began to recover in 2013 and continued to increase until 2017. The recent decrease in estimated headboat angler days resulted from the removal of state-permitted headboat vessels from the SRHS beginning in 2017, mainly from southeast Florida.

4.7.3 Total Recreational Fishing Effort

Combined effort estimates in angler trips (MRIP and SRHS) are shown in Table 4.12.10, Figure 4.13.8, and mapped in Figure 4.13.9. These effort estimates depict all recreational fishing activity in the South Atlantic and are not specific to Scamp. The vast majority (about 95%) of the general recreational fishing effort in the South Atlantic comes from the private mode. Geographically, the majority of the fishing effort comes from East Florida, including the Florida Keys (about 70%), followed by North Carolina (about 20%). Effort estimates have steadily increased until about the mid-2000s and have generally remained consistent since then.

4.8 COMMENTS OD ADEQUACY OF DATA FOR ASSESSMENT ANALYSES

Task 10: Regarding the adequacy of the available recreational data for assessment analyses, the recreational working group discussed the following:

- Catch estimates (landings and discards) appear to be adequate for the time period covered (1955-2018)
- Size data appear to adequately represent the landed catch for all modes
- Limited South Atlantic discard size data are available for Scamp and Yellowmouth Grouper, but the data provided are adequate for describing discard size composition

- Uncertainty for total recreational landing estimates are considered adequate for use in this assessment.

4.9 Itemized List of Tasks for Completion following Workshop

- Weighted length and age compositions will be completed for the Assessment Workshop

4.10 RESEARCH RECOMMENDATIONS

4.10.1 Research Recommendations for SEDAR 68

Task 11:

1. ***Increase sampling of the recreational fishing fleet, particularly the charter boat and private angler sector, to improve discard data collection. Discard length data and discard mortality are two areas of importance that should be included.***
2. ***Continue to develop methods to provide uncertainty estimates around landings and discard estimates***
3. ***Investigate the implications of the MRIP imputed lengths and weighting factors for a range of data-rich to data-limited species, where the length frequency distributions become erratic***

4.11 Literature Cited

Brennan, K. 2020. SEDAR 68-DW-11. Estimates of Historic Recreational Landings of Scamp and Yellowmouth Grouper in the Gulf of Mexico Using the FHWAR Census Method. National Marine Fisheries Service (NMFS) Southeast Fisheries Science Center (SEFSC) Beaufort Laboratory. Beaufort, NC.

Dettloff, K and V Matter. 2019. SEDAR 64-RD-12. Model-estimated conversion factors for calibrating Coastal Household Telephone Survey (CHTS) charter boat catch and effort estimates with For-hire Survey (FHS) estimates in the Atlantic and Gulf of Mexico with application to red grouper and greater amberjack. National Marine Fisheries Service (NMFS) Southeast Fisheries Science Center (SEFSC) Fisheries Statistics Division. Miami, FL.

Dettloff, K and V Matter. 2019. SEDAR 67-WP-06. Sample Size Sensitivity Analysis for calculating MRIP Weight Estimates. National Marine Fisheries Service (NMFS) Southeast Fisheries Science Center (SEFSC) Fisheries Statistics Division. Miami, FL.

Dettloff, K, V Matter, and M Nuttall. 2020. SEDAR 68-DW-10. SEFSC Computation of Variance Estimates for Custom Data Aggregations from the Marine Recreational Information Program. National Marine Fisheries Service (NMFS) Southeast Fisheries Science Center (SEFSC) Fisheries Statistics Division. Miami, FL.

Fisheries Ecosytems Branch. 2020. SEDAR68-DW32. Discards of scamp (*Mycteroperca phenax*) for the headboat fishery in the South Atlantic. National Marine Fisheries Service (NMFS), Southeast Fisheries Science Center (SEFSC), Beaufort, NC.

Lazarre, D, C Wilson, and K Fitzpatrick. 2020. SEDAR 68-DW-23. Scamp Length Frequency Distributions from At-Sea Headboat Surveys in the South Atlantic, 2005 to 2017. Florida Fish and Wildlife Conservation Commission (FWC), Fish and Wildlife Research Institute (FWRI) Saint Petersburg, FL.

Matter, VM and A Rios. 2013. SEDAR 32-DW-02. MRFSS to MRIP Adjustment Ratios and Weight Estimation Procedures for South Atlantic and Gulf of Mexico Managed Species. National Marine Fisheries Service (NMFS) Southeast Fisheries Science Center (SEFSC) Fisheries Statistics Division. Miami, FL.

Matter, V, N Cummings, J Isely, K Brennan, and K Fitzpatrick. 2012. SEDAR 28-DW-12. Estimated conversion factors for calibrating MRFSS charter boat landings and effort estimates for the South Atlantic and Gulf of Mexico in 1981-1985 with For-hire Survey estimates with application to Spanish mackerel and cobia landings. National Marine Fisheries Service (NMFS) Southeast Fisheries Science Center (SEFSC) Fisheries Statistics Division. Miami, FL.

Matter, V and M Nuttall. 2020. SEDAR 68-WP-08. General Recreational Survey Data for Scamp and Yellowmouth Grouper in the South Atlantic. National Marine Fisheries Service (NMFS) Southeast Fisheries Science Center (SEFSC) Fisheries Statistics Division. Miami, FL.

Matter, V and M Nuttall. 2020. SEDAR 68-DW-13. Marine Recreational Information Program: Metadata for the Atlantic, Gulf of Mexico, and Caribbean Regions. National Marine Fisheries Service (NMFS) Southeast Fisheries Science Center (SEFSC) Fisheries Statistics Division. Miami, FL.

Nuttall, M, K Dettloff, K Fitzpatrick, K Brennan, and V Matter. 2020. SEDAR 68-DW-31. SEFSC Computation of Uncertainty for Southeast Regional Headboat Survey and Total Recreational Landings Estimates. National Marine Fisheries Service (NMFS) Southeast Fisheries Science Center (SEFSC) Fisheries Statistics Division. Miami, FL.

SEDAR Procedural Workshop 7. 2015. SEDAR-PW-07. Data Best Practices. SEDAR, North Charleston, SC.

SEDAR 68 Stock ID Panel. 2020. Gulf of Mexico and Atlantic Scamp Stock ID Process Final Report. SEDAR68-SID-05. SEDAR, North Charleston, SC.

4.12 TABLES

Table 4.12.1. Estimated SRHS headboat landings of South Atlantic Scamp and Yellowmouth Grouper. Landings are provided in number of fish and pounds whole weight; CVs are not available in weight units. Due to headboat area definitions and confidentiality issues, estimates of SRHS catch are combined for eastern Florida and Georgia.

	Number					Pounds			
Year	FLE/GA	NC	SC	Total	CV	FLE/GA	NC	SC	Total
1981	4,839	1,042	1,405	7,286	0.059	17,167	5,775	7,468	30,411
1982	2,585	2,612	2,824	8,021	0.025	11,822	17,606	14,026	43,454
1983	3,587	1,548	3,375	8,510	0.027	17,046	9,673	23,421	50,140
1984	2,306	2,639	2,372	7,317	0.020	11,857	15,166	16,046	43,069
1985	1,822	2,198	4,452	8,472	0.050	10,475	11,636	25,775	47,886
1986	1,829	1,801	4,611	8,241	0.026	8,523	6,302	22,279	37,104
1987	2,340	4,951	7,577	14,868	0.018	8,212	14,745	30,633	53,590
1988	1,286	6,172	6,670	14,128	0.020	3,503	14,206	34,628	52,336
1989	1,321	4,370	6,407	12,098	0.058	4,658	12,236	29,478	46,372
1990	1,819	8,902	7,374	18,095	0.022	7,921	18,173	36,479	62,573
1991	1,597	17,221	4,832	23,650	0.034	12,842	135,120	24,655	172,617
1992	1,082	1,701	9,768	12,551	0.046	8,035	11,637	48,229	67,901
1993	942	1,545	6,766	9,253	0.030	5,148	10,669	38,398	54,216
1994	983	2,433	8,919	12,296	0.016	5,531	10,926	47,135	63,593
1995	1,631	794	13,470	15,585	0.008	6,978	5,085	66,897	78,960
1996	1,052	1,084	7,494	9,397	0.024	5,057	6,607	45,493	57,158
1997	2,150	1,366	11,235	14,206	0.004	7,777	11,590	57,070	76,437
1998	1,678	1,180	13,630	16,095	0.023	7,349	6,110	66,186	79,645
1999	1,547	1,897	14,660	17,697	0.027	6,361	14,599	69,614	90,574
2000	1,742	1,842	9,932	13,162	0.012	10,053	15,034	50,960	76,047
2001	792	2,095	7,766	10,549	0.021	4,879	13,948	50,522	69,349
2002	1,100	2,149	7,531	10,514	0.022	6,619	11,850	44,547	63,017
2003	855	1,202	8,238	10,065	0.013	3,982	7,994	47,341	59,318
2004	1,379	1,057	11,127	13,254	0.025	7,212	7,798	72,846	87,856
2005	1,675	1,237	5,606	8,244	0.018	9,942	10,059	39,736	59,737
2006	1,389	801	8,746	10,571	0.021	7,433	5,530	52,359	65,321
2007	1,041	809	15,034	16,741	0.025	4,482	5,255	91,252	100,989
2008	1,045	535	3,789	5,061	0.017	5,630	2,841	20,600	29,071
2009	884	297	2,620	3,622	0.016	4,930	2,025	17,745	24,701
2010	491	408	2,496	3,285	0.005	3,516	2,331	14,960	20,807
2011	431	207	1,476	2,020	0.010	1,978	2,494	17,459	21,931
2012	390	198	1,547	2,075	0.000	1,639	1,876	9,746	13,261
2013	372	171	1,272	1,790	0.002	2,633	1,662	11,186	15,481
2014	518	189	1,147	1,837	0.000	3,751	1,738	9,990	15,478
2015	717	453	1,079	2,223	0.000	3,209	2,630	6,747	12,585
2016	477	256	1,072	1,782	0.003	3,188	1,517	6,155	10,859
2017	382	194	1,103	1,669	0.000	2,869	1,629	9,870	14,368
2018	208	97	845	1,123	0.008	1,367	711	5,788	7,866

Table 4.12.2. Estimated historical recreational landings for Scamp and Yellowmouth Grouper in the South Atlantic 1955-1980 (CV=0.47).

Year	Number
1955	4,836
1956	5,309
1957	5,781
1958	6,254
1959	6,726
1960	7,199
1961	7,851
1962	8,503
1963	9,155
1964	9,807
1965	10,459
1966	10,520
1967	10,581
1968	10,642
1969	10,704
1970	10,765
1971	11,829
1972	12,893
1973	13,957
1974	15,021
1975	16,084
1976	16,266
1977	16,447
1978	16,629
1979	16,810
1980	16,992

Table 4.12.3. Total recreational landings estimates (AB1) for South Atlantic Scamp and Yellowmouth Grouper combined across all surveys (MRIP and SRHS) by year and mode in numbers of fish. The associated coefficients of variation (CV) are provided for total recreational landings (in numbers). Annual landings are also provided in pounds whole weight (lbs); CVs are not available in weight units.

Year	Cbt	Priv	Hbt	Total	CV	lbs
1981	1,682	12,364	7,286	21,332	0.59	65,340
1982	1,591	8,859	8,021	18,472	0.41	115,464
1983	1,048	0	8,510	9,558	0.07	57,364
1984	7,500	3,154	7,317	17,971	0.28	84,034
1985	1,307	4,988	8,472	14,767	0.35	91,060
1986	613	2,291	8,241	11,145	0.15	57,114
1987	543	983	14,868	16,395	0.05	64,110
1988	14,133	4,918	14,128	33,179	0.21	134,040
1989	10,571	8,720	12,098	31,389	0.21	116,585
1990	15,496	10,488	18,095	44,079	0.23	119,381
1991	4,277	6,115	23,650	34,041	0.12	209,226
1992	4,101	10,419	12,551	27,071	0.20	154,843
1993	8,998	10,396	9,253	28,647	0.24	150,152
1994	15,496	17,276	12,296	45,068	0.22	212,895
1995	95	0	15,585	15,680	0.01	79,616
1996	3,756	3,838	9,397	16,991	0.26	82,714
1997	578	2,585	14,206	17,370	0.15	99,090
1998	2,085	1,641	16,095	19,820	0.06	102,365
1999	6,970	957	17,697	25,625	0.12	196,310
2000	5,577	24,178	13,162	42,917	0.26	353,103
2001	5,320	9,386	10,549	25,255	0.18	168,082
2002	36,468	11,500	10,514	58,482	0.21	406,273
2003	13,682	21,522	10,065	45,269	0.30	295,353
2004	7,541	20,173	13,254	40,968	0.26	290,522
2005	23,049	3,633	8,244	34,926	0.51	192,024
2006	9,612	32,368	10,571	52,551	0.41	368,903
2007	15,826	26,623	16,741	59,190	0.22	378,934
2008	5,816	21,011	5,061	31,888	0.29	196,342
2009	1,034	13,449	3,622	18,105	0.40	127,788
2010	2,313	5,550	3,285	11,148	0.32	82,033
2011	1,342	3,504	2,020	6,867	0.35	62,988
2012	925	6,073	2,075	9,073	0.36	88,574
2013	2,489	6,304	1,790	10,584	0.34	99,460
2014	569	37,820	1,837	40,226	0.90	419,136
2015	865	4,366	2,223	7,453	0.42	52,258
2016	900	5,908	1,782	8,590	0.40	70,809
2017	12,307	0	1,669	13,976	0.74	98,748
2018	509	2,436	1,123	4,068	0.35	26,801

Table 4.12.4. Estimated SRHS headboat discards of South Atlantic Scamp and Yellowmouth Grouper. Discards are provided in number of fish. Due to headboat area definitions and confidentiality issues, estimates of SRHS catch are combined for eastern Florida and Georgia.

Year	FLE/GA	SC	NC	Total
1981	0	0	0	0
1982	0	0	0	0
1983	0	0	0	0
1984	0	0	0	0
1985	0	0	0	0
1986	0	0	0	0
1987	0	0	0	0
1988	0	0	0	0
1989	0	0	0	0
1990	0	0	0	0
1991	0	0	0	0
1992	934	1,269	6,661	8,864
1993	814	1,152	4,614	6,580
1994	789	1,815	6,082	8,685
1995	929	592	9,186	10,707
1996	548	808	5,110	6,467
1997	1,014	1,019	7,661	9,695
1998	842	880	9,295	11,016
1999	707	1,415	9,997	12,119
2000	957	1,374	6,773	9,104
2001	523	1,562	5,296	7,382
2002	539	1,603	5,136	7,277
2003	383	896	5,618	6,897
2004	903	701	5,086	6,690
2005	1,216	1,450	2,317	4,983
2006	772	1,044	2,690	4,506
2007	298	1,073	4,348	5,719
2008	815	519	1,806	3,140
2009	839	179	2,092	3,110
2010	577	397	2,064	3,038
2011	398	165	1,065	1,628
2012	442	66	801	1,309
2013	101	38	1,036	1,175
2014	117	131	1,275	1,523
2015	109	224	1,303	1,636
2016	125	177	1,039	1,341
2017	41	115	757	913
2018	42	52	596	690

Table 4.12.5. Total recreational discard estimates (B2) for South Atlantic Scamp and Yellowmouth Grouper combined across all surveys (MRIP and SRHS) by year and mode in numbers of fish. The associated coefficients of variation (CV) are provided for total recreational discards (in numbers).

Year	Cbt	Priv	Hbt	Total	CV
1981	0	0	0	0	0.00
1982	0	0	0	0	0.00
1983	0	0	0	0	0.00
1984	0	0	0	0	0.00
1985	0	0	0	0	0.00
1986	0	0	0	0	0.00
1987	0	0	0	0	0.00
1988	0	9,538	0	9,538	1.00
1989	20	0	0	20	1.00
1990	0	4,522	0	4,522	1.00
1991	0	0	0	0	0.00
1992	3,157	0	8,864	12,021	0.40
1993	6,043	10,728	6,580	23,351	0.53
1994	7,143	4,317	8,685	20,145	0.28
1995	4,314	0	10,707	15,021	0.44
1996	3,985	0	6,467	10,452	0.61
1997	6,067	0	9,695	15,762	0.97
1998	1,321	0	11,016	12,338	0.65
1999	1,049	2,613	12,119	15,781	0.48
2000	2,320	4,643	9,104	16,066	0.48
2001	10,216	4,053	7,382	21,650	0.36
2002	9,948	10,429	7,277	27,655	0.29
2003	12,453	11,609	6,897	30,959	0.41
2004	5,967	20,071	6,690	32,728	0.35
2005	4,853	998	4,983	10,834	0.56
2006	2,759	7,257	4,506	14,522	0.37
2007	2,068	45,867	5,719	53,654	0.50
2008	4,313	17,244	3,140	24,696	0.41
2009	2,148	19,771	3,110	25,029	0.48
2010	1,512	9,418	3,038	13,967	0.51
2011	1,090	2,181	1,628	4,899	0.69
2012	665	21,692	1,309	23,665	0.97
2013	688	1,256	1,175	3,120	0.71
2014	7	0	1,523	1,530	1.00
2015	143	3,183	1,636	4,962	0.96
2016	174	1,059	1,341	2,574	0.65
2017	16	0	913	929	1.00
2018	0	3,993	690	4,683	0.68

Table 4.12.6. Summary of weight measurements (pounds whole weight) from MRIP-intercepted Scamp and Yellowmouth Grouper by state and year. Summaries include the number of fish weighed by MRIP (Fish), the number of angler trips from which those fish were weighed (Trp), and the minimum (Min), geometric mean (Avg), and maximum (Max) size of fish weights.

	FLKeys					FLE					GA					SC					NC				
Year	Fish	Trp	Min	Avg	Max	Fish	Trp	Min	Avg	Max	Fish	Trp	Min	Avg	Max	Fish	Trp	Min	Avg	Max	Fish	Trp	Min	Avg	Max
1981	3	2	0.2	1.5	2.5	0	0	0.0	0.0	0.0	0	0	0.0	0.0	0.0	0	0	0.0	0.0	0.0	0	0	0.0	0.0	0.0
1982	0	0	0.0	0.0	0.0	2	2	0.7	2.4	4.1	0	0	0.0	0.0	0.0	0	0	0.0	0.0	0.0	0	0	0.0	0.0	0.0
1983	0	0	0.0	0.0	0.0	0	0	0.0	0.0	0.0	0	0	0.0	0.0	0.0	11	2	3.4	10.2	18.2	0	0	0.0	0.0	0.0
1984	6	2	0.9	2.3	5.5	1	1	1.1	1.1	1.1	0	0	0.0	0.0	0.0	0	0	0.0	0.0	0.0	2	1	3.3	3.3	3.3
1985	0	0	0.0	0.0	0.0	3	3	2.4	3.6	4.4	1	1	16.5	16.5	16.5	0	0	0.0	0.0	0.0	0	0	0.0	0.0	0.0
1986	0	0	0.0	0.0	0.0	0	0	0.0	0.0	0.0	0	0	0.0	0.0	0.0	8	3	1.1	9.3	15.0	0	0	0.0	0.0	0.0
1987	0	0	0.0	0.0	0.0	0	0	0.0	0.0	0.0	0	0	0.0	0.0	0.0	3	3	2.3	7.1	12.1	9	5	3.6	8.3	19.6
1988	0	0	0.0	0.0	0.0	0	1	0.0	0.0	0.0	0	0	0.0	0.0	0.0	4	5	2.2	8.9	12.8	13	21	0.9	2.9	5.8
1989	0	0	0.0	0.0	0.0	1	1	1.8	1.8	1.8	0	0	0.0	0.0	0.0	4	4	1.1	9.0	16.5	65	23	0.5	3.7	25.0
1990	0	0	0.0	0.0	0.0	0	0	0.0	0.0	0.0	0	0	0.0	0.0	0.0	5	3	0.9	2.4	4.0	74	24	0.6	2.3	5.4
1991	0	0	0.0	0.0	0.0	0	0	0.0	0.0	0.0	0	0	0.0	0.0	0.0	9	3	8.2	10.1	15.5	37	15	1.0	3.2	6.9
1992	3	3	1.4	5.4	7.4	1	1	3.1	3.1	3.1	0	0	0.0	0.0	0.0	12	2	4.8	5.6	8.7	54	22	1.6	6.4	21.9
1993	3	3	6.3	11.8	15.7	0	0	0.0	0.0	0.0	0	0	0.0	0.0	0.0	0	0	0.0	0.0	0.0	49	16	2.0	4.4	11.0
1994	6	4	5.3	10.1	15.3	0	0	0.0	0.0	0.0	5	1	3.1	4.3	5.2	0	0	0.0	0.0	0.0	103	37	0.5	4.0	8.2
1995	0	0	0.0	0.0	0.0	0	0	0.0	0.0	0.0	0	0	0.0	0.0	0.0	0	0	0.0	0.0	0.0	2	2	3.1	6.6	10.2
1996	0	0	0.0	0.0	0.0	6	4	2.6	4.6	6.8	0	0	0.0	0.0	0.0	0	0	0.0	0.0	0.0	19	12	0.4	3.1	4.9
1997	1	1	9.3	9.3	9.3	0	0	0.0	0.0	0.0	0	0	0.0	0.0	0.0	17	6	3.3	8.3	16.4	0	0	0.0	0.0	0.0
1998	4	4	3.5	8.2	16.2	2	2	4.5	13.8	23.1	0	0	0.0	0.0	0.0	27	7	0.4	5.9	14.9	3	2	3.3	3.6	3.8
1999	4	4	2.3	4.0	5.6	24	12	4.1	13.0	39.5	23	8	6.6	15.1	21.6	2	2	4.6	6.0	7.4	5	4	2.4	3.4	3.8
2000	1	1	3.5	3.5	3.5	40	18	1.7	9.0	19.3	11	2	5.2	18.7	34.2	29	16	4.0	9.8	23.6	0	0	0.0	0.0	0.0
2001	9	5	2.7	4.6	6.3	29	14	3.0	7.1	15.5	7	5	6.1	9.8	14.2	0	0	0.0	0.0	0.0	24	13	3.6	6.5	14.4
2002	5	4	4.2	6.0	7.0	31	21	2.1	6.4	15.7	7	5	3.5	12.3	22.5	0	0	0.0	0.0	0.0	106	20	3.2	7.4	21.8
2003	3	3	2.9	4.4	5.8	51	19	3.6	9.1	23.0	20	12	4.1	16.6	46.3	3	1	2.6	3.9	6.2	32	11	3.4	6.1	12.9
2004	7	5	1.4	5.0	17.4	16	11	3.0	4.9	11.9	17	10	2.9	7.3	17.4	17	5	3.3	9.8	14.8	37	9	3.4	7.4	13.9
2005	2	2	1.7	3.2	4.6	9	6	2.9	4.6	9.1	10	5	2.9	5.0	8.8	1	1	1.5	1.5	1.5	22	7	3.0	4.9	11.1
2006	3	3	2.1	3.5	4.6	30	16	3.4	6.0	9.9	13	5	2.9	6.3	16.1	17	5	1.5	3.0	6.4	50	10	3.0	6.6	17.5
2007	15	7	1.5	4.4	9.3	38	10	1.6	7.2	12.4	4	3	2.9	8.1	16.1	5	2	1.5	6.2	12.8	36	10	3.3	6.7	15.4
2008	9	6	2.1	6.0	10.9	2	2	4.1	10.1	16.1	7	5	3.3	7.9	16.5	4	2	3.2	8.3	14.1	33	16	3.2	7.0	15.4
2009	1	1	3.1	3.1	3.1	0	0	0.0	0.0	0.0	5	4	4.0	9.5	15.9	9	5	2.6	8.1	17.6	39	14	3.2	7.1	17.6
2010	0	0	0.0	0.0	0.0	4	2	8.0	10.1	13.9	13	4	5.1	10.4	19.8	0	0	0.0	0.0	0.0	50	19	3.2	7.3	19.0

	FLKeys					FLE					GA					SC					NC				
Year	**Fish**	**Trp**	**Min**	**Avg**	**Max**	**Fish**	**Trp**	**Min**	**Avg**	**Max**	**Fish**	**Trp**	**Min**	**Avg**	**Max**	**Fish**	**Trp**	**Min**	**Avg**	**Max**	**Fish**	**Trp**	**Min**	**Avg**	**Max**
2011	0	0	0.0	0.0	0.0	2	1	4.9	5.7	6.5	2	2	5.1	9.1	13.2	0	0	0.0	0.0	0.0	26	8	3.3	8.7	19.3
2012	0	0	0.0	0.0	0.0	1	1	7.9	7.9	7.9	7	2	3.2	7.6	9.7	1	1	6.4	6.4	6.4	20	6	4.9	11.7	22.0
2013	2	1	2.8	2.8	2.8	3	3	4.3	10.5	13.6	0	0	0.0	0.0	0.0	9	2	4.0	7.9	15.2	18	8	5.4	10.1	23.1
2014	6	2	3.9	5.6	8.4	23	11	4.4	9.0	22.7	1	1	4.0	4.0	4.0	2	1	4.9	5.6	6.4	9	3	6.3	11.7	22.7
2015	0	0	0.0	0.0	0.0	1	1	9.9	9.9	9.9	0	0	0.0	0.0	0.0	8	1	4.0	6.6	13.4	9	4	3.5	8.2	13.9
2016	0	0	0.0	0.0	0.0	9	7	3.8	8.5	15.2	1	1	17.4	17.4	17.4	4	4	4.0	7.9	14.8	4	3	3.5	8.1	14.8
2017	1	1	17.2	17.2	17.2	5	3	3.2	10.8	18.7	0	0	0.0	0.0	0.0	8	2	5.7	8.8	12.3	0	0	0.0	0.0	0.0
2018	1	1	4.0	4.0	4.0	2	2	3.8	6.7	9.6	0	0	0.0	0.0	0.0	2	1	7.3	9.8	12.3	8	4	5.3	11.6	23.1

Table 4.12.7. Summary of weight measurements (kilograms whole weight) from SRHS-intercepted Scamp and Yellowmouth Grouper by state and year. Summaries include the number of fish weighed by SRHS (Fish), the number of angler trips from which those fish were weighed (Trips), and the geometric mean (Mean), minimum (Min), and maximum (Max) size of fish weights.

	FLE/GA					NC					SC					South Atlantic				
YEAR	Fish (n)	Trips (n)	Mean (kg)	Min (kg)	Max (kg)	Fish (n)	Trips (n)	Mean (kg)	Min (kg)	Max (kg)	Fish (n)	Trips (n)	Mean (kg)	Min (kg)	Max (kg)	Fish (n)	Trips (n)	Mean (kg)	Min (kg)	Max (kg)
1972						145	36	4.63	1.59	12.08	231	72	4.52	1.36	19.07	376	108	4.57	1.36	19.07
1973						202	60	3.80	1.14	10.55	179	76	4.65	0.91	14.53	381	136	4.23	0.91	14.53
1974						210	45	3.93	1.14	7.81	185	70	4.81	1.41	9.08	395	115	4.37	1.14	9.08
1975						344	76	4.10	0.25	17.48	130	55	5.58	1.77	10.43	474	131	4.84	0.25	17.48
1976	3	2	7.57	6.72	8.63	771	124	4.53	0.27	8.85	77	40	6.23	1.04	12.03	851	166	6.11	0.27	12.03
1977	18	13	4.39	1.50	9.31	364	78	4.31	0.23	9.40	79	40	6.13	0.86	9.13	461	131	4.94	0.23	9.40
1978	38	24	3.05	0.48	9.74	218	57	4.23	0.50	15.89	57	31	5.58	0.37	11.50	313	112	4.29	0.37	15.89
1979	59	34	1.92	0.36	10.30	112	39	3.73	0.42	9.13	20	11	4.38	1.04	8.15	191	84	3.34	0.36	10.30
1980	83	39	1.93	0.20	9.75	81	31	2.83	0.58	10.70	12	11	3.03	1.45	7.65	176	81	2.60	0.20	10.70
1981	99	61	2.03	0.25	8.10	20	11	2.64	0.50	5.20	9	7	2.17	0.38	5.90	128	79	2.28	0.25	8.10
1982	86	47	2.37	0.50	6.90	145	55	2.93	0.18	10.50	31	23	2.33	0.23	5.10	262	125	2.54	0.18	10.50
1983	190	93	2.14	0.32	8.80	155	64	2.79	0.32	7.50	104	47	3.06	0.42	8.95	449	204	2.66	0.32	8.95
1984	167	82	2.41	0.22	10.70	177	62	2.41	0.40	9.31	148	77	3.11	0.22	8.40	492	221	2.64	0.22	10.70
1985	203	87	2.09	0.10	7.80	150	69	2.25	0.27	8.18	132	57	2.57	0.44	9.30	485	213	2.30	0.10	9.30

1986	86	47	1.89	0.14	8.45	201	99	2.03	0.19	9.15	140	61	2.41	0.22	8.20	427	207	2.11	0.14	9.15
1987	43	27	1.61	0.14	5.65	288	145	1.27	0.14	9.00	234	92	1.90	0.23	8.80	565	264	1.59	0.14	9.00
1988	41	26	1.60	0.08	4.80	301	131	1.12	0.13	11.22	134	66	2.08	0.34	9.73	476	223	1.60	0.08	11.22
1989	21	15	1.67	0.11	3.45	233	90	1.17	0.19	8.60	109	51	1.93	0.17	7.92	363	156	1.59	0.11	8.60
1990	29	20	1.82	0.44	3.80	160	60	0.94	0.09	5.16	150	55	2.12	0.22	8.00	339	135	1.63	0.09	8.00
1991	17	11	3.79	1.26	8.47	324	87	1.33	0.12	10.06	68	36	2.28	0.38	7.33	409	134	2.47	0.12	10.06
1992	20	18	3.68	1.43	10.50	83	38	2.77	0.74	6.60	176	50	2.41	0.69	6.30	279	106	2.95	0.69	10.50
1993	15	14	2.50	1.52	4.77	129	60	3.03	0.72	10.44	195	52	2.54	0.47	8.10	339	126	2.69	0.47	10.44
1994	33	13	2.82	1.28	8.56	33	20	1.98	1.23	6.99	276	72	2.42	0.94	6.68	342	105	2.41	0.94	8.56
1995	29	21	2.15	1.43	4.03	19	13	3.00	1.62	7.14	322	80	2.28	0.18	7.76	370	114	2.48	0.18	7.76
1996	13	12	2.67	1.37	4.62	35	24	2.89	0.76	7.08	234	66	2.65	0.82	7.57	282	102	2.74	0.76	7.57
1997	38	22	2.67	0.50	9.36	57	27	3.55	1.40	8.43	265	68	2.24	0.98	7.55	360	117	2.82	0.50	9.36
1998	44	26	2.67	0.60	10.69	59	32	2.94	1.36	9.66	290	65	2.19	0.93	6.89	393	123	2.60	0.60	10.69
1999	23	15	2.79	1.54	5.04	59	29	3.57	1.35	7.64	265	50	2.20	0.88	7.11	347	94	2.85	0.88	7.64
2000	26	22	3.19	1.47	6.91	74	36	3.88	1.33	9.08	123	41	2.28	1.21	5.54	223	99	3.11	1.21	9.08
2001	19	14	2.85	1.38	7.82	122	55	2.91	0.50	9.96						141	69	2.88	0.50	9.96
2002	21	18	3.64	1.51	8.14	38	14	2.65	1.44	6.11	79	28	2.55	0.88	7.23	138	60	2.95	0.88	8.14
2003	18	11	2.94	1.49	8.36	27	12	2.89	1.67	7.44	164	64	2.52	0.80	7.53	209	87	2.78	0.80	8.36
2004	5	5	4.18	1.76	6.32	31	20	3.22	1.58	9.68	38	16	2.75	0.32	6.86	74	41	3.39	0.32	9.68
2005	6	5	2.31	1.41	4.46	37	22	3.58	1.19	7.56	25	8	3.57	1.02	7.77	68	35	3.16	1.02	7.77
2006	12	8	3.14	1.36	5.80	18	11	2.88	1.35	8.72	62	37	2.66	0.23	6.61	92	56	2.89	0.23	8.72
2007	10	9	2.18	1.58	3.61	21	14	3.02	1.35	4.29	100	45	2.71	1.31	7.80	131	68	2.64	1.31	7.80
2008	12	10	2.76	1.73	6.39	13	7	2.17	1.56	3.25	52	23	2.63	1.32	5.55	77	40	2.52	1.32	6.39
2009	11	10	2.82	1.64	6.87	13	6	3.57	1.82	6.91	68	26	2.77	1.37	6.12	92	42	3.05	1.37	6.91
2010	5	5	3.30	1.62	5.59	9	6	2.46	1.45	3.48	45	19	2.75	1.27	7.09	59	30	2.84	1.27	7.09
2011	3	3	2.96	1.85	4.07	4	3	5.34	1.64	11.00	7	7	2.33	1.34	3.15	14	13	3.55	1.34	11.00
2012	37	17	2.24	1.19	5.38	13	6	4.48	1.62	8.23	16	7	3.00	1.43	6.47	66	30	3.24	1.19	8.23
2013	32	14	2.62	0.85	5.09	24	11	5.14	1.65	10.64	59	19	3.06	1.41	6.27	115	44	3.61	0.85	10.64
2014	19	14	3.20	1.03	7.27	20	9	4.37	0.23	9.20	21	10	4.07	1.68	7.46	60	33	3.88	0.23	9.20
2015	23	12	2.36	1.32	5.94	16	7	2.68	1.59	6.79	4	2	3.20	1.63	4.89	43	21	2.74	1.32	6.79
2016	55	20	2.96	0.70	14.20	8	8	3.02	1.57	5.10	19	13	3.35	1.56	6.90	82	41	3.11	0.70	14.20
2017	16	10	3.55	0.80	7.60	6	6	3.64	1.67	8.25	14	8	3.04	1.58	5.57	36	24	3.41	0.80	8.25
2018	7	3	3.13	1.55	4.53	5	3	3.45	1.37	5.39	32	15	3.36	1.60	8.56	44	21	3.31	1.37	8.56

Table 4.12.8. Number of aged and positive trips sampled in the recreational fishery by year and state, 1972-2018.

	CH				PR				HB (SRHS)					
	FL		NC		FL		NC		FLE/GA		NC		SC	
Year	Fish (n)	Trips (n)	Fish (n)	Trips (n)	Fish (n)	Trips (n)	Fish (n)	Trips (n)	Fish (n)	Trips (n)	Fish (n)	Trips (n)	Fish (n)	Trips (n)
1979									5	3				
1980									33	19	6	3	2	2
1981									53	34	3	1		
1982									3	3	2	2		
1983									6	4			1	1
1984									1	1				
1989													5	3
1991											1	1		
1993											1	1		
1995									3	2			9	1
1996									2	2	4	3	119	42
1997											2	1		
2000													1	1
2001	6	4							1	1				
2002	44	22											4	3
2003	60	33									1	1		
2004	87	42									3	3		
2005	86	42							3	1	12	11		
2006	59	17							7	7			26	26
2007	15	5							9	7	4	4	33	33
2008									5	4	1	1	17	17
2009	9	3							17	14	2	1	40	22
2010	2	1	7	2			2	1	8	5	7	6	27	17
2011	1	1							3	3			6	6
2012									25	13	10	6	11	7
2013	2	1							19	10	17	11	25	13
2014					1	1			17	13	19	9	6	4
2015									16	8	11	7	2	2
2016							2	1	44	20	5	5	6	6
2017	3	3							14	9	6	4	5	4
2018							5	4	6	3	8	5	13	8

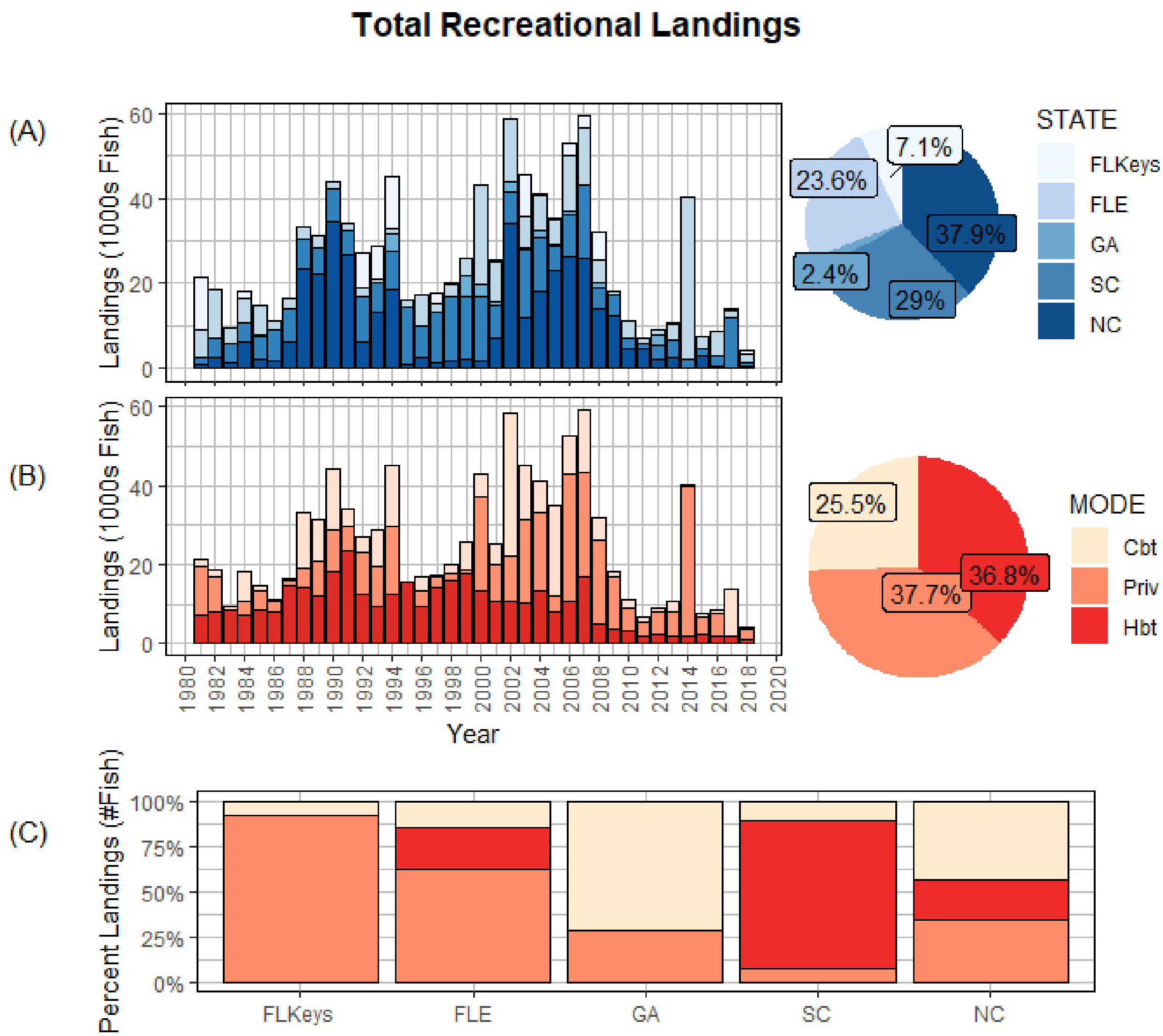
Table 4.12.9. Estimated SRHS headboat effort (in angler days) for South Atlantic anglers. Due to headboat area definitions and confidentiality issues, estimates of SRHS effort are combined for eastern Florida and Georgia.

Year	FLE/GA	NC	SC	Total
1981	298,883	19,374	59,030	377,287
1982	293,133	26,939	67,539	387,611
1983	277,863	23,830	65,733	367,426
1984	288,994	28,865	67,314	385,173
1985	280,845	31,384	66,001	378,230
1986	317,058	31,187	67,227	415,472
1987	333,041	35,261	78,806	447,108
1988	301,775	42,421	76,468	420,664
1989	316,864	38,678	62,708	418,250
1990	322,895	43,240	57,151	423,286
1991	280,022	40,936	67,982	388,940
1992	264,523	41,176	61,790	367,489
1993	236,973	42,786	64,457	344,216
1994	242,781	36,691	63,231	342,703
1995	210,714	40,295	61,739	312,748
1996	199,857	35,142	54,929	289,928
1997	173,273	37,189	60,150	270,612
1998	155,341	37,399	61,342	254,082
1999	164,052	31,596	55,499	251,147
2000	182,249	31,351	40,291	253,891
2001	163,389	31,779	49,265	244,433
2002	151,546	27,601	42,467	221,614
2003	145,011	22,998	36,556	204,565
2004	175,400	27,255	48,763	251,418
2005	172,839	31,573	34,036	238,448
2006	175,522	25,736	56,074	257,332
2007	157,150	29,002	60,729	246,881
2008	123,943	17,158	47,287	188,388
2009	136,420	19,468	40,919	196,807
2010	123,662	21,071	44,951	189,684
2011	132,492	18,457	44,645	195,594
2012	147,699	20,766	41,003	209,468
2013	165,679	20,547	40,963	227,189
2014	195,890	22,691	42,025	260,606
2015	194,979	22,716	39,702	257,397
2016	196,660	21,565	42,207	260,432
2017	126,126	20,170	36,914	183,210
2018	120,560	16,813	37,611	174,984

Table 4.12.10. Total recreational fishing effort (in angler trips) for South Atlantic anglers by mode and year (MRIP, SRHS).

Year	Cbt	Hbt	Priv	Total
1981	443,445	390,850	11,061,600	11,895,895
1982	543,344	493,679	13,686,090	14,723,113
1983	549,886	442,655	12,624,744	13,617,284
1984	631,740	574,202	15,880,341	17,086,283
1985	647,288	590,477	13,834,345	15,072,111
1986	734,582	624,372	15,120,221	16,479,175
1987	684,175	642,224	16,117,325	17,443,724
1988	574,659	578,118	13,538,214	14,690,992
1989	703,403	591,441	15,444,757	16,739,601
1990	594,310	601,884	14,473,240	15,669,434
1991	615,933	573,907	16,717,086	17,906,926
1992	574,093	548,672	16,543,089	17,665,854
1993	617,079	489,219	17,777,777	18,884,076
1994	632,200	509,688	17,436,754	18,578,642
1995	647,404	468,511	16,353,858	17,469,773
1996	632,194	476,781	17,329,456	18,438,432
1997	574,241	410,943	17,753,982	18,739,166
1998	618,206	376,149	17,065,966	18,060,321
1999	555,961	423,607	17,628,410	18,607,978
2000	514,365	457,442	20,705,579	21,677,385
2001	600,971	416,386	19,463,855	20,481,212
2002	693,754	387,978	20,401,196	21,482,928
2003	658,098	393,916	22,137,279	23,189,293
2004	663,047	457,115	21,673,683	22,793,844
2005	614,999	450,385	22,332,397	23,397,782
2006	588,260	474,955	24,764,335	25,827,551
2007	630,150	376,793	25,901,061	26,908,003
2008	545,399	285,972	24,141,904	24,973,275
2009	558,034	287,905	24,949,760	25,795,698
2010	483,966	285,752	26,837,256	27,606,973
2011	509,413	297,725	24,406,769	25,213,907
2012	537,932	331,077	22,770,757	23,639,766
2013	518,665	357,846	22,554,404	23,430,914
2014	619,611	419,851	24,333,837	25,373,299
2015	693,462	420,472	23,251,246	24,365,180
2016	716,062	428,292	22,540,147	23,684,501
2017	677,522	282,493	22,440,708	23,400,722
2018	723,594	267,265	23,909,857	24,900,716

4.13 FIGURES



	FLKeys	FLE	GA	SC	NC
Cbt	5,786	33,699	16,484	29,597	161,420
Hbt	0	52,284	0	230,267	79,653
Priv	63,754	144,481	6,769	22,724	128,070

Figure 4.13.1. Total recreational landings (AB1) for South Atlantic Scamp and Yellowmouth Grouper across all surveys (MRIP and SRHS). Landings are provided (A) by state and year (1981-2018) in thousands of fish, (B) by mode and year in thousands of fish, and (C) by mode and state in numbers of fish (as a percentage). Due to headboat area definitions and confidentiality issues, estimates of SRHS landings are combined for eastern Florida and Georgia, which is allocated as eastern Florida landings.

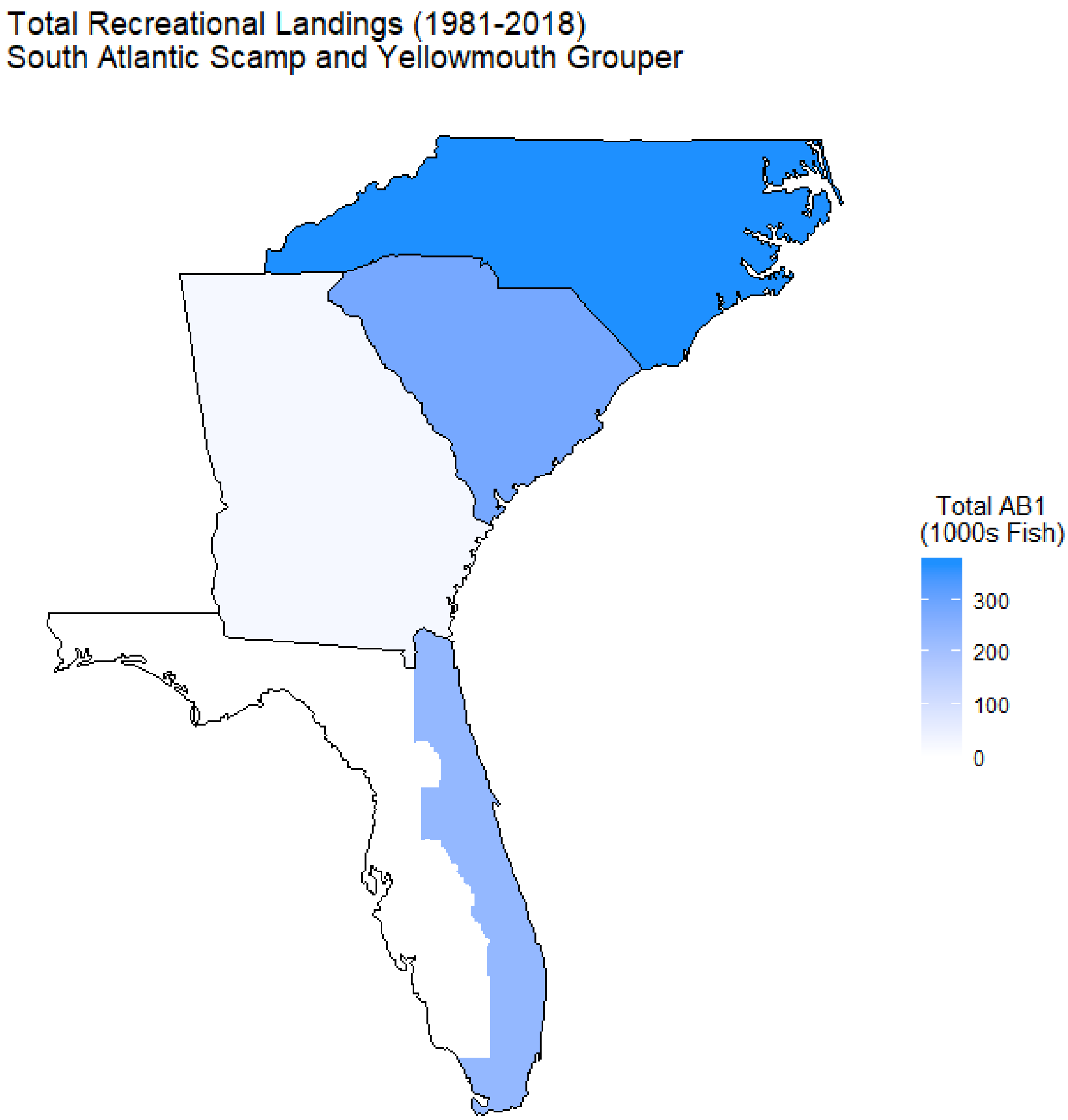


Figure 4.13.2. Distribution of total recreational landings (AB1), in thousands of fish, for Scamp and Yellowmouth Grouper across the South Atlantic. Estimates are combined across all surveys (MRIP and SRHS) and years (1981-2018). East Florida landings include the Florida Keys. Due to headboat area definitions and confidentiality issues, estimates of SRHS landings are combined for eastern Florida and Georgia, which is allocated as eastern Florida landings.

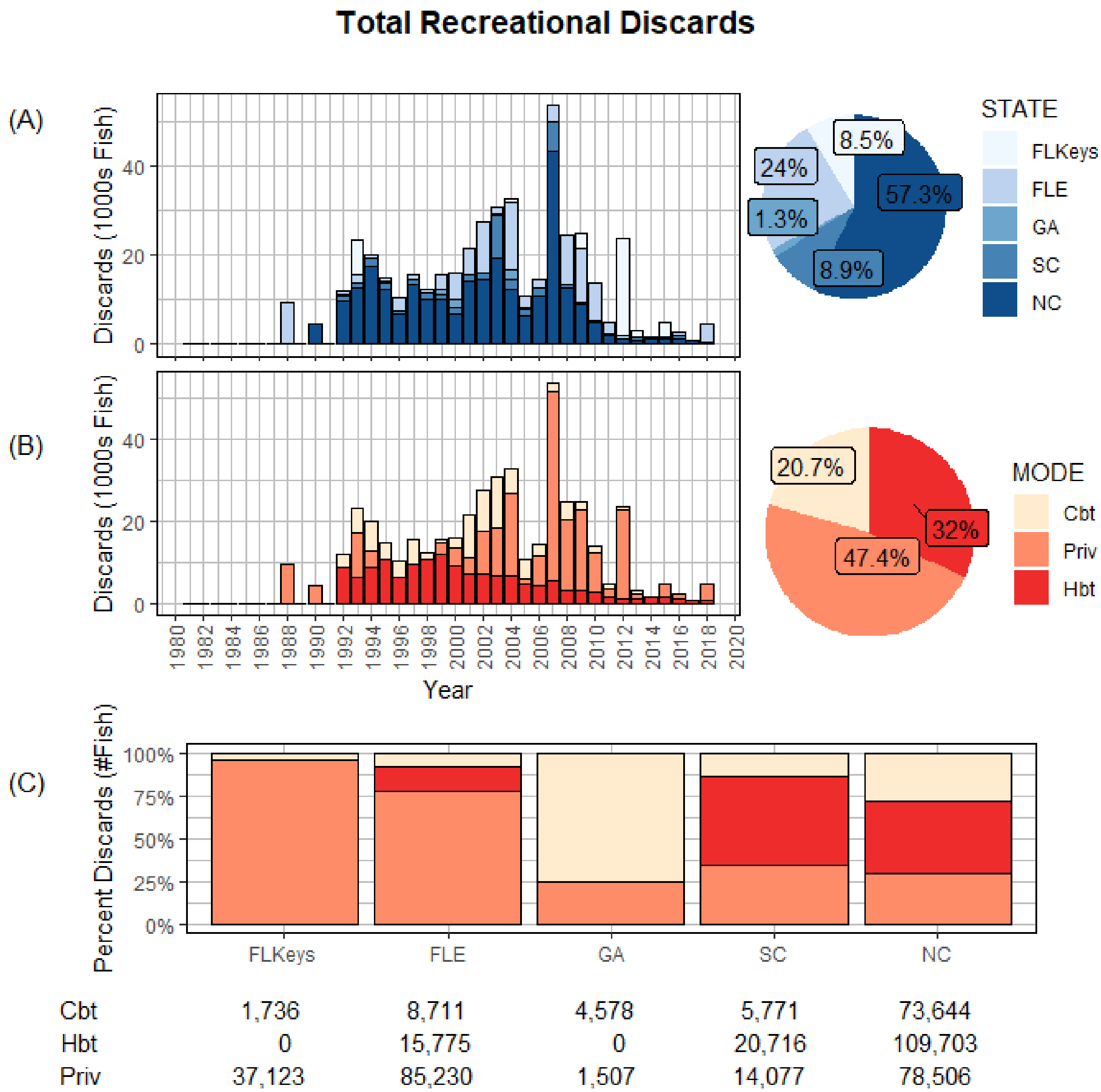


Figure 4.13.3. Total recreational discards (B2) for South Atlantic Scamp and Yellowmouth Grouper across all surveys (MRIP and SRHS). Discards are provided (A) by state and year (1981-2018) in thousands of fish, (B) by mode and year in thousands of fish, and (C) by mode and state in numbers of fish (as a percentage). Due to headboat area definitions and confidentiality issues, estimates of SRHS discards are combined for eastern Florida and Georgia, which is allocated as eastern Florida discards.

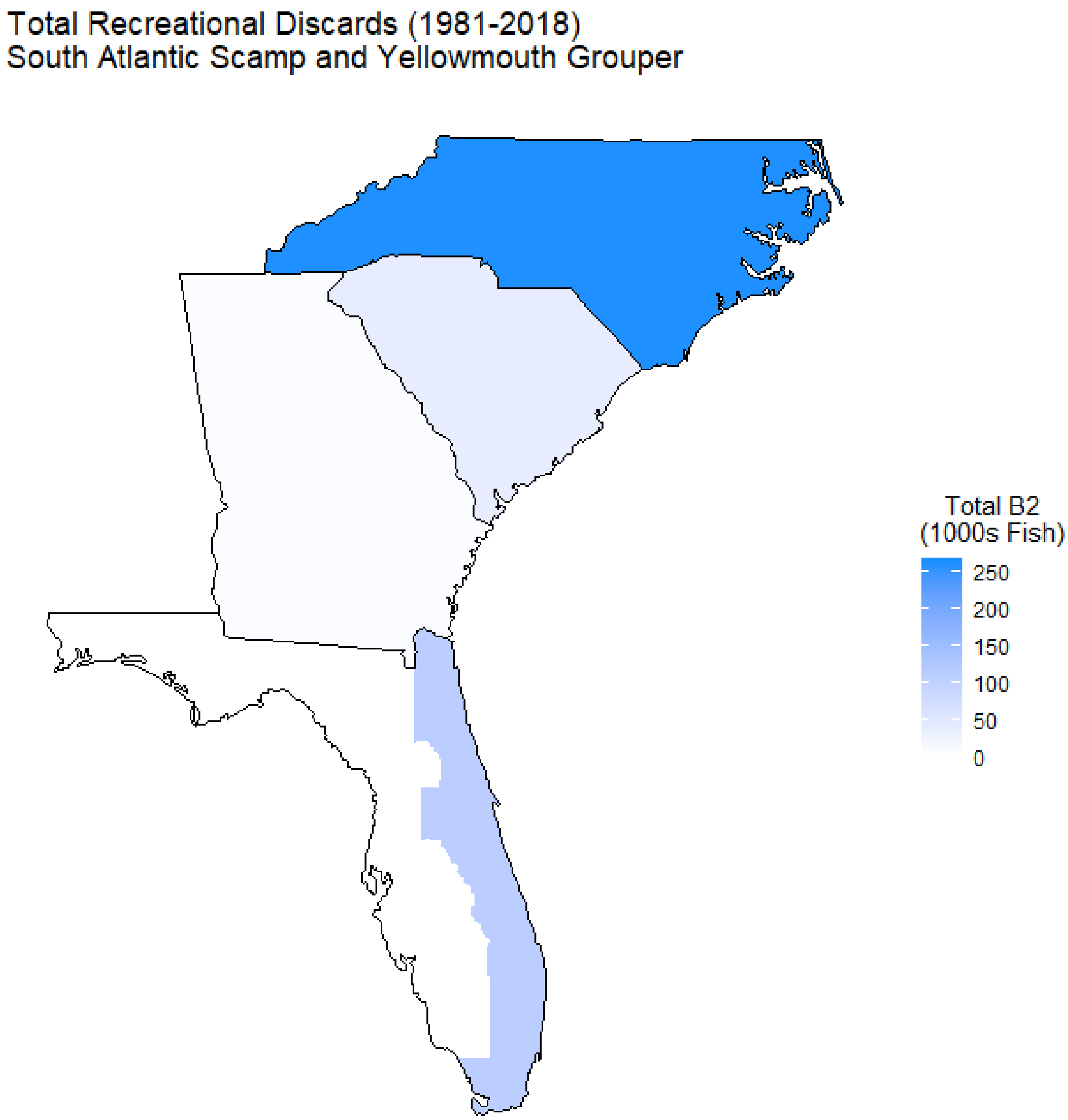
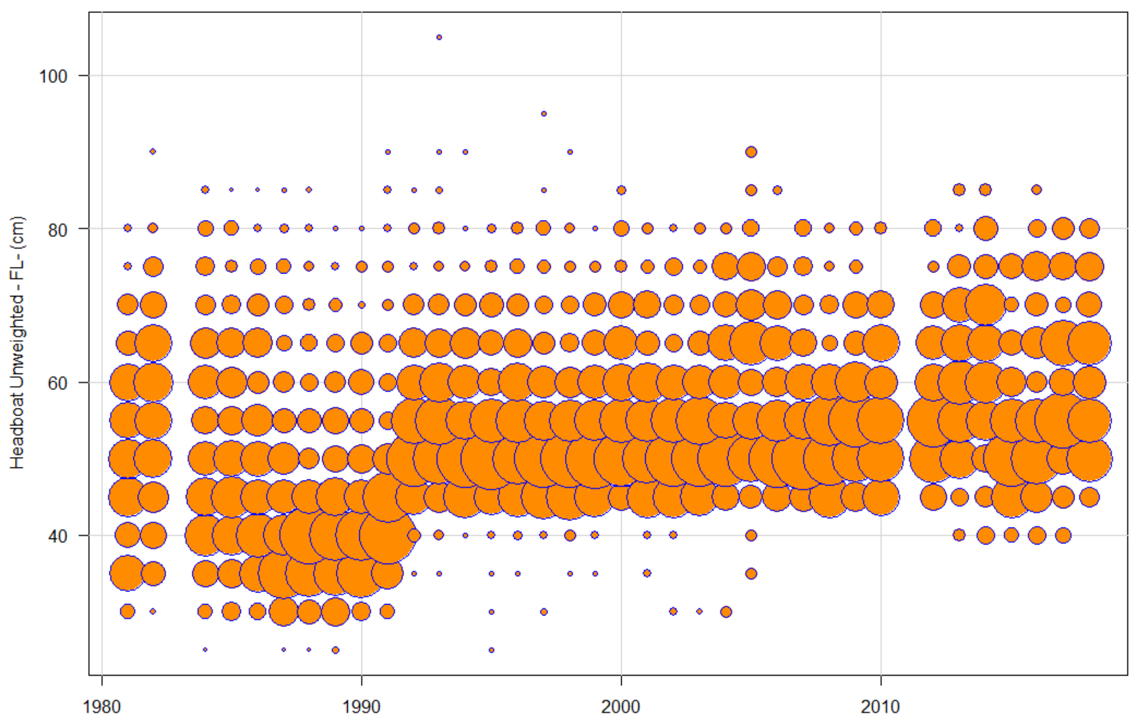


Figure 4.13.4. Distribution of total recreational discards (B2), in thousands of fish, for Scamp and Yellowmouth Grouper across the South Atlantic. Estimates are combined across all surveys (MRIP and SRHS) and years (1981-2018). East Florida landings include the Florida Keys. Due to headboat area definitions and confidentiality issues, estimates of SRHS discards are combined for eastern Florida and Georgia, which is allocated as eastern Florida discards.

(A)



(B)

Figure 4.13.5. Nominal length frequency distribution of the MRIP CHPR (A) and SRHS headboat fishery (B) in the South Atlantic.

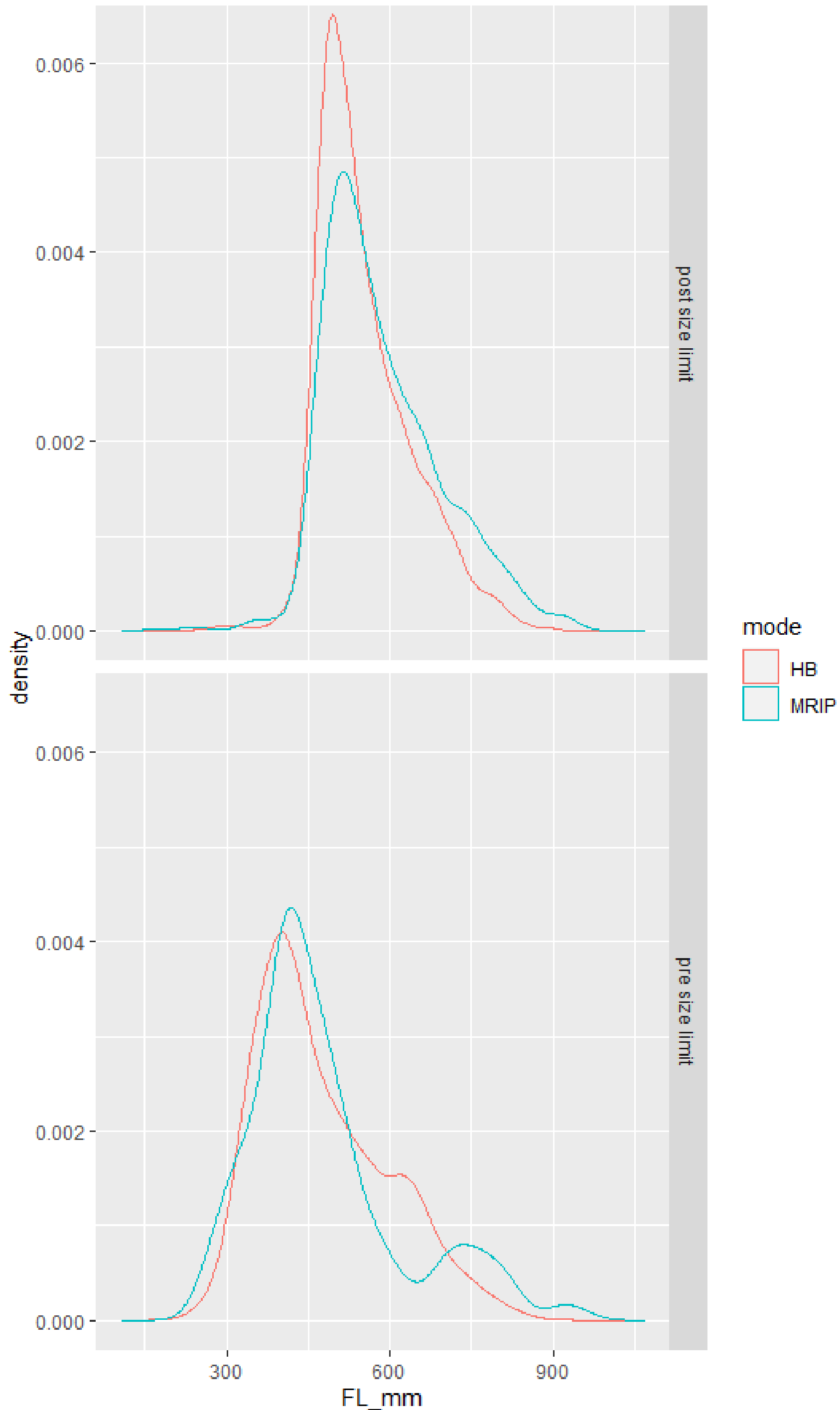


Figure 4.13.6. Nominal length frequency distribution of the MRIP CHPR and SRHS headboat fishery in the South Atlantic pre- and post- size limit.

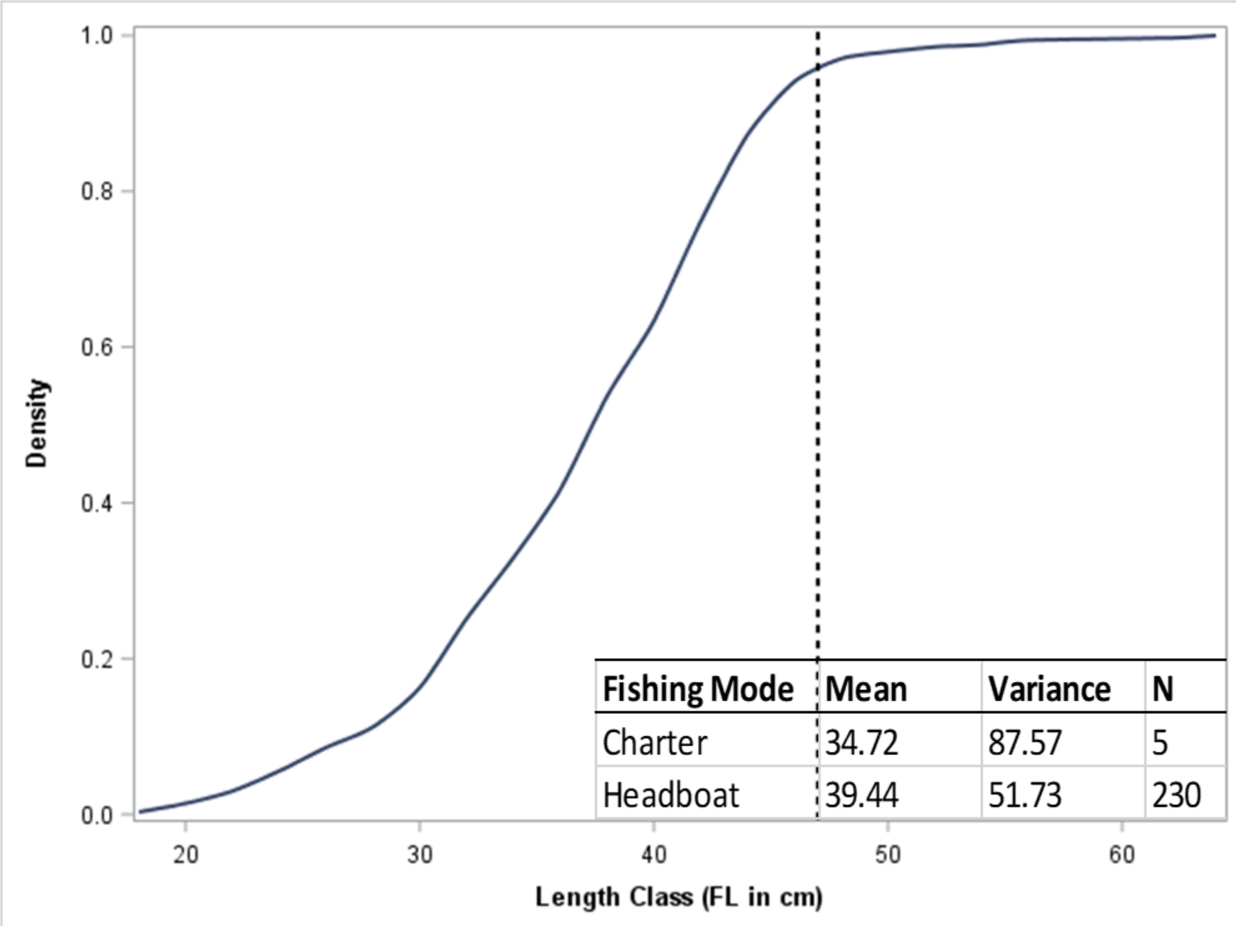
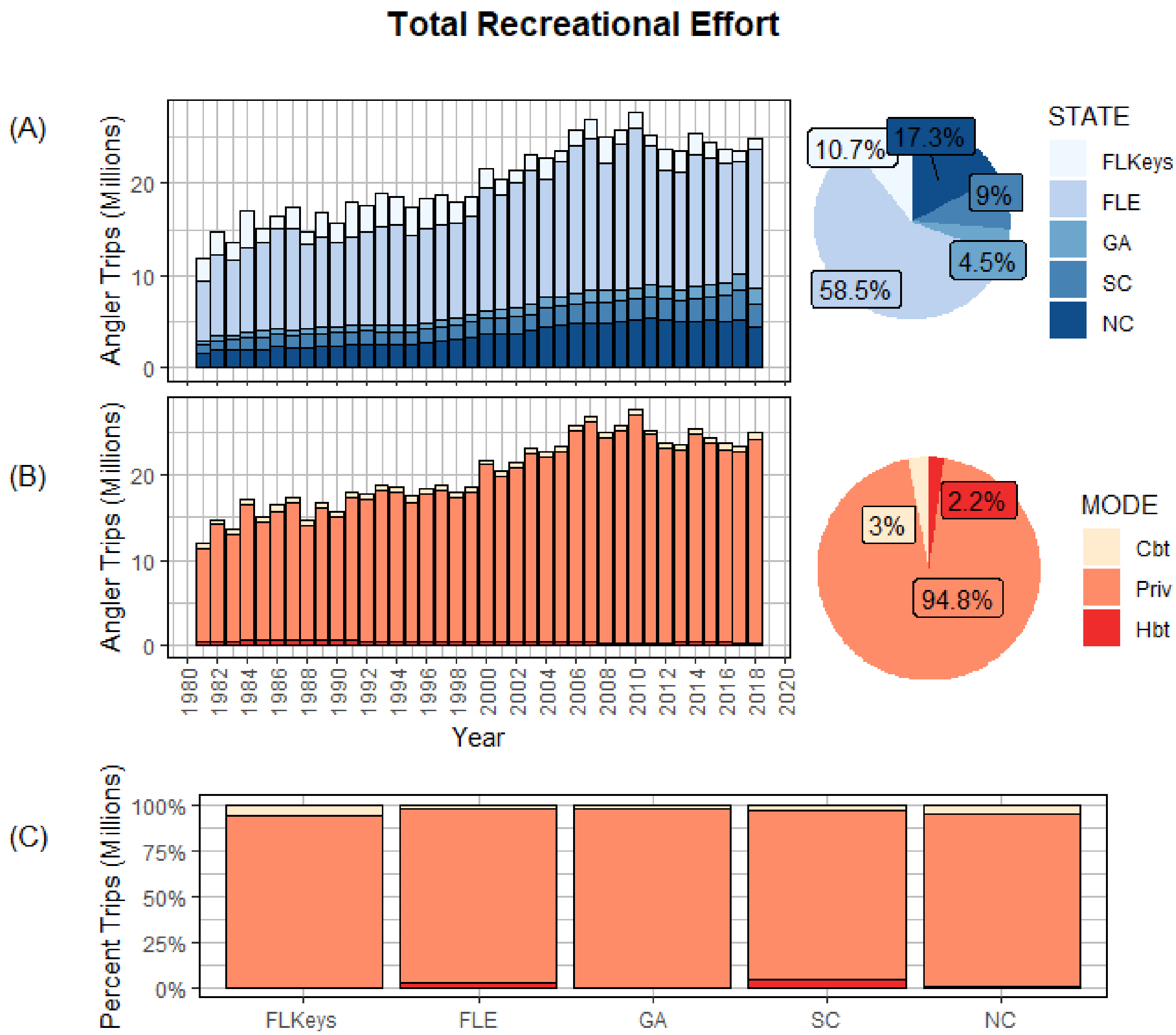


Figure 4.13 7. Cumulative frequency distribution for Scamp and Yellowmouth Grouper discard lengths collected from the South Atlantic headboat fishery from 2005 to 2017, all years combined. The dotted line represents the fork length associated with the current South Atlantic recreational minimum size limit of 20 inches total length.



	FLKeys	FLE	GA	SC	NC
Cbt	5	8	1	2	7
Hbt	0	13	0	3	1
Priv	78	433	34	65	126

Figure 4.13.8. Total recreational fishing effort for South Atlantic anglers in millions of angler trips (MRIP and SRHS). Effort is provided (A) by state and year (1981-2018), (B) by mode and year, and (C) by mode and state (as a percentage). Due to headboat area definitions and confidentiality issues, estimates of SRHS effort are combined for eastern Florida and Georgia, which is allocated as eastern Florida effort.

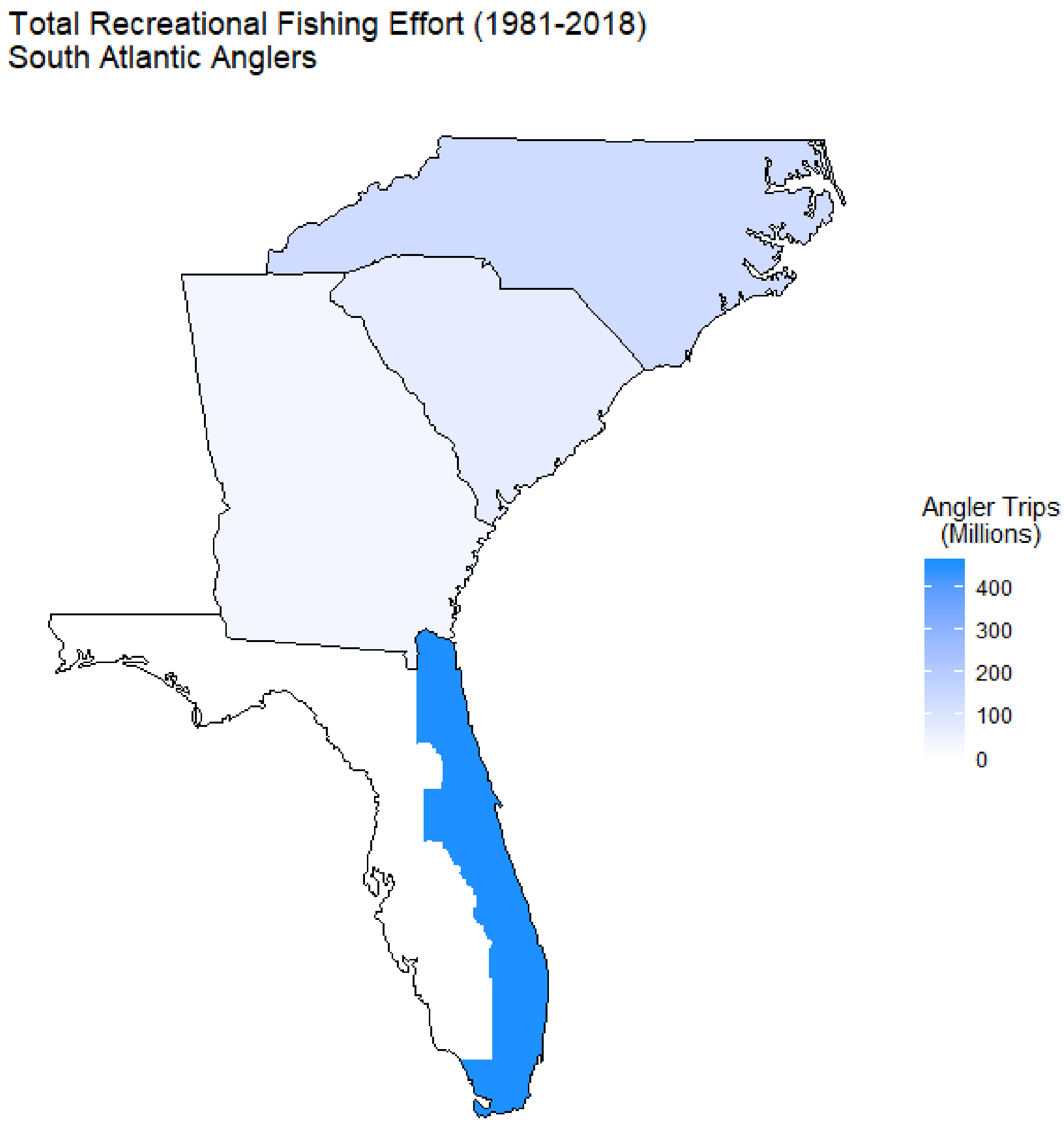


Figure 4.13.9. Distribution of total recreational fishing effort by South Atlantic anglers. Estimates are combined across all surveys (MRIP and SRHS) and years (1981-2018). East Florida landings include the Florida Keys. Due to headboat area definitions and confidentiality issues, estimates of SRHS effort are combined for eastern Florida and Georgia, which is allocated as eastern Florida effort.

5 INDICES OF POPULATION ABUNDANCE

5.1 OVERVIEW

For the South Atlantic U.S. region, four fishery independent data sets were considered for use as an index of abundance (Table 5.1). During the data webinar prior to the DW, one of these datasets was discarded because of small sample sizes and limited geographic extent. Two fishery independent data sets were retained for further consideration at the DW: SERFS chevron traps and SERFS video survey.

For the South Atlantic U.S. region, five fishery dependent data sets were considered for use as an index of abundance (Table 5.1). During the data webinars, three were recommended for further consideration at the DW. Ultimately, the DW recommended indices from two of these fishery dependent data sets for potential use in the assessment model: recreational headboat logbook index and commercial handline logbook index.

In total, the DW recommended two fishery independent indices (SERFS chevron traps and video survey) and two fishery dependent indices (recreational headboat index and a commercial handline index) for potential use in the scamp and yellowmouth grouper stock assessment. These indices are listed in Table 5.1, with pros and cons of each in Table 5.2.

5.1.1 Group membership

Membership of this DW Index Working Group (IWG) included Nate Bacheler, Wally Bubley, Rob Cheshire, Eric Fitzpatrick, Chris Gardner, Robert Leaf, Kevin McCarthy, Kate Overly, Will Patterson, Skyler Sagarese, Alexei Sharov, Kyle Shertzer, Tracy Smart, Ted Switzer, Kevin Thompson and Jim Tolan. Several other DW panelists and observers contributed to the IWG discussions throughout the Data Workshop webinars.

5.2 REVIEW OF WORKING PAPERS

The relevant working papers describing index construction were presented to the IWG (SEDAR 68-DW-01, SEDAR 68-DW-02, SEDAR 68-DW-03, SEDAR 68-DW-04 and SEDAR 68-DW-06). In most cases, the IWG recommended modifications to the initial modeling attempts, such that data treatments and/or model specifications were updated during the DW. Final working papers reflect decisions made during the DW, using addenda if necessary.

The index working papers provide information on methodology, sample sizes, diagnostics of model fits, and in some cases, maps of catch and effort. A summary of each index is provided below.

5.3 FISHERY-INDEPENDENT INDICES

Until 2009, virtually all fishery independent sampling of reef fishes in southeast U.S. Atlantic waters was conducted by the Marine Resources Monitoring, Assessment, and Prediction (MARMAP) program. In 2009, the Southeast Area Monitoring and Assessment Program – South Atlantic (SEAMAP-SA) program joined the chevron trap survey through their Reef Fish Complement. In 2010, the Southeast Fisheries Independent Survey (SEFIS) was created and joined the chevron trap survey. The partner-led survey is now referred to as the Southeast Reef Fish Survey (SERFS). With the advent of the partner programs, sampling coverage in the region has expanded, primarily in Florida. SERFS now samples between Cape Hatteras, North Carolina and St. Lucie Inlet, Florida, and it targets a sampling universe of approximately 4,300 sites of hard-bottom habitats between approximately 15 and 100 meters deep.

5.3.1 Chevron trap

5.3.1.1 Methods, Gears, and Coverage

Chevron traps were baited with whole and cut Clupeids and deployed at stations randomly selected by computer from a database of live bottom stations on the continental shelf and shelf edge and soaked for approximately 90 minutes.

An index of abundance was developed by standardizing catch (number of scamp and yellowmouth grouper caught) using a zero-inflated negative binomial model (SEDAR68-DW-04; Zuur et al. 2009). Effort (trap soak minutes) was included as an offset in the regression. Analyses were computed using the *pscl* library in R (Jackman 2008; Zeileis et al 2008; R Development Core Team 2014). Model covariates included sampling characteristics and environmental data.

5.3.1.2 Sampling Intensity and Time Series

Chevron traps were deployed from 1990 through 2018, ranging from 224 to 1736 traps per year meeting the covariate criteria for this analysis. SERFS/MARMAP chevron trap sampling adequately covers the center of distribution of Scamp/Yellowmouth Grouper (SC/NC) since the inception of the survey. Proportion positive catches have consistently been under 0.05 since 2008. The cause of this is unknown, but could be related to a combination of reduced abundance and a sampling artefact of increased effort in areas of lower abundance, such as Florida. The annual number of traps (collections) used to compute the index is shown in Table 5.3.

5.3.1.3. Size/Age data

The ages of scamp and yellowmouth grouper collected by chevron traps (1990-2018) ranged from 0 to 30 (median = 5, mean = 6.5, n= 1897), and sizes ranged from 18 to 88 cm fork length. Age composition data are available for estimating the selectivity of this gear.

5.3.1.4. Catch Rates

Standardized catch rates are shown in Table 5.3 and in Figure 5.1 (top panel). The units on catch rates are in numbers of fish. Effort was modeled as an offset, rather than as the denominator in the response variable.

5.3.1.5. Uncertainty and Measures of Precision

Measures of precision were computed using a bootstrap procedure, in which 5,000 sampling events were drawn at random with replacement. The CVs are shown in Table 5.3.

5.3.1.6 Comments on Adequacy for Assessment

This index was considered to be adequate for the assessment, with sample sizes in the time series being sufficiently large to create a meaningful index. Recent years of the survey show a reduced proportion positive, but the cause is unknown. Because the chevron trap index is fishery independent and has accompanying selectivity information (lengths and ages), it was considered by the IWG to be the highest ranking source of information on trends in population abundance.

One issue discussed by the group, was the non-independence between chevron traps and the video survey and the potential for different selectivities between gears. In recent assessments for different species, the chevron trap and video indices were combined and a common selectivity was assigned because the video index did not have any age or length compositions directly associated with it to inform selectivity. There was discussion as to how to treat the two indices, whether to combine them and either assign one selectivity or explore a means to assign a selectivity to each component or to have them input as separate indices even though they are not independent.

5.3.2 Video Survey

5.3.2.1 Methods, Gears, and Coverage

The Marine Resources Monitoring, Assessment, and Prediction (MARMAP) program has conducted most of the historical fishery-independent sampling in the U.S. South Atlantic (North Carolina to Florida). MARMAP has used a variety of gears over time, but chevron traps are one of the primary gears used to monitor reef fish species and have been deployed since the late 1980s. In 2009, MARMAP began receiving additional funding to monitor reef fish through the SEAMAP-SA program. In 2010, the SouthEast Fishery-Independent Survey (SEFIS) was initiated by NMFS to work collaboratively with MARMAP/SEAMAP-SA using identical methods to collect additional fishery-independent samples in the region. Together, these three programs are now called the Southeast Reef Fish Survey (SERFS). In 2010, video cameras were attached to some traps deployed by SERFS, and beginning in 2011 all traps included video cameras.

The SERFS currently samples between Cape Hatteras, North Carolina and St. Lucie Inlet, Florida. This survey targets hardbottom habitats between approximately 15 and 100 meters deep. SERFS began affixing high-definition video cameras to chevron traps on a limited basis in 2010 (Georgia and Florida only), but since 2011 has attached cameras to all chevron traps as part of their normal monitoring efforts. In 2015, the video cameras were changed from Canon to GoPro, to implement a wider field of view and thus observe more fish. A calibration study (detailed below) with both camera types used simultaneously was undertaken to account for differences in fish counts.

Hard-bottom sampling stations were selected for sampling in one of three ways. First, most sites were randomly selected from the SERFS sampling frame that consisted of approximately 3,000 sampling stations on or very near hard bottom habitat. Second, some stations in the sampling frame were sampled opportunistically even though they were not randomly selected for sampling in a given year. Third, new hard-bottom stations were added during the study period through the use of information from various sources including fishermen, charts, and historical surveys. These new locations were investigated using a vessel echosounder or drop cameras and sampled if hard bottom was detected. Only those new stations landing on hardbottom habitat were included in the analyses. All sampling for this study occurred during daylight hours between April and October on the R/V *Savannah*, R/V *Palmetto*, R/V *Sand Tiger*, or the NOAA Ship *Pisces* using identical methodologies as described below. Samples were intentionally spread out spatially on each cruise.

Chevron traps were constructed from plastic-coated, galvanized 2-mm diameter wire (mesh size = 3.4 cm^2) and measured 1.7 m × 1.5 m × 0.6 m, with a total volume of 0.91 m^3. Trap mouth openings were shaped like a teardrop and measured approximately 18 cm wide and 45 cm high. Each trap was baited with 24 menhaden (*Brevoortia* spp.). Traps were typically deployed in groups of six, and each trap in a set was deployed at least 200 m (usually > 400 m) from all other traps to provide some measure of independence between traps. A soak time of 90 minutes was targeted for each trap deployed.

Canon Vixia HFS-200 high-definition video cameras in Gates underwater housings were attached to chevron traps in 2011–2014, facing outward over the mouth. In 2015, Canon cameras were replaced with GoPro Hero 4 cameras over the trap mouth. Fish were counted exclusively using cameras over the trap mouth. A second high-definition GoPro Hero video or Nikon Coolpix S210/S220 still camera was attached over the nose of most traps in an underwater housing, and was used to quantify microhabitat features in the opposite direction. Cameras were turned on and set to record before traps were deployed, and were turned off after trap retrieval. Trap-video samples were excluded from our analysis if videos were unreadable for any reason (e.g., too dark, camera out of focus, files corrupt) or the traps did not fish properly (e.g., bouncing or dragging due to waves or current, trap mouth was obstructed).

In advance of the switch to GoPro cameras exclusively in 2015, we conducted a calibration study in the summer of 2014 where Canon and GoPro cameras were attached to traps side-by-side and fish were counted at the same time. A total of 54 side-by-side comparisons were recorded. Twelve samples observed scamp for both cameras and were used to develop a calibration. There were no yellowmouth grouper observed in the calibration data set.

Relative abundance of reef fish on video has been estimated using the *MeanCount* approach (Conn 2011; Schobernd et al. 2014). *MeanCount* was calculated as the mean number of individuals of each species over a number of video frames in the video sample. Video reading time was limited to an interval of 20 total minutes, commencing 10 minutes after the trap landed on the bottom to allow time for the trap to settle. One-second snapshots were read every 30 seconds for the 20-minute time interval, totaling 41 snapshots read for each video. The mean number of individuals for each target species in the 41 snapshots is the *MeanCount* for that species in each video sample. Zero-inflated modeling approaches described below require count data instead of continuous data like *MeanCount*. Therefore, these analyses used a response variable called *SumCount*, which was simply the sum of all individuals seen across all video frames. *SumCount* and *MeanCount* track exactly linearly with one another when the same numbers of video frames are used in their calculation (Bacheler and Carmichael 2014). Therefore, *SumCount* values were only used from videos where 41 frames were read (~93% of all samples).

SERFS employed video readers to count fish on videos. There was an extensive training period for each video reader, and all videos from new readers were re-read by fish video reading experts until they were very high quality. After that point, 10% or 15 videos (whichever was larger) were re-read annually by fish video reading experts as part of quality control. Video readers also quantified microhabitat features (biotic density and substrate composition), in order to standardize for habitat types sampled over time. Water clarity was also scored for each sample as poor, fair, or good. If bottom substrate could not be seen, then water clarity was considered poor, and if bottom habitat could be seen but the horizon was not visible, water clarity was considered fair. If the horizon could be seen in the distance, water clarity was considered to be good. Including water clarity in index models allowed for a standardization of fish counts based on variable water clarities over time and across the study area. A CTD cast was also taken for each simultaneously deployed group of traps, within 2 m of the bottom, and water temperature from these CTD casts was available for standardization models.

5.3.2.2 Sampling Intensity and Time Series

Overall, there were 11,590 survey videos with data available covering a period of 8 years (2011–2018). Although data were available from 2010, they were not considered here due to limitations in spatial overlap of the survey area and the spatial occupancy of scamp and yellowmouth grouper, consistent with recommendations from the Southeast Reef Fish Survey Video Index Development Workshop (SEDAR41-RD23). For the years considered, several data filters were applied. We removed any data points in which the survey video was considered unreadable by an analyst (e.g., too dark, corrupt video file), or if the trapping event was flagged for any irregularity that could have affected catch rates (e.g., trap dragged or bounced). Additionally, any survey video for which fewer than 41 video frames were read was removed from the full data set. Standardizing the number or readable frames for any data point was essential due to our use of *SumCount* as a response variable (see above). We also identified any video sample in which corresponding predictor variable were missing and removed them from the final data set.

Of the 10,107 video samples considered for inclusion, 1,785 were removed based on the data subsetting guidelines described above, leaving 9805 sampling events for the analysis, of which 1201 were positive for scamp or yellowmouth grouper (12.2%). The spatial distribution of the videos included in the analysis cover the area from NC to South Florida.

5.3.2.3. Size/Age data

As currently implemented, the size and age composition of populations sampled with the SERFS video survey gear are limited, and therefore selectivity of the gear cannot be estimated from data. However, in a different system, Langlois et al. (2015) compared length compositions of snappers and groupers caught in traps to those observed on video cameras, and found those length compositions to be quite similar. Based on that, previous IWG have recommended applying selectivity of chevron traps to the video gear, in one of two ways: 1) if chevron trap selectivity is flat-topped, the video gear selectivity should mirror that of the chevron traps, or 2) if chevron trap selectivity is dome-shaped, the video gear selectivity should mirror only the ascending portion and then assume flat-topped selectivity.

This recommendation was based on the expectation that the video gear should be flat-topped, because older, larger fish are present throughout the depths sampled and because there is no known reason why larger (older) individuals would be less observable on video than smaller (younger) individuals. The SEDAR 68 IWG recognized the need for age/size compositions of the video survey.

Selectivity of the SERFS chevron trap and video gear were discussed at the DW. In previous assessments these indices have been combined but there were concerns with this approach due to potential differences in selectivity. During the spring DW there were insufficient stereo length data from the video survey to determine if larger individuals were present in the videos while not being captured in the chevron traps. Following the delay of SEDAR 68, SERFS staff were able to provide video stereo lengths of scamp and yellowmouth grouper (Figure 5.2). At the final DW webinar, the consensus recommendation was to keep these indices separate in light of the new evidence provided by the SERFS staff while also recognizing the dependency of the gears. These two indices are developed from gear that are attached and sampling the same locations. It was also mentioned at the DW plenary that additional research is needed regarding combining indices that may have different selectivity but are sampling the same site.

5.3.2.4. Catch Rates

Annual standardized index values for scamp and yellowmouth grouper, including CVs, are presented in Table 5.4 and in Figure 5.3.

5.3.2.5. Uncertainty and Measures of Precision

Using a bootstrap procedure with 1000 replicates, confidence intervals of 2.5% and 97.5% were calculated for each year of the survey (Figure 5.3), as were CVs (Table 5.4).

5.3.2.6 Comments on Adequacy for Assessment

The scamp and yellowmouth grouper video index (2010-2018) was recommended for use in the assessment. The resulting index was ranked second of the two fishery independent sources based on the absence of information concerning the age composition of the video sampling gear. Non-independence between the video survey and chevron traps was discussed and identified as a topic for future research.

5.4 FISHERY-DEPENDENT INDICES

In general, indices derived from fishery-independent surveys are believed to represent abundance more accurately than those from fishery-dependent data sources. This is because fishery-dependent indices can be strongly affected by factors other than abundance, such as management regulations on the focal or other species, shifts in targeting, changes in fishing efficiency (technology creep), and density-dependent catchability (hyperdepletion or hyperstability). The standardization procedures attempt to account for some of these issues to the extent possible.

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 5.4). 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 identification. Biological data and discard data were recorded for some trips in some years.

The IWG, along with headboat captains, discussed several key issues related to this index:

- Beginning in 1992, a 20” TL minimum size regulation was implemented. In some cases, the size limit may have influenced the fishing behavior of headboats that relied heavily on scamp and yellowmouth grouper catch. Thus, the IWG recommended modeling the change in selectivity that likely resulted from the size limit, and further acknowledged that the assessment model could be configured to allow for time-varying catchability.

- The scamp and yellowmouth grouper closure starting in 2010 led to a shift in fishing behavior (avoidance). Because of that, and because this index is based on landings only (i.e., no discards included), the IWG decided to end the index in 2009.

5.4.1.1 Methods of Estimation

Data Filtering

The headboat data and programmatic evaluation (SEDAR41-46) found a small percentage of logbook reports to be extreme outliers. Those values were likely erroneous and were removed from the data set prior to deriving the index.

Trips to be included in the computation of the index need to be determined based on effective effort for scamp and yellowmouth grouper. This may not be straightforward, because some trips caught scamp and yellowmouth grouper only incidentally, and some trips likely directed effort at scamp and yellowmouth grouper unsuccessfully. Given that direct information on species targeted is not available, effective effort must be inferred.

To determine which trips should be used to compute the index, the method of Stephens and MacCall (2004) was applied. The Stephens and MacCall method uses multiple logistic regression to estimate a probability for each trip that the focal species was caught, given other species caught on that trip. Species compositions differ across the south Atlantic; thus, the method was applied separately for two different regions: north (areas 2-10) and south (areas 11, 12, and 17) (Shertzer *et al.* 2009). To avoid rare species, the number of species in each analysis was limited to those species that occurred in 1% or more of trips. The most general model therefore included all species in the snapper-grouper complex which occurred in 1% or more of trips as main effects, excluding red porgy. Red porgy was removed because of regulations (closure followed by strict bag limits), which could erroneously remove trips likely to have caught scamp and yellowmouth grouper in recent years. A backward stepwise AIC procedure (Venables and Ripley 1997) was then used to perform further selection among possible species as predictor variables. In this procedure, a generalized linear model with Bernoulli response was used to relate presence/absence of scamp and yellowmouth grouper in headboat trips to presence/absence of other species.

Model Description

Response and explanatory variables

The response variable, catch per unit effort (CPUE), has units of fish/angler and was calculated as the number of scamp and yellowmouth grouper caught divided by the number of anglers. All explanatory (predictor) variables were modeled as categorical, rather than as continuous.

Years – 1981-2009

Area – Initially, the three areas include the Carolinas (CAR), Georgia and North Florida (to Cape Canveral, FL), South Florida (South of Cape Canaveral, FL) but due to low number of positive trips from south of Cape Canaveral, FL, the three areas chosen were North Carolina, (NCAR), South Carolina (SCAR) and Georgia-Florida (GAFL). These areas were defined due to shelf characteristics and associated fishing behavior as well as species compositions.

Season – A third of the months were dropped due to the spawning closure for the longer index, while retained for the truncated index. The patterns in the remaining positive scamp and yellowmouth grouper trips by month and region show few trips in the Carolinas for Nov and Dec. However, Nov and Dec have the most positive scamp and yellowmouth grouper trips for South Florida. The seasonal pattern in cpue across months seems consistent across areas with slightly higher values for Sep. - Dec. compared to May-Aug. Season was chosen as the explanatory variable.

Vessel Size– A factor was developed for the number of anglers using the quartiles of the number of anglers across all trips as breaks for the factors. Given the large range of vessel sizes, a trip with 20 anglers could be either almost full or almost empty. Here we develop a factor for vessel size and crowding separately using the number of anglers. The proxy for vessel size is the maximum anglers reported over all trips for a vessel. This was then divided into two factors based on visual inspection of the density plots into: 1. fewer than 60 maximum anglers 2. 60 or more maximum anglers.

Percent Full – The number of anglers reported for a trip was divided by the maximum number of anglers for a vessel to obtain an estimate of crowding. This was initially developed using quartiles but upon further inspection of the density plot the factor was then divided into 2 factors; 1. less than 50% full and 50% or more full.

Standardization

CPUE was modeled using the delta-glm approach (Lo *et al*. 1992; Dick 2004; Maunder and Punt 2004). In particular, fits of lognormal and gamma models were compared for positive CPUE. Also, the combination of predictor variables was examined to best explain CPUE patterns (both for positive CPUE and the Bernoulli submodels). All analyses were performed in the R programming language (R Development Core Team 2014), with much of the code adapted from Dick (2004).

Bernoulli submodel. One component of the delta-GLM is a logistic regression model that attempts to explain the probability of either catching or not catching scamp and yellowmouth grouper on a particular trip. First, a model was fit with all main effects to determine which effects should remain in the binomial component of the delta-GLM. Stepwise AIC (Venables and Ripley1997) with a backward selection algorithm was then used to eliminate those that did not improve model fit. In this case, the stepwise AIC procedure did not remove any predictor variables. No concerning patterns were apparent in the quantile residuals (Dunn and Smyth 1996).

Positive CPUE submodel. To determine predictor variables important for describing positive CPUE, the positive portion of the model was fitted with all main effects using both the lognormal and gamma distributions. Stepwise AIC (Venables and Ripley1997) with a backward selection algorithm was then used to eliminate those that did not improve model fit. In this case, no predictor variables were removed for either error term.

Both submodels (Bernoulli and either lognormal or gamma) were then combined, and the models were compared using AIC. In this case, the delta-lognormal distribution performed best and used in the final analysis. No concerning patterns were apparent in standard diagnostic plots of residuals.

5.4.1.2 Sampling Intensity

The resulting data set contained more than 26,000 trips across years with approximately 60% positive for scamp and yellowmouth grouper. Annual numbers of trips used to compute the index are shown in Table 5.5.

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 5.5, and tabulated in Table 5.5. The units on catch rates were number of fish landed per angler.

5.4.1.5 Uncertainty and Measures of Precision

Measures of precision were computed using the bootstrap procedure. Annual CVs of catch rates are tabulated in Table 5.5.

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 are intended to represent a census of the headboats. The data set has an adequately large sample size and has a long enough time series to provide potentially meaningful information for the assessment. For the duration of the index, sampling was consistent over time, and some of the data were verified by port samplers and observers.

The primary caveat concerning this index was that it 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. The headboat index was truncated in 2009 due to the potential effects of the management regulations on the adequacy of the index.

5.4.2 Commercial Handline Index

Landings and fishing effort of commercial vessels operating in the southeast U.S. 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 U.S.

Catch per unit effort (CPUE) from the logbooks was used to develop an index of abundance for scamp and yellowmouth grouper landed with vertical lines (manual handline and electric reel), the dominant gear for this scamp and yellowmouth grouper stock. The time series used for construction of the index spanned 1993−2009, when all vessels with federal snapper-grouper permits were required to submit logbooks on each fishing trip. Management regulations beginning in 2010 were a concern for those in the IWG discussion, specifically how these regulations may affect the subsetting method for identifying effective effort in the scamp fishery.

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 southeast U.S. Atlantic stock, areas used in analysis were those between 24 and 37 degrees latitude, inclusive of the boundaries (Figure 5.6.

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 gears fished, which prevents designating catch and effort to specific gears. Therefore, only those trips that reported one gear fished were included in the analyses. Where trips reported multiple areas, the first area reported was used in the analysis. Only the latitude from the area designated was used in the analysis assuming most trips with multiple areas fished were moving across the shelf rather than north and south.

Clear outliers (>99.5 percentile) in the data were also excluded from the analyses. These outliers were identified for all snapper/grouper trip manual handlines as records reporting more than 6 lines fished, 8 hooks per line fished, 10 days at sea, 5 crew members or 105 hours fished; outliers were identified for electric reels as records reporting more than 6 lines fished, 10 hooks per line fished, 12 days at sea, 5 crew members or 143 hours fished. Trips reporting fewer than 4 hours fished for both gears were removed. Positive scamp and yellowmouth grouper trips reporting greater than 24 pounds/hook-hr were excluded for both gears.

To determine which trips should be used to compute the index, the method of Stephens and MacCall (2004) was applied. The Stephens and MacCall method uses multiple logistic regression to estimate a probability for each trip that the focal species was caught, given other species caught on that trip. Species compositions differ across the south Atlantic; thus, the method was applied separately for areas north and south of Cape Canaveral, which has been identified as a zoogeographical boundary (Shertzer et al. 2009). Cape Canaveral falls in the middle of the one degree commercial sampling grid and was assigned to the south with the split at 29 degrees. To avoid rare species, the number of species in each analysis was limited to those species that occurred in 1% or more of trips. The most general model therefore included all species in the snapper-grouper complex which occurred in 1% or more of trips as main effects, excluding red porgy. Red porgy was removed because of regulations (closure followed by strict bag limits), which could erroneously remove trips likely to have caught scamp and yellowmouth grouper in recent years. A backward stepwise AIC procedure (Venables and Ripley 1997) was then used to perform further selection among possible species as predictor variables. In this procedure, a generalized linear model with Bernoulli response was used to relate presence/absence of scamp and yellowmouth grouper in commercial trips to presence/absence of other species. An alternative generalized linear model with Bernoulli response related the catch in pounds of other species to the presence/absence of scamp and yellowmouth grouper. Although the alternative method theoretically may be more efficient at identifying species associations, the IWG rejected the method due to concerns that the increase in trip limits in recent years may bias the results.

Model Description

Response and explanatory variables

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

CPUE = pounds of scamp and yellowmouth grouper/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.

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

Years – Year was necessarily included, as standardized catch rates by year are the desired outcome. Years modeled were 1993–2009.

Season – Season included two levels: summer (May - August) and fall (September-December).

Lat – Areas reported in the logbook on a one degree grid. The majority of the positive trips and catch for commercial handline is in the Carolina. Initially, a regional split at Cape Canaveral was considered but due to the limited samples in the SF region the coast was divided into two areas split at 32 degrees Latitude near Savannah, GA..

Days at sea – Days at sea (sea days) were pooled into three levels: one day (one), two to four days (twotofour), and five or more days (fiveplus)

Crew size – Crew size (includes Captain) could influence the total effort during a trip and could be a psuedo-factor for vessel size. The quartile split values (at 25, 50, and 75%) for scamp and yellowmouth grouper crew size fall at 1, 2, and 3 plus crew per trip.

Standardization

CPUE was modeled using the delta-glm approach (Lo et al. 1992; Dick 2004; Maunder and Punt 2004). In particular, fits of lognormal and gamma models were compared for positive CPUE. Also, the combination of predictor variables was examined to best explain CPUE patterns (both for positive CPUE and the Bernoulli submodels). All analyses were performed in the R programming language (R Development Core Team 2014), with much of the code adapted from Dick (2004).

Bernoulli submodel. One component of the delta-GLM is a logistic regression model that attempts to explain the probability of either catching or not catching scamp and yellowmouth grouper on a particular trip. First, a model was fit with all main effects to determine which effects should remain in the binomial component of the delta-GLM. Stepwise AIC (Venables and Ripley1997) with a backward selection algorithm was then used to eliminate those that did not improve model fit. In this case, the stepwise AIC procedure did not remove any predictor variables. No concerning patterns were apparent in the quantile residuals (Dunn and Smyth 1996).

Positive CPUE submodel. To determine predictor variables important for describing positive CPUE, the positive portion of the model was fitted with all main effects using both the lognormal and gamma distributions. Stepwise AIC (Venables and Ripley1997) with a backward selection algorithm was then used to eliminate those that did not improve model fit. In this application, the lognormal distribution outperformed the gamma distribution, and was therefore used to compute the index.

Both submodels (Bernoulli and lognormal) were then combined into a single delta-lognormal model (1993-2009), with all predictor variables used for both submodels. No concerning patterns were apparent in standard diagnostic plots of residuals.

5.4.2.2 Sampling Intensity

Annual numbers of trips used to compute the index is typically greater than 1000, as shown in Table 5.7.

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 5.7 and are tabulated in Table 5.7. 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 5.6.

5.4.2.6 Comments on Adequacy for Assessment

The index of abundance created from the commercial logbook 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 adequately large sample size and has a long enough time series to provide potentially meaningful information for the assessment.

Several concerns were discussed by the IWG, all related to this index coming from fishery dependent data. First, commercial fishermen may target different species through time. If changes in targeting have occurred, effective effort can be difficult to estimate. However, the DW recognized that the method of Stephens and MacCall (2004), used here to identify trips for the analysis, can accommodate changes in targeting, as long as species assemblages are consistent. Second, the data are self-reported and largely unverified. Some attempts at verification have found the data to be reliable. Third and probably foremost, the data are obtained from a directed fishery and therefore the index could contain problems associated with any fishery dependent index. Fishing efficiency of the fleet has likely improved over time due to improved electronics. In addition, overall efficiency may have changed throughout the time series if fishermen of marginal skill have left the fishery at a greater rate than more successful fishermen. Also of concern is whether catch rates in a directed fishery are density-dependent. As fish abundance decreases, fishermen may maintain relatively high catch rates, and as fish abundance increases, catch rates may saturate. Due to increases in management regulations beginning in 2010, the index was truncated, 1993-2009.

5.5 OTHER DATA SOURCES CONSIDERED DURING THE DW

Several data sources were discussed during the pre-DW webinar for the potential to support indices of abundance, and some of these were discarded based on initial summaries of data. Three data sources were recommended during the webinar for further consideration, but were subsequently not recommended by the DW for use in the assessment: SCDNR charterboat logbooks, the South Atlantic ROV data and the MARMAP short bottom longline survey.Reasons for their exclusion are provided in Table 5.1. The nominal index for the SCDNR chartboat logbook was provided and compared to the other indices from the working group to help corroborate the other indices relative to South Carolina. The SCDNR charterboat nominal index is higher in the earlier years but tends to show a similar downward trend in the last 20-25 years.

5.6 CONSENSUS RECOMMENDATIONS AND SURVEY EVALUATIONS

The DW recommended two fishery independent indices(chevron trap and video) and two fishery dependent indices (headboat logbook and commercial handline logbook) for potential use in the scamp and yellowmouth grouper stock assessment. Pearson correlations and significance values (p-values) between indices are presented in Table 5.8. All recommended indices and their CVs are in Table 5.9, and the indices are compared graphically in Figure 5.8.

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 pros and cons of each listed in Table 5.2.

1. Chevron traps
2. Video
3. Headboat index
4. Commercial handline index

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 indices 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.

5.7 LITERATURE CITED

Conn, P. B. 2011. An Evaluation and Power Analysis of Fishery Independent Reef Fish Sampling in the Gulf of Mexico and U. S. South Atlantic. NOAA Tech. Memorandum NMFS-SEFSC-610.

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

Dunn, K. P. and G.K. Smyth. 1996. Randomized quantile residuals. J. Comp. Graph. Stat. 5:1−10.

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

Jackman S. 2008. *pscl*: Classes and Methods for R Developed in the Political Science Computational Laboratory, Stanford University. Department of Political Science, Stanford University. Stanford, California. R package version 1.04.1. https://pscl.stanford.edu/.

Langlois, T.J., Newman, S.J., Cappo, M., Harvey, E.S., Rome, B.M., Skepper, C.L., Wakefield, C.B. 2015. Length selectivity of commercial fish traps assessed from in situ comparisons with stereo-video: Is there evidence of sampling bias?. Fish. Res. 161:145−155.

Lo, N.C., Jacobson, L.D., Squire, J.L. 1992. Indices of relative abundance from fish spotter data based on delta-lognormal models. Can. J. Fish. Aquat. Sci. 49:2515−2526.

Maunder, M.N., Punt, A.E. 2004. Standardizing catch and effort data: a review of recent approaches. Fish. Res. 70:141−159.

Schobernd, Z. H., N. M. Bacheler, and P. B. Conn. 2014. Examining the Utility of Alternative

Video Monitoring Metrics for Indexing Reef Fish Abundance. CJFAS. 71:464-471.

Shertzer, K.W., E.H. Williams, and J.C. Taylor. 2009. Spatial structure and temporal patterns in a large marine ecosystem: Exploited reef fishes of the southeast United States. Fish. Res. 100:126−133.

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, 2^{nd} Edition. Springer-Verlag, New York.

R Development Core Team (2014). 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

Zeileis A., C. Kleiber, and S. Jackman. 2008. Regression modesl for count data in R. Journal of Statistical Software 27(8). http://www.jstatsoft.org/v27/i08/.

Zuur, A.F., E.N. Ieno, N.J. Walker, A.A. Saveliev, and G.M. Smith. 2009. Mixed Effects Models and Extensions in Ecology with R. Springer, New York.

5.8 TABLES

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

Fishery Type	Data Source	Area	Yrs	Units	Standardization Method	Issues	Use?
Recreational	Headboat	NC-FL	1981-2009	N kept/ angler*hour	Delta-GLM	Fishery dependent, self reported	Yes
Recreational	Headboat-at-sea-observer	NC-FL	2005-2018	N caught ≤20"/ angler		Low sample size.	No
Recreational	SCDNR charterboat logbook	SC	1993-2018	N caught/ angler-hr	Nominal	Limited geographic coverage; low sample size (1% proportion positive), Serves as additional corroborative evidence to support the other indices.	No
Commercial	Commercial logbook handline	NC-FL	1993-2009	lb kept/ hook-hour	Delta-GLM	Fishery dependent, self reported	Yes
Independent	SERFS: chevron trap	NC-FL	1990-2018	N caught	Zero inflated negative binomial	Expanded spatial coverage through time	Yes
Independent	SERFS: video survey	NC-FL	2010-2018	N observed	Zero inflated negative binomial	Ages/sizes unknown	Yes
Independent	ROV South Atlantic					Few samples, imperfect survey design around MPA, not suitable for a standardized index, individuals possibly being double counted	No
Independent	MARMAP: blackfish trap	Mostly SC	1981-1987			Few samples	No
Independent	MARMAP: Florida trap	Mostly SC	1981-1987			Few samples	No
Independent	MARMAP: Short-bottom longline	Mostly SC	1993-2018			Few samples, missing year, limited spatial coverage, few trips and fish. Serves as additional corroborative evidence to support the other indices.	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.

Fishery independent index

SERFS Chevron Trap Index (*Recommended for use*)

Pros:

- Fishery independent random hard bottom survey
- Adequate regional coverage
- Standardized sampling techniques
- All fish caught are aged and measured

Cons:

- Change in spatial coverage since 2008

SERFS Video Index (*Recommended for use*)

Pros:

- Fishery independent random hard bottom survey
- Adequate regional coverage
- Standardized sampling techniques
- Relatively high detection probabilities
- Likely to be less selective than capture gears

Cons:

- Change in spatial coverage in early years
- Ages/sizes observed are unknown

MARMAP/SEAMAP-SA Short Bottom Longline Index (*Not recommended for use*)

Pros:

- Fishery independent random hard bottom survey
- Standardized sampling techniques
- All fish caught are aged and measured

Cons:

- Limited regional coverage
- Small sample size
- Gaps in the time series

Fishery dependent indices

Recreational Headboat (*Recommended for use*)

Pros:

- Complete census
- Covers the entire management area
- Some data are verified by port samplers and observers
- Large sample size
- Strongly correlated with headboat at-sea-observer index
- Generally non-targeted for focal species, which should minimize changes in catchability relative to fishery dependent indices that target specific species

Cons:

- Fishery dependent (i.e., potentially affected by regulations, targeting, hyperdepletion, hyperstability)
- Little information on discard rates, particularly before mid-2000s
- Catchability may vary over time or with abundance
- Effective effort is difficult to identify

Commercial Logbook – Handline (*Recommended for use*)

Pros:

- Complete census
- Covers the entire management area
- Large sample size

Cons:

- Fishery dependent (i.e., potentially affected by regulations, targeting, hyperdepletion, hyperstability)
- Data are self-reported and largely unverified
- Catchability may vary over time or with abundance
- Landings could be cross-referenced with other data sources, but effective effort difficult to identify
- No information on discard rates
- Potential shifts in species targeted; commercial fishermen more skillful than general recreational fishermen at targeting focal species

SCDNR Charterboat *(Not recommended for use)*

Pros:

- Census

Cons:

- Fishery dependent (i.e., potentially affected by regulations, targeting, hyperdepletion, hyperstability)

- South Carolina only, limited geographic coverage relative to south Atlantic
- Low proportion of positive scamp and yellowmouth trips (1%)
- No field validation

Table 5.3 The number of trapping events (N), standardized index, and CV for the scamp and yellowmouth grouper index computed from SERFS chevron traps.

					Nominal CPUE	ZINB Standardized CPUE	
Year	Included Collections	Positive Collections	Proportion Positive	Total Fish	Normalized	Normalized	CV
1990	313	32	0.1	63	1.34	1.33	0.17
1991	272	30	0.11	48	1.18	1.17	0.17
1992	288	29	0.1	49	1.13	1.42	0.19
1993	392	41	0.1	72	1.22	1.53	0.17
1994	387	71	0.18	127	2.19	1.41	0.12
1995	361	52	0.14	117	2.16	2.1	0.14
1996	361	41	0.11	69	1.27	1.35	0.16
1997	406	69	0.17	162	2.66	2.1	0.12
1998	426	51	0.12	120	1.88	1.87	0.15
1999	233	25	0.11	49	1.4	1.24	0.22
2000	298	43	0.14	60	1.34	1.2	0.16
2001	245	35	0.14	60	1.63	1.16	0.17
2002	244	25	0.1	37	1.01	1	0.22
2003	224	24	0.11	41	1.22	1.63	0.22
2004	282	36	0.13	54	1.28	1.64	0.19
2005	303	33	0.11	61	1.34	1.23	0.17
2006	297	10	0.03	15	0.34	0.36	0.34
2007	337	40	0.12	61	1.21	0.96	0.16
2008	303	10	0.03	13	0.29	0.28	0.33
2009	404	12	0.03	17	0.28	0.35	0.32
2010	725	31	0.04	47	0.43	0.74	0.2
2011	726	27	0.04	30	0.28	0.37	0.2
2012	1,174	42	0.04	58	0.33	0.55	0.18
2013	1,360	49	0.04	55	0.27	0.4	0.15
2014	1,472	53	0.04	72	0.33	0.38	0.18
2015	1,463	55	0.04	70	0.32	0.41	0.15
2016	1,484	41	0.03	51	0.23	0.22	0.16
2017	1,541	58	0.04	72	0.31	0.38	0.14
2018	1,736	29	0.02	39	0.15	0.19	0.2
Totals	18,057	1,094	0.06	1,789			

Table 5.4 The nominal index (*SumCount*), number of trapping events (N), proportion positive, standardized index, and CV for the scamp and yellowmouth grouper index computed from the SERFS video survey.

Year	Relative nominal (*SumCount*)	N	Proportion positive	Standardized index	CV
2011	1.124	586	0.157	1.424	0.15
2012	0.752	1076	0.096	1.156	0.14
2013	1.110	1221	0.091	1.165	0.14
2014	0.820	1381	0.154	1.137	0.11
2015	1.322	1394	0.134	0.978	0.12
2016	1.222	1393	0.150	0.948	0.11
2017	1.057	1333	0.124	0.743	0.12
2018	0.594	1318	0.081	0.450	0.16

Table 5.5 The number of trips (N), nominal CPUE, relative nominal CPUE, standardized index, and CV for scamp and yellowmouth grouper from headboat logbook data, 1976-2009.

Year	N	Proportion Positive	Nominal CPUE	Relative nominal	Standardized CPUE	CV
1981	706	0.44	0.00	0.22	0.55	0.07
1982	1031	0.53	0.01	0.42	0.64	0.06
1983	1118	0.53	0.01	0.37	0.55	0.05
1984	970	0.53	0.01	0.38	0.58	0.06
1985	1009	0.56	0.01	0.55	0.74	0.05
1986	943	0.56	0.01	0.50	0.68	0.05
1987	1098	0.58	0.01	0.68	0.86	0.04
1988	1193	0.57	0.01	0.63	0.78	0.05
1989	614	0.54	0.02	0.74	0.79	0.07
1990	695	0.68	0.02	1.10	1.23	0.05
1991	760	0.71	0.03	1.30	1.29	0.07
1992	850	0.66	0.02	1.14	0.95	0.06
1993	895	0.66	0.02	0.94	0.77	0.06
1994	962	0.64	0.02	1.00	0.95	0.05
1995	1044	0.62	0.03	1.18	1.16	0.06
1996	931	0.64	0.02	0.82	0.85	0.05
1997	1070	0.72	0.03	1.31	1.30	0.05
1998	1172	0.64	0.03	1.29	1.36	0.04
1999	1092	0.68	0.03	1.46	1.61	0.04
2000	1039	0.67	0.03	1.59	1.38	0.05
2001	927	0.60	0.03	1.24	1.09	0.05
2002	828	0.64	0.03	1.53	1.25	0.05
2003	631	0.63	0.03	1.53	1.35	0.06
2004	846	0.59	0.03	1.37	1.33	0.05
2005	826	0.57	0.02	1.14	1.20	0.05
2006	662	0.64	0.03	1.51	1.19	0.06
2007	884	0.60	0.03	1.56	1.29	0.05
2008	688	0.52	0.02	0.89	0.76	0.07
2009	714	0.50	0.01	0.65	0.53	0.06

Table 5.7. The number of trips (N), proportion positive, relative nominal CPUE, standardized index, and CV for scamp and yellowmouth grouper from commercial logbook data (handlines).

Year	N	Nominal CPUE	Relative nominal	Standardized CPUE	Proportion Positive	CV
1993	1323	0.35	0.89	0.90	0.75	0.04
1994	1504	0.32	0.80	0.78	0.75	0.04
1995	1902	0.36	0.91	0.96	0.77	0.03
1996	1719	0.33	0.84	0.87	0.77	0.03
1997	1821	0.37	0.93	0.94	0.76	0.03
1998	1641	0.38	0.95	0.96	0.72	0.04
1999	1615	0.43	1.09	1.12	0.69	0.04
2000	1508	0.45	1.14	1.17	0.77	0.03
2001	1657	0.37	0.94	0.94	0.77	0.03
2002	1765	0.38	0.97	0.94	0.76	0.03
2003	1381	0.44	1.11	1.08	0.78	0.04
2004	1299	0.39	0.98	0.92	0.79	0.04
2005	1347	0.44	1.11	1.09	0.78	0.04
2006	1298	0.49	1.24	1.28	0.81	0.04
2007	1586	0.46	1.17	1.22	0.77	0.03
2008	1606	0.39	1.00	0.96	0.78	0.04
2009	1349	0.36	0.92	0.87	0.78	0.04

Table 5.8. Pearson correlation values for indices recommended for use. P-values (in parentheses) represent the probability of obtaining the Pearson value under the null hypothesis of correlation=0. Trap= SERFS trap, CVT=chevron traps, HB=headboats, and Comm=commercial handline.

	HB	cHL	Trap	Video
HB	1			
cHL	0.66	1		
Trap	0.54	0.20	1	
Video	0.59	0.59	0.35	1

Table 5.9. Scamp and yellowmouth grouper standardized indices of abundance and annual CVs recommended for potential use in the stock assessment. CVT=chevron traps, HB=headboats, and Comm=commercial handline. Each index is scaled to its mean.

	Standardized indices				**CVs**			
Year	HB	CVT	Video	Comm	HB	CVT	Video	Comm
1981	0.55				0.07			
1982	0.64				0.06			
1983	0.55				0.05			
1984	0.58				0.06			
1985	0.74				0.05			
1986	0.68				0.05			
1987	0.86				0.04			
1988	0.78				0.05			
1989	0.79				0.07			
1990	1.23	1.34			0.05	0.17		
1991	1.29	1.18			0.07	0.17		
1992	0.95	1.13			0.06	0.19		
1993	0.77	1.22		0.90	0.06	0.17		0.04
1994	0.95	2.19		0.78	0.05	0.12		0.04
1995	1.16	2.16		0.96	0.06	0.14		0.03
1996	0.85	1.27		0.87	0.05	0.16		0.03
1997	1.30	2.66		0.94	0.05	0.12		0.03
1998	1.36	1.88		0.96	0.04	0.15		0.04
1999	1.61	1.40		1.12	0.04	0.22		0.04
2000	1.38	1.34		1.17	0.05	0.16		0.03
2001	1.09	1.63		0.94	0.05	0.17		0.03
2002	1.25	1.01		0.94	0.05	0.22		0.03
2003	1.35	1.22		1.08	0.06	0.22		0.04
2004	1.33	1.28		0.92	0.05	0.19		0.04
2005	1.20	1.34		1.09	0.05	0.17		0.04
2006	1.19	0.34		1.28	0.06	0.34		0.04
2007	1.29	1.21		1.22	0.05	0.16		0.03
2008	0.76	0.29		0.96	0.07	0.33		0.04
2009	0.53	0.28		0.87	0.06	0.32		0.04
2010		0.43				0.20		
2011		0.28	1.42			0.20	0.15	
2012		0.33	1.16			0.18	0.14	
2013		0.27	1.17			0.15	0.14	
2014		0.33	1.14			0.18	0.11	
2015		0.32	0.98			0.15	0.12	
2016		0.23	0.95			0.16	0.11	
2017		0.31	0.74			0.14	0.12	
2018		0.15	0.45			0.20	0.16	

5.9 FIGURES

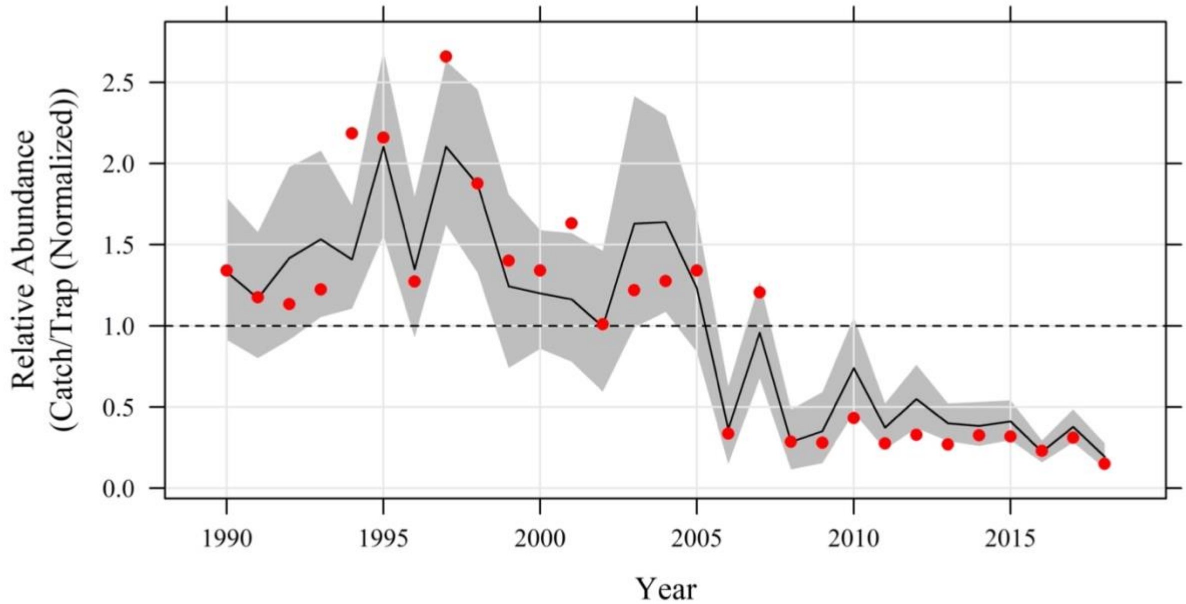


Figure 5.1. The nominal (red dots) and standardized index (solid black line) for scamp and yellowmouth grouper computed from SERFS chevron traps. Gray shaded area represents 95% confidence interval as estimated from 10,000 bootstraps.

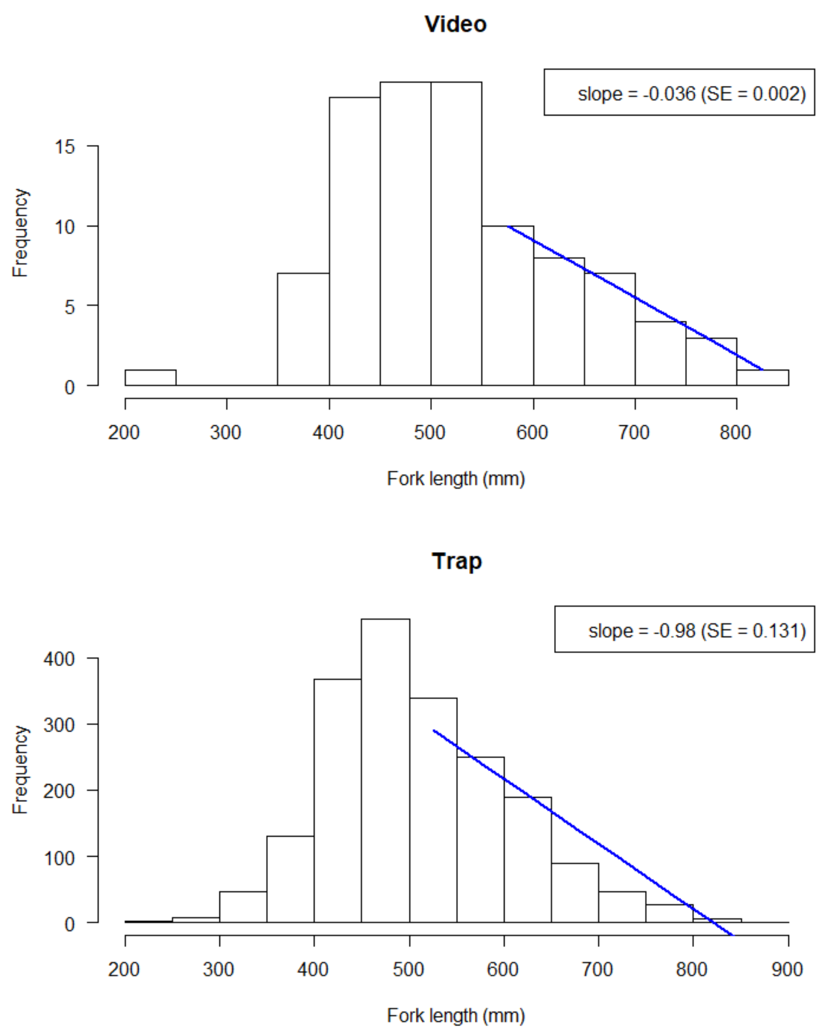


Figure 5.2. Comparison of lengths of scamp and yellowmouth grouper from SERFS chevron traps and SERFS video sampling gear in the South Atlantic.

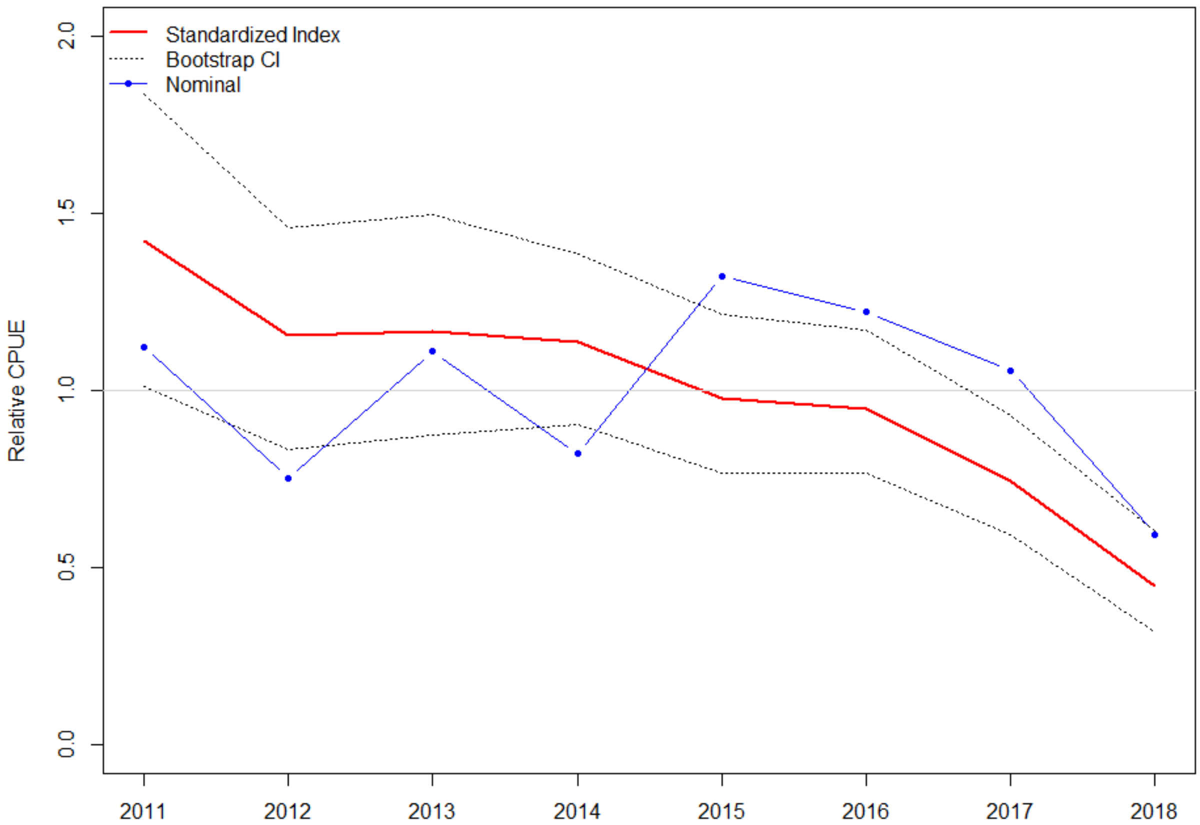


Figure 5.3. The nominal and standardized index for scamp and yellowmouth grouper computed from the SERFS video survey.

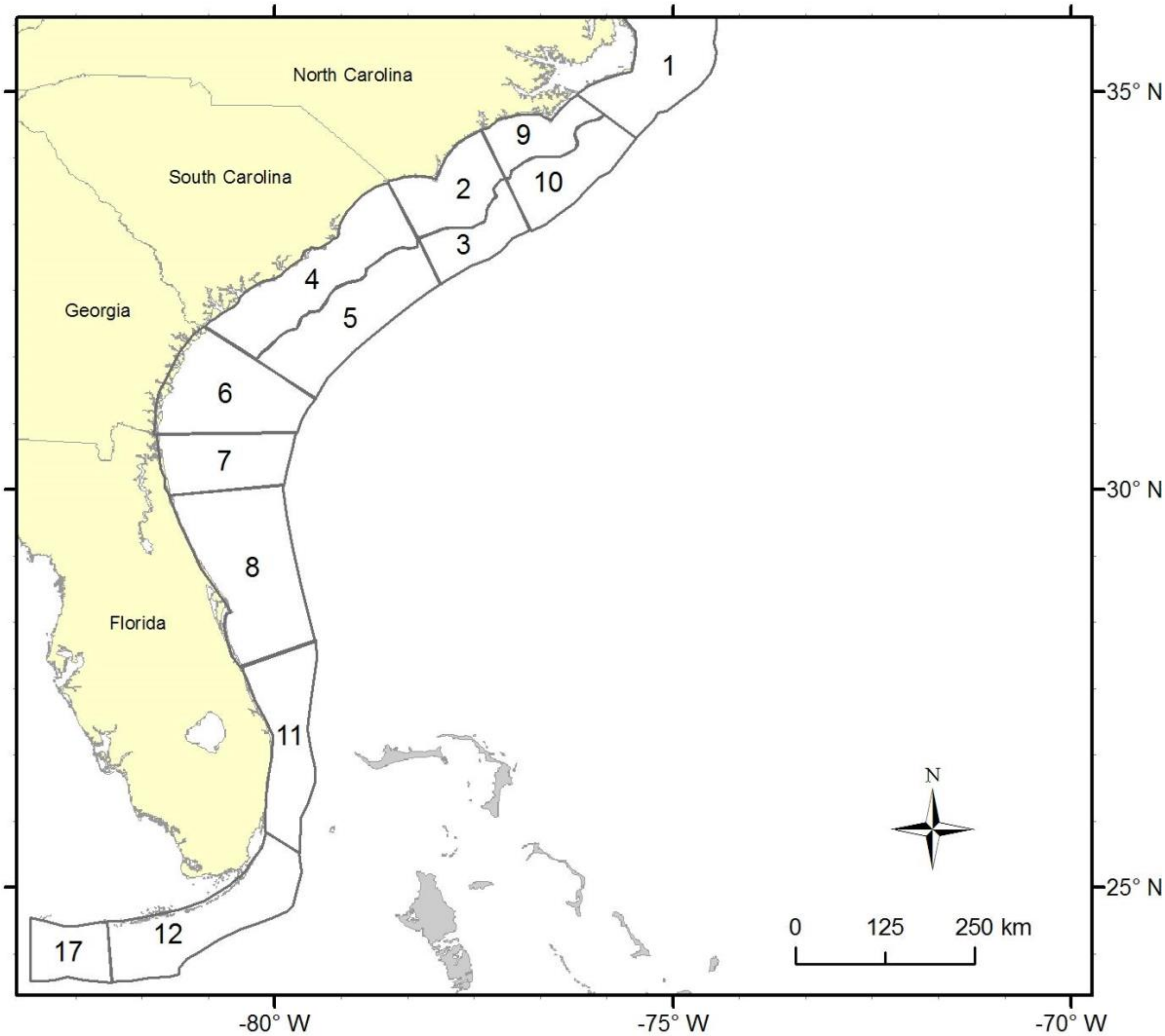


Figure 5.4. Map of headboat sampling area definitions. For analysis, areas were pooled as described in the text.

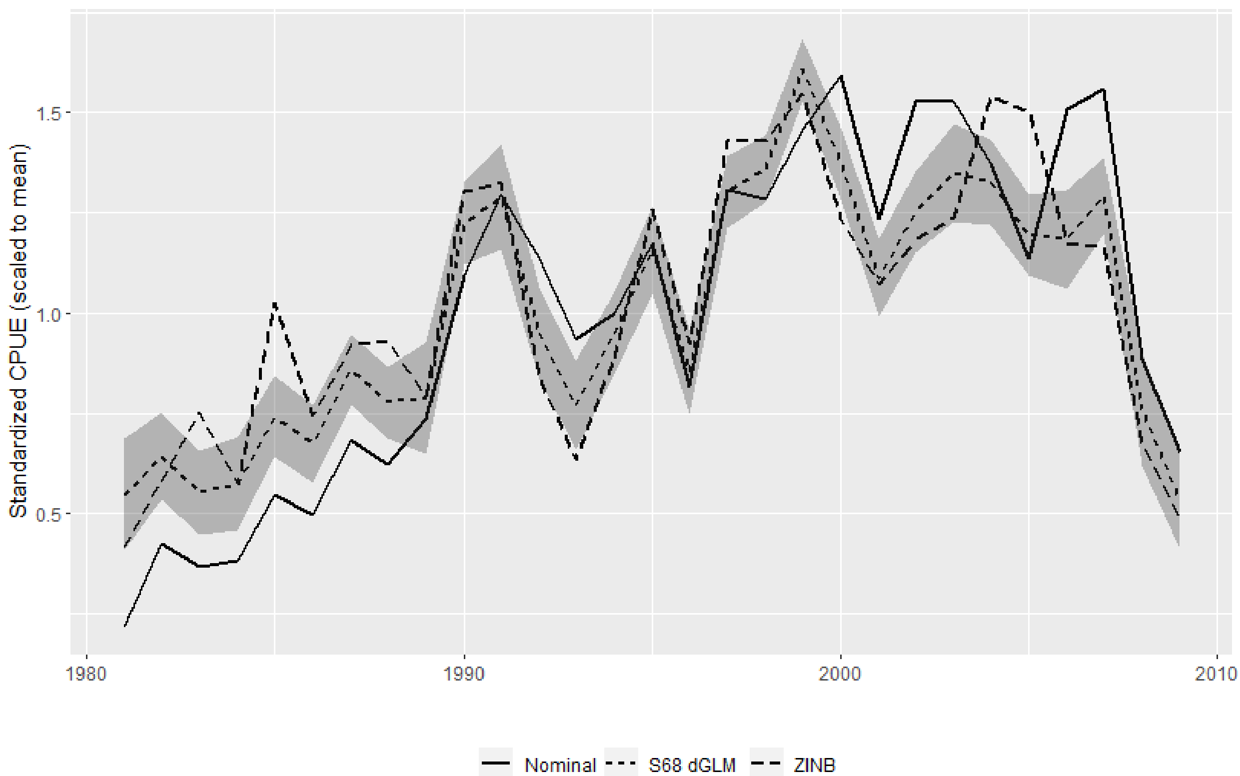


Figure 5.5. The nominal and standardized index for scamp and yellowmouth grouper computed from headboat data, 1981-2009. Shaded region represent approximate 95% confidence intervals.

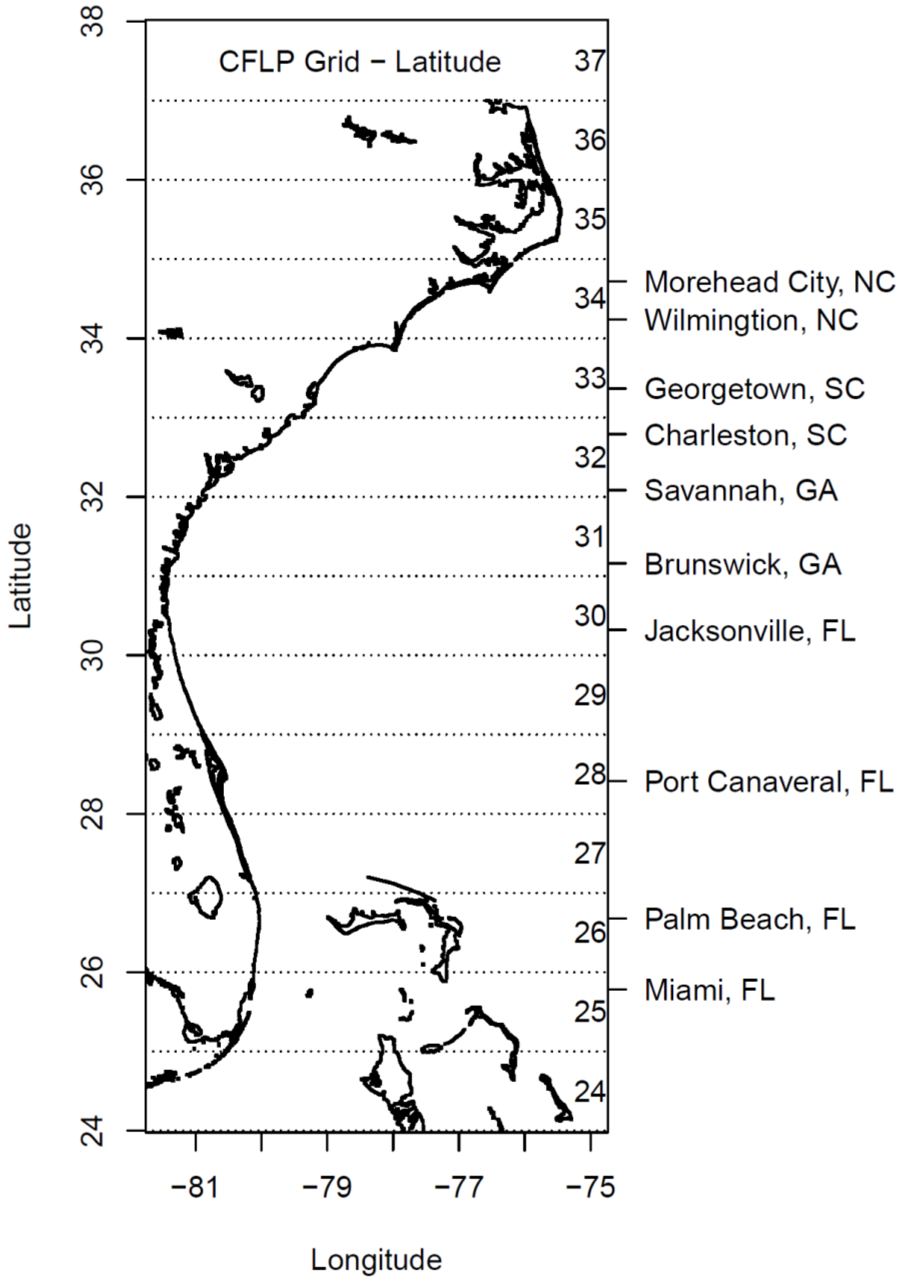


Figure 5.6. Latitude reported in the Coastal Fisheries Logbook Program (CFLP, commercial logbooks). Area is recorded in degrees where the first two digits signify degrees latitude, second two degrees longitude. Only latitude was used in this analysis.

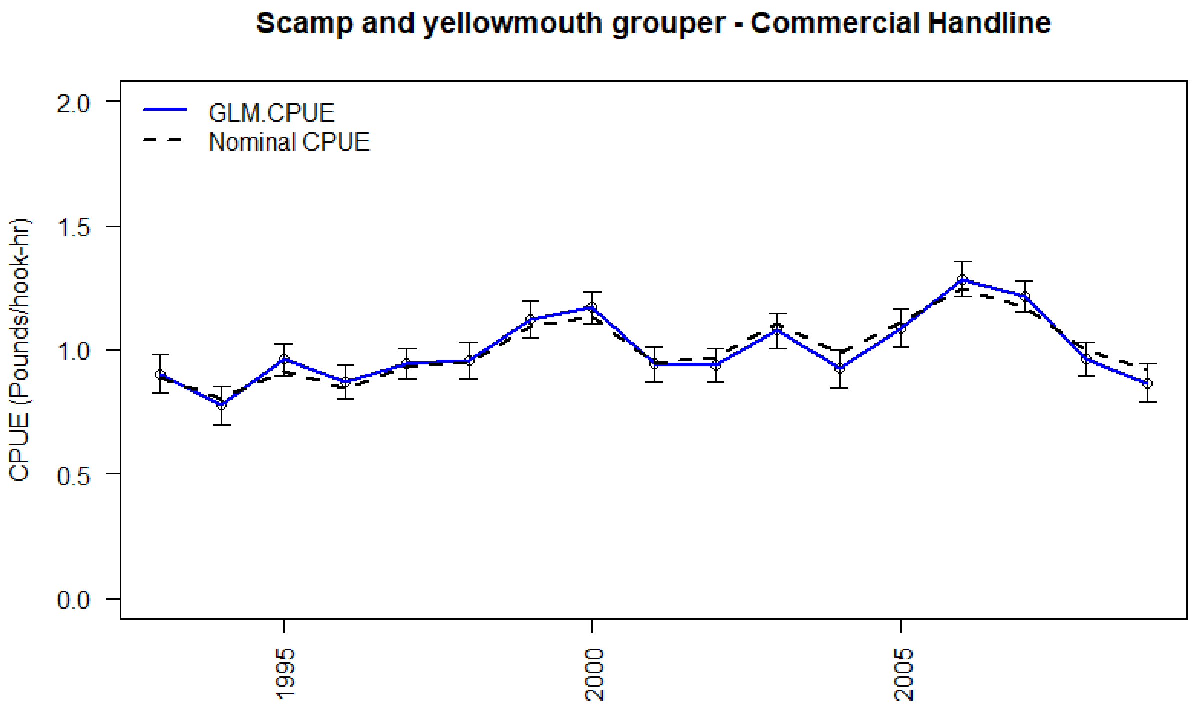


Figure 5.7. The nominal and standardized index for scamp and yellowmouth grouper computed from commercial logbook handline data, 1993–2009. Error bars represent approximate 95% confidence intervals.

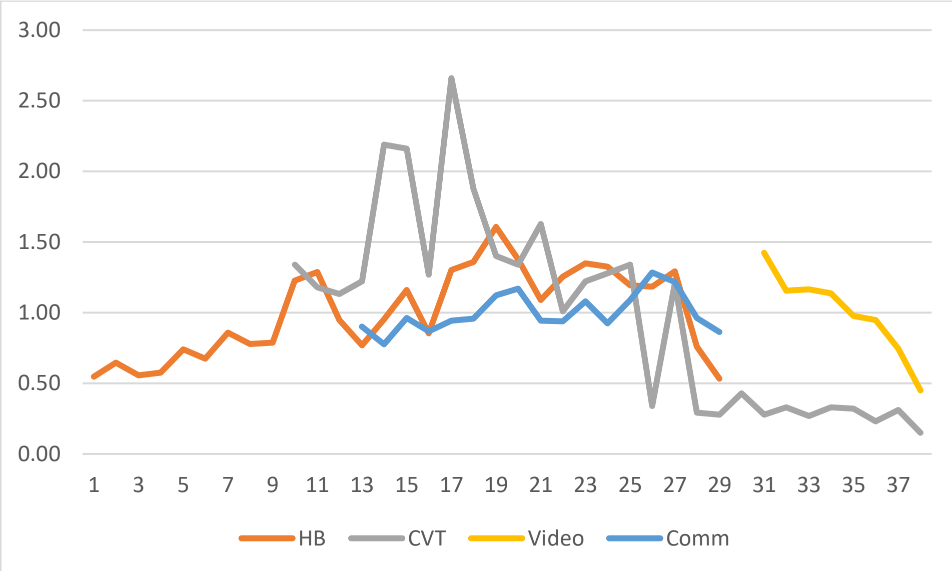


Figure 5.8. All indices (scaled to their respective means) recommended for potential use in the scamp and yellowmouth grouper stock assessment. CVT=Chevron traps, and HB=Headboat,

6 DISCARD MORTALITY AD-HOC WORKING GROUP

Data workshop panelists and data providers convened two ad-hoc working group meetings (led by Dominique Lazarre, FL FWCC/FWRI, St. Petersburg, FL) to present and discuss available data that could be used to inform recommendations for discard mortality rates for SEDAR 68. Anecdotal information, observed/assumed immediate mortality, and estimates of survival from an empirical study were presented by five data providers, representing both the Gulf of Mexico and South Atlantic regions. Commercial data sources included Mote Marine Laboratory (SEDAR68-DW-22) and the NOAA Reef Fish Observer / Shark Bottom Longline Observer Programs (SEDAR68-DW-16, SEDAR68-DW-17). Mote observed discarding of Scamp (N = 804) on commercial vessels in the Gulf of Mexico between 2016 and 2019 through their electronic monitoring program. These data indicated a low proportion of Scamp discards; 3.35% of Scamp were released, with only 0.75% of Scamp released dead. The NOAA Observer Programs have monitored discarding in both the bottom longline and vertical line fisheries in the Gulf of Mexico since 2006. A range of immediate mortality estimates were provided, with the lower bound representing only observed dead Scamp (immediate mortality) and the upper bound including both dead discards and all discarded Scamp displaying barotrauma injury (assumed mortality). The observed to assumed immediate mortality ranged from 6.6% to 69.2% in the bottom longline fishery (N=228) and 0% to 41.8% in the vertical line fishery in the Gulf of Mexico (N=592, Table 1). The observed to assumed range of immediate mortality estimates was also provided for the vertical line fishery in the South Atlantic, 0.2%-16.5% (N = 491, Table 1).

Observations of immediate mortality in the recreational for-hire fisheries were provided by the Florida Fish and Wildlife Conservation Commission for both the Gulf of Mexico and South Atlantic (SEDAR68-DW-23, SEDAR68-DW-24). A summary of depth data from Scamp positive trips intercepted during state dockside intercept surveys and the at-sea observer data indicate the for-hire and private recreational fisheries tend to occur in depths shallower than 45 meters. Observations of discarding on for-hire vessels were summarized in a similar manner as those provided by the NOAA Observer Programs, the lower bound represents immediate observed mortality (immediate mortality) in the fisheries and the upper bound represents both immediate mortality and any fish observed with injuries (assumed mortality). In the Gulf of Mexico, the range of observed to assumed immediate mortality was reported to be 0.30% to 4.19% in the charter fishery (N = 334) and 2.13% to 11.64% in the headboat fishery (N = 1,452; SEDAR68-DW-24). Data from the South Atlantic were limited for the charter fishery, with no immediate mortality observed, from the six individuals observed. The observed to assumed immediate mortality for the headboat fishery ranged from 2.61% to 24.3% (N = 115). In addition to observer data, trip reports from two self-reporting platforms, MyFishCounts and the SAFMC Release applications, were summarized by representatives of the South Atlantic Fishery Management Council (SEDAR68-DW-25, SEDAR68-DW-26). These data provided primarily anecdotal information on the discarding behavior from participating anglers. The reports describe some rationale for discarding behavior and fishing practices, primarily that discarding during the open season occurs as a result of undersized fish being captured. Additionally, anglers reported that Scamp may be found in deeper water than some of the other shallow water grouper species being targeted, reducing interactions with this species.

Lastly, an empirical study that estimated survival of Scamp and Yellowmouth Grouper descended upon release was presented. Researchers captured 18 Scamp / Yellowmouth Grouper in depths ranging from 60 to 116 meters. Acoustic telemetry was used to track the fate of 16 Scamp that were descended, resulting in a survival estimate of 0.47 (0.27, 0.80). Two fish were released at the surface; one floated after release and was determined to be dead the second was tracked with telemetry, with its mortality documented later the same day. The working paper associated with this study provided an updated analysis that includes survival estimates for a complex of deepwater groupers (Gag, Red Grouper, Scamp, Snowy Grouper, Speckled Hind, and Yellowmouth Grouper). This updated analysis provided a survival estimate of 0.46 (0.33, 0.80; N=40) for groupers released with descender devices on the continental shelf break (SEDAR68-DW-27).

All the data provided were discussed in a second ad-hoc discard mortality session to determine how to use the available data to recommend discard mortality rates by fleet and jurisdictions. The group discussed the need for more empirical studies, as it is not likely that the surface release data provided by observer coverage fully captures post-release mortality. The group discussed the wide range of discard mortality estimates provided in the literature. It was widely accepted by the group that use of empirical studies that directly measure mortality / survival is optimal. It was also acknowledged that many of the empirical studies that estimate mortality / survival are conducted in depths that may not be representative of the commercial and recreational fleets. The group decided to use an approach that would combine available depth data that represents each fishery in conjunction with the species-specific logistic regression approach used by Pulver (2017) to estimate immediate mortality to provide point estimates for each commercial fleet. This analysis will be updated to provide upper and lower bounds during the assessment workshop. The group decided that a similar approach would be applied for the recreational fleet, with Jeff Pulver updating his analysis to create a model for recreational fisheries using observer data to fit the model. While these analyses are being updated, the group determined that the mean depth for each fishery would be used to provide a placeholder estimate in the assessment models.

Throughout the discussions, research recommendations were suggested that may help improve the available discard mortality estimates. These include:

- Conduct more empirical studies to investigate post-release mortality particularly in depth ranges that are representative of the fisheries

- Encourage use of modeling approaches to incorporate depth data into estimates of immediate mortality from the surface release data, potentially collaborating with empirical studies to generate more realistic estimates
- Improve data collection of depth data for each fleet, to allow additional modeling approaches to be employed to estimate a range of post-release mortality, particularly in the private boat recreational fleet
- Explore the use of descending devices and other barotrauma mitigation techniques (e.g. venting) on discard mortality estimates

An additional assessment working paper will be generated to document the additional analyses that will be conducted to generate point estimates with updated versions of the commercial and recreational models of the Pulver (2017) model.

6.1 LITERATURE CITED

Atkinson, Sarina F. 2020. Commercial Discard Length Composition for South Atlantic Scamp and Yellowmouth Grouper. SEDAR68-DW-16. SEDAR, North Charleston, SC. 8 pp.

Atkinson, Sarina F. 2020. Commercial Discard Length Composition for Gulf of Mexico Scamp and Yellowmouth Grouper. SEDAR68-DW-17. SEDAR, North Charleston, SC. 14 pp.

Byrd, Julia. 2020. Summary of the SAFMC Scamp Release Citizen Science Pilot Project for SEDAR 68. SEDAR68-DW-24. SEDAR, North Charleston, SC. 5 pp.

Collier, Chip. 2020. Voluntary reports of Scamp caught by private recreational anglers in MyFishCount for SEDAR 68. SEDAR68-DW-26. SEDAR, North Charleston, SC. 3 pp.

Lazarre, Dominique, Chris Wilson, Kelly Fitzpatrick. 2020. Scamp Length Frequency Distributions from At-Sea Headboat Surveys in the South Atlantic, 2005 to 2017. SEDAR68- DW-23. SEDAR, North Charleston, SC. 11 pp.

Lazarre, Dominique. 2020. A Summary of Observer Data from the Size Distribution and Release Condition of Scamp Discards from Recreational Fishery Surveys in the Eastern Gulf of Mexico. SEDAR68-DW-24. SEDAR, North Charleston, SC. 20 pp.

Neidig, Carole, L., Daniel Roberts, Max Lee, Ryan Schloesser. 2020. Preliminary Non Technical Fishery Profile and Limited Data Summary for Scamp, *Mycteroperca phenax* with Focus on the West Florida Shelf: Application of Electronic Monitoring on Commercial Snapper Grouper Bottom Longline Vessels. SEDAR68-DW-22. SEDAR, North Charleston, SC. 15 pp.

Pulver, Jeff J. 2017. Sink or swim? Factors affecting immediate discard mortality for the Gulf of Mexico commercial reef fish fishery. Fisheries Research 188:166-172.

Runde, Brendan J., Theo Michelot, Nathan M. Bacheler, Kyle W. Shertzer, and Jeffrey A. Buckel. 2020. Assigning fates in telemetry studies using hidden Markov models: an application to deepwater groupers released with descender devices. SEDAR68-DW-27. SEDAR, North Charleston, SC. 42 pp.

6.2 TABLES

Table 1. Proxy for release mortality observed in the NOAA Observer Programs. The lower bound classifies dead scamp using only onboard condition and the upper bound classifies dead camp using a combination of onboard condition and disposition. † Included scamp alive with barotrauma. ‡ Included scamp with barotrauma and released dead.

Gear	Depth Bin (m)	Lower Bound of Release Mortality				Upper Bound of Release Mortality			
		Number Discarded	*Number of Trips*	*Percent Alive†*	*Percent Dead*	*Number Discarded*	*Number of Trips*	*Percent Alive*	*Percent Dead‡*
SOUTH ATLANTIC									
Vertical Line	<40	146	24	100.00%	0.00%	146	24	84.90%	15.10%
	41-60	343	24	100.00%	0.00%	343	24	76.00%	24.00%
	>60	2	15	99.40%	0.60%	2	15	89.70%	10.30%
	Total	*491*	*43*	*99.80%*	*0.20%*	*491*	*43*	*83.50%*	*16.50%*
GULF OF MEXICO									
Vertical Line	<40	251	92	100.00%	0.00%	248	91	82.70%	17.30%
	41-80	216	107	100.00%	0.00%	216	107	55.60%	44.40%
	>80	125	23	100.00%	0.00%	125	23	14.40%	85.60%
	Total	*592*	*202*	*100.00%*	*0.00%*	*589*	*202*	*58.20%*	*41.80%*
Bottom Longline	<70	74	46	97.30%	2.70%	74	46	32.40%	67.60%
	71-100	124	53	91.10%	8.90%	123	52	27.60%	72.40%
	>100	30	12	93.30%	6.70%	30	12	40.00%	60.00%
	Total	*228*	*95*	*93.40%*	*6.60%*	*227*	*94*	*30.80%*	*69.20%*

SEDAR

Southeast Data, Assessment, and Review

SEDAR 68

Atlantic Scamp Grouper

SECTION III: Assessment Process Report

August 2021

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

NOTE: Modifications to the model results reported in this report were made during the Review Workshop held August 30 – September 3, 2021. For complete results reflecting those changes, please see the Addendum of this Stock Assessment Report (Section VI).

Contents

List of Tables

List of Figures

1. ASSESSMENT PROCESS PROCEEDINGS

1.1. INTRODUCTION

1.1.1. WORKSHOP TIME AND PLACE

The SEDAR 68 Assessment Process for Atlantic Snapper was conducted via a series of webinars held between December 2020 and May 2021.

1.1.2. TERMS OF REFERENCE

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

2. Develop population assessment model(s) that are appropriate for the available data

3. Recommend biological reference points for use in management
   a. Consider how reference points could be affected by management, ecosystem, climate, species interactions, habitat considerations, and/or episodic events.

4. Provide estimates of stock population parameters, including:
   - Fishing mortality, abundance, biomass, selectivity, stock-recruitment relationship, sex ratio, and other parameters as necessary to describe the population.

5. Characterize uncertainty in the assessment and estimated values.
   - Consider uncertainty in input data, modeling approach, and model configuration.
   - Provide appropriate measures of model performance, reliability, and 'goodness of fit'.
   - Provide measures of uncertainty for estimated parameters and derived quantities such as biological reference points and stock status.

6. Provide recommendations for future research and data collection. Emphasize items that will improve future assessment capabilities and reliability. Consider data, monitoring, and assessment needs.

7. Complete an Assessment Workshop Report in accordance with project schedule deadlines.

1.1.3. LIST OF PARTICIPANTS

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Eric Fitzpatrick.......................................NMFS Beaufort
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Jeff Pulver.......................................NMFS SERO
John Quinlan.......................................NMFS Miami
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1.1.4. LIST OF ASSESSMENT PROCESS WORKING PAPERS AND REFERENCE DOCUMENTS

Documents Prepared for the Assessment Process			
SEDAR68-AP-01	Gulf of Mexico Scamp (*Mycteroperca phenax*) and Yellowmouth Grouper (*Mycteroperca interstitialis*) Commercial and Recreational Length and Age Compositions	Molly H. Stevens	27 January 2021
SEDAR68-AP-02	A description of system dynamics of scamp populations in the Gulf of Mexico and South Atlantic to support ecosystem considerations in the assessment and management process	Matt McPherson and Mandy Karnauskas	29 January 2021
SEDAR68-AP-03	SEDAR 68 Commercial Discard Mortality Estimates Based on Observer Data	Jeff Pulver	9 March 2021
SEDAR68-AP-04	Estimation of a Commercial Abundance Index for Gulf of Mexico Scamp & Yellowmouth Grouper Using Reef Fish Observer Data	Steven G. Smith, Skyler Sagarese, Stephanie Martinez-Rivera, Kevin J. McCarthy	29 March 2021

1.2. Panel Recommendations and Comments on Terms of Reference

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

Section 2.2 reviews the data used and any deviations from the Data Workshop.

2. Develop population assessment model(s) that are appropriate for the available data
   Section 3 details the population assessment model and data configurations used.

3. Recommend biological reference points for use in management
   a. Consider how reference points could be affected by management, ecosystem, climate, species interactions, habitat considerations, and/or episodic events.
   Sections 3.3.13, 3.6 and 4.9 detail the biological reference point methods and results.

4. Provide estimates of stock population parameters, including:
   - Fishing mortality, abundance, biomass, selectivity, stock-recruitment relationship, sex ratio, and other parameters as necessary to describe the population.
   Section 4 provides these estimates of the stock population parameters.

5. Characterize uncertainty in the assessment and estimated values.
   • Consider uncertainty in input data, modeling approach, and model configuration.
   • Provide appropriate measures of model performance, reliability, and 'goodness of fit'.
   • Provide measures of uncertainty for estimated parameters and derived quantities such as biological reference points and stock status.
   Sections 3.7 and 4.10 details the uncertainty in the model.

6. Provide recommendations for future research and data collection. Emphasize items that will improve future assessment capabilities and reliability. Consider data, monitoring, and assessment needs.
   The research recommendations were compiled from members of the Panel and reported in 5.2 of the report.

7. Complete an Assessment Workshop Report in accordance with project schedule deadlines.
   Complete, and the report was submitted in a timely manner.

Executive Summary

This research track assessment evaluated the stock of scamp, *Mycteroperca phenax*, off the southeastern United States within the South Atlantic Fishery Management Council's (SAFMC) jurisdiction[1]. The primary objectives of this assessment were to consider new and existing data sources and analytical methods. Data compilation and assessment methods were guided by the methodologies of previous assessments, as well as by current SEDAR best practices. The assessment period is 1969–2017.

Available data on this stock included two fishery-independent and two fishery-dependent indices of abundance, as well as landings, discards, and samples of annual length and age compositions from fishery-dependent and fishery-independent sources. Data on landings and discards were available from the recreational and commercial fleets. Scamp and yellowmouth grouper were treated as a single complex for this research track assessment as recommended by the Stock ID Panel.

The primary model used in this assessment was the Beaufort Assessment Model (BAM), an integrated catch-age formulation. A base run of BAM was configured to provide point estimates of key management quantities, such as stock and fishery status. Uncertainty in estimates from the base run was evaluated through an ensemble modeling approach as well as sensitivities and retrospective analyses.

Results of this research track assessment suggest that the stock is undergoing overfishing and is overfished. Steepness was estimable in the base run of BAM and the final stock and fishery statuses are influenced by the estimated value of steepness and natural mortality assumptions. The largest influence on the estimated value of steepness resulted from the terminal year in the retrospective analysis and natural mortality values.

[1]Abbreviations and acronyms used in this report are defined in Appendix A

2 Data Review and Update

In this research track assessment, the start year is 1969 and the terminal year is 2017. The start year of 1969 was chosen based on the availability of length composition data and available landings data. Data for both scamp and yellowmouth grouper were pooled for this assessment. Morphometric characteristics between the two species are very similar and there exists a high potential for misidentification, additionally, the proportion of yellowmouth grouper to scamp within the data is considered to be quite small The input data for this assessment are described below:

2.1 Data Review

In this research track assessment, the Beaufort Assessment Model (BAM) was fitted to data sources similar to those used in previous SEDAR assessments in the South Atlantic.

- Landings: Commercial (handline, longline, spear/diving and other), recreational (headboat, charterboat, and private boat modes)
- Discards: Commercial (handline), Recreational (all modes)
- Indices of abundance: Commercial handline, Recreational headboat, Chevron trap and video surveys
- Length compositions: Commercial, Recreational, pooled Commercial discards, Chevron trap
- Age compositions: Commercial, Recreational, Chevron trap

In addition to data fitted by the model, this assessment utilized life-history information that was treated as input. These inputs included natural mortality, female maturity at age, the population growth curve, a fishery model growth curve, time of peaking spawning, and discard mortality. Scamp is a protogynous species and the proportion female at age was included.

2.2 Data Update

Data available for this assessment are summarized in Tables 1–5.

- Fleet Structure: All commercial landings were combined as a single pooled fleet. Similarly, private, charterboat and headboat landings were pooled as a single recreational fleet. Commercial and recreational discards were modeled as separate removal streams.
- Discards and discard mortality: The discard mortality working group provided a commercial discard mortality rate of 0.39 (0.33–0.45) and a recreational discard rate of 0.26 (0.16–0.40).
- Indices of abundance: Two fishery-dependent indices of abundance, the commercial handline index and the headboat index, were used in this assessment. Two fishery-independent indices, chevron trap and video survey, were considered. The two indices were combined into one index using the Conn method during the assessment phase (Conn 2010).
- Size/age compositions: Commercial and recreational length and age composition data were used for this assessment. Only age composition data were retained in years that had both length and age data available from the fleets. Chevron trap data contained both age and length compositions and all available data was used.
- Size compositions of discards: Commercial discard length composition data were pooled for this assessment due to low trip sample sizes.

- Life History: A von Bertalannfy growth curve was used for the population and a fishery growth model was applied to landings beginning in 1992. The female maturity schedule, proportion female and other life history inputs remained the same as discussed in the data workshop.
- This assessment used the Lorenzen natural mortality curve scaled to the Then et al. point estimate as recommended by the data workshop (Lorenzen 1996; Then et al. 2015).

2.2.1 Fleet Structure

Commercial landings are dominated by the handline gear in the South Atlantic for scamp (90%). Additionally, the available age and length composition data were from the handline gear; therefore, the Panel recommended pooling the landings from other gear types (longline, other and spear/diving) with the handline gear for a single commercial fleet.

The headboat fleet was combined with the charter and private recreational modes as a single recreational fleet, as recommended by the recreational working group, due to minimal differences between the recreational length composition for fishing modes.

Commercial discards were available 1993–2017 while recreational discards were available 1988–2017. Both were modeled as separate removal streams.

2.2.2 Discard Mortality

The discard mortalities for the two discard fleets were recommended by the Discard Mortality Ad-hoc Working Group after reviewing the available literature and species-specific logistic regression analysis (Pulver 2017). Observer data paired with fishery specific depth was applied to the species-specific logistic regression approach to provide point estimates of immediate mortality. Delayed mortality estimates combined with bootstrapping provided ranges associated with the immediate mortality point estimate. A discard mortality rate of 26% for the recreational fleet was recommended with an upper bound of 40% and a lower bound of 16%. The group recommended a commercial discard mortality rate of 39% with an upper bound of 45% and a lower bound of 33% (Pulver 2021; SEDAR 2021).

2.2.3 Recreational Landings and Discards

Marine Recreational Information Program (MRIP) and Southeast Region Headboat Survey (SHRS) data were used as input for the landings for the recreational fleet from 1981 to 2017. The FHWAR method was used to generate an estimate of recreational landings for years 1969-1980 (see SEDAR 58 (SEDAR 2019; Brennan 2020)). Self-reported discards are not validated within the SRHS but the At-Sea Observer Survey can be used to validate the discard estimates. Headboat discards were calculated using a proxy method approach as described in the Data Workshop report and were available from 1992-2017 (SEDAR 2021). Discards were assumed to be negligible prior to 1992 due to the lack of size regulations. Estimates of MRIP discards were available from 1988–2017.

2.2.4 Commercial Landings and Discards

Commercial landings for all gears were provided from Florida, Georgia, South Carolina and North Carolina at the species level from 1980–2017. Prior to 1980, grouper landings were not classified by species and a proportion was applied to estimate the landings from 1969–1979 as outlined in the Data Workshop report. The commercial discards were estimated using data from the discard logbook and coastal logbook datasets as observer datasets were insufficient to estimate commercial discards in the South Atlantic. However, estimates obtained from discard logbook data are often greater than the estimates from observer data. To account for this, a bias correction factor was applied to the discard logbook data using observer discard estimates from the Gulf of Mexico to account for this potential overestimation (SEDAR 2021; McCarthy et al. 2020). Handline discard estimates were available from 1993–2017. Longline discard estimates were fewer than 50 fish per year and considered to have a negligible effect on the stock assessment and were not included.

2.2.5 Indices of Abundance

Four indices of abundance were considered to be adequate for use in the assessment by the DW Index Working Group, the commercial handline index, headboat index, SERFS chevron traps and video survey. The commercial handline index was standardized from 1993–2018 using a delta-GLM approach. However, after discussion by the DW Index Working Group, he index was truncated in 2009 due to the potential effects of management regulations. The shallow-water grouper closure began in 2010 and in 2012 there were sporadic closures for commercial scamp and yellowmouth grouper.

The headboat index was standardized from 1981-2018 using the delta-GLM approach, however, the Index Working Group recommneded truncating the series in 2009 due to management considerations. The shallow-water grouper closure began in 2010, potentially causing a change in fisher behaviour. The CV's from these two fishery dependent indices were scaled to a common mean of 0.2 to account for the greater uncertainty in fishery dependent indices as compared to the fishery dependent indices (Francis et al. 2003)).

SERFS/MARMAP chevron trap sampling began in 1990 with corresponding length and age composition data. The chevron trap index was standardized using a zero-inflated negative binomial model from 1990–2017. This index was considered to be the highest ranking source of information of the available indices of abundance. The video survey was standardised from 2011–2017 and was considered the second highest ranking source of information by the DW Index Working Group. The chevron trap and video indices were initially entered separately into the model, however the panel recommended that they be combined using the Conn model averaging method (Conn 2010). The two indices were combined as the video index exhibited a similar abundance pattern seen in the overlapping years of the chevron trap index and did not have any corresponding length or age composition data. Additionally, the DW Index Working Group raised the potential for non-independence of the video survey and chevron trap data as the videos are mounted to the chevron traps. The panel discussed truncating the chevron trap data in 2011 and solely using the video survey from 2011 onwards owing to an increase in sampling area and a corresponding decrease in the scamp proportion positives. However, the model averaging approach was chosen so as to retain the chevron trap age composition data and due to the fact that the video and chevron trap indices exhibited similar trends in abundance from 2011 onwards. Additionally, these two surveys are considered to have similar selectivities for scamp.

2.2.6 Length Compositions

Length compositions were available for the commercial handline, combined recreational MRIP and headboat, commercial vertical line discards and the chevron traps. The Panel considered possible applications of length composition data, such as including length compositions in years with age composition data. Initially, all available length compositions were included in the model but due to low sample sizes at larger lengths, compositions were truncated at 890 mm. Length composition data were removed from years that contained age compositions as including these resulted in a poorer fit to commercial handline and recreational age compositions. Recreational length composition data began in 1972 but the panel recommended that the years from 1972–1977 be removed from the model due to potential bias in those years. Sampling across all states began in 1978 and the prior years data solely came from South Carolina and North Carolina. The commercial vertical line discard length composition data did not meet the minimum trip threshold for inclusion so the data were pooled over years and weighted by sample size (number of trips) in order to estimate selectivity of commercial discards.

2.2.7 Age Compositions

Age composition data were available for the commercial handline, the combined recreational MRIP and headboat and the SERFS/MARMAP chevron traps. Recreational age data was available beginning in 1979, however, the sample sizes were insufficient for inclusion once the data were weighted by the length frequency distribution by year. The recreational age composition data used in the model began in 1996 but did not have another year of data until 2002. The initial oldest age class (plus group) selected was 12 years as the majority of composition data occurred below age 12, however, after initial model explorations and model fits the panel determined that a plus group of 15 was more appropriate. All reported ages are in years.

2.2.8 Life History Data

A von Bertalanffy growth curve was used for the population and the fishery growth model was used for the commercial and recreational landings beginning in 1992 as recommended by the ADT in the Data Workshop report. The fishery growth model used was a von Bertalanffy curve fit to age-length data from landings. The female maturity schedule was estimated using a Logit model and yielded an age at 50% female maturity of 2.9 years and 375.2 mm. Scamp is a protogynous species and the age at transition from female to male was best estimated using a probit model, which yielded an estimate of 10.6 years at 50% sex transition. A combined male and female spawning stock biomass was recommended by the panel. The natural mortality was estimated from the Lorenzen age-based equation scaled to the Then point estimate (Then et al. 2015) using a recalculated maximum age regression for Serranidae species. The regression on the 12 selected Serrandidae species resulted in a natural mortality of 0.155. The age-based scaling of the M vector was based on the fully recruited ages' (6–34) survivability. Age 34 was considered to be the maximum of age for scamp in the South Atlantic.

3 Stock Assessment Methods

An integrated catch-age model developed for this assessment of scamp. The methods are reviewed below.

3.1 Overview

This assessment used the Beaufort Assessment Model (BAM, Williams and Shertzer 2015), which applies an integrated catch-age formulation, implemented with the AD Model Builder software (Fournier et al. 2012). In essence, the model simulates a population forward in time while including fishing processes (Quinn and Deriso 1999; Shertzer et al. 2014). Quantities to be estimated are systematically varied until characteristics of the simulated population match available data on the real population. The model is similar in structure to Stock Synthesis (Methot and Wetzel 2013; Li et al. In Press). Versions of BAM have been used in previous SEDAR assessments of reef fishes in the U.S. South Atlantic and is now the primary model used in stock assessments in the region.

3.2 Data Sources

The catch-age model included data from two fleets that caught scamp in southeastern U.S. waters from the Florida Keys to the North Carolina-Virginia border: a commercial fleet and a recreational fleet. The model was fitted to data on annual landing and annual discards (in units of 1000 lb whole weight for commercial and 1000 fish for recreational). The discard mortality rate was set to 0.39 for the commercial fleet and 0.26 for the recreational fleet. The model was also fitted to annual age and length compositions of recreational landings, annual age and length compositions of commercial landings, a pooled length composition of commercial discards, annual age and length compositions of the chevron trap data, two fishery-dependent indices (headboat and commercial handline), and one fishery-independent index (combined chevron trap and video). Data used in the model are tabulated in §2 of this report.

3.3 Model Configuration

Model structure and equations of the BAM are detailed in Williams and Shertzer (2015). The assessment time period was 1969–2017. A general description of the assessment model follows.

3.3.1 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 $1 - 20^{+}$, where the oldest age class 20^{+} allowed for the accumulation of fish (i.e. plus group). Age compositions were fit to years $1 - 15^{+}$ with 15^{+} as the plus group.

3.3.2 Initialization

Initial (1969) abundance at age was estimated in the model as follows. First, the equilibrium age structure was computed for ages 2–20 years based on natural and initial fishing mortality (F_{init}), where F_{init} was assumed equal to the geometric mean of estimated F for the period 1969–1971. Second, lognormal deviations around that equilibrium age structure were estimated. The deviations were lightly penalized, such that the initial abundance of each age could vary from equilibrium if suggested by early composition data, but remain estimable if data were uninformative. Early runs indicated that initial age structure did not vary much from the equilibrium age structure. Given that the Panel recommended removal of all landings length compositions, which would have informed the initialization, an equilibrium age structure was assumed for the initial year of the model. Given the initial abundance of ages 2–20, initial (1969) abundance of age-1 fish was computed using the same methods as for recruits in other years (described below).

3.3.3 Growth

Mean size at age of the population (total length, TL) was modeled with the von Bertalanffy equation (Figure 1), and weight at age (whole weight, WW) was modeled as a function of total length. Growth parameters and conversion equations (TL-WW) were used as recommended by the DW Life History Working Group; both were treated as input to the assessment model. The von Bertalanffy parameter estimates for the population were $L_{\infty} = 787.36$ mm, $K = 0.149$, and $t_0 = -1.845$ yrs. The fishery growth model parameter estimates for the commercial and recreational landings were $L_{\infty} = 919.06$ mm, $K = 0.076$, and $t_0 = -5.19$ yrs. The CV's for the population and the landings–only curve were estimated within the model.

3.3.4 Natural mortality rate

The natural mortality rate (M) was assumed constant over time, but decreasing with age. The form of M as a function of age was based on Lorenzen (1996). The Lorenzen approach assumes a size-dependent mortality schedule in which the instantaneous mortality rate at age is inversely proportional to length at age. The point estimate of M was scaled to the point estimate from the Then method based on 12 Serranidae species to provide M as a function of age (Then et al. 2015; SEDAR 2021).

3.3.5 Female maturity and spawning stock

The age at 50% female maturity was estimated to be 2.9 years and nearly all female fish were mature by age-7. Spawning stock was modeled as biomass of mature males and females measured at the time of peak spawning. For scamp, peak spawning was considered to be at the start of May.

3.3.6 Recruitment

Expected recruitment of age-1 fish were estimated from the Beverton-Holt stock-recruitment model. Annual variation in recruitment was assumed to occur with lognormal deviations during 1980–2015. Outside those years, recruitment followed the bias-corrected (mean unbiased) Beverton-Holt curve.

Initial model runs estimated the initial (1969) number at age deviations, however these were poorly estimated at the start of the model due to a lack of age and length compositions. When these deviations were estimated in the model, it was not possible to estimate steepness and the likelihood profile on steepness did not exhibit a minimum. The ADT recommended that the number at age deviations be fixed in the model and steepness was able to be estimated in subsequent model runs without the use of a prior.

The likelihood profile of steepness showed a clear minimum in the likelihood surface indicating the stock–recruit relationship is potentially well–defined. Steepness values were also examined in the sensitivity runs discussed later.

3.3.7 Landings

The model included time series of landings from two fleets: commercial (all gears) and recreational (headboat, charterboat, and private boats combined). Landings were modeled with the Baranov catch equation (Baranov 1918) and were fitted in units of weight (1000 lb whole weight for commercial and 1000 fish for recreational). Observed landings were provided back to the first assessment year (1969) for each fleet.

3.3.8 Discards

Commercial discards were provided from 1993 to 2017 and were assumed zero prior to this time period. Discards from the recreational fleet were available from 1988-2017. Commercial and recreational discards were modeled separately from their respective landings assuming a discard mortality rate (deaths per released fish) of 0.39 for the commercial fleet and 0.26 for the recreational fleet.

3.3.9 Fishing

For each time series of landings and dead discards, 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.

3.3.10 Selectivities

Selectivity curves were estimated using a parametric approach. This approach applies plausible structure on the shape of the selectivity curves, and achieves greater parsimony than occurs with unique parameters for each age. 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. Given the limited data available for scamp, this was not the case and several assumptions were made regarding the shape of the selectivity curve for different components of the removals and for the indices. Selectivities of landings from all fleets were modeled as flat-topped, using a two-parameter logistic function. The selectivity of the fishery-dependent indices (headboat and commercial handline) were assumed the same as the recreational and commercial fleets.

In past SEDAR assessments for other species, selectivity of the fishery–independent chevron index has been informed by the age and length compositions of fish caught in the associated Chevron traps from the SERFS survey. The lengths of scamp caught in Chevron traps ranged from 230 to 890 mm, indicating nearly the full size range of scamp modeled were available to the Chevron trap. A broad range of ages (Ages 1–27) were also captured in the Chevron traps. Previous SEDAR assessments have modeled the chevron selectivity as a double logistic due to concerns that the largest and oldest fish could not access the traps. However, the presence of older scamp in the traps indicated that larger fish were able to enter the traps. A double logistic selectivity was attempted, however the panel recommended that a logistic selectivity curve was more appropriate due to the presence of the older fish in the data. In initial model runs a double logistic selectivity curve was applied, however the model estimated a flat-topped selectivity. The descending limb parameter consistently hit a bound and the likelihood profile of that parameter did not exhibit a minimum.

Two selectivity time blocks around the recreational and commercial size limits implemented in 1992 were included in the model. However, there were no age composition data available prior to the size limit and estimates of selectivity based on length compositions indicated a shift to younger rather than older fish for both fleets after the size limits were implemented. This created a mismatch whereby age compositions provide the primary source of information on selectivity after the size limit regulation, while length compositions are the only source of information on selectivity prior to the size limit. Despite these limitations, time blocks were used to reflect the management regulations in place.

The same double logistic selectivity curve was used for both the commercial and recreational discards.

3.3.11 Indices of abundance

The model was fit to a fishery–dependent index standardized from commercial logbooks (1993–2009), a fishery–dependent index standardized from headboat logbooks (1981–2009), and a fishery-independent combined chevron trap and video index (1990–2017). The predicted indices are conditional on selectivities and were computed from abundance at the midpoint of the year (Figure 2).

3.3.12 Catchability

In the BAM, catchability scales indices of relative abundance to estimated population abundance at large. Several options for time-varying catchability were implemented in the BAM following recommendations of the 2009 SEDAR procedural workshop on catchability (SEDAR Procedural Guidance 2009). In particular, the BAM allows for density dependence, linear trends, and random walk, as well as time-invariant catchability. For scamp, catchability of the index was assumed to be constant, as the Panel decided there was little reason to think that catchability for scamp has changed since 1969. The exception to this are the fishery-dependent indices as it was thought that fisher behaviour changed in response to changes in management beginning in 2010. However, these indices were truncated and therefore this change in catchability was not explicitly included in the model.

3.3.13 Biological reference points

Biological reference points (benchmarks) included MSY, fishing mortality rate at MSY (F_{MSY}), and spawning stock at MSY (SSB_{MSY})(Gabriel and Mace 1999). In this assessment, spawning stock measures biomass of mature males and females, as this approach has been shown to provide more robust estimates of benchmarks for protogynous stocks than male- or female- only measures of SSB (Brooks et al. 2008). 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 (2015–2017) of the assessment.

3.3.14 Fitting criterion

The fitting criterion was a penalized likelihood approach in which observed landings were fit closely, and observed composition data and the abundance indices were fit to the degree that they were compatible. Landings, discard mortalities and indices were fitted using lognormal likelihoods. Length and age composition data were fitted using the Dirichlet-multinomial distribution, with sample size represented by the annual number of trips, adjusted by an estimated variance inflation factor.

This assessment fit the composition data using the Dirichlet-multinomial distribution (Francis 2017; Thorson et al. 2017). This distribution is self-weighting and therefore iterative re-weighting (e.g., Francis (2011)) is unnecessary, and better accounts for intra-haul correlations (i.e., fish caught in the same set are more alike in length or age than fish caught in a different set). The Dirichlet-multinomial allows for observed zeros, and has recently been implemented in Stock Synthesis (Methot and Wetzel 2013; Thorson et al. 2017) and in the BAM, and since SEDAR41 has become the standard for fitting composition data in assessments of South Atlantic reef fishes.

The model includes the capability for each component of the likelihood to be weighted by user-supplied values. When applied to indices, these weights modified the effect of the input CVs. Weights on the index were adjusted iteratively, starting from initial weights in an attempt to achieve standard deviations of normalized residuals (SDNRs) near 1.0. Commercial landings are technically fit in the model, but set up in such a way that they are matched very closely and essentially assumed to be known without error. This is a computational convenience. Uncertainty in landings estimates are addressed through an ensemble approach described below.

3.3.15 Sensitivity analyses

Sensitivity runs were chosen to investigate issues that arose specifically with this research track assessment. They were intended to demonstrate directionality of results with changes in inputs or simply to explore model behavior, and not all were considered equally plausible. Sensitivity runs vary from the base run as follows.

- S1: Recreational landing CVs set at 0.05.
- S2: Low M (0.147), max age of 36.
- S3: High M (0.164), max age of 32.
- S4: Proportion of males 25%: Proportion of males age 3 and onwards set at 25%, 100% female ages 1 and 2
- S5: Proportion of males 50%: Proportion of males age 3 and onwards set at 50%, 100% female ages 1 and 2
- S6: Proportion of males 75%: Proportion of males age 3 and onwards set at 75%, 100% female ages 1 and 2
- S7: Proportion of males 100%: Proportion of males age 3 and onwards set at 100%, 100% female ages 1 and 2
- S8: Aging error matrix included.
- S9: Beta prior on estimated steepness parameter (Shertzer and Conn 2012).
- S10: Low M with beta prior on estimated steepness parameter.
- S11: High M with beta prior on estimated steepness parameter.
- S12: Runs a–e are the 5 retrospective peels. Retrospective analyses, or peels, were run by incrementally dropping one year at a time for five iterations making the terminal years 2016, 2015, 2014, 2013 and 2012.

3.4 Parameters Estimated

The model estimated 223 parameters. This included recruitment parameters (3), annual recruitment deviations (36), Dirichlet-multinomial variance inflation factors for each composition (8), parameters characterizing selectivity (14) and catchability (3), average F for each fleet (4) and annual F deviations (153), and CV of size at age (2). Not all of these parameters equate to statistical degrees of freedom, particularly the F parameters are constrained to match the landings and thus represent a computational convenience rather than freely estimated parameters.

3.5 Per Recruit and Equilibrium Analyses

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 the computation of MSY related benchmarks (described in §3.6), per recruit and equilibrium analyses applied the most recent selectivity patterns averaged across fleets, weighted by each fleet's F from the last three years of the assessment (2015–2017).

3.6 Benchmark/Reference Point Methods

In this assessment of scamp, the quantities F_{MSY}, SSB_{MSY}, B_{MSY}, and MSY were estimated by the method of Shepherd (1982). In that method, the point of maximum yield is calculated 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 removals.

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

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

where R_0 is virgin recruitment, h is steepness, and $\Phi_F = \phi_F/\phi_0$ is spawning potential ratio 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 SSB_{MSY} follows from the corresponding equilibrium age structure, as does the benchmark estimate of discard mortalities (D_{MSY}), here separated from ASY (and consequently, MSY).

Estimates of MSY and related benchmarks are conditional on selectivity pattern. The selectivity pattern used here was an average of terminal-year selectivities from each fleet, where each fleet-specific selectivity was weighted in proportion to its corresponding estimate of F averaged over the last three years (2015–2017). 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 proposed to be set to F_{MSY}, and the minimum stock size threshold (MSST) as $\text{MSST} = 75\%\text{SSB}_{\text{MSY}}$. Overfishing is defined as $F > \text{MFMT}$ and overfished as $\text{SSB} < \text{MSST}$. Current status of the stock is represented by SSB in the latest assessment year (2017), and current status of the fishery is represented by the geometric mean of F from the latest three years (2015–2017).

3.7 Uncertainty and Measures of Precision

For the base run of the catch-age model (BAM), uncertainty in results and precision of estimates was computed through an ensemble modeling approach (Scott et al. 2016; Jardim et al. 2021) using a mixed Monte Carlo and bootstrap framework (Efron and Tibshirani 1993; Manly 1997). Monte Carlo and bootstrap methods 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 assessment model many times with different values of "observed" data and key input parameters. A chief advantage of the ensemble modeling approach is that the resulting ensemble model describes 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, though parallel computing can somewhat mitigate those demands.

In this assessment, the BAM was successively re-fit in $n = 4000$ trials that differed from the original inputs by bootstrapping on data sources, and by Monte Carlo sampling of several key input parameters. Of those 4000, 3934 trials were retained based on a trim of initial runs to satisfy the criteria that $F_{\text{MSY}} < 0.45$, $R_0 < 845,000$, $\sigma_R^2 < 1.0$ and $\sigma < 0.98$. The $n = 3934$ trials used to characterize uncertainty were sufficient for convergence of standard errors in management quantities.

The ensemble model should be interpreted as providing an approximation to the uncertainty associated with each output. The results are approximate as all runs are given equal weight in the results, yet some might provide better fits to data than others.

3.7.1 Bootstrap of observed data

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

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

The term $\sigma^2_{s,y}/2$ is a bias correction that centers the multiplicative error on the value of 1.0. Standard deviations in log space were computed from CVs in arithmetic space, $\sigma_{s,y} = \sqrt{\log(1.0 + CV^2_{s,y})}$. As used for fitting the base run, CVs of commercial landings in all years were assumed to be 0.05. The CVs for recreational landings and both commercial and recreational discards were those provided by the data providers (see Table 3) as were the CVs of indices of abundance (see Table 4).

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

3.7.2 Monte Carlo sampling

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

Natural mortality Because natural mortality is highly uncertain, the Panel recommended that M be varied in the ensemble modeling approach in a way consistent with the Lorenzen method. The point estimate of the maximum age of scamp was varied by ± 2 yrs drawn from a uniform distribution. This value was used in the Then et al. equation, and the resulting point estimate of M was used to scale the Lorenzen curve in the same way as in the base run.

Discard mortalities Uncertainty in discard mortality rates (δ) were included in the ensemble modeling based on the estimates and range of discard mortality provided by the DW Discard Mortality Working Group. A new value for commercial discard mortality was drawn for each model run from a uniform distribution (range [0.16, 0.4])and the recreational discard mortality was drawn from a uniform distribution (range [0.33, 0.45]).

4 Stock Assessment Results

4.1 Measures of Overall Model Fit

The Beaufort Assessment Model (BAM) fit well to the available data. Predicted age compositions from both the recreational and commercial fisheries and the chevron traps were reasonably close to observed data (Figure 3). The model was configured to fit observed commercial landings closely (Figure 4). The provided CVs from the recreational fleet were used and the model did not fit these landings as closely (Figure 5). The model closely fit the observed discards for the commercial and recreational fleets (Figures 6–7). The fit to the three indices of abundance generally captured the observed trend but not all annual fluctuations (Figures 8–10).

4.2 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.

4.3 Stock Abundance and Recruitment

Estimated abundance at age shows an overall declining trend, with a steep decline starting in 2005. The estimated abundance from the early 1980s to the early 2000s appeared generally stable from an initial decline from the start of the model in 1969 (Figure 11; Table 6). Total estimated abundance at the end of the assessment period showed a slight slowdown in the recent sharp decline that began in 2005. Annual number of recruits is shown in Table 6 (age-1 column) and in Figure 12. Weak recruitment was predicted beginning in 2005, following a period of generally above average recruitment in the 1990s and early 2000s. Recruitment for the most recent years have been higher than prior weak recruitment years (2009–2015), however these values are constrained to fall on the stock-recruitment curve, as there is no information content in the data to estimate recruitment deviations in the terminal years.

4.4 Total and Spawning Biomass

Estimated biomass at age, as well as total biomass and spawning biomass followed a similar pattern as abundance at age (Figures 13 and 14 ; Tables 7 and 8).

4.5 Selectivity

Selectivities of landings and discards from commercial and recreational fleets are shown in Figures 15–18. Selectivity from the SERFS gear generally fit well though the model could not completely capture the older year classes and the plus group seen in the seen in some years of chevron trap age compositions (Figures 19 and 3).

Full selection occurred near age-6 for both the recreational fleet and the commercial fleet. Full selectivity for the chevron traps occurred at age-4. Discards were comprised primarily of age-1 and some age-2 and age-3 fish.

Average selectivities of landings, discards and total fishing mortality were computed from F-weighted selectivities in the most recent period of regulations (Figures 20–22). These average selectivities were used to compute benchmarks. All selectivities from the most recent period, including average selectivities, are tabulated in Table 9.

4.6 Fishing Mortality, Landings and Discards

The estimated fishing mortality rates (F) have shown an increasing trend, peaking in the late 2000s (Figure 23). The commercial fleet has been the largest contributor to total F (Table 10). Estimates of total F at age are shown in Table 11. Table 12 shows total landings at age in numbers, and Table 13 in weight. In general, the majority of estimated landings were from the commercial fleet (Figures 24, 25; Tables 14, 15). The majority of estimated discards were from the recreational fleet (Figures 26, 27; Tables 16, 17).

4.7 Spawner-Recruitment Parameters

The spawner-recruit relationship with estimated steepness is shown in Figure 28. Density dependence is depicted graphically by recruits per spawner as a function of spawners. Values of recruitment-related parameters were as follows: steepness $\widehat{h} = 0.57$, unfished age-1 recruitment $\widehat{R_0} = 743,534$, and standard deviation of recruitment residuals in log space $\widehat{\sigma_R} = 0.498$. Uncertainty in these quantities was estimated through the ensemble modeling (Figure 29).

4.8 Per Recruit and Equilibrium Analyses

Yield per recruit and spawning potential ratio were computed as functions of F (Figure 30). Per recruit analyses applied the most recent selectivity patterns averaged across fleets, weighted by F from the last three years (2015–2017).

As in per recruit analyses, equilibrium landings and spawning biomass were computed as functions of F (Figures 31–32).

4.9 Benchmarks / Reference Points

As described in §3.6, biological reference points (benchmarks) were derived analytically assuming equilibrium dynamics, corresponding to the expected recruitment (Figure 28). Reference points estimated were F_{MSY}, MSY, B_{MSY} and SSB_{MSY}. Standard deviations of benchmarks were approximated as those from ensemble model (§3.7).

Estimates of benchmarks are summarized in Table 18. Point estimates of MSY-related quantities were $F_{\text{MSY}} = 0.21$ (y^{-1}), MSY = 207 (klb), $B_{\text{MSY}} = 2754$ (mt), and $\text{SSB}_{\text{MSY}} = 1952$ (mt). Distributions of these benchmarks from the ensemble model are shown in Figure 33.

4.9.1 Status of the Stock and Fishery

The estimated time series of spawning stock biomass showed an overall decline from the start of the model with the steepest decline starting in the early 2000s (Figure 14). Current stock status was estimated in the base run to be $\text{SSB}_{2017}/\text{MSST} = 0.55$ and $\text{SSB}_{2017}/\text{SSB}_{\text{MSY}} = 0.41$ (Table 18 and Figure 34), indicating that the stock is overfished. Uncertainty from the ensemble modeling suggested that the estimate of SSB relative to both SSB_{MSY} and SSB/MSST is very robust (Figures 35, 36), with 100% of ensemble modeling runs indicate the stock is below MSST. Age structure estimated by the base run was below the equilibrium age structure expected at MSY and has varied slightly over time (Figure 37).

The estimated time series of fishing mortality rate increased from the 1970s through the early 1990s, generally stabilized in the 1990s with large annual variations, peaking in the late 2000s (Figure 34). Current fishery status in the terminal year, with current F represented by the geometric mean from 2015–2017, was estimated by the base run to be $F_{2015-2017}/F_{\mathrm{MSY}} = 1.23$ (Table 18 and Figures 35 and 36). The results of the ensemble model are relatively consistent with those results, with 75.3% of models within the ensemble estimate the stock is undergoing overfishing.

4.10 Sensitivity and Retrospective Analyses

Sensitivity runs, described in §3.3, were used for exploring data or model issues that arose during the assessment process, for evaluating implications of assumptions in the base assessment model, and for interpreting ensemble model results in terms of expected effects of input parameters (Figures 38–43). Sensitivity runs are a tool for better understanding model behavior, and therefore should not be used as the basis for management. All runs are not considered equally plausible or representative of alternative states of nature.

Time series of F/F_{MSY} and $\mathrm{SSB}/\mathrm{SSB}_{\mathrm{MSY}}$ demonstrate the model was not sensitive to the changing the male contribution, moderately sensitive to including the aging error matrix, and most sensitive to natural mortality (Figure 39). The largest changes were not observed in the time series overall but in the values of estimated steepness. This was particulary evident with changes to the natural mortality, the high M run had a steepness $\widehat{h} = 0.46$ and the low M run steepness $\widehat{h} = 0.71$. Using a beta prior on steepness resulted in a steepness $\widehat{h} = 0.62$ with little discernable effect on the time series of F/F_{MSY} and $\mathrm{SSB}/\mathrm{SSB}_{\mathrm{MSY}}$ (Figure 42). The use of the beta prior on steepness for the shifts in natural mortality did not largely change the estimated steepness as compared the high and low natural mortality runs using no prior on steepness $\widehat{h} = 0.49$ and $\widehat{h} = 0.76$ respectively). Varying the percentage of male composition to the population had minimal effects on the estimated steepness value while the inclusion of the aging error matrix did not change the estimated steepness value from the base run 19).

Retrospective analyses had the largest effect on the estimated value of steepness. Each successive yearly peel resulted in a higher estimated value of steepness, with the exception of the year 2014 peel (Figures 44).

5 Discussion

5.1 Comments on the Assessment

This assessment is the first SEDAR assessment of scamp as well as the first research track assessment. Steepness was estimable and values of MSY were able to be obtained. The base run of BAM indicated that the stock is overfished ($\mathrm{SSB}_{2017}/\mathrm{MSST} = 0.55$), and that overfishing is occurring ($F_{2015-2017}/F_{\mathrm{MSY}} = 1.23$). The ensemble model indicated that the stock status is above MSST with 100% of the runs indicating the stock is overfished. About 75% of the ensemble model runs indicated that the stock is experiencing overfishing. The population abundance has been at its lowest level over the last decade, a period when recruitment has been relatively low. The relatively higher period of abundance, as compared to the recent decade, in the late 1990s coincides with a period of higher than average recruitment. The relatively low recruitment over the last decade seems to account for the current status of the stock as landings have been declining over the past decade.

Steepness was estimable as noted and in many of the sensitivity runs, steepness estimates did not vary greatly from the base run estimate, with the exception of the retrospective analysis. Steepness parameters values increased with each successive yearly peel, indicating that the most recent data potentially influenced the steepness results.

This research track assessment was conducted on the complex of scamp and yellowmouth grouper as opposed to a single species. Available data does suggest scamp is the dominant species within the complex, however, this adds further uncertainty to assumptions used within this assessment, particulary around the stock-recruitment relationship. The high potential for species misidentification between the two species and the overall scarcity of data for these species necessitated the combination of the two species for this assessment.

There remains large uncertainty in the recreational landings, evidenced by the poor fit of the model to the reported landings and the correspondingly high CVs for certain years, most notably 2014. In initial model runs, the provided CVs could not be used and placeholder CVs of 0.5 needed to be employed. Once the model was better parameterized, the provided CVs were able to be used though this did result in the poor recreational landing fits. This uncertainty was further highlighted in the ensemble model results. The recreational landings for 2014 were highly uncertain and larger as compared to surrounding years, primarily coming from a small spatial area (SEDAR 2021). This larger than expected value also had an effect on the steepness estimate for the 2014 retrospective analysis. However, the effect of the 2014 landings were negligible as exhibited in sensitivity run 1 where 0.05 CVs were used and the predicted landings closely fit the observed data.

The fishery–independent chevron trap index reflected a similar decline in abundance of scamp occurring in the past decade despite a corresponding increase in spatial coverage of the survey. This decline in abundance was also observed in the chevron trap and video data analyzed by Bachelor and Ballenger (Bacheler and Ballenger 2018). They observed declines in both smaller and larger scamp, though the proportion of larger scamp did increase over time period of the survey. The authors concluded from those data that a recruitment failure was likely the cause of the decline in abundance. This conclusion is consistent with the findings of this assessment, which used those same data but also additional sources.

This assessment highlighted the need for continued and increased age sampling. Sufficient age composition data is critical for characterizing year class strength and for informing selectivity patterns of various fishing fleets. Length composition data have less utility in this regard due to the typically large variation in length-at-age for many southeast U.S. species; this was particularly true for scamp. The lack of long-term age composition data made estimating changes in selectivity due to size limit regulations difficult. The size limits for scamp implemented in 1992 appeared to have little influence on the length distributions of fish in the landings. However, sufficient data to estimate selectivity during this early period was not available, and so the composition of early removals and discards is uncertain.

5.2 Research Recommendations

- Develop methods to characterize length and age composition of scamp observed on videos from the SERFS fishery–independent survey.
- Implement a systematic age sampling program for both the recreational and commercial sectors.
- Better characterize reproductive parameters including age at maturity, batch fecundity, spawning seasonality, and spawning frequency. Mature male and female biomass was the measure of reproductive potential for scamp in the assessment, but may be biased if reproductive parameters vary significantly with size or age.
- Age-dependent natural mortality was estimated by indirect methods for this assessment of scamp. Mark-recapture approaches (conventional, telemetry, or close-kin) might make it possible to obtain direct estimates of natural mortality of scamp.
- Better characterize the movement dynamics of the stock and the potential for distribution shifts.

6 References

Bacheler, N. M., and J. C. Ballenger. 2018. Decadal-scale decline of scamp (Mycteroperca phenax) abundance along the southeast United States Atlantic coast. Fisheries Research **204**:74–87.

Baranov, F. I. 1918. On the question of the biological basis of fisheries. Nauchnye Issledovaniya Ikhtiologicheskii Instituta Izvestiya **1**:81–128.

Brennan, K., 2020. Estimates of Historic Recreational Landings of Scamp and Yellowmouth Grouper in the South Atlantic Using the FHWAR Census Method. SEDAR68-DW-11. SEDAR, North Charleston, SC. 7p.

Brooks, E. N., K. W. Shertzer, T. Gedamke, and D. S. Vaughan. 2008. Stock assessment of protogynous fish: evaluating measures of spawning biomass used to estimate biological reference points. Fishery Bulletin **106**:12–23.

Conn, P. B. 2010. Hierarchical analysis of multiple noisy abundance indices. Canadian Journal of Fisheries and Aquatic Sciences .

Efron, B., and R. Tibshirani. 1993. An Introduction to the Bootstrap. Chapman and Hall, London.

Fournier, D. A., H. J. Skaug, J. Ancheta, J. Ianelli, A. Magnusson, M. N. Maunder, A. Nielsen, and J. Sibert. 2012. AD Model Builder: using automatic differentiation for statistical inference of highly parameterized complex nonlinear models. Optimization Methods and Software **27**:233–249.

Francis, R. 2011. Data weighting in statistical fisheries stock assessment models. Canadian Journal of Fisheries and Aquatic Sciences **68**:1124–1138.

Francis, R. 2017. Revisiting data weighting in fisheries stock assessment models. Fisheries Research **192**:5–15.

Francis, R., R. Hurst, and J. Renwick. 2003. Quantifying annual variation in catchability for commercial and research fishing. Fishery Bulletin **101**:293–304.

Gabriel, W. L., and P. M. Mace, 1999. A review of biological reference points in the context of the precautionary approach. NOAA Technical Memorandum-F/SPO-40.

Jardim, E., M. Azevedo, J. Brodziak, E. N. Brooks, K. F. Johnson, N. Klibansky, C. P. Millar, C. Minto, I. Mosqueira, R. D. M. Nash, P. Vasilakopoulos, and B. K. Wells. 2021. Operationalizing model ensembles for scientific advice to fisheries management. ICES Journal of Marine Science **https://doi.org/10.1093/icesjms/fsab010**.

Legault, C. M., J. E. Powers, and V. R. Restrepo. 2001. Mixed Monte Carlo/bootstrap approach to assessing king and Spanish mackerel in the Atlantic and Gulf of Mexico: Its evolution and impact. Amercian Fisheries Society Symposium **24**:1–8.

Li, B., K. W. Shertzer, P. D. Lynch, J. N. Ianelli, C. M. Legault, E. H. Williams, R. D. Methot Jr., E. N. Brooks, J. J. Deroba, A. M. Berger, S. R. Sagarese, J. K. T. Brodziak, I. G. Taylor, M. A. Karp, C. R. Wetzel, and M. Supernaw. In Press. A comparison of four primary age-structured stock assessment models used in the United States. Fishery Bulletin .

Lorenzen, K. 1996. The relationship between body weight and natural mortality in juvenile and adult fish: a comparison of natural ecosystems and aquaculture. Journal of Fish Biology **49**:627–642.

Manly, B. F. J. 1997. Randomization, Bootstrap and Monte Carlo Methods in Biolog, 2nd edition. Chapman and Hall, London.

McCarthy, K., J. Diaz, and S. Smith, 2020. Estimated discards of scamp and yellowmouth grouper from the commercial vertical line fishing vessels in the South Atlantic. SEDAR68-WP-xx, SEDAR, North Charleston, SC. 7pp.

Methot, R. D., and C. R. Wetzel. 2013. Stock synthesis: a biological and statistical framework for fish stock assessment and fishery management. Fisheries Research **142**:86–99.

Pulver, J., 2021. SEDAR 68 Commercial Discard Mortality Estimates Based on Observer Data. SEDAR, North Charleston, SC.

Pulver, J. R. 2017. Sink or swim? Factors affecting immediate discard mortality for the gulf of Mexico commercial reef fish fishery. Fisheries Research **188**:166–172.

Quinn, T. J., and R. B. Deriso. 1999. Quantitative Fish Dynamics. Oxford University Press, New York, New York.

Restrepo, V. R., J. M. Hoenig, J. E. Powers, J. W. Baird, and S. C. Turner. 1992. A simple simulation approach to risk and cost analysis, with applications to swordfish and cod fisheries. Fishery Bulletin **90**:736–748.

Scott, F., E. Jardim, C. Millar, and S. Cervino. 2016. An applied framework for incorporating multiple sources of uncertainty in fisheries stock assessments. PLOS ONE **11**:1–21.

SEDAR, 2004. SEDAR 4: Stock assessment of the deepwater snapper-grouper complex in the South Atlantic.

SEDAR, 2009. SEDAR 19: South Atlantic Red Grouper.

SEDAR, 2010. SEDAR 24: South Atlantic Red Snapper.

SEDAR, 2019. SEDAR 58: South Atlantic Cobia.

SEDAR, 2021. SEDAR 68 Data Workshop Report.

SEDAR Procedural Guidance, 2009. SEDAR Procedural Guidance Document 2: Addressing Time-Varying Catchability.

SEDAR Procedural Guidance, 2010. SEDAR Procedural Workshop IV: Characterizing and Presenting Assessment Uncertainty.

Shepherd, J. G. 1982. A versatile new stock-recruitment relationship for fisheries, and the construction of sustainable yield curves. Journal du Conseil pour l'Exploration de la Mer **40**:67–75.

Shertzer, K. W., and P. B. Conn. 2012. Spawner-recruit relationships of demersal marine fishes: Prior distribution of steepness. Bulletin of Marine Science **88**:39–50.

Shertzer, K. W., E. H. Williams, M. H. Prager, and D. S. Vaughan, 2014. Fishery models. Pages 1582–1593 *in* S. E. Jorgensen and F. Fath, editors. Population Dynamics. Vol. [2] of Encyclopedia of Ecology, 5 vols. Elsevier, Oxford.

Then, A. Y., J. M. Hoenig, N. G. Hall, and D. A. Hewitt. 2015. Evaluating the predictive performance of empirical estimators of natural mortality rate using information on over 200 fish species. ICES Journal of Marine Science **72**:82–92.

Thorson, J. T., K. F. Johnson, R. D. Methot, and I. G. Taylor. 2017. Model-based estimates of effective sample size in stock assessment models using the Dirichlet-multinomial distribution. Fisheries Research **192**:84–93.

Williams, E. H., and K. W. Shertzer, 2015. Technical documentation of the Beaufort Assessment Model (BAM). NOAA Technical Memorandum-NMFS-SEFSC-671.

7 Tables

Table 1. Life-history characteristics at age, including average body length and weight (mid-year), proportion females mature, and natural mortality at age. The CV of length was estimated by the assessment model; other values were treated as input.

Age	Total length (mm)	Total length (in)	CV length	Whole wgt (kg)	Whole wgt (lb)	Fem. mat.	prop. fem.	M
1	309.0	12.2	0.1	0.39	0.86	0.11	1.00	0.3821
2	375.3	14.8	0.1	0.68	1.50	0.39	0.99	0.3247
3	432.3	17.0	0.1	1.02	2.25	0.77	0.97	0.2884
4	481.5	19.0	0.1	1.39	3.06	0.94	0.95	0.2635
5	523.8	20.6	0.1	1.77	3.90	0.99	0.92	0.2456
6	560.3	22.1	0.1	2.15	4.73	1.00	0.87	0.2322
7	591.7	23.3	0.1	2.51	5.54	1.00	0.80	0.2218
8	618.8	24.4	0.1	2.86	6.30	1.00	0.72	0.2137
9	642.1	25.3	0.1	3.18	7.00	1.00	0.62	0.2072
10	662.2	26.1	0.1	3.47	7.65	1.00	0.51	0.2019
11	679.6	26.8	0.1	3.74	8.24	1.00	0.40	0.1976
12	694.5	27.3	0.1	3.98	8.77	1.00	0.30	0.1941
13	707.3	27.8	0.1	4.19	9.24	1.00	0.21	0.1912
14	718.4	28.3	0.1	4.38	9.66	1.00	0.14	0.1887
15	728.0	28.7	0.1	4.55	10.04	1.00	0.09	0.1867
16	736.2	29.0	0.1	4.70	10.37	1.00	0.05	0.1849
17	743.3	29.3	0.1	4.83	10.66	1.00	0.03	0.1835
18	749.4	29.5	0.1	4.95	10.91	1.00	0.02	0.1822
19	754.6	29.7	0.1	5.05	11.13	1.00	0.01	0.1812
20	759.2	29.9	0.1	5.14	11.32	1.00	0.00	0.1803

Table 2. Observed time series of landings (L) and discards (D) for the commercial (COM) and recreational (REC) fleets. Landings are in units of 1000 lb whole weight for commercial landings, and in units of 1000 fish for general recreational landings and all discards.

Year	L.COM	L.REC	D.COM	D.REC
1969	33.70	10.70	.	.
1970	44.67	10.76	.	.
1971	49.98	11.83	.	.
1972	36.54	12.89	.	.
1973	48.40	13.96	.	.
1974	66.55	15.02	.	.
1975	67.25	16.08	.	.
1976	85.71	16.27	.	.
1977	125.52	16.45	.	.
1978	277.94	16.63	.	.
1979	262.80	16.81	.	.
1980	252.56	16.99	.	.
1981	244.28	21.33	.	.
1982	378.56	18.47	.	.
1983	322.83	9.56	.	.
1984	320.17	17.97	.	.
1985	255.34	14.77	.	.
1986	286.40	11.15	.	.
1987	328.42	16.40	.	.
1988	348.05	33.18	.	2.480
1989	376.67	31.39	.	0.005
1990	484.32	44.08	.	1.175
1991	394.16	34.04	.	0.000
1992	285.89	27.07	.	3.125
1993	312.02	28.65	1.924	6.071
1994	311.33	45.07	1.961	5.239
1995	345.13	15.68	2.245	3.905
1996	286.95	16.99	2.510	2.717
1997	289.43	17.37	2.716	4.098
1998	266.37	19.82	2.491	3.208
1999	383.35	25.63	2.592	4.103
2000	299.47	42.92	2.044	4.178
2001	227.07	25.26	2.407	5.629
2002	238.35	58.48	2.665	7.189
2003	263.41	45.27	2.938	8.050
2004	259.64	40.97	2.833	8.510
2005	276.84	34.93	2.505	2.816
2006	322.19	52.55	2.241	3.775
2007	344.34	59.19	2.137	13.949
2008	258.11	31.89	1.906	6.422
2009	260.79	18.11	2.328	6.508
2010	184.48	11.15	1.680	3.632
2011	159.05	6.87	1.898	1.274
2012	161.31	9.07	2.374	6.154
2013	141.15	10.58	1.957	0.811
2014	164.53	40.23	1.843	0.398
2015	128.13	7.45	1.597	1.290
2016	111.00	8.59	1.936	0.668
2017	110.35	13.98	1.465	0.242

Table 3. Landings (L) and Discards (D) CVs used in the ensemble model for the commercial (COM) and recreational (REC) fleets.).

Year	COM	COM D	REC	REC D
1969	0.05	.	0.47	.
1970	0.05	.	0.47	.
1971	0.05	.	0.47	.
1972	0.05	.	0.47	.
1973	0.05	.	0.47	.
1974	0.05	.	0.47	.
1975	0.05	.	0.47	.
1976	0.05	.	0.47	.
1977	0.05	.	0.47	.
1978	0.05	.	0.47	.
1979	0.05	.	0.47	.
1980	0.05	.	0.47	.
1981	0.05	.	0.59	.
1982	0.05	.	0.41	.
1983	0.05	.	0.07	.
1984	0.05	.	0.29	.
1985	0.05	.	0.35	.
1986	0.05	.	0.15	.
1987	0.05	.	0.05	.
1988	0.05	.	0.21	0.5
1989	0.05	.	0.21	0.5
1990	0.05	.	0.23	0.5
1991	0.05	.	0.12	0.5
1992	0.05	.	0.20	0.5
1993	0.05	0.5	0.24	0.5
1994	0.05	0.5	0.22	0.5
1995	0.05	0.5	0.01	0.5
1996	0.05	0.5	0.26	0.5
1997	0.05	0.5	0.15	0.5
1998	0.05	0.5	0.07	0.5
1999	0.05	0.5	0.12	0.5
2000	0.05	0.5	0.26	0.5
2001	0.05	0.5	0.18	0.5
2002	0.05	0.5	0.21	0.5
2003	0.05	0.5	0.30	0.5
2004	0.05	0.5	0.26	0.5
2005	0.05	0.5	0.51	0.5
2006	0.05	0.5	0.41	0.5
2007	0.05	0.5	0.22	0.5
2008	0.05	0.5	0.29	0.5
2009	0.05	0.5	0.40	0.5
2010	0.05	0.5	0.32	0.5
2011	0.05	0.5	0.35	0.5
2012	0.05	0.5	0.36	0.5
2013	0.05	0.5	0.34	0.5
2014	0.05	0.5	0.90	0.5
2015	0.05	0.5	0.42	0.5
2016	0.05	0.5	0.40	0.5
2017	0.05	0.5	0.74	0.5

Table 4. Observed indices of abundance and their corresponding CVs (commercial, COM, recreational, REC, and the chevron trap/video survey combined, CVT/VID).

Year	COM	COM CV	REC	REC CV	CVT/VID	CVT/VID.CV
1969	.	.	.	.	.	.
1970	.	.	.	.	.	.
1971	.	.	.	.	.	.
1972	.	.	.	.	.	.
1973	.	.	.	.	.	.
1974	.	.	.	.	.	.
1975	.	.	.	.	.	.
1976	.	.	.	.	.	.
1977	.	.	.	.	.	.
1978	.	.	.	.	.	.
1979	.	.	.	.	.	.
1980	.	.	.	.	.	.
1981	.	.	0.55	0.26	.	.
1982	.	.	0.64	0.20	.	.
1983	.	.	0.55	0.20	.	.
1984	.	.	0.58	0.22	.	.
1985	.	.	0.74	0.19	.	.
1986	.	.	0.68	0.18	.	.
1987	.	.	0.86	0.16	.	.
1988	.	.	0.78	0.17	.	.
1989	.	.	0.79	0.26	.	.
1990	.	.	1.23	0.19	1.29	0.26
1991	.	.	1.29	0.24	1.15	0.26
1992	.	.	0.95	0.21	1.10	0.27
1993	0.90	0.22	0.77	0.21	1.18	0.26
1994	0.78	0.22	0.95	0.19	2.05	0.22
1995	0.96	0.18	1.16	0.20	2.02	0.23
1996	0.87	0.19	0.85	0.20	1.22	0.25
1997	0.94	0.18	1.30	0.17	2.47	0.22
1998	0.96	0.21	1.36	0.16	1.77	0.24
1999	1.12	0.20	1.61	0.14	1.34	0.28
2000	1.17	0.19	1.38	0.17	1.29	0.25
2001	0.94	0.19	1.09	0.18	1.55	0.25
2002	0.94	0.19	1.25	0.19	0.99	0.29
2003	1.08	0.20	1.35	0.23	1.18	0.29
2004	0.92	0.22	1.33	0.20	1.23	0.27
2005	1.09	0.21	1.20	0.19	1.29	0.26
2006	1.28	0.20	1.19	0.23	0.39	0.40
2007	1.22	0.18	1.29	0.18	1.17	0.25
2008	0.96	0.20	0.76	0.26	0.34	0.39
2009	0.87	0.22	0.53	0.23	0.32	0.39
2010	.	.	.	.	0.45	0.31
2011	.	.	.	.	0.36	0.24
2012	.	.	.	.	0.35	0.21
2013	.	.	.	.	0.32	0.22
2014	.	.	.	.	0.34	0.21
2015	.	.	.	.	0.31	0.20
2016	.	.	.	.	0.27	0.21
2017	.	.	.	.	0.27	0.21

Table 5. Sample sizes (number of trips) length compositions (len) or age compositions (age) by fleet. Data sources are commercial (COM), general recreational (REC), and chevron trap (CVT).

Year	len.COM	len.REC	len.CVT	age.COM	age.REC	age.CVT
1978	.	112	.	.	.	.
1979	.	84	.	.	.	.
1980	.	81	.	.	.	.
1981	.	.	.	.	.	.
1982	.	127	.	.	.	.
1983	.	206	.	.	.	.
1984	119	223	.	.	.	.
1985	178	216	.	.	.	.
1986	127	209	.	.	.	.
1987	171	272	.	.	.	.
1988	153	229	.	.	.	.
1989	138	.	.	.	.	.
1990	122	133	35	.	.	13
1991	178	133	35	.	.	33
1992	.	104	33	.	.	31
1993	.	.	44	.	.	43
1994	.	.	71	.	.	69
1995	.	.	52	.	.	50
1996	.	.	71	.	45	68
1997	.	.	87	.	.	87
1998	.	.	53	.	.	53
1999	.	.	32	.	.	32
2000	.	.	46	.	.	44
2001	.	.	39	.	.	38
2002	.	.	33	.	22	33
2003	.	.	.	.	33	27
2004	.	.	40	46	42	40
2005	.	.	35	110	54	33
2006	.	.	.	263	50	11
2007	.	.	41	368	49	40
2008	.	.	.	345	18	11
2009	.	.	.	260	40	12
2010	.	.	37	201	32	36
2011	.	.	31	225	.	31
2012	.	.	46	187	26	46
2013	.	.	53	129	35	53
2014	.	.	55	124	27	55
2015	.	.	57	100	17	57
2016	.	.	43	114	32	43
2017	.	.	58	80	20	57

Table 6. 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	16	17	18	19	20	Total
1969	851.05	580.78	419.75	314.56	241.57	188.49	148.32	117.34	93.16	74.28	59.50	47.87	38.64	31.28	25.39	20.65	16.82	13.73	11.21	50.52	3344.91
1970	851.05	580.78	419.75	314.56	241.58	188.51	148.37	117.44	93.31	74.43	59.63	47.97	38.73	31.35	25.45	20.69	16.86	13.76	11.24	50.63	3346.07
1971	851.21	580.78	419.75	314.56	241.58	188.51	148.36	117.39	93.23	74.38	59.61	47.96	38.72	31.35	25.44	20.69	16.86	13.75	11.24	50.61	3345.96
1972	851.11	580.88	419.75	314.56	241.56	188.46	148.25	117.24	93.03	74.17	59.45	47.84	38.62	31.27	25.38	20.64	16.82	13.72	11.21	50.50	3344.47
1973	850.90	580.82	419.82	314.55	241.53	188.35	147.99	116.97	92.85	74.01	59.29	47.72	38.54	31.20	25.33	20.60	16.78	13.69	11.18	50.39	3342.51
1974	850.59	580.68	419.77	314.60	241.52	188.28	147.79	116.57	92.38	73.62	58.95	47.42	38.30	31.02	25.18	20.48	16.69	13.61	11.12	50.10	3338.68
1975	850.00	580.46	419.67	314.56	241.55	188.22	147.62	116.18	91.73	72.90	58.35	46.92	37.88	30.68	24.91	20.26	16.51	13.47	11.00	49.57	3332.45
1976	849.22	580.06	419.52	314.48	241.51	188.21	147.50	115.96	91.34	72.32	57.73	46.40	37.44	30.31	24.61	20.02	16.32	13.31	10.88	48.99	3326.12
1977	848.39	579.53	419.23	314.37	241.45	188.18	147.46	115.73	90.89	71.73	57.02	45.71	36.86	29.83	24.21	19.70	16.06	13.10	10.70	48.22	3318.36
1978	847.23	578.96	418.84	314.15	241.35	188.10	147.33	115.38	90.12	70.75	56.03	44.73	35.97	29.10	23.61	19.20	15.65	12.77	10.43	47.01	3306.72
1979	844.81	578.17	418.43	313.86	241.16	187.92	146.86	113.99	87.51	67.75	53.27	42.34	33.91	27.35	22.18	18.03	14.69	11.99	9.80	44.15	3278.18
1980	251.52	576.52	417.86	313.54	240.92	187.72	146.62	113.54	86.41	65.77	50.99	40.24	32.09	25.78	20.84	16.94	13.79	11.25	9.20	41.45	2663.00
1981	473.09	171.65	416.66	313.11	240.67	187.48	146.33	113.20	85.94	64.84	49.42	38.46	30.45	24.36	19.61	15.89	12.93	10.55	8.62	38.85	2462.11
1982	987.00	322.85	124.05	312.20	240.27	187.02	145.56	112.33	85.15	64.07	48.41	37.04	28.92	22.96	18.41	14.85	12.06	9.83	8.03	36.18	2817.18
1983	1145.45	673.55	233.33	92.95	239.53	186.53	144.62	110.21	81.93	60.98	45.85	34.75	26.67	20.88	16.63	13.36	10.80	8.78	7.16	32.27	3186.21
1984	949.37	781.68	486.79	174.84	71.36	186.55	145.61	111.21	82.07	60.05	44.68	33.70	25.63	19.73	15.49	12.35	9.94	8.05	6.55	29.48	3255.12
1985	925.75	647.87	564.93	364.73	134.12	55.35	143.92	110.00	81.12	58.86	43.05	32.13	24.32	18.55	14.31	11.26	8.99	7.25	5.88	26.35	3278.72
1986	776.99	631.75	468.22	423.28	279.79	104.07	42.77	109.33	81.23	59.12	42.91	31.49	23.58	17.90	13.68	10.58	8.34	6.67	5.38	23.98	3161.05
1987	645.31	530.23	456.58	350.84	324.84	217.56	80.85	32.63	80.58	58.86	42.81	31.17	22.95	17.24	13.12	10.05	7.78	6.14	4.92	21.69	2956.17
1988	805.48	440.37	383.20	342.09	269.14	252.04	167.82	60.72	23.38	56.38	41.09	29.98	21.90	16.17	12.17	9.28	7.12	5.53	4.37	18.95	2967.19
1989	852.40	549.18	317.67	286.51	261.75	207.25	190.40	121.83	41.60	15.56	37.39	27.32	19.99	14.65	10.84	8.18	6.25	4.80	3.73	15.77	2993.08
1990	702.05	581.69	396.88	237.97	219.51	201.82	156.86	138.11	82.84	27.37	10.19	24.55	18.00	13.21	9.70	7.19	5.44	4.16	3.20	13.02	2853.77
1991	1748.34	478.88	420.01	296.97	181.98	168.10	149.64	109.32	88.10	50.49	16.55	6.18	14.92	10.97	8.07	5.94	4.41	3.34	2.56	9.99	3774.77
1992	858.29	1193.09	346.08	314.60	227.41	139.96	126.21	106.84	72.47	56.22	32.03	10.52	3.94	9.54	7.03	5.18	3.82	2.84	2.16	8.11	3526.34
1993	1182.74	584.63	858.54	256.91	233.07	157.24	90.79	81.05	68.94	47.05	36.69	20.99	6.92	2.60	6.31	4.66	3.44	2.54	1.89	6.85	3653.85
1994	1594.22	805.40	420.41	636.34	189.13	157.62	98.34	56.00	50.21	42.96	29.47	23.08	13.25	4.38	1.65	4.01	2.97	2.20	1.62	5.59	4138.86
1995	1871.30	1085.91	579.38	311.28	464.45	124.34	94.35	57.82	33.04	29.80	25.63	17.66	13.88	7.99	2.65	1.00	2.44	1.80	1.34	4.40	4730.45
1996	1239.17	1275.29	782.10	430.01	228.66	308.62	75.14	55.98	34.43	19.79	17.94	15.50	10.71	8.44	4.87	1.62	0.61	1.49	1.11	3.53	4515.01
1997	869.85	844.70	919.03	581.29	317.88	155.63	194.28	46.65	34.90	21.59	12.47	11.36	9.85	6.83	5.39	3.12	1.04	0.39	0.96	2.98	4040.19
1998	1091.54	592.67	608.17	682.50	429.75	216.79	98.31	121.08	29.20	21.97	13.67	7.93	7.24	6.30	4.38	3.47	2.01	0.67	0.25	2.55	3940.45
1999	1050.93	743.77	426.80	452.03	506.99	298.52	141.28	63.43	78.49	19.04	14.41	9.00	5.24	4.80	4.18	2.91	2.31	1.34	0.45	1.88	3827.81
2000	919.75	715.80	535.08	316.47	332.42	339.66	183.20	85.29	38.43	47.84	11.67	8.87	5.56	3.24	2.98	2.60	1.82	1.44	0.84	1.46	3554.41
2001	1331.59	626.47	515.00	396.86	233.37	226.48	215.36	114.75	53.66	24.33	30.44	7.46	5.68	3.57	2.09	1.93	1.68	1.18	0.94	1.49	3794.33
2002	1343.22	906.68	450.52	382.45	295.92	165.38	152.97	144.62	77.48	36.46	16.61	20.88	5.13	3.92	2.47	1.45	1.34	1.17	0.82	1.69	4011.21
2003	1254.42	914.32	651.46	333.66	281.98	203.13	106.65	97.70	92.82	50.03	23.66	10.83	13.66	3.37	2.58	1.63	0.96	0.88	0.78	1.67	4046.18
2004	850.77	853.78	656.83	482.52	246.24	193.56	130.61	67.86	62.47	59.70	32.35	15.37	7.06	8.93	2.21	1.69	1.07	0.63	0.58	1.61	3675.85
2005	592.13	578.90	613.03	486.32	356.26	169.31	124.73	83.31	43.50	40.28	38.70	21.06	10.04	4.62	5.86	1.45	1.12	0.71	0.42	1.45	3173.21
2006	483.51	403.39	416.68	455.18	360.11	245.64	109.28	79.65	53.45	28.07	26.14	25.22	13.77	6.58	3.04	3.86	0.96	0.74	0.47	1.24	2716.99
2007	510.54	329.14	289.84	308.32	333.29	240.05	150.47	65.91	48.23	32.56	17.19	16.07	15.56	8.52	4.08	1.89	2.41	0.60	0.46	1.07	2376.21
2008	541.17	345.70	233.93	211.74	222.10	214.66	139.84	85.97	37.79	27.81	18.87	10.01	9.39	9.12	5.01	2.40	1.11	1.42	0.35	0.91	2119.32
2009	394.74	367.64	247.39	172.48	155.27	149.90	134.31	86.35	53.32	23.58	17.45	11.89	6.33	5.95	5.80	3.19	1.53	0.71	0.91	0.81	1839.54
2010	208.18	267.99	262.76	182.25	126.64	105.08	93.92	83.02	53.61	33.30	14.80	11.00	7.52	4.02	3.79	3.69	2.04	0.98	0.46	1.10	1466.15
2011	169.80	141.52	192.09	194.43	135.35	88.80	69.70	61.81	54.93	35.69	22.29	9.95	7.42	5.09	2.72	2.57	2.51	1.39	0.67	1.06	1199.79
2012	289.83	115.51	101.60	142.45	145.11	96.23	60.19	46.97	41.89	37.46	24.47	15.34	6.87	5.14	3.54	1.89	1.79	1.76	0.97	1.21	1140.23
2013	324.22	195.86	81.82	74.27	105.11	101.81	64.17	39.89	31.31	28.09	25.25	16.57	10.43	4.68	3.51	2.42	1.30	1.23	1.21	1.50	1114.64
2014	213.92	220.56	140.60	60.64	55.26	74.11	68.20	42.70	26.68	21.07	19.01	17.16	11.30	7.13	3.21	2.41	1.67	0.90	0.85	1.87	989.26
2015	140.65	145.60	158.43	104.01	44.41	36.92	45.60	41.34	25.99	16.34	12.97	11.75	10.65	7.03	4.45	2.01	1.51	1.04	0.56	1.71	812.97
2016	528.92	95.63	104.38	117.17	76.89	30.61	23.81	29.10	26.51	16.77	10.60	8.45	7.68	6.98	4.62	2.93	1.32	1.00	0.69	1.51	1095.55
2017	504.00	359.92	68.67	77.31	86.53	52.71	19.58	15.05	18.48	16.94	10.77	6.83	5.47	4.99	4.54	3.01	1.91	0.87	0.65	1.44	1259.67
2018	489.02	343.43	259.12	50.91	56.63	57.51	32.08	11.72	9.05	11.17	10.29	6.57	4.19	3.36	3.07	2.80	1.86	1.18	0.54	1.30	1355.81

Table 7. 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	16	17	18	19	20	Total
1969	730.6	870.4	944.2	963.9	942.9	892.4	821.4	738.8	652.3	568.4	490.3	419.8	357.1	302.3	254.9	214.1	179.2	149.7	124.8	571.9	11189.3
1970	730.6	870.4	944.2	963.9	942.9	892.7	821.7	739.4	653.5	569.5	491.2	420.6	358.0	302.9	255.5	214.5	179.7	150.1	125.0	573.2	11199.3
1971	730.8	870.4	944.2	963.9	942.9	892.7	821.7	739.2	652.8	569.0	491.2	420.6	357.8	302.9	255.3	214.5	179.7	149.9	125.0	573.0	11197.3
1972	730.6	870.6	944.2	963.9	942.7	892.4	821.0	738.3	651.5	567.5	489.9	419.5	356.9	302.3	254.9	214.1	179.2	149.7	124.8	571.7	11185.2
1973	730.4	870.4	944.5	963.9	942.7	891.8	819.7	736.6	650.1	566.1	488.5	418.4	356.3	301.6	254.2	213.6	178.8	149.3	124.6	570.6	11171.7
1974	730.2	870.2	944.2	964.1	942.7	891.5	818.4	734.1	646.8	563.3	485.7	415.8	354.1	299.8	252.9	212.3	177.7	148.6	123.7	567.2	11143.3
1975	729.7	869.9	944.0	963.9	942.7	891.1	817.5	731.7	642.4	557.8	480.8	411.4	350.1	296.5	250.0	210.1	175.9	146.8	122.4	561.3	11096.1
1976	729.1	869.3	943.8	963.6	942.5	891.1	816.8	730.2	639.6	553.4	475.5	406.8	346.1	293.0	247.1	207.7	173.9	145.3	121.0	554.7	11050.2
1977	728.4	868.4	943.1	963.2	942.3	890.9	816.6	728.8	636.5	548.7	469.8	400.8	340.8	288.4	242.9	204.1	171.1	142.9	119.0	545.9	10993.1
1978	727.3	867.7	942.3	962.5	942.0	890.7	815.9	726.6	631.2	541.2	461.6	392.2	332.5	281.3	237.0	199.1	166.7	139.3	116.2	532.2	10905.2
1979	725.3	866.4	941.2	961.7	941.2	889.8	813.3	717.8	612.9	518.3	438.9	371.3	313.5	264.3	222.7	187.0	156.5	130.7	109.1	500.0	10681.8
1980	215.8	864.0	940.1	960.8	940.3	888.9	812.0	715.0	605.2	503.1	420.2	353.0	296.5	249.1	209.2	175.5	147.0	122.8	102.3	469.4	9989.8
1981	406.1	257.3	937.2	959.5	939.4	887.6	810.4	712.8	601.9	496.0	407.2	337.3	281.5	235.5	196.9	164.7	137.8	115.1	95.9	439.8	9419.7
1982	847.2	483.9	279.1	956.6	937.6	885.6	806.0	707.2	596.4	490.1	398.8	324.7	267.2	222.0	184.7	153.9	128.5	107.1	89.3	409.6	9276.2
1983	983.3	1009.5	524.9	284.8	934.8	883.2	800.9	694.0	573.9	466.5	377.7	304.7	246.5	201.9	166.9	138.5	115.1	95.7	79.8	365.3	9247.5
1984	815.0	1171.5	1095.0	535.7	278.4	883.4	806.5	700.2	574.7	459.4	368.2	295.6	237.0	190.7	155.4	128.1	106.0	87.7	73.0	333.8	9294.9
1985	794.8	970.9	1270.7	1117.5	523.4	262.1	797.0	692.7	568.1	450.2	354.7	281.8	224.7	179.2	143.7	116.6	95.9	79.1	65.5	298.3	9287.0
1986	667.1	946.7	1053.4	1297.0	1091.9	492.7	236.8	688.5	568.8	452.2	353.6	276.0	218.0	173.1	137.3	109.6	88.8	72.8	60.0	271.4	9255.9
1987	554.0	794.5	1027.1	1075.0	1267.9	1030.0	447.8	205.5	564.4	450.4	352.7	273.4	212.1	166.7	131.6	104.1	82.9	67.0	54.7	245.6	9107.5
1988	691.4	659.8	862.0	1048.3	1050.5	1193.4	929.2	382.3	163.8	431.4	338.6	262.8	202.4	156.3	122.1	96.1	75.8	60.2	48.5	214.5	8990.0
1989	731.7	823.0	714.5	877.9	1021.6	981.3	1054.5	767.2	291.2	119.0	308.0	239.6	184.7	141.5	108.9	84.9	66.6	52.5	41.4	178.6	8788.7
1990	602.7	871.7	892.9	729.1	856.7	955.7	868.6	869.7	580.0	209.4	84.0	215.4	166.4	127.6	97.4	74.5	58.0	45.4	35.7	147.5	8488.2
1991	1500.9	717.6	944.9	910.1	710.3	795.9	828.7	688.5	617.1	386.2	136.5	54.2	138.0	106.0	80.9	61.5	47.0	36.4	28.4	113.1	8901.8
1992	736.8	1787.9	778.5	964.1	887.6	662.7	698.9	672.9	507.5	430.1	263.9	92.4	36.4	92.2	70.5	53.8	40.8	31.1	24.0	91.9	8923.4
1993	1015.2	876.1	1931.2	787.3	909.6	744.5	502.9	510.4	482.8	360.0	302.3	184.1	63.9	25.1	63.3	48.3	36.6	27.8	21.2	77.6	8970.2
1994	1368.6	1207.0	945.8	1949.8	738.1	746.3	544.5	352.7	351.6	328.7	242.7	202.4	122.6	42.3	16.5	41.7	31.5	24.0	18.1	63.3	9338.3
1995	1606.5	1627.5	1303.4	953.7	1812.6	588.6	522.5	364.2	231.5	228.0	211.2	154.8	128.3	77.2	26.7	10.4	26.0	19.6	14.8	49.8	9957.0
1996	1063.7	1911.2	1759.3	1317.7	892.4	1461.2	416.2	352.5	241.2	151.5	147.7	135.8	99.0	81.6	48.9	16.8	6.6	16.3	12.3	39.9	10171.9
1997	746.7	1265.9	2067.3	1781.1	1240.8	737.0	1075.9	293.7	244.5	165.1	102.7	99.6	91.1	65.9	54.2	32.4	11.0	4.2	10.6	33.7	10123.6
1998	937.0	888.2	1368.2	2091.3	1677.3	1026.5	544.5	762.4	204.4	168.2	112.7	69.4	67.0	60.8	43.9	35.9	21.4	7.3	2.9	28.9	10118.1
1999	902.1	1114.7	960.1	1385.2	1978.6	1413.4	782.4	399.5	549.6	145.7	118.6	78.9	48.5	46.3	41.9	30.2	24.7	14.6	5.1	21.2	10061.5
2000	789.5	1072.8	1203.7	969.8	1297.4	1608.3	1014.6	537.0	269.2	366.0	96.1	77.8	51.4	31.3	30.0	26.9	19.4	15.7	9.3	16.5	9502.4
2001	1143.1	938.9	1158.5	1216.1	910.7	1072.3	1192.7	722.7	375.7	186.1	250.9	65.5	52.5	34.6	20.9	20.1	17.9	12.8	10.4	17.0	9419.3
2002	1153.0	1358.7	1013.5	1172.0	1155.0	783.1	847.2	910.7	542.6	278.9	136.9	183.2	47.4	37.9	24.9	15.0	14.3	12.8	9.0	19.2	9715.1
2003	1077.0	1370.2	1465.4	1022.3	1100.5	961.9	590.6	615.3	649.9	382.7	194.9	95.0	126.3	32.6	26.0	17.0	10.1	9.7	8.6	19.0	9774.6
2004	730.4	1279.6	1477.5	1478.4	961.0	916.5	723.3	427.3	437.4	456.8	266.5	134.7	65.3	86.2	22.0	17.6	11.5	6.8	6.4	18.3	9523.8
2005	508.4	867.5	1379.0	1490.1	1390.5	801.6	690.7	524.7	304.7	308.2	318.8	184.7	92.8	44.8	58.9	15.0	11.9	7.7	4.6	16.5	9020.9
2006	415.1	604.5	937.4	1394.6	1405.4	1163.2	605.2	501.6	374.3	214.7	215.4	221.1	127.2	63.7	30.4	40.1	10.1	8.2	5.3	14.1	8351.6
2007	438.3	493.2	651.9	944.7	1300.7	1136.7	833.3	415.1	337.7	249.1	141.5	140.9	143.7	82.5	41.0	19.6	25.6	6.6	5.1	12.1	7419.7
2008	464.5	518.1	526.2	648.8	866.9	1016.3	774.5	541.5	264.6	212.7	155.4	87.7	86.9	88.2	50.3	24.9	11.9	15.4	4.0	10.4	6369.2
2009	338.9	550.9	556.4	528.4	606.1	709.7	743.8	543.9	373.5	180.3	143.7	104.3	58.4	57.5	58.2	33.1	16.3	7.7	10.1	9.0	5630.6
2010	178.8	401.7	591.1	558.4	494.3	497.6	520.1	522.7	375.4	254.9	121.9	96.6	69.4	38.8	37.9	38.4	21.6	10.8	5.1	12.6	4847.7
2011	145.7	212.1	432.1	595.7	528.2	420.4	386.0	389.1	384.7	273.2	183.6	87.3	68.6	49.2	27.3	26.7	26.9	15.2	7.5	12.1	4271.5
2012	248.9	173.1	228.6	436.5	566.4	455.7	333.3	295.9	293.4	286.6	201.5	134.5	63.5	49.6	35.5	19.6	19.2	19.2	10.8	13.7	3885.2
2013	278.2	293.4	184.1	227.5	410.3	482.2	355.4	251.1	219.1	215.0	208.1	145.3	96.3	45.2	35.3	25.1	13.9	13.4	13.4	17.0	3529.6
2014	183.6	330.5	316.4	185.8	215.6	351.0	377.7	269.0	187.0	161.2	156.5	150.6	104.5	69.0	32.2	24.9	17.9	9.7	9.5	21.2	3173.3
2015	120.8	218.3	356.5	318.8	173.3	174.8	252.4	260.4	182.1	125.0	106.9	103.0	98.3	67.9	44.5	20.7	16.1	11.5	6.2	19.4	2676.9
2016	454.2	143.3	234.8	358.9	300.0	145.1	131.8	183.2	185.6	128.3	87.3	74.1	71.0	67.5	46.3	30.4	14.1	10.8	7.7	17.0	2691.6
2017	432.8	539.5	154.5	236.8	337.7	249.6	108.5	94.8	129.4	129.6	88.6	60.0	50.5	48.3	45.6	31.3	20.3	9.5	7.3	16.3	2790.4
2018	419.8	514.6	582.9	156.1	221.1	272.3	177.7	73.9	63.3	85.5	84.9	57.5	38.6	32.4	30.9	29.1	19.8	13.0	6.0	14.8	2894.0

Table 8. Estimated time series and status indicators. Fishing mortality rate is apical F. Total biomass (B, mt) is at the start of the year, and spawning biomass (SSB mature male and female biomass) at the time of peak spawning (beginning of May). The $MSST$ is defined by $\mathrm{MSST} = 0.75SSBmsy$. *Prop.fem is proportion of age-2^+ population that is female.*

Year	F	$F/Fmsy$	B	B/B_{unfished}	SSB	$SSB/SSBmsy$	$SSB/MSST$	Prop.fem
1969	0.0178	0.0858	5075	0.926	4083	2.092	2.789	0.871
1970	0.0202	0.0974	5080	0.927	4087	2.094	2.792	0.871
1971	0.0224	0.1076	5079	0.927	4084	2.092	2.790	0.871
1972	0.0222	0.1067	5074	0.926	4079	2.090	2.786	0.871
1973	0.0257	0.1238	5067	0.925	4070	2.085	2.781	0.871
1974	0.0307	0.1477	5054	0.922	4055	2.077	2.770	0.871
1975	0.0317	0.1526	5033	0.918	4034	2.067	2.756	0.871
1976	0.0359	0.1730	5012	0.915	4013	2.056	2.741	0.872
1977	0.0454	0.2184	4986	0.910	3983	2.041	2.721	0.872
1978	0.0827	0.3984	4947	0.903	3922	2.009	2.679	0.872
1979	0.0831	0.4002	4845	0.884	3830	1.962	2.616	0.873
1980	0.0847	0.4076	4531	0.827	3731	1.912	2.549	0.874
1981	0.0911	0.4386	4273	0.780	3573	1.831	2.441	0.874
1982	0.1343	0.6464	4208	0.768	3331	1.706	2.275	0.853
1983	0.1103	0.5312	4195	0.765	3145	1.611	2.148	0.847
1984	0.1324	0.6373	4216	0.769	3113	1.595	2.126	0.868
1985	0.1153	0.5551	4213	0.769	3146	1.612	2.149	0.886
1986	0.1221	0.5880	4198	0.766	3201	1.640	2.187	0.891
1987	0.1591	0.7662	4131	0.754	3215	1.647	2.196	0.894
1988	0.2109	1.0155	4078	0.744	3143	1.610	2.147	0.891
1989	0.2234	1.0757	3986	0.727	3019	1.547	2.062	0.884
1990	0.3040	1.4637	3850	0.702	2881	1.476	1.968	0.875
1991	0.2558	1.2313	4038	0.737	2775	1.422	1.896	0.875
1992	0.2249	1.0827	4048	0.739	2777	1.423	1.897	0.876
1993	0.2659	1.2802	4069	0.742	2804	1.437	1.915	0.906
1994	0.3147	1.5149	4236	0.773	2791	1.430	1.907	0.906
1995	0.3056	1.4714	4516	0.824	2845	1.458	1.943	0.912
1996	0.2595	1.2493	4614	0.842	3034	1.555	2.073	0.919
1997	0.2555	1.2302	4592	0.838	3252	1.666	2.222	0.922
1998	0.2203	1.0606	4589	0.837	3341	1.712	2.283	0.914
1999	0.2879	1.3863	4564	0.833	3272	1.676	2.235	0.899
2000	0.2502	1.2049	4310	0.786	3104	1.590	2.121	0.893
2001	0.1794	0.8638	4272	0.780	3023	1.549	2.065	0.893
2002	0.2303	1.1089	4407	0.804	3018	1.546	2.062	0.885
2003	0.2341	1.1272	4434	0.809	3032	1.553	2.071	0.893
2004	0.2317	1.1154	4320	0.788	3073	1.574	2.099	0.902
2005	0.2307	1.1105	4092	0.747	3060	1.568	2.090	0.907
2006	0.2886	1.3896	3788	0.691	2889	1.480	1.973	0.900
2007	0.3433	1.6531	3366	0.614	2531	1.297	1.729	0.888
2008	0.2645	1.2736	2889	0.527	2161	1.107	1.476	0.878
2009	0.2635	1.2687	2554	0.466	1907	0.977	1.303	0.872
2010	0.1998	0.9618	2199	0.401	1714	0.878	1.171	0.873
2011	0.1757	0.8459	1937	0.353	1563	0.801	1.068	0.871
2012	0.1923	0.9258	1762	0.322	1393	0.714	0.952	0.860
2013	0.1887	0.9083	1601	0.292	1220	0.625	0.834	0.853
2014	0.2835	1.3648	1439	0.263	1068	0.547	0.729	0.862
2015	0.2311	1.1129	1214	0.222	931	0.477	0.636	0.880
2016	0.2410	1.1603	1221	0.223	846	0.433	0.578	0.882
2017	0.2961	1.4255	1266	0.231	798	0.409	0.545	0.879
2018	.	.	1313	0.239	.	.	.	0.916

Table 9. Selectivity at age for the commercial fleet (COM), recreational fleet (REC), combined COM and REC discards, CVT, landings averaged across fisheries (L.avg), discards averaged across fisheries (D.avg), and weighted sum of landings and discards (LandD.avg). TL is total length.

Age	TL(mm)	TL(in)	COM	Discards	REC	CVT	L.avg	D.avg	LandD.avg
1	309.0	12.2	0.000	0.480	0.001	0.013	0.001	0.009	0.009
2	375.3	14.8	0.003	0.965	0.008	0.090	0.004	0.018	0.022
3	432.3	17.0	0.022	1.000	0.048	0.436	0.026	0.019	0.044
4	481.5	19.0	0.135	0.619	0.230	0.857	0.150	0.011	0.162
5	523.8	20.6	0.522	0.282	0.640	0.979	0.542	0.005	0.547
6	560.3	22.1	0.885	0.110	0.914	0.997	0.890	0.002	0.892
7	591.7	23.3	0.982	0.040	0.984	1.000	0.982	0.001	0.983
8	618.8	24.4	0.997	0.014	0.997	1.000	0.997	0.000	0.998
9	642.1	25.3	1.000	0.005	1.000	1.000	1.000	0.000	1.000
10	662.2	26.1	1.000	0.002	1.000	1.000	1.000	0.000	1.000
11	679.6	26.8	1.000	0.001	1.000	1.000	1.000	0.000	1.000
12	694.5	27.3	1.000	0.000	1.000	1.000	1.000	0.000	1.000
13	707.3	27.8	1.000	0.000	1.000	1.000	1.000	0.000	1.000
14	718.4	28.3	1.000	0.000	1.000	1.000	1.000	0.000	1.000
15	728.0	28.7	1.000	0.000	1.000	1.000	1.000	0.000	1.000
16	736.2	29.0	1.000	0.000	1.000	1.000	1.000	0.000	1.000
17	743.3	29.3	1.000	0.000	1.000	1.000	1.000	0.000	1.000
18	749.4	29.5	1.000	0.000	1.000	1.000	1.000	0.000	1.000
19	754.6	29.7	1.000	0.000	1.000	1.000	1.000	0.000	1.000
20	759.2	29.9	1.000	0.000	1.000	1.000	1.000	0.000	1.000

Table 10. Estimated time series of fully selected fishing mortality rates for the commercial fleet landings and discards (F.COM and F.COM.D) and the recreational fleet landings and discards (F.REC and F.REC.D). Also shown is apical F, the maximum F at age summed across fleets.

Year	F.COM	F.REC	F.COM.D	F.REC.D	Apical F
1969	0.007	0.010	0.000	0.000	0.018
1970	0.010	0.010	0.000	0.000	0.020
1971	0.011	0.011	0.000	0.000	0.022
1972	0.008	0.014	0.000	0.000	0.022
1973	0.011	0.015	0.000	0.000	0.026
1974	0.015	0.016	0.000	0.000	0.031
1975	0.015	0.017	0.000	0.000	0.032
1976	0.019	0.017	0.000	0.000	0.036
1977	0.029	0.017	0.000	0.000	0.045
1978	0.066	0.017	0.000	0.000	0.083
1979	0.065	0.018	0.000	0.000	0.083
1980	0.065	0.020	0.000	0.000	0.085
1981	0.065	0.026	0.000	0.000	0.091
1982	0.106	0.028	0.000	0.000	0.134
1983	0.096	0.014	0.000	0.000	0.110
1984	0.100	0.032	0.000	0.000	0.132
1985	0.084	0.031	0.000	0.000	0.115
1986	0.101	0.021	0.000	0.000	0.122
1987	0.130	0.029	0.000	0.000	0.159
1988	0.152	0.059	0.000	0.002	0.211
1989	0.168	0.055	0.000	0.000	0.223
1990	0.223	0.081	0.000	0.001	0.304
1991	0.190	0.065	0.000	0.000	0.256
1992	0.183	0.042	0.002	0.002	0.225
1993	0.219	0.047	0.001	0.003	0.266
1994	0.242	0.072	0.001	0.002	0.315
1995	0.282	0.024	0.001	0.002	0.306
1996	0.234	0.026	0.001	0.001	0.259
1997	0.231	0.024	0.001	0.002	0.256
1998	0.196	0.024	0.001	0.002	0.220
1999	0.258	0.030	0.001	0.002	0.288
2000	0.196	0.054	0.001	0.002	0.250
2001	0.147	0.032	0.001	0.003	0.179
2002	0.155	0.076	0.001	0.004	0.230
2003	0.176	0.059	0.001	0.004	0.234
2004	0.178	0.054	0.001	0.004	0.232
2005	0.190	0.041	0.002	0.002	0.231
2006	0.222	0.066	0.002	0.003	0.289
2007	0.254	0.089	0.002	0.014	0.343
2008	0.207	0.058	0.002	0.007	0.265
2009	0.227	0.036	0.003	0.008	0.264
2010	0.175	0.024	0.002	0.005	0.200
2011	0.160	0.016	0.004	0.003	0.176
2012	0.170	0.023	0.006	0.015	0.192
2013	0.159	0.030	0.004	0.002	0.189
2014	0.214	0.070	0.004	0.001	0.283
2015	0.201	0.030	0.004	0.003	0.231
2016	0.203	0.038	0.004	0.001	0.241
2017	0.232	0.065	0.002	0.000	0.296

Table 11. Estimated instantaneous fishing mortality rate (per yr) at age

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1969	0.000	0.000	0.000	0.000	0.002	0.007	0.012	0.015	0.017	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018
1970	0.000	0.000	0.000	0.000	0.002	0.007	0.012	0.017	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020
1971	0.000	0.000	0.000	0.001	0.003	0.008	0.014	0.019	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022
1972	0.000	0.000	0.000	0.001	0.003	0.010	0.015	0.020	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022
1973	0.000	0.000	0.000	0.001	0.003	0.010	0.017	0.022	0.025	0.026	0.026	0.026	0.026	0.026	0.026	0.026	0.026	0.026	0.026	0.026
1974	0.000	0.000	0.000	0.001	0.004	0.011	0.019	0.026	0.030	0.030	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031
1975	0.000	0.000	0.000	0.001	0.004	0.012	0.020	0.027	0.031	0.031	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032
1976	0.000	0.000	0.000	0.001	0.004	0.012	0.021	0.030	0.035	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036
1977	0.000	0.000	0.000	0.001	0.004	0.012	0.024	0.036	0.043	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045
1978	0.000	0.000	0.000	0.001	0.005	0.015	0.035	0.063	0.078	0.082	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083
1979	0.000	0.000	0.000	0.001	0.005	0.016	0.036	0.063	0.078	0.082	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083
1980	0.000	0.000	0.000	0.001	0.005	0.017	0.037	0.065	0.080	0.084	0.084	0.085	0.085	0.085	0.085	0.085	0.085	0.085	0.085	0.085
1981	0.000	0.000	0.000	0.001	0.007	0.021	0.043	0.071	0.086	0.090	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091
1982	0.000	0.000	0.000	0.001	0.008	0.025	0.056	0.102	0.127	0.133	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134
1983	0.000	0.000	0.000	0.001	0.004	0.015	0.041	0.081	0.104	0.109	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110
1984	0.000	0.000	0.000	0.002	0.008	0.027	0.059	0.102	0.125	0.131	0.132	0.132	0.132	0.132	0.132	0.132	0.132	0.132	0.132	0.132
1985	0.000	0.000	0.000	0.002	0.008	0.026	0.053	0.090	0.109	0.114	0.115	0.115	0.115	0.115	0.115	0.115	0.115	0.115	0.115	0.115
1986	0.000	0.000	0.000	0.001	0.006	0.020	0.049	0.091	0.115	0.121	0.122	0.122	0.122	0.122	0.122	0.122	0.122	0.122	0.122	0.122
1987	0.000	0.000	0.000	0.002	0.008	0.027	0.065	0.120	0.150	0.157	0.159	0.159	0.159	0.159	0.159	0.159	0.159	0.159	0.159	0.159
1988	0.001	0.002	0.002	0.004	0.016	0.048	0.098	0.164	0.200	0.209	0.211	0.211	0.211	0.211	0.211	0.211	0.211	0.211	0.211	0.211
1989	0.000	0.000	0.000	0.003	0.014	0.046	0.099	0.172	0.211	0.221	0.223	0.223	0.223	0.223	0.223	0.223	0.223	0.223	0.223	0.223
1990	0.000	0.001	0.002	0.005	0.021	0.067	0.139	0.236	0.288	0.301	0.303	0.304	0.304	0.304	0.304	0.304	0.304	0.304	0.304	0.304
1991	0.000	0.000	0.001	0.003	0.017	0.054	0.115	0.197	0.242	0.253	0.255	0.256	0.256	0.256	0.256	0.256	0.256	0.256	0.256	0.256
1992	0.002	0.004	0.010	0.036	0.123	0.201	0.221	0.224	0.225	0.225	0.225	0.225	0.225	0.225	0.225	0.225	0.225	0.225	0.225	0.225
1993	0.002	0.005	0.011	0.043	0.146	0.237	0.261	0.265	0.266	0.266	0.266	0.266	0.266	0.266	0.266	0.266	0.266	0.266	0.266	0.266
1994	0.002	0.005	0.012	0.051	0.174	0.281	0.309	0.314	0.315	0.315	0.315	0.315	0.315	0.315	0.315	0.315	0.315	0.315	0.315	0.315
1995	0.001	0.003	0.010	0.045	0.163	0.271	0.300	0.305	0.306	0.306	0.306	0.306	0.306	0.306	0.306	0.306	0.306	0.306	0.306	0.306
1996	0.001	0.003	0.008	0.039	0.139	0.231	0.255	0.259	0.259	0.259	0.259	0.259	0.259	0.259	0.259	0.259	0.259	0.259	0.259	0.259
1997	0.002	0.004	0.009	0.039	0.137	0.227	0.251	0.255	0.255	0.256	0.256	0.256	0.256	0.256	0.256	0.256	0.256	0.256	0.256	0.256
1998	0.002	0.004	0.008	0.034	0.119	0.196	0.216	0.220	0.220	0.220	0.220	0.220	0.220	0.220	0.220	0.220	0.220	0.220	0.220	0.220
1999	0.002	0.005	0.011	0.044	0.155	0.256	0.283	0.287	0.288	0.288	0.288	0.288	0.288	0.288	0.288	0.288	0.288	0.288	0.288	0.288
2000	0.002	0.005	0.010	0.041	0.138	0.223	0.246	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250
2001	0.002	0.005	0.009	0.030	0.099	0.160	0.176	0.179	0.179	0.179	0.179	0.179	0.179	0.179	0.179	0.179	0.179	0.179	0.179	0.179
2002	0.003	0.006	0.012	0.041	0.131	0.207	0.227	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230
2003	0.003	0.006	0.012	0.040	0.131	0.209	0.230	0.234	0.234	0.234	0.234	0.234	0.234	0.234	0.234	0.234	0.234	0.234	0.234	0.234
2004	0.003	0.007	0.012	0.040	0.129	0.207	0.228	0.231	0.232	0.232	0.232	0.232	0.232	0.232	0.232	0.232	0.232	0.232	0.232	0.232
2005	0.002	0.004	0.009	0.037	0.126	0.206	0.227	0.230	0.231	0.231	0.231	0.231	0.231	0.231	0.231	0.231	0.231	0.231	0.231	0.231
2006	0.003	0.006	0.013	0.048	0.160	0.258	0.284	0.288	0.289	0.289	0.289	0.289	0.289	0.289	0.289	0.289	0.289	0.289	0.289	0.289
2007	0.008	0.017	0.026	0.065	0.194	0.308	0.338	0.343	0.343	0.343	0.343	0.343	0.343	0.343	0.343	0.343	0.343	0.343	0.343	0.343
2008	0.005	0.010	0.016	0.047	0.148	0.237	0.260	0.264	0.264	0.265	0.265	0.265	0.265	0.265	0.265	0.265	0.265	0.265	0.265	0.265
2009	0.005	0.011	0.017	0.045	0.145	0.235	0.259	0.263	0.263	0.264	0.264	0.264	0.264	0.264	0.264	0.264	0.264	0.264	0.264	0.264
2010	0.004	0.008	0.013	0.034	0.109	0.178	0.197	0.199	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200
2011	0.003	0.007	0.011	0.029	0.095	0.157	0.173	0.175	0.176	0.176	0.176	0.176	0.176	0.176	0.176	0.176	0.176	0.176	0.176	0.176
2012	0.010	0.020	0.025	0.041	0.109	0.173	0.190	0.192	0.192	0.192	0.192	0.192	0.192	0.192	0.192	0.192	0.192	0.192	0.192	0.192
2013	0.003	0.007	0.011	0.032	0.104	0.169	0.186	0.188	0.189	0.189	0.189	0.189	0.189	0.189	0.189	0.189	0.189	0.189	0.189	0.189
2014	0.003	0.006	0.013	0.048	0.158	0.253	0.279	0.283	0.283	0.283	0.283	0.283	0.283	0.283	0.283	0.283	0.283	0.283	0.283	0.283
2015	0.004	0.008	0.013	0.039	0.126	0.206	0.227	0.231	0.231	0.231	0.231	0.231	0.231	0.231	0.231	0.231	0.231	0.231	0.231	0.231
2016	0.003	0.006	0.012	0.040	0.132	0.215	0.237	0.240	0.241	0.241	0.241	0.241	0.241	0.241	0.241	0.241	0.241	0.241	0.241	0.241
2017	0.002	0.004	0.011	0.048	0.163	0.264	0.291	0.295	0.296	0.296	0.296	0.296	0.296	0.296	0.296	0.296	0.296	0.296	0.296	0.296

Table 12. 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	16	17	18	19	20
1969	0.00	0.01	0.03	0.13	0.52	1.20	1.55	1.62	1.44	1.18	0.95	0.77	0.62	0.50	0.41	0.33	0.27	0.22	0.18	0.82
1970	0.00	0.01	0.03	0.14	0.53	1.23	1.64	1.80	1.63	1.34	1.08	0.87	0.71	0.57	0.47	0.38	0.31	0.25	0.21	0.93
1971	0.00	0.01	0.03	0.15	0.57	1.34	1.80	1.98	1.80	1.48	1.19	0.96	0.78	0.63	0.51	0.42	0.34	0.28	0.23	1.02
1972	0.00	0.01	0.04	0.18	0.70	1.59	2.01	2.04	1.79	1.46	1.18	0.95	0.77	0.62	0.51	0.41	0.34	0.27	0.22	1.01
1973	0.00	0.01	0.04	0.19	0.75	1.72	2.22	2.32	2.07	1.69	1.37	1.10	0.89	0.72	0.59	0.48	0.39	0.32	0.26	1.17
1974	0.00	0.01	0.05	0.21	0.80	1.86	2.47	2.69	2.43	2.00	1.61	1.30	1.05	0.85	0.69	0.57	0.46	0.38	0.31	1.39
1975	0.00	0.01	0.05	0.22	0.83	1.94	2.57	2.78	2.50	2.05	1.65	1.33	1.08	0.87	0.71	0.58	0.47	0.38	0.31	1.42
1976	0.00	0.01	0.05	0.22	0.84	1.97	2.72	3.07	2.80	2.30	1.85	1.49	1.20	0.98	0.79	0.65	0.53	0.43	0.35	1.58
1977	0.00	0.01	0.05	0.22	0.87	2.08	3.08	3.73	3.48	2.86	2.29	1.84	1.49	1.21	0.98	0.80	0.65	0.53	0.43	1.96
1978	0.00	0.01	0.06	0.25	0.99	2.56	4.52	6.33	6.12	5.04	4.04	3.23	2.60	2.11	1.71	1.39	1.14	0.93	0.76	3.42
1979	0.00	0.01	0.06	0.27	1.04	2.65	4.60	6.30	5.97	4.85	3.85	3.07	2.46	1.99	1.62	1.31	1.07	0.88	0.72	3.23
1980	0.00	0.01	0.06	0.29	1.11	2.81	4.77	6.42	6.01	4.79	3.75	2.97	2.37	1.91	1.55	1.26	1.02	0.84	0.68	3.08
1981	0.00	0.01	0.08	0.36	1.40	3.46	5.48	7.00	6.44	5.07	3.90	3.05	2.42	1.94	1.56	1.27	1.03	0.84	0.69	3.10
1982	0.01	0.01	0.03	0.41	1.60	4.10	7.17	9.81	9.17	7.23	5.52	4.24	3.31	2.63	2.11	1.71	1.39	1.13	0.92	4.17
1983	0.00	0.01	0.03	0.07	0.93	2.56	5.20	7.75	7.29	5.72	4.35	3.30	2.54	1.99	1.59	1.28	1.03	0.84	0.69	3.09
1984	0.01	0.03	0.12	0.26	0.53	4.48	7.44	9.70	8.74	6.69	5.03	3.80	2.90	2.23	1.75	1.40	1.13	0.91	0.74	3.35
1985	0.01	0.03	0.13	0.51	0.95	1.25	6.68	8.50	7.60	5.76	4.25	3.19	2.41	1.84	1.42	1.12	0.90	0.72	0.59	2.63
1986	0.00	0.02	0.08	0.44	1.48	1.86	1.83	8.61	7.98	6.10	4.48	3.30	2.47	1.88	1.44	1.11	0.88	0.70	0.57	2.53
1987	0.00	0.02	0.11	0.50	2.34	5.25	4.54	3.32	10.16	7.78	5.72	4.18	3.08	2.32	1.76	1.35	1.05	0.83	0.66	2.93
1988	0.01	0.03	0.17	0.91	3.59	10.56	14.13	8.31	3.84	9.66	7.10	5.20	3.80	2.81	2.12	1.62	1.24	0.96	0.76	3.31
1989	0.01	0.04	0.14	0.72	3.32	8.39	16.17	17.38	7.19	2.81	6.81	4.99	3.66	2.68	1.99	1.50	1.15	0.88	0.69	2.90
1990	0.01	0.06	0.25	0.87	4.04	11.66	18.33	26.23	18.82	6.48	2.43	5.88	4.31	3.17	2.33	1.73	1.31	1.00	0.77	3.14
1991	0.02	0.04	0.21	0.88	2.72	7.95	14.63	17.70	17.18	10.27	3.40	1.27	3.08	2.26	1.67	1.23	0.91	0.69	0.53	2.07
1992	0.10	0.94	1.78	9.31	23.28	22.74	22.53	19.40	13.23	10.29	5.87	1.93	0.72	1.76	1.30	0.96	0.71	0.53	0.40	1.50
1993	0.16	0.54	5.17	8.90	27.85	29.70	18.81	17.08	14.60	9.99	7.81	4.47	1.48	0.56	1.35	1.00	0.74	0.54	0.41	1.47
1994	0.28	0.94	3.16	26.88	26.71	34.59	23.59	13.66	12.30	10.56	7.26	5.69	3.27	1.08	0.41	0.99	0.74	0.54	0.40	1.39
1995	0.25	1.00	3.62	11.62	61.93	26.49	22.06	13.75	7.90	7.14	6.15	4.25	3.34	1.93	0.64	0.24	0.59	0.44	0.32	1.06
1996	0.14	1.03	4.25	13.87	26.30	56.91	15.23	11.55	7.14	4.11	3.74	3.23	2.24	1.77	1.02	0.34	0.13	0.31	0.23	0.74
1997	0.10	0.67	4.90	18.41	36.00	28.30	38.85	9.49	7.14	4.43	2.56	2.34	2.03	1.41	1.11	0.64	0.21	0.08	0.20	0.62
1998	0.11	0.41	2.84	18.87	42.48	34.50	17.22	21.59	5.23	3.95	2.46	1.43	1.31	1.14	0.79	0.63	0.36	0.12	0.05	0.46
1999	0.14	0.67	2.58	16.18	64.29	60.39	31.37	14.33	17.82	4.33	3.29	2.06	1.20	1.10	0.96	0.67	0.53	0.31	0.10	0.43
2000	0.13	0.65	3.16	10.60	37.85	60.84	35.97	17.04	7.72	9.63	2.35	1.79	1.12	0.66	0.60	0.53	0.37	0.29	0.17	0.30
2001	0.12	0.39	2.11	9.37	19.26	29.92	31.31	16.98	7.98	3.63	4.55	1.12	0.85	0.54	0.31	0.29	0.25	0.18	0.14	0.22
2002	0.20	0.86	2.71	12.60	31.87	27.58	27.90	26.83	14.45	6.82	3.11	3.92	0.96	0.74	0.47	0.27	0.25	0.22	0.15	0.32
2003	0.17	0.81	3.71	10.67	30.36	34.30	19.73	18.39	17.56	9.49	4.50	2.06	2.60	0.64	0.49	0.31	0.18	0.17	0.15	0.32
2004	0.11	0.73	3.64	15.11	26.15	32.35	23.94	12.66	11.71	11.22	6.09	2.90	1.33	1.69	0.42	0.32	0.20	0.12	0.11	0.31
2005	0.07	0.46	3.21	14.67	37.27	28.15	22.77	15.48	8.12	7.54	7.26	3.96	1.89	0.87	1.11	0.27	0.21	0.13	0.08	0.28
2006	0.08	0.43	2.87	17.67	46.95	49.97	24.32	18.03	12.16	6.40	5.97	5.77	3.16	1.51	0.70	0.89	0.22	0.17	0.11	0.29
2007	0.10	0.43	2.43	14.39	51.21	56.83	38.87	17.31	12.73	8.62	4.56	4.27	4.14	2.27	1.09	0.50	0.64	0.16	0.12	0.29
2008	0.08	0.33	1.46	7.48	26.62	40.40	28.83	18.03	7.97	5.88	4.00	2.12	1.99	1.94	1.07	0.51	0.24	0.30	0.08	0.19
2009	0.05	0.32	1.42	5.77	18.24	28.05	27.59	18.05	11.20	4.97	3.68	2.51	1.34	1.26	1.23	0.68	0.33	0.15	0.19	0.17
2010	0.02	0.17	1.13	4.60	11.43	15.30	15.06	13.55	8.80	5.48	2.44	1.82	1.24	0.66	0.63	0.61	0.34	0.16	0.08	0.18
2011	0.01	0.08	0.70	4.24	10.74	11.47	9.94	8.97	8.02	5.22	3.27	1.46	1.09	0.75	0.40	0.38	0.37	0.20	0.10	0.16
2012	0.03	0.07	0.41	3.44	12.59	13.51	9.32	7.40	6.64	5.95	3.90	2.45	1.10	0.82	0.57	0.30	0.29	0.28	0.16	0.19
2013	0.03	0.12	0.34	1.81	9.05	14.08	9.77	6.18	4.88	4.39	3.95	2.60	1.64	0.74	0.55	0.38	0.20	0.19	0.19	0.24
2014	0.03	0.24	0.97	2.34	7.11	14.85	14.94	9.52	5.98	4.73	4.28	3.87	2.55	1.61	0.73	0.55	0.38	0.20	0.19	0.43
2015	0.02	0.11	0.79	3.05	4.61	6.14	8.34	7.70	4.86	3.06	2.44	2.21	2.01	1.33	0.84	0.38	0.29	0.20	0.11	0.32
2016	0.06	0.08	0.56	3.65	8.35	5.29	4.52	5.62	5.15	3.26	2.07	1.65	1.50	1.37	0.91	0.57	0.26	0.20	0.14	0.30
2017	0.08	0.39	0.48	3.06	11.53	10.96	4.45	3.48	4.30	3.95	2.52	1.60	1.28	1.17	1.07	0.71	0.45	0.20	0.15	0.34

Table 13. 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	16	17	18	19	20
1969	0.00	0.01	0.07	0.41	2.02	5.67	8.56	10.20	10.09	9.04	7.85	6.74	5.74	4.87	4.11	3.45	2.89	2.42	2.02	9.25
1970	0.00	0.01	0.07	0.42	2.05	5.80	9.09	11.31	11.41	10.26	8.92	7.66	6.53	5.53	4.67	3.92	3.29	2.75	2.29	10.51
1971	0.00	0.01	0.08	0.46	2.24	6.34	9.96	12.46	12.58	11.32	9.84	8.45	7.20	6.11	5.15	4.33	3.63	3.03	2.53	11.60
1972	0.00	0.01	0.09	0.55	2.71	7.55	11.14	12.85	12.55	11.20	9.73	8.36	7.12	6.04	5.09	4.28	3.59	3.00	2.50	11.47
1973	0.00	0.01	0.10	0.60	2.91	8.15	12.29	14.62	14.47	12.95	11.25	9.66	8.24	6.98	5.89	4.95	4.15	3.47	2.89	13.26
1974	0.00	0.02	0.11	0.64	3.11	8.78	13.69	16.96	17.04	15.31	13.30	11.42	9.74	8.26	6.97	5.86	4.91	4.10	3.42	15.69
1975	0.00	0.02	0.11	0.66	3.25	9.16	14.22	17.49	17.49	15.66	13.60	11.67	9.95	8.43	7.12	5.99	5.02	4.19	3.50	16.03
1976	0.00	0.02	0.11	0.67	3.28	9.35	15.05	19.34	19.61	17.57	15.22	13.06	11.12	9.43	7.96	6.69	5.61	4.69	3.91	17.92
1977	0.00	0.02	0.11	0.69	3.39	9.86	17.03	23.50	24.37	21.87	18.89	16.16	13.76	11.66	9.84	8.28	6.94	5.80	4.84	22.17
1978	0.00	0.02	0.13	0.78	3.88	12.10	25.02	39.83	42.86	38.58	33.25	28.34	24.07	20.38	17.19	14.45	12.11	10.13	8.45	38.73
1979	0.00	0.02	0.14	0.82	4.06	12.56	25.46	39.69	41.83	37.11	31.75	26.94	22.78	19.24	16.22	13.63	11.42	9.55	7.97	36.53
1980	0.00	0.02	0.15	0.87	4.34	13.30	26.40	40.44	42.08	36.67	30.93	26.06	21.94	18.45	15.51	13.03	10.91	9.12	7.61	34.90
1981	0.00	0.01	0.18	1.11	5.48	16.37	30.36	44.09	45.07	38.81	32.17	26.72	22.34	18.71	15.66	13.11	10.98	9.17	7.65	35.10
1982	0.01	0.02	0.06	1.26	6.25	19.43	39.69	61.76	64.21	55.34	45.49	37.15	30.63	25.46	21.22	17.70	14.78	12.34	10.28	47.19
1983	0.00	0.02	0.07	0.21	3.61	12.12	28.82	48.79	51.05	43.72	35.80	28.98	23.48	19.25	15.93	13.23	11.00	9.16	7.63	34.98
1984	0.01	0.05	0.27	0.79	2.08	21.21	41.20	61.10	61.21	51.20	41.43	33.36	26.79	21.59	17.62	14.52	12.02	9.97	8.28	37.94
1985	0.01	0.04	0.30	1.57	3.72	5.91	36.98	53.50	53.21	44.07	35.05	27.93	22.32	17.82	14.29	11.62	9.55	7.89	6.52	29.78
1986	0.00	0.03	0.19	1.35	5.78	8.82	10.11	54.24	55.89	46.69	36.88	28.90	22.85	18.16	14.43	11.53	9.35	7.66	6.31	28.61
1987	0.00	0.03	0.25	1.52	9.15	24.85	25.13	20.90	71.12	59.54	47.12	36.64	28.48	22.39	17.71	14.03	11.17	9.03	7.39	33.15
1988	0.01	0.05	0.39	2.78	14.03	49.98	78.25	52.35	26.91	73.89	58.53	45.57	35.15	27.17	21.27	16.76	13.23	10.51	8.48	37.45
1989	0.01	0.06	0.30	2.21	12.96	39.71	89.55	109.43	50.31	21.47	56.08	43.75	33.80	25.92	19.95	15.56	12.22	9.62	7.63	32.81
1990	0.01	0.09	0.56	2.67	15.78	55.20	101.52	165.18	131.80	49.54	20.05	51.54	39.88	30.64	23.39	17.93	13.94	10.92	8.58	35.51
1991	0.02	0.06	0.48	2.70	10.61	37.65	81.00	111.45	120.33	78.57	28.00	11.15	28.44	21.89	16.74	12.73	9.73	7.54	5.90	23.45
1992	0.01	0.22	0.82	7.21	27.08	36.88	48.17	52.46	43.75	40.54	26.97	10.16	4.29	11.58	9.40	7.55	6.02	4.81	3.88	15.48
1993	0.01	0.13	2.39	6.90	32.41	48.16	40.21	46.18	48.29	39.36	35.84	23.51	8.75	3.66	9.78	7.88	6.29	4.98	3.95	15.15
1994	0.02	0.22	1.46	20.82	31.07	56.09	50.44	36.92	40.69	41.59	33.32	29.91	19.38	7.14	2.96	7.85	6.28	4.98	3.92	14.32
1995	0.02	0.23	1.68	9.00	72.06	42.95	47.17	37.18	26.12	28.13	28.26	22.32	19.80	12.70	4.64	1.91	5.02	3.99	3.15	10.98
1996	0.01	0.24	1.97	10.74	30.60	92.29	32.57	31.22	23.60	16.20	17.15	16.99	13.25	11.64	7.40	2.68	1.09	2.87	2.27	7.64
1997	0.01	0.16	2.26	14.26	41.89	45.89	83.07	25.66	23.60	17.44	11.77	12.28	12.02	9.28	8.07	5.09	1.83	0.74	1.94	6.38
1998	0.01	0.10	1.31	14.62	49.43	55.95	36.83	58.37	17.30	15.56	11.30	7.52	7.75	7.50	5.74	4.96	3.11	1.11	0.45	4.78
1999	0.01	0.16	1.19	12.53	74.81	97.92	67.09	38.74	58.94	17.08	15.09	10.80	7.10	7.25	6.95	5.28	4.53	2.82	1.00	4.46
2000	0.01	0.15	1.46	8.21	44.05	98.66	76.92	46.06	25.52	37.94	10.81	9.41	6.66	4.33	4.38	4.17	3.15	2.68	1.66	3.06
2001	0.01	0.09	0.97	7.26	22.41	48.51	66.95	45.92	26.40	14.30	20.89	5.87	5.05	3.53	2.28	2.29	2.16	1.62	1.37	2.32
2002	0.02	0.20	1.25	9.76	37.09	44.72	59.66	72.55	47.79	26.86	14.29	20.59	5.71	4.87	3.38	2.16	2.15	2.02	1.51	3.30
2003	0.01	0.19	1.72	8.27	35.33	55.62	42.20	49.73	58.09	37.40	20.66	10.84	15.43	4.24	3.58	2.46	1.56	1.55	1.45	3.30
2004	0.01	0.17	1.68	11.70	30.43	52.46	51.20	34.22	38.73	44.21	27.98	15.23	7.90	11.13	3.03	2.54	1.73	1.09	1.08	3.16
2005	0.01	0.11	1.48	11.36	43.37	45.64	48.70	41.85	26.86	29.71	33.34	20.80	11.19	5.74	8.02	2.16	1.80	1.22	0.77	2.84
2006	0.01	0.10	1.33	13.68	54.63	81.03	52.01	48.75	40.22	25.23	27.43	30.34	18.70	9.96	5.06	7.01	1.88	1.55	1.05	2.95
2007	0.01	0.10	1.12	11.15	59.58	92.15	83.12	46.80	42.10	33.95	20.93	22.43	24.52	14.95	7.89	3.98	5.48	1.46	1.20	2.95
2008	0.01	0.08	0.67	5.79	30.98	65.51	61.66	48.76	26.35	23.16	18.36	11.16	11.82	12.78	7.73	4.05	2.03	2.77	0.73	2.00
2009	0.00	0.07	0.65	4.47	21.22	45.48	59.00	48.81	37.05	19.57	16.91	13.21	7.93	8.32	8.91	5.35	2.78	1.38	1.88	1.77
2010	0.00	0.04	0.52	3.57	13.30	24.80	32.20	36.64	29.09	21.59	11.21	9.55	7.37	4.38	4.55	4.84	2.88	1.49	0.74	1.89
2011	0.00	0.02	0.32	3.29	12.50	18.60	21.25	24.26	26.51	20.57	15.01	7.68	6.46	4.94	2.91	3.00	3.17	1.88	0.96	1.62
2012	0.00	0.02	0.19	2.67	14.66	21.91	19.92	20.02	21.95	23.44	17.88	12.86	6.50	5.42	4.10	2.40	2.45	2.58	1.52	2.01
2013	0.00	0.03	0.16	1.40	10.53	22.82	20.89	16.71	16.13	17.29	18.15	13.65	9.69	4.85	4.01	3.01	1.75	1.78	1.86	2.45
2014	0.00	0.05	0.45	1.81	8.27	24.07	31.95	25.73	19.77	18.64	19.64	20.33	15.10	10.62	5.27	4.31	3.22	1.86	1.88	4.39
2015	0.00	0.03	0.37	2.36	5.36	9.96	17.83	20.81	16.08	12.07	11.19	11.63	11.89	8.74	6.09	3.00	2.44	1.81	1.04	3.35
2016	0.01	0.02	0.26	2.83	9.72	8.58	9.67	15.20	17.02	12.86	9.49	8.67	8.90	9.01	6.57	4.54	2.22	1.79	1.32	3.06
2017	0.01	0.09	0.22	2.37	13.41	17.78	9.53	9.42	14.21	15.56	11.55	8.41	7.59	7.71	7.73	5.59	3.84	1.86	1.50	3.50

Table 14. Estimated time series of landings in numbers (1000 fish) for the commercial fleet (L.COM) and general recreational (L.REC))

Year	L.COM	L.REC	Total
1969	4.10	8.66	12.76
1970	5.43	8.68	14.11
1971	6.08	9.45	15.53
1972	4.45	11.68	16.13
1973	5.89	12.41	18.30
1974	8.10	13.03	21.13
1975	8.19	13.55	21.74
1976	10.44	13.39	23.83
1977	15.28	13.29	28.57
1978	33.76	13.45	47.21
1979	32.09	13.87	45.96
1980	31.03	14.69	45.72
1981	30.20	18.90	49.09
1982	47.07	19.61	66.67
1983	40.67	9.58	50.25
1984	40.78	20.48	61.27
1985	32.64	17.85	50.49
1986	36.37	11.39	47.76
1987	41.46	16.44	57.90
1988	44.93	35.21	80.14
1989	50.54	32.85	83.38
1990	66.50	46.32	112.83
1991	54.34	34.38	88.71
1992	111.16	28.11	139.27
1993	123.10	29.51	152.62
1994	129.45	44.97	174.43
1995	159.05	15.68	174.73
1996	136.97	17.31	154.28
1997	142.03	17.45	159.49
1998	136.11	19.84	155.96
1999	196.99	25.76	222.74
2000	146.69	45.09	191.77
2001	104.07	25.45	129.52
2002	104.81	57.44	162.24
2003	113.97	42.67	156.64
2004	112.43	38.69	151.12
2005	123.47	30.33	153.80
2006	147.61	50.05	197.67
2007	158.67	62.29	220.95
2008	114.70	34.83	149.52
2009	108.54	18.66	127.20
2010	72.67	11.03	83.70
2011	60.84	6.74	67.58
2012	60.65	8.76	69.42
2013	51.19	10.14	61.33
2014	56.00	19.47	75.47
2015	42.03	6.76	48.79
2016	37.58	7.92	45.50
2017	39.81	12.36	52.17
.	.	.	.

Table 15. Estimated time series of landings in whole weight (1000 lb) for the commercial fleet (L.COM) and general recreational (L.REC).

Year	L.COM	L.REC	Total
1969	33.65	61.77	95.42
1970	44.59	61.92	106.51
1971	49.89	67.43	117.32
1972	36.52	83.33	119.85
1973	48.36	88.48	136.84
1974	66.46	92.86	159.32
1975	67.14	96.42	163.56
1976	85.51	95.10	180.61
1977	125.01	94.17	219.19
1978	275.41	94.87	370.28
1979	260.63	97.08	357.71
1980	250.67	102.07	352.74
1981	242.61	130.48	373.09
1982	375.84	134.41	510.25
1983	322.43	65.42	387.85
1984	321.60	141.05	462.65
1985	257.31	124.77	382.08
1986	289.47	78.32	367.79
1987	331.88	107.73	439.61
1988	350.38	222.37	572.75
1989	378.66	204.68	583.34
1990	486.89	287.85	774.74
1991	394.67	213.75	608.43
1992	288.98	68.30	357.28
1993	314.19	69.65	383.84
1994	311.33	98.06	409.39
1995	346.01	31.30	377.31
1996	288.84	33.58	322.42
1997	291.06	32.59	323.65
1998	267.79	35.88	303.67
1999	386.39	47.34	433.73
2000	301.59	87.69	389.29
2001	227.77	52.43	280.20
2002	237.90	121.98	359.88
2003	262.15	91.45	353.60
2004	257.81	81.88	339.69
2005	274.71	62.25	336.97
2006	321.35	101.57	422.92
2007	347.26	128.61	475.88
2008	261.00	75.39	336.38
2009	261.93	42.87	304.79
2010	184.19	26.45	210.63
2011	158.41	16.54	174.95
2012	160.49	22.01	182.49
2013	140.45	26.69	167.14
2014	163.00	54.36	217.36
2015	126.82	19.22	146.04
2016	110.16	21.57	131.73
2017	110.05	31.83	141.88
.	.	.	.

Table 16. Estimated time series of dead discards in numbers (1000 fish) for commercial (D.COM) and general recreational (D.REC).

Year	D.COM	D.REC
1969	0.00	0.00
1970	0.00	0.00
1971	0.00	0.00
1972	0.00	0.00
1973	0.00	0.00
1974	0.00	0.00
1975	0.00	0.00
1976	0.00	0.00
1977	0.00	0.00
1978	0.00	0.00
1979	0.00	0.00
1980	0.00	0.00
1981	0.00	0.00
1982	0.00	0.00
1983	0.00	0.00
1984	0.00	0.00
1985	0.00	0.00
1986	0.00	0.00
1987	0.00	0.00
1988	0.00	2.44
1989	0.00	0.01
1990	0.00	1.16
1991	0.00	0.00
1992	3.59	3.07
1993	1.92	5.94
1994	1.96	5.15
1995	2.24	3.84
1996	2.50	2.67
1997	2.70	4.02
1998	2.48	3.15
1999	2.58	4.02
2000	2.04	4.10
2001	2.40	5.51
2002	2.66	7.03
2003	2.93	7.88
2004	2.83	8.36
2005	2.50	2.77
2006	2.24	3.71
2007	2.13	13.41
2008	1.89	6.20
2009	2.31	6.31
2010	1.67	3.56
2011	1.90	1.26
2012	2.38	6.08
2013	1.95	0.80
2014	1.85	0.39
2015	1.61	1.28
2016	1.95	0.66
2017	1.47	0.24
.	.	.

Table 17. Estimated time series of dead discards in whole weight (1000 lb) for commercial (D.COM) and general recreational (D.REC).

Year	D.COM	D.REC
1969	0.00	0.00
1970	0.00	0.00
1971	0.00	0.00
1972	0.00	0.00
1973	0.00	0.00
1974	0.00	0.00
1975	0.00	0.00
1976	0.00	0.00
1977	0.00	0.00
1978	0.00	0.00
1979	0.00	0.00
1980	0.00	0.00
1981	0.00	0.00
1982	0.00	0.00
1983	0.00	0.00
1984	0.00	0.00
1985	0.00	0.00
1986	0.00	0.00
1987	0.00	0.00
1988	0.00	4.79
1989	0.00	0.01
1990	0.00	2.18
1991	0.00	0.00
1992	6.27	5.36
1993	3.54	10.97
1994	3.47	9.11
1995	3.79	6.50
1996	4.52	4.83
1997	5.40	8.02
1998	5.02	6.38
1999	4.99	7.78
2000	3.88	7.80
2001	4.35	10.01
2002	4.68	12.38
2003	5.27	14.17
2004	5.45	16.10
2005	5.19	5.76
2006	4.83	8.02
2007	4.45	28.05
2008	3.69	12.08
2009	4.47	12.20
2010	3.49	7.41
2011	4.23	2.80
2012	4.89	12.52
2013	3.53	1.45
2014	3.40	0.72
2015	3.25	2.59
2016	3.30	1.12
2017	2.31	0.38
.	.	.

Table 18. Estimated status indicators, benchmarks, and related quantities from the base run of the Beaufort Assessment Model, conditional on estimated current selectivities averaged across fleets. Median values and standard deviations (SD) approximated from the ensemble model are also provided. Rate estimates (F) are in units of y^{-1}*; status indicators are dimensionless; and biomass estimates are whole weight in units of metric tons or pounds, as indicated. Spawning stock biomass (SSB) is measured as mature female biomass.*

Quantity	Units	Estimate	Median	SD
F_{MSY}	y^{-1}	0.21	0.23	0.05
B_{MSY}	mt	2754	2645	129
SSB_{MSY}	mt	1952	1879	108
MSST	mt	1464	1409	81
MSY	1000 lb	207	93	12
R_{MSY}	1000 age-1 fish	711	672	43
$F_{2015-2017}/F_{\text{MSY}}$	—	1.23	1.23	0.37
$\text{SSB}_{2017}/\text{MSST}$	—	0.55	0.55	0.10
$\text{SSB}_{2017}/\text{SSB}_{\text{MSY}}$	—	0.41	0.41	0.08

Table 19. Results from sensitivity runs and retrospective analysis 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 and males combined. See text for full description of sensitivity runs.

Run	Description	F_{MSY}	SSB_{MSY} (mt)	B_{MSY} (mt)	MSY(1000 lb)	$F_{2015-2017}/F_{\text{MSY}}$	$\text{SSB}_{2017}/\text{MSST}$	$\text{SSB}_{2017}/\text{SSB}_{\text{MSY}}$	steep	R0(1000)
Base	—	0.208	1952	2754	207	1.23	0.55	0.41	0.57	744
S1	Rec CV 0.5	0.21	1952	2757	209	1.21	0.55	0.41	0.57	745
S2	Low M	0.245	1816	2568	218	1.06	0.58	0.43	0.71	639
S3	High M	0.171	2120	2988	193	1.44	0.52	0.39	0.46	879
S4	male cont. 25%	0.207	1971	2753	207	1.23	0.54	0.41	0.57	744
S5	male cont. 50%	0.206	1995	2752	207	1.24	0.54	0.4	0.56	744
S6	male cont. 75%	0.206	2018	2750	206	1.24	0.53	0.4	0.56	744
S7	male cont. 100%	0.205	2042	2749	206	1.25	0.53	0.4	0.55	744
S8	Aging Error Matrix incl.	0.202	1902	2675	199	1.39	0.51	0.39	0.55	701
S9	beta prior h	0.232	1911	2728	216	1.06	0.58	0.44	0.62	736
S10	Low M beta prior h	0.264	1790	2553	223	0.97	0.61	0.45	0.76	635
S11	High M beta prior h	0.192	2074	2955	203	1.25	0.55	0.41	0.49	870
S12	2016 Terminal Year	0.232	1931	2756	218	1.22	0.61	0.46	0.62	757
S13	2015 Terminal Year	0.297	1849	2717	237	0.97	0.67	0.51	0.76	747
S14	2014 Terminal Year	0.338	1797	2684	244	0.94	0.68	0.51	0.86	731
S15	2013 Terminal Year	0.316	1871	2768	243	0.71	0.8	0.6	0.83	757
S16	2012 Terminal Year	0.363	1841	2774	254	0.64	0.87	0.65	0.99	760

8 Figures

Figure 1. Mean length at age (mm) and estimated upper and lower 95% confidence intervals of the population

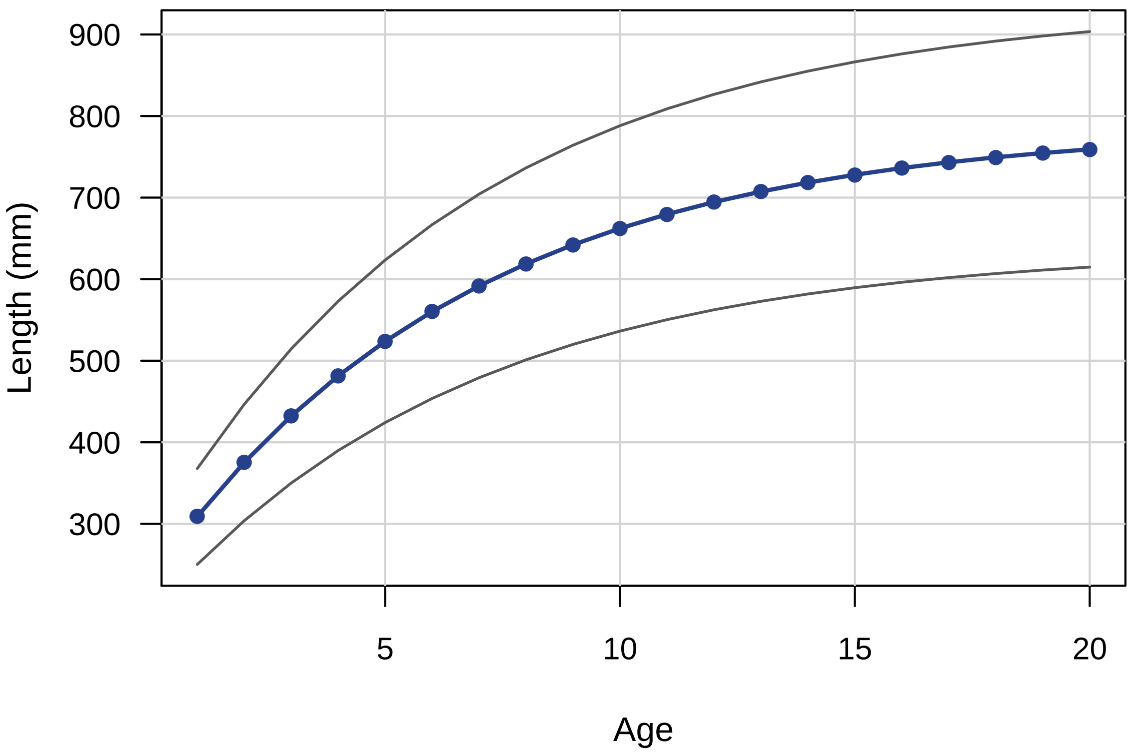


Figure 2. Indices of abundance used in fitting the assessment model. U.COM is the commercial handline logbook data, U.REC is recreational headboat data, and U.CVT/VID is the combined SERFS chevron trap and video data.

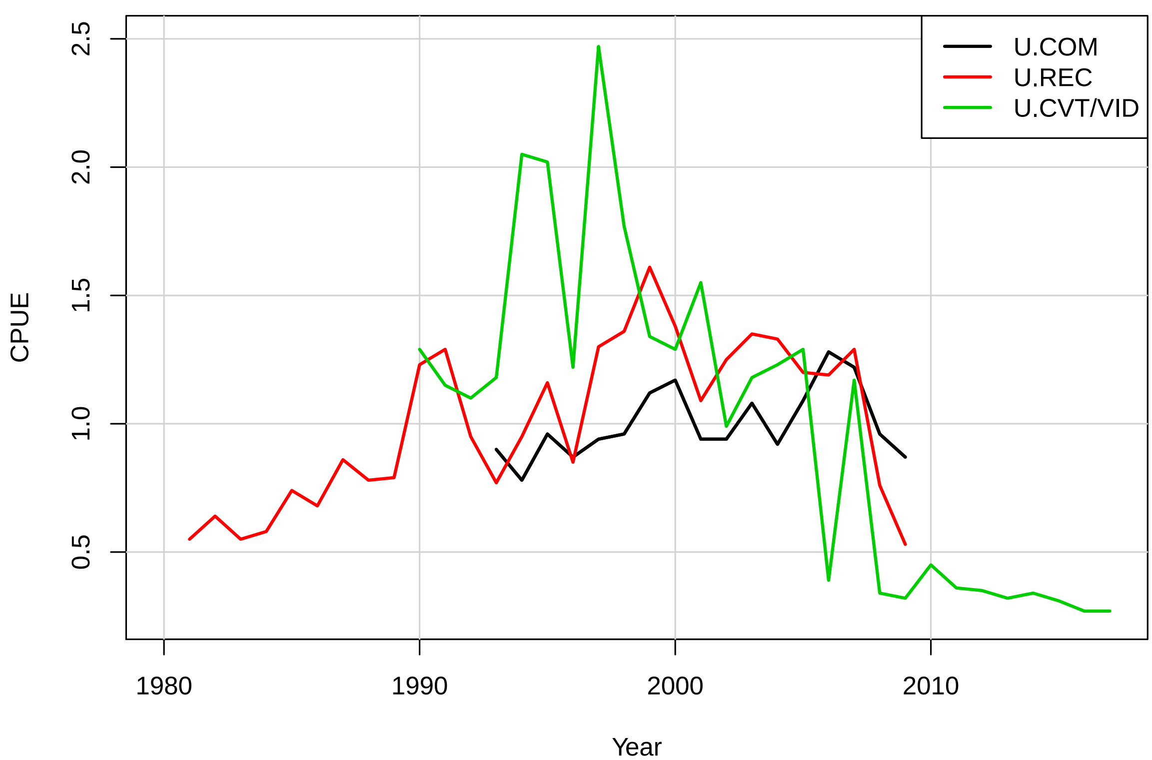


Figure 3. Observed (open circles) and estimated (solid line) annual length and age compositions by fleet or survey from the base run. In panels indicating the data set, lcomp refers to length compositions, acomp to age compositions, CVT to SERFS chevron traps, COM to the commercial fleet, and REC to recreational. N indicates the number of trips from which individual fish samples were taken. Effective N refers to the sample size from the Dirichlet multinomial distribution. Grayed out boxes not used in fitting due to insufficient sample size.

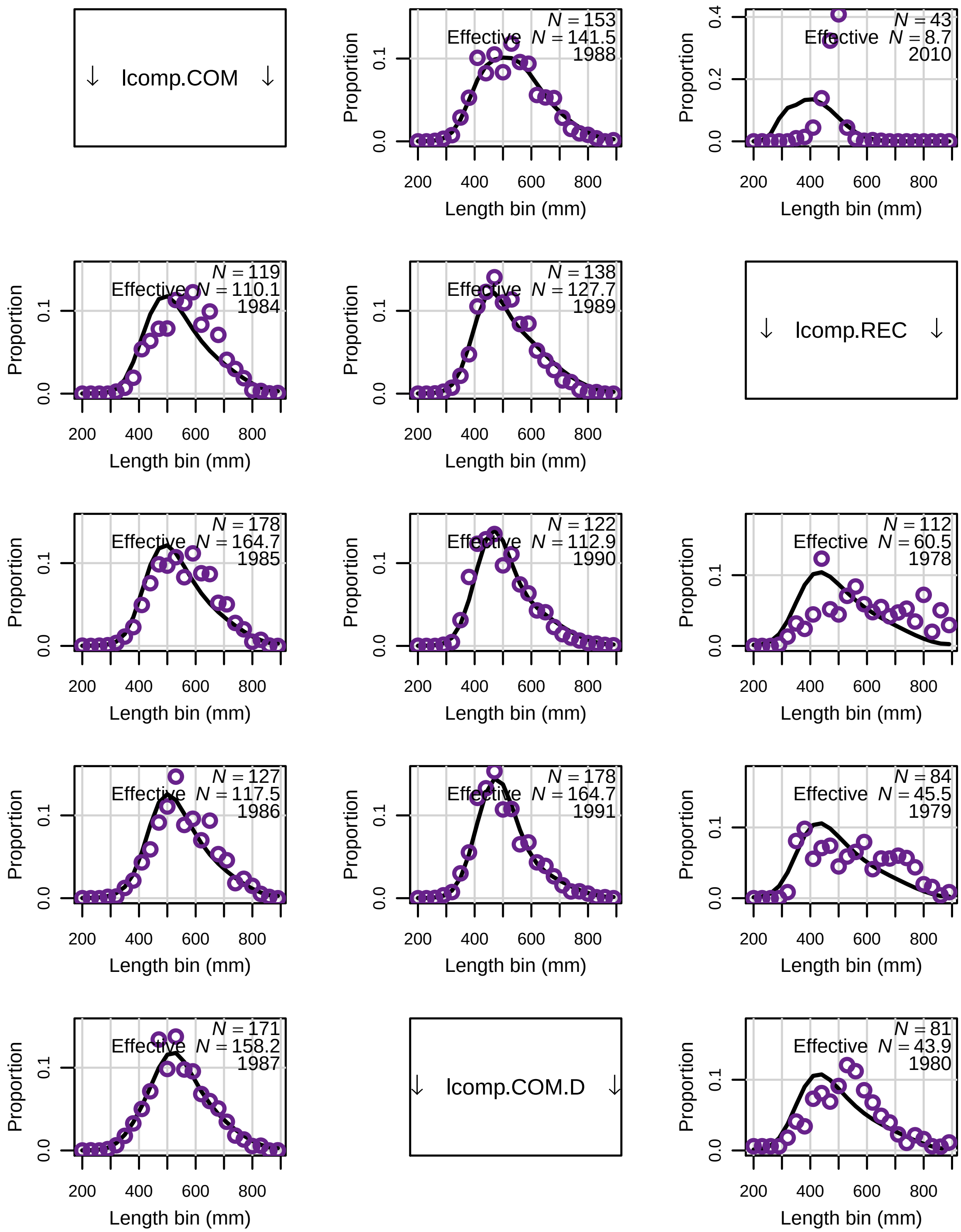


Figure 3. (cont.) Observed (open circles) and estimated (solid line) annual length and age compositions by fleet or survey from the base run.

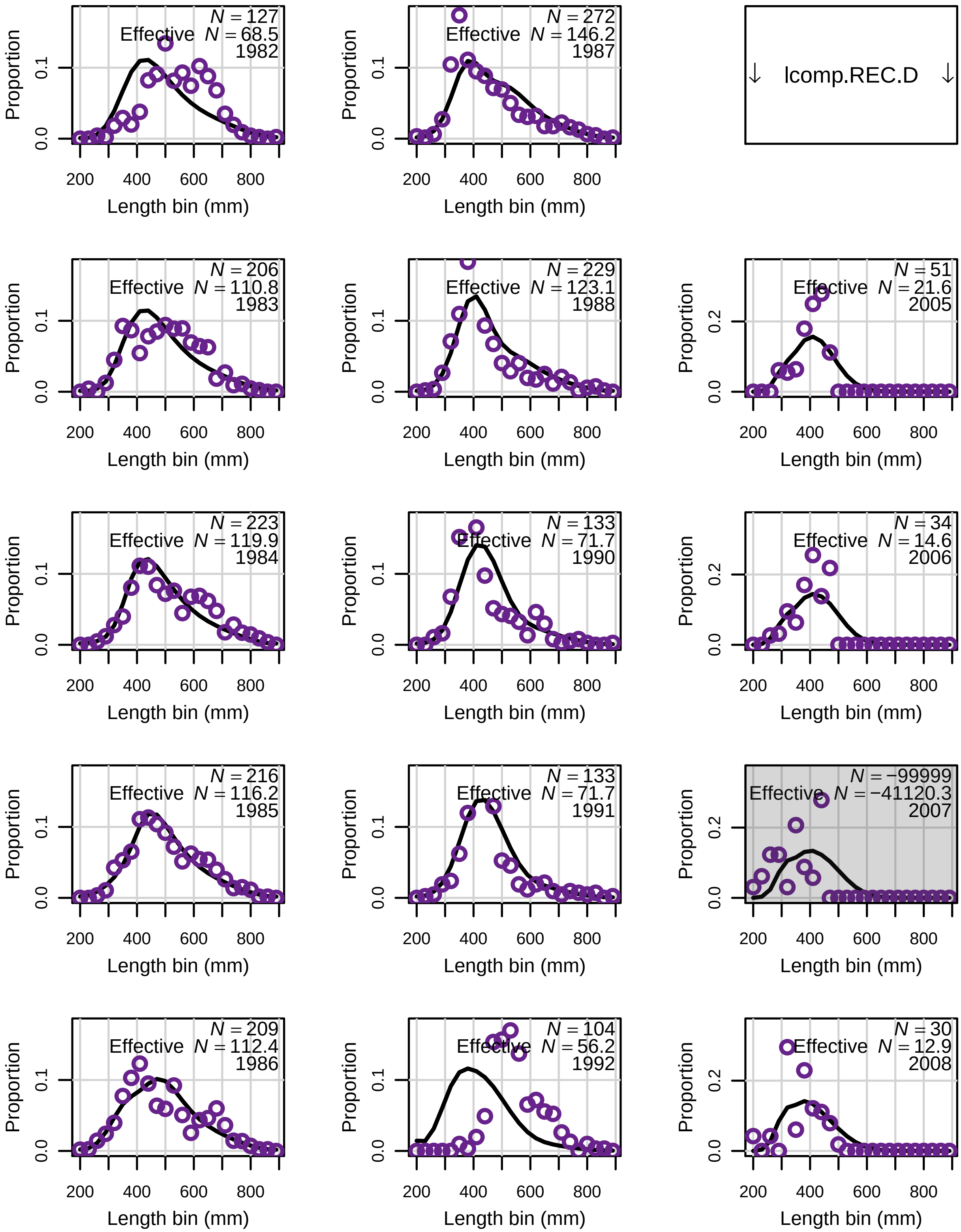


Figure 3. (cont.) Observed (open circles) and estimated (solid line) annual length and age compositions by fleet or survey from the base run.

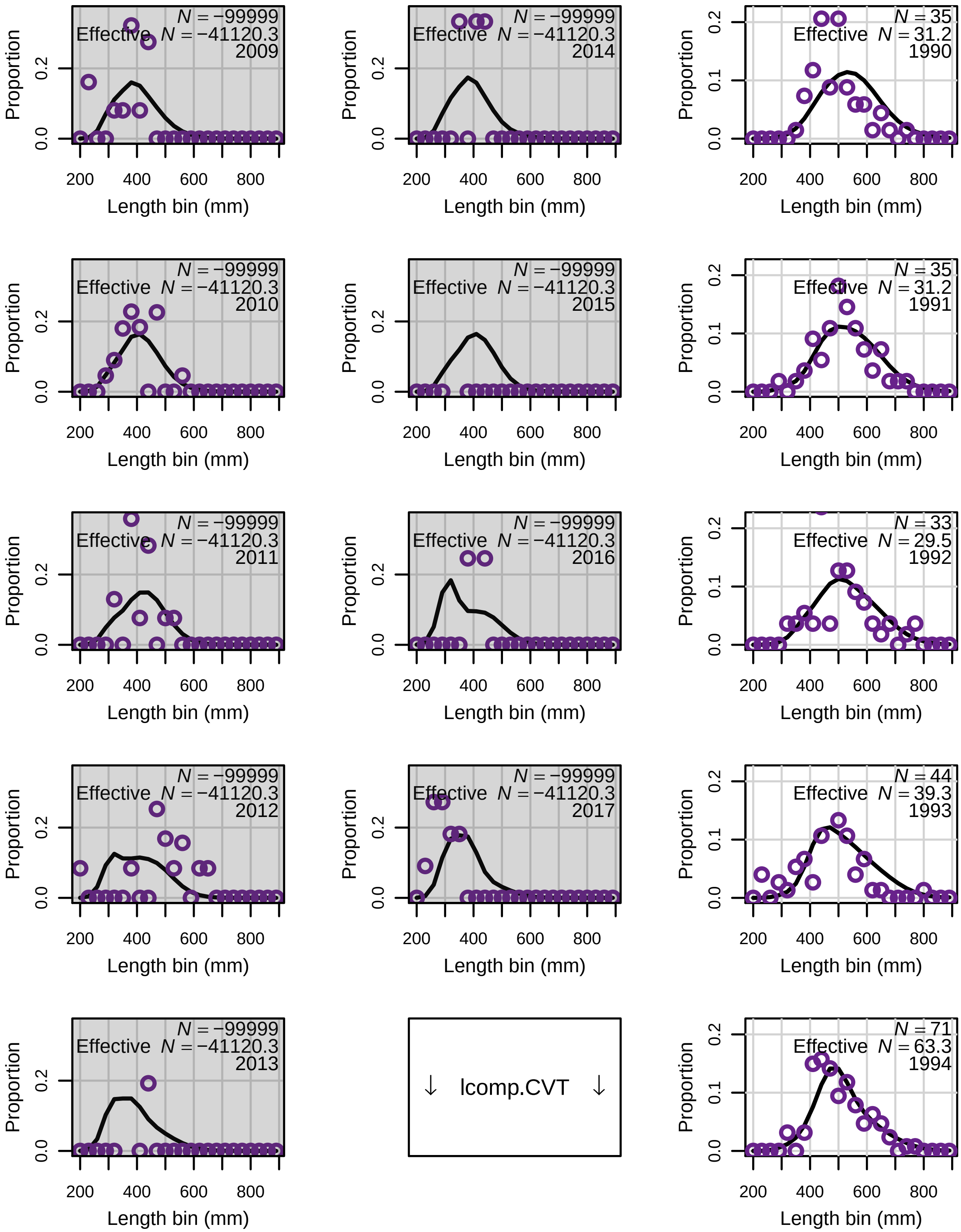


Figure 3. (cont.) Observed (open circles) and estimated (solid line) annual length and age compositions by fleet or survey from the base run.

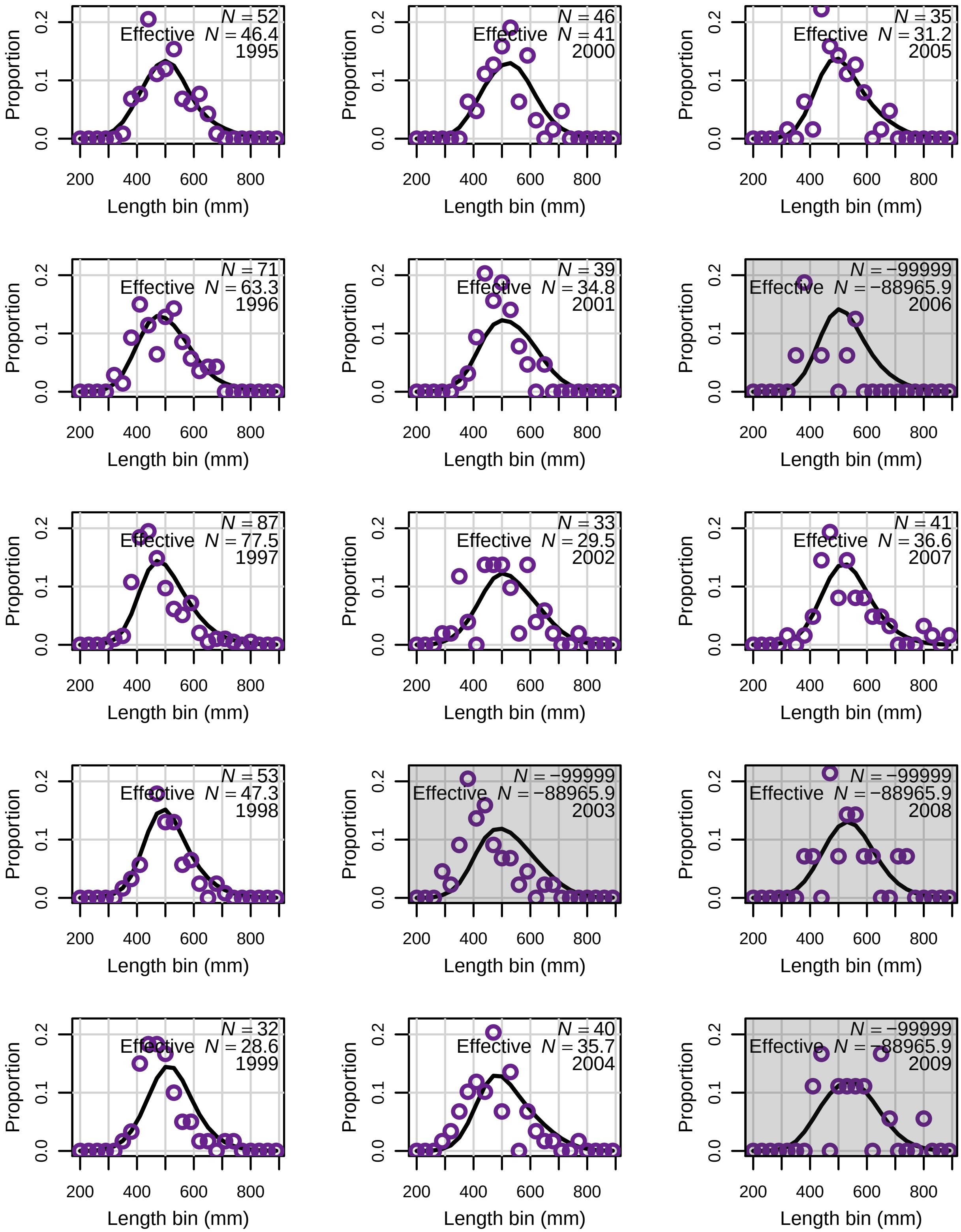


Figure 3. (cont.) Observed (open circles) and estimated (solid line) annual length and age compositions by fleet or survey from the base run.

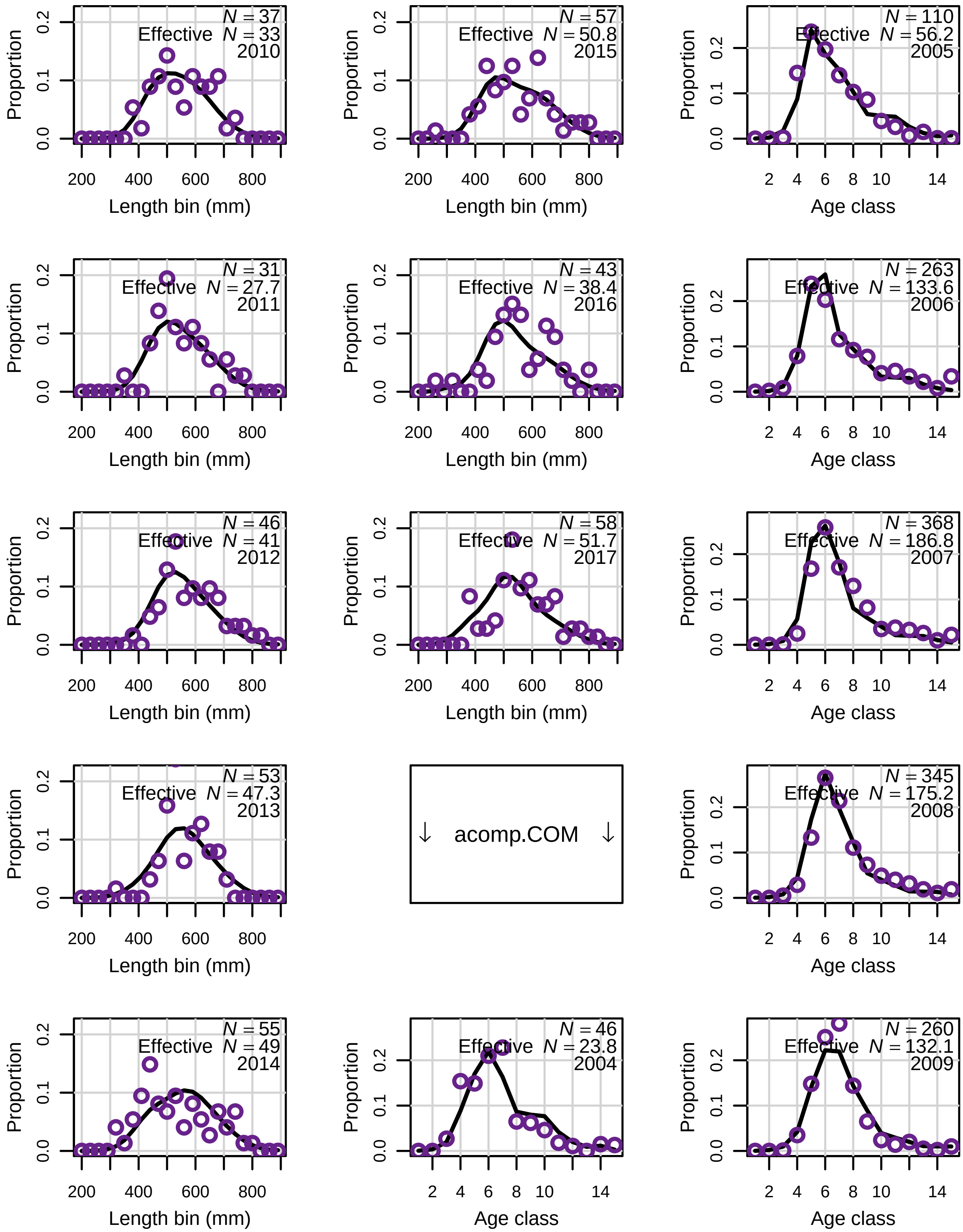


Figure 3. (cont.) Observed (open circles) and estimated (solid line) annual length and age compositions by fleet or survey from the base run.

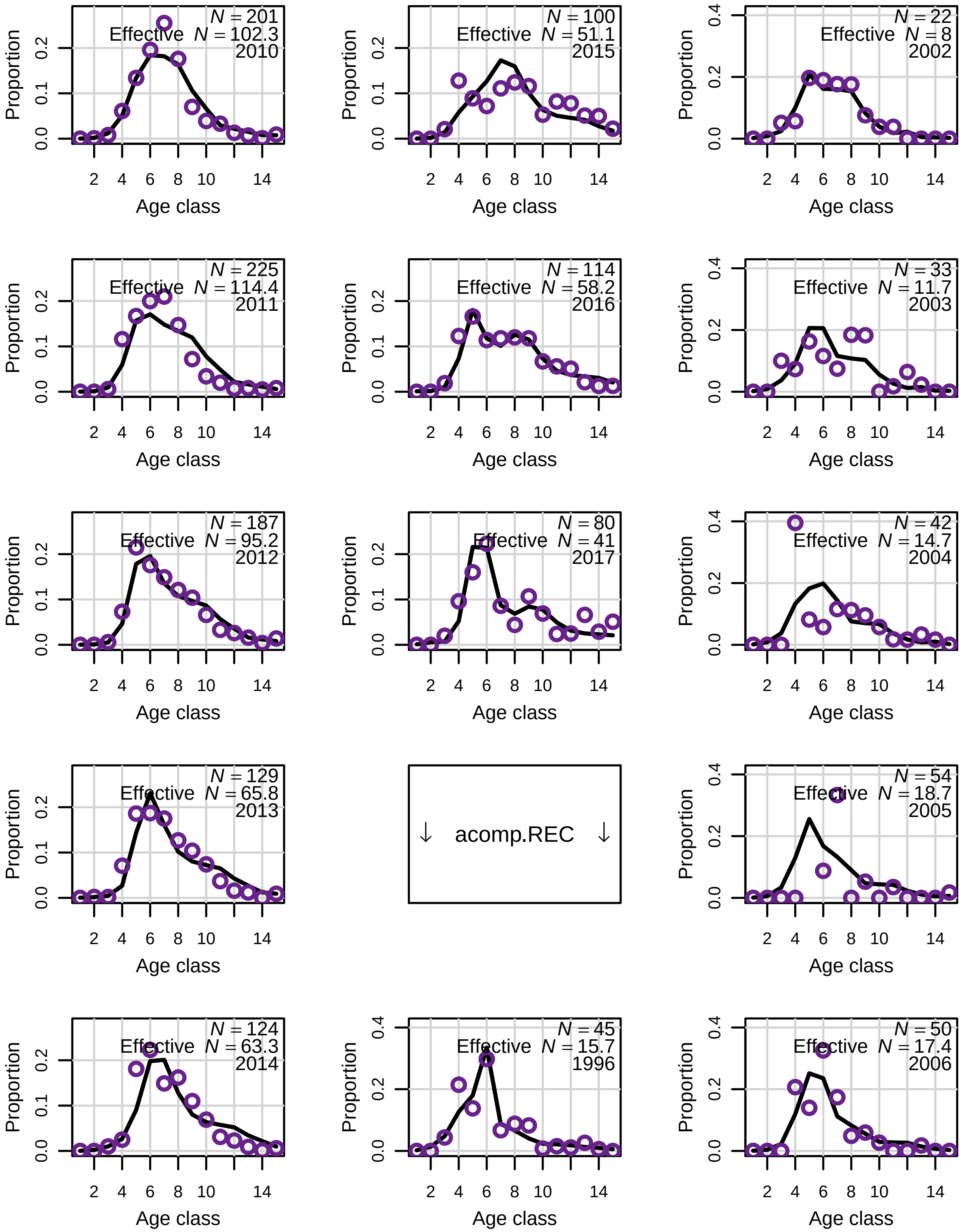


Figure 3. (cont.) Observed (open circles) and estimated (solid line) annual length and age compositions by fleet or survey from the base run.

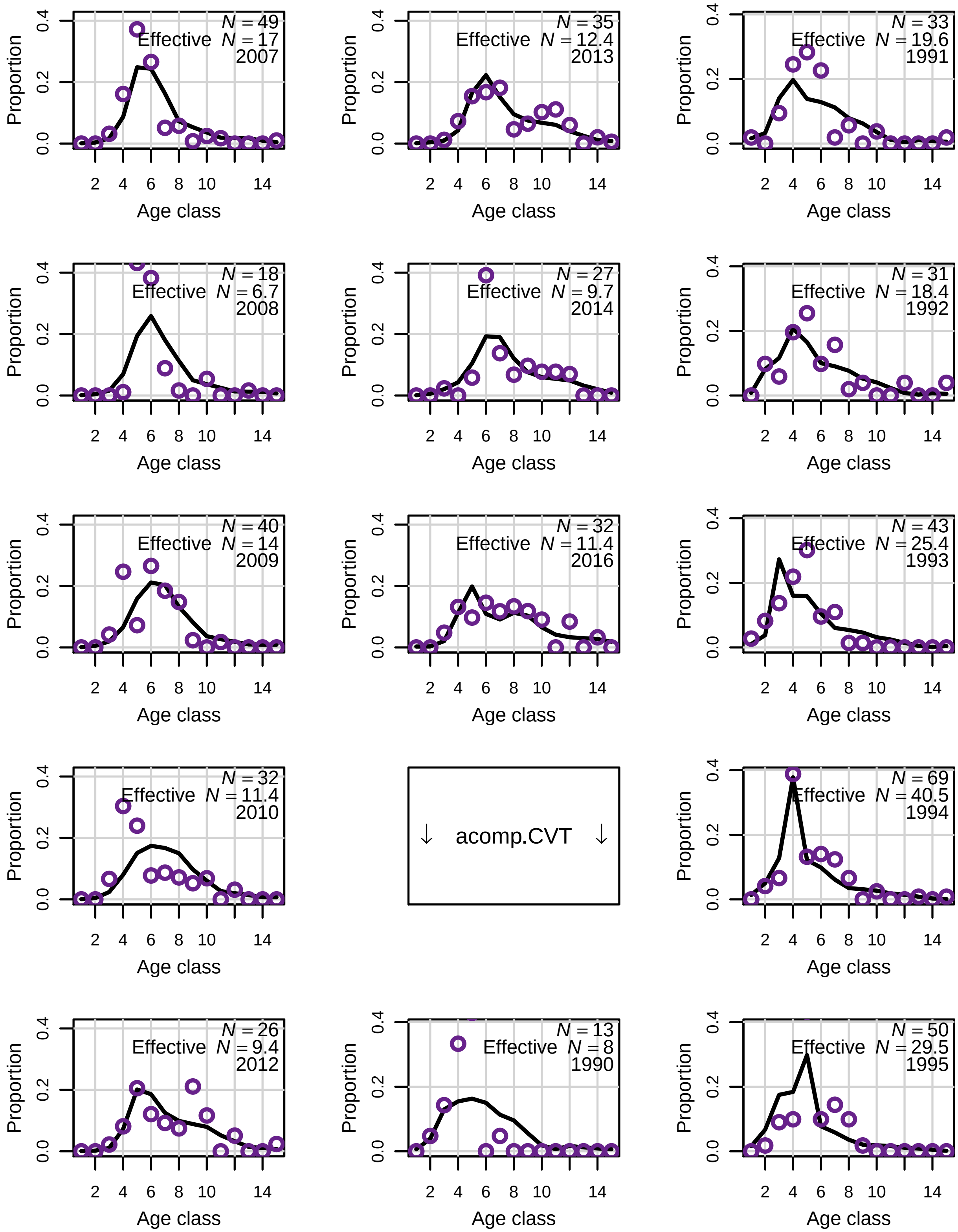


Figure 3. (cont.) Observed (open circles) and estimated (solid line) annual length and age compositions by fleet or survey from the base run.

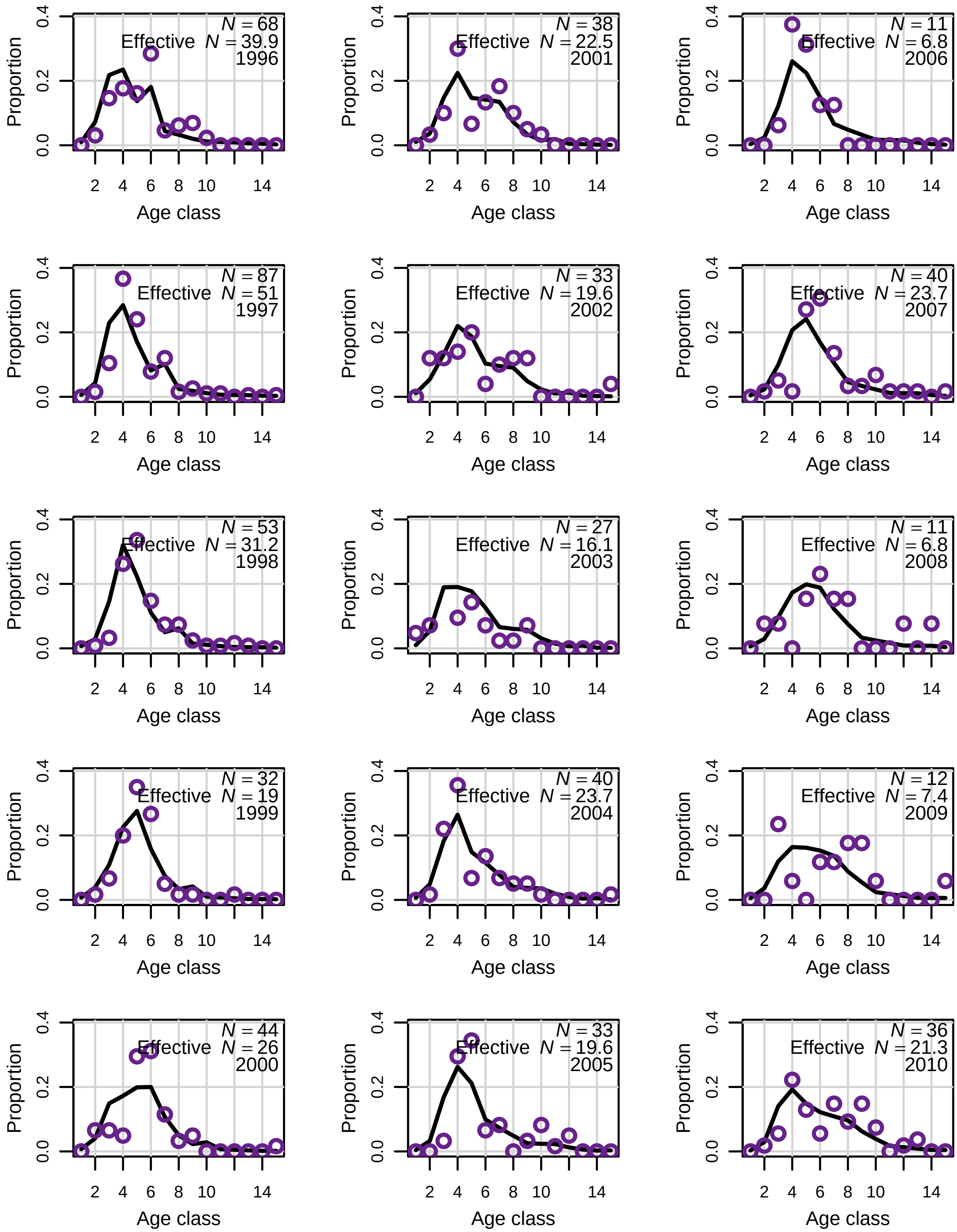


Figure 3. (cont.) Observed (open circles) and estimated (solid line) annual length and age compositions by fleet or survey from the base run.

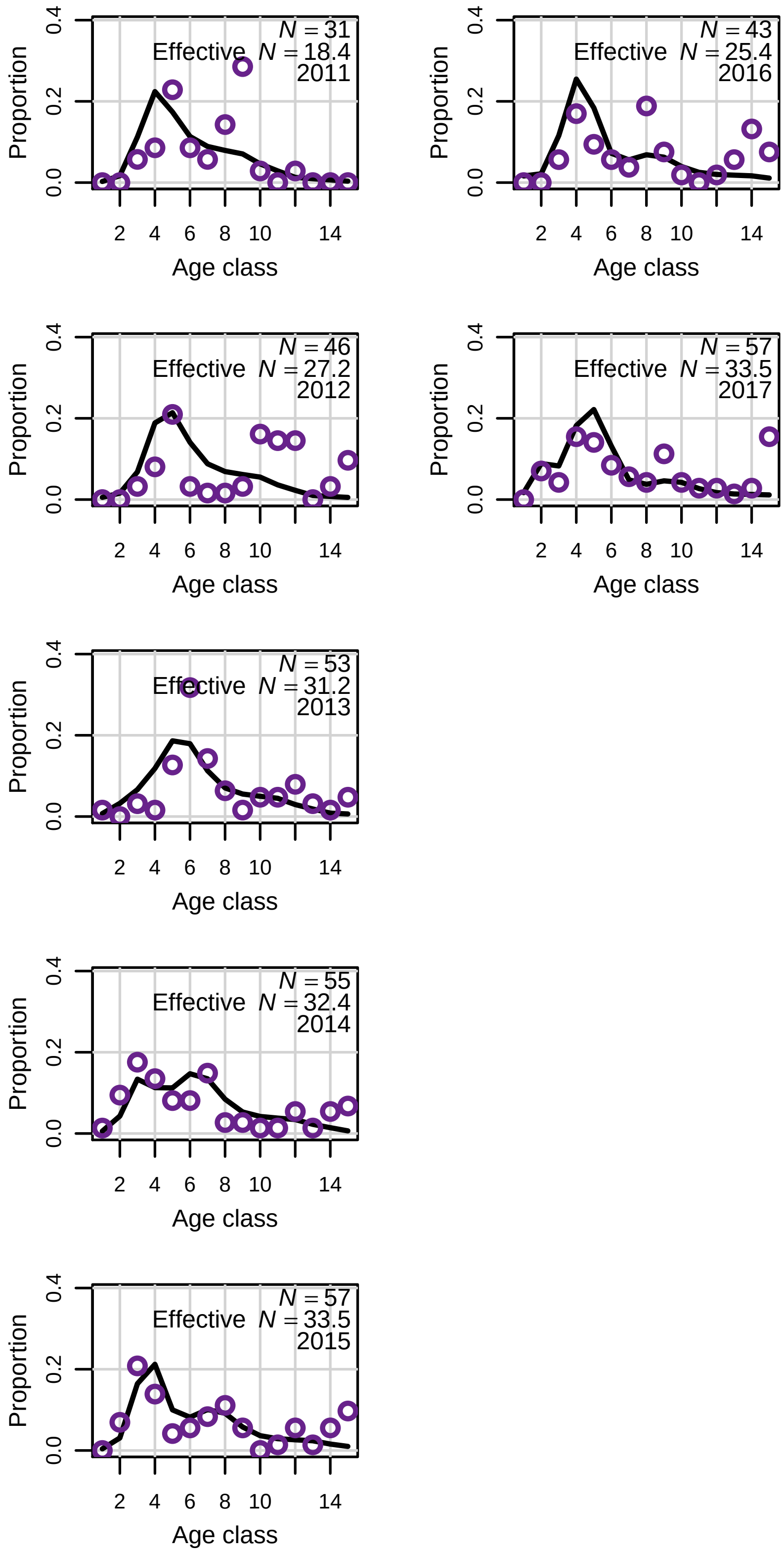


Figure 4. Observed (open circles) and estimated (line, solid circles) commercial landings (1000 lb whole weight).

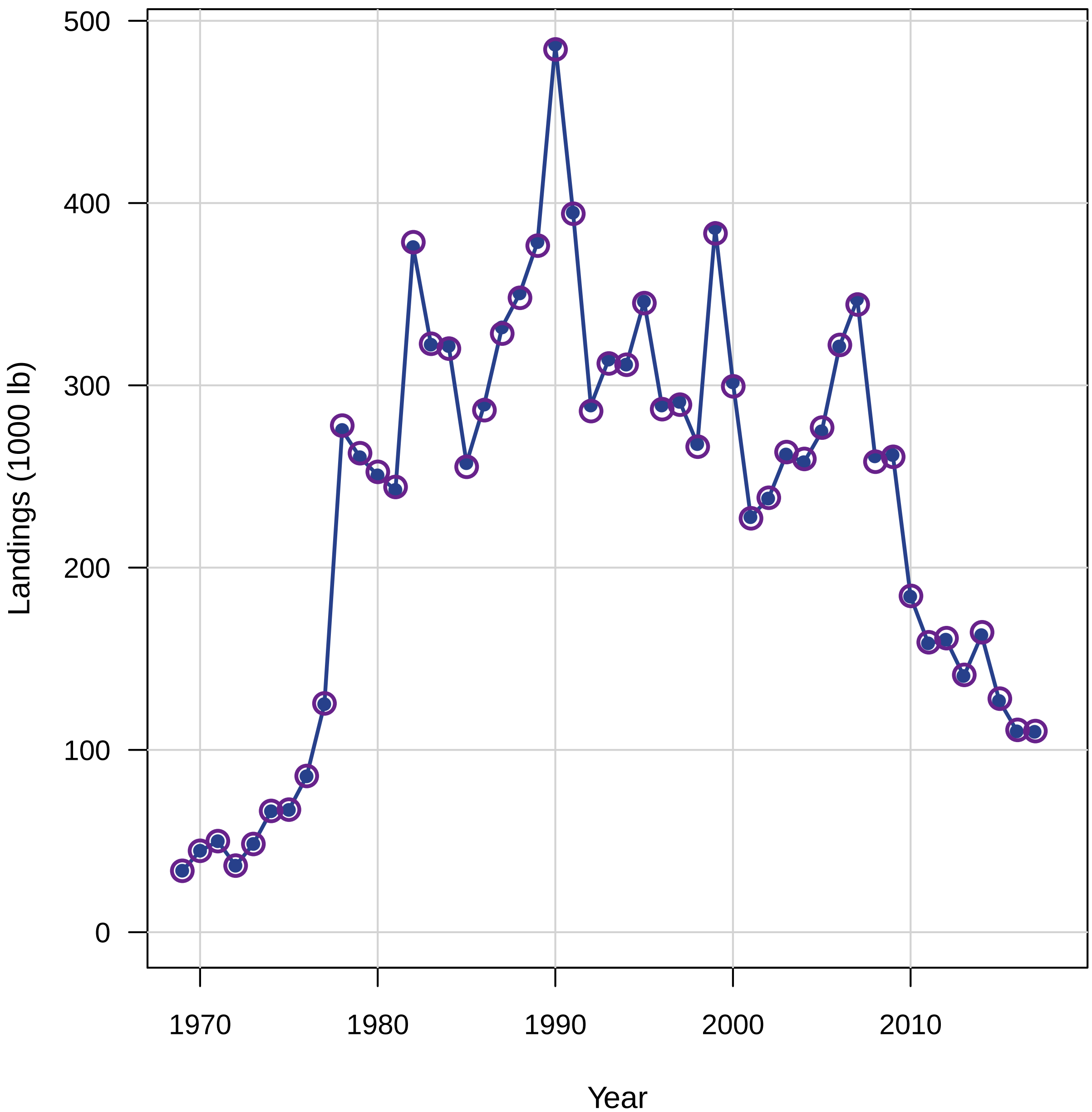


Figure 5. Observed (open circles) and estimated (line, solid circles) recreational landings (1000 fish).

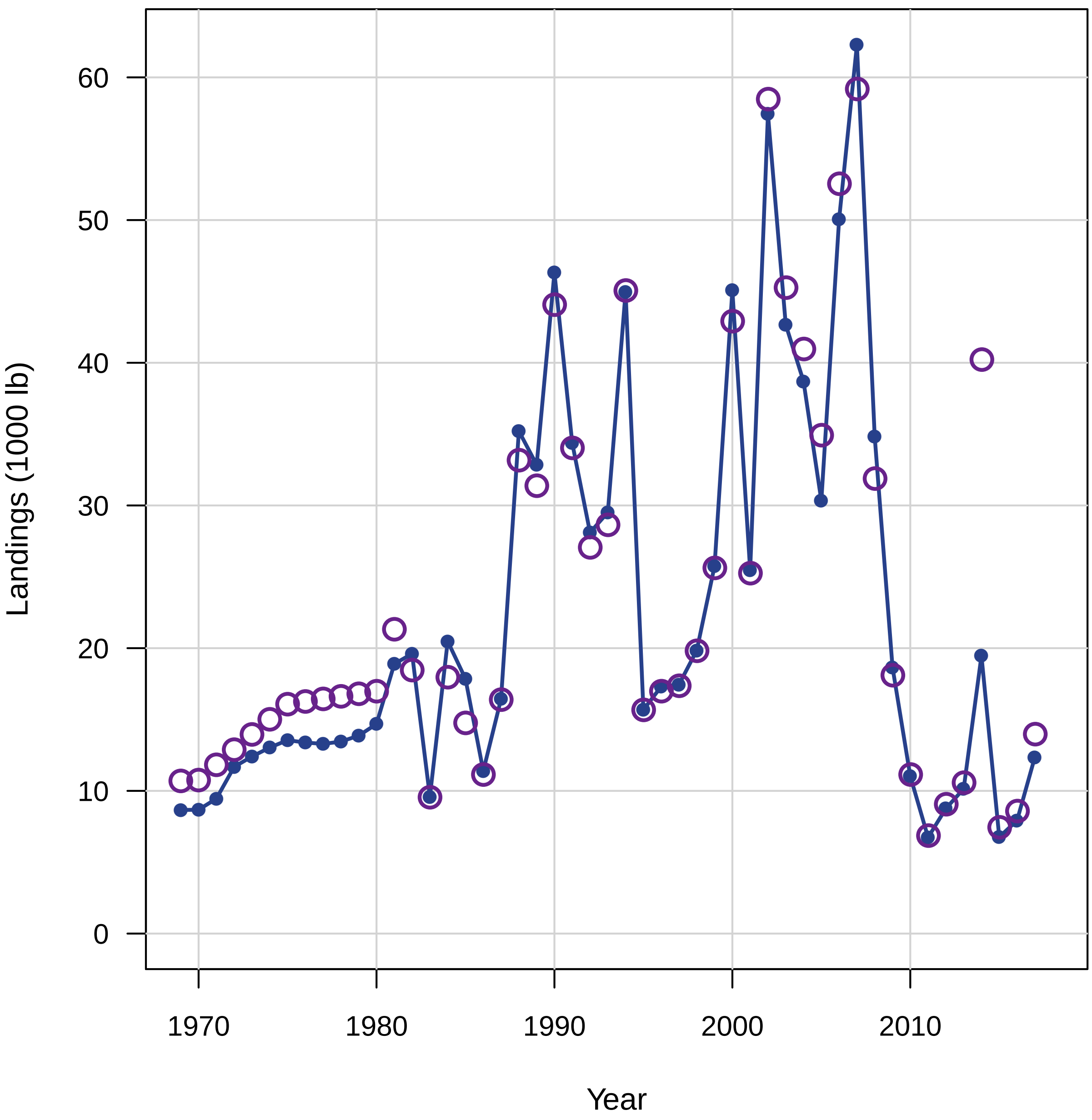


Figure 6. Observed (open circles) and estimated (line, solid circles) commercial discards (1000 fish).

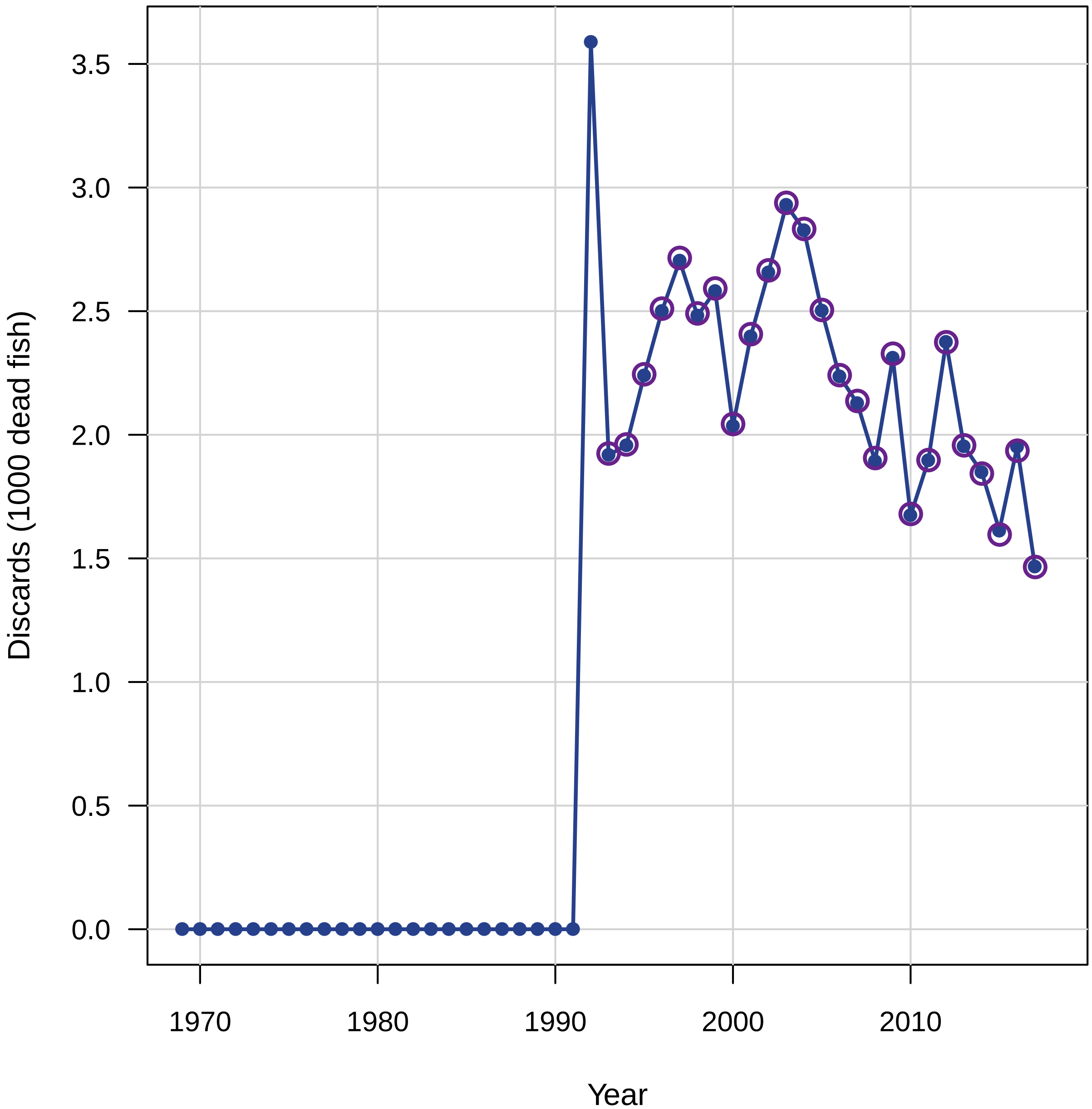


Figure 7. Observed (open circles) and estimated (line, solid circles recreational discards (1000 fish).

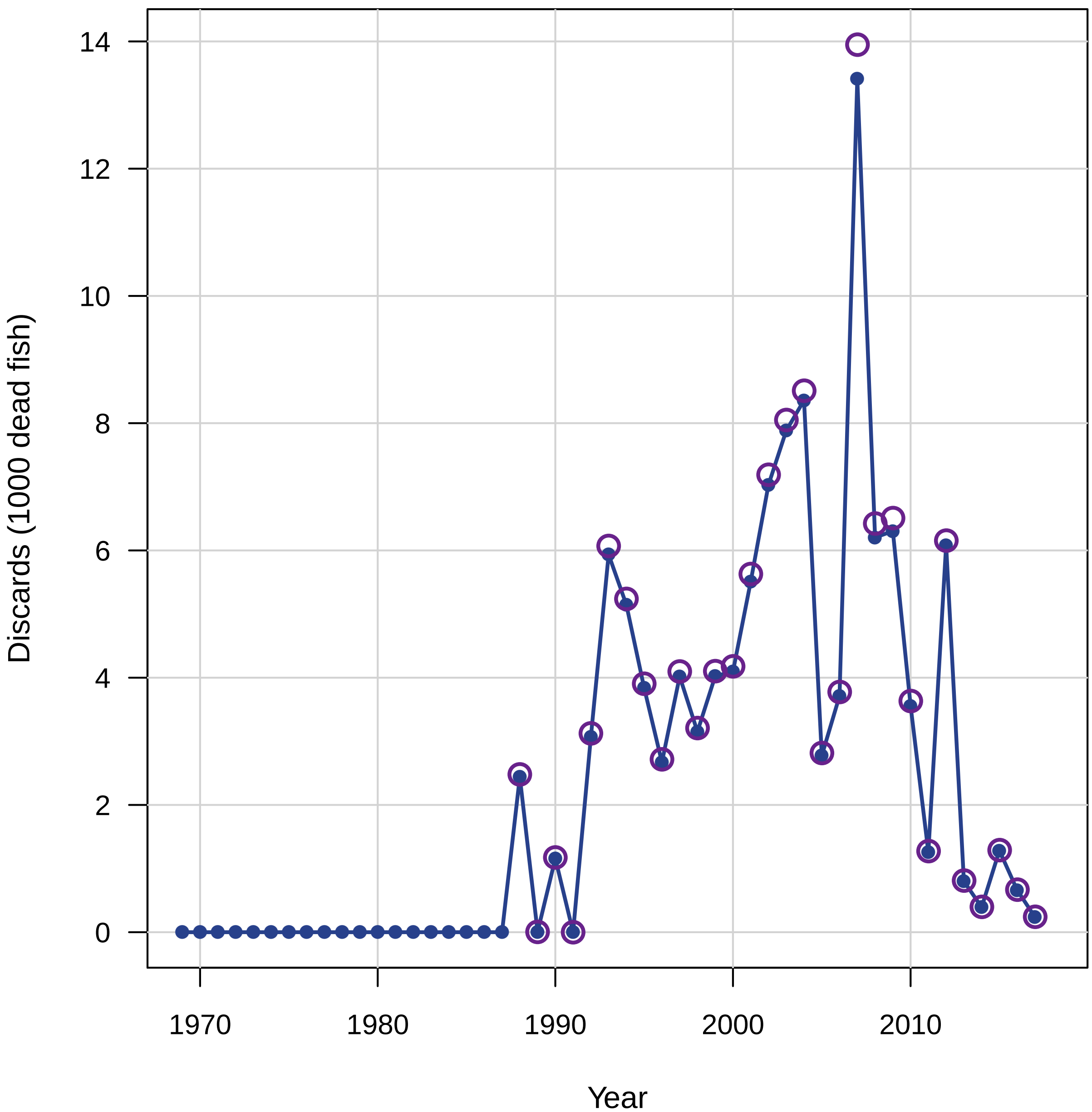


Figure 8. Observed (open circles) and estimated (line, solid circles) index of abundance from the recreational fleet.

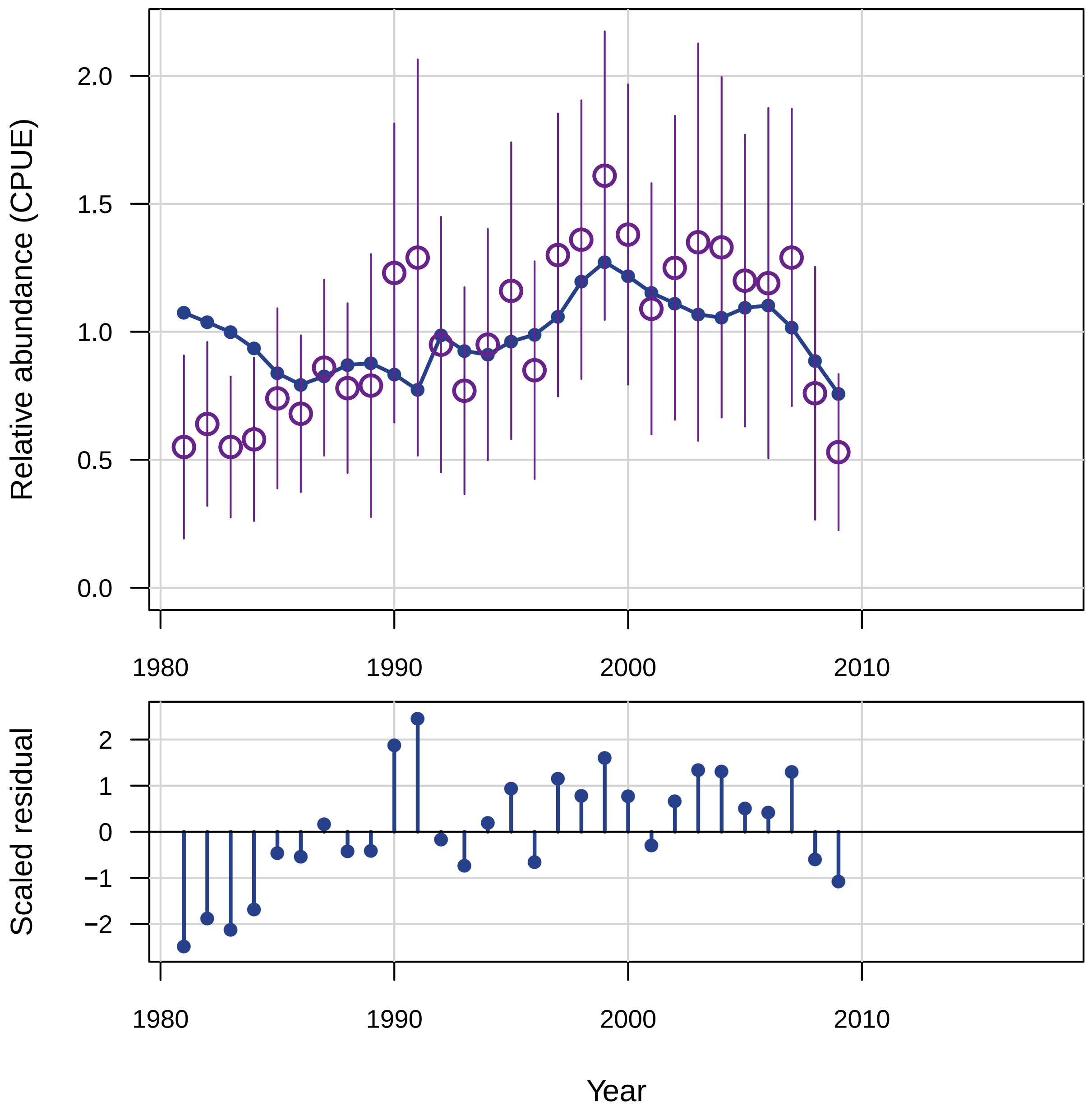


Figure 9. Observed (open circles) and estimated (line, solid circles) index of abundance from the commercial fleet.

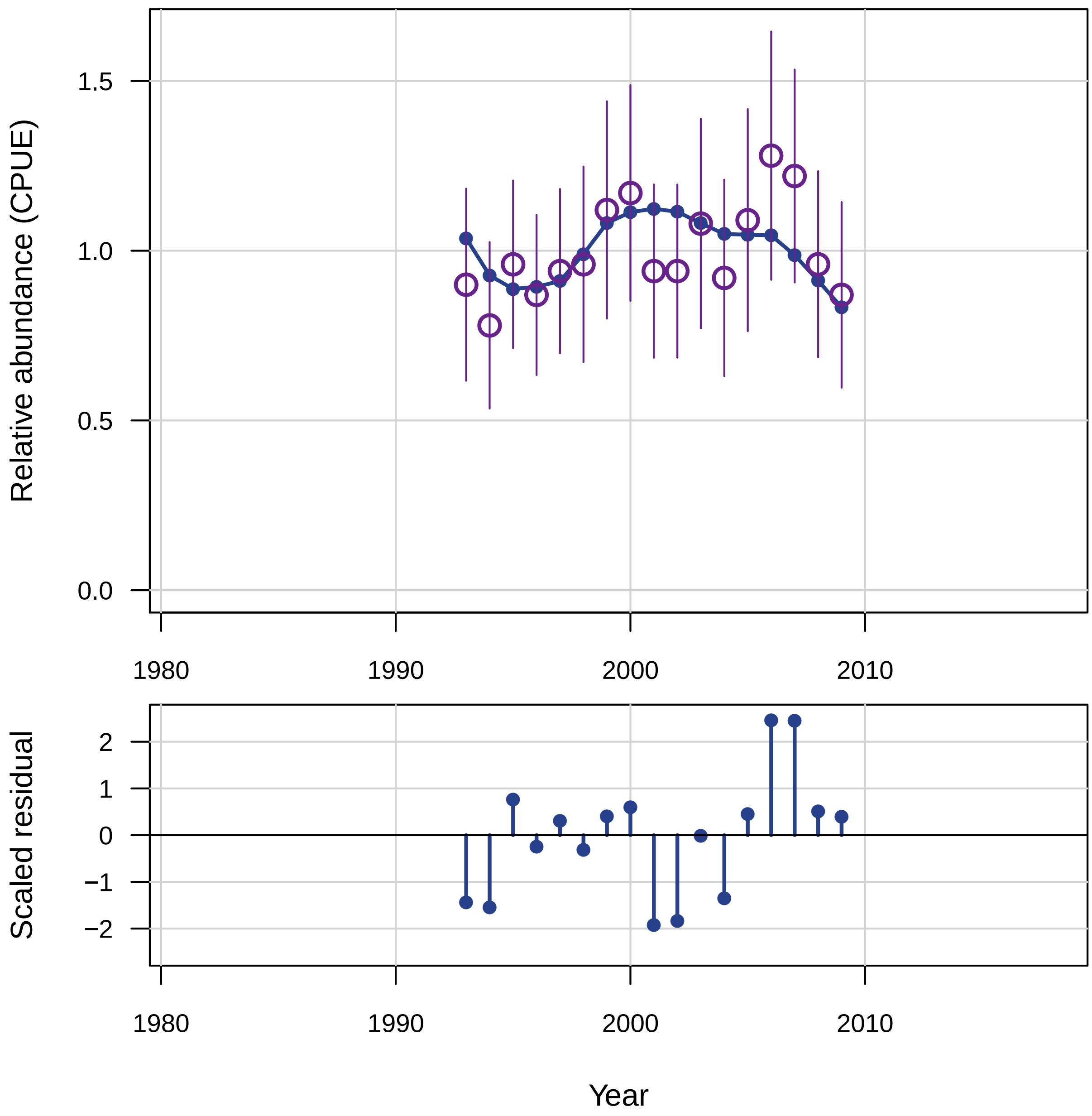


Figure 10. Observed (open circles) and estimated (line, solid circles) index of abundance from the combined SERFS chevron trap and video surveys.

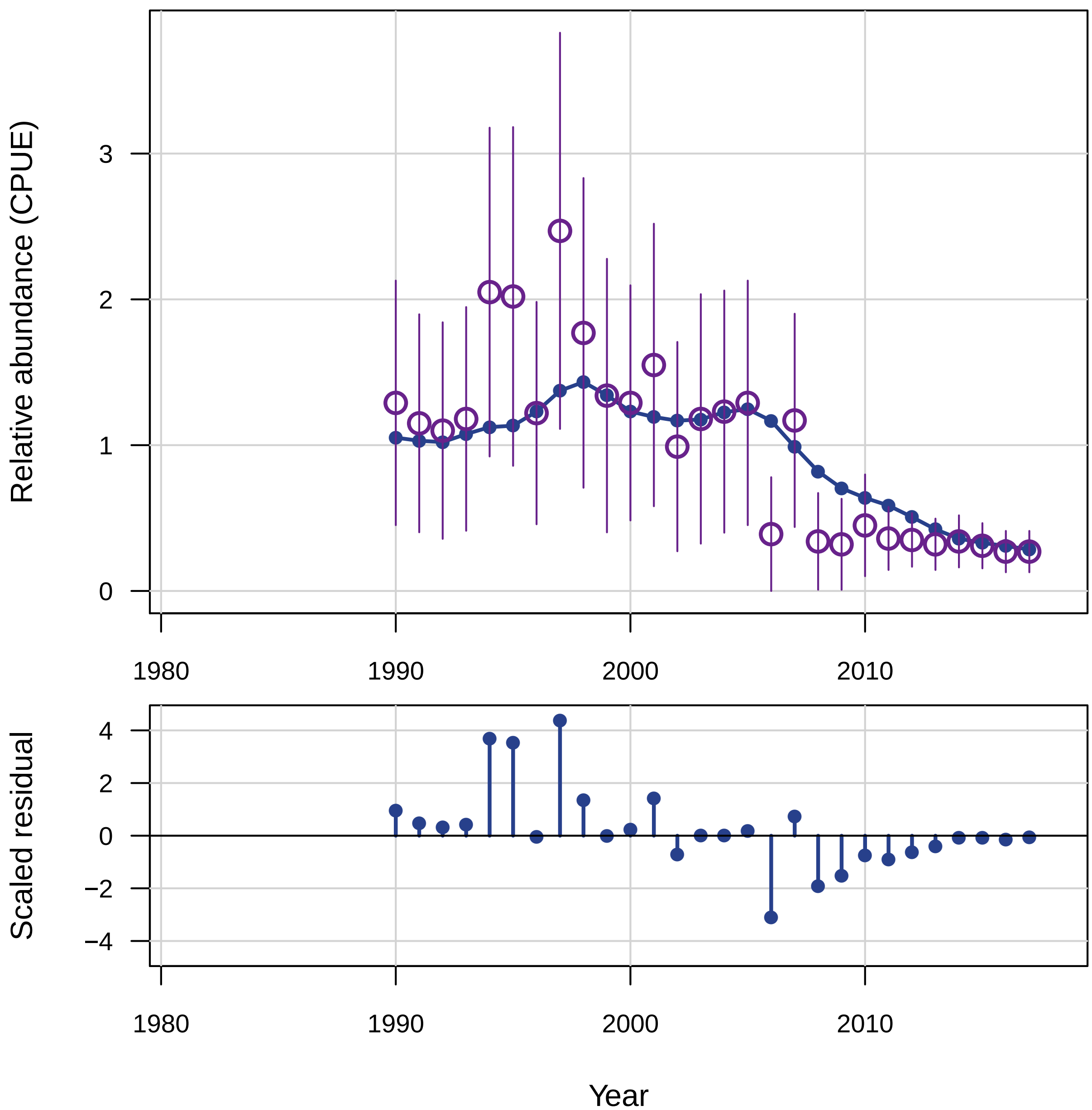


Figure 11. Estimated abundance at age at start of year.

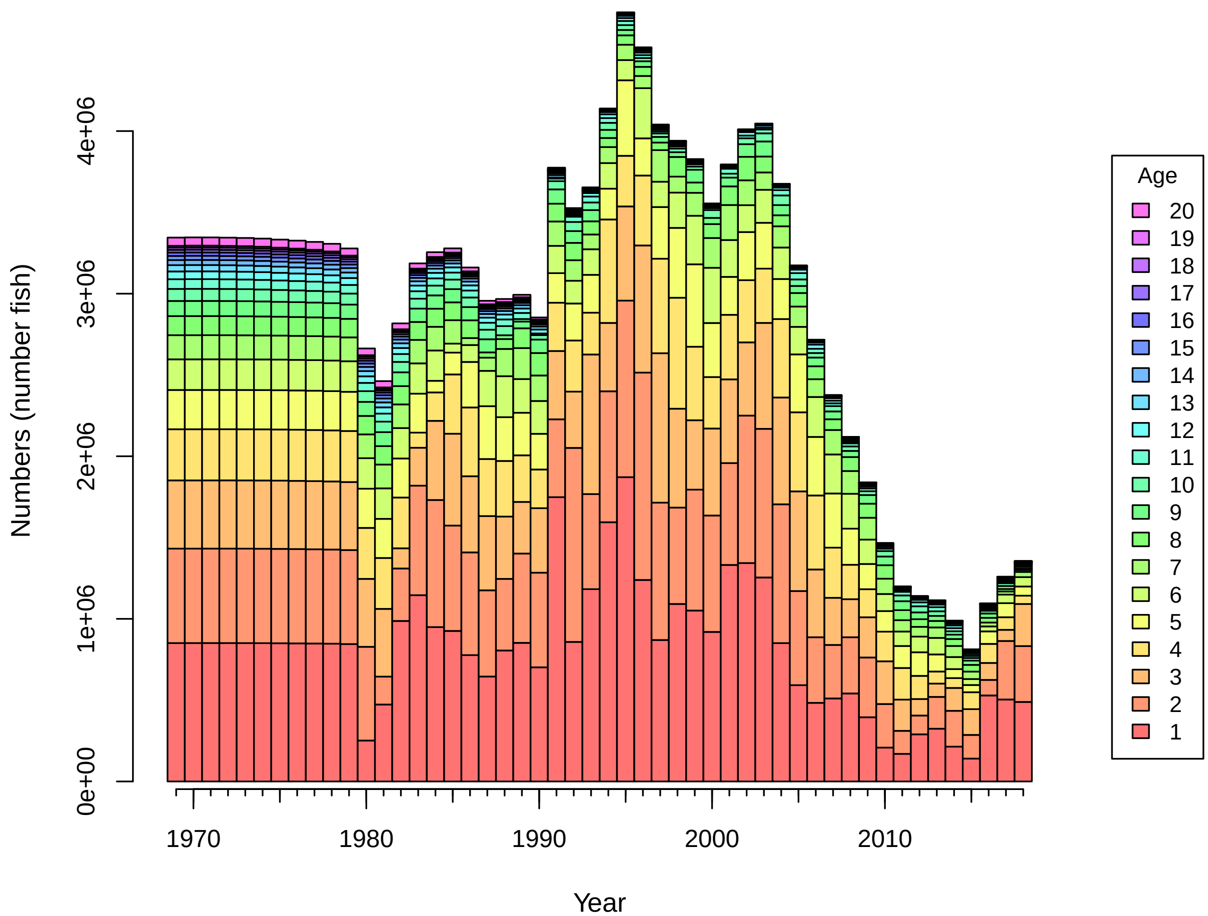


Figure 12. Top panel: Estimated recruitment of age-1 fish. Horizontal dashed line indicates R_{MSY}. Bottom panel: log recruitment residuals.

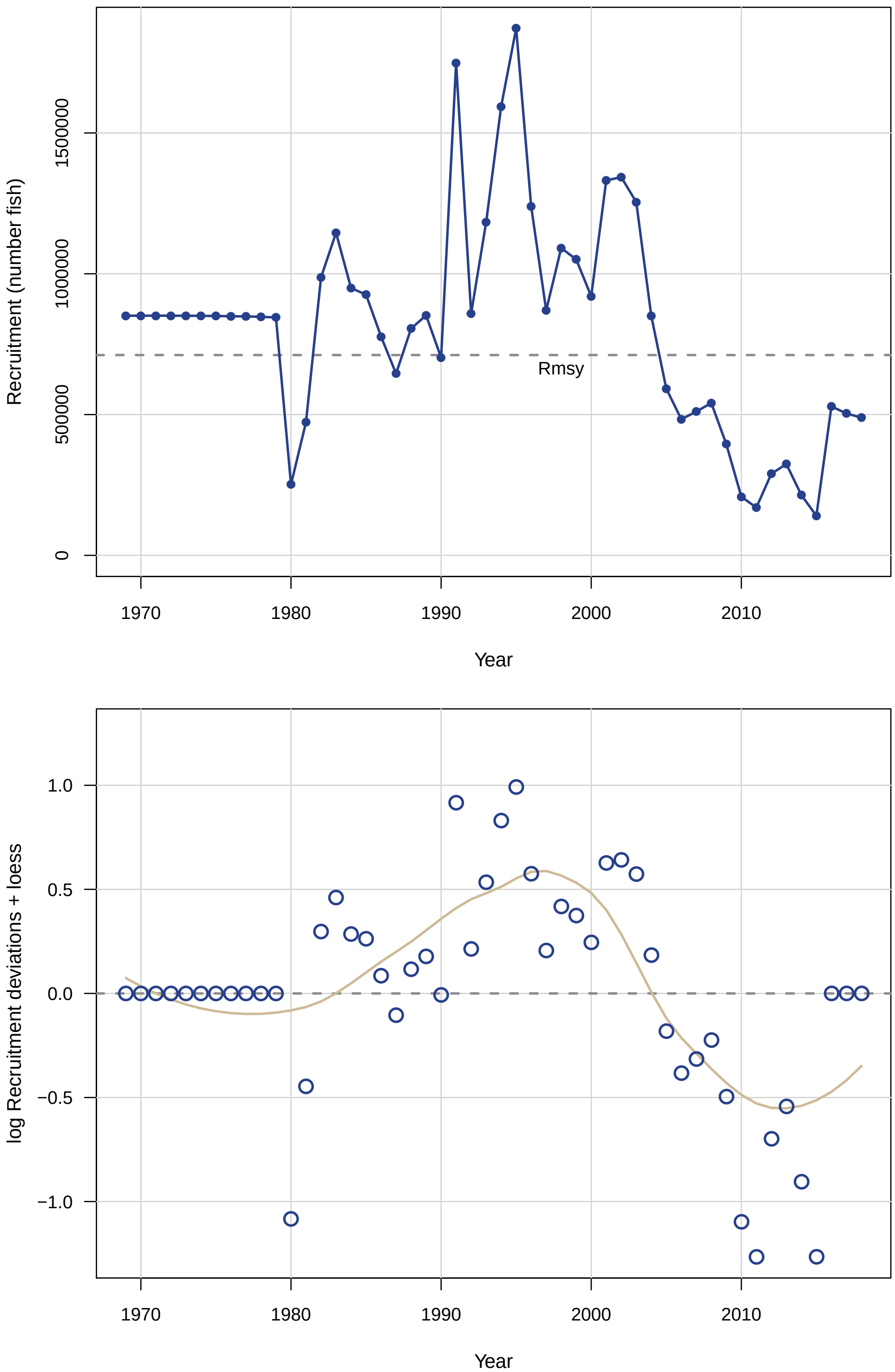


Figure 13. Estimated biomass at age at start of year.

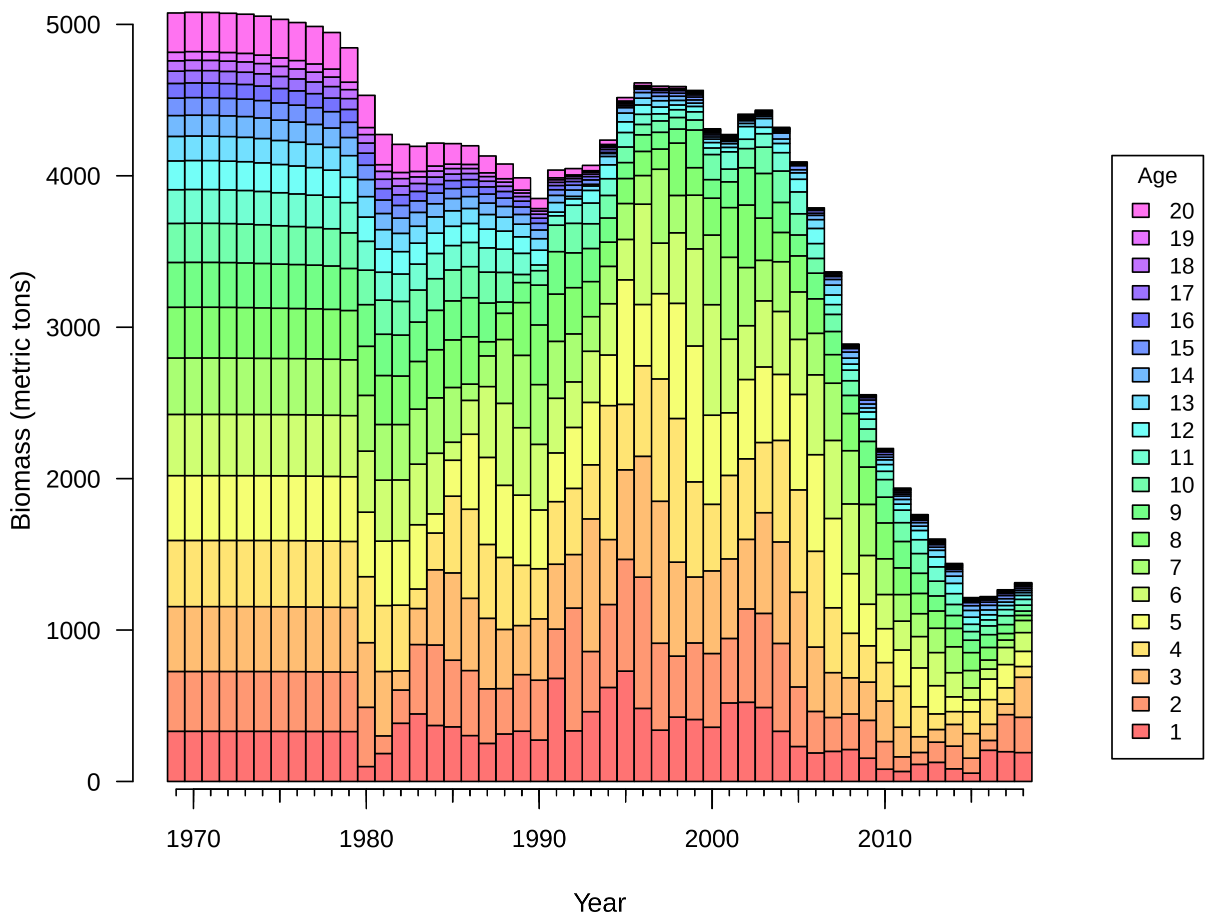


Figure 14. Top panel: Estimated total biomass (metric tons) at start of year. Horizontal dashed line indicates B_{MSY}. *Bottom panel: Estimated spawning stock (mature female biomass) at time of peak spawning.*

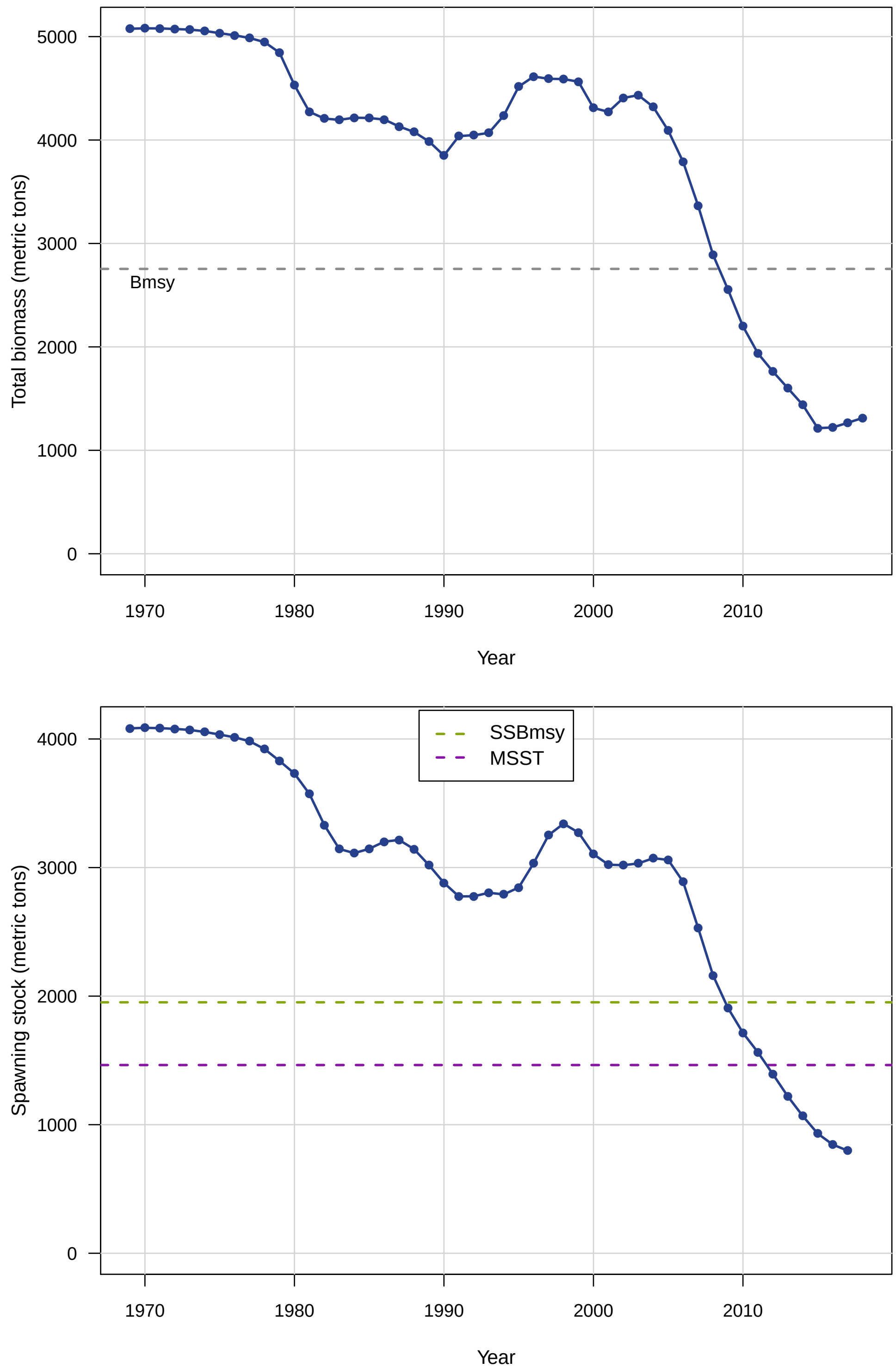


Figure 15. Estimated selectivities of the commercial fleet. Years indicated on plot signify the first year of a time block.

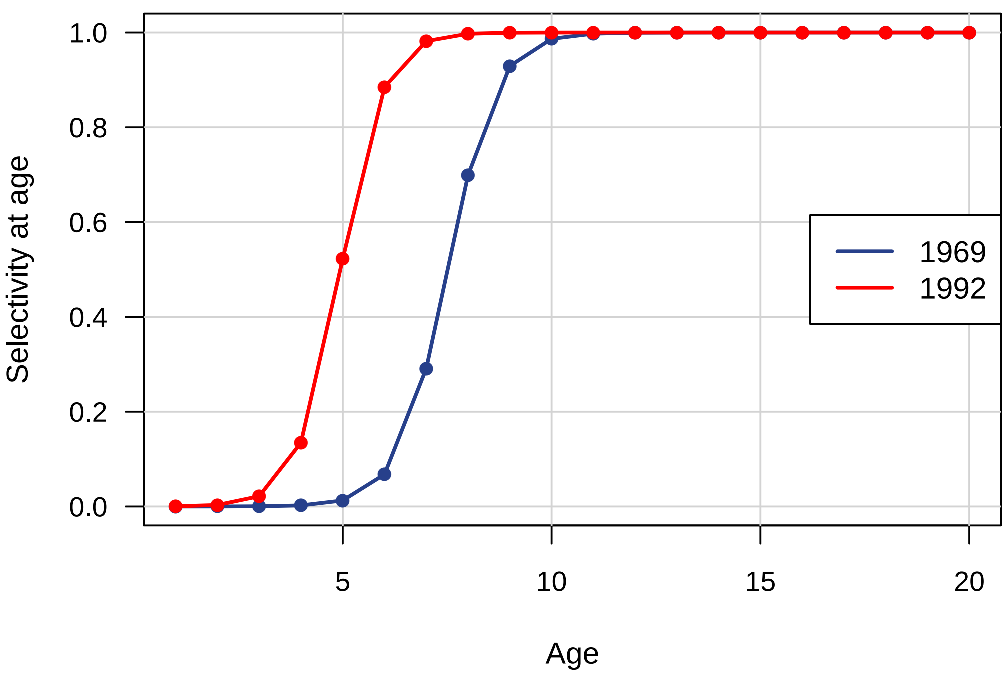


Figure 16. Estimated selectivity of the commercial fleet discards. Years indicated on plot signify the first year of a time block.

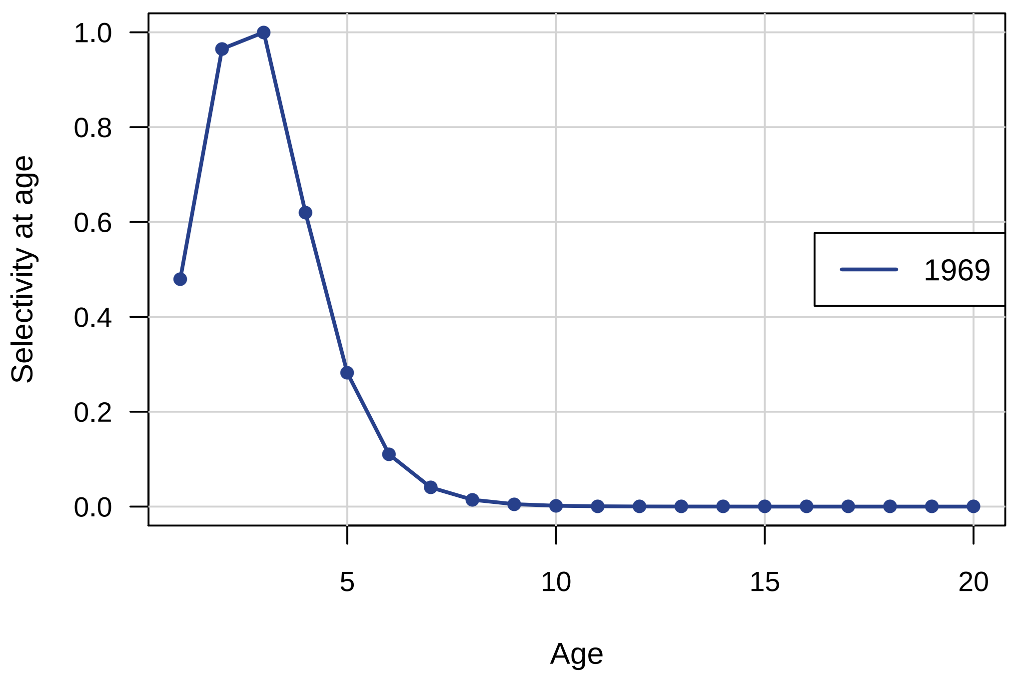


Figure 17. Estimated selectivities of the recreational fleet. Years indicated on plot signify the first year of a time block.

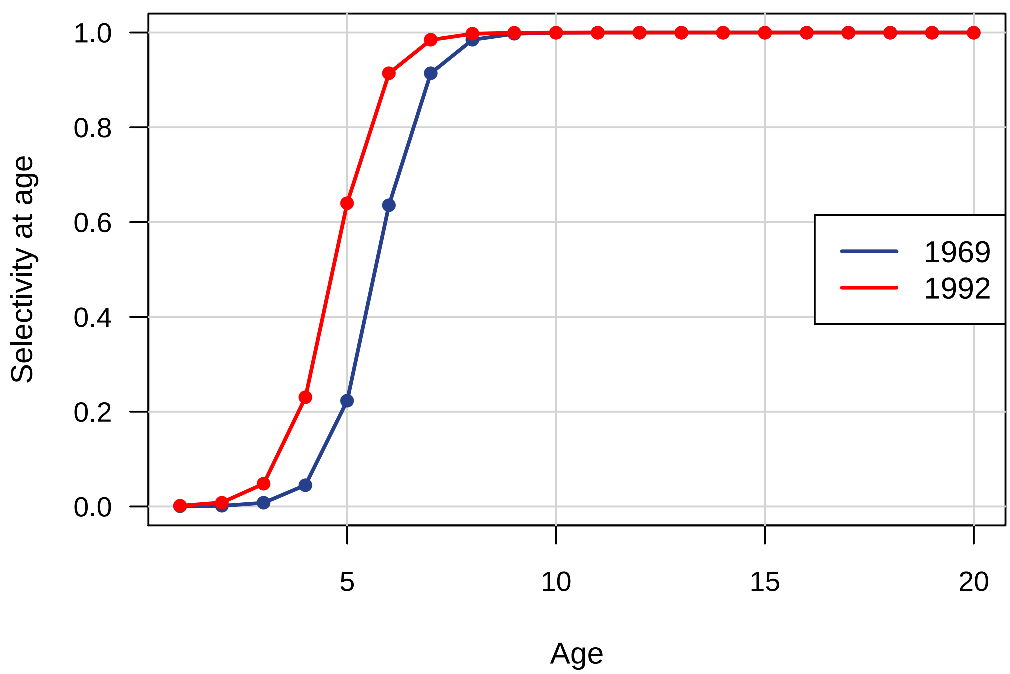


Figure 18. Estimated selectivities of the recreational fleet discards. Years indicated on plot signify the first year of a time block.

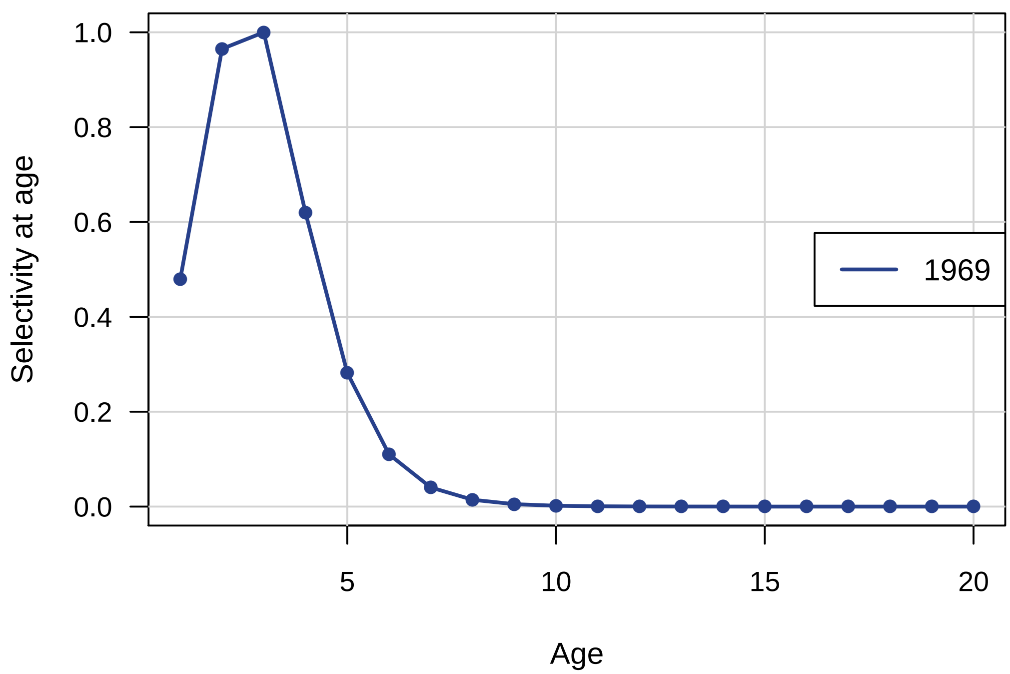


Figure 19. Estimated selectivity of the SERFS index.

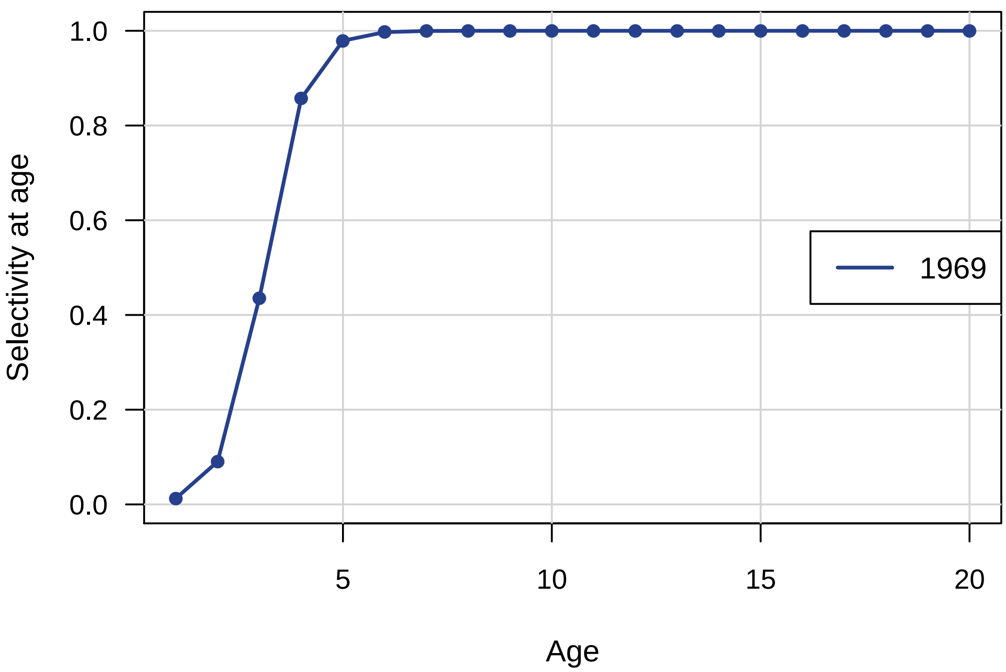


Figure 20. Average selectivity of landings from the terminal assessment years, weighted by geometric mean F s from the last three assessment years, and used in computation of benchmarks and projections.

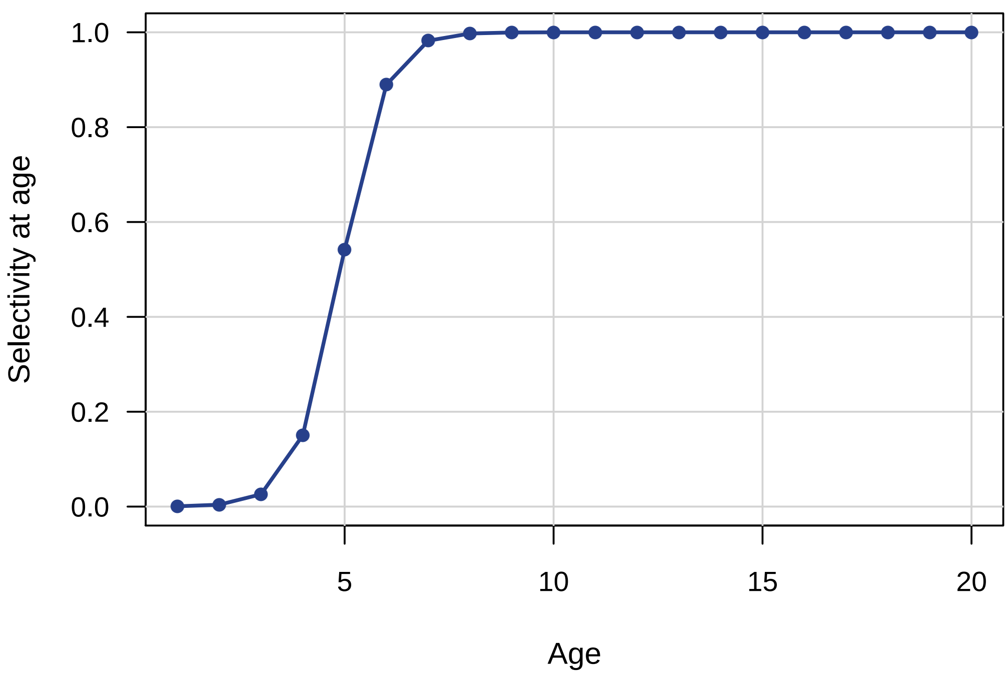


Figure 21. Average selectivity of discards from the terminal assessment years, weighted by geometric mean Fs from the last three assessment years, and used in computation of benchmarks and projections.

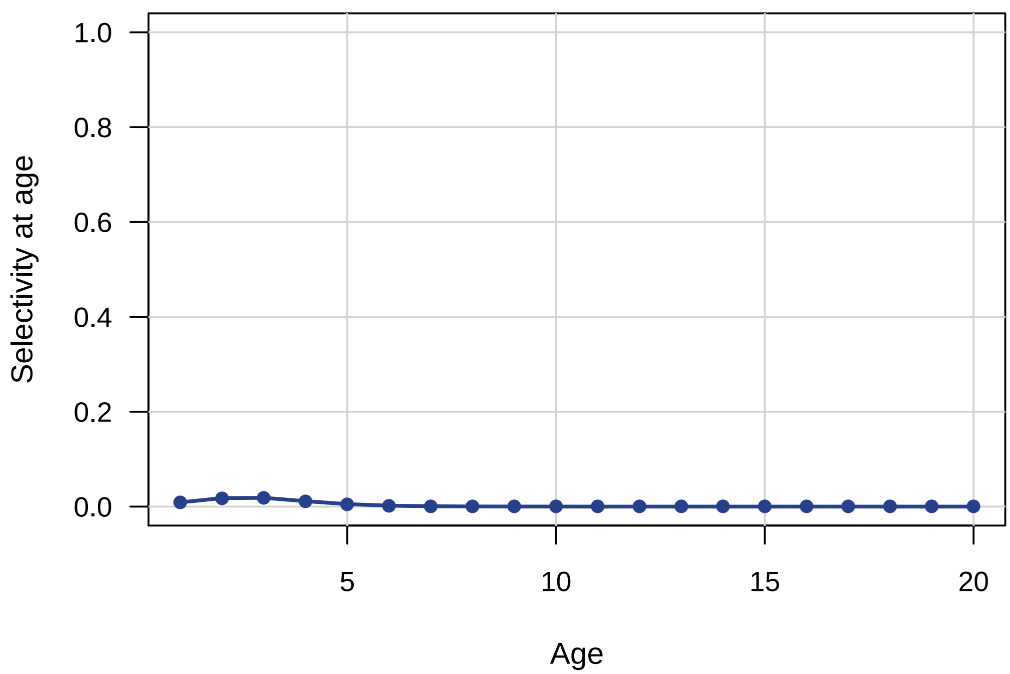


Figure 22. Average selectivity from the terminal assessment years, weighted by geometric mean Fs from the last three assessment years, and used in computation of benchmarks and projections.

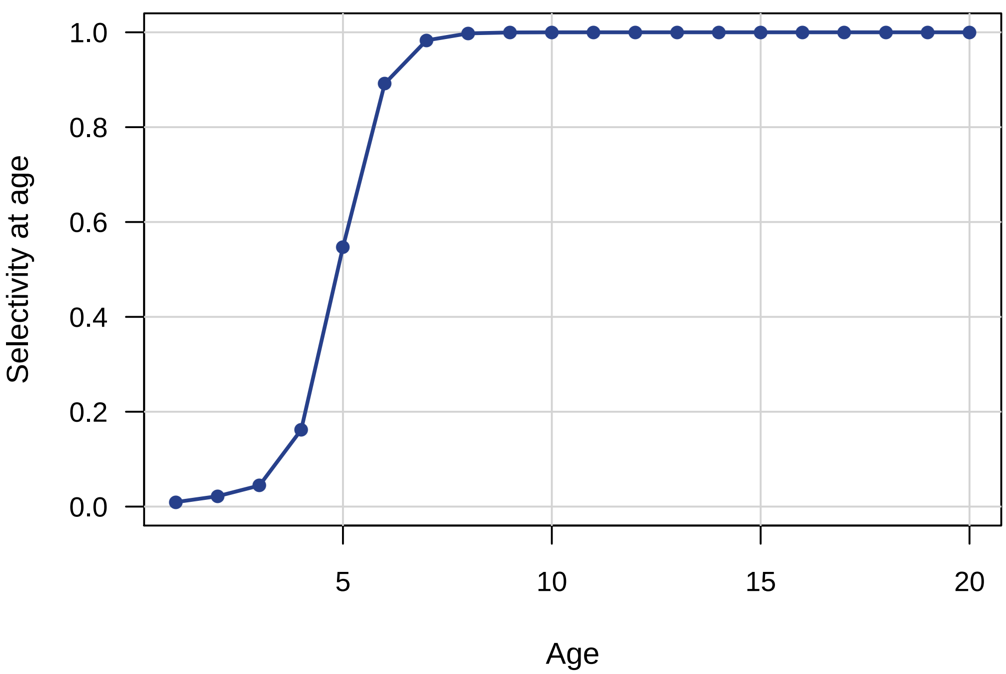


Figure 23. Estimated fully selected fishing mortality rate (per year) by fishery. COM refers to commercial, REC refers to recreational, and D refers to discards from each fleet.

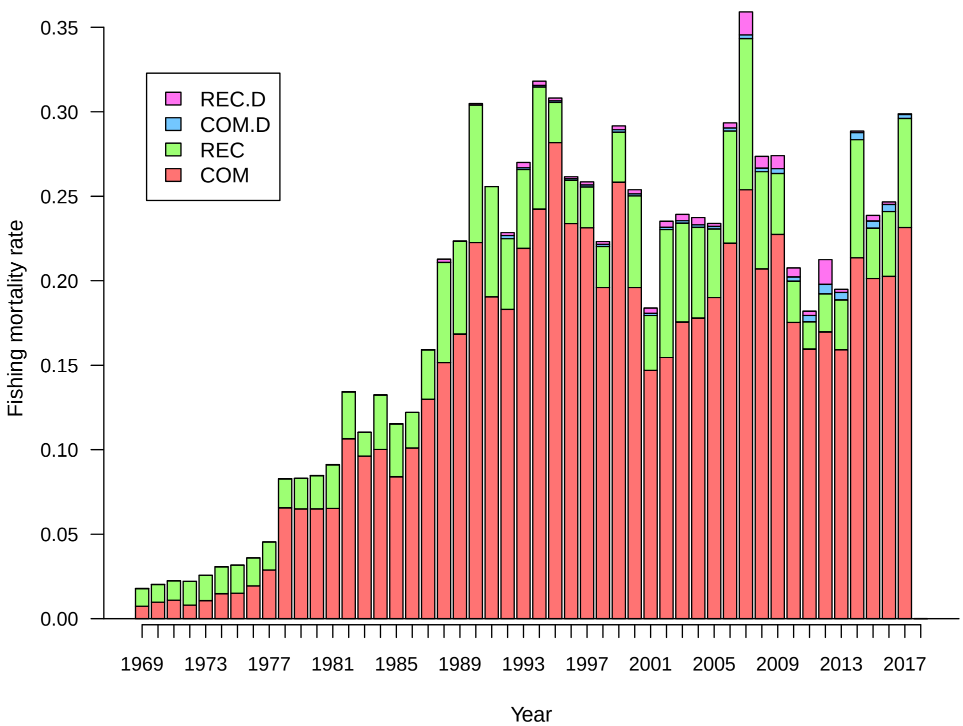


Figure 24. Estimated landings in weight (klb) by fishery from the catch-age model. COM refers to commercial and REC to recreational.

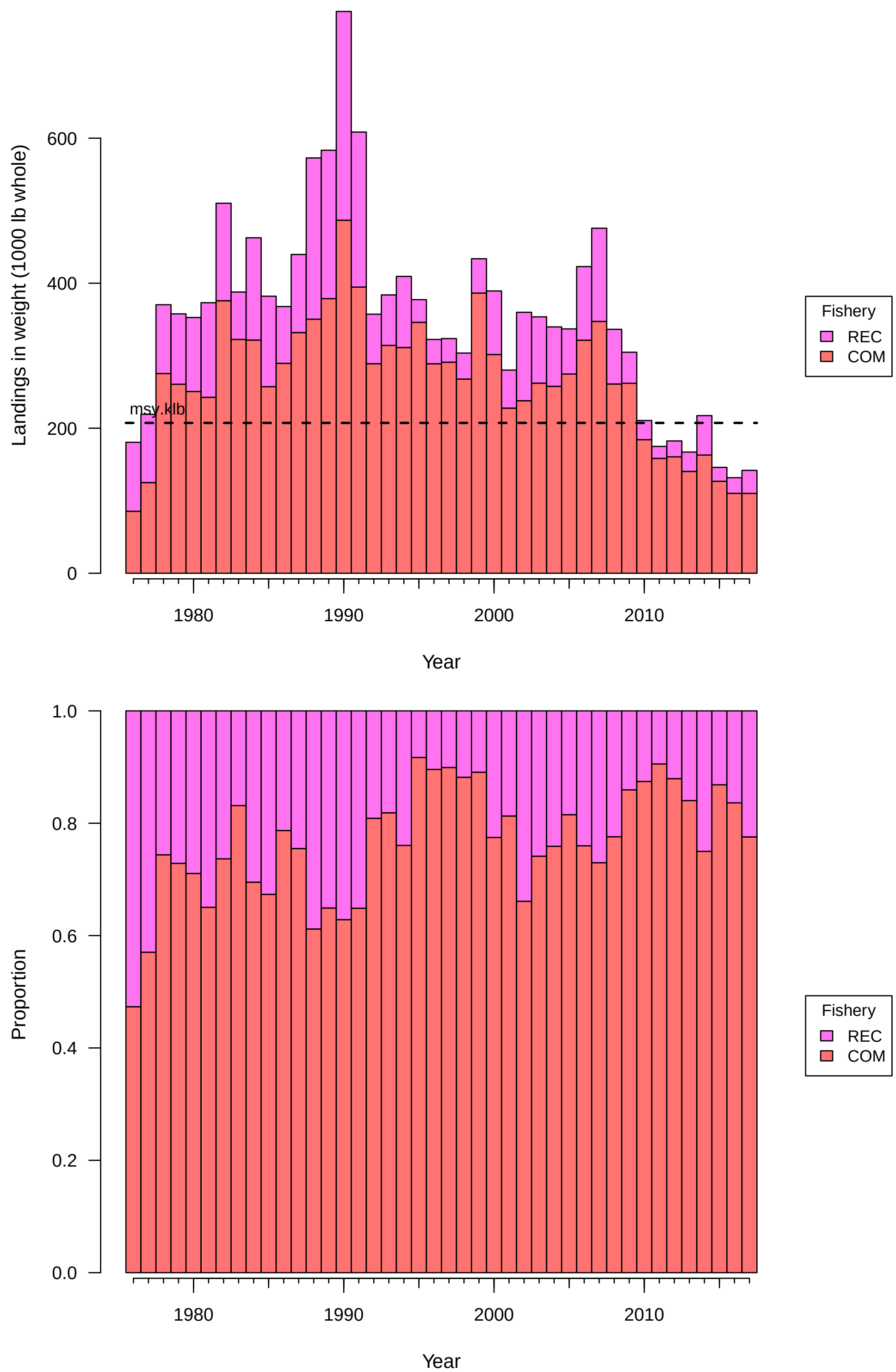


Figure 25. Estimated landings in numbers (1000s) by fishery from the catch-age model. COM refers to commercial and REC to general recreational.

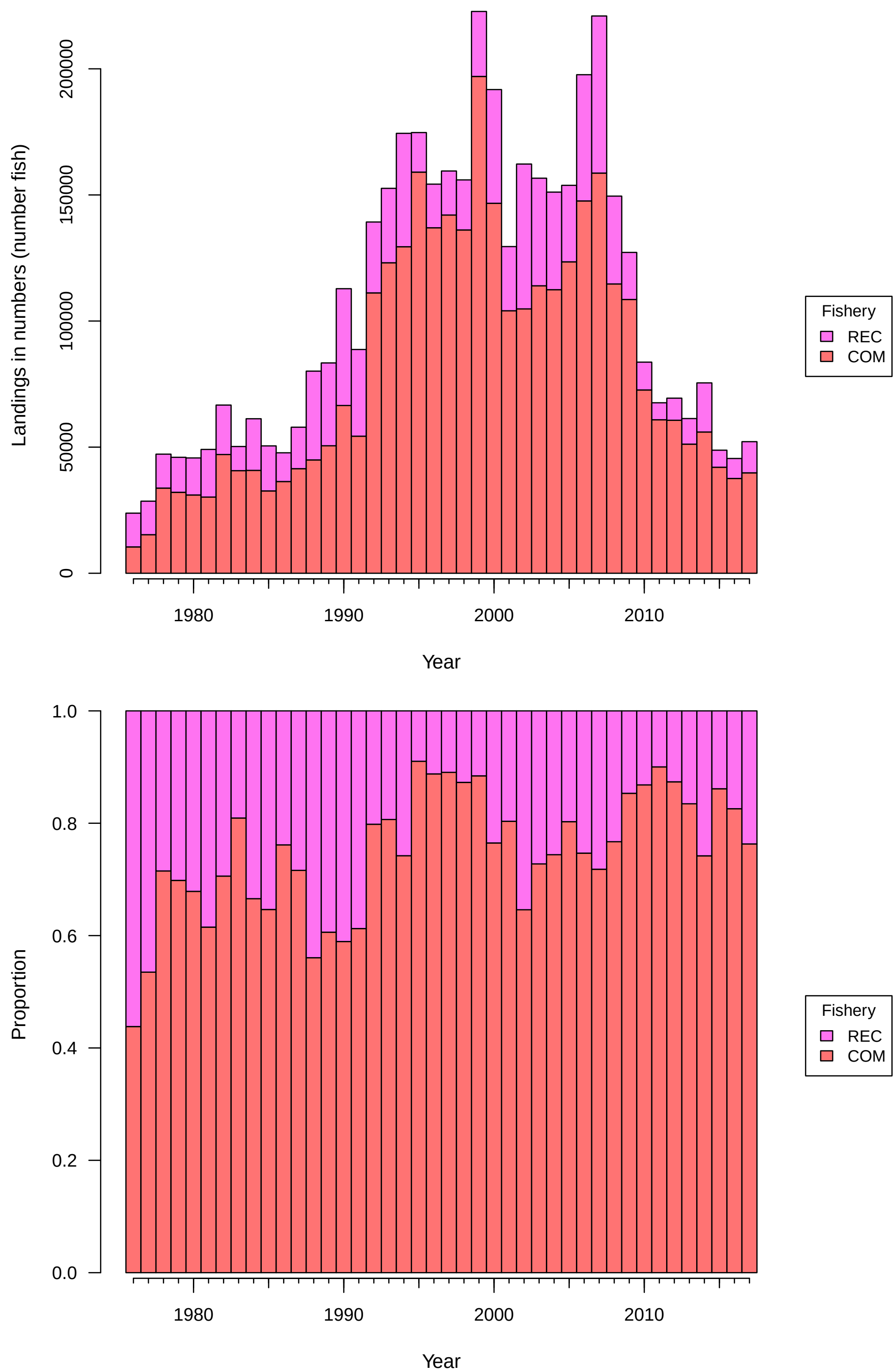


Figure 26. Estimated landings in weight (klb) by fishery from the catch-age model. COM refers to commercial and REC to recreational.

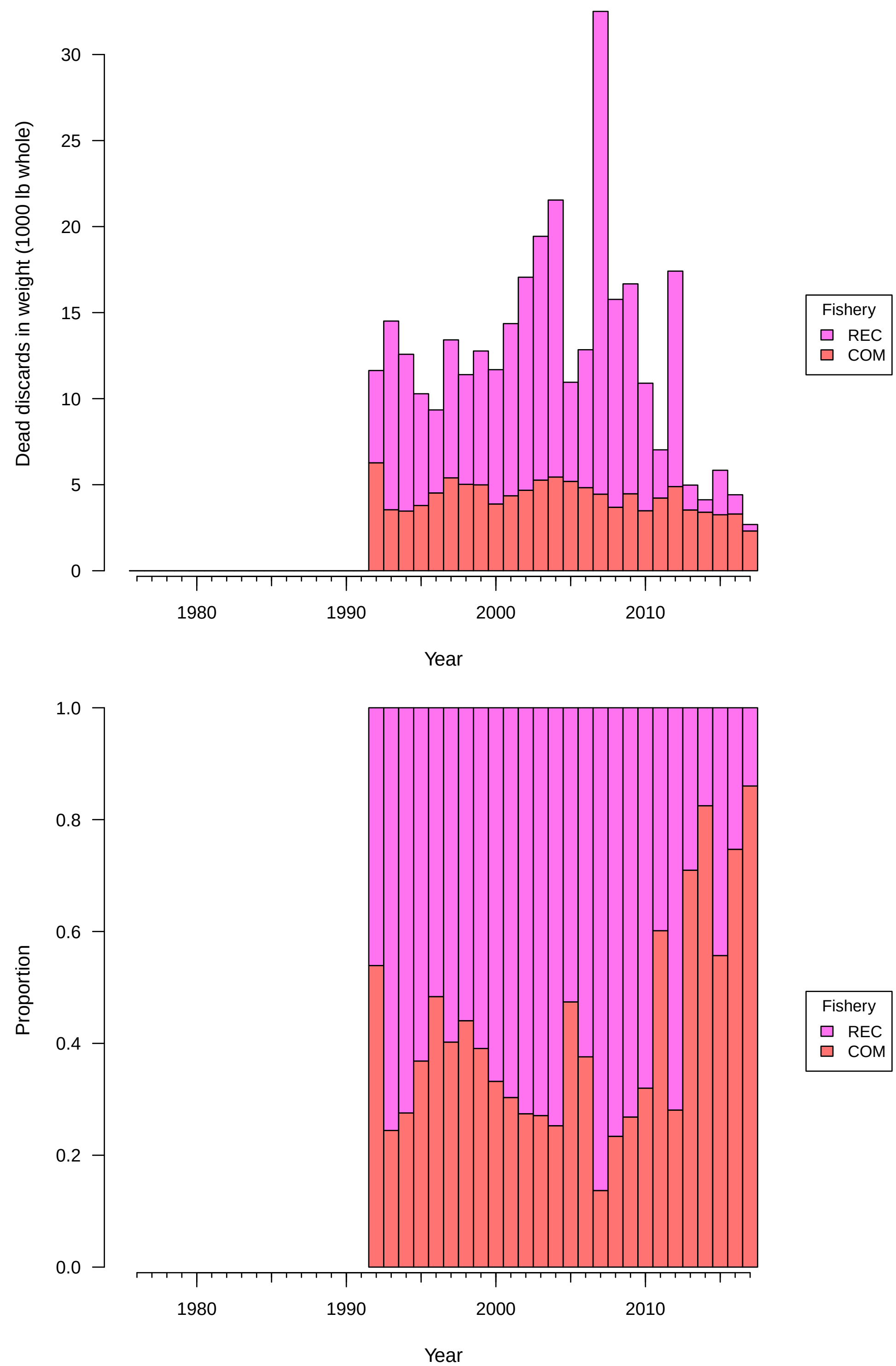


Figure 27. Estimated discards in numbers (1000s) by fishery from the catch-age model. COM refers to commercial and REC to recreational.

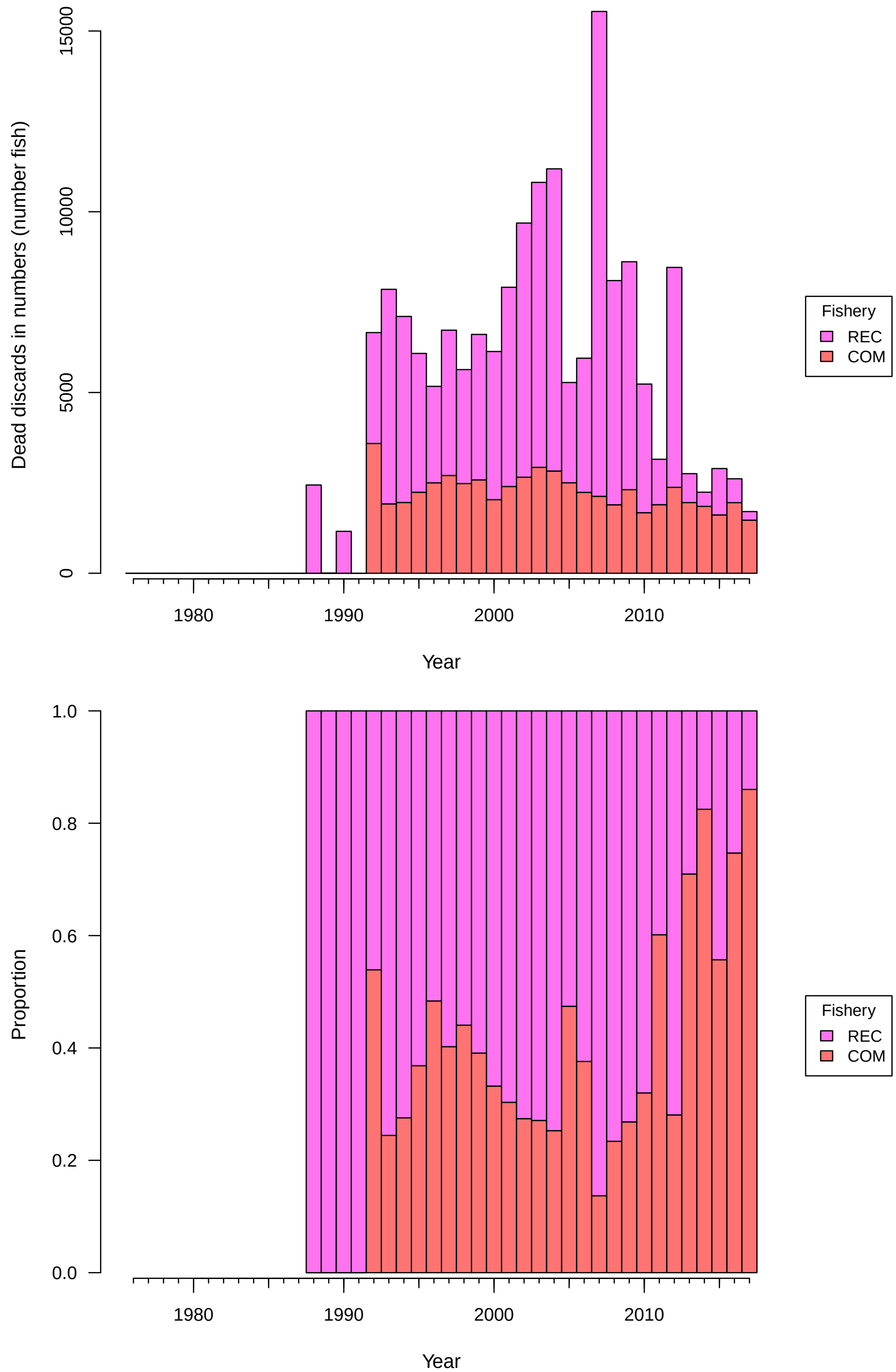


Figure 28. Top panel: Beverton–Holt spawner-recruit curves, with and without lognormal bias correction. The expected (upper) curve was used for computing management benchmarks. Years within panel indicate year of recruitment generated from spawning biomass. Bottom panel: log of recruits (number age-1 fish) per spawner as a function of spawners.

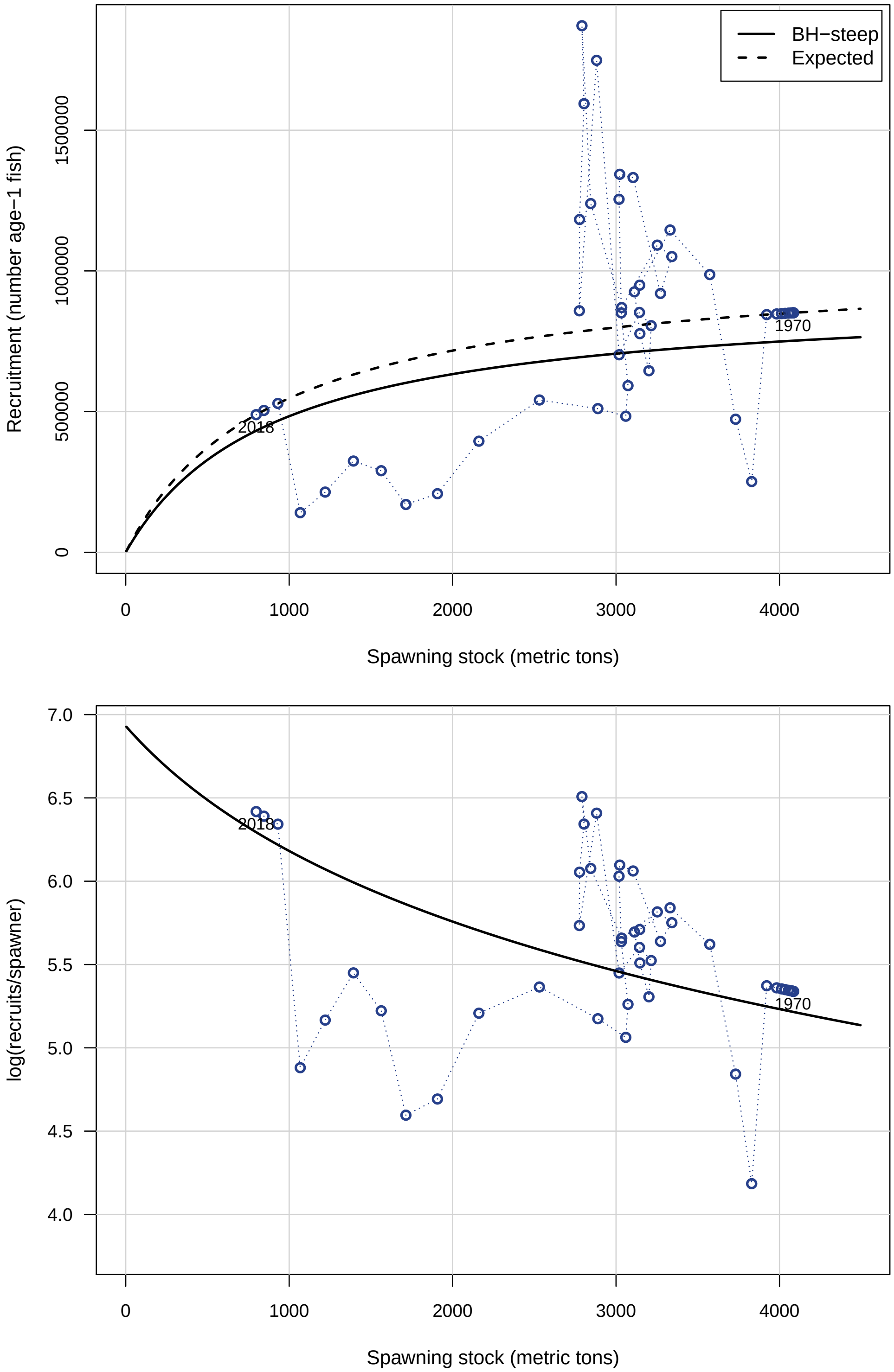


Figure 29. Probability densities of spawner-recruit quantities R0 (unfished recruitment of age-1 fish), the SD of recruitment residuals, steepness, and unfished spawners per recruit. Vertical lines represent point estimates or values from the base run of the Beaufort Assessment Model.

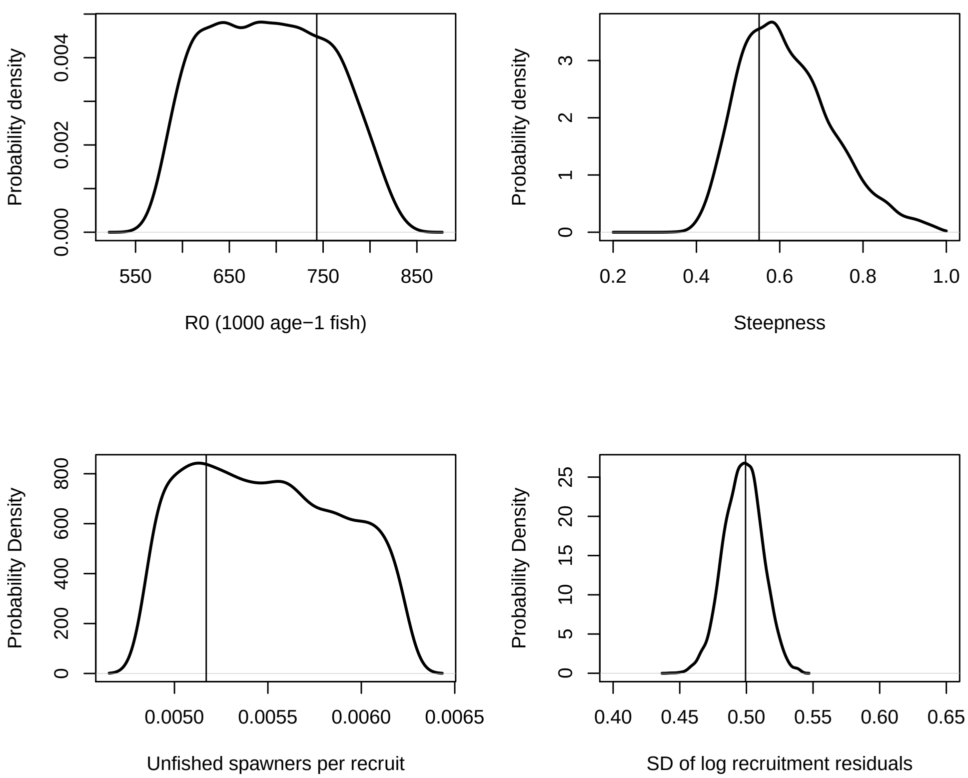


Figure 30. Top panel: yield per recruit (lb). Bottom panel: Spawning potential ratio (spawning biomass per recruit relative to that at the unfished level). Both curves are based on average selectivity from the end of the assessment period.

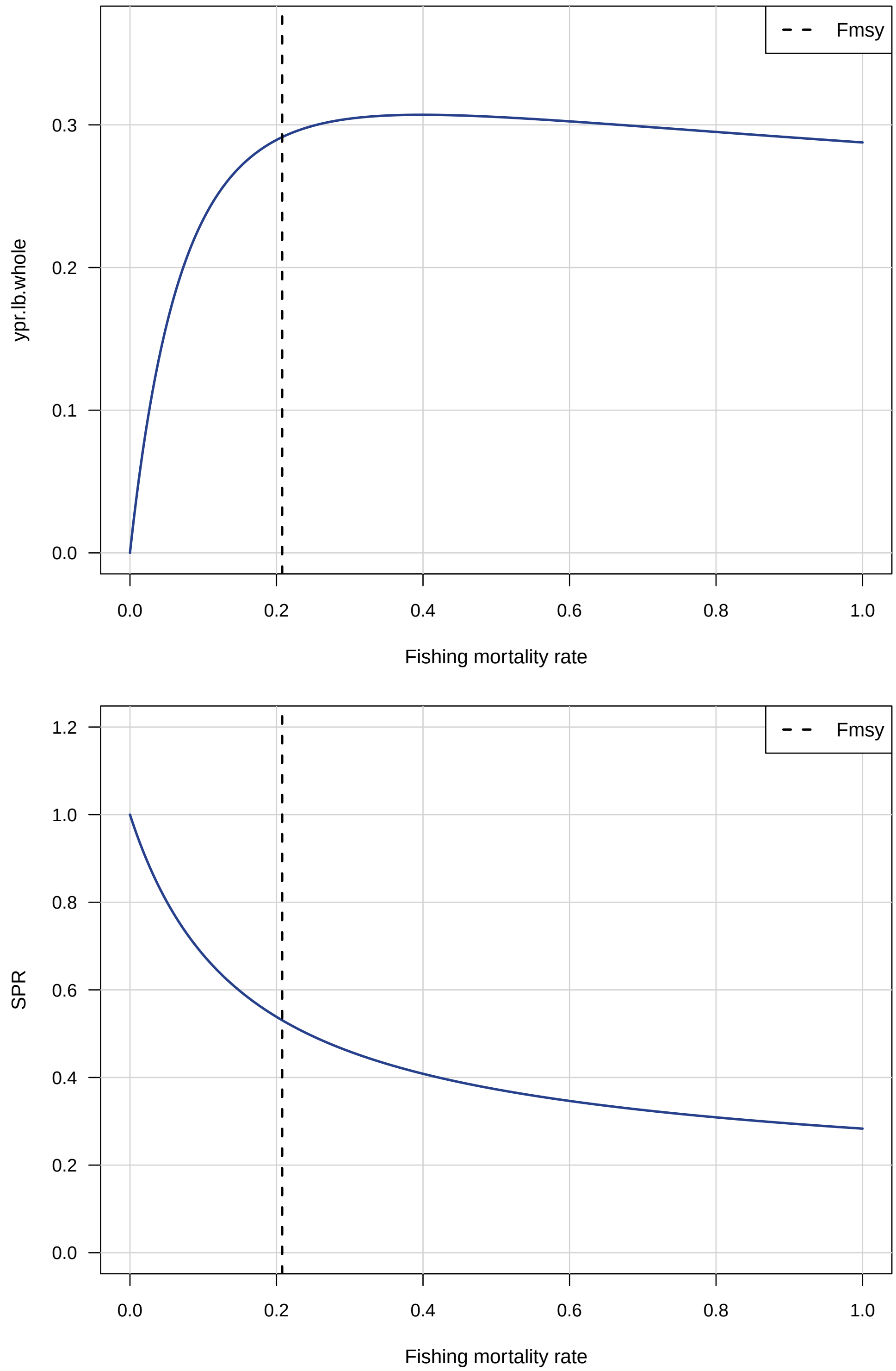


Figure 31. Equilibrium landings. The vertical line occurs where fishing rate is $F_{\mathrm{MSY}} = 0.21$ *and equilibrium landings are 207(1000 lb). Curve based on average selectivity from the end of the assessment period.*

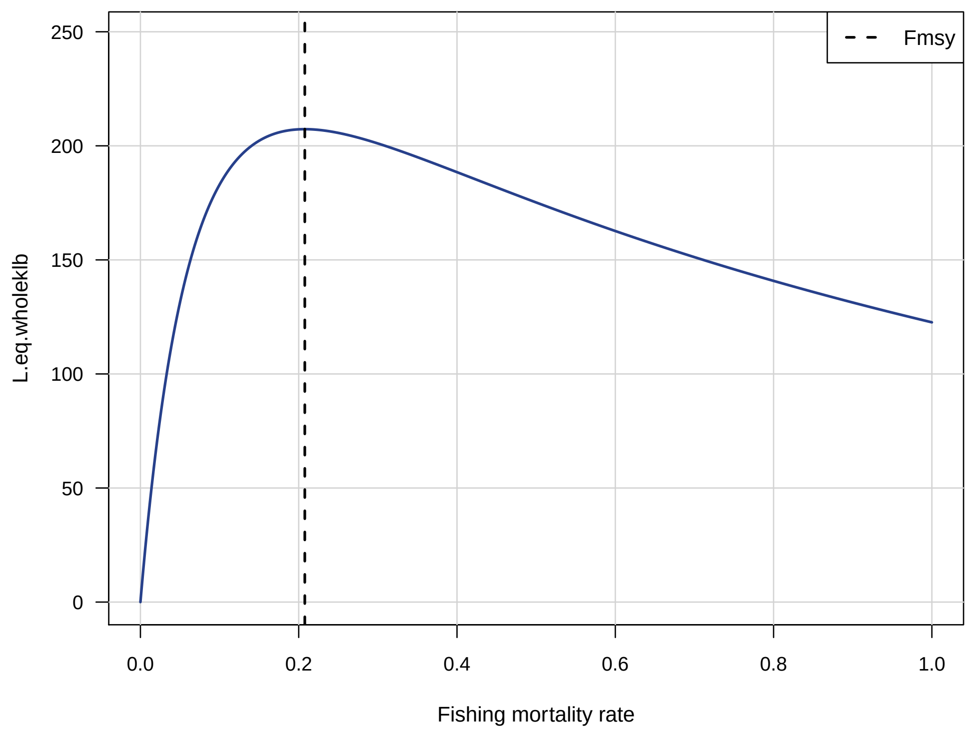


Figure 32. Equilibrium spawning biomass (mt). Curve based on average selectivity from the end of the assessment period.

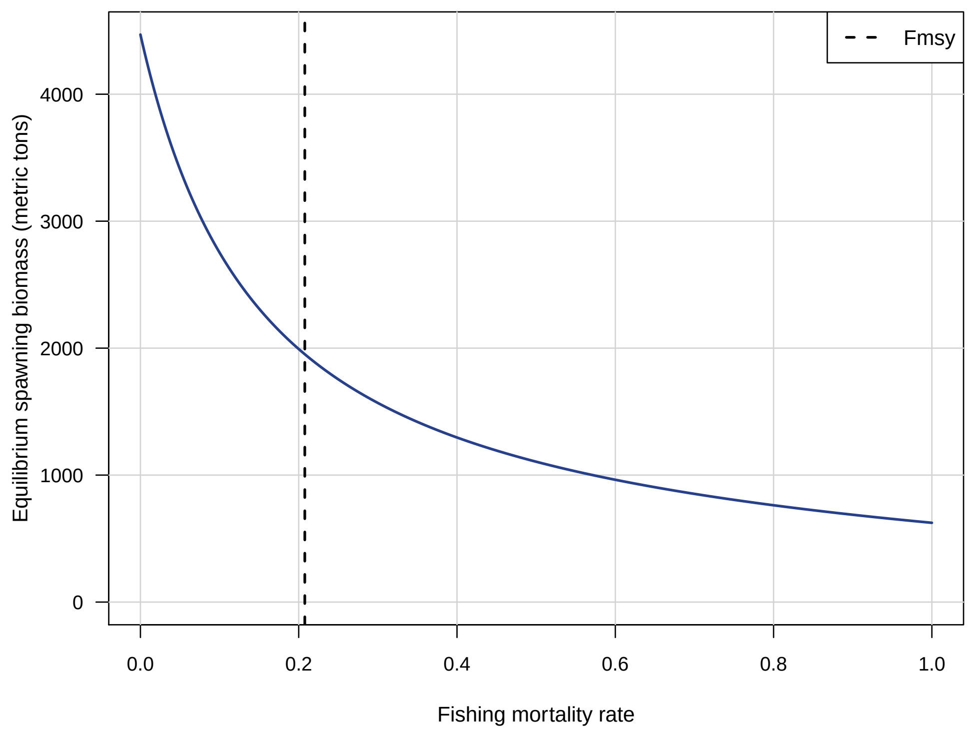


Figure 33. Probability densities of F_{MSY} benchmarks from the ensemble model of the Beaufort Assessment Model. Vertical lines represent point estimates from the base run.

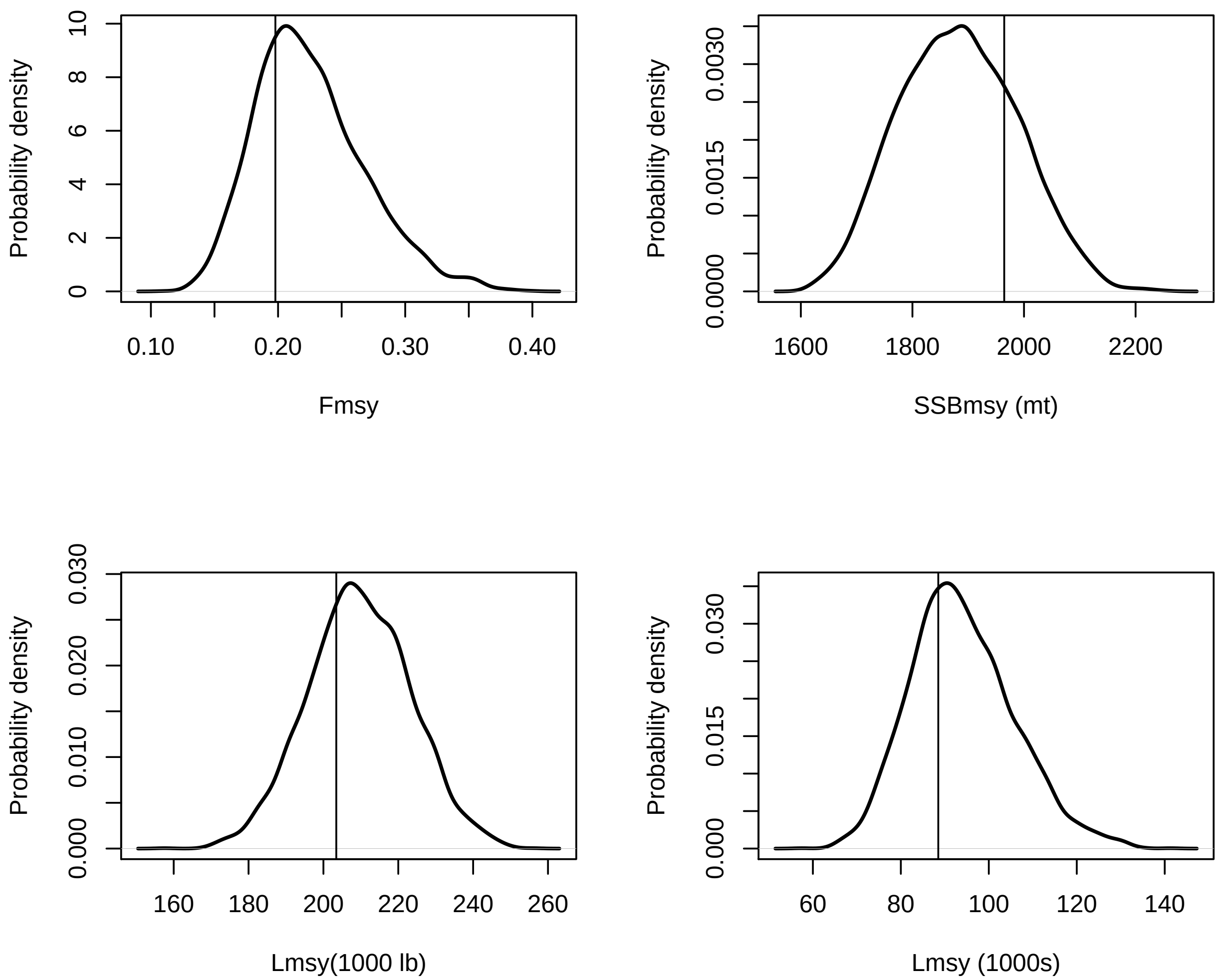


Figure 34. Estimated time series relative to benchmarks. Solid line indicates estimates from base run of the Beaufort Assessment Model; gray error bands indicate 5^{th} *and* 95^{th} *percentiles of the ensemble modeling. Top panel: spawning biomass relative to the minimum stock size threshold (*MSST*). Middle panel: spawning biomass relative to* $\mathrm{SSB}_{\mathrm{MSY}}$. *Bottom panel: F relative to* F_{MSY}.

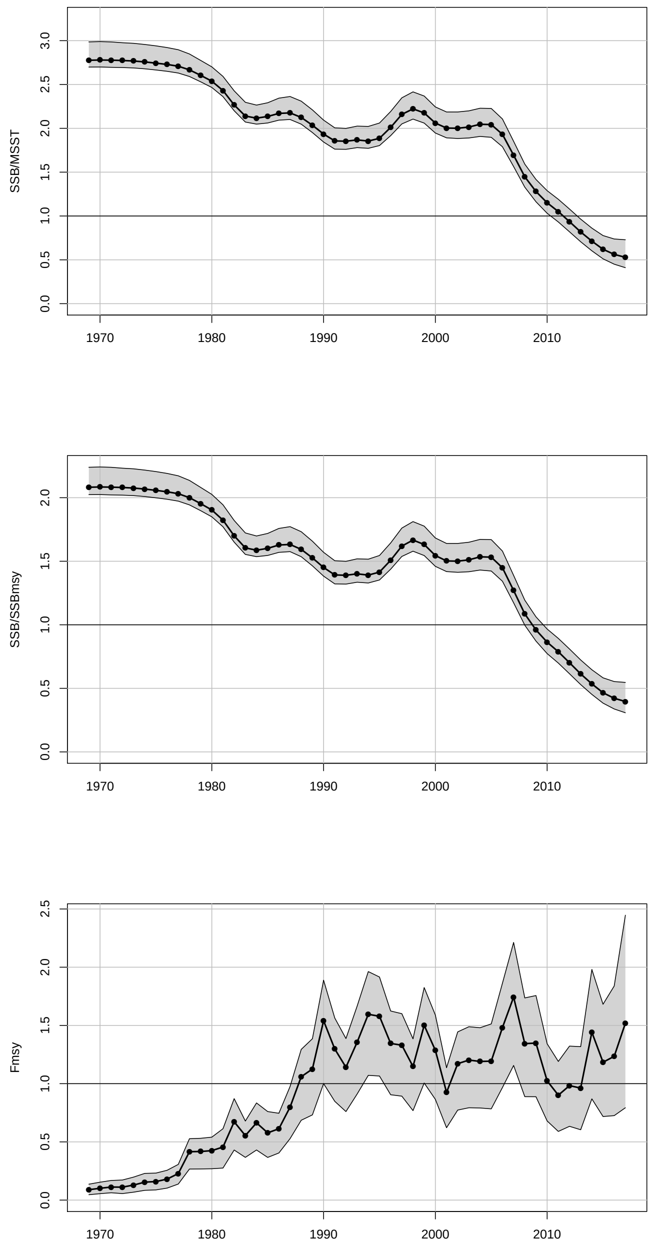


Figure 35. Probability densities of terminal status estimates from ensemble model of the Beaufort Assessment Model. Vertical lines represent point estimates from the base run.

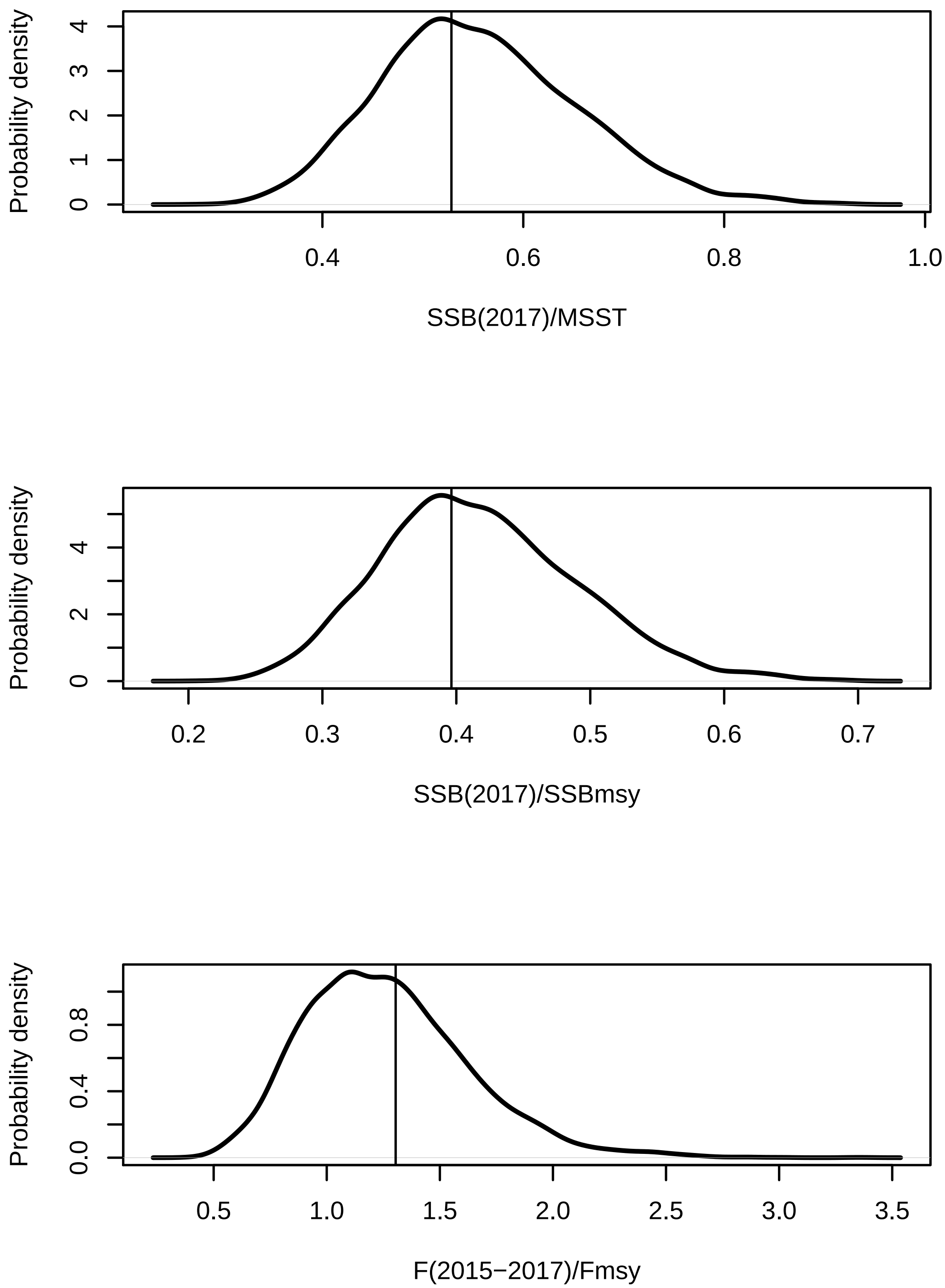
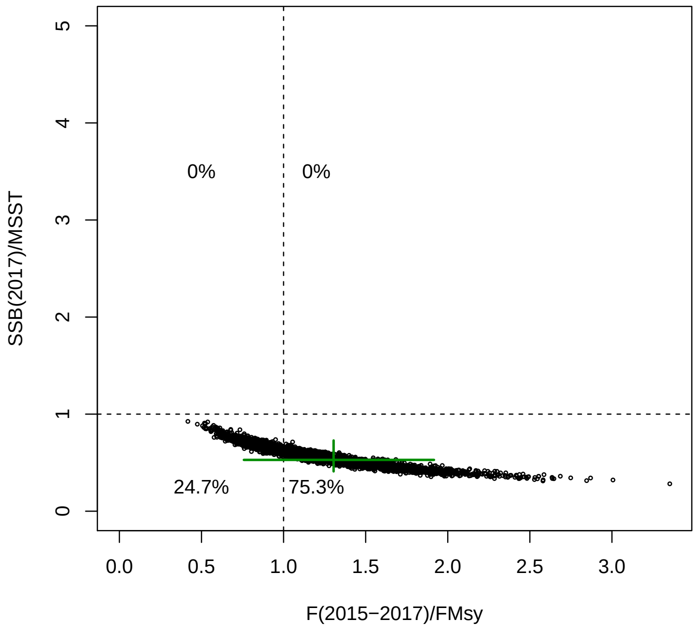


Figure 36. Phase plots of terminal status estimates from the ensemble model of the Beaufort Assessment Model. Top panel is status relative to MSST*, and the bottom panel is status relative to* $\mathrm{SSB_{MSY}}$*. The intersection of crosshairs indicates estimates from the base run; lengths of crosshairs defined by* 5^{th} *and* 95^{th} *percentiles.*



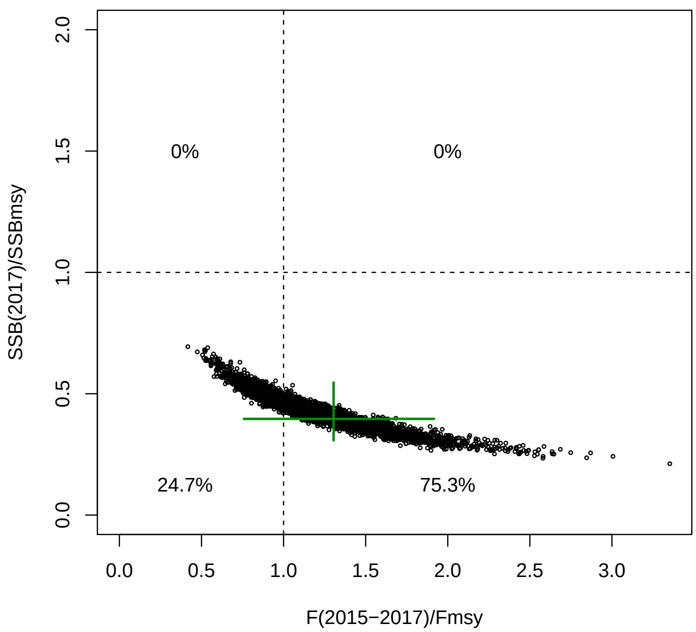


Figure 37. Age structure relative to the equilibrium expected at MSY*.*

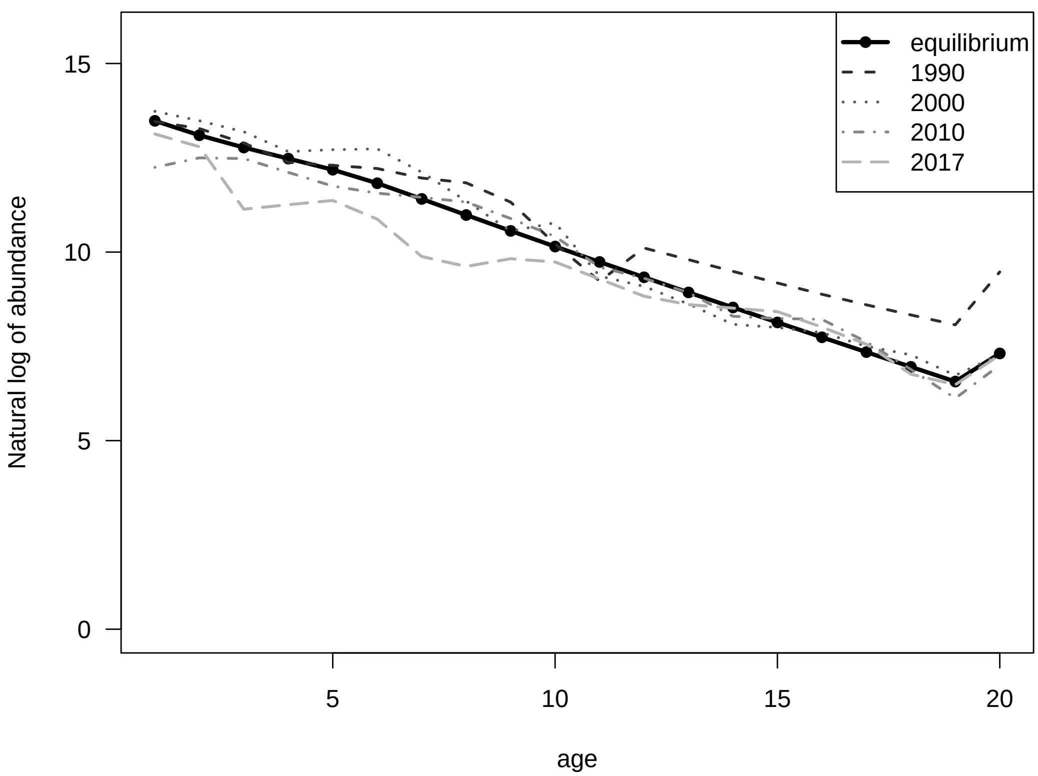


Figure 38. Sensitivity to recreational CVs fixed at 0.05 (sensitivity run S1). Top panel: Ratio of F to F_{MSY}. Bottom panel: Ratio of SSB *to* SSB_{MSY}.

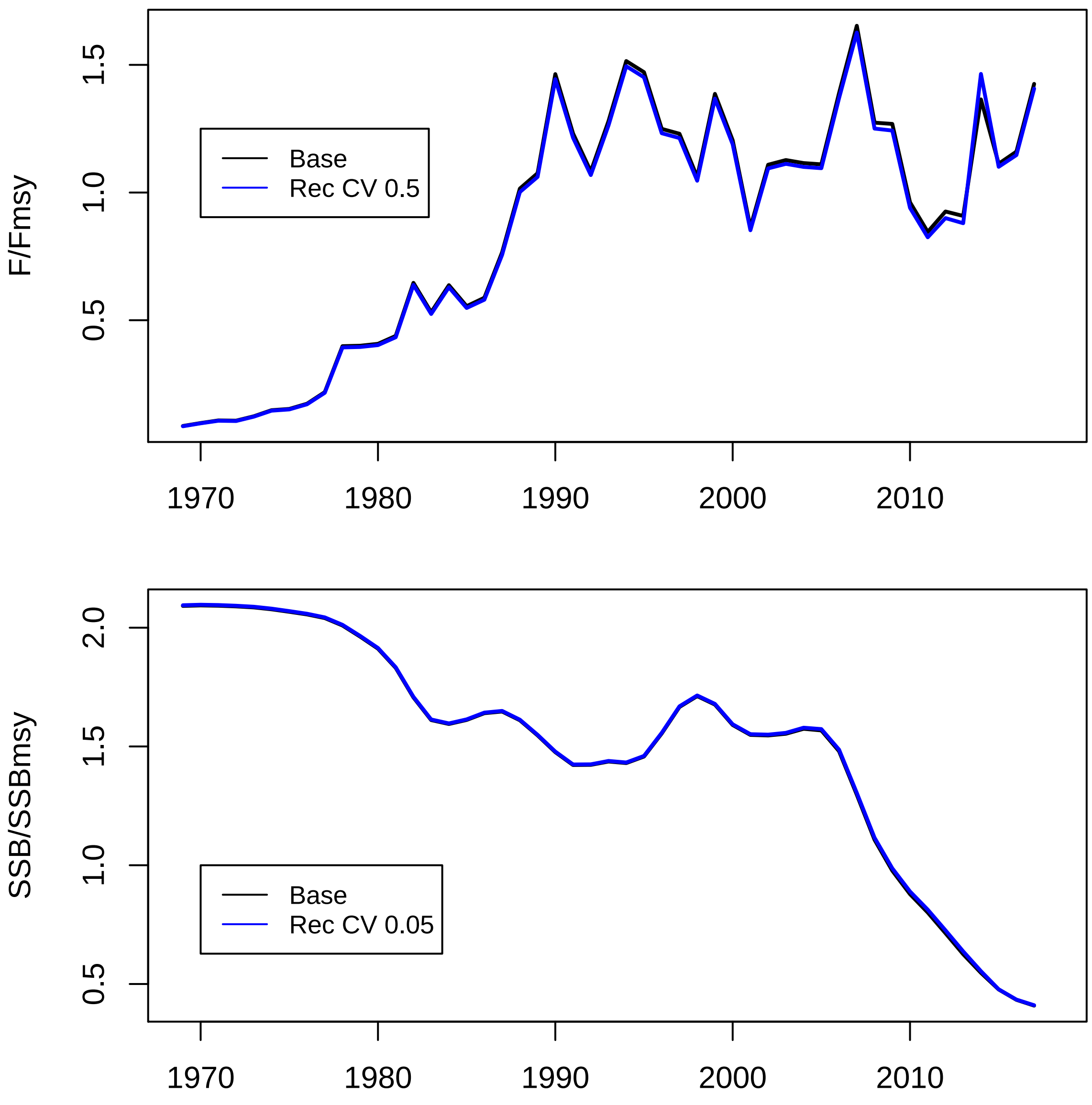


Figure 39. Sensitivity to a lower, upper, and base value for natural mortality (sensitivity runs S2 and S3). Top panel: Ratio of F to F_{MSY}. Bottom panel: Ratio of SSB *to* $\mathrm{SSB}_{\mathrm{MSY}}$.

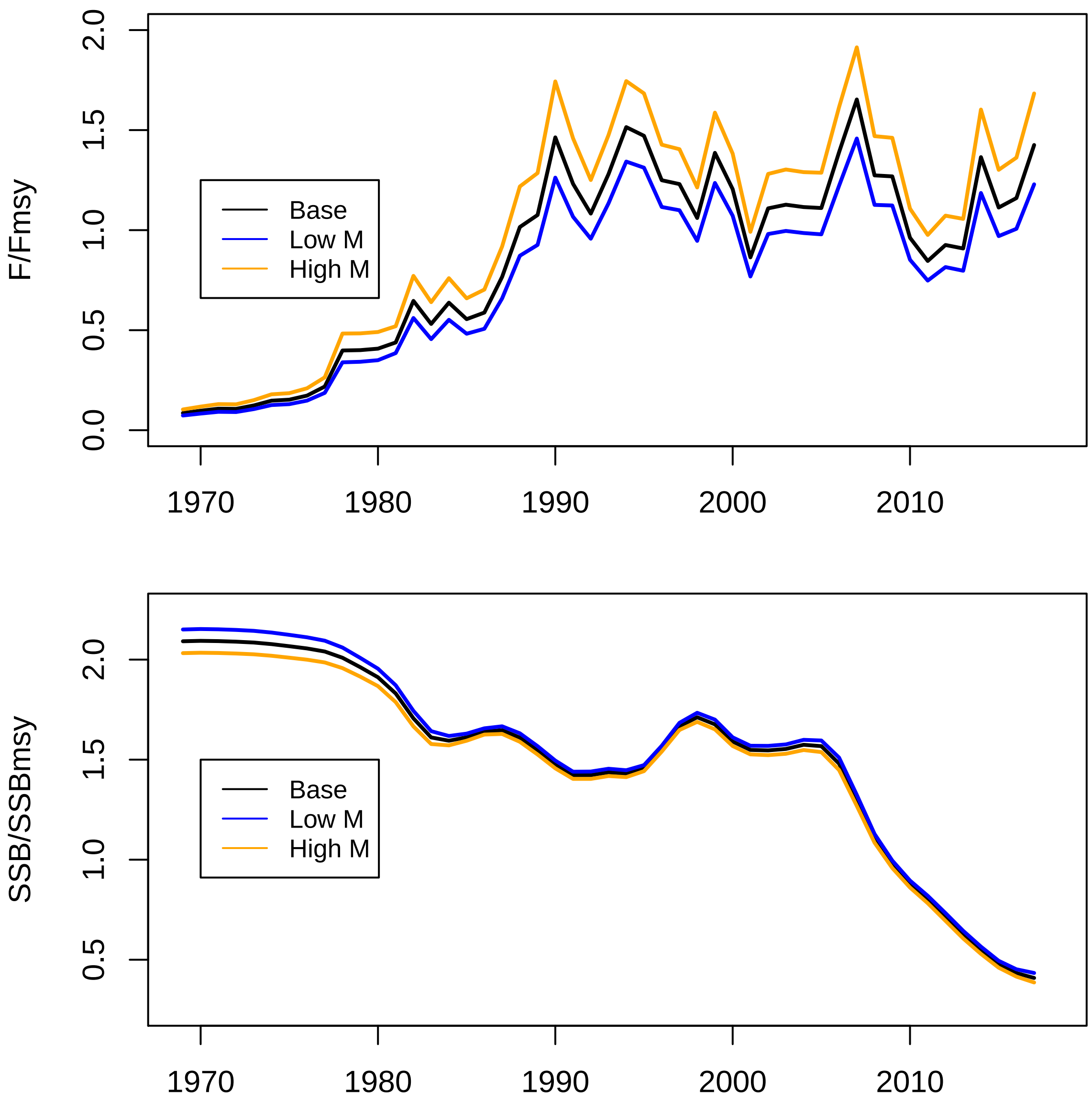


Figure 40. Sensitivity to proportion of males to population (sensitivity run S4, S5, and S6). Top panel: Ratio of F to F_{MSY}*. Bottom panel: Ratio of* SSB *to* $\mathrm{SSB}_{\mathrm{MSY}}$*.*

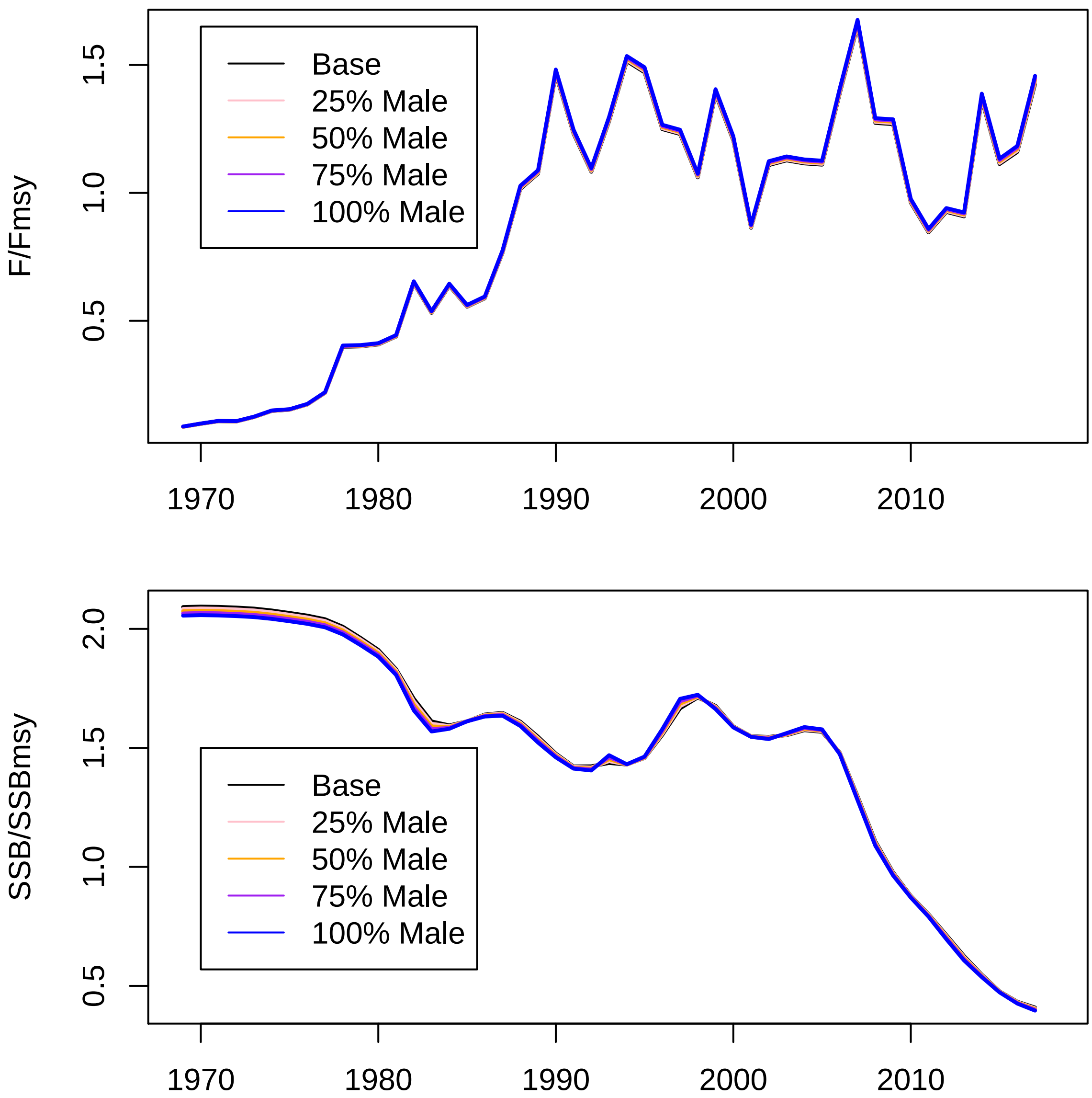


Figure 41. Sensitivity to including aging error matrix (sensitivity runs S8). Top panel: Ratio of F to F_{MSY}. Bottom panel: Ratio of SSB *to* $\mathrm{SSB}_{\mathrm{MSY}}$.

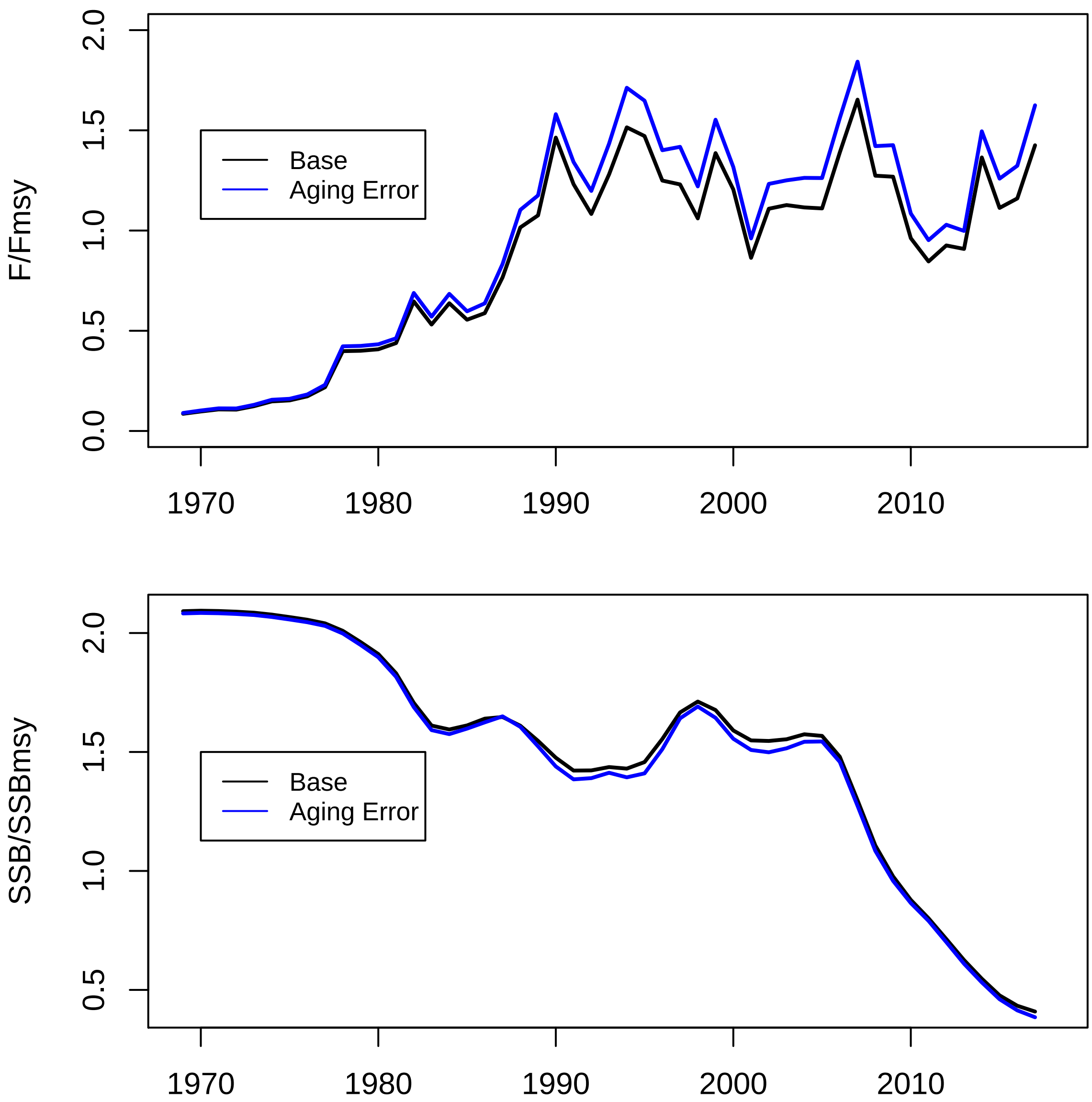


Figure 42. Sensitivity to placing a beta prior on steepness (sensitivity runs S9). Top panel: Ratio of F to F_{MSY}*. Bottom panel: Ratio of* SSB *to* $\mathrm{SSB}_{\mathrm{MSY}}$*.*

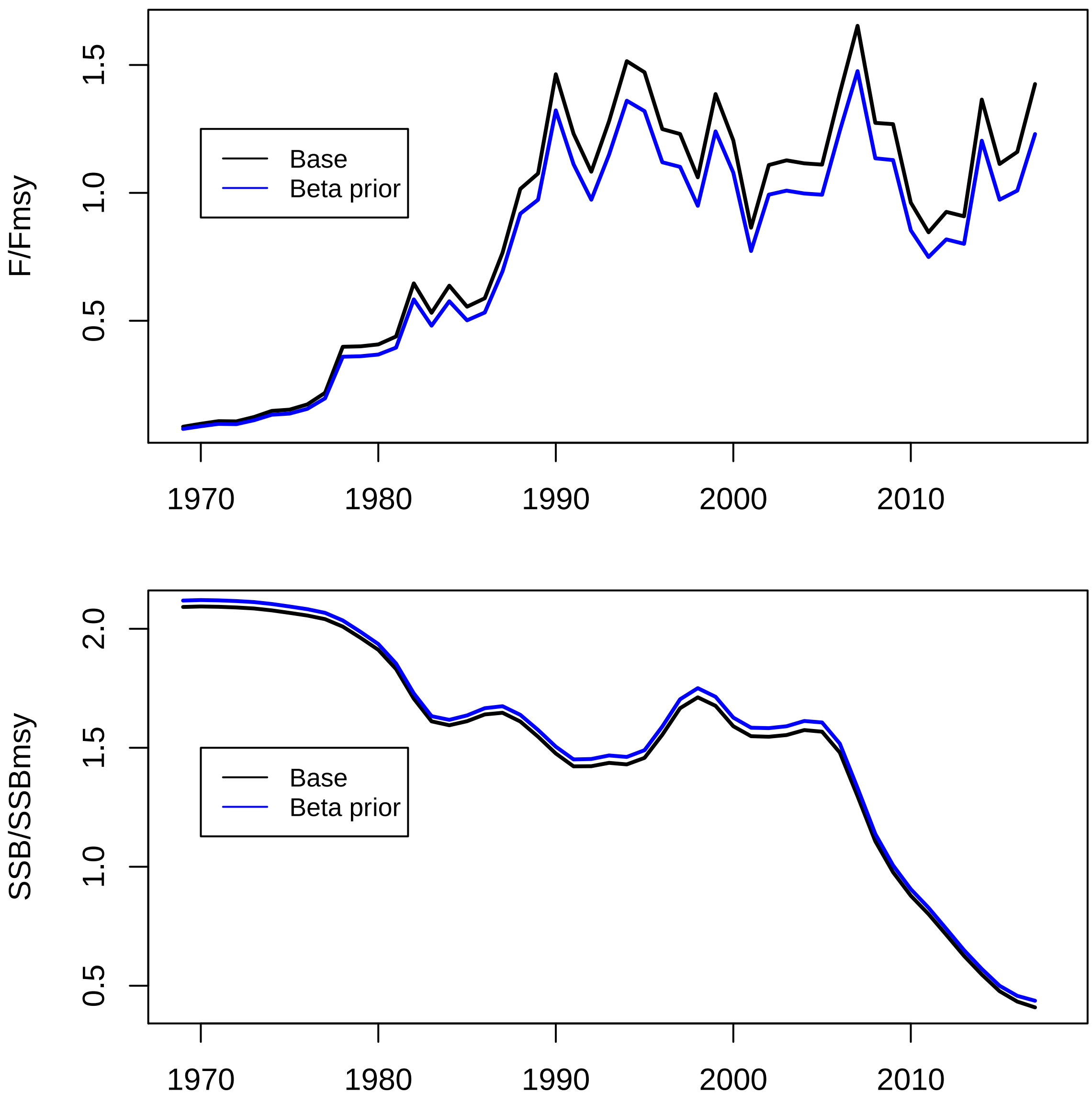


Figure 43. Sensitivity to natural mortality with beta prior on steepness (sensitivity runs S10 and S11). Top panel: Ratio of F to F_{MSY}. Bottom panel: Ratio of SSB *to* SSB_{MSY}.

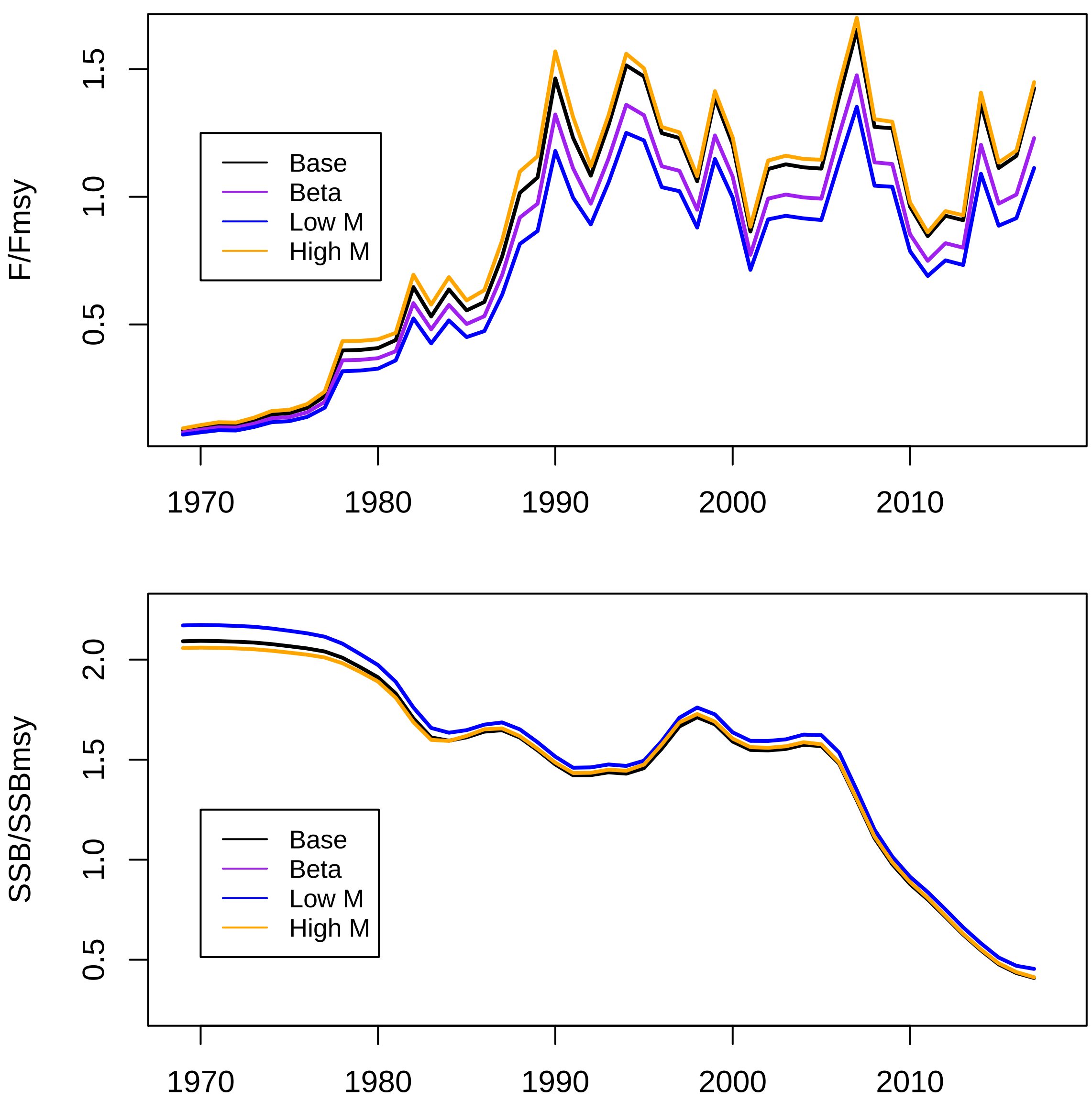
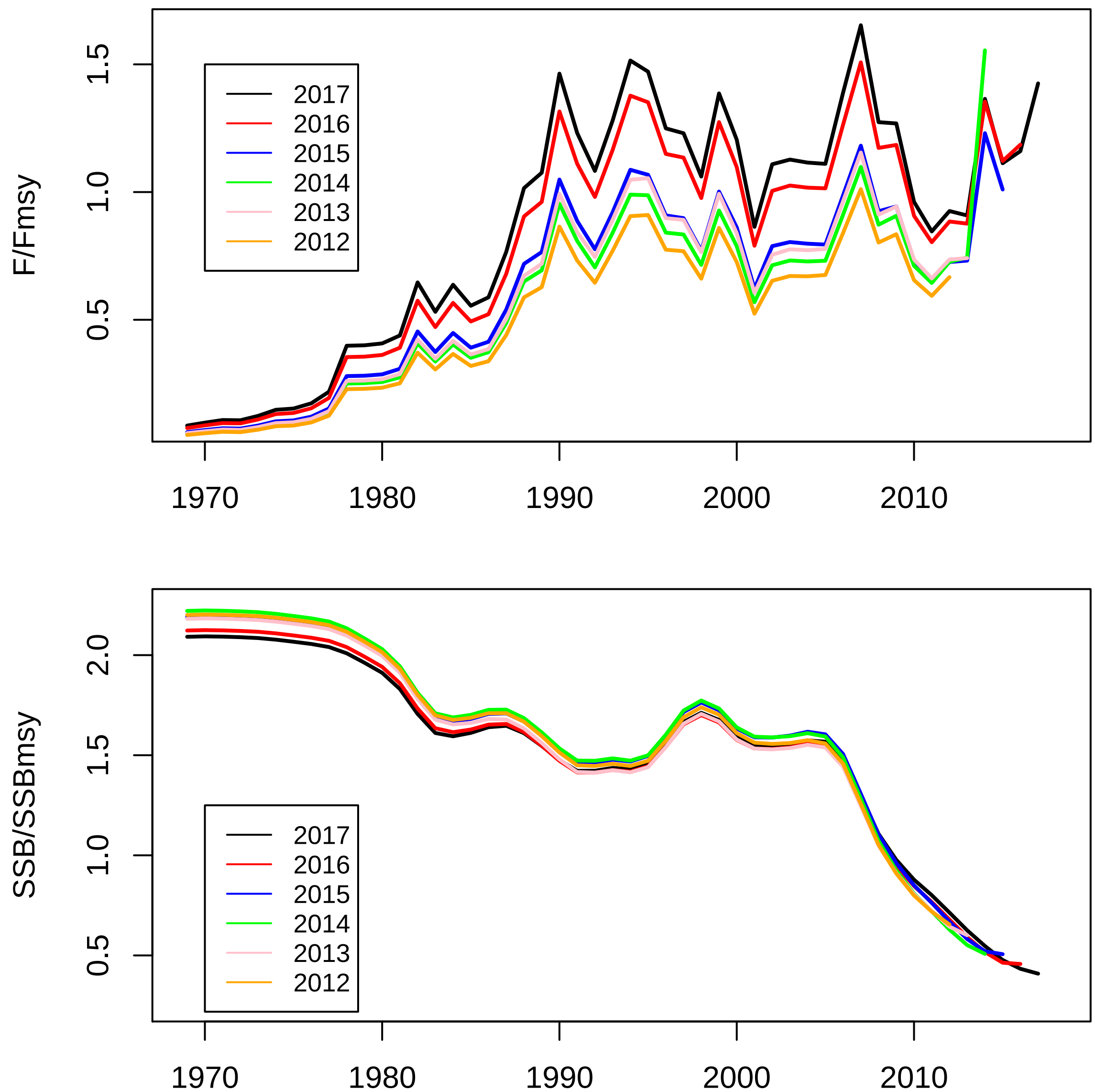


Figure 44. Retrospective analyses. Sensitivity to terminal year of data (sensitivity runs S12 a–e). Top panel: Recruits. Bottom panel: Spawning biomass. Closed circles show terminal-year estimates. Imperceptible lines overlap results of the base run.



Appendix A Abbreviations and symbols

Table 20. Acronyms and abbreviations used in this report

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

Appendix B Parameter estimates from the Beaufort Assessment Model

```
# Number of parameters = 223  Objective function value = 21541.7  Maximum gradient component = 0.000351907
# Linf:
787.360000000
# K:
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# t0:
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# len_cv_val:
0.0970244475657
# Linf_L:
919.060000000
# K_L:
0.0760000000000
# t0_L:
-0.660000000000
# len_cv_val_L:
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# log_Nage_dev:
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 0.00000000000 0.00000000000 0.00000000000 0.00000000000 0.00000000000 0.00000000000
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# steep:
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# rec_sigma:
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# R_autocorr:
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# log_rec_dev:
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  0.213748611800 0.534298246439 0.830464964295 0.991816112845 0.575031708870 0.206087079523 0.417727491515 0.374047225096 0.245190664283 0.626761328457 0.641486054004 0.573418766316
  0.184085309929 -0.181355356338 -0.383032785169 -0.315328370839 -0.224176200670 -0.495877424962 -1.09744963811 -1.26590742273 -0.698645980501 -0.543020660329 -0.904923486908 -1.26546618119
# log_dm_COM_lc:
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# log_dm_COM_D_lc:
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# log_dm_REC_lc:
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# log_dm_REC_D_lc:
-0.358954768672
# log_dm_CVT_lc:
2.08736683533
# log_dm_COM_ac:
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# log_dm_REC_ac:
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# log_dm_CVT_ac:
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# selpar_A50_COM1:
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# selpar_slope_COM1:
1.73296182869
# selpar_A50_COM3:
4.95413697337
# selpar_slope_COM3:
1.95074072245
# selpar_A50_REC1:
5.69088942567
# selpar_slope_REC1:
1.80512300323
# selpar_A50_REC3:
4.67677672675
# selpar_slope_REC3:
1.78426534012
# selpar_A50_D:
1.71885579527
# selpar_slope_D:
1.47111730199
# selpar_A502_D:
1.53143222075
# selpar_slope2_D:
1.04065745361
# selpar_A50_CVT:
3.12590936479
# selpar_slope_CVT:
2.05003772025
# log_q_COM:
-7.22286465651
# log_q_REC:
-13.4266629669
# log_q_CVT:
-13.9081081451
# q_RW_log_dev_COM:
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 0.00000000000 0.00000000000 0.00000000000 0.00000000000
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  -0.439804142103 -0.439463021552 -0.435551834139 0.0543745814403 -0.0469099733823 -0.00670388370829 -0.182868266142 0.00172788921312 0.253166458051
  0.407205425118 0.513149148752 0.791897376732 0.636031095387 0.596483963335 0.776479495265 0.877072674308 1.02747809996 0.841133779955 0.830351331772
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# log_F_dev_REC:
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# log_F_dev_REC_D:
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SEDAR

Southeast Data, Assessment, and Review

SEDAR 68

Atlantic Scamp

SECTION IV: Research Recommendations

SEDAR
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1. DATA WORKSHOP RESEARCH RECOMMENDATIONS

1.1 LIFE HISTORY RESEARCH RECOMMENDATIONS

Natural Mortality

- Convene a topical workgroup or other workshop to critically review literature used in Then et al. (2015), discuss recent advancements in ageing approaches (e.g., Gray Triggerfish), and propose best options for selecting species for inclusion in regression analyses for reef fish species in the US Southeast Region to be used in estimating natural mortality.
- Research the Thorson FishLife program for use in natural mortality estimates and measures of uncertainty. https://github.com/James-Thorson-NOAA/FishLife

Reproductive Biology

- Investigate the male contribution to spawning success and the potential for sperm limitation in the population through model simulations and field research that will fill in critical gaps in knowledge (i.e., fertilization rate under various sex ratio scenarios, mating strategy) and continue to monitor sex ratio.
- Additional sampling with better spatial and especially temporal coverage to confirm preliminary results that male gonadosomatic index (GSI) indicates that Scamp are spawning in pairs or small groups. This information is lacking for Yellowmouth Grouper.

- Collect all sizes of Yellowmouth Grouper and larger female Scamp (> 650 mm FL) during the spawning season to assess batch fecundity and thereby fill a data gap that prevents estimating total egg production.
- Given the likely smaller population size of Yellowmouth Grouper, samples with a wide range of size/age, from fishery-dependent and fishery-independent sources, are needed to determine reproductive parameters for this species and to allow comparisons with those of Scamp.

1.2 COMMERCIAL FISHERY STATISTICS RESEARCH RECOMMENDATIONS

- **Recommendation for the use of EM to facilitate the improvement of discard accounting in the South Atlantic**
    - The Center for Electronic Monitoring at Mote (CFEMM) has been applying Electronic Monitoring (EM) in the Gulf of Mexico (GoM) using Saltwater Inc. (SWI) software since 2016. EM is a valuable monitoring tool for researchers to directly observe and permanently document location, identify bycatch hotspots, catch, effort, and discard data to reduce uncertainty in critical finfish and shark fishery data for use by industry and management.
    - In the absence of a robust reef fish observer program in the South Atlantic, the commercial workgroup recognizes EM as a tool to improve discard accounting in the region. Additionally, the COVID-19 pandemic has hampered interactions between the fishing industry and state/federal fisheries data collections. The workgroup recognizes the potential for work pioneered by the CFEMM to advance biological sampling needs without human observers.
    - Continue to explore additional methods, such as citizen science (e.g. SAFMC Scamp Release), to help supplement information to characterize discard size composition
- **Recommendation for South Atlantic and Gulf of Mexico unified methodology in preparation of commercial landings**
    - The SEDAR 68 commercial workgroup has recognized that there are significant differences in the South Atlantic and Gulf of Mexico in the approach to the preparation of commercial landings. These differences were identified specifically in discussions of proportioning, validation, and data provision formats.

  - In order to resolve the issue, the workgroup recommends that SEDAR staff convene and facilitate a joint-regional workshop for commercial workgroup members from both regions in order to follow-up on and confirm the best practices in Procedural Workshop 7.
  - Previous workgroup leaders should be consulted in establishing the TORs for the workshop.
  - The workshop should review past decisions made for various species and summarize best practices, which could greatly simplify the content needed within stock assessment reports (e.g., focus text on details specific to the species being assessed)
- **Recommendation for Expanding Reef Fish Observer Program Coverage to the South Atlantic**
  - Programmatic funding should be allocated to expand existing observer temporal and spatial coverage in the South Atlantic reef fish fishery. Observer coverage should be sufficient to provide for statistically rigorous discard estimation methods and to provide adequate discard size composition data for use in stock assessments.

1.3 RECREATIONAL FISHERY STATISTICS RESEARCH RECOMMENDATIONS

- Increase sampling of the recreational fishing fleet, particularly the charter boat and private angler sector, to improve discard data collection. Discard length data and discard mortality are two areas of importance that should be included.
- Continue to develop methods to provide uncertainty estimates around landings and discard estimates
- Investigate the implications of the MRIP imputed lengths and weighting factors for a range of data-rich to data-limited species, where the length frequency distributions become erratic

1.4 MEASURES OF POPULTAION ABUNDANCE RESEARCH RECOMMENDATIONS

No recommendations were provided.

2. ASSESSMENT PROCESS RESEARCH RECOMMENDATIONS

- Develop methods to characterize length and age composition of scamp observed on videos from the SERFS fishery-independent survey.
- Implement a systematic age sampling program for both the recreational and commercial sectors.
- Better characterize reproductive parameters including age at maturity, batch fecundity, spawning seasonality, and spawning frequency. Mature male and female biomass was the measure of reproductive potential for scamp in the assessment, but may be biased if reproductive parameters vary significantly with size or age.
- Age-dependent natural mortality was estimated by indirect methods for this assessment of scamp. Mark-recapture approaches (conventional, telemetry, or close-kin) might make it possible to obtain direct estimates of natural mortality of scamp.
- Better characterize the movement dynamics of the stock and the potential for distribution shifts.

3. REVIEW PANEL RESEARCH RECOMMENDATIONS

The Review Panel supports the research recommendations identified by the Data and Assessment stages for the Gulf of Mexico and South Atlantic assessment processes.

In particular, the Review Panel supported:

- The recommendations to develop artificial intelligence approaches as well as additional automation for image processing and for reading and analysis of video, otoliths, gonad sections and other samples that contribute to scamp stock assessments.

The Review Panel further recommended the following short-term and long-term research needs.

<u>(Short-term, within 6 months)</u>

- Fleet-specific plots of the spatial distribution of the fisheries in both the Gulf and S. Atlantic could help interpret changes in length and age composition over time.
- Dockside sampling was not always randomly structured and in the past, sampling was opportunistic. Investigate modeling issues that may have occurred as a consequence of this.

- For the Gulf, investigate the apparent conflict between the von Bertalanffy model parameters estimated by the model and those provided by the Life History Working Group.
- Further investigation of size and age composition data in the South Atlantic is desirable. Consider "borrowing" length and age composition samples from the Gulf to address poorly sampled strata in the South Atlantic. This assumes that during the historical period, fishery regulations by fleet may have been comparable between the two management units.

(Longer-term)

- Conclude investigation of the taxonomic status of yellowmouth grouper. It has been deemed historically to be a separate species. There is a need to develop a time series of the proportion of yellowmouth grouper over time, perhaps by sampling the catch in the fishery independent series (chevron traps).
- Further investigate changes in reporting of recreational landings from all data sources and how the changes contribute to imprecision in the series.
- Consider the possibility that the ROV data collected by Lewis et al. (2020) could provide another fishery-independent abundance index in the Gulf (see SEDAR 68 RD44: Changes in Reef Fish Community Structure Following the Deepwater Horizon Oil Spill for a copy of their paper.
- More age samples required for all fleets.
- More effort should be given to formally evaluate and incorporate ecosystem considerations.
- Hold a Best Practices Workshop to address how best to use weights or numbers for recreational harvest in assessment models. This is a much more complex issue than can be resolved in an assessment process.

- **If applicable, provide recommendations for improvement or for addressing any inadequacies identified in the data or assessment modeling. These recommendations should be described in sufficient detail for application, and should be practical for short-term implementation (e.g., achievable within ~6**

months). Longer-term recommendations should instead be listed as research recommendations above.

Additionally, the Review Panel recommends the following:

- The assessment reports could be strengthened by the inclusion of descriptions of the biology and the fishery that are important for the assessment, including information on how management of other species may have affected the fishery in question. For example, in the current case, it was not clear until a late stage of the document that scamp are not directly targeted in the fisheries.
- Move towards a model ensemble of different plausible configurations selected by hypothesis testing and weighed by a comprehensive diagnostic against performance criteria agreed beforehand which is developed to provide stocks status and management advice for both stocks. As best practice, and as a minimum, the ensemble should integrate the three main sources of uncertainty (process uncertainty, parameter uncertainty, and observation error) in the data.
- In these assessments *a priori* assumptions were made about the shape of the selection curve which, while reasonable, there does not seem to be any direct evidence for these fleets that the shape chosen is the right one.
- Currently the Beaufort Assessment Model does not support an option to model discards with a retention function and appears to require this catch category to be modelled as a separate fleet. This does not reflect the way the observations are collected and the model needs to be enhanced to allow discards to be modelled with a separate retention function for the fleet concerned. In addition, having the option in the Beaufort Assessment Model to model selectivity by length would be desirable in the future.
- In order to overcome the problem of changes of scale seen in the Gulf retrospectives a more robust way of expressing F and biomass over time would be to use ratio estimators such as B/B_{MSY} and F/F_{MSY}.

5. Provide recommendations on possible ways to improve the Research Track Assessment process.

- Recognizing that the Research Track process is new, further background on regarding how it differs from other past and present SEDAR assessments would have been helpful.
- Having the involvement of the Chair of Data Working Group could increase the efficiency of this stage of the review.
- We appreciate the inclusion of some ecosystem considerations in the Gulf assessment where red tide and the 2010 Deep Water Horizon oil spill could have important consequences for fisheries; however more effort should be given to formally evaluate and incorporate ecosystem considerations throughout the assessment process.
- Make assessment data and models fully available to panelist. Removing certain data due to confidentiality hinder the work of the reviewers and negatively affects its quality.

SEDAR

Southeast Data, Assessment, and Review

SEDAR 68

Atlantic Scamp

SECTION V: Review Workshop Report

September 2021

SEDAR
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Table of Contents

1. INTRODUCTION

1.1 WORKSHOP TIME AND PLACE

The SEDAR 68 Review Workshop was held via webinar August 30 – September 3, 2021.

1.2 TERMS OF REFERENCE

1. Evaluate the data used in the assessment, including discussion of the strengths and weaknesses of data sources and decisions. Consider the following:

    - Are data decisions made by the DW and AW justified?
    - Are data uncertainties acknowledged, reported, and within normal or expected levels?
    - Is the appropriate model applied properly to the available data?
    - Are input data series sufficient to support the assessment approach?

2. Evaluate and discuss the strengths and weaknesses of the methods used to assess the stock, taking into account the available data. Consider the following:

    - Are methods scientifically sound and robust?
    - Are priority modeling issues clearly stated and addressed?
    - Are the methods appropriate for the available data?
    - Are assessment models configured properly and used in a manner consistent with standard practices?

3. 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.

- Comment on the likely relationship of this variability with possible ecosystem or climate factors and possible mechanisms for encompassing this into management reference points.

4. Provide, or comment on, recommendations to improve the assessment

- Consider the research recommendations provided by the Data and Assessment workshops in the context of overall improvement to the assessment, and make any additional research recommendations warranted.
- If applicable, provide recommendations for improvement or for addressing any inadequacies identified in the data or assessment modeling. These recommendations should be described in sufficient detail for application, and should be practical for short-term implementation (e.g., achievable within ~6 months). Longer-term recommendations should instead be listed as research recommendations above.

5. Provide recommendations on possible ways to improve the Research Track Assessment process.

6. Prepare a Review Workshop Summary Report describing the Panel's evaluation of the Research Track stock assessment and addressing each Term of Reference.

1.3 LIST OF PARTICIPANTS

Workshop Panel
Luiz Barbieri .... GMFMC SSC
Massimiliano Cardinale .... CIE
Robin Cook .... CIE
Doug Gregory (Chair) .... GMFMC SSC
Anne Lange .... SAFMC SSC
John Neilson .... CIE
George Sedberry .... SAFMC SSC

Analytic Team
Francesca Forrestal, Atlantic Lead Analyst .... NMFS Miami
Skyler Sagarese, Gulf of Mexico Lead Analyst .... NMFS Miami
Katie Siegfried .... NMFS Miami

Council Representation
Tim Griner .... SAFMC

Attendees
Wally Bubley .... SCDNR/MARMAP
Nancie Cummings .... NMFS Miami
LaTresse Denson .... NMFS Miami
Margaret Finch .... SCDNR
Dawn Glasgow .... SCDNR

Seward McLean .... NCDENR
Kyle Shertzer .... NMFS Beaufort
Matt Smith .... NMFS Miami
Michelle Willis.. SCDNR

Staff
Julie Neer .... SEDAR
Chip Collier.. SAFMC Staff
Judd Curtis .... SAFMC Staff
Ryan Rindone.. GMFMC Staff
Mike Schmidtke .... SAFMC Staff

1.4 LIST OF REVIEW WORKSHOP WORKING PAPERS AND DOCUMENTS

Documents Prepared for the Review Workshop		
Modeling of recreational landings in Gulf stock assessments	Gulf Branch – Sustainable Fisheries Division	10 August 2021

2. REVIEW PANEL REPORT

<u>Executive Summary</u>

The SEDAR 68 Scamp Review Workshop was held virtually during the week of August 30 – September 3, 2021. Based on input from the Stock ID Panel, the Gulf of Mexico and South Atlantic scamp stocks were assessed separately. The Gulf of Mexico assessment was conducted with the Stock Synthesis model and the South Atlantic assessment was conducted with the Beaufort Assessment Model.

Although scamp is an important component of the southeastern U.S. grouper fisheries, it is not a targeted species, like the more common, red, black, and gag groupers. Consequently, both assessments were considered data moderate assessments with concomitant issues that could not be fully resolved.

The assessments were thoroughly conducted by the assessment team with transparent acknowledgement of challenges, uncertainties, and any unresolved issues. The models used were appropriate for the available data and the results and diagnostics were not unexpected given the challenges presented by this being a data moderate assessment. For example, non-random retrospective patterns were present in both assessments.

The primary challenges to these assessments were with the estimation of selectivity and growth parameters. A part of the problem could have been the inclusion of yellowmouth grouper, however minor, in the overall scamp catch, as well as the possible misidentification of larger fish, like warsaw grouper, as scamp. Also, South Atlantic scamp were not aged in the earlier years of the assessment time period and conversion of lengths to weight with a growth curve may have caused the selectivity problem observed in the assessment. Improvements are also needed in the Gulf ageing samples which are likely to be resolved in time for the Operational Assessment.

Overall, the final models (i.e., after incorporating modifications recommended by the review workshop panel) for both the Gulf of Mexico and South Atlantic scamp appear to be robust relative to the trends in spawning stock biomass and fishing mortality. Numerous scenarios were conducted by the assessment team and the review workshop panel. While fits to age and length compositions were not ideal and retrospective patterns could not be resolved, it is deemed that these issues are the result of the data moderate nature of this initial assessment of scamp and that little to no further improvements could be made to these assessments at this time.

Prior to conducting the operational assessments, uncertainties in length and age composition over time need to be further investigated. It may also be useful to evaluate the effects of including yellowmouth grouper and the larger, possibly misidentified, outlier fish on model fits to age and length compositions. Longer term, greater integration of environmental factors and ecosystem considerations in assessment models will be needed to help address climate change effects. It would also be helpful to move towards an ensemble modeling approach to integrate the main sources of uncertainty.

Terms of Reference

1. **Evaluate the data used in the assessment, including discussion of the strengths and weaknesses of data sources and decisions. Consider the following:**

   - **Are data decisions made by the DW and AW justified?**

     The comments provided below apply to both the Gulf and South Atlantic scamp assessments unless specified otherwise. The decision on the stock structure/management boundary was supported by the absence of fish movements between management jurisdictions and seemed pragmatic for management purposes until more data is available. Similarly, the decision to combine scamp and yellowmouth grouper landings seemed justifiable given the difficulty in species identification and the relatively small fraction of scamp landings thought to be yellowmouth. Despite the paucity of biological samples available for both regions, decisions on life history parameters such as growth, maturity and natural mortality were supported by appropriate analyses. For landings and CPUE information, decisions on the start of landings time series were made appropriately with respect to the availability of species-specific data and considering the effects of significant management measures. Appropriate standardizations were used for fishery-dependent indices of abundance. Discard information was available for both the commercial and recreational fleets and used appropriately.

- **Are data uncertainties acknowledged, reported, and within normal or expected levels?**

  Yes, data uncertainties are acknowledged, reported and within expected levels for both the Gulf and South Atlantic assessments. However, it should be noted that for both regions scamp are considered data moderate, meaning that significant data limitations exist both in terms of data quality and quantity. For the Gulf, annual estimates of recreational landings and discards were fixed at a higher standard error relative to that of the annual commercial landings. For the South Atlantic, both recreational and commercial landings were assigned annual coefficient of variations (CVs). For the Gulf, the lead analyst noted concerns about ageing error, especially for older fish. Concerns about age data from 2003-2012 led to the use of otolith weight as a proxy for age. Otoliths from that sample set will be reread and the data included in the upcoming operational assessment. There were relatively few length composition samples available in the earliest trimester of the South Atlantic assessment. The impact of aggregating yellowmouth and scamp, while thought to be slight, should be investigated further (see Research Recommendations below).

  Some high CVs are associated with the annual mean weights for the charter/private and headboat sectors. Uncertainty in conversion of recreational landings from number to weight is considered an issue since allocations are based on weight. Very high CVs also were associated with some derived values, being substantially higher than the CVs of the input values.

- **Is the appropriate model applied properly to the available data?**

  Yes, Stock Synthesis (SS) in the Gulf and the Beaufort Assessment Model (BAM) are standard models used in SEDAR assessments. Both models were appropriate for the respective data sets available to the analysts. Key advantages of these models include flexibility in estimation of time-varying selectivity, and, to the extent possible, accounting for imprecision of input data. These attributes are particularly important when developing a reliable operational assessment for management advice.

- **Are input data series sufficient to support the assessment approach?**

  As mentioned above, Gulf and South Atlantic scamp are considered to be data-moderate stocks; however, the data series were sufficient to support the approach for both the Gulf and South Atlantic assessments. A number of data limitations and uncertainties were identified and improvements are needed, as recognized by the assessment team (see following list) and some are discussed in more detail under Research Recommendations.

Identified concerns include the following items.

- Improvements needed in age data, including more ages and rereading of some Gulf 2003-2012 otoliths which were determined to have errors in some age assignments.
- Changes in the Marine Recreational Information Program (MRIP) survey methods and pooling of a number of other recreational fisheries surveys contributed to imprecision in the series.
- Dockside sampling was not always randomly structured and in the past, some sampling was opportunistic. This is thought to have contributed to modeling issues, such as requiring conditional age-at-length data to be replaced with nominal commercial age compositions.
- Knowledge of the proportion of yellowmouth grouper over time was assumed to be small and non-varying over time.

2. Evaluate and discuss the strengths and weaknesses of the methods used to assess the stock, taking into account the available data. Consider the following:

- **Are methods scientifically sound and robust?**

  Yes, the analysts' treatment of data sets used in the Gulf and South Atlantic assessments, the methods used to configure those data, and the application of the respective models was scientifically sound and robust.

- **Are priority modeling issues clearly stated and addressed?**

  Yes, the analyses team did a good job explaining the issues. There are some modeling issues which require further investigation before the operational assessment.

- **Are the methods appropriate for the available data?**

  Yes. There are relatively reliable landings, length and age compositions, and abundance indices. The methods used for each assessment were appropriate for the available data.

- **Are assessment models configured properly and used in a manner consistent with standard practices?**

  Yes, the models for the Gulf and South Atlantic scamp, based on Stock Synthesis and the Beaufort Assessment Model, respectively, were configured properly and in a manner consistent with standard practices.

3. 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.**

Both assessments used a set of standard approaches to investigating uncertainty. These include examination of residual plots, likelihood profiles, sensitivity runs, retrospective analyses, and jitter analyses. In addition, for the Atlantic assessment, an ensemble modelling approach (Monte Carlo Bootstrap Ensemble) was undertaken. The panel thought this was an important step forward in quantifying uncertainty. It considers uncertainty in the catch and abundance indices as well as a number of constants used in the model such as natural mortality and discard survival and provides a more comprehensive insight into the overall uncertainty in the assessment. Nevertheless, the model diagnostic toolbox should be expanded to include, at a minimum, test runs of the residuals, retrospective and forecast Mohn´s rho, hindcasting, and MCMC. Furthermore, a model ensemble needs to be developed that integrates the three main sources of uncertainty (process uncertainty, parameter uncertainty, and observation error). The challenge with this approach is to identify a manageable range of models to simulate that adequately consider plausible differences in population dynamics and fleet behavior.

The panel requested a number of runs of the assessments to examine specific issues.

<u>For the Gulf scamp assessment requested runs included:</u>

- Replacing the conditional age-at-length data with nominal commercial age compositions. Conditional age-at-length assumes each age observation is random but the analyst found, through the Trip Interview Program, that at least some samples were not random.
- Removing all the Reef Fish Observer Program (RFOP) index data as this survey appeared to show a conflicting trend compared with all other indices.
- Including only the Video and RFOP indices/compositions to illustrate the impact of the RFOP in the absence of the other fishery dependent indices. The video survey is regarded as the preferred fishery independent index so was retained.
- Creating a length plus group bin at 84 or 75 cm to examine the sensitivity of the model to choice of accumulator bin since most fish in the samples are below the base model maximum bin size. This generally improves the estimation of the selectivity parameters, especially the descending part of a double normal.
- Setting an upper bound for the Dirichlet multinomial at 5 as recommended by the Stock Synthesis manual.
- Fixing the Dirichlet parameters that are estimated at the upper bound as this has no impact on the model estimation but reduces the number of model parameters (i.e. increased parsimony).

Overall, the results of the sensitivity runs presented in the Assessment Report and the additional runs performed during the review workshop suggested that the overall qualitative trend in the estimated biomass and fishing mortality were similar. The various sensitivity configurations did, however, impact the scale of the biomass and the rate of biomass decline in recent years. Removal of the RFOP survey, for example, suggests a greater decline in biomass as this survey, in contrast to all the others, has an increasing trend in recent years.

The jitter analysis for the base run in the Assessment Report showed that the objective function has a poorly defined minimum with a large number of runs failing to converge but no run having a smaller log likelihood than the base run. Estimated biomass and fishing mortality remained similar across jitter of runs that converged, although, a number of the model parameters relating to selectivity differed. This points to some parameters having substantial uncertainty. However, while this does not impact the trend in spawning stock biomass and fishing mortality it may have implications for reference point estimation and forward projections.

<u>The Review Panel final base model for Gulf scamp included the following changes to the original base model:</u>

- Input recreational landings in numbers and fit to mean weight of landed fish for recreational fleets.
- Increase starting fishing mortality standard error for headboats from 0.01 to 0.05.
- Input commercial age composition instead of conditional age-at-length as these provide a better model fit.
- Estimate an extra standard deviation parameter for each index to allow poorly fit surveys to be downweighted.
- Create a length plus group bin = 84 cm fork length to obtain a better fit to the length compositions and improve estimates of selectivity.
- Set an upper bound for the Dirichlet multinomial at 5, and fix Dirichlet parameters that are at the upper bound.
- Natural mortality adjustment to account for pre-recruit mortality.
- Estimate the inflection point for fishery retention curves to obtain a better model fit.
- Fix steepness at 0.69. This is a weighted mean of the estimate from FishLife and the South Atlantic estimate in the current assessment. This value was used since steepness could not be estimated within the model.

<u>For the South Atlantic Scamp assessment requested additional runs included:</u>

- Combining dead discards with landings to avoid modelling separate fleets for each catch component and improve parsimony given that discards account for only a very small fraction of the catch.

- Theoretical works have shown that selectivity in models like the Beaufort Assessment Model (i.e. based on gear selectivity plus fish availability) are typically dome shaped but the extent of the dome might vary. Thus, selectivity for the recreational and commercial sectors was requested to be modelled with a double normal, which does not *a priori* impose any particular shape to the selectivity function and allow parameters and shape to be determined by the data.
- Removing the two time blocks, as well as increasing them to six time blocks to investigate the apparently inconsistent selection patterns in each block. Here the later period selection pattern is expected to lie to the right of the early period but the base model estimates the reverse. The underlying issues may be due to an absence of direct ageing in the earlier years of the assessment.
- Including an ageing error matrix selectivity as there is evidence of uncertainty in age determination especially in older fish.

In common with the Gulf assessment, the results of the sensitivity runs presented in the Assessment Report and the additional runs performed during the review workshop suggested that the overall qualitative trend in the estimated biomass and fishing mortality were similar. However, removal of time blocks resulted in a greater decline in estimated biomass and a much reduced estimate of steepness which the panel felt was unrealistic. While the inclusion of time blocks improved the estimate for steepness, the estimated selectivity for each block was apparently not consistent with the change in the size regulations for which the blocks were designed. However, at least part of this disparity was partially attributed to compliance being based on total length while the model was run with fork lengths.

The assessment is heavily conditioned on the commercial landings data as these are assumed to have very low observation error. Relaxing this assumption has some impact on the model results. However, for the time being, the final base model assumes a low observation error for commercial landings.

The Review Panel final base model for South Atlantic scamp included the following changes to the original base model:

- Combined dead discards with landings.
- Used dome shaped selectivity for recreational and commercial sectors.
- Retained time blocks in the final model because their removal resulted in unusually low estimates of steepness.

- **Comment on the likely relationship of this variability with possible ecosystem or climate factors and possible mechanisms for encompassing this into management reference points.**

Apart from a comparison of areas of hypoxia associated with red tide events and the spatial distribution of scamp in the Gulf of Mexico, a comprehensive examination of ecosystem or climate related factors on scamp productivity was not undertaken. However, the Panel noted that work is ongoing to describe system dynamics for Gulf and South Atlantic scamp populations. This work should generate plausible hypotheses for incorporation of ecosystem considerations in the assessment process.

A recent climate vulnerability assessment for South Atlantic scamp has rated the species Very High in Overall Climate Vulnerability, because of climate change threats to its habitat and prey species, and its narrow temperature preferences.

Scamp is an included species in the South Atlantic Region Ecosystem Diet Model for the Ecopath with Ecosim Model of the South Atlantic Region. This model offers promise for inclusion of additional ecosystem parameters in future stock assessments for scamp.

4. Provide, or comment on, recommendations to improve the assessment.

- **Consider the research recommendations provided by the Data and Assessment workshops in the context of overall improvement to the assessment, and make any additional research recommendations warranted.**

The Review Panel supports the research recommendations identified by the Data and Assessment stages for the Gulf of Mexico and South Atlantic assessment processes.

In particular, the Review Panel supported:

- The recommendations to develop artificial intelligence approaches as well as additional automation for image processing and for reading and analysis of video, otoliths, gonad sections and other samples that contribute to scamp stock assessments.

The Review Panel further recommended the following short-term and long-term research needs.

<u>(Short-term, within 6 months)</u>

- Fleet-specific plots of the spatial distribution of the fisheries in both the Gulf and S. Atlantic could help interpret changes in length and age composition over time.
- Dockside sampling was not always randomly structured and in the past, sampling was opportunistic. Investigate modeling issues that may have occurred as a consequence of this.
- For the Gulf, investigate the apparent conflict between the von Bertalanffy model parameters estimated by the model and those provided by the Life History Working Group.
- Further investigation of size and age composition data in the South Atlantic is desirable. Consider "borrowing" length and age composition samples from the Gulf to address poorly sampled strata in the South Atlantic. This assumes that during the

historical period, fishery regulations by fleet may have been comparable between the two management units.

(Longer-term)

- Conclude investigation of the taxonomic status of yellowmouth grouper. It has been deemed historically to be a separate species. There is a need to develop a time series of the proportion of yellowmouth grouper over time, perhaps by sampling the catch in the fishery independent series (chevron traps).
- Further investigate changes in reporting of recreational landings from all data sources and how the changes contribute to imprecision in the series.
- Consider the possibility that the ROV data collected by Lewis et al. (2020) could provide another fishery-independent abundance index in the Gulf (see SEDAR 68 RD44: Changes in Reef Fish Community Structure Following the Deepwater Horizon Oil Spill for a copy of their paper.
- More age samples required for all fleets.
- More effort should be given to formally evaluate and incorporate ecosystem considerations.
- Hold a Best Practices Workshop to address how best to use weights or numbers for recreational harvest in assessment models. This is a much more complex issue than can be resolved in an assessment process.

- **If applicable, provide recommendations for improvement or for addressing any inadequacies identified in the data or assessment modeling. These recommendations should be described in sufficient detail for application, and should be practical for short-term implementation (e.g., achievable within ~6 months). Longer-term recommendations should instead be listed as research recommendations above**.

  Additionally, the Review Panel recommends the following:

  - The assessment reports could be strengthened by the inclusion of descriptions of the biology and the fishery that are important for the assessment, including information on how management of other species may have affected the fishery in question. For example, in the current case, it was not clear until a late stage of the document that scamp are not directly targeted in the fisheries.
  - Move towards a model ensemble of different plausible configurations selected by hypothesis testing and weighed by a comprehensive diagnostic against performance criteria agreed beforehand which is developed to provide stocks status and management advice for both stocks. As best practice, and as a minimum, the ensemble should integrate the three main sources of uncertainty (process uncertainty, parameter uncertainty, and observation error) in the data.

- In these assessments *a priori* assumptions were made about the shape of the selection curve which, while reasonable, there does not seem to be any direct evidence for these fleets that the shape chosen is the right one.

- Currently the Beaufort Assessment Model does not support an option to model discards with a retention function and appears to require this catch category to be modelled as a separate fleet. This does not reflect the way the observations are collected and the model needs to be enhanced to allow discards to be modelled with a separate retention function for the fleet concerned. In addition, having the option in the Beaufort Assessment Model to model selectivity by length would be desirable in the future.

- In order to overcome the problem of changes of scale seen in the Gulf retrospectives a more robust way of expressing F and biomass over time would be to use ratio estimators such as B/B_{MSY} and F/F_{MSY}.

5. Provide recommendations on possible ways to improve the Research Track Assessment process.

- Recognizing that the Research Track process is new, further background on regarding how it differs from other past and present SEDAR assessments would have been helpful.

- Having the involvement of the Chair of Data Working Group could increase the efficiency of this stage of the review.

- We appreciate the inclusion of some ecosystem considerations in the Gulf assessment where red tide and the 2010 Deep Water Horizon oil spill could have important consequences for fisheries; however more effort should be given to formally evaluate and incorporate ecosystem considerations throughout the assessment process.

- Make assessment data and models fully available to panelist. Removing certain data due to confidentiality hinder the work of the reviewers and negatively affects its quality.

6. Prepare a Review Workshop Summary Report describing the Panel's evaluation of the Research Track stock assessment and addressing each Term of Reference.

This report fulfills the requirement of this Term of Reference.

SEDAR

Southeast Data, Assessment, and Review

SEDAR 68

Atlantic Scamp Grouper

SECTION VI: Post-Review Workshop Addendum Report

September 2021

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

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1 Introduction

The SEDAR 68 Scamp Grouper Assessment Review Workshop (RW) took place August 30th – September 3rd, 2021 remotely over GoToWebinar. During the RW, the SEDAR 68 Review Panel (RP) revisited discussions and decisions made during the Data Workshop and Assessment Webinars and requested several additional analyses from the analytical team. Below is a summary of these requests and how they pertain to the assessment model.

2 Base Model Configuration Sensitivities

The majority of the discussions by the RP dealt with the shift in selectivities for both the commercial and recreational fleets from older, larger fish in the first time block to younger, smaller fish in the second time block. This is counter-intuitive as the second time block was placed to account for the implementation of a size-limit for scamp. BAM uses age compositions to fit the model and where there are no age compositions, the model converts length compositions to ages. This is not new for South Atlantic stock assessments, as there is a lack of aging data in the time period encompassed by the first time block, necessitating length compositions be used to fit the model in the first time block.

The additional analyses requested by the RP are listed below:

- Run 1: Dead discards combined with landings
- Run 2: Apply dome shaped selectivities to recreational and commercial fleets
- Run 3: Remove time blocks from Review Workshop run 2
- Run 4: Remove time blocks from AW base run
- Run 5: Include aging error matrix in AW base run
- Run 6: Increase time blocks to six on AW base run
- Run 7: Francis re-weighting

2.1 Run 1: Dead discards combined with landings

The AW base run had four separate removal fleets, commercial landings, recreational landings, commercial discards and recreational discards. The discards comprised both live and dead discards. Dead discards were estimated using the point estimates of discard mortality provided during the Data Workshop. The commercial discard mortality rate of 39% was applied to the estimated commercial discards and recreational discard mortality rate of 26% was applied to the estimated recreational landings (Table 1). The RP requested that the discards be combined with landings, creating two removal fleets, commercial catches and recreational catches. Discards length compositions were removed from the model and the dead discard amounts were added to the reported landings for the commercial and recreational fleets.

Results

The amounts of dead discards from the commercial fleet were negligible and did not change the estimated selectivity parameters (Table 2). The overall model fits for the commercial catches and age compositions did not greatly vary for the commercial or recreational fleets. The dead discards were a larger component for the recreational fleet than the commercial fleet but did not significantly change the estimated selectivity parameter values. The largest changes were observed in the fits to the catches in the earliest years of the recreational time series Figure 5.

The RP recommended that this model run be used as the accepted RW Base Model. BAM does not use retention parameters so it is difficult to separate the selectivity between discards and landings due to the lack of discard composition data for scamp. Including the dead discards with the landings avoided this problem and did not greatly change the structure of the model or the overall model time series. The updated tables and figures for the RW Base Model are included (Tables 3–11 and Figures 3–27).

2.2 Run 2: Apply dome shaped selectivities to commercial and recreational fleets

The AW base run used a logistic, two-parameter selectivity for both the commercial and recreational fleets. The RP requested a run using a double logistic, four-parameter selectivity function for the commercial and recreational landings fleets. This exploratory run included separate landings and discards for both the commercial and recreational fleets.

Results

The commercial descending limb slope parameter for the first time block hit the lower bound of 0.0 and the selectivities did not fit the data very well for both fleets and time blocks (Figure 28). The RP recommended a logistic selectivity should be used for both fleets.

2.3 Run 3: Remove time blocks from Review Workshop model run 2

The AW base run had two time blocks in place, one from the start of the model in 1969 until 1991 and the second from 1992 until the terminal year of 2017. The second time block represented a management shift from no size regulations to a size limit of 20 inches total length for scamp. This model run used double-logistic selectivities for the commercial and recreational fleets

Results

None of the selectivity parameters hit bounds however the model fit a logistic shape for commercial and recreational fleets despite the flexibility to fit a dome shaped (Figure 30). The RP did not recommend this run for further exploration.

2.4 Run 4: Remove time blocks from Assessment Workshop Base run 2

This run removed the time blocks from the AW base run with logistic selectivities for the commercial and recreational fleets.

Results

The age composition data were poorly fit in this run for both fleets. Additionally, the recreational index was greatly overestimated at the start of the time series (Figures 32–34). The RP did not recommend this run for further exploration.

2.5 Run 5: Include aging error matrix to AW Base Run

The aging error matrix was included to possibly improve the mis-match between the selectivities.

Results

There was no discernable change to the model by including the aging error matrix. The RP did not recommend this run for further exploration.

2.6 Run 6: Increase time blocks to six on RW Run 1

The RP discussed the possibility of using an annual random walk on the first selectivity parameter (a50) instead of time blocks to better fit the composition data, however this would necessitate a change to the BAM source code. Changes to the source code requires internal testing before full implementation and this was not feasible over the course of the RW. However, this remains a possibility for the subsequent Operational Assessment.

In lieu of the annual random walk, the RP requested the use of six time blocks instead of the two already in use to explore how selectivity may change through time. The time blocks were placed in 1978, 1986, 1992, 2000 and 2010.

Results

The model was able to estimate selectivity parameters for all six time blocks, however it did not greatly affect the selectivity at age issue. The youngest fish caught were in the earliest time block from 1969-1977, however the most recent time block of 2010-2017 caught the next youngest fish (Figures 37–38).

The selected time blocks were not based on management decisions so further research and modeling is needed to determine if different years for the time blocks yield different model likelihoods. The RP did not recommend changing the number of time blocks for this Research Track Assessment, however this also remains a possible modification for the Operational Assessment.

2.7 Run 7: Francis re-weighting

The BAM scamp model uses two forms of weighting on data, a Dirichlet-multinomial on the length and age compositions and the Francis re-weighting method on indices. The Francis re-weighting is an iterative process while the Dirichlet method is not; the RP discussed whether applying the Francis re-weighting on the indices would have an effect on the estimated Dirichlet parameters for the compositions. The Dirichlet parameter values before the Francis re-weighting were compared to values obtained after the re-weighting was applied. This investigation was done using the AW base run and as such, the discard composition data remained in the model. There was a minimal difference observed between the two sets of parameter values (Table 12) and the RP was satisfied that the Francis re-weighting did not have an effect on the Dirichlet weighting method.

3 Review Workshop Base Model

The final RW Base Model configuration that was accepted by the RP combined the dead discards into the commercial and recreational landings as described in Section 2.1. The RW Base Model differed from the AW Base Run in that the discards were completely removed from the model. This included removing the discard composition data and the discard selectivities for the commercial and recreational discard fleets. There were no further changes to the AW Base Run configuration. The time blocks and the fleet selectivities remained unchanged from the AW Base Model.

4 Tables

Table 1. Observed time series of landings (L) combined with dead discards for the commercial (COM) and general recreational (REC) fleets from the RW approved Base Model. Landings are in units of 1000 lb whole weight for commercial landings, and in units of 1000 fish for general recreational landings.

Year	L.COM	L.REC
1969	33.70	10.70
1970	44.67	10.76
1971	49.98	11.83
1972	36.54	12.89
1973	48.40	13.96
1974	66.55	15.02
1975	67.25	16.08
1976	85.71	16.27
1977	125.52	16.45
1978	277.94	16.63
1979	262.80	16.81
1980	252.56	16.99
1981	244.28	21.33
1982	378.56	18.47
1983	322.83	9.56
1984	320.17	17.97
1985	255.34	14.77
1986	286.40	11.15
1987	328.42	16.40
1988	348.05	35.66
1989	376.67	31.39
1990	484.32	45.25
1991	394.16	34.04
1992	285.89	30.20
1993	313.94	34.72
1994	313.29	50.31
1995	347.37	19.59
1996	289.46	19.71
1997	292.15	21.47
1998	268.86	23.03
1999	385.94	29.73
2000	301.52	47.09
2001	229.48	30.88
2002	241.02	65.67
2003	266.35	53.32
2004	262.47	49.48
2005	279.34	37.74
2006	324.43	56.33
2007	346.48	73.14
2008	260.02	38.31
2009	263.12	24.61
2010	186.16	14.78
2011	160.95	8.14
2012	163.68	15.23
2013	143.10	11.39
2014	166.38	40.62
2015	129.72	8.74
2016	112.93	9.26
2017	111.82	14.22

Table 2. Selectivity parameters for the Review Workshop approved Base Model run (RW) compared to the Assessment Workshop base run (AW).

Parameters	AW	RW
$selA50COM1$	7.513	7.499
$selslopeCOM1$	1.733	1.733
$selA50COM2$	4.954	4.947
$selslopeCOM2$	1.951	1.948
$selA50REC1$	5.690	5.676
$selslopeREC1$	1.805	1.815
$selA50REC2$	4.677	4.717
$selslopeREC2$	1.784	1.744

Table 3. Estimated time series and status indicators from the RW approved Base Model. Fishing mortality rate is apical F. Total biomass (B, mt) is at the start of the year, and spawning biomass (SSB mature female biomass) at the time of peak spawning (start of May). The $MSST$ is defined by $\text{MSST} = 0.75SSBmsy$*. Prop.fem is proportion of age-*2^+ *population that is female.*

Year	F	$F/Fmsy$	B	B/B_{unfished}	SSB	$SSB/SSBmsy$	$SSB/MSST$	Prop.fem
1969	0.0175	0.0809	5161	0.927	4153	2.112	2.817	0.871
1970	0.0199	0.0919	5166	0.928	4157	2.115	2.819	0.871
1971	0.0220	0.1015	5165	0.927	4154	2.113	2.818	0.871
1972	0.0218	0.1005	5160	0.926	4149	2.110	2.814	0.871
1973	0.0253	0.1167	5154	0.925	4140	2.106	2.808	0.871
1974	0.0301	0.1391	5141	0.923	4125	2.098	2.798	0.871
1975	0.0312	0.1438	5119	0.919	4104	2.088	2.784	0.871
1976	0.0353	0.1630	5098	0.915	4083	2.077	2.769	0.872
1977	0.0446	0.2056	5072	0.911	4053	2.061	2.749	0.872
1978	0.0812	0.3745	5032	0.904	3991	2.030	2.707	0.872
1979	0.0815	0.3760	4931	0.885	3899	1.984	2.645	0.873
1980	0.0830	0.3828	4613	0.828	3800	1.933	2.577	0.874
1981	0.0895	0.4130	4352	0.782	3640	1.852	2.469	0.874
1982	0.1314	0.6062	4285	0.769	3395	1.727	2.303	0.853
1983	0.1076	0.4966	4281	0.769	3208	1.632	2.176	0.847
1984	0.1290	0.5954	4305	0.773	3179	1.617	2.156	0.868
1985	0.1122	0.5179	4311	0.774	3218	1.637	2.183	0.886
1986	0.1187	0.5479	4301	0.772	3279	1.668	2.224	0.892
1987	0.1543	0.7122	4235	0.760	3298	1.678	2.237	0.894
1988	0.2089	0.9639	4189	0.752	3227	1.642	2.189	0.891
1989	0.2161	0.9971	4101	0.736	3104	1.579	2.105	0.884
1990	0.2951	1.3616	3971	0.713	2972	1.512	2.016	0.875
1991	0.2454	1.1322	4169	0.749	2872	1.461	1.948	0.876
1992	0.2211	1.0201	4184	0.751	2879	1.465	1.953	0.876
1993	0.2667	1.2308	4209	0.756	2909	1.480	1.973	0.906
1994	0.3126	1.4424	4374	0.785	2893	1.472	1.962	0.906
1995	0.3004	1.3863	4663	0.837	2947	1.499	1.999	0.912
1996	0.2543	1.1737	4768	0.856	3143	1.599	2.132	0.918
1997	0.2521	1.1634	4750	0.853	3370	1.714	2.286	0.921
1998	0.2167	1.0000	4752	0.853	3466	1.763	2.351	0.913
1999	0.2820	1.3012	4732	0.850	3400	1.730	2.306	0.899
2000	0.2461	1.1355	4479	0.804	3234	1.645	2.194	0.893
2001	0.1800	0.8308	4445	0.798	3152	1.603	2.138	0.892
2002	0.2314	1.0678	4585	0.823	3146	1.600	2.134	0.885
2003	0.2359	1.0885	4607	0.827	3159	1.607	2.143	0.893
2004	0.2346	1.0828	4479	0.804	3200	1.628	2.170	0.902
2005	0.2256	1.0410	4236	0.761	3184	1.620	2.160	0.907
2006	0.2820	1.3012	3924	0.705	3007	1.530	2.040	0.900
2007	0.3512	1.6205	3490	0.627	2631	1.338	1.784	0.886
2008	0.2670	1.2322	2982	0.535	2238	1.139	1.518	0.877
2009	0.2685	1.2390	2630	0.472	1971	1.002	1.337	0.872
2010	0.2025	0.9346	2259	0.406	1766	0.899	1.198	0.872
2011	0.1748	0.8066	1987	0.357	1609	0.818	1.091	0.870
2012	0.2036	0.9395	1807	0.324	1430	0.727	0.970	0.860
2013	0.1887	0.8708	1634	0.293	1248	0.635	0.847	0.853
2014	0.2797	1.2909	1469	0.264	1093	0.556	0.741	0.862
2015	0.2321	1.0710	1240	0.223	954	0.485	0.647	0.879
2016	0.2410	1.1123	1247	0.224	866	0.440	0.587	0.881
2017	0.2924	1.3492	1293	0.232	817	0.416	0.554	0.878
2018	.	.	1342	0.241	.	.	.	0.916

Table 4. Selectivity at age for the commercial fleet (COM), general recreational fleet (REC), CVT, landings averaged across fisheries (L.avg) and weighted sum of landings from the RW approved Base Model. FL is fork length.

Age	FL(mm)	FL(in)	COM	REC	CVT	L.avg
1	309.0	12.2	0.000	0.002	0.013	0.001
2	375.3	14.8	0.003	0.009	0.093	0.004
3	432.3	17.0	0.022	0.048	0.443	0.026
4	481.5	19.0	0.136	0.223	0.861	0.151
5	523.8	20.6	0.526	0.621	0.980	0.542
6	560.3	22.1	0.886	0.904	0.997	0.889
7	591.7	23.3	0.982	0.982	1.000	0.982
8	618.8	24.4	0.997	0.997	1.000	0.997
9	642.1	25.3	1.000	0.999	1.000	1.000
10	662.2	26.1	1.000	1.000	1.000	1.000
11	679.6	26.8	1.000	1.000	1.000	1.000
12	694.5	27.3	1.000	1.000	1.000	1.000
13	707.3	27.8	1.000	1.000	1.000	1.000
14	718.4	28.3	1.000	1.000	1.000	1.000
15	728.0	28.7	1.000	1.000	1.000	1.000
16	736.2	29.0	1.000	1.000	1.000	1.000
17	743.3	29.3	1.000	1.000	1.000	1.000
18	749.4	29.5	1.000	1.000	1.000	1.000
19	754.6	29.7	1.000	1.000	1.000	1.000
20	759.2	29.9	1.000	1.000	1.000	1.000

Table 5. Estimated time series of fully selected fishing mortality rates for the commercial fleet landings (F.COM) and the general recreational fleet landings (F.REC). Also shown is apical F, the maximum F at age summed across fleets from the RW approved Base Model.

Year	F.COM	F.REC	Apical F
1969	0.007	0.010	0.018
1970	0.010	0.010	0.020
1971	0.011	0.011	0.022
1972	0.008	0.014	0.022
1973	0.010	0.015	0.025
1974	0.014	0.016	0.030
1975	0.015	0.016	0.031
1976	0.019	0.016	0.035
1977	0.028	0.016	0.045
1978	0.064	0.017	0.081
1979	0.064	0.018	0.081
1980	0.064	0.019	0.083
1981	0.064	0.026	0.089
1982	0.104	0.027	0.131
1983	0.094	0.014	0.108
1984	0.098	0.031	0.129
1985	0.082	0.031	0.112
1986	0.098	0.021	0.119
1987	0.126	0.028	0.154
1988	0.147	0.062	0.209
1989	0.163	0.053	0.216
1990	0.214	0.081	0.295
1991	0.183	0.063	0.245
1992	0.176	0.046	0.221
1993	0.211	0.055	0.267
1994	0.234	0.079	0.313
1995	0.271	0.029	0.300
1996	0.225	0.029	0.254
1997	0.223	0.029	0.252
1998	0.189	0.028	0.217
1999	0.248	0.034	0.282
2000	0.188	0.058	0.246
2001	0.142	0.038	0.180
2002	0.149	0.082	0.231
2003	0.170	0.066	0.236
2004	0.172	0.062	0.235
2005	0.183	0.042	0.226
2006	0.213	0.069	0.282
2007	0.243	0.108	0.351
2008	0.200	0.067	0.267
2009	0.221	0.048	0.269
2010	0.171	0.031	0.203
2011	0.156	0.019	0.175
2012	0.167	0.036	0.204
2013	0.158	0.031	0.189
2014	0.210	0.069	0.280
2015	0.198	0.034	0.232
2016	0.201	0.040	0.241
2017	0.228	0.064	0.292
2018	.	.	.

Table 6. Estimated instantaneous fishing mortality rate (per yr) at age for RW approved Base Model

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1969	0.000	0.000	0.000	0.000	0.002	0.007	0.012	0.015	0.017	0.017	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018
1970	0.000	0.000	0.000	0.000	0.002	0.007	0.012	0.017	0.019	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020
1971	0.000	0.000	0.000	0.001	0.003	0.008	0.014	0.019	0.021	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022
1972	0.000	0.000	0.000	0.001	0.003	0.009	0.015	0.019	0.021	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022
1973	0.000	0.000	0.000	0.001	0.003	0.010	0.017	0.022	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
1974	0.000	0.000	0.000	0.001	0.004	0.011	0.019	0.026	0.029	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030
1975	0.000	0.000	0.000	0.001	0.004	0.012	0.019	0.027	0.030	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031
1976	0.000	0.000	0.000	0.001	0.004	0.012	0.021	0.029	0.034	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035
1977	0.000	0.000	0.000	0.001	0.004	0.012	0.023	0.036	0.043	0.044	0.044	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045
1978	0.000	0.000	0.000	0.001	0.005	0.015	0.035	0.062	0.077	0.080	0.081	0.081	0.081	0.081	0.081	0.081	0.081	0.081	0.081	0.081
1979	0.000	0.000	0.000	0.001	0.005	0.016	0.035	0.062	0.077	0.081	0.081	0.081	0.081	0.081	0.081	0.081	0.081	0.081	0.081	0.081
1980	0.000	0.000	0.000	0.001	0.005	0.017	0.037	0.064	0.079	0.082	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083
1981	0.000	0.000	0.000	0.001	0.007	0.021	0.042	0.070	0.085	0.089	0.089	0.089	0.089	0.089	0.089	0.089	0.089	0.089	0.089	0.089
1982	0.000	0.000	0.000	0.001	0.008	0.025	0.056	0.100	0.124	0.130	0.131	0.131	0.131	0.131	0.131	0.131	0.131	0.131	0.131	0.131
1983	0.000	0.000	0.000	0.001	0.004	0.015	0.040	0.080	0.101	0.106	0.107	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108	0.108
1984	0.000	0.000	0.000	0.002	0.008	0.027	0.058	0.100	0.122	0.128	0.129	0.129	0.129	0.129	0.129	0.129	0.129	0.129	0.129	0.129
1985	0.000	0.000	0.000	0.002	0.008	0.025	0.052	0.088	0.107	0.111	0.112	0.112	0.112	0.112	0.112	0.112	0.112	0.112	0.112	0.112
1986	0.000	0.000	0.000	0.001	0.006	0.020	0.048	0.089	0.112	0.117	0.118	0.119	0.119	0.119	0.119	0.119	0.119	0.119	0.119	0.119
1987	0.000	0.000	0.000	0.002	0.008	0.027	0.063	0.117	0.146	0.153	0.154	0.154	0.154	0.154	0.154	0.154	0.154	0.154	0.154	0.154
1988	0.000	0.000	0.001	0.003	0.016	0.050	0.100	0.165	0.199	0.207	0.209	0.209	0.209	0.209	0.209	0.209	0.209	0.209	0.209	0.209
1989	0.000	0.000	0.000	0.003	0.014	0.045	0.097	0.167	0.205	0.214	0.216	0.216	0.216	0.216	0.216	0.216	0.216	0.216	0.216	0.216
1990	0.000	0.000	0.001	0.004	0.021	0.067	0.138	0.231	0.280	0.292	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295
1991	0.000	0.000	0.001	0.003	0.017	0.053	0.112	0.190	0.233	0.243	0.245	0.245	0.245	0.245	0.245	0.245	0.245	0.245	0.245	0.245
1992	0.000	0.001	0.006	0.034	0.121	0.197	0.217	0.220	0.221	0.221	0.221	0.221	0.221	0.221	0.221	0.221	0.221	0.221	0.221	0.221
1993	0.000	0.001	0.007	0.041	0.145	0.237	0.262	0.266	0.267	0.267	0.267	0.267	0.267	0.267	0.267	0.267	0.267	0.267	0.267	0.267
1994	0.000	0.001	0.009	0.049	0.172	0.278	0.307	0.312	0.312	0.313	0.313	0.313	0.313	0.313	0.313	0.313	0.313	0.313	0.313	0.313
1995	0.000	0.001	0.007	0.043	0.161	0.267	0.295	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300
1996	0.000	0.001	0.006	0.037	0.136	0.226	0.250	0.254	0.254	0.254	0.254	0.254	0.254	0.254	0.254	0.254	0.254	0.254	0.254	0.254
1997	0.000	0.001	0.006	0.037	0.135	0.224	0.248	0.251	0.252	0.252	0.252	0.252	0.252	0.252	0.252	0.252	0.252	0.252	0.252	0.252
1998	0.000	0.001	0.005	0.032	0.117	0.192	0.213	0.216	0.217	0.217	0.217	0.217	0.217	0.217	0.217	0.217	0.217	0.217	0.217	0.217
1999	0.000	0.001	0.007	0.041	0.151	0.250	0.277	0.281	0.282	0.282	0.282	0.282	0.282	0.282	0.282	0.282	0.282	0.282	0.282	0.282
2000	0.000	0.001	0.007	0.039	0.135	0.219	0.242	0.245	0.246	0.246	0.246	0.246	0.246	0.246	0.246	0.246	0.246	0.246	0.246	0.246
2001	0.000	0.001	0.005	0.028	0.098	0.160	0.177	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180
2002	0.000	0.001	0.007	0.039	0.129	0.206	0.227	0.231	0.231	0.231	0.231	0.231	0.231	0.231	0.231	0.231	0.231	0.231	0.231	0.231
2003	0.000	0.001	0.007	0.038	0.130	0.210	0.232	0.235	0.236	0.236	0.236	0.236	0.236	0.236	0.236	0.236	0.236	0.236	0.236	0.236
2004	0.000	0.001	0.007	0.037	0.129	0.209	0.230	0.234	0.235	0.235	0.235	0.235	0.235	0.235	0.235	0.235	0.235	0.235	0.235	0.235
2005	0.000	0.001	0.006	0.034	0.123	0.201	0.222	0.225	0.225	0.226	0.226	0.226	0.226	0.226	0.226	0.226	0.226	0.226	0.226	0.226
2006	0.000	0.001	0.008	0.044	0.155	0.251	0.277	0.281	0.282	0.282	0.282	0.282	0.282	0.282	0.282	0.282	0.282	0.282	0.282	0.282
2007	0.000	0.002	0.010	0.057	0.195	0.313	0.345	0.350	0.351	0.351	0.351	0.351	0.351	0.351	0.351	0.351	0.351	0.351	0.351	0.351
2008	0.000	0.001	0.008	0.042	0.147	0.238	0.262	0.266	0.267	0.267	0.267	0.267	0.267	0.267	0.267	0.267	0.267	0.267	0.267	0.267
2009	0.000	0.001	0.007	0.041	0.146	0.239	0.264	0.268	0.268	0.268	0.268	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.269
2010	0.000	0.001	0.005	0.030	0.109	0.180	0.199	0.202	0.202	0.203	0.203	0.203	0.203	0.203	0.203	0.203	0.203	0.203	0.203	0.203
2011	0.000	0.001	0.004	0.025	0.094	0.155	0.172	0.174	0.175	0.175	0.175	0.175	0.175	0.175	0.175	0.175	0.175	0.175	0.175	0.175
2012	0.000	0.001	0.005	0.031	0.110	0.181	0.200	0.203	0.204	0.204	0.204	0.204	0.204	0.204	0.204	0.204	0.204	0.204	0.204	0.204
2013	0.000	0.001	0.005	0.028	0.102	0.168	0.185	0.188	0.189	0.189	0.189	0.189	0.189	0.189	0.189	0.189	0.189	0.189	0.189	0.189
2014	0.000	0.001	0.008	0.044	0.154	0.249	0.275	0.279	0.280	0.280	0.280	0.280	0.280	0.280	0.280	0.280	0.280	0.280	0.280	0.280
2015	0.000	0.001	0.006	0.035	0.125	0.206	0.228	0.231	0.232	0.232	0.232	0.232	0.232	0.232	0.232	0.232	0.232	0.232	0.232	0.232
2016	0.000	0.001	0.006	0.036	0.131	0.214	0.237	0.240	0.241	0.241	0.241	0.241	0.241	0.241	0.241	0.241	0.241	0.241	0.241	0.241
2017	0.000	0.001	0.008	0.045	0.160	0.260	0.287	0.292	0.292	0.292	0.292	0.292	0.292	0.292	0.292	0.292	0.292	0.292	0.292	0.292

Table 7. Estimated total landings at age in numbers (1000 fish) from the RW approved Base Model.

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1969	0.00	0.01	0.03	0.14	0.53	1.21	1.56	1.63	1.44	1.18	0.95	0.77	0.62	0.50	0.41	0.33	0.27	0.22	0.18	0.82
1970	0.00	0.01	0.03	0.14	0.54	1.24	1.65	1.80	1.63	1.34	1.08	0.87	0.71	0.57	0.47	0.38	0.31	0.25	0.21	0.93
1971	0.00	0.01	0.03	0.15	0.58	1.36	1.81	1.99	1.80	1.48	1.20	0.97	0.78	0.63	0.51	0.42	0.34	0.28	0.23	1.03
1972	0.00	0.01	0.04	0.18	0.71	1.61	2.02	2.05	1.79	1.46	1.18	0.95	0.77	0.63	0.51	0.41	0.34	0.28	0.23	1.02
1973	0.00	0.01	0.04	0.20	0.76	1.74	2.23	2.33	2.07	1.69	1.37	1.10	0.89	0.72	0.59	0.48	0.39	0.32	0.26	1.18
1974	0.00	0.01	0.05	0.21	0.81	1.88	2.49	2.70	2.43	2.00	1.61	1.30	1.05	0.86	0.70	0.57	0.46	0.38	0.31	1.39
1975	0.00	0.01	0.05	0.22	0.85	1.96	2.59	2.79	2.50	2.05	1.65	1.33	1.08	0.87	0.71	0.58	0.47	0.39	0.32	1.42
1976	0.00	0.01	0.05	0.22	0.86	2.00	2.74	3.08	2.80	2.30	1.85	1.49	1.20	0.98	0.79	0.65	0.53	0.43	0.35	1.59
1977	0.00	0.01	0.05	0.23	0.88	2.11	3.10	3.75	3.48	2.86	2.29	1.84	1.49	1.21	0.98	0.80	0.65	0.53	0.44	1.97
1978	0.00	0.01	0.06	0.26	1.01	2.59	4.56	6.35	6.12	5.04	4.03	3.23	2.60	2.11	1.71	1.40	1.14	0.93	0.76	3.43
1979	0.00	0.01	0.06	0.27	1.06	2.69	4.64	6.32	5.97	4.85	3.85	3.07	2.47	1.99	1.62	1.32	1.07	0.88	0.72	3.24
1980	0.00	0.01	0.06	0.29	1.13	2.85	4.81	6.44	6.00	4.79	3.76	2.98	2.38	1.91	1.55	1.26	1.03	0.84	0.69	3.10
1981	0.00	0.01	0.08	0.37	1.44	3.53	5.55	7.04	6.45	5.08	3.92	3.06	2.43	1.95	1.57	1.27	1.04	0.85	0.69	3.13
1982	0.01	0.01	0.03	0.41	1.63	4.16	7.22	9.82	9.15	7.22	5.52	4.24	3.32	2.64	2.12	1.72	1.39	1.14	0.93	4.20
1983	0.00	0.01	0.03	0.07	0.93	2.58	5.23	7.74	7.26	5.69	4.34	3.30	2.54	2.00	1.59	1.28	1.04	0.84	0.69	3.11
1984	0.01	0.03	0.12	0.26	0.54	4.51	7.45	9.68	8.70	6.67	5.02	3.81	2.90	2.24	1.76	1.41	1.14	0.92	0.75	3.38
1985	0.01	0.02	0.14	0.51	0.97	1.25	6.68	8.47	7.56	5.74	4.25	3.19	2.42	1.85	1.43	1.13	0.90	0.73	0.59	2.66
1986	0.00	0.02	0.08	0.45	1.48	1.89	1.82	8.58	7.93	6.07	4.47	3.30	2.48	1.89	1.45	1.12	0.88	0.71	0.57	2.56
1987	0.00	0.02	0.11	0.50	2.39	5.23	4.58	3.28	10.08	7.74	5.70	4.17	3.09	2.33	1.77	1.36	1.06	0.84	0.67	2.97
1988	0.01	0.03	0.18	0.99	3.85	11.37	14.60	8.56	3.88	9.81	7.23	5.31	3.89	2.89	2.18	1.67	1.28	1.00	0.79	3.43
1989	0.01	0.04	0.13	0.72	3.39	8.36	16.31	17.11	7.18	2.77	6.78	4.98	3.66	2.69	2.00	1.51	1.16	0.89	0.69	2.95
1990	0.01	0.06	0.25	0.89	4.16	12.07	18.42	26.56	18.65	6.54	2.43	5.92	4.36	3.21	2.37	1.76	1.34	1.02	0.79	3.23
1991	0.02	0.04	0.21	0.89	2.72	7.94	14.73	17.44	17.23	10.13	3.42	1.27	3.09	2.28	1.69	1.25	0.93	0.70	0.54	2.12
1992	0.11	1.00	1.87	9.63	23.88	22.96	22.76	19.88	13.36	10.63	5.98	2.01	0.75	1.82	1.35	1.00	0.74	0.55	0.42	1.59
1993	0.18	0.59	5.57	9.45	29.24	31.07	19.41	17.65	15.29	10.31	8.24	4.66	1.57	0.58	1.43	1.06	0.79	0.58	0.44	1.59
1994	0.31	1.01	3.33	27.87	27.60	35.81	24.46	13.98	12.60	10.96	7.42	5.95	3.37	1.14	0.43	1.04	0.78	0.58	0.43	1.48
1995	0.27	1.06	3.79	12.03	63.46	27.18	22.71	14.17	8.03	7.26	6.34	4.31	3.47	1.97	0.67	0.25	0.61	0.46	0.34	1.13
1996	0.16	1.09	4.40	14.21	26.82	58.02	15.65	11.91	7.37	4.19	3.81	3.34	2.28	1.84	1.05	0.36	0.13	0.33	0.24	0.78
1997	0.11	0.72	5.16	19.01	36.87	29.02	40.02	9.86	7.45	4.62	2.64	2.41	2.12	1.45	1.17	0.67	0.23	0.09	0.21	0.66
1998	0.12	0.44	2.98	19.49	43.20	35.12	17.65	22.25	5.44	4.12	2.57	1.47	1.35	1.19	0.82	0.66	0.38	0.13	0.05	0.49
1999	0.15	0.71	2.70	16.69	65.60	61.13	31.93	14.69	18.37	4.51	3.43	2.15	1.24	1.13	1.00	0.69	0.56	0.32	0.11	0.46
2000	0.14	0.70	3.31	10.93	38.75	62.23	36.72	17.50	7.99	10.02	2.47	1.89	1.19	0.68	0.63	0.56	0.38	0.31	0.18	0.32
2001	0.14	0.43	2.29	9.96	20.21	31.29	32.78	17.73	8.39	3.84	4.84	1.20	0.92	0.58	0.33	0.31	0.27	0.19	0.15	0.24
2002	0.22	0.95	2.91	13.26	33.26	28.80	29.20	28.11	15.10	7.17	3.30	4.17	1.04	0.80	0.50	0.29	0.27	0.24	0.16	0.35
2003	0.19	0.90	4.03	11.34	31.94	35.97	20.70	19.30	18.43	9.93	4.74	2.19	2.78	0.69	0.53	0.34	0.20	0.18	0.16	0.35
2004	0.12	0.81	4.01	16.24	27.68	34.13	25.22	13.32	12.32	11.81	6.40	3.06	1.42	1.81	0.45	0.35	0.22	0.13	0.12	0.33
2005	0.07	0.47	3.29	15.18	38.22	28.74	23.25	15.77	8.26	7.67	7.39	4.01	1.93	0.90	1.14	0.29	0.22	0.14	0.08	0.29
2006	0.08	0.44	2.89	17.91	48.34	51.34	24.96	18.50	12.45	6.55	6.10	5.90	3.22	1.55	0.72	0.92	0.23	0.18	0.11	0.30
2007	0.12	0.49	2.66	15.24	54.30	61.28	41.87	18.61	13.68	9.23	4.88	4.57	4.43	2.42	1.17	0.54	0.70	0.17	0.14	0.31
2008	0.09	0.37	1.58	7.91	27.45	42.08	30.60	19.09	8.41	6.20	4.21	2.23	2.09	2.04	1.12	0.54	0.25	0.32	0.08	0.21
2009	0.06	0.35	1.57	6.28	19.32	29.08	28.96	19.28	11.93	5.27	3.91	2.66	1.42	1.33	1.30	0.71	0.35	0.16	0.21	0.19
2010	0.02	0.19	1.21	4.99	12.17	15.99	15.48	14.10	9.31	5.78	2.57	1.91	1.30	0.70	0.66	0.64	0.35	0.17	0.08	0.20
2011	0.01	0.08	0.73	4.36	11.24	11.92	10.19	9.05	8.18	5.42	3.38	1.51	1.12	0.77	0.41	0.39	0.38	0.21	0.10	0.16
2012	0.03	0.08	0.48	3.88	13.74	14.95	10.26	8.04	7.09	6.43	4.28	2.68	1.20	0.90	0.62	0.33	0.31	0.31	0.17	0.21
2013	0.03	0.13	0.36	1.87	9.31	14.32	10.15	6.39	4.97	4.40	4.01	2.68	1.68	0.76	0.57	0.39	0.21	0.20	0.19	0.24
2014	0.04	0.24	0.98	2.35	7.18	15.07	15.03	9.78	6.11	4.77	4.24	3.88	2.60	1.64	0.74	0.55	0.38	0.20	0.19	0.43
2015	0.02	0.12	0.83	3.17	4.75	6.35	8.65	7.89	5.09	3.19	2.51	2.24	2.05	1.38	0.87	0.39	0.30	0.20	0.11	0.33
2016	0.07	0.08	0.58	3.75	8.58	5.42	4.66	5.81	5.26	3.40	2.14	1.69	1.51	1.39	0.94	0.59	0.27	0.20	0.14	0.30
2017	0.09	0.40	0.48	3.06	11.64	11.12	4.51	3.55	4.39	3.99	2.60	1.64	1.30	1.16	1.07	0.72	0.46	0.21	0.16	0.34

Table 8. Estimated total landings at age in whole weight (1000 lb) for RW approved Base Model.

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1969	0.00	0.01	0.07	0.42	2.06	5.74	8.63	10.24	10.11	9.05	7.86	6.75	5.75	4.88	4.12	3.46	2.90	2.43	2.02	9.30
1970	0.00	0.01	0.07	0.42	2.09	5.89	9.16	11.36	11.43	10.27	8.93	7.67	6.54	5.54	4.68	3.93	3.30	2.76	2.30	10.56
1971	0.00	0.01	0.08	0.46	2.28	6.43	10.05	12.51	12.60	11.33	9.85	8.46	7.22	6.12	5.16	4.34	3.64	3.04	2.54	11.66
1972	0.00	0.01	0.09	0.56	2.76	7.63	11.20	12.88	12.55	11.20	9.73	8.36	7.13	6.04	5.10	4.29	3.59	3.00	2.51	11.51
1973	0.00	0.01	0.10	0.60	2.96	8.24	12.36	14.65	14.47	12.95	11.25	9.66	8.24	6.99	5.90	4.96	4.16	3.48	2.90	13.32
1974	0.00	0.02	0.11	0.64	3.16	8.89	13.78	17.01	17.05	15.31	13.31	11.43	9.75	8.27	6.98	5.87	4.92	4.11	3.43	15.76
1975	0.00	0.02	0.11	0.67	3.31	9.28	14.32	17.55	17.50	15.67	13.61	11.68	9.96	8.45	7.13	6.00	5.03	4.20	3.51	16.11
1976	0.00	0.02	0.11	0.68	3.34	9.47	15.17	19.41	19.63	17.57	15.23	13.07	11.14	9.44	7.97	6.71	5.62	4.70	3.92	18.01
1977	0.00	0.02	0.11	0.70	3.45	10.00	17.18	23.58	24.38	21.87	18.90	16.18	13.78	11.68	9.86	8.29	6.95	5.81	4.85	22.28
1978	0.00	0.02	0.13	0.79	3.95	12.28	25.25	39.96	42.84	38.55	33.24	28.34	24.08	20.39	17.21	14.47	12.13	10.15	8.47	38.89
1979	0.00	0.02	0.14	0.83	4.13	12.74	25.69	39.80	41.81	37.08	31.75	26.96	22.81	19.27	16.25	13.66	11.45	9.58	7.99	36.71
1980	0.00	0.02	0.15	0.88	4.41	13.50	26.63	40.54	42.05	36.65	30.94	26.09	21.98	18.49	15.55	13.07	10.95	9.15	7.64	35.11
1981	0.00	0.01	0.19	1.13	5.62	16.70	30.75	44.32	45.15	38.89	32.27	26.84	22.46	18.81	15.76	13.20	11.06	9.24	7.71	35.44
1982	0.00	0.02	0.06	1.27	6.36	19.68	39.98	61.83	64.09	55.25	45.49	37.21	30.71	25.55	21.31	17.78	14.85	12.41	10.34	47.54
1983	0.00	0.02	0.07	0.21	3.65	12.20	28.94	48.71	50.82	43.56	35.72	28.96	23.50	19.29	15.98	13.28	11.04	9.20	7.67	35.22
1984	0.01	0.05	0.27	0.80	2.09	21.33	41.28	60.95	60.92	51.02	41.37	33.37	26.84	21.66	17.70	14.60	12.10	10.04	8.34	38.28
1985	0.01	0.04	0.31	1.57	3.79	5.91	36.98	53.31	52.92	43.89	34.99	27.94	22.36	17.89	14.37	11.70	9.62	7.95	6.58	30.09
1986	0.00	0.03	0.18	1.37	5.79	8.95	10.06	54.02	55.54	46.45	36.79	28.90	22.90	18.23	14.51	11.62	9.43	7.73	6.37	28.95
1987	0.00	0.03	0.25	1.52	9.33	24.76	25.35	20.68	70.58	59.18	46.96	36.60	28.53	22.48	17.81	14.13	11.27	9.12	7.47	33.59
1988	0.01	0.05	0.41	3.02	15.02	53.85	80.83	53.91	27.15	75.03	59.60	46.53	35.98	27.89	21.88	17.27	13.66	10.87	8.77	38.88
1989	0.01	0.06	0.30	2.21	13.22	39.59	90.34	107.76	50.28	21.20	55.84	43.69	33.85	26.03	20.08	15.70	12.35	9.74	7.73	33.39
1990	0.01	0.09	0.57	2.73	16.24	57.15	102.00	167.28	130.59	50.01	20.02	51.91	40.30	31.05	23.77	18.27	14.23	11.17	8.79	36.54
1991	0.02	0.06	0.48	2.73	10.63	37.61	81.58	109.82	120.63	77.53	28.20	11.11	28.59	22.07	16.93	12.91	9.89	7.69	6.02	24.05
1992	0.01	0.23	0.86	7.46	27.78	37.23	48.67	53.75	44.18	41.87	27.47	10.56	4.41	12.02	9.78	7.89	6.30	5.04	4.08	16.37
1993	0.02	0.14	2.58	7.32	34.02	50.38	41.51	47.71	50.58	40.63	37.84	24.47	9.30	3.85	10.38	8.38	6.71	5.33	4.24	16.36
1994	0.03	0.23	1.54	21.59	32.11	58.06	52.29	37.79	41.66	43.16	34.07	31.29	19.99	7.52	3.08	8.25	6.62	5.27	4.16	15.30
1995	0.02	0.25	1.75	9.31	73.84	44.08	48.57	38.31	26.55	28.60	29.13	22.67	20.56	13.00	4.85	1.97	5.24	4.18	3.31	11.63
1996	0.01	0.25	2.03	11.00	31.20	94.08	33.47	32.21	24.37	16.51	17.48	17.55	13.49	12.12	7.59	2.81	1.13	3.00	2.38	8.09
1997	0.01	0.17	2.39	14.72	42.90	47.05	85.57	26.66	24.63	18.21	12.12	12.65	12.55	9.55	8.50	5.28	1.94	0.78	2.05	6.82
1998	0.01	0.10	1.38	15.10	50.27	56.95	37.75	60.16	17.99	16.24	11.80	7.74	7.99	7.84	5.91	5.22	3.22	1.18	0.47	5.09
1999	0.01	0.17	1.25	12.93	76.33	99.12	68.28	39.72	60.76	17.76	15.75	11.29	7.32	7.47	7.27	5.44	4.77	2.93	1.06	4.75
2000	0.01	0.16	1.53	8.47	45.09	100.90	78.52	47.32	26.41	39.48	11.34	9.92	7.02	4.51	4.56	4.40	3.27	2.85	1.74	3.28
2001	0.01	0.10	1.06	7.71	23.52	50.74	70.09	47.95	27.73	15.13	22.23	6.30	5.44	3.81	2.42	2.43	2.33	1.72	1.49	2.52
2002	0.02	0.22	1.34	10.27	38.71	46.71	62.44	76.00	49.93	28.23	15.13	21.92	6.13	5.25	3.64	2.30	2.29	2.18	1.60	3.59
2003	0.02	0.21	1.86	8.78	37.16	58.32	44.25	52.17	60.95	39.13	21.74	11.49	16.45	4.55	3.86	2.66	1.67	1.65	1.56	3.56
2004	0.01	0.19	1.86	12.58	32.21	55.35	53.93	36.02	40.76	46.54	29.36	16.08	8.40	11.90	3.26	2.75	1.88	1.17	1.15	3.43
2005	0.01	0.11	1.52	11.75	44.47	46.61	49.71	42.63	27.32	30.22	33.91	21.09	11.41	5.90	8.28	2.25	1.88	1.28	0.79	2.96
2006	0.01	0.10	1.34	13.87	56.25	83.25	53.38	50.01	41.16	25.79	28.02	31.00	19.05	10.20	5.23	7.28	1.97	1.63	1.11	3.09
2007	0.01	0.11	1.23	11.81	63.19	99.37	89.53	50.32	45.23	36.38	22.40	24.00	26.23	15.95	8.47	4.30	5.95	1.60	1.32	3.23
2008	0.01	0.09	0.73	6.13	31.94	68.24	65.44	51.61	27.82	24.43	19.31	11.72	12.41	13.42	8.09	4.26	2.15	2.96	0.79	2.15
2009	0.00	0.08	0.73	4.87	22.49	47.16	61.92	52.14	39.46	20.78	17.94	13.98	8.38	8.78	9.42	5.63	2.95	1.48	2.02	1.92
2010	0.00	0.04	0.56	3.86	14.16	25.93	33.11	38.12	30.80	22.78	11.79	10.04	7.73	4.59	4.76	5.07	3.01	1.56	0.78	2.02
2011	0.00	0.02	0.34	3.37	13.08	19.33	21.78	24.46	27.04	21.35	15.52	7.92	6.66	5.08	2.99	3.08	3.25	1.92	0.99	1.69
2012	0.00	0.02	0.22	3.00	15.99	24.25	21.94	21.75	23.45	25.34	19.67	14.09	7.11	5.91	4.47	2.61	2.67	2.80	1.64	2.21
2013	0.00	0.03	0.16	1.45	10.84	23.22	21.71	17.29	16.45	17.34	18.41	14.09	9.97	4.98	4.10	3.08	1.78	1.81	1.89	2.51
2014	0.00	0.06	0.45	1.82	8.36	24.44	32.14	26.44	20.21	18.80	19.47	20.38	15.41	10.80	5.34	4.37	3.25	1.87	1.89	4.44
2015	0.00	0.03	0.38	2.46	5.53	10.30	18.49	21.34	16.85	12.58	11.50	11.75	12.15	9.09	6.31	3.10	2.52	1.86	1.07	3.45
2016	0.01	0.02	0.27	2.91	9.98	8.79	9.96	15.70	17.39	13.41	9.85	8.87	8.95	9.16	6.80	4.68	2.28	1.84	1.36	3.14
2017	0.01	0.09	0.22	2.37	13.54	18.03	9.65	9.60	14.52	15.71	11.92	8.62	7.68	7.67	7.78	5.72	3.92	1.90	1.52	3.55

Table 9. Estimated time series of landings in numbers (1000 fish) for the commercial fleet (L.COM) and general recreational (L.REC) from the RW approved Base Model.

Year	L.COM	L.REC	Total
1969	4.10	8.72	12.82
1970	5.44	8.74	14.18
1971	6.08	9.52	15.60
1972	4.45	11.73	16.18
1973	5.90	12.47	18.36
1974	8.11	13.11	21.21
1975	8.19	13.64	21.83
1976	10.45	13.48	23.93
1977	15.29	13.39	28.68
1978	33.79	13.56	47.35
1979	32.12	13.99	46.11
1980	31.05	14.83	45.88
1981	30.21	19.24	49.45
1982	47.10	19.79	66.88
1983	40.68	9.59	50.27
1984	40.79	20.51	61.29
1985	32.63	17.85	50.48
1986	36.34	11.39	47.74
1987	41.44	16.44	57.88
1988	44.91	38.03	82.94
1989	50.52	32.84	83.36
1990	66.46	47.58	114.04
1991	54.30	34.36	88.66
1992	110.82	31.46	142.28
1993	123.69	36.01	159.69
1994	130.24	50.28	180.52
1995	159.92	19.59	179.51
1996	137.83	20.14	157.97
1997	142.87	21.60	164.47
1998	136.87	23.06	159.93
1999	197.67	29.90	227.56
2000	147.28	49.60	196.89
2001	104.96	31.14	136.10
2002	105.86	64.23	170.10
2003	115.22	49.64	164.86
2004	113.80	46.15	159.95
2005	124.89	32.41	157.30
2006	148.87	53.82	202.69
2007	159.34	77.48	236.81
2008	115.07	41.81	156.87
2009	109.15	25.20	134.34
2010	73.31	14.51	87.82
2011	61.66	7.95	69.61
2012	61.62	14.38	75.99
2013	51.99	10.88	62.87
2014	56.73	19.67	76.41
2015	42.62	7.83	50.44
2016	38.29	8.49	46.78
2017	40.36	12.53	52.89
.	.	.	.

Table 10. Estimated time series of landings in whole weight (1000 lb) for the commercial fleet (L.COM) and general recreational (L.REC) from the RW approved Base Model.

Year	L.COM	L.REC	Total
1969	33.65	62.16	95.81
1970	44.59	62.32	106.91
1971	49.89	67.89	117.78
1972	36.52	83.62	120.14
1973	48.36	88.84	137.20
1974	66.47	93.31	159.78
1975	67.15	96.96	164.11
1976	85.51	95.70	181.22
1977	125.03	94.83	219.86
1978	275.52	95.61	371.13
1979	260.73	97.92	358.65
1980	250.77	103.05	353.82
1981	242.71	132.83	375.55
1982	376.09	135.64	511.73
1983	322.59	65.45	388.04
1984	321.71	141.32	463.03
1985	257.34	124.85	382.19
1986	289.48	78.35	367.83
1987	331.89	107.75	439.65
1988	350.41	240.20	590.61
1989	378.70	204.69	583.38
1990	486.92	295.79	782.71
1991	394.68	213.88	608.56
1992	288.85	77.15	365.99
1993	316.06	85.67	401.73
1994	313.35	110.66	424.01
1995	348.33	39.49	387.82
1996	291.35	39.44	330.79
1997	293.76	40.79	334.55
1998	270.24	42.18	312.43
1999	388.88	55.49	444.37
2000	303.55	97.24	400.79
2001	230.12	64.63	294.75
2002	240.51	137.41	377.92
2003	265.01	107.06	372.07
2004	260.58	98.23	358.81
2005	277.21	66.91	344.13
2006	323.72	110.01	433.74
2007	349.19	161.44	510.63
2008	262.43	91.27	353.69
2009	263.83	58.28	322.11
2010	185.73	34.98	220.71
2011	160.26	19.62	179.88
2012	162.82	36.31	199.12
2013	142.37	28.75	171.12
2014	164.84	55.09	219.93
2015	128.41	22.34	150.75
2016	112.08	23.28	135.36
2017	111.52	32.51	144.03
.	.	.	.

Table 11. Estimated status indicators, benchmarks, and related quantities from the RW approved Base Model run of the Beaufort Assessment Model, conditional on estimated current selectivities averaged across fleets. Median values and standard deviations (SD) approximated from the ensemble model are also provided. Rate estimates (F) are in units of y^{-1}*; status indicators are dimensionless; and biomass estimates are whole weight in units of metric tons or pounds, as indicated. Spawning stock biomass (SSB) is measured as mature female biomass.*

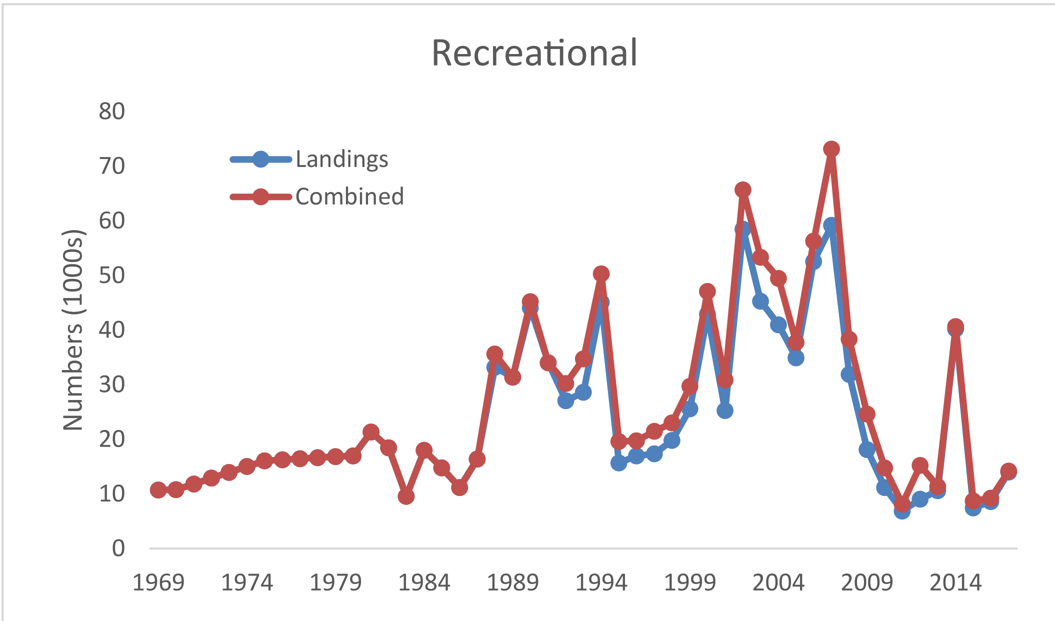
Quantity	Units	Estimate	Median	SD
F_{MSY}	y^{-1}	0.22	0.23	0.05
B_{MSY}	mt	2779.88	2627	129
SSB_{MSY}	mt	1965.83	1859	108
MSST	mt	1474.37	1394	81
MSY	1000 lb	214.23	211	12
R_{MSY}	1000 age-1 fish	754	685	43
$F_{2015-2017}/F_{\text{MSY}}$	—	1.17	1.18	0.37
$\text{SSB}_{2017}/\text{MSST}$	—	0.55	0.56	0.10
$\text{SSB}_{2017}/\text{SSB}_{\text{MSY}}$	—	0.42	0.42	0.08

Table 12. Estimated Dirichlet-multinomial composition parameters before and after Francis re-weighting applied to indices.

Parameter	Before	After
com LC	2.520	2.507
com D LC	-1.485	-1.487
rec LC	0.146	0.143
rec D LC	-0.352	-0.359
CVT LC	2.069	2.087
COM AC	0.016	0.025
REC AC	-0.672	-0.689
CVT AC	0.292	0.328

5 Figures

Figure 1. Top panel: Total removals for AW Base run (Landings in blue) and RW Run 1 (Combined in red). Bottom panel: Total discards (blue) compared to dead discards (red)



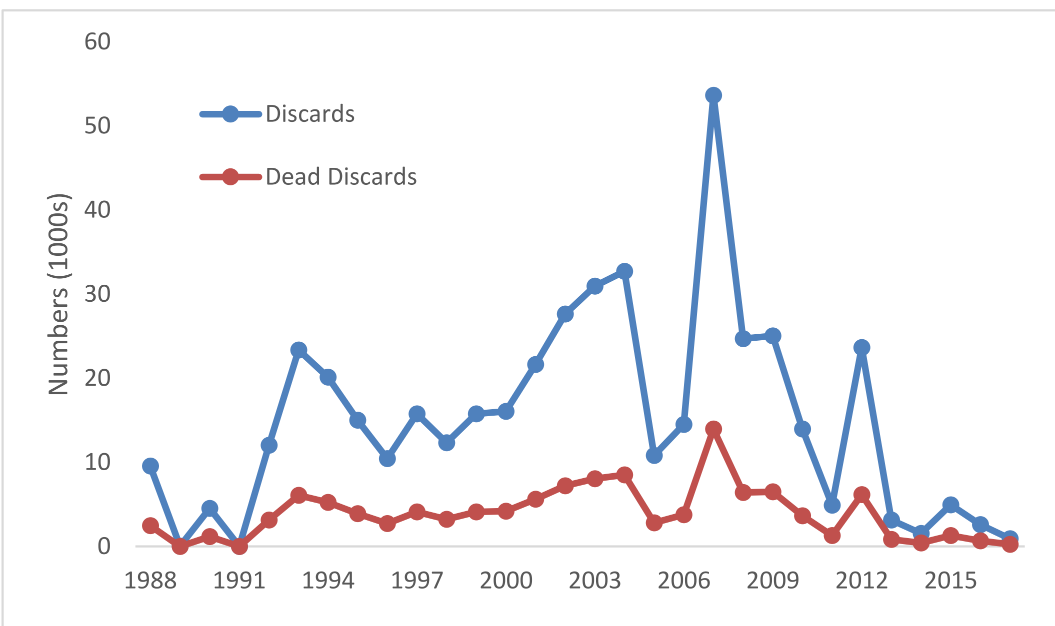


Figure 2. Top panel: Total removals for AW Base run (Landings in blue) and RW Run 1 (Combined in red). Bottom panel: Total discards (blue) compared to dead discards (red)

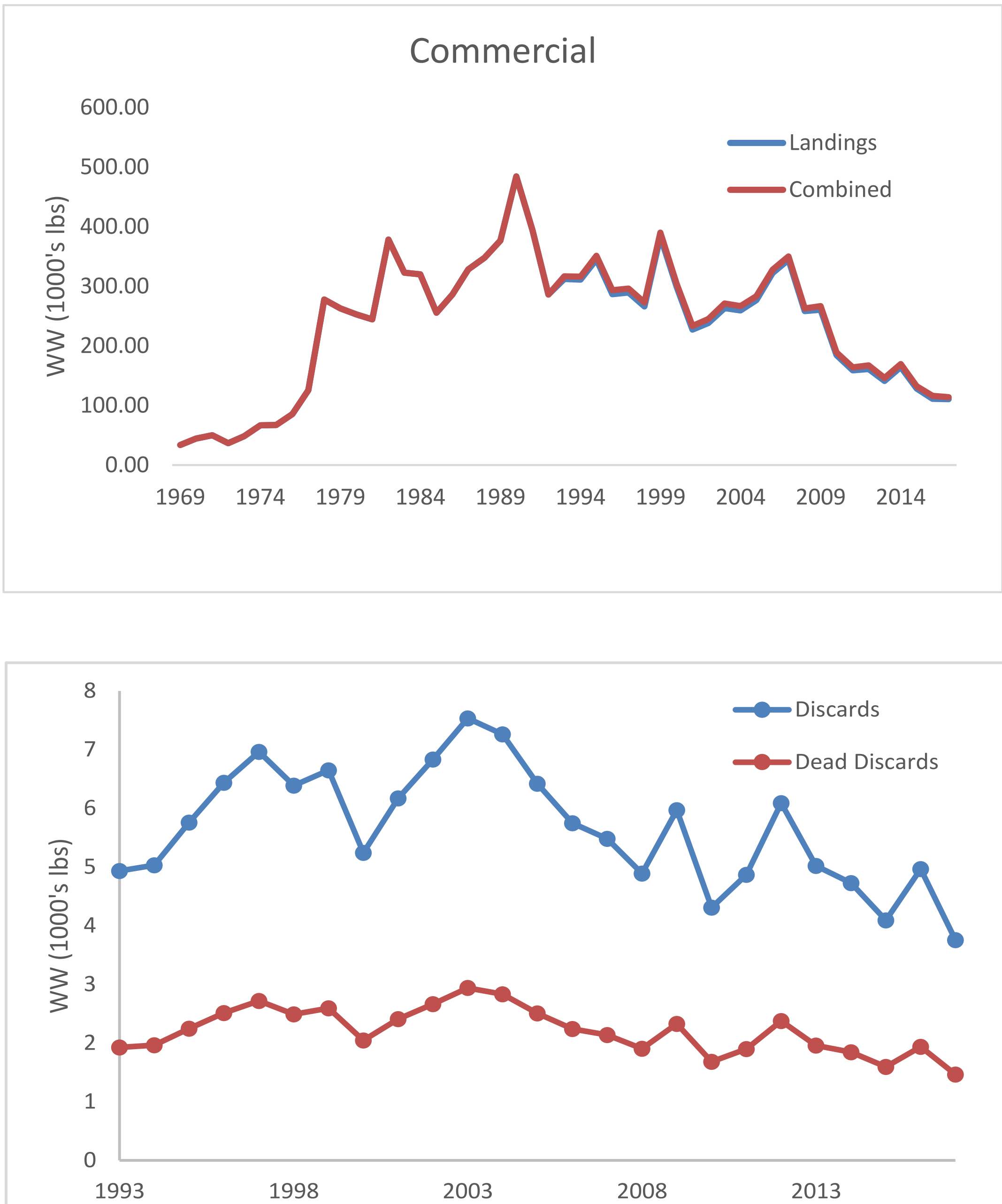


Figure 3. Observed (open circles) and estimated (solid line) annual length and age compositions by fleet or survey from the RW approved Base Model. In panels indicating the data set, lcomp refers to length compositions, acomp to age compositions, CVT to SERFS chevron traps, COM to the commercial fleet, and REC to recreational. N indicates the number of trips from which individual fish samples were taken. Effective N refers to the sample size from the Dirichlet multinomial distribution. Grayed out boxes not used in fitting due to insufficient sample size.

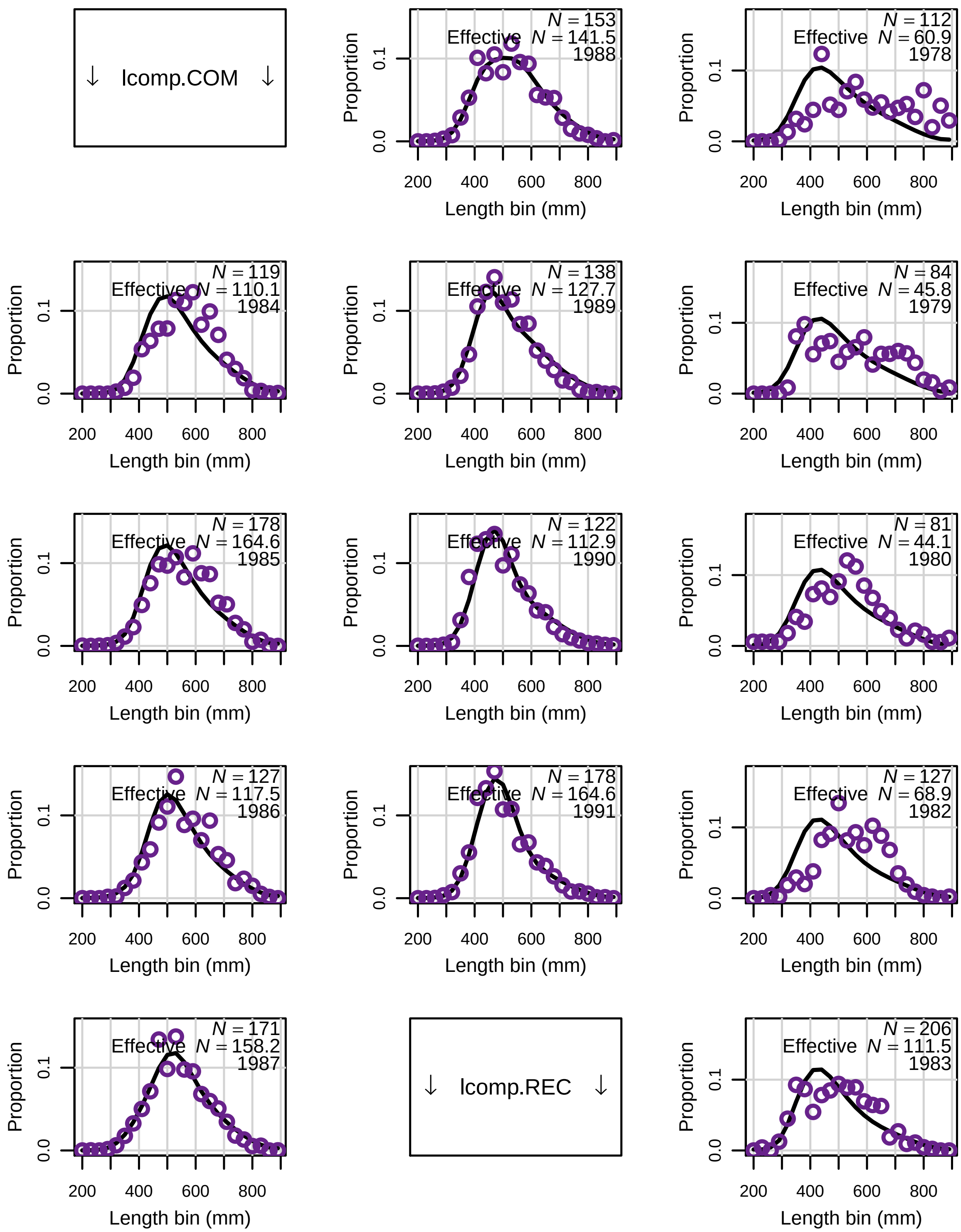


Figure 3. (cont.) Observed (open circles) and estimated (solid line) annual length and age compositions by fleet or survey from the RW approved Base Model.

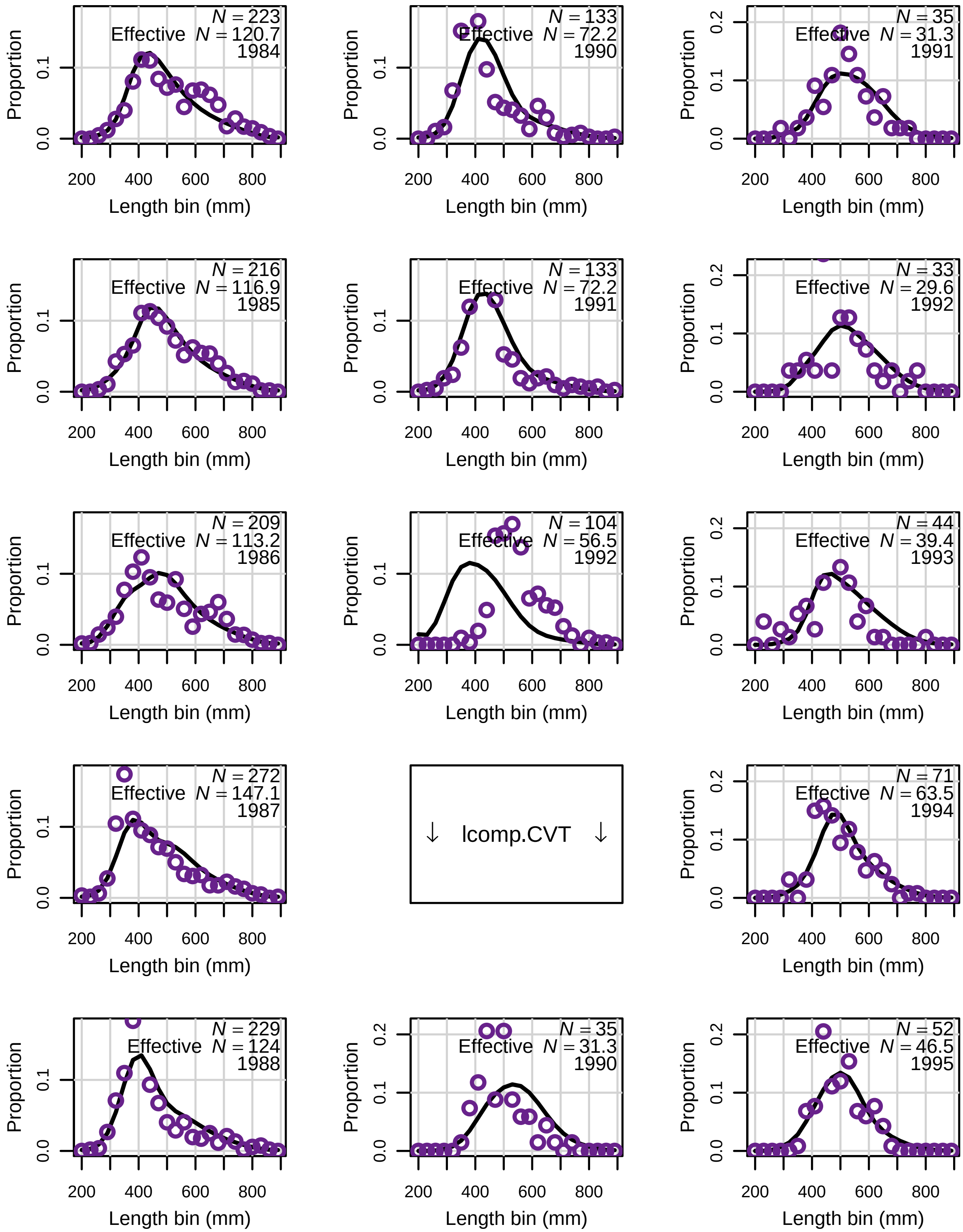


Figure 3. (cont.) Observed (open circles) and estimated (solid line) annual length and age compositions by fleet or survey from the RW approved Base Model.

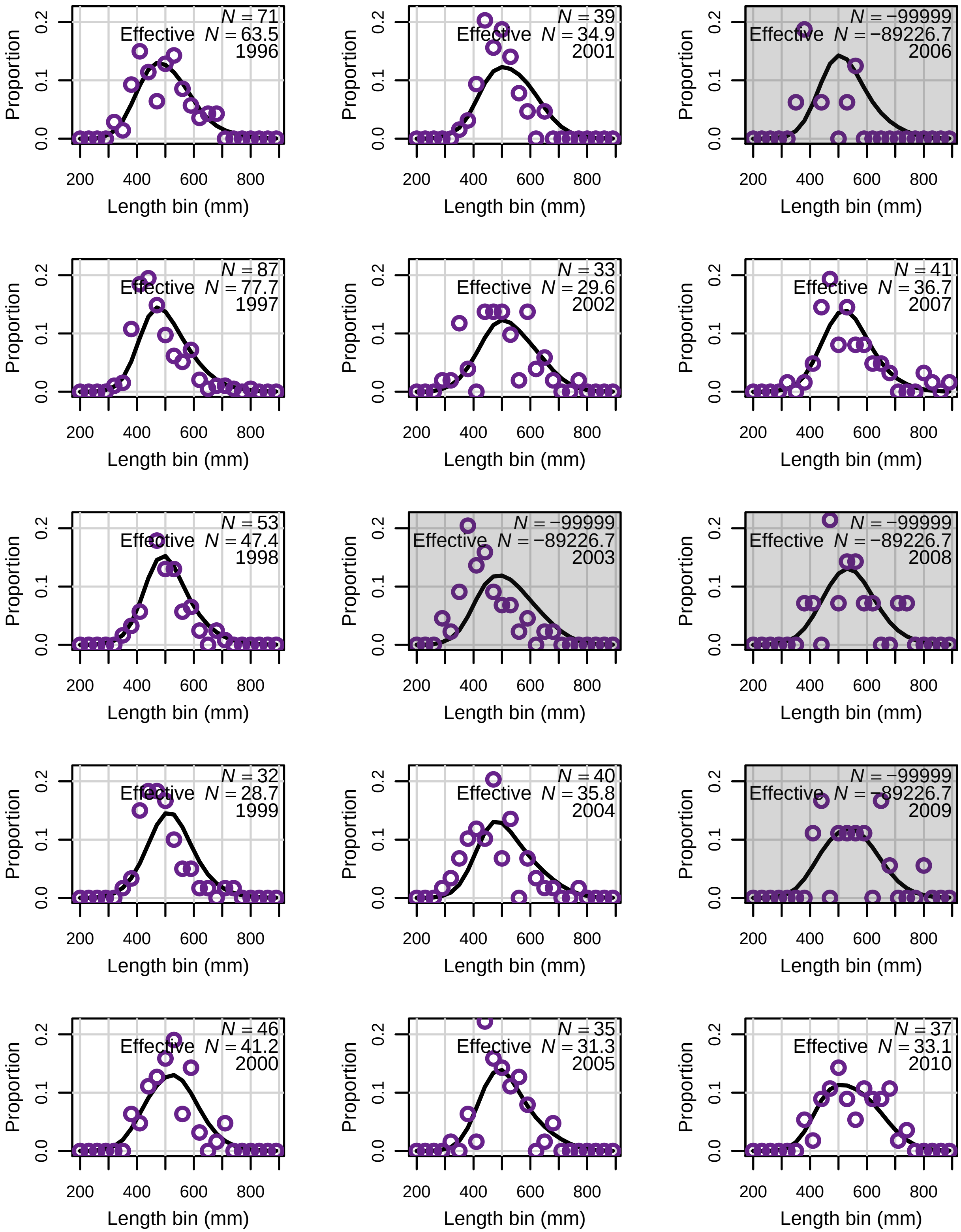


Figure 3. (cont.) Observed (open circles) and estimated (solid line) annual length and age compositions by fleet or survey from the RW approved Base Model.

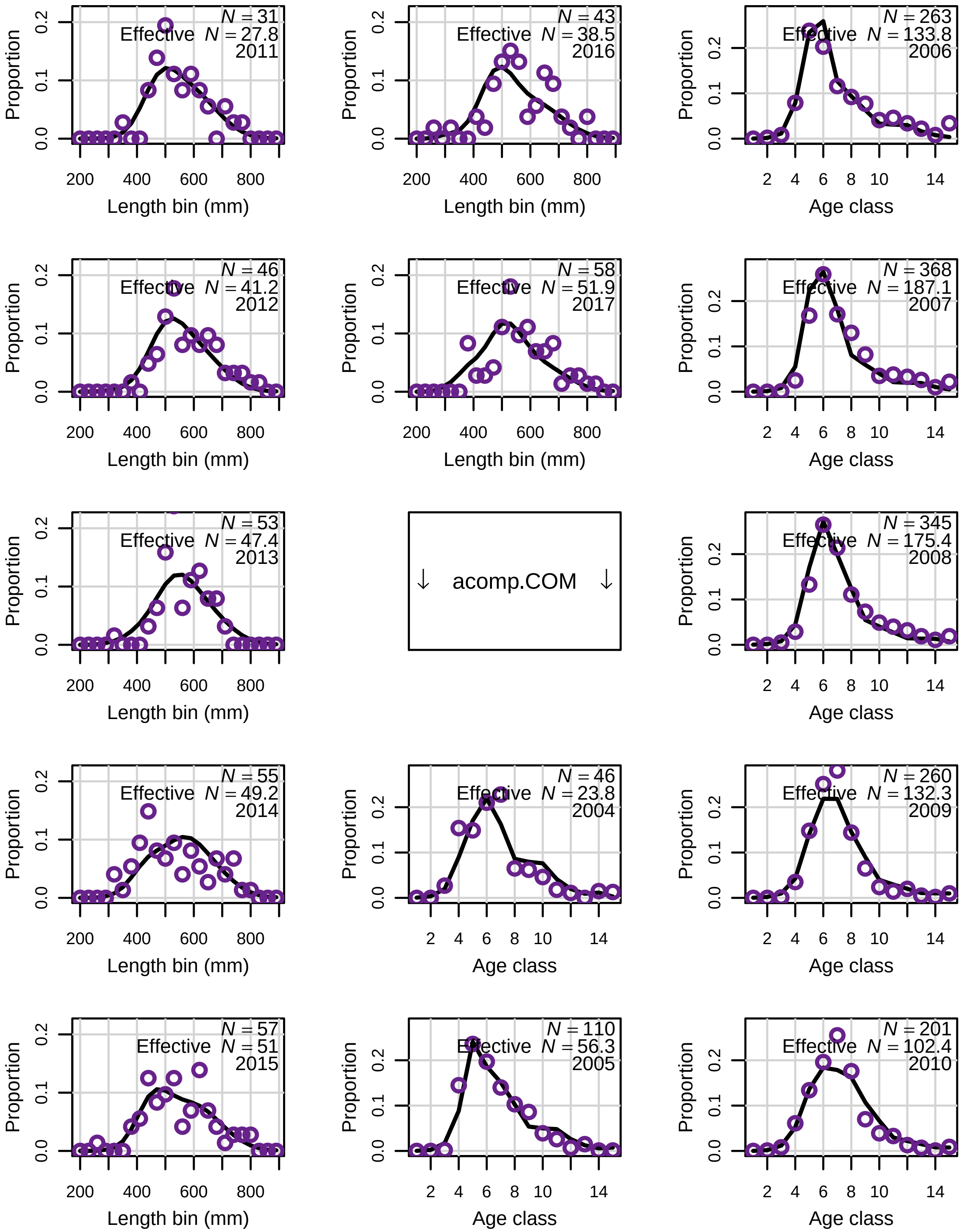


Figure 3. (cont.) Observed (open circles) and estimated (solid line) annual length and age compositions by fleet or survey from the RW approved Base Model.

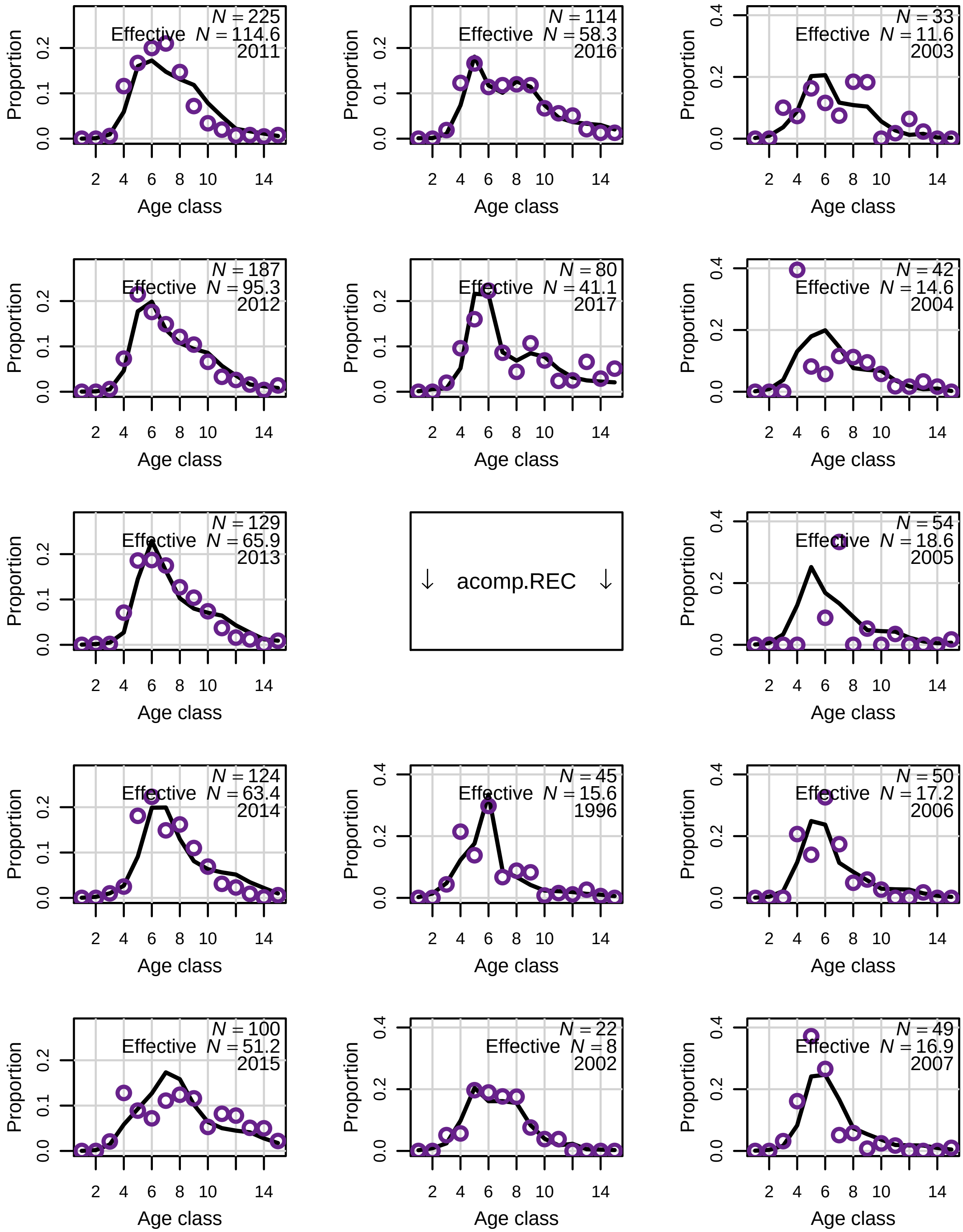


Figure 3. (cont.) Observed (open circles) and estimated (solid line) annual length and age compositions by fleet or survey from the RW approved Base Model.

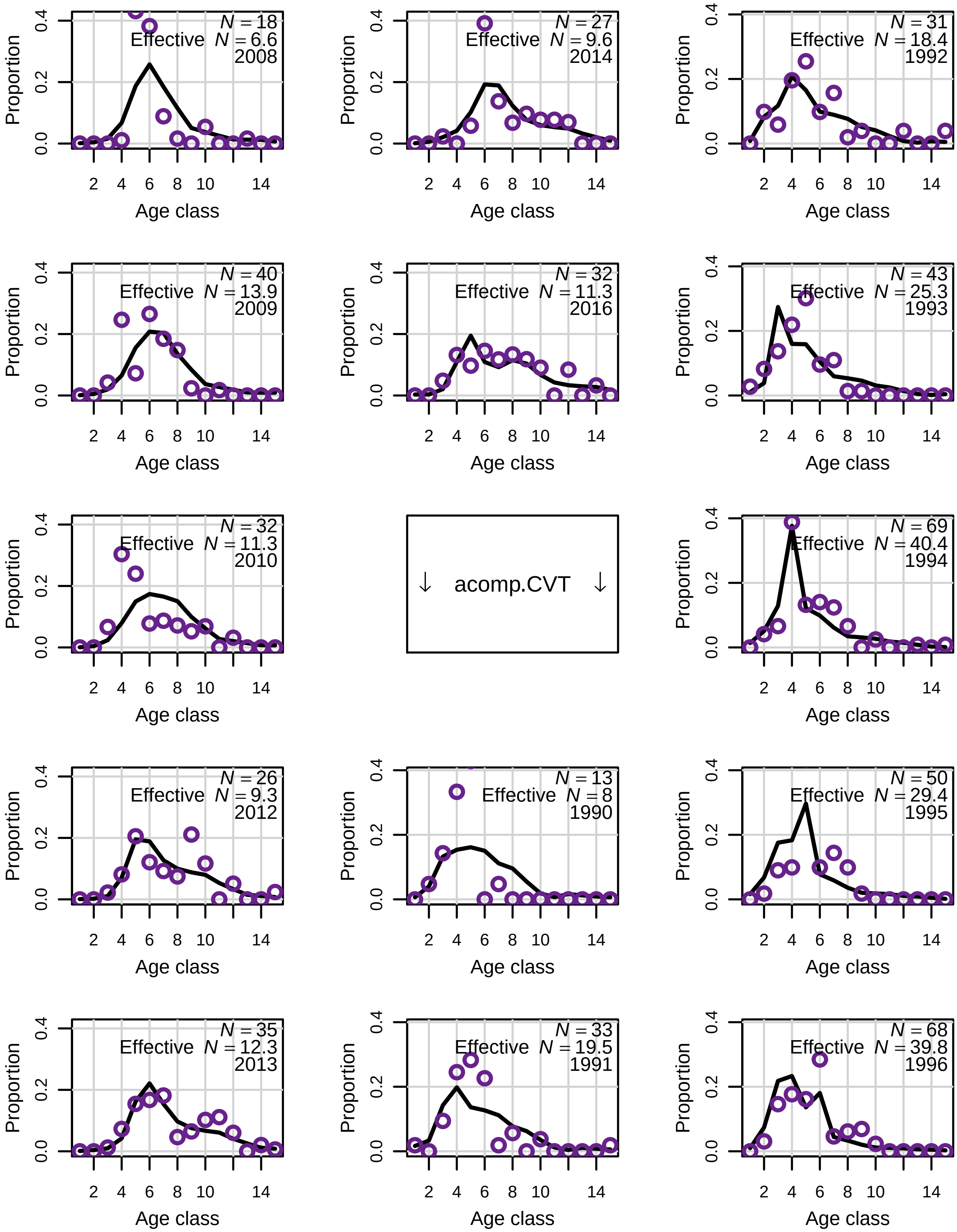


Figure 3. (cont.) Observed (open circles) and estimated (solid line) annual length and age compositions by fleet or survey from the RW approved Base Model.

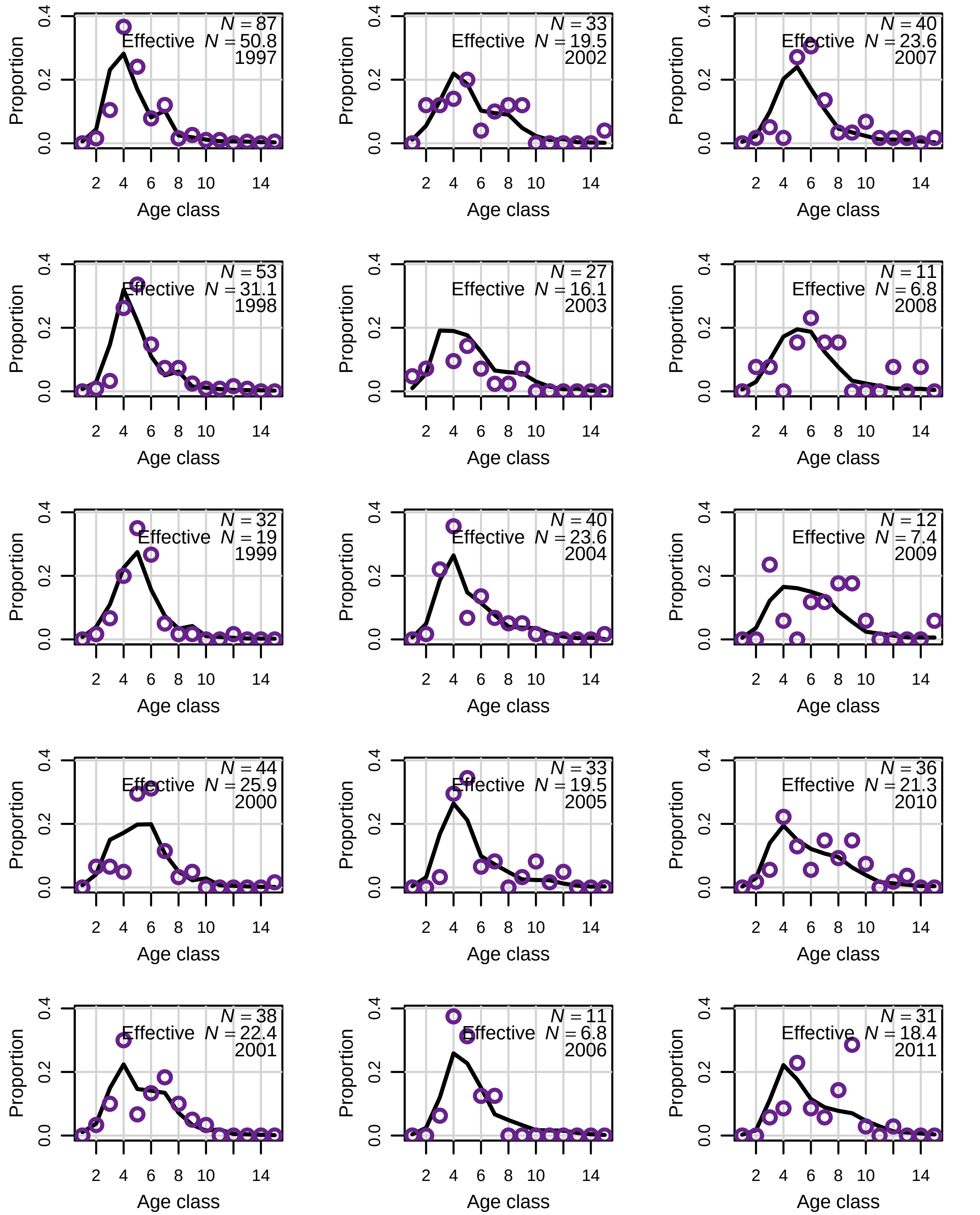


Figure 3. (cont.) Observed (open circles) and estimated (solid line) annual length and age compositions by fleet or survey from the RW approved Base Model.

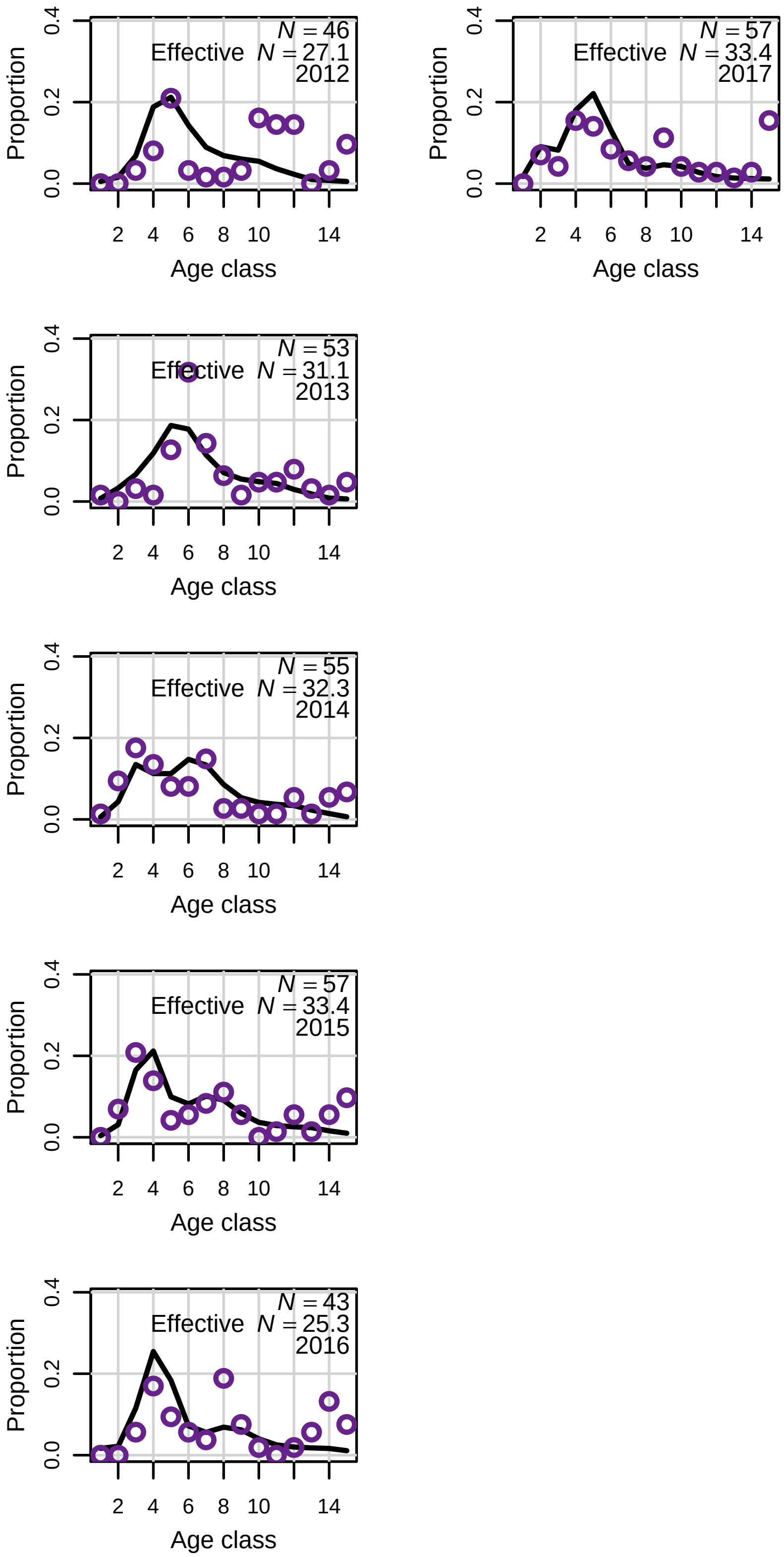


Figure 4. Observed (open circles) and estimated (line, solid circles) commercial landings (1000 lb whole weight) from the RW approved Base Model.

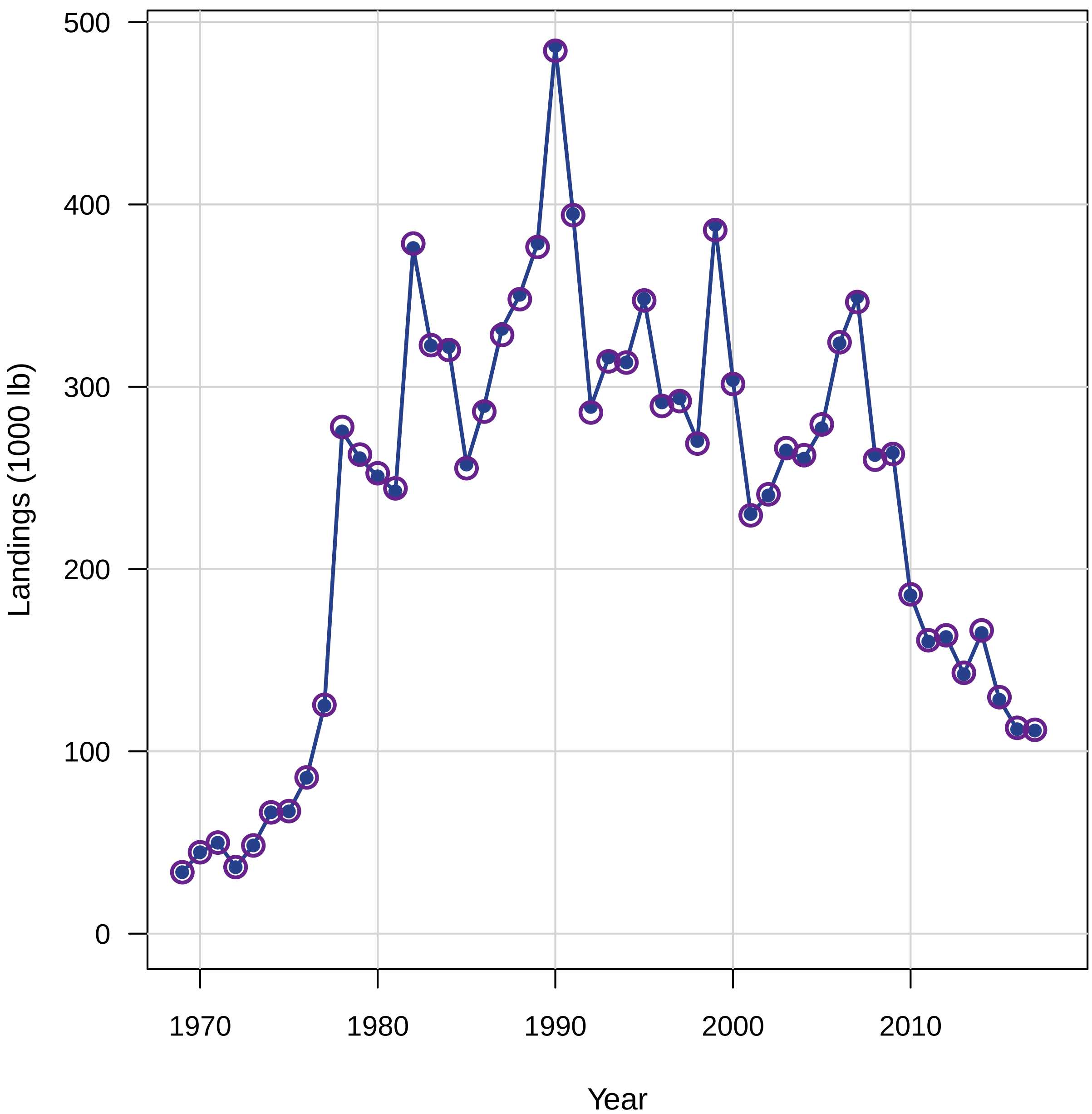


Figure 5. Observed (open circles) and estimated (line, solid circles) recreational landings (1000 fish) from the RW approved Base Model.

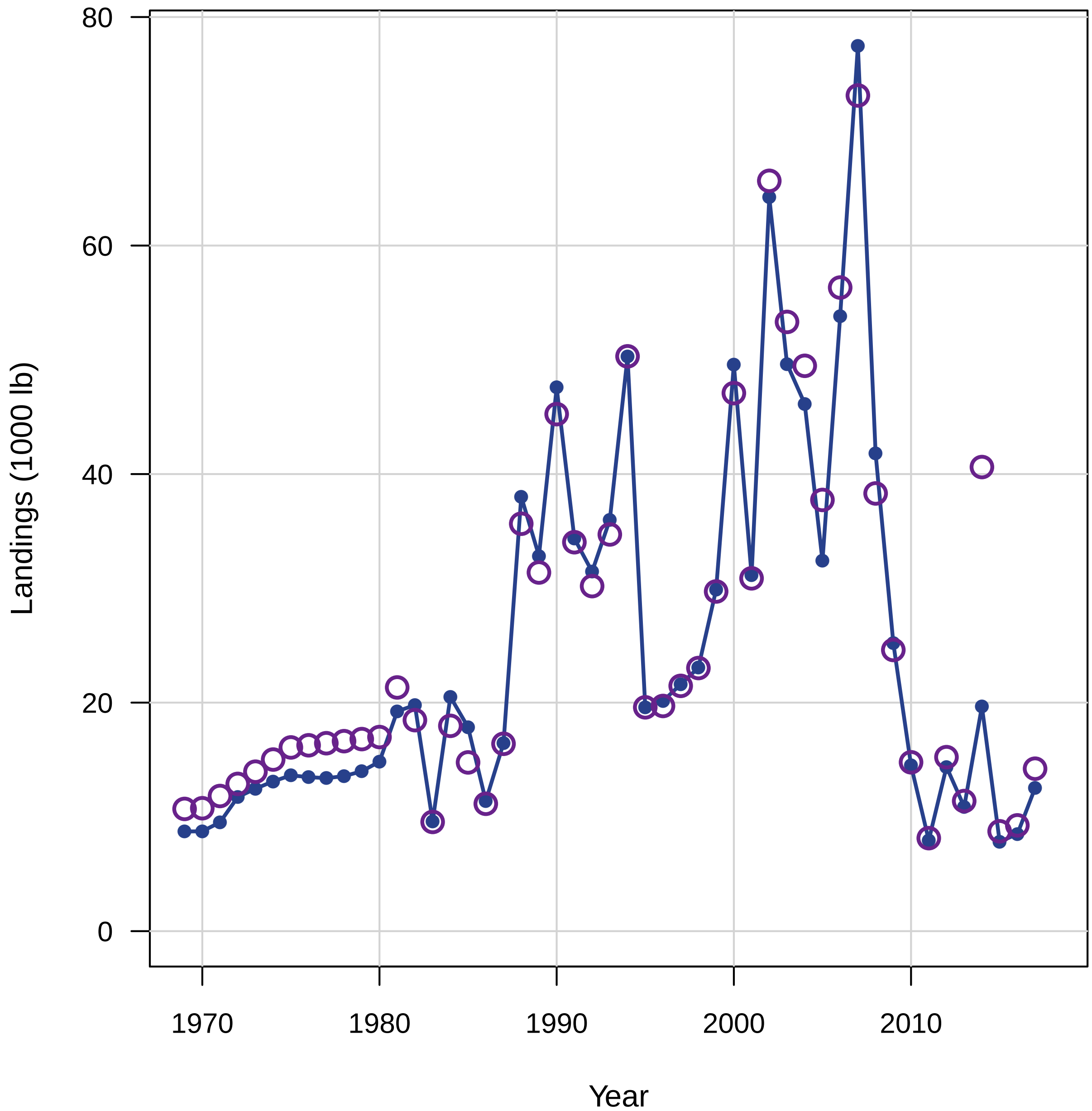


Figure 6. Observed (open circles) and estimated (line, solid circles) index of abundance from the recreational fleet from the RW approved Base Model.

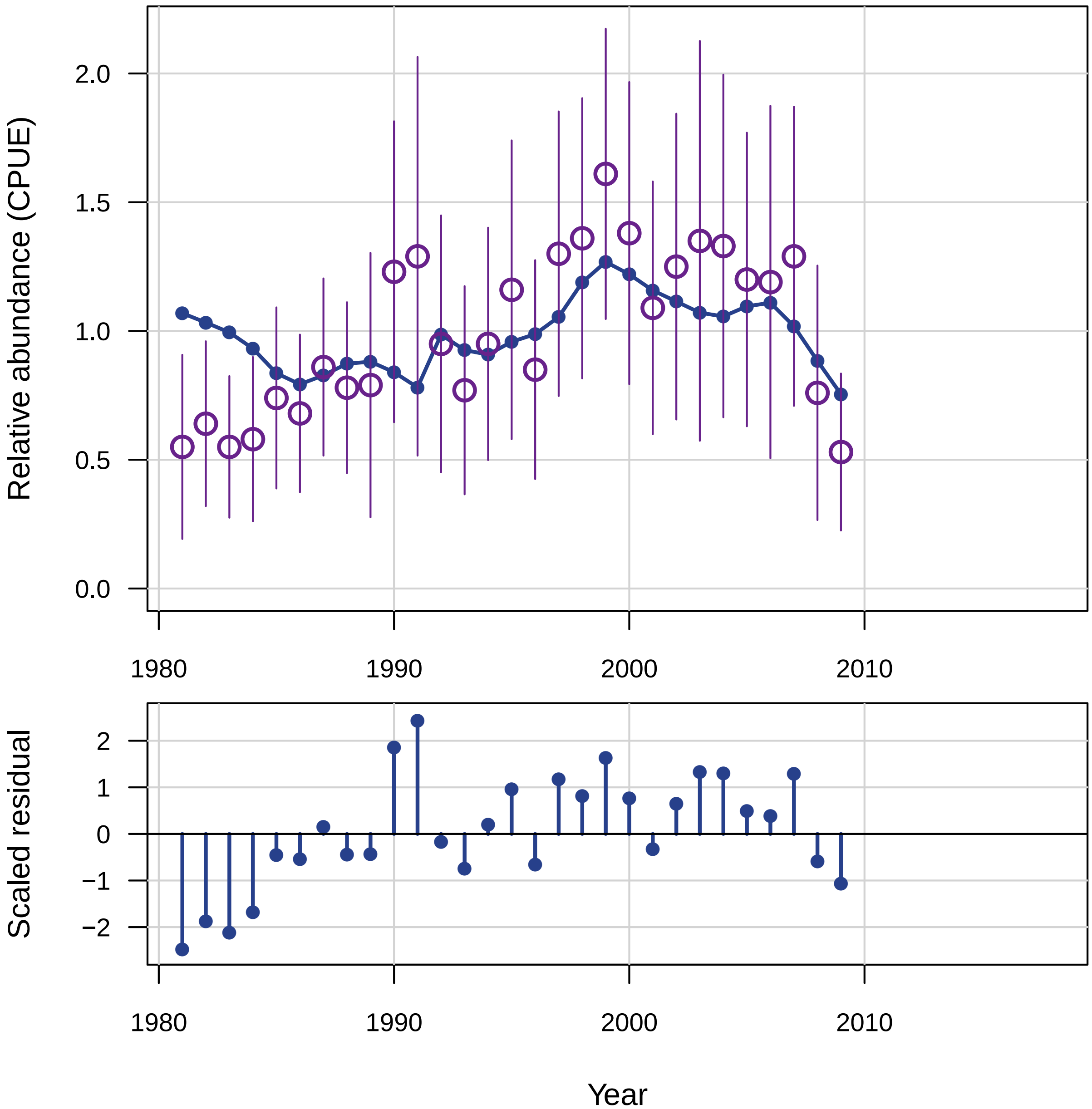


Figure 7. Observed (open circles) and estimated (line, solid circles) index of abundance from the commercial fleet from the RW approved Base Model.

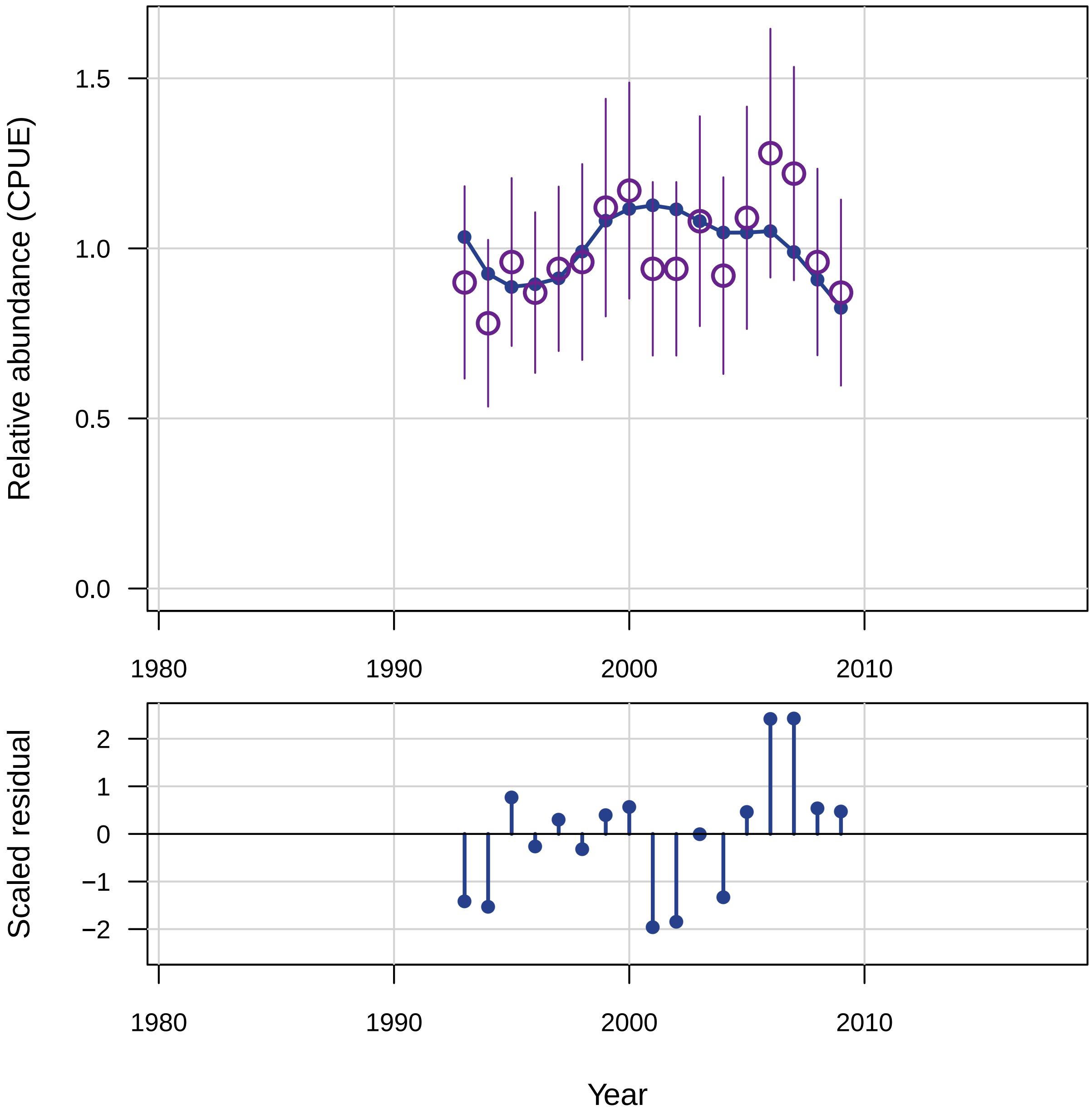


Figure 8. Observed (open circles) and estimated (line, solid circles) index of abundance from the combined SERFS chevron trap and video surveys from the RW approved Base Model.

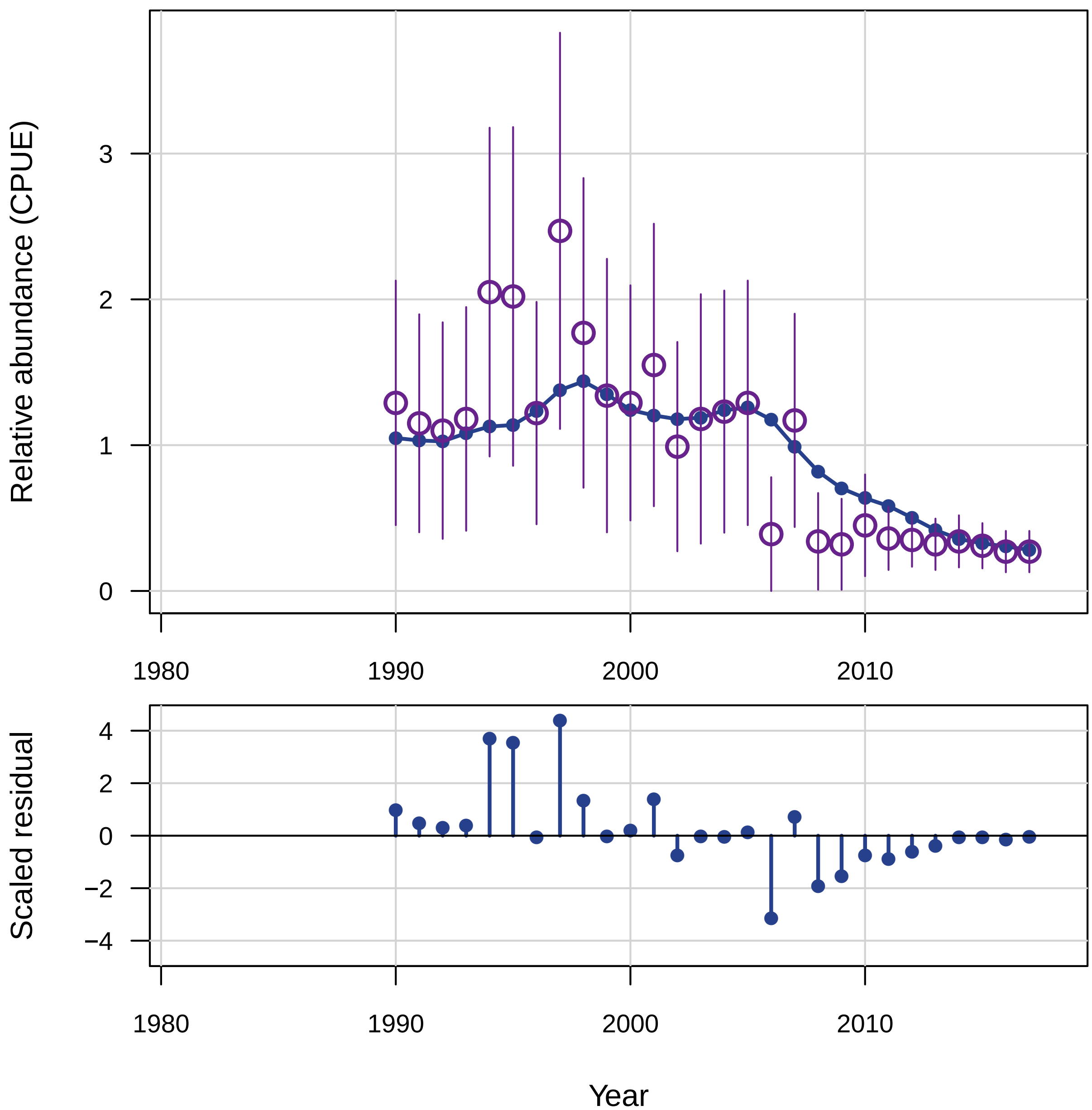


Figure 9. Estimated abundance at age at start of year from the RW approved Base Model.

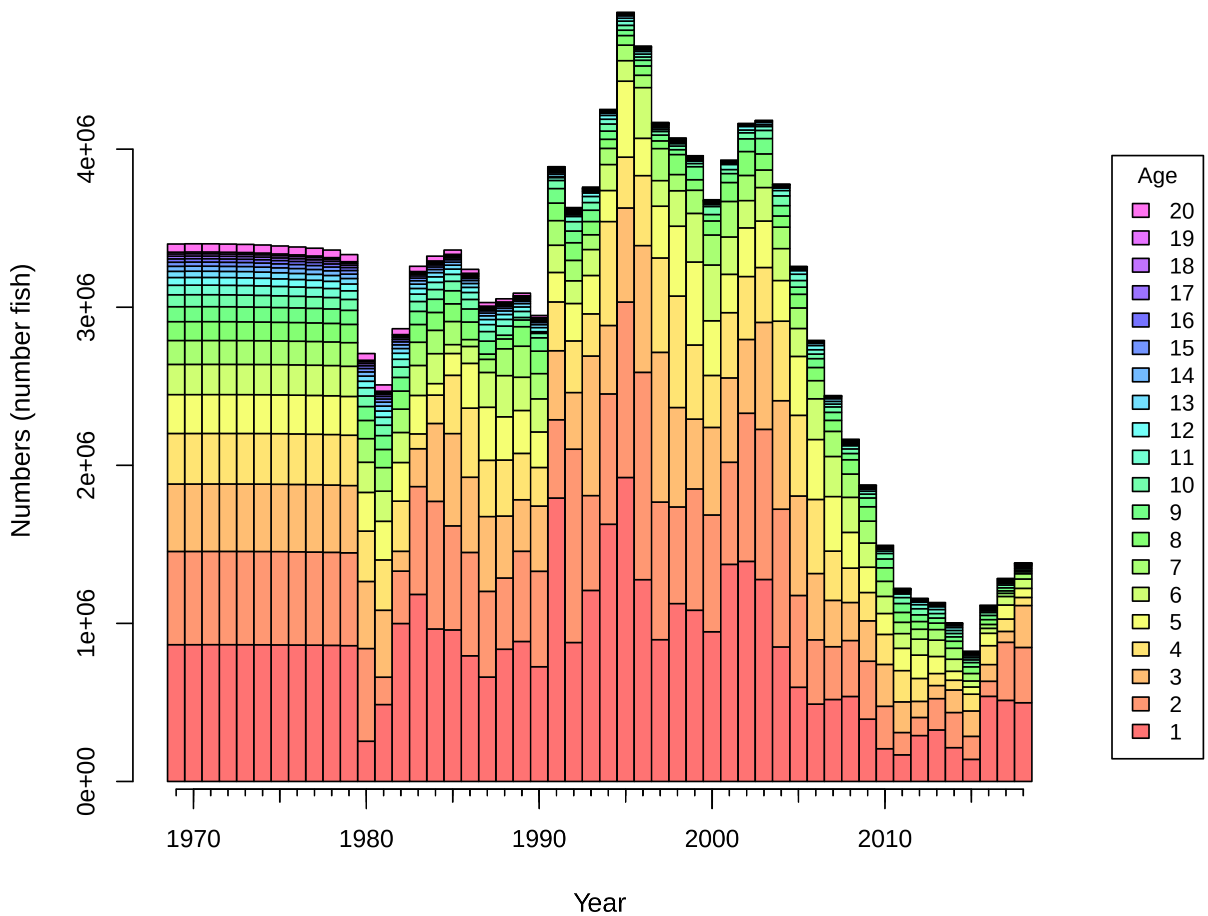


Figure 10. Top panel: Estimated recruitment of age-1 fish from the RW approved Base Model. Horizontal dashed line indicates R_{MSY}. Bottom panel: log recruitment residuals.

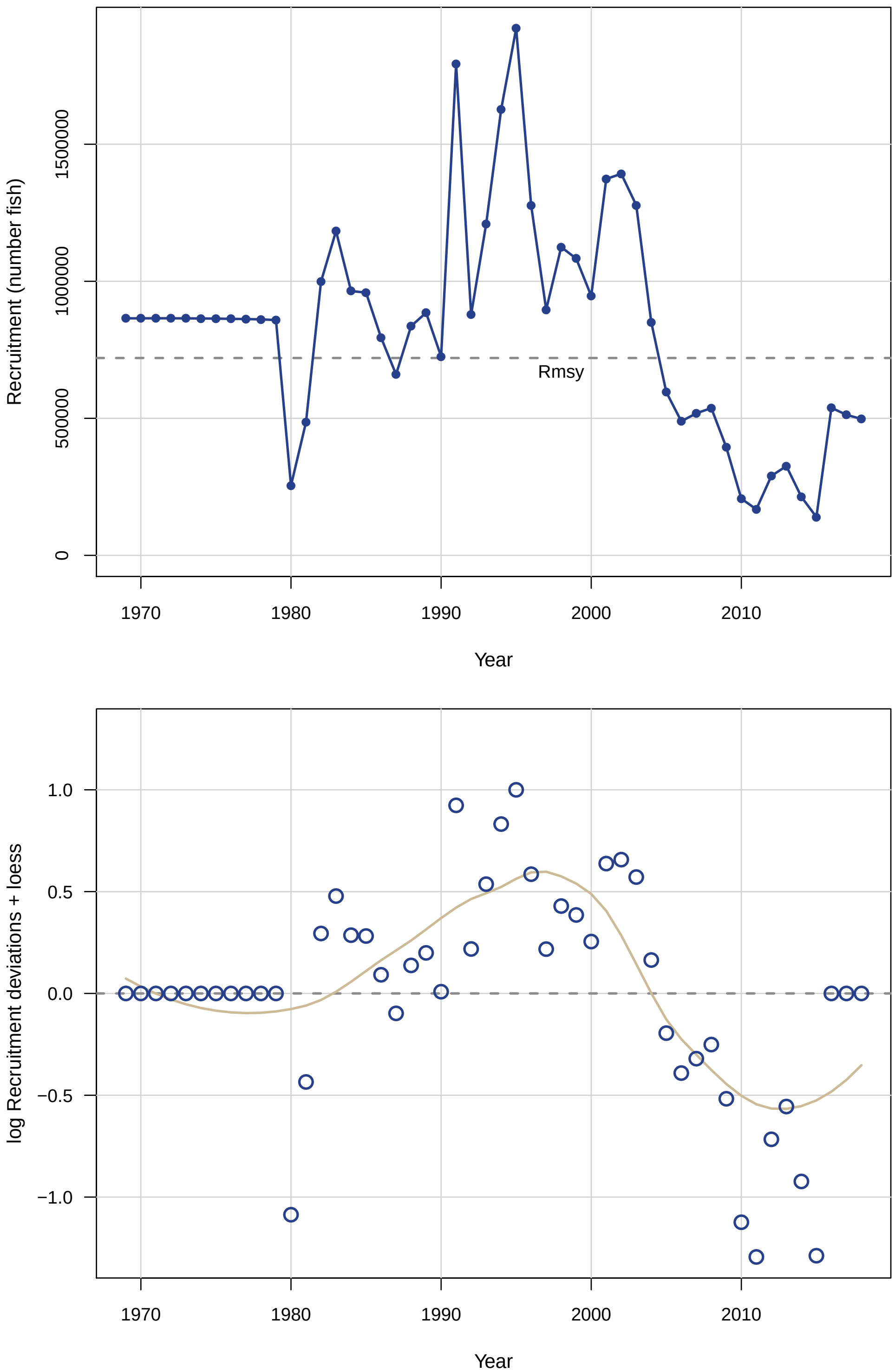


Figure 11. Estimated biomass at age at start of year from the RW approved Base Model.

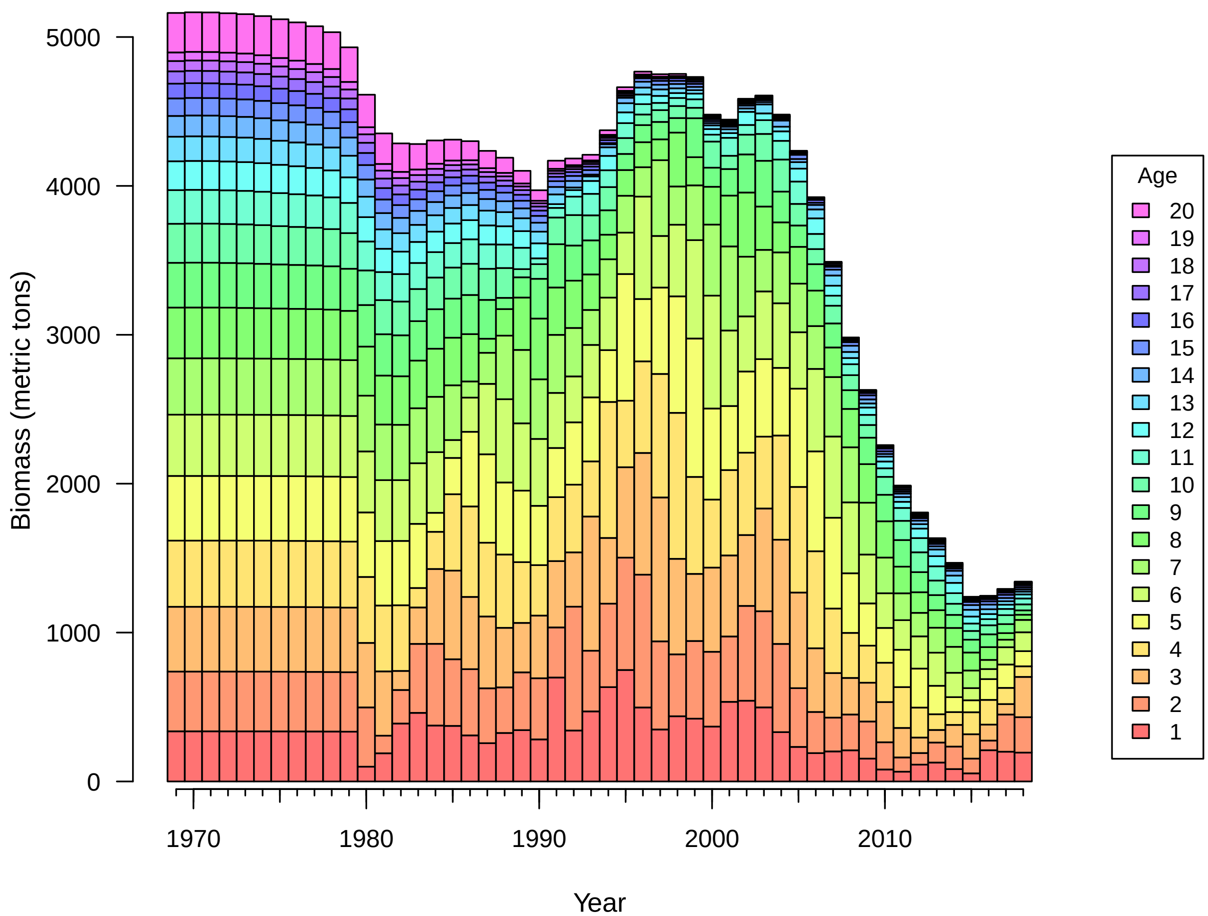


Figure 12. Top panel: Estimated total biomass (metric tons) at start of year from the RW approved Base Model. Horizontal dashed line indicates B_{MSY}. Bottom panel: Estimated spawning stock (mature female biomass) at time of peak spawning.

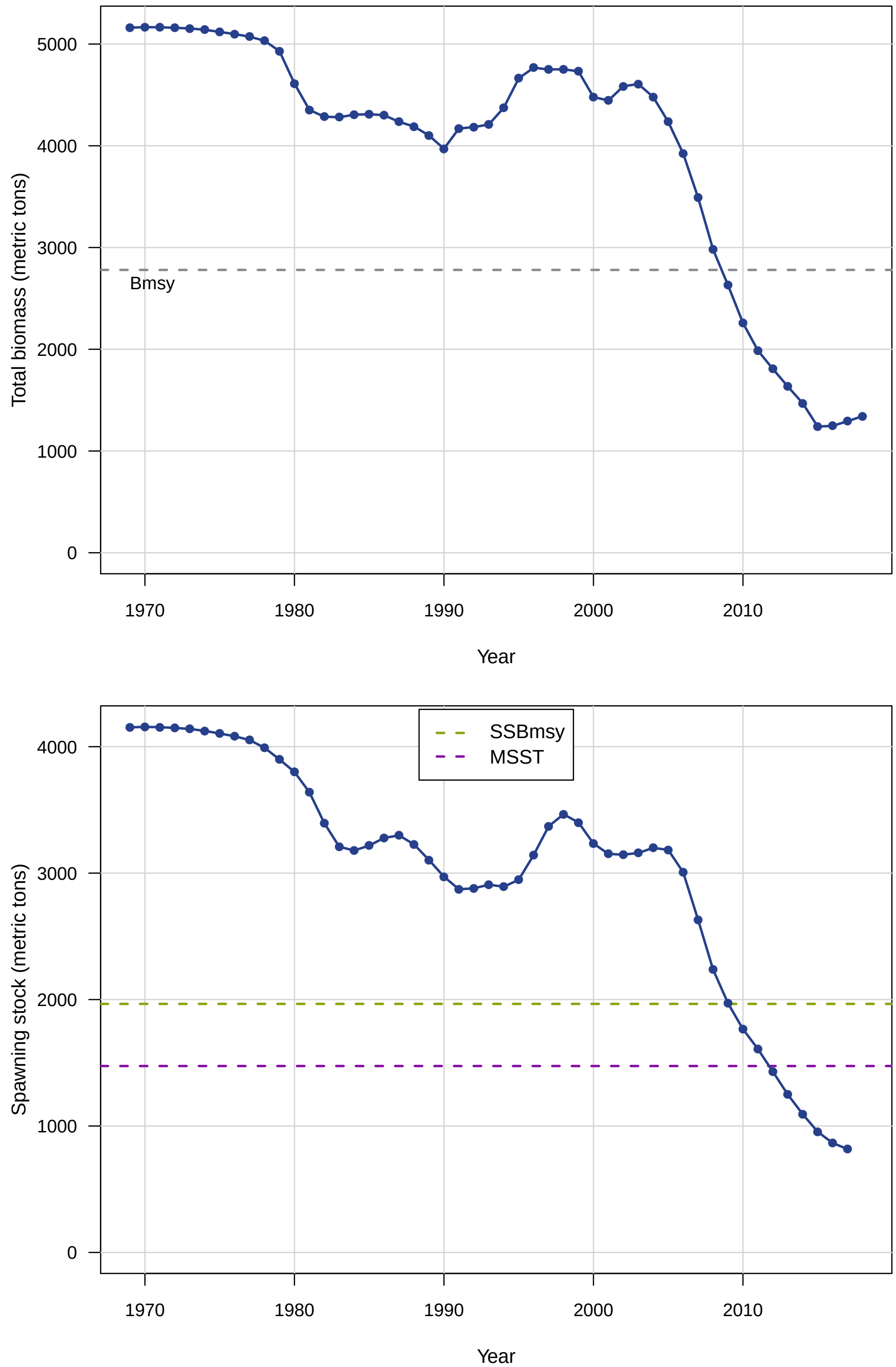


Figure 13. Estimated selectivities of the commercial fleet from the RW approved Base Model. Years indicated on plot signify the first year of a time block.

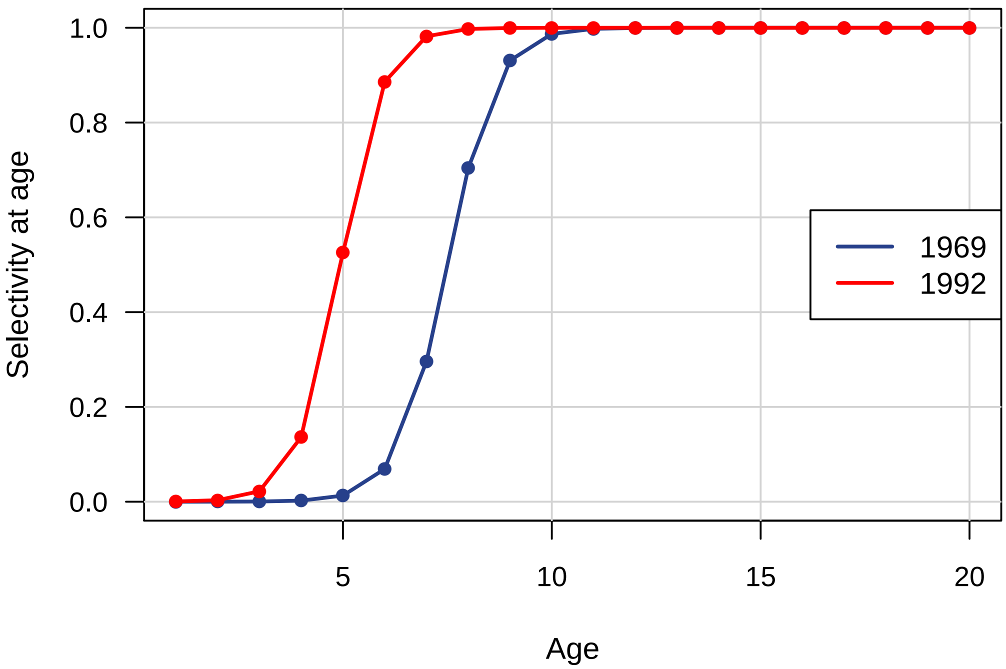


Figure 14. Estimated selectivities of the recreational fleet from the RW approved Base Model. Years indicated on plot signify the first year of a time block.

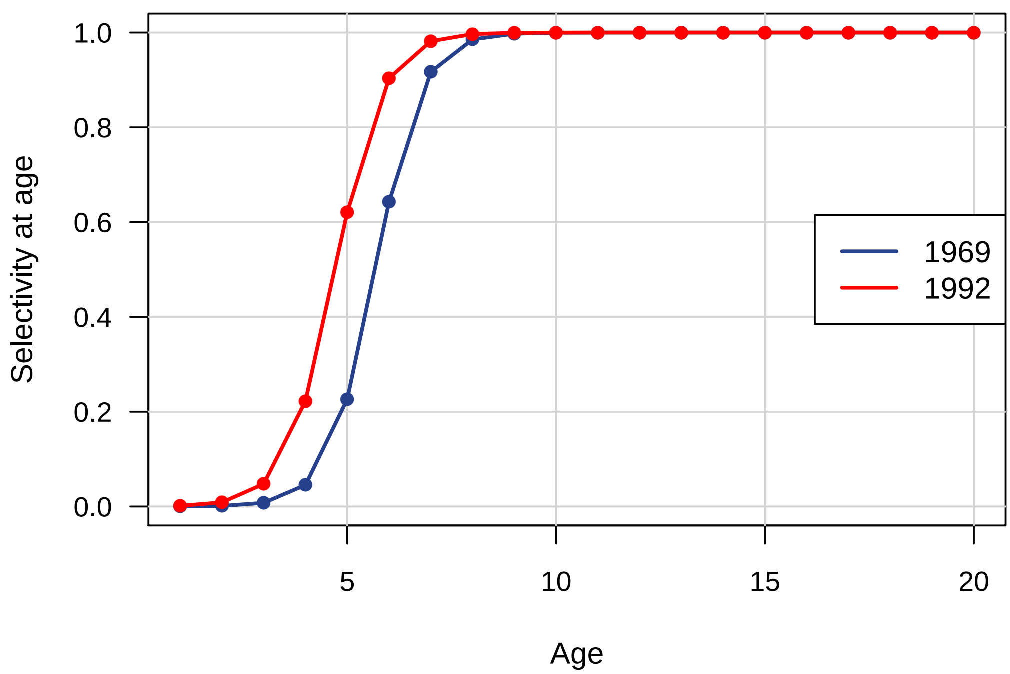


Figure 15. Estimated selectivity of the SERFS index from the RW approved Base Model.

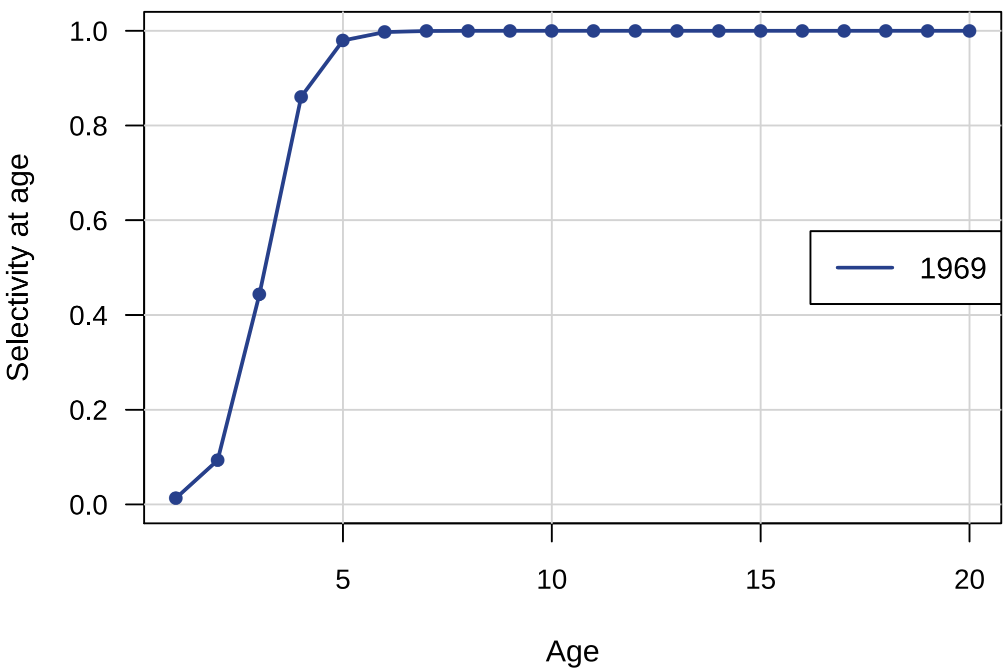


Figure 16. Estimated fully selected fishing mortality rate (per year) by fishery. COM refers to commercial, REC refers to recreational.

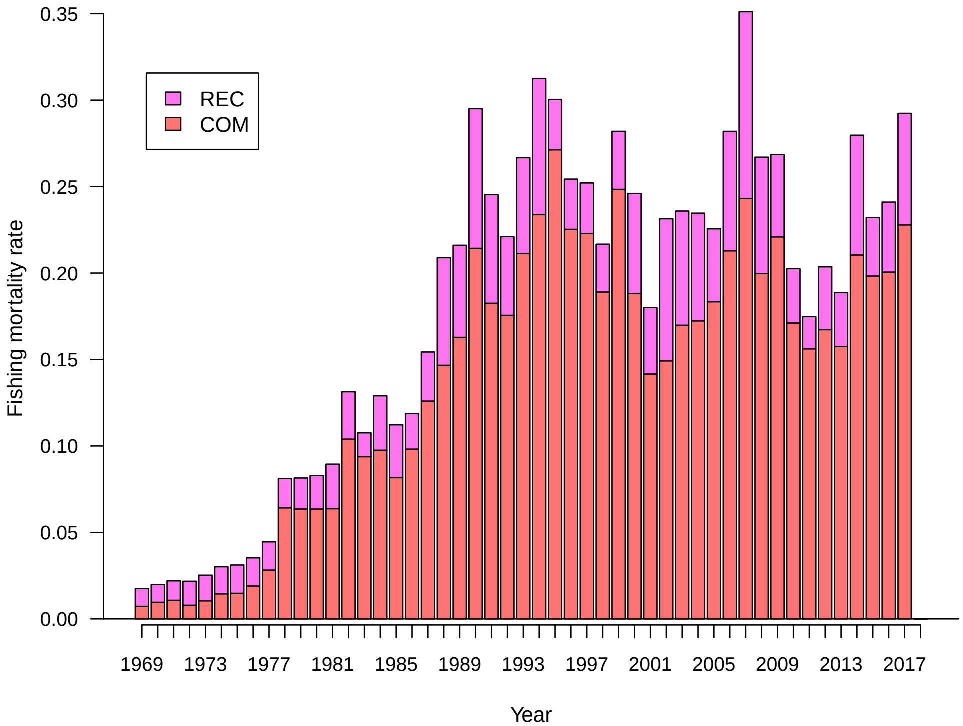
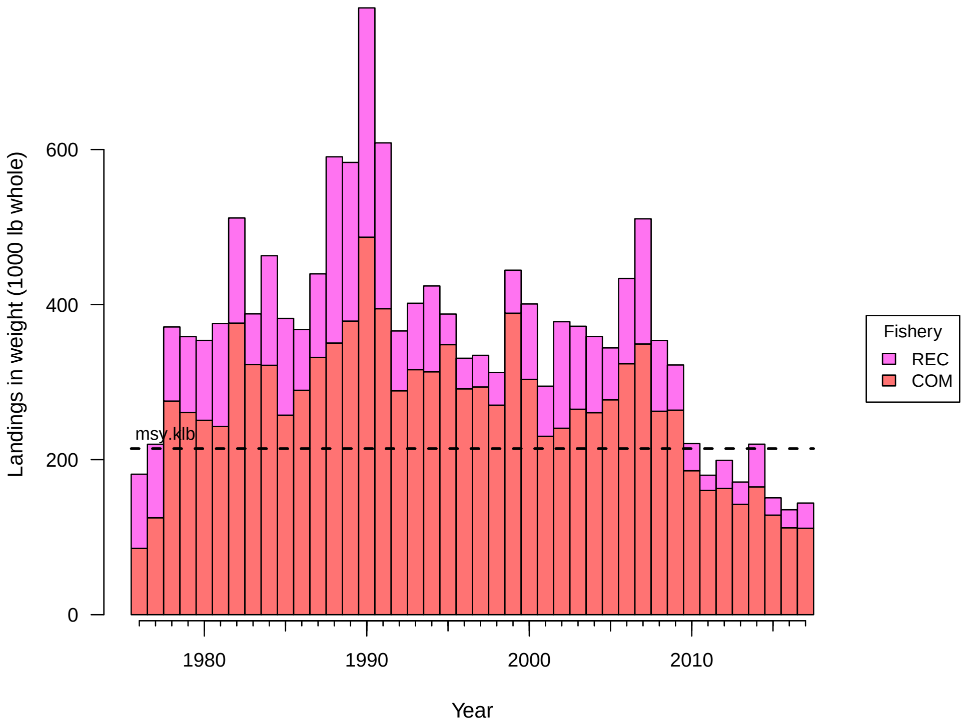


Figure 17. Estimated landings in weight (klb) by fishery from the catch-age model for RW approved Base Model. COM refers to commercial and REC to recreational.



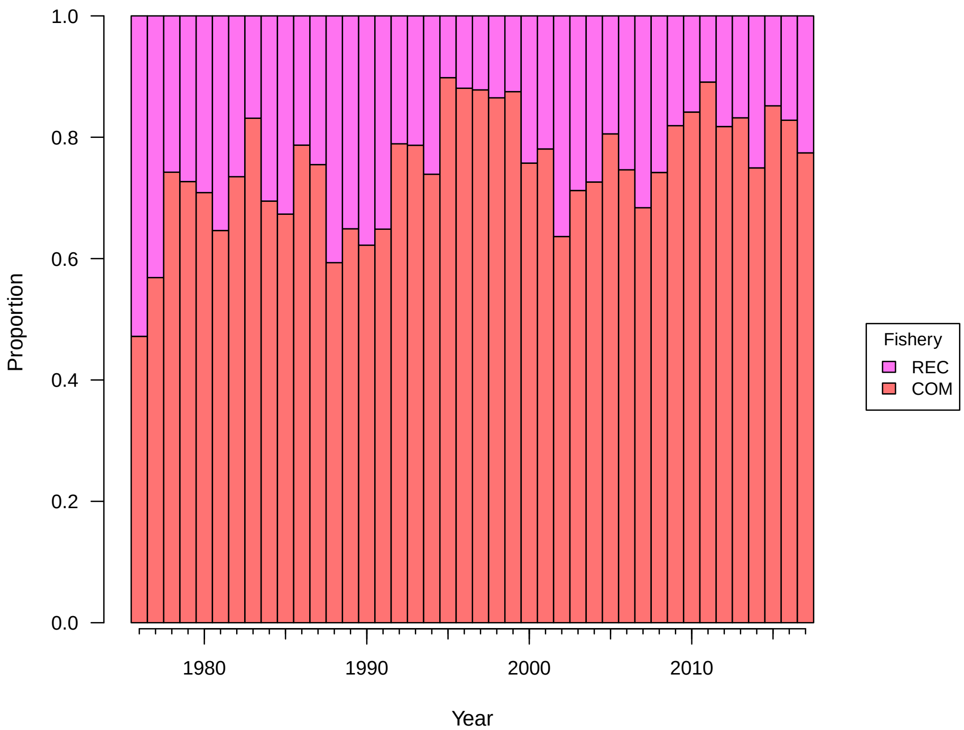


Figure 18. Estimated landings in numbers (1000s) by fishery from the catch-age model for RW approved Base Model. COM refers to commercial and REC to general recreational.

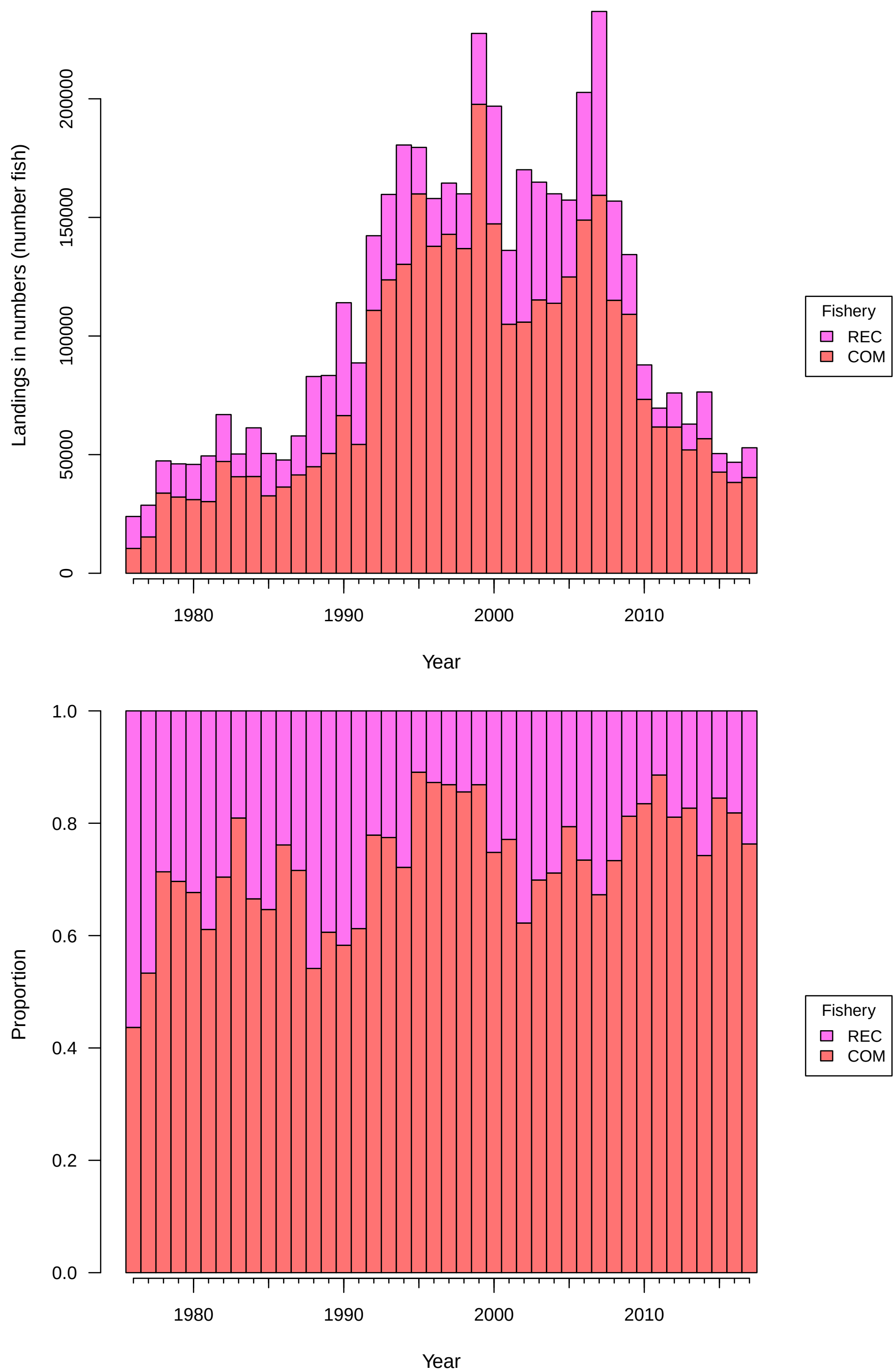
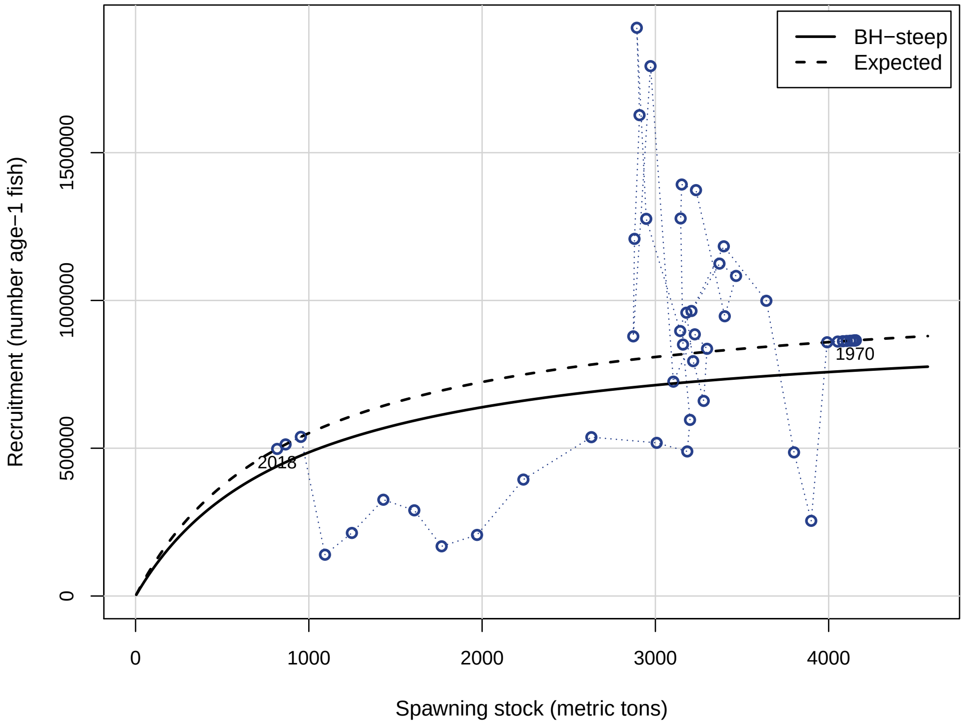


Figure 19. Top panel: Beverton–Holt spawner-recruit curves, with and without lognormal bias correction from the RW approved Base Model. The expected (upper) curve was used for computing management benchmarks. Years within panel indicate year of recruitment generated from spawning biomass. Bottom panel: log of recruits (number age-1 fish) per spawner as a function of spawners from the RW approved Base Model.



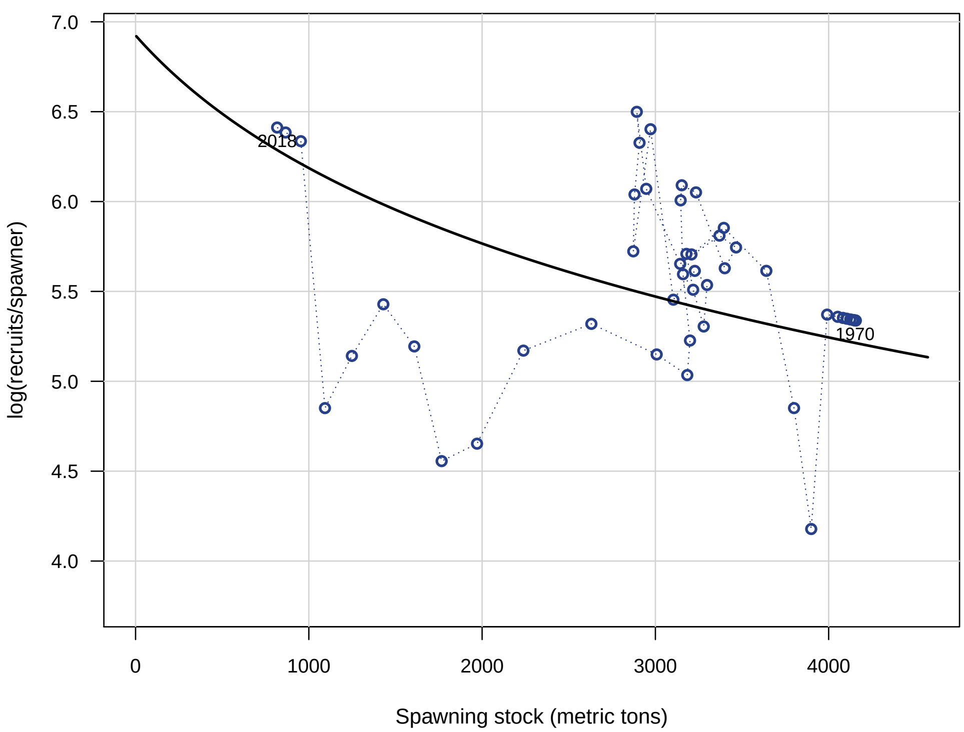


Figure 20. Probability densities of spawner-recruit quantities R0 (unfished recruitment of age-1 fish), the SD of recruitment residuals, steepness, and unfished spawners per recruit. Vertical lines represent point estimates or values from the RW approved Base Model of the Beaufort Assessment Model.

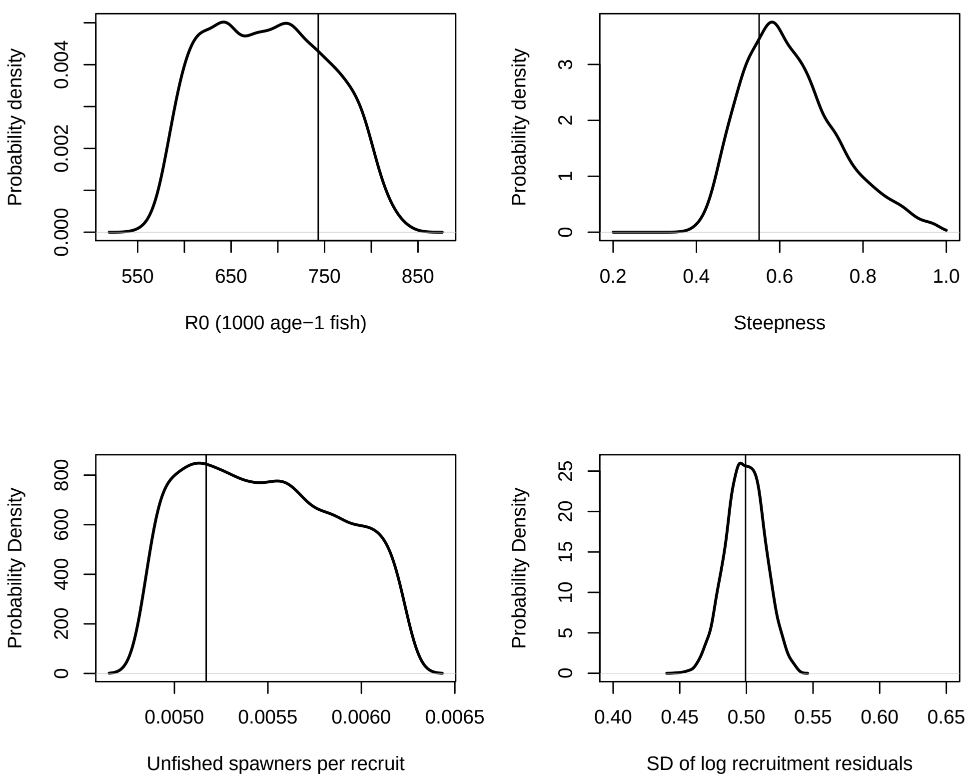


Figure 21. Top panel: yield per recruit (lb). Bottom panel: Spawning potential ratio (spawning biomass per recruit relative to that at the unfished level). Both curves are based on average selectivity from the end of the assessment period from the RW approved Base Model.

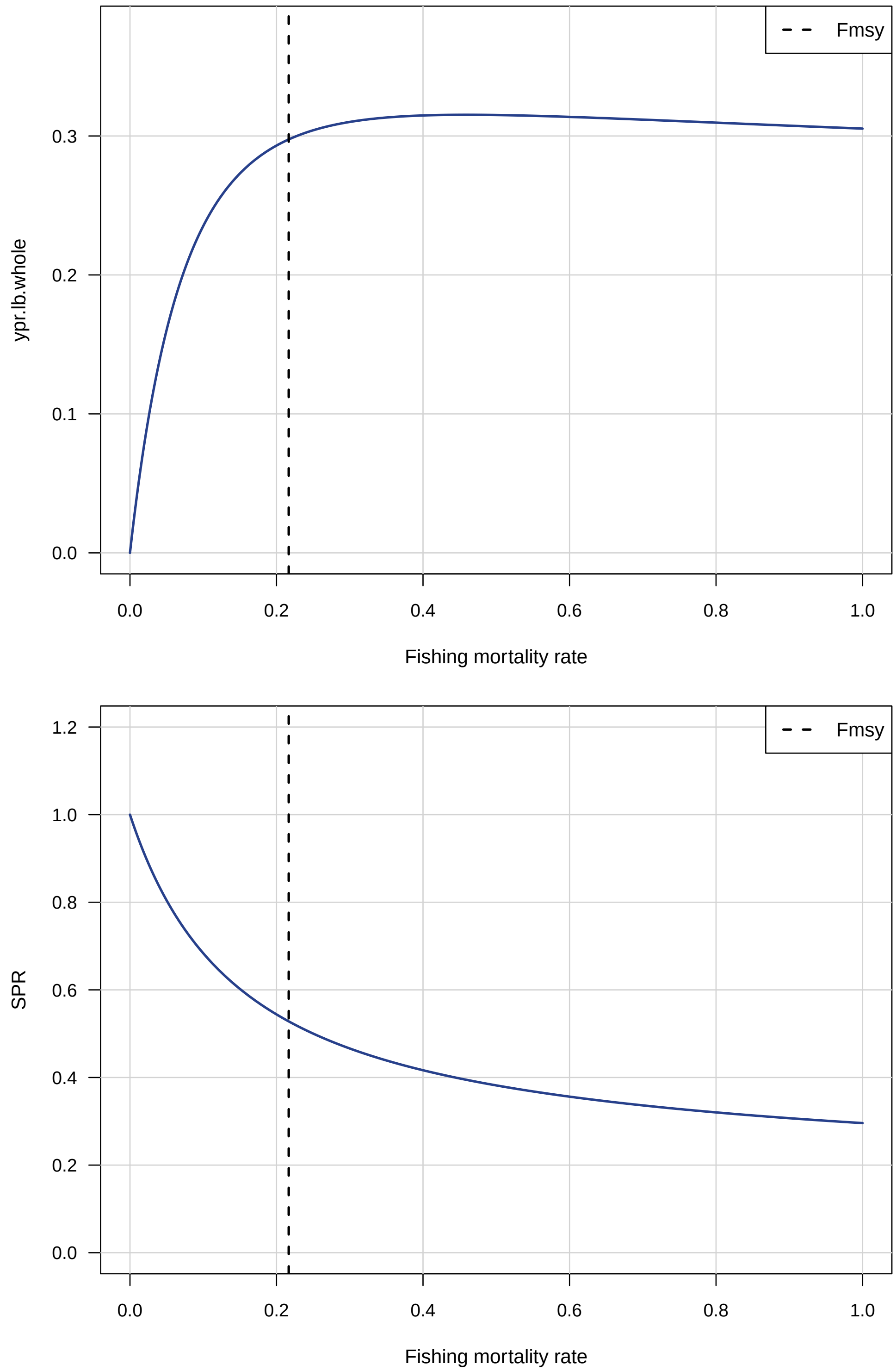


Figure 22. Equilibrium landings. The vertical line occurs where fishing rate is $F_{\mathrm{MSY}} = 0.22$ *and equilibrium landings are 214.23(1000 lb). Curve based on average selectivity from the end of the assessment period from the RW approved Base Model.*

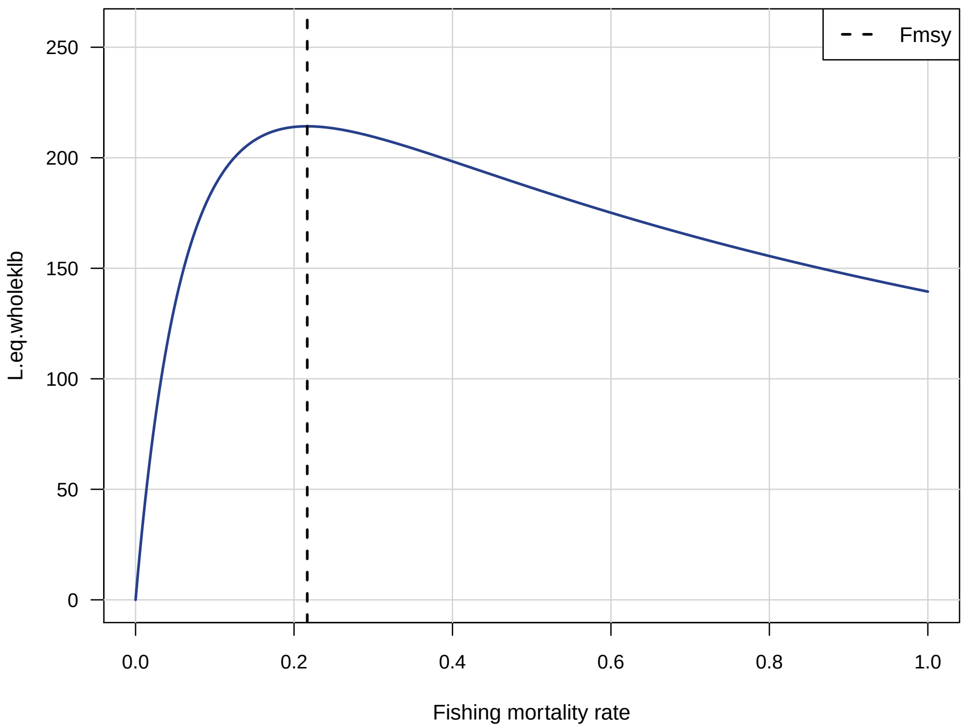


Figure 23. Equilibrium spawning biomass (mt). Curve based on average selectivity from the end of the assessment period from the RW approved Base Model.

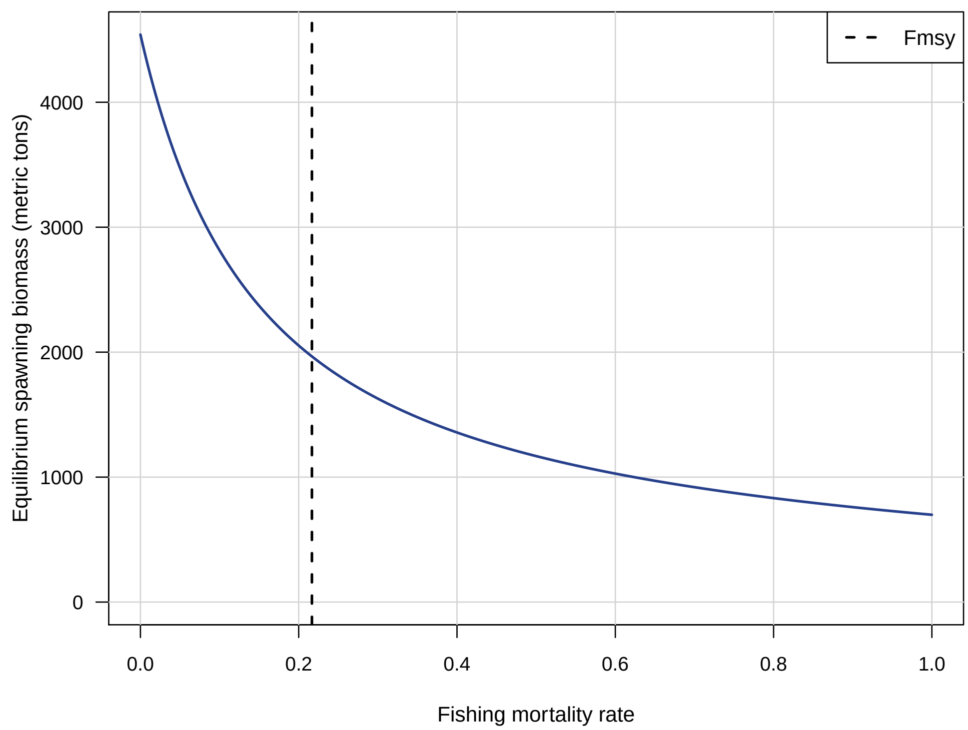


Figure 24. Probability densities of F_{MSY} benchmarks from the ensemble model of the Beaufort Assessment Model. Vertical lines represent point estimates from the base run.

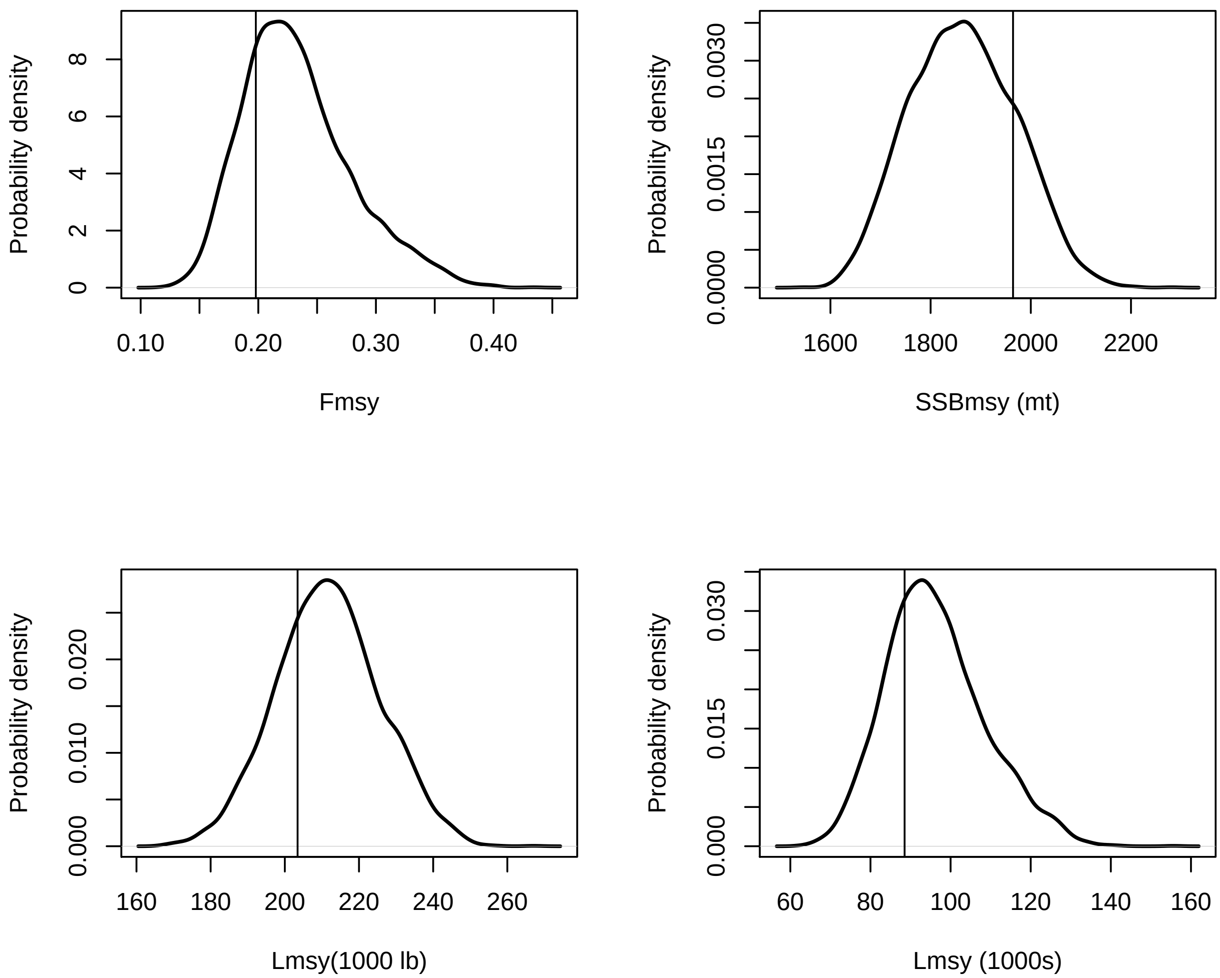


Figure 25. Estimated time series relative to benchmarks. Solid line indicates estimates from base run of the Beaufort Assessment Model; gray error bands indicate 5^{th} *and* 95^{th} *percentiles of the ensemble modeling. Top panel: spawning biomass relative to the minimum stock size threshold (*MSST*). Middle panel: spawning biomass relative to* $\mathrm{SSB}_{\mathrm{MSY}}$*. Bottom panel: F relative to* F_{MSY}*.*

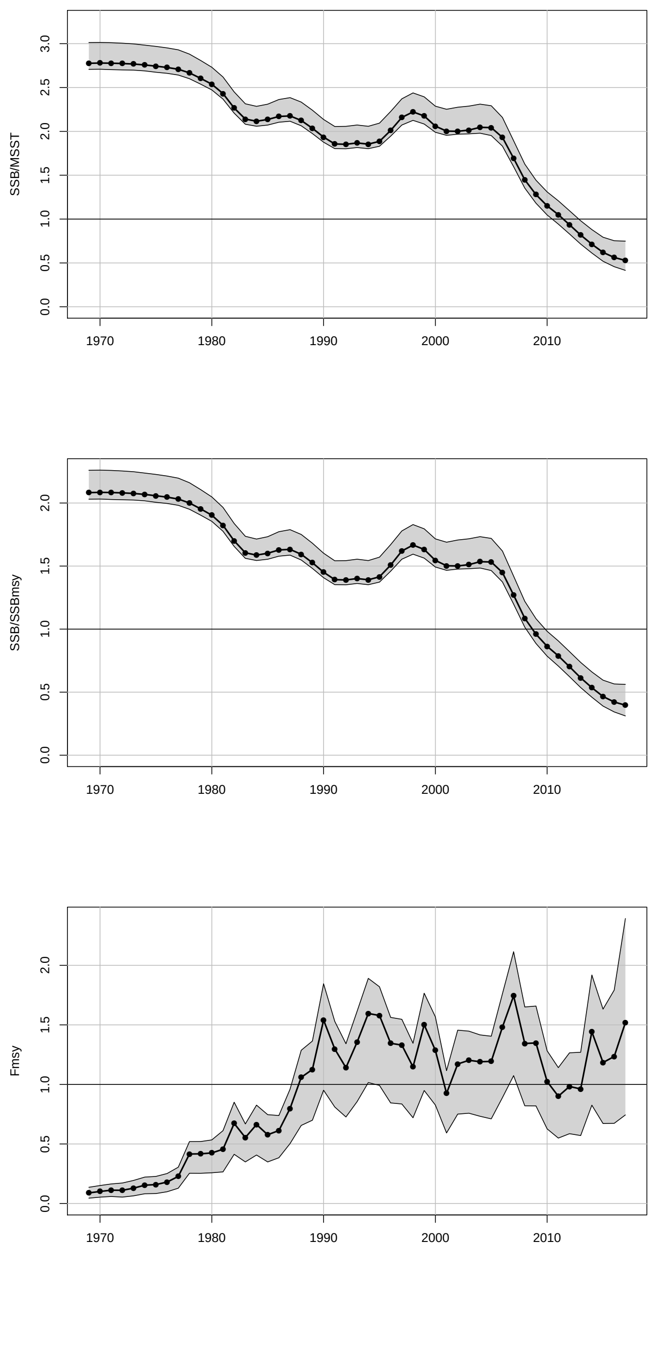


Figure 26. Probability densities of terminal status estimates from ensemble model of the Beaufort Assessment Model. Vertical lines represent point estimates from the RW approved Base Model.

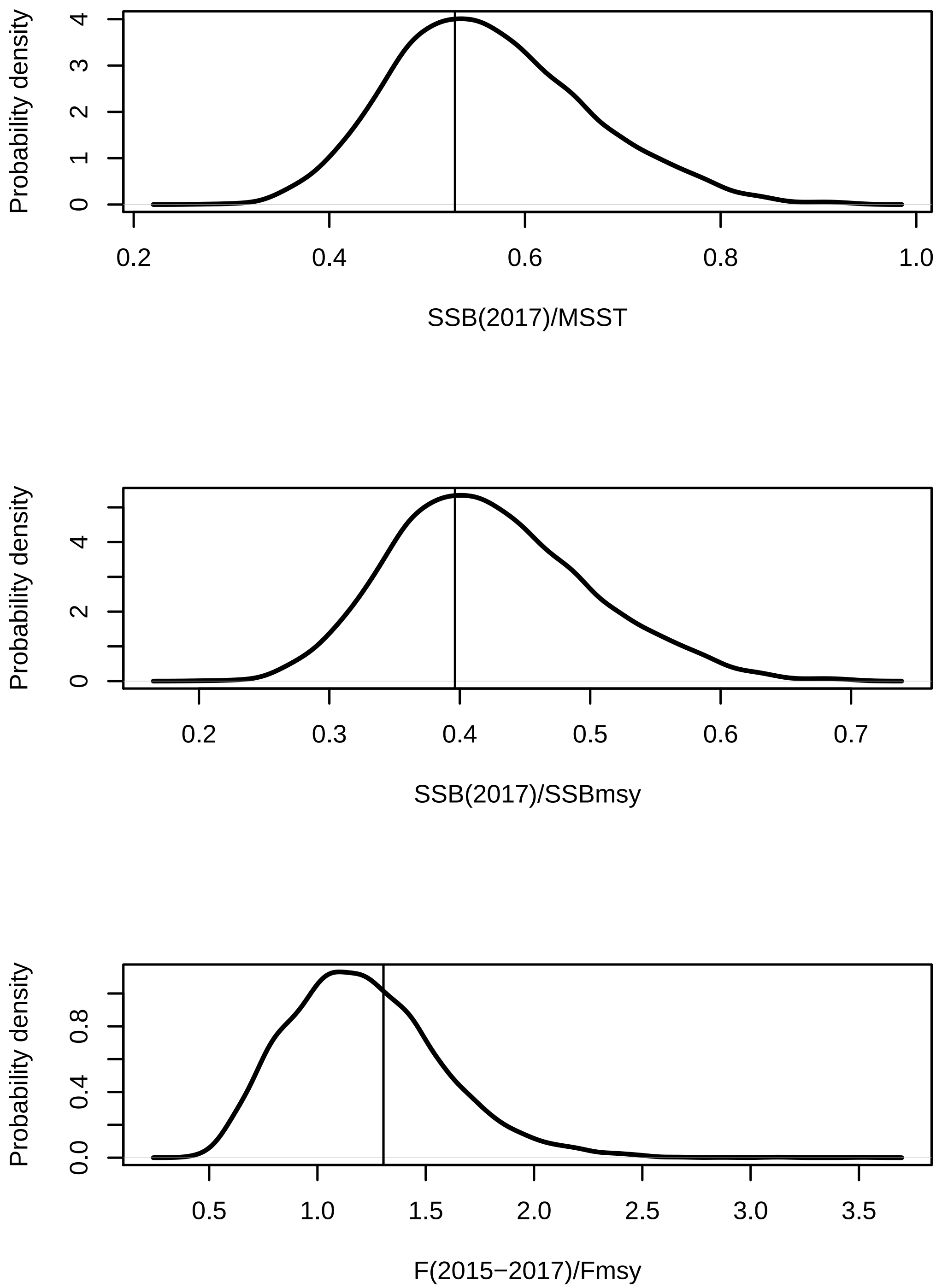
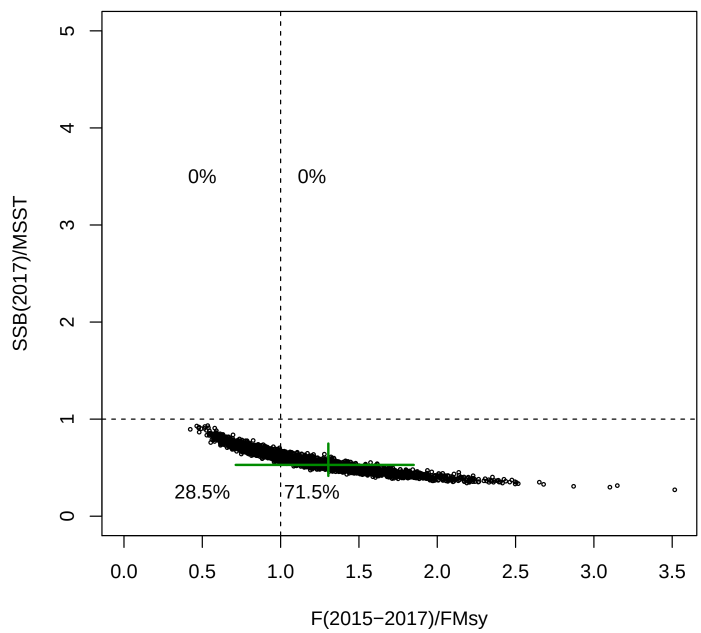


Figure 27. Phase plots of terminal status estimates from the ensemble model of the Beaufort Assessment Model. Top panel is status relative to MSST, *and the bottom panel is status relative to* $\mathrm{SSB_{MSY}}$. *The intersection of crosshairs indicates estimates from the RW approved Base Model; lengths of crosshairs defined by* 5^{th} *and* 95^{th} *percentiles.*



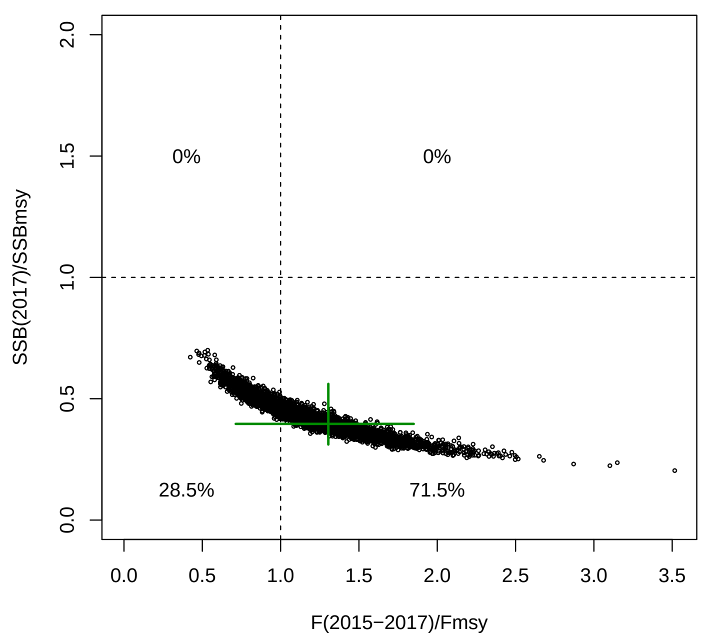


Figure 28. Estimated selectivities of the recreational fleet for RW Run 2. Years indicated on plot signify the first year of a time block.

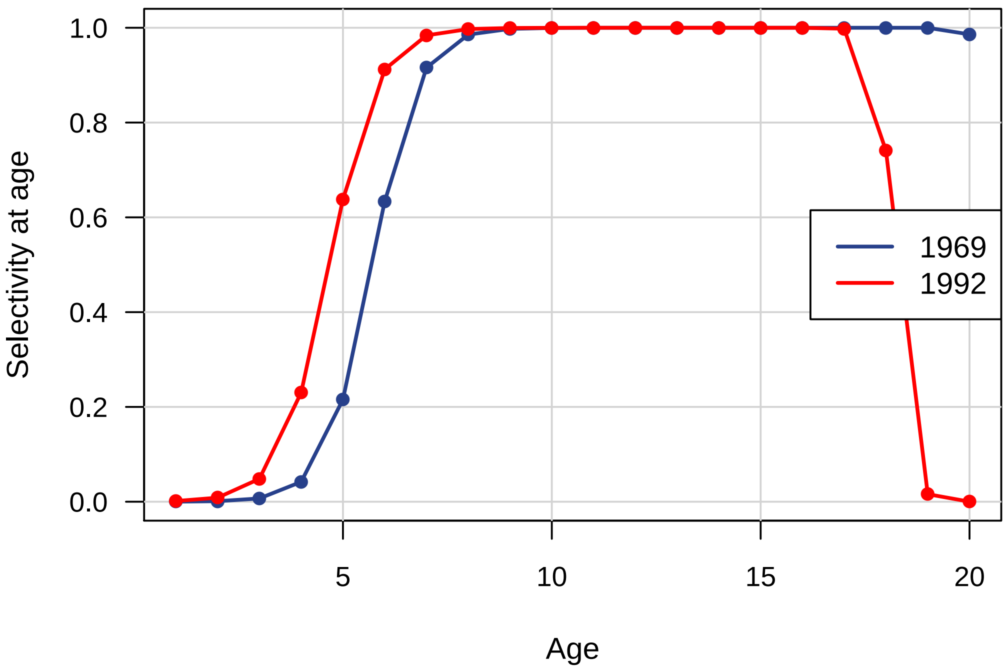


Figure 29. Estimated selectivities of the commercial fleet for RW Run 2. Years indicated on plot signify the first year of a time block.

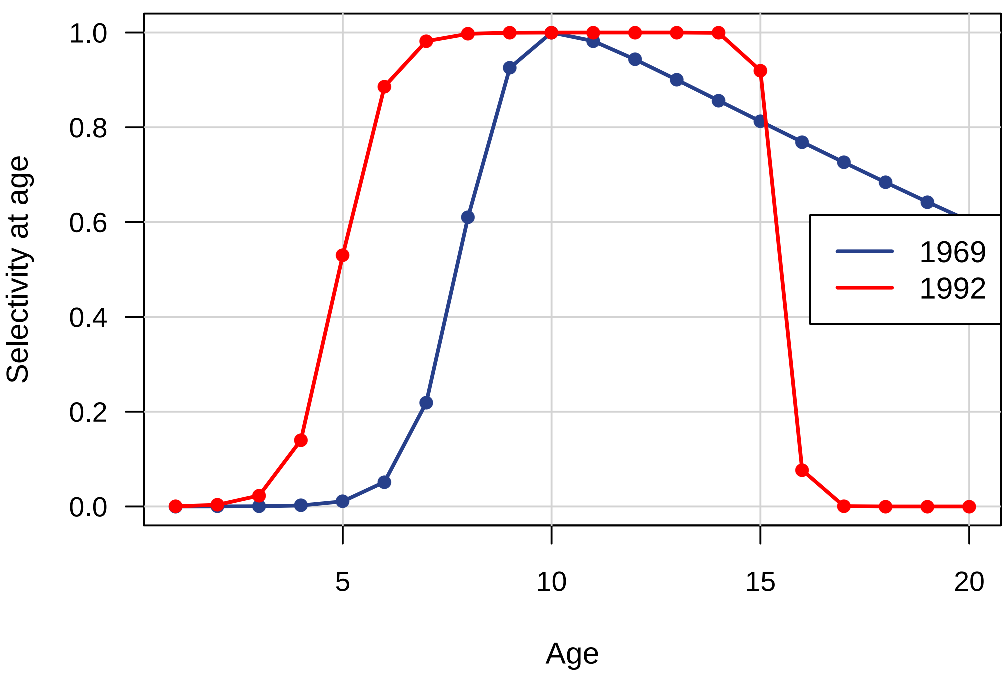


Figure 30. Estimated selectivities of the recreational fleet for RW Run 3.

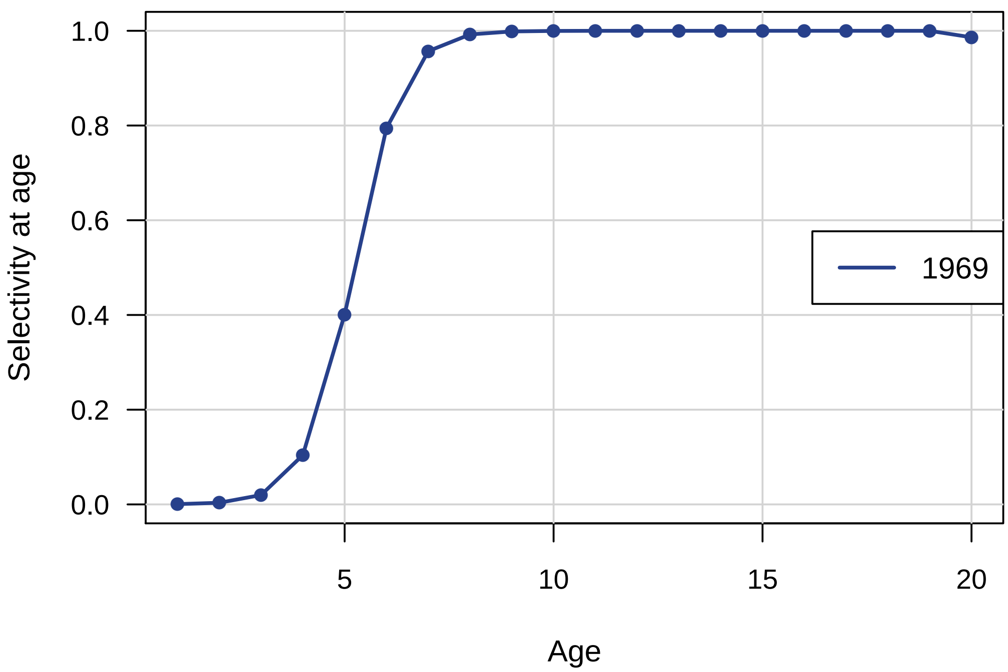


Figure 31. Estimated selectivities of the commercial fleet for RW Run 3.

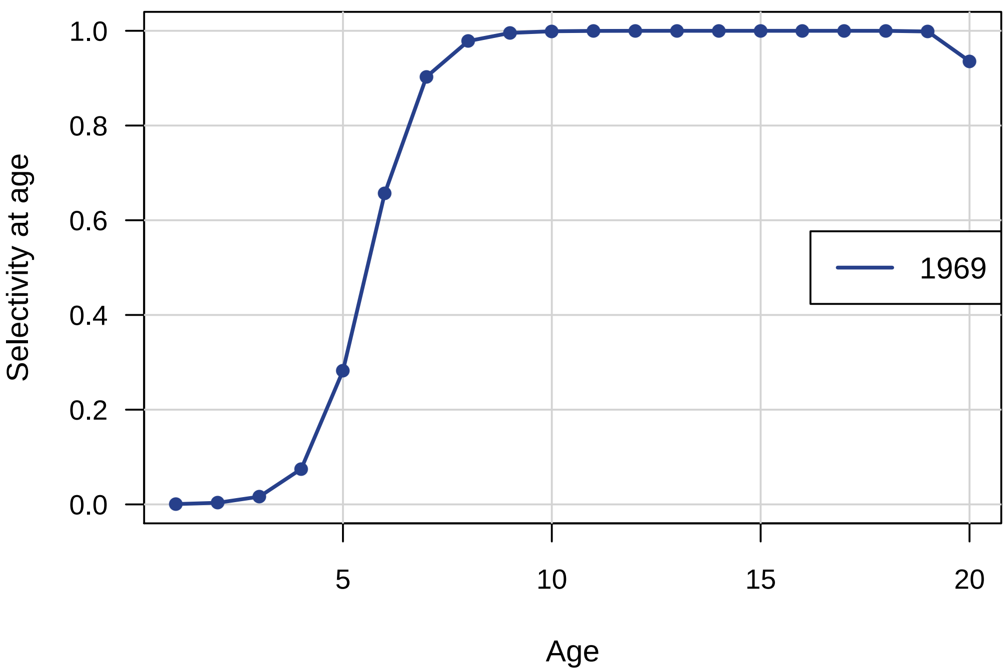


Figure 32. Commercial pooled age compositions for Run 4.

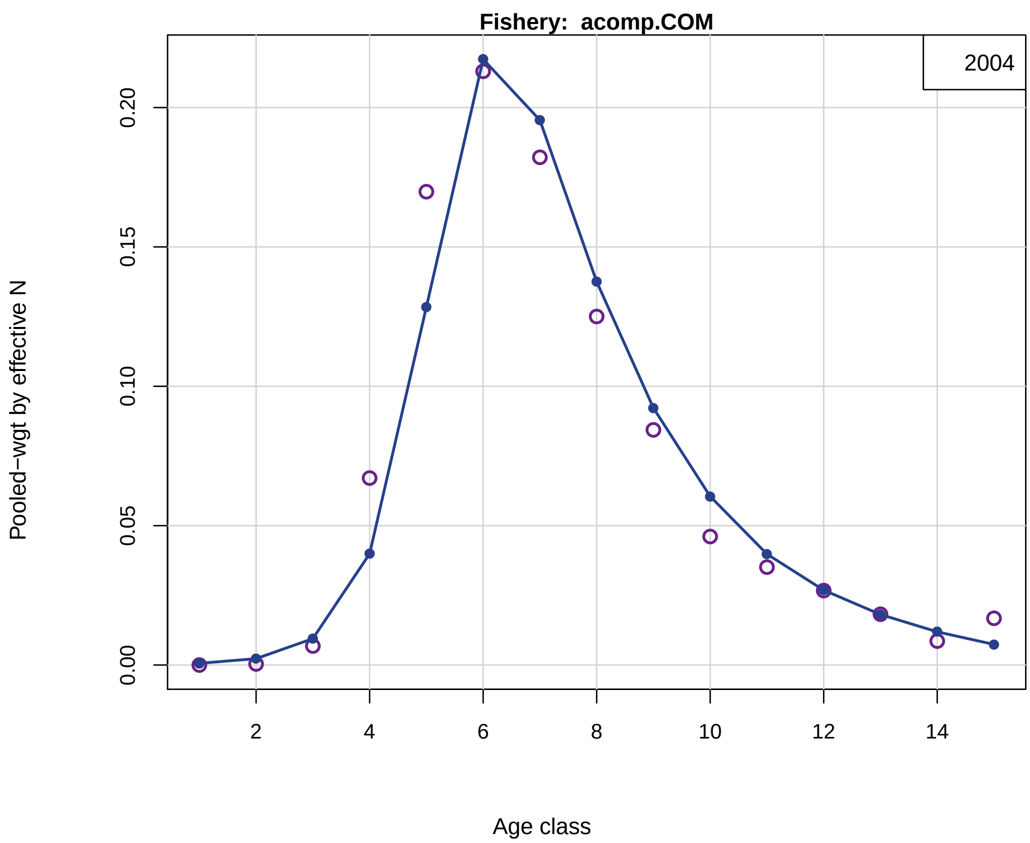


Figure 33. Recreational pooled age compositions for Run 4.

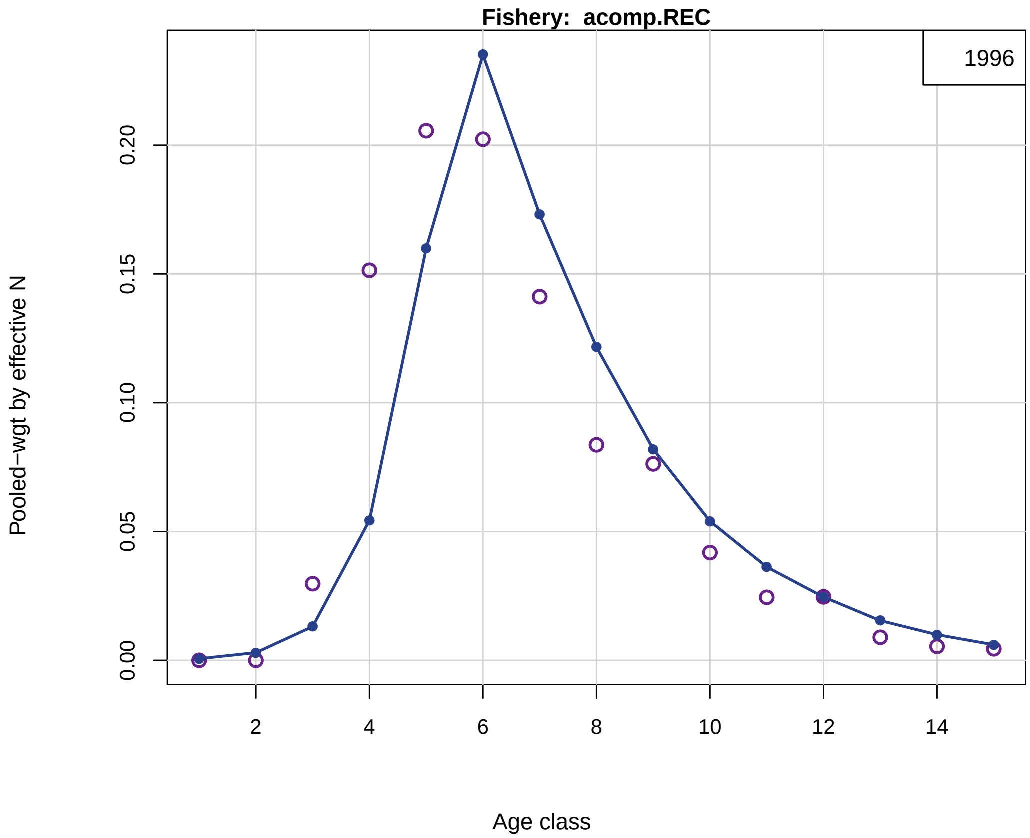


Figure 34. Recreational index for Run 4.

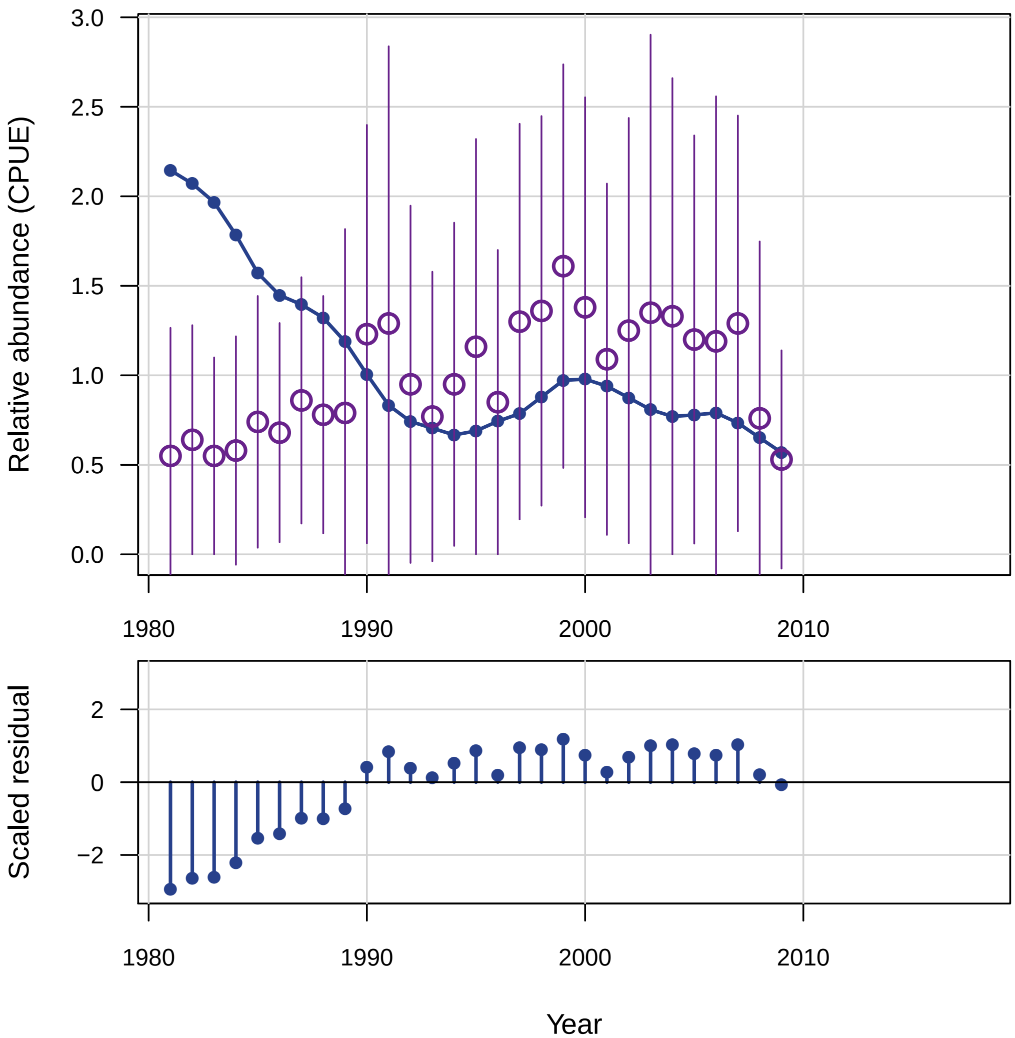


Figure 35. Estimated selectivities of the recreational fleet for RW Run 4.

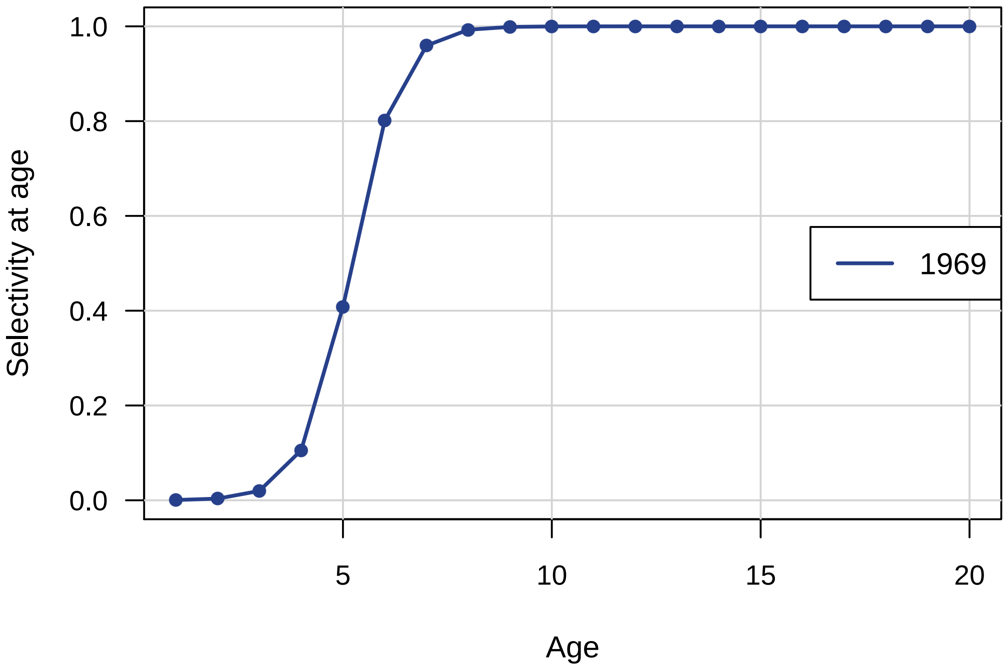


Figure 36. Estimated selectivities of the commercial fleet for RW Run 4.

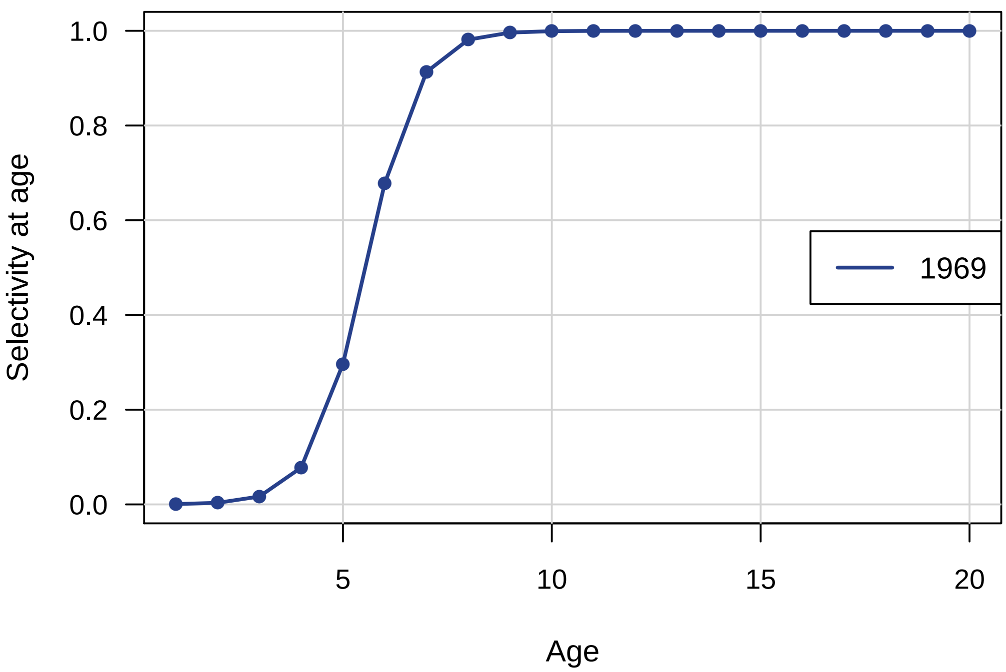


Figure 37. Estimated selectivities of the recreational fleet for RW Run 6. Years indicated on plot signify the first year of a time block.

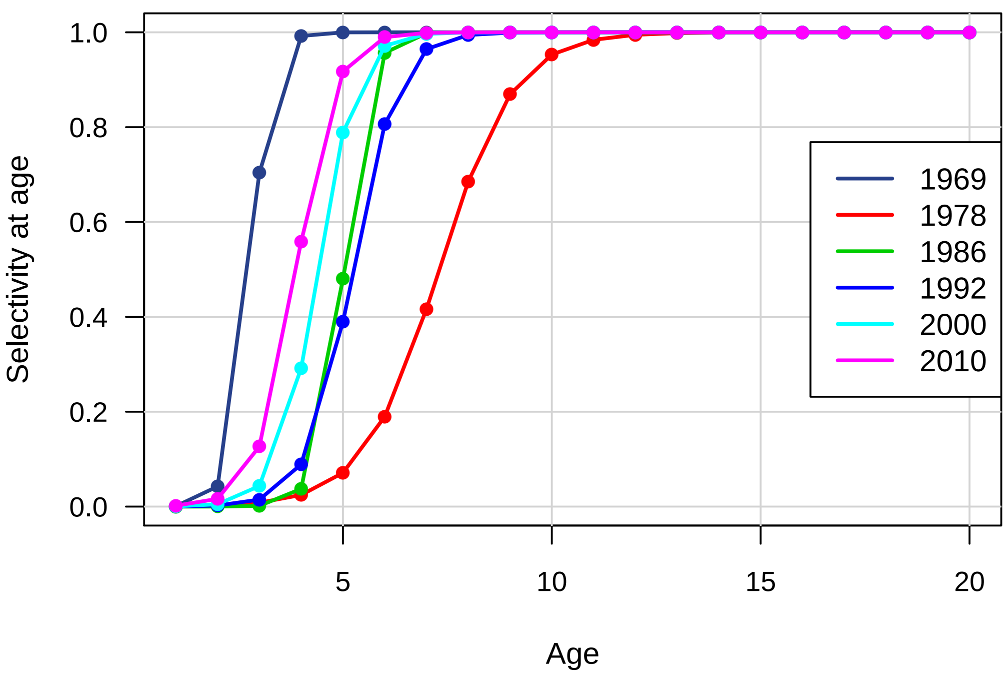


Figure 38. Estimated selectivities of the commercial fleet for RW Run 6. Years indicated on plot signify the first year of a time block.