SEDAR

Southeast Data, Assessment, and Review

SEDAR 94
Stock Assessment Report

Florida Hogfish:
West Florida Shelf Stock and East Florida/Florida Keys Stock

August 2026

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

Table of Contents

Section I. Introduction	PDF page	3
Section II. Data Workshop Report	PDF page	43
Section III. Assessment Workshop Report	PDF page	284
Section IV. Research Recommendations	PDF page	520
Section V. Review Workshop Report	PDF page	528
Section VI. Post-Review Workshop Addenda	PDF pg	557

SEDAR

Southeast Data, Assessment, and Review

SEDAR 94

Florida Hogfish: West Florida Shelf Stock and East Florida/Florida Keys Stock

SECTION I: Introduction

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

Introduction

SEDAR 94 addressed the stock assessments for two stocks of hogfish: West Florida Shelf Stock and East Florida/Florida Keys Stock. The process consisted of an in-person Data Workshop, a series of assessment webinars, and an in-person Review Workshop.

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 stages of the process 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 Report (SAR) for Florida hogfish was disseminated to the public in August 2026. The Gulf and South Atlantic Fishery Management Councils' Scientific and Statistical Committee (SSC) will review the SAR for the stock within their management jurisdiction. The SSC is 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).

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 is managed by the three Regional Fishery Management Councils in the Southeast in coordination with NOAA Fisheries, the Interstate Marine Fisheries Commissions (Atlantic States MFC and Gulf States MFC), and the Florida Fish and Wildlife Conservation Commission (FL FWC).

SEDAR seeks to improve the quality and reliability of stock assessments, improve the quantitative basis of fishery management actions, and increase the relevance of research and monitoring programs in the Southeast Region. It 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 often 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 FLORIDA HOGFISH MANAGEMENT OVERVIEW

2.1. Fishery Management Plan and Amendments

The Florida Fish and Wildlife Conservation Commission (FWC) is responsible for managing fish and wildlife resources for the people of the State of Florida. There are multiple federal and state agencies which also management fish and wildlife resources with overlapping responsibilities and jurisdictions, and the FWC works cooperatively with the regional fishery management councils (South Atlantic and Gulf Fishery Management Councils) and the National Marine Fisheries Service to effectively manage saltwater fisheries in Florida. The FWC Fish and Wildlife Institute is responsible for providing information and research on fish and wildlife resources in the state, including assessments of the status of fish populations such as mutton snapper.

The following summary describes only those management actions in the southeastern U.S. in the jurisdictions of the South Atlantic Fishery Management Council (SAFMC), the Gulf Fishery Management Council (GFMC), and the Florida Fish and Wildlife Conservation Commission (FWC) that were likely to affect hogfish fisheries and harvest.

2.1.1 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 fishery conservation zone (FCZ) under the area of authority of the South Atlantic Fishery Management Council (SAFMC) and the territorial seas of the states, extending from the North Carolina/Virginia border through the Atlantic side of the Florida Keys to 83° W longitude. In the case of the sea basses, the management regime applies only to south of Cape Hatteras, North Carolina. Regulations apply only to federal waters.

SAFMC FMP Amendments affecting hogfish

Description of Action	FMP/Amendment	Effective Date
4" trawl mesh; established minimum size limits for several species; limitations on harvest and gear	Snapper Grouper FMP	08/31/1983
Trawls prohibited	Snapper Grouper Amend 1	01/12/1989
Required permit to fish for, land or sell snapper grouper species	Snapper Grouper Amend 3	01/31/1991
Fish traps prohibited, entanglement nets & longlines within 50 fathoms prohibited, aggregate bag limit of 10 snappers	Snapper Grouper Amend 4	01/01/1992
Oculina Experimental Closed Area	Snapper Grouper Amend 6	06/27/1994
Established a minimum size limit of 12" (305 mm) FL for Hogfish; specified allowable gear; required dealer, charter, and headboat federal permits	Snapper Grouper Amend 7	01/23/1995
Implemented a Hogfish recreational bag limit of 5 per person within Florida EEZ	Snapper Grouper Regulatory Amend 6	05/1995
Limited entry program: transferable permits and 225-lb non-transferable permits	Snapper Grouper Amend 8	12/14/1998
MSY proxy for Hogfish is 30% static SPR; OY proxy is 40% static SPR	Snapper Grouper Amend 11B	12/02/1999
Extended for an indefinite period the regulation prohibiting fishing for and possessing snapper grouper species within the *Oculina* Experimental Closed Area	Snapper Grouper Amend 13A	04/26/2004
Established eight deepwater Type II marine protected areas to protect a portion of the population and habitat of long-lived deepwater snapper grouper species	Snapper Grouper Amend 14	02/12/2009
Required use by commercial and recreational fishermen of dehooking devices for releasing reef fish	Snapper Grouper Amend 16	07/29/2009
Use of non-stainless steel circle hooks in the snapper grouper fishery not required south of 28°N	Snapper Grouper Amend 17A	03/02/2011
Comprehensive ACL Amendment to meet MSA mandate to establish ACLs and AMs for species managed by the council that are not undergoing overfishing, including Hogfish. ACL for Hogfish in commercial sector: 48,772 lb (22,123 kg) round weight; ACL for Hogfish in recreational sector: 98,866 lb (44,845 kg) round weight	Snapper Grouper Amend 25	04/16/2012
Action to revise the acceptable biological catch estimates, annual catch limits (ACL), and recreational annual catch targets for Hogfish; ACL for Hogfish in commercial sector: 49,469 lb (22,439 kg) round weight; ACL for Hogfish in recreational sector: 85,355 lb (38,716 kg) round weight	Snapper Grouper Regulatory Amend 13	07/17/2013
Modified the hogfish fishery management unit (GA-NC and EFL/FLK now separate stocks); specified fishing levels for the two South Atlantic hogfish stocks; established a rebuilding plan for the Florida Keys/East Florida stock; established/revised management measures	Snapper Grouper Amend 37	08/24/2017

for both hogfish stocks in the South Atlantic Region, such as size limits, recreational bag limits, and commercial trip limits		
Rigged and ready descending device required for all sectors to fish for or possess SG species; Non-offset, non-stainless steel circle hooks required to fish for SG species using hook and line gear and natural baits in the EEZ north of 28 deg N Lat.; powerheads are allowed to be used in harvesting SG species in the EEZ off South Carolina	Snapper Grouper Regulatory Amend 34	07/15/2020

2.1.2 ORIGINAL GFMC FMP

The Fishery Management Plan (FMP) for the reef fish fishery of the Gulf of Mexico was implemented on November 8, 1984. This plan is for the management of reef fish resources under the authority of the Gulf of Mexico Fishery Management Council. The plan considers reef fish resources throughout its range from Florida through Texas. The areas which will be regulated by the federal government under this plan are confined to the waters of the fishery conservation zone (FCZ). The estimated area of the FCZ is 6.82×10^5 km^2 (263,525 square miles) and of that 12.4% of it is estimated as part of the continental shelf that is encompassed within the FCZ. Hogfish is one of the many species included in the fishery management unit. The four objectives of the FMP were: (1) to rebuild the declining reef fish stocks wherever they occur within the fishery; (2) establish a fishery reporting system for monitoring the reef fish fishery; (3) conserve reef fish habitats and increase reef fish habitats in appropriate areas and to provide protection for juveniles while protecting existing new habitats; (4) to minimize conflicts between user groups of the resource and conflicts for space.

GFMC FMP Amendments affecting hogfish

Description of Action	FMP/Amendment	Effective Date
MSY and OY estimates for all groupers and snappers in aggregate, permits and gear specifications for fish traps and limits on the number of fish traps allowed per vessel, establishment of a stressed area within which the use of fish traps, roller trawls, and powerheads for reef fish harvest was prohibited, explosives and poisons for taking reef fish prohibited.	Reef Fish FMP	11/08/1984
The stressed area was expanded, and a longline/buoy gear boundary was established. The number of fish traps allowed per vessel was reduced from 200 to 100. Reef fish permits were required for commercial reef fish vessels. Commercial harvest of reef fish using trawls or entangling nets was prohibited. Reporting requirements established for commercial and for-hire recreational vessels, prohibited use of entangling gear for direct harvest, reef fish vessel permit established with an income qualification.	Reef Fish Amendment 1	02/21/1990

Moratorium on new reef fish permits which was extended at various times and was in effect through 2005.	Reef Fish Amendment 4	05/1992
Established restrictions on the use of fish traps in the Gulf EEZ, implemented a three-year moratorium on the use of fish traps, created a SMZ off AL coast, created framework procedures for future SMZs.	Reef Fish Amendment 5	02/1994
Created an aggregate bag limit of 20 reef fish for all reef fish species not having a bag limit.	Reef Fish Amendment 12	01/1997
Provided a ten-year phase-out for the fish trap fishery; prohibited use of fish traps west of Cape San Blas, Florida.	Reef Fish Amendment 14	03/1997
Prohibited harvest of reef fish from traps other than permitted reef fish traps, stone crab traps, or spiny lobster traps.	Reef Fish Amendment 15	01/1998
Addresses new provisions implemented by the Sustainable Fisheries Act; proposed scientific definitions (MSY, OY, MFMT, MSST) for Hogfish	Generic SFA Amendment	02/24/1999
Hogfish moved to the list of species in the Reef Fish FMP management unit; established a minimum size limit of 12" (305 mm) FL and adopted a recreational bag limit of 5 Hogfish per person for entire Gulf EEZ to be compatible with FL regs.	Reef Fish Amendment 16B	11/1999
Prohibited retention of reef fish exhibiting "trap rash" on vessels with a reef fish permit that is fishing spiny lobster or stone crab traps except for vessels possessing a valid fish trap endorsement.	Reef Fish Amendment 16A	01/2000
Established a 3-year moratorium on the issuance of new charter and headboat vessel permits in the recreational for hire fisheries in the Gulf EEZ.	Reef Fish Amendment 20	07/2002
Generic amendment addressing the establishment of the Tortugas Marine Reserves – establishes two marine reserves and prohibits fishing for any species and anchoring by fishing vessels inside the two marine reserves.	Reef Fish Amendment 19	08/19/2002
Established a permanent limited access system for the commercial fishery for Gulf reef fish.	Reef Fish Amendment 24	08/2005
Established a limited access system on for-hire reef fish and coastal migratory pelagics permits.	Reef Fish Amendment 25	06/2006
Commercial and recreational fishermen fishing for reef fish required to use non-stainless steel circle hooks when using natural baits, and to use dehooking and venting tools for releasing reef fish.	Reef Fish Amendment 27	02/2008
Required that all vessels with federal commercial or charter reef fish permits must comply with the more restrictive of state or federal reef fish regulations when fishing in state waters.	Reef Fish Amendment 30B	05/2009

Generic Annual Catch Limits/Accountability Measures Amendment to the Red Drum, Reef Fish Resources, Shrimp, and Coral and Coral Reefs Fishery Management Plans for the Gulf; set a stock ACL (208,000 lb, round weight) and implemented Ams for Gulf Hogfish	Generic ACL Amendment	12/2011
Increased crew size limits for dually permitted vessels from three to four.	Reef Fish Amendment 34	11/2012
Revises the Gulf hogfish fishery management unit to include all hogfish found in the Gulf Federal Waters north of the line extending due west from 25°09′ North latitude off the west coast of Florida and sets annual catch limits (ACL) for 2017 and 2018 at 219,000 pounds whole weight. The ACL will revert to 159,300 pounds for 2019 and subsequent years. Increased the commercial and recreational minimum size limit to 14 inches fork length and prohibited the use of powerheads for harvesting hogfish in the Gulf stressed area.	Reef Fish Amendment 43	08/2017
Standardized the minimum stock size threshold (MSST) for certain reef fish species. The MSST for hogfish is equal to 50% of the biomass at maximum sustainable yield (MSY).	Reef Fish Amendment 44	12/2017
Reduced the stock ACL for west Florida hogfish.	Reef Fish Framework Action	04/2019
Modified status determination criteria for hogfish. Set MSY proxy at $F_{30\% SPR}$. Sets the MFMT equal to F_{MSY}. Sets OY at 90% of MSY.	Reef Fish Amendment 48	08/2022

2.1.3 State of Florida

Florida's management of reef fish fisheries, prior to the establishment of the Marine Fisheries Commission (MFC) in 1983, began with the implementation of size limits in 1979 (Florida Statutes in chapter 370.11) for several groupers (red, Nassau, gag, black, and goliath). In July of 1985, the Florida MFC implemented rules in the Florida Administrative Code (F. A. C.) to establish minimum size limits for many species, however hogfish was not included. Hogfish regulations were implemented July 1, 1994, establishing a minimum size limit of 12" fork length and a 5-fish bag limit.

State of Florida F.A.C. Rules affecting Hogfish

Description of Action	F.A.C. Rules	Effective Date
Designates hogfish as a "restricted species" and includes in Florida reef fish rule. Thereby, prohibiting harvest to hook-and-line and spearing gear only. Establishes a minimum size limit of 12 inches fork length, and a daily recreational bag limit of 5 hogfish per person.	F.A.C. Chap 46-14	07/1994

Allows a two-day possession limit for reef fish, including hogfish, for persons aboard charter and headboats on trips exceeding 24 hours provided that the vessel is equipped with a permanent berth for each passenger aboard, and each passenger has a receipt verifying the trip length		
Required federal commercial permit for fishing in state waters	F.A.C. Chap 68-14	01/1998
Requires all reef fish, including hogfish, be landed in whole condition	F.A.C. Chap 68-14	12/1998
Prohibited commercial fishermen from harvesting or possessing the recreational bag limit of reef fish species on commercial trips.	F.A.C. Chap 68-14	07/2007
Required commercial and recreational anglers fishing for any Gulf reef fish species to use circle hooks, de-hooking devices, and venting tools.	F.A.C. Chap 68-14	06/2008
Requires dehooking tools to be aboard commercial and recreational vessels for anglers to use as needed to remove hooks from Atlantic reef fish	F.A.C. Chap 68-14	01/2010
Eliminated the requirement to possess and use venting tools when fishing for reef fish in the Gulf.	F.A.C. Chap 68-14	01/2014
Established new state management boundary at 25˚09' North latitude; Increased the minimum size limit to 14" FL in Gulf and 16" FL in the Atlantic; Reduced the Atlantic recreational bag limit to 1 fish per person; Set a May 1 – Oct. 31 recreational harvest season in the Atlantic; and set minimum size limit for importation and sales at 14" FL statewide	F.A.C. Chap 68-14	08/2017
Established hogfish as a species that recreational anglers are required to report their intention to harvest or attempt to harvest certain reef fish species annually in all Florida waters through the State Reef Fish Survey.	F.A.C. Chap 68-14	07/2020
Established a requirement for anglers using hook-and-line with natural bait to target reef fish, including hogfish, from a vessel in Atlantic state waters to use non-stainless steel, non-offset circle hooks north of 28 degrees north latitude and non-stainless steel hooks south of 28 degrees north latitude.	F.A.C. Chap 68-14	01/2021
Clarifies requirements for passengers on for-hire trips that span more than 24 hours to possess and land double the bag limit for reef fish. New requirements are consistent with federal conditions.	F.A.C. Chap 68-14	08/2021
Established a requirement to have a descending device or venting tool rigged and ready for reef fish, including hogfish, in state waters when fishing from a vessel and a requirement to use a descending device or venting tool upon releasing a reef fish is experiencing barotrauma.	F.A.C. Chap 68-14	04/2023

2.2 Emergency and Interim Rules

December 2, 2013 – NOAA's National Marine Fisheries Service (NOAA Fisheries Service) issued a temporary final rule implementing accountability measures for the commercial and recreational sectors for Hogfish in the exclusive economic zone of the Gulf for the 2013 fishing year. Based on the commercial and recreational landings, NMFS determined that the stock (commercial and recreational) annual catch limit (ACL) for Gulf Hogfish had been reached. Therefore, NMFS closed the commercial and recreational sectors for Hogfish in the Gulf EEZ at 12:01 a.m., local time, December 2, 2013, until January 1, 2014.

2.3 Management Program Specifications

Table 2.3.1. General Management Information

South Atlantic	Species	Hogfish (*Lachnolaimus maximus*)
	Management Unit	Southeastern U.S.
	Management Unit Definition	All waters within the South Atlantic Fishery Management Council boundaries. Defined as the economic zone (EEZ), 200 miles from state boundary line.
	Management Entity	South Atlantic Fishery Management Council
	Current stock exploitation status	East Florida/Florida Keys stock: Overfished and Overfishing is occurring (SEDAR 37, 2014)
Gulf of America	Species	Hogfish (*Lachnolaimus maximus*)
	Management Unit	U. S. Gulf of America
	Management Unit Definition	All waters within the Gulf Fishery Management Council boundaries. Defined as the economic zone (EEZ), 200 miles from state boundary line.
	Management Entity	Gulf Fishery Management Council
	Current stock exploitation status	Insufficient evidence to determine stock status (SEDAR 6, 2004)

Table 2.3.2. Specific Management Criteria

East Florida/Florida Keys		
Criteria	Results from SEDAR 37 (Current)	
	Definition	Value
MSST (Minimum Stock Size Threshold)	[(1-M) or 0.5, whichever is greater] *BMSY (The estimated population biomass at MSY) (1000 lb)	856.664
MFMT (Maximum Fishing Mortality Threshold)	F_{MSY}	0.138
MSY (Maximum Sustainable Yield)	MSY (1000 lb)	156.986
F_{MSY} (Fishing Mortality Rate at MSY)	F_{MSY}	0.138
OY (Optimum Yield) (from Am 37)	95%ABC (numbers of fish)	2025: 51,474 2026: 55,934 2027: 60,130
M (Natural Mortality Rate)	Age-specific	Target of 0.179 yr^{-1}

West Florida Shelf		
Criteria	Results from SEDAR 37 (Current)	
	Definition	Value
MSST (Minimum Stock Size Threshold)	[(1-M) or 0.5, whichever is greater] *BMSY (The estimated population biomass at MSY) (1000 lb)	856.664
MFMT (Maximum Fishing Mortality Threshold)	F_{MSY}	0.138
MSY (Maximum Sustainable Yield)	MSY (1000 lb)	156.986
F_{MSY} (Fishing Mortality Rate at MSY)	F_{MSY}	0.138
OY (Optimum Yield) (from Am 37)	95%ABC (numbers of fish)	2025: 51,474 2026: 55,934 2027: 60,130
M (Natural Mortality Rate)	Age-specific	Target of 0.179 yr^{-1}

2.4 Stock Rebuilding Information

Amendment 37 to the SAFMC FMP specified a 10-year rebuilding schedule with the rebuilding time period ending in 2027.

As the west Florida Hogfish stock is neither overfished nor undergoing overfishing (SEDAR 37), there is no rebuilding plan for this stock.

2.5 Stock projection information.

SAFMC

Requested Information	Value
First Year of Management	Assume management begins in 2028.
Interim basis	ACL (95% ABC), if average landings for the most recent 5 years of data are within 10% of the ACL; average landings for the most recent 5 years of data otherwise.
Current Acceptable Biological Catch	(from Am 37 rebuilding plan) 2025: 54,183 fish 2026: 58,878 fish 2027: 63,295 fish
Projection Outputs	
Total Removals	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

GFMC

Requested Information	Value
First Year of Management	Assume management begins in 2028.
Interim basis	ACL (95% ABC), if average landings for the most recent 5 years of data are within 10% of the ACL; average landings for the most recent 5 years of data otherwise.
Current Acceptable Biological Catch	(from Am 37 rebuilding plan) 2025: 54,183 fish 2026: 58,878 fish 2027: 63,295 fish
Projection Outputs	
Total Removals	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

Base Run Projections Specifications. Long Term and Equilibrium conditions.

EFL/FLK hogfish is currently in a rebuilding plan, implemented in SAFMC Snapper Grouper Amendment 37. The rebuilding period is 10 years, ending in 2027. Rebuilding is based on fixed exploitation at F=.070.

Criteria	Definition	If not rebuilt	If rebuilt
Projection Span	Years	10	10
Projection Values	$F_{CURRENT}$	X	X
	F_{MSY}	X	X
	75% F_{MSY}	X	X
	$F_{REBUILD}$	X	

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

Short term projections (P* or exploitation based)

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. Projections based on exploitation rates should provide probabilities of both overfishing and overfished conditions.

Basis	Value	Years to Project	P* applies to
P*	50%	Interim + 3, Interim + 5	Probability of overfishing
If not overfished, P* from ABC Control Rule; Stock Risk Rating: High Risk	If B>B_{MSY}, 40%; If B>midpoint between B_{MSY} and MSST, 30%; If B<midpoint between B_{MSY} and MSST, 20%	Interim + 3, Interim + 5	Probability of overfishing
Exploitation	98% of F_{MSY}	Interim + 3, Interim + 5	NA

2.6 Quota Calculation Details

SAFMC Amendment 37 (2017) implemented a total ACL for EFL/FLK hogfish equal to 95% of ABC in numbers of fish. Specific annual values are shown in Table 2.6.1. Sector allocations are 9.63% commercial and 90.37% recreational. The recreational ACL is in numbers of fish, and the commercial ACL is in pounds whole weight (lbs ww).

Table 2.6.1. Acceptable biological catch (ABC) and annual catch limits (ACL) for East Florida and Florida Keys hogfish, 2017-2027 (SAFMC Snapper Grouper Amendment 37).

Year	ABC (numbers)	Total ACL (numbers)	Recreational ACL (numbers)	Commercial ACL (lbs ww)	Commercial ACL (numbers)
2017	17,930	17,034	15,689	3,510	1,345
2018	21,421	20,350	18,617	4,524	1,733
2019	24,996	23,746	21,574	5,670	2,173
2020	29,200	27,740	25,086	6,926	2,654
2021	33,965	32,267	29,096	8,277	3,171
2022	39,027	37,076	33,358	9,703	3,718
2023	44,162	41,954	37,671	11,179	4,283
2024	49,254	46,791	41,934	12,677	4,857
2025	54,183	51,474	46,046	14,167	5,428
2026	58,878	55,934	49,949	15,621	5,985
2027	63,295	60,130	53,610	17,018	6,520

2.7 Literature Cited

Florida Fish and Wildlife Conservation Commission, Division of Marine Fisheries Management. Evolution of each saltwater regulation (1985-2010). Prepared by Lee Schlesinger (revised May 24, 2014). http://www.myfwc.com/fishing/saltwater/regulations/history/

GMFMC (Gulf of Mexico Fishery Management Council). 1981. Fishery management plan for the reef fish fishery of the Gulf of Mexico and environmental impact statement. Gulf of Mexico Fishery Management Council, Tampa, Florida. 155 p.

GMFMC (Gulf of Mexico Fishery Management Council). 1989. Amendment 1 to the reef fish fishery management plan. Gulf of Mexico Fishery Management Council, Tampa, Florida. 356 pp.

GMFMC (Gulf of Mexico Fishery Management Council). 1991. Amendment 4 to the reef fish fishery management plan. Gulf of Mexico Fishery Management Council, Tampa, Florida. 42 pp.

GMFMC (Gulf of Mexico Fishery Management Council). 1993. Amendment 5 to the reef fish fishery management plan for the reef fish resources of the Gulf of Mexico. Gulf of Mexico Fishery Management Council, Tampa, Florida. 450 pp.

GMFMC (Gulf of Mexico Fishery Management Council). 1995. Amendment 12 to the reef fish fishery management plan for the reef fish resources of the Gulf of Mexico. Gulf of Mexico Fishery Management Council, Tampa, Florida. 44 pp.

GMFMC (Gulf of Mexico Fishery Management Council). 1996. Amendment 14 to the reef fish fishery management plan for the reef fish fishery of the Gulf of Mexico. Gulf of Mexico Fishery Management Council, Tampa, Florida. 89 pp.

GMFMC (Gulf of Mexico Fishery Management Council). 1997. Amendment 15 to the reef fish fishery management plan for the reef fish fishery of the Gulf of Mexico. Gulf of Mexico Fishery Management Council, Tampa, Florida. 114 pp.

GMFMC (Gulf of Mexico Fishery Management Council). 1998. Amendment 16A to the reef fish fishery management plan for the reef fish fishery of the Gulf of Mexico. Gulf of Mexico Fishery Management Council, Tampa, Florida. 49 pp.

GMFMC (Gulf of Mexico Fishery Management Council). 1999. Amendment 16B to the fishery management plan for the reef fish resources of the Gulf of Mexico. Gulf of Mexico Fishery Management Council, Tampa, Florida. 56 pp.

GMFMC (Gulf of Mexico Fishery Management Council). 1999. Generic Sustainable Fisheries Act Amendment. Gulf of Mexico Fishery Management Council, Tampa, Florida. 318 pp.

GMFMC (Gulf of Mexico Fishery Management Council). 2001. Generic Amendment (Amendment 13), Coral and Coral Reefs Fishery Management Plan (Amendment 4), Red Drum Fishery Management Plan (Amendment 4), Reef Fish Fishery Management Plan (Amendment 19), Shrimp Fishery Management Plan (Amendment 12), Spiny Lobster Fishery Management Plan (Amendment 7), Stone Crab Fishery Management Plan (Amendment 8) (includes an IRFA, RIR and a FSEIS) (EFH Amendment 2). Gulf of Mexico Fishery Management Council, Tampa, Florida. 194 pp.

GMFMC (Gulf of Mexico Fishery Management Council). 2003. Corrected amendment for a charter vessel/headboat permit moratorium amending the FMPs for: Reef fish (Amendment 20) and coastal migratory pelagics (Amendment 14) (Including EA/RIR/IRFA). Gulf of Mexico Fishery Management Council, Tampa, Florida. 164 pp.

GMFMC (Gulf of Mexico Fishery Management Council). 2005. Final Amendment 24 to the reef fish fishery management plan for reef fish resources in the Gulf of Mexico including environmental assessment, regulatory impact review, and initial regulatory flexibility analysis.
Gulf of Mexico Fishery Management Council, Tampa, Florida. 143 pp.

GMFMC (Gulf of Mexico Fishery Management Council). 2005. Final amendment to the FMPs for: Reef fish (Amendment 25) and coastal migratory pelagics (Amendment 17) for extending the charter vessel/headboat permit moratorium (including SEIS/RIR/IRFA). Gulf of Mexico Fishery Management Council, Tampa, Florida. 111 pp.

GMFMC (Gulf of Mexico Fishery Management Council). 2007. Amendment 27 to the Reef Fish FMP and Amendment 14 to the Shrimp FMP to end overfishing and rebuild the red snapper stock. Gulf of Mexico Fishery Management Council, 2203 North Lois Avenue, Suite 1100, Tampa, Florida 33607. 490 pp.

GMFMC (Gulf of Mexico Fishery Management Council). 2011. Final Generic Annual Catch Limits/Accountability Measures Amendment for the Gulf of Mexico Fishery Management

Council's Red Drum, Reef Fish, Shrimp, Coral and Coral Reefs, Fishery Management Plans including Environmental Impact Statement, Regulatory Impact Review, Regulatory Flexibility Analysis, Fishery Impact Statement. Gulf of Mexico Fishery Management Council, 2203 North Lois Avenue, Suite 1100, Tampa, Florida 33607. 362 pp.

GMFMC (Gulf of Mexico Fishery Management Council). Under development. Amendment 18B to the reef fish fishery management plan for the reef fish fishery of the Gulf of Mexico. Gulf of Mexico Fishery Management Council, Tampa, Florida.

SAFMC (South Atlantic Fishery Management Council). 1983. Fishery Management Plan, Regulatory Impact Review and Final Environmental Impact Statement for the Snapper Grouper Fishery of the South Atlantic Region. South Atlantic Fishery Management Council, 1 Southpark Circle, Suite 306, Charleston, South Carolina, 29407-4699.

SAFMC (South Atlantic Fishery Management Council). 1988. Amendment Number 1 and Environmental Assessment and Regulatory Impact Review to the Fishery Management Plan for the Snapper Grouper Fishery of the South Atlantic Region. South Atlantic Fishery Management Council, 1 Southpark Cir., Suite 306, Charleston, S.C. 29407-4699. 63 pp.

SAFMC (South Atlantic Fishery Management Council). 1990. Amendment Number 3, Regulatory Impact Review, Initial Regulatory Flexibility Analysis and Environmental Assessment for the Fishery Management Plan for the Snapper Grouper Fishery of the South Atlantic Region. South Atlantic Fishery Management Council, 1 Southpark Cir., Suite 306, Charleston, S.C. 29407-4699.

SAFMC (South Atlantic Fishery Management Council). 1991. Amendment Number 4, Regulatory Impact Review, Initial Regulatory Flexibility Analysis and Environmental Assessment for the Fishery Management Plan for the Snapper Grouper Fishery of the South Atlantic Region. South Atlantic Fishery Management Council, 1 Southpark Cir., Suite 306, Charleston, S.C. 29407-4699. 57 pp.

SAFMC (South Atlantic Fishery Management Council). 1993. Amendment Number 6, Regulatory Impact Review, Initial Regulatory Flexibility Analysis and Environmental Assessment for the Fishery Management Plan for the Snapper Grouper Fishery of the South Atlantic Region. South Atlantic Fishery Management Council, 1 Southpark Cir., Suite 306, Charleston, S.C. 29407-4699. 155 pp.

SAFMC (South Atlantic Fishery Management Council). 1994. Amendment Number 7, Regulatory Impact Review and Environmental Assessment for the Snapper Grouper Fishery of the South Atlantic Region. South Atlantic Fishery Management Council, 1 Southpark Cir., Suite 306, Charleston, S.C. 29407-4699. 293 pp.

SAFMC (South Atlantic Fishery Management Council). 1994. Regulatory Amendment 6 (Including regulatory impact review and environmental assessment) for the Snapper Grouper Fishery of the South Atlantic Region. South Atlantic Fishery Management Council, 1 Southpark Cir., Suite 306, Charleston, S.C. 29407-4699. 69 pp.

SAFMC (South Atlantic Fishery Management Council). 1997. Amendment Number 8, Regulatory Impact Review, Social Impact Assessment, Initial Regulatory Flexibility Analysis and Supplemental Environmental Impact Statement for the Fishery Management Plan for the Snapper Grouper Fishery of the South Atlantic Region. South Atlantic Fishery Management Council, 1 Southpark Cir., Ste 306, Charleston, S.C. 29407-4699. 124 pp.

SAFMC (South Atlantic Fishery Management Council). 1998b. Comprehensive Amendment Addressing Sustainable Fishery Act Definitions and Other Required Provisions in Fishery Management Plans of the South Atlantic Region (Amendment 11 to the Snapper Grouper Fishery Management Plan). South Atlantic Fishery Management Council, 1 Southpark Cir., Suite 306, Charleston, S.C. 29407-4699. 151 pp.

SAFMC (South Atlantic Fishery Management Council). 2003. Amendment 13A to the Fishery Management Plan for the Snapper Grouper Fishery of the South Atlantic Region. South Atlantic Fishery Management Council, 1 Southpark Cir., Suite 306, Charleston, S.C. 29407-4699. 268 pp.

SAFMC (South Atlantic Fishery Management Council). 2007. Snapper Grouper Amendment 14 including a final environmental impact statement, biological assessment, initial regulatory flexibility analysis, regulatory impact review, and social impact assessment/fishery impact statement. South Atlantic Fishery Management Council, 1 Southpark Cir., Suite 306, Charleston,
S.C. 29407-4699. 601 pp.

SAFMC (South Atlantic Fishery Management Council). 2008. Amendment Number 16, Final Environmental Impact Statement, Initial Regulatory Flexibility Analysis/Regulatory Impact Review, and Social Impact Assessment/Fishery Impact Statement for the Fishery Management Plan for the Snapper Grouper Fishery of the South Atlantic Region. South Atlantic Fishery Management Council, 4055 Faber Place, Ste 201, North Charleston, S.C. 29405. 375 pp.

SAFMC (South Atlantic Fishery Management Council). 2010. Final Amendment Number 17A for the Snapper Grouper Fishery of the South Atlantic Region with Final Environmental Impact Statement, Initial Regulatory Flexibility Act Analysis/Regulatory Impact Review, and Social Impact Assessment/Fishery Impact Statement. South Atlantic Fishery Management Council, 4055 Faber Place, Ste 201, North Charleston, S.C. 29405. 375 pp. + XXI + Summary (20 pp.).

SAFMC (South Atlantic Fishery Management Council). 2012. Amendment 25 to the Fishery Management Plan for the Snapper Grouper Fishery of the South Atlantic Region (Comprehensive Annual Catch Limit Amendment). South Atlantic Fishery Management Council, 4055 Faber Place, Ste 201, North Charleston, S.C. 29405.

SAFMC (South Atlantic Fishery Management Council). 2013. Regulatory Amendment 13 to the Fishery Management Plan for the Snapper Grouper Fishery of the South Atlantic Region.

South Atlantic Fishery Management Council, 4055 Faber Place, Ste 201, North Charleston, S.C. 29405.

SAFMC (South Atlantic Fishery Management Council). 2016. Amendment 37 to the Fishery Management Plan for the Snapper Grouper Fishery of the South Atlantic Region. South Atlantic Fishery Management Council, 4055 Faber Place, Ste 201, North Charleston, S.C. 29405.

SAFMC (South Atlantic Fishery Management Council). 2020. Regulatory Amendment 29 to the Fishery Management Plan for the Snapper Grouper Fishery of the South Atlantic Region. South Atlantic Fishery Management Council, 4055 Faber Place, Ste 201, North Charleston, S.C. 29405.

2.8 Management and Regulatory Timeline

The following tables provides a timeline for federal and state management actions related to size and bag limits for the Hogfish fishery.

Annual Hogfish Regulatory Summary (Size and Bag Limits)

	SAFMC		Florida		GFMC	
Year	Minimum size FL (inches)	Bag limit	Minimum size FL (Inches) Gulf/Atlantic	Bag limit (Gulf/Atlantic)	Minimum size FL (inches)	Bag limit
1982	-----	-----	-----	-----	-----	-----
1983	-----	-----	-----	-----	-----	-----
1984	-----	-----	-----	-----	-----	-----
1985	-----	-----	-----	-----	-----	-----
1986	-----	-----	-----	-----	-----	-----
1987	-----	-----	-----	-----	-----	-----
1988	-----	-----	-----	-----	-----	-----
1989	-----	-----	-----	-----	-----	-----
1990	-----	-----	-----	-----	-----	-----
1991	-----	-----	-----	-----	-----	-----
1992	-----	-----	-----	-----	-----	-----
1993	-----	-----	-----	-----	-----	-----
1994	-----	-----	12/12	5/5	-----	-----
1995	12	5	12/12	5/5	-----	-----
1996	12	5	12/12	5/5	-----	-----
1997	12	5	12/12	5/5	-----	20 (aggregate)
1998	12	5	12/12	5/5	-----	20 (aggregate)
1999	12	5	12/12	5/5	12	5
2000	12	5	12/12	5/5	12	5
2001	12	5	12/12	5/5	12	5
2002	12	5	12/12	5/5	12	5
2003	12	5	12/12	5/5	12	5
2004	12	5	12/12	5/5	12	5
2005	12	5	12/12	5/5	12	5
2006	12	5	12/12	5/5	12	5

2007	12	5	12/12	5/5	12	5
2008	12	5	12/12	5/5	12	5
2009	12	5	12/12	5/5	12	5
2010	12	5	12/12	5/5	12	5
2011	12	5	12/12	5/5	12	5
2012	12	5	12/12	5/5	12	5
2013	12	5	12/12	5/5	12	5
2014	12	5	12/12	5/5	12	5
2015	12	5	12/12	5/5	12	5
2016	12	5	12/12	5/5	12	5
2017	12/16	5/1	12/12	5/5	12/14	5
2018	16	1	14/16	5/1	14	5
2019	16	1	14/16	5/1	14	5
2020	16	1	14/16	5/1	14	5
2021	16	1	14/16	5/1	14	5
2022	16	1	14/16	5/1	14	5
2023	16	1	14/16	5/1	14	5
2024	16	1	14/16	5/1	14	5

Federal Harvest Restrictions – Trip Limits*

*Trip limits do not apply during closures (if season is closed, then trip limit is 0)

South Atlantic	First Yr In Effect	Effective Date	End Date	Fishery	Bag Limit Per Person/Day	Bag Limit Per Boat/Day	Region Affected	Amendment Number or Rule Type
	1983	9/28/83	8/23/17	Comm	None	None	South Atlantic	Snapper Grouper FMP
	1983	9/28/83	5/21/95	Rec	None	None	South Atlantic	Snapper Grouper FMP
	1995	5/22/95	8/23/17	Rec	5 fish	NA	South Atlantic - EFL/FLK	SG Regulatory Amendment 6
	2017	8/24/17	Ongoing	Comm	NA	25 lbs ww	South Atlantic - EFL/FLK	SG Amendment 37
	2017	8/24/17	Ongoing	Rec	1 fish	NA	South Atlantic - EFL/FLK	SG Amendment 37

Gulf	First Yr In Effect	Effective Date	End Date	Fishery	Bag Limit Per Person/Day	Bag Limit Per Boat/Day	Region Affected	Amendment Number or Rule Type
	1984	11/8/84	11/23/99	Both	-	-	Gulf of Mexico	Original Reef Fish FMP
	1999	11/24/99	Present	Rec	5 w/in 20 reef fish agg	-	Gulf of Mexico	RF Amendment 16B

Federal Harvest Restrictions – Size Limits*
*Size limits do not apply during closures

South Atlantic	First Yr In Effect	Effective Date	End Date	Fishery	Size Limit	Length Type	Region Affected	FR Reference	Amendment Number or Rule Type
	1983	9/28/83	1/22/95	Commercial	None	NA	South Atlantic		Snapper Grouper FMP
	1983	9/28/83	1/22/95	Rec	None	NA	South Atlantic		Snapper Grouper FMP
	1995	1/23/95	8/23/17	Commercial	12 inches	FL	South Atlantic	59 FR 66270	SG Amendment 7
	1995	1/23/95	8/23/17	Rec	12 inches	FL	South Atlantic	59 FR 66270	SG Amendment 7
	2017	8/24/17	Ongoing	Commercial	16 inches	FL	South Atlantic - EFL/FLK	82 FR 34584	SG Amendment 37
	2017	8/24/17	Ongoing	Rec	16 inches	FL	South Atlantic - EFL/FLK	82 FR 34584	SG Amendment 37

Gulf	First Yr In Effect	Effective Date	End Date	Fishery	Size Limit	Length Type	Region Affected	FR Reference	Amendment Number or Rule Type
	1984	11/8/84	11/1/99	Both	none	none	Gulf of Mexico		Original RF FMP
	1999	11/24/99	8/24/17	Both	12"	FL	Gulf of Mexico		RF Amendment 16B
	2017	8/24/17	Present	Both	14"	FL	Gulf stock		RF Amendment 43

Federal Harvest Restrictions – Fishery Closures*
*Area specific regulations are documented under spatial restrictions

South Atlantic	First Yr In Effect	Effective Date	End Date	Fishery	Closure Type	First Day Closed	Last Day Closed	Region Affected	FR Reference	Amendment Number or Rule Type	Species Associated with Closure
	2015	8/24/15	12/31/15	Recreational	ACL	8/24/15	12/31/15	South Atlantic EEZ	80 FR 50585	Temporary Rule	Hogfish (SA EEZ)
	2016	11/30/16	12/31/16	Recreational	ACL	11/30/16	12/31/16	South Atlantic EEZ	81 FR 85446	Temporary Rule	Hogfish (SA EEZ)
	2017	8/24/17	12/31/17	Commercial	ACL	8/24/17	12/31/17	South Atlantic - EFL/FLK	82 FR 40075	Temporary Rule	Hogfish (FLK/EFL)
	2017	8/24/17	12/31/17	Recreational	ACL	8/24/17	12/31/17	South Atlantic - EFL/FLK	82 FR 40075	Temporary Rule	Hogfish (FLK/EFL)
	2018	8/24/17	Ongoing	Recreational	Seasonal Closure	1/1	4/30	South Atlantic - EFL/FLK	82 FR 34584	SG Amendment 37	Hogfish (FLK/EFL)
	2018	8/24/17	Ongoing	Recreational	Seasonal Closure	11/1	12/31	South Atlantic - EFL/FLK	82 FR 34584	SG Amendment 37	Hogfish (FLK/EFL)
	2018	11/16/18	12/31/18	Commercial	ACL	11/16/18	12/31/18	South Atlantic - EFL/FLK	83 FR 57339	Temporary Rule	Hogfish (FLK/EFL)
Gulf	2013	12/3/13	12/31/13	Both	ACL	12/3/13	12/31/13	Gulf of Mexico	78 FR 72583	Temporary Rule	Hogfish

Federal Harvest Restrictions – Spatial Restrictions – South Atlantic

Area	First Yr In Effect	Effective Date	End Date	Fishery	First Day Closed	Last Day Closed	Restriction in Area	FR Reference	Amendment Number or Rule Type
Oculina Bank Experimental Closed Area	1994	6/27/94	4/25/04	Both	Year round		Fishing prohibited	59 FR 27242	Amendment 6
	2004	4/26/04	Ongoing	Both	Year round		Extended fishing prohibition and possesion of snapper grouper species	69 FR 15731	Amendment 13A
Snowy Grouper Wreck MPA	2009	2/12/09	Ongoing	Both	Year round		Fishing prohibited	74 FR 1621	Amendment 14
Northern South Carolina MPA	2009	2/12/09	Ongoing	Both	Year round		Fishing prohibited	74 FR 1621	Amendment 14
Edisto MPA	2009	2/12/09	Ongoing	Both	Year round		Fishing prohibited	74 FR 1621	Amendment 14
Charleston Deep Artificial Reef MPA	2009	2/12/09	Ongoing	Both	Year round		Fishing prohibited	74 FR 1621	Amendment 14
Georgia MPA	2009	2/12/09	Ongoing	Both	Year round		Fishing prohibited	74 FR 1621	Amendment 14
North Florida MPA	2009	2/12/09	Ongoing	Both	Year round		Fishing prohibited	74 FR 1621	Amendment 14
St. Lucie Hump MPA	2009	2/12/09	Ongoing	Both	Year round		Fishing prohibited	74 FR 1621	Amendment 14
East Hump MPA	2009	2/12/09	Ongoing	Both	Year round		Fishing prohibited	74 FR 1621	Amendment 14
South Cape Lookout Spawning SMZ	2017	7/31/17	Ongoing	Both	Year round		Fishing prohibited	82 FR 29772	Amendment 36
Devil's Hole/Georgetown Hole Spawning SMZ	2017	7/31/17	Ongoing	Both	Year round		Fishing prohibited	82 FR 29772	Amendment 36

Area 51 Spawning SMZ	2017	7/31/17	Ongoing	Both	Year round	Fishing prohibited	82 FR 29772	Amendment 36
Area 53 Spawning SMZ	2017	7/31/17	Ongoing	Both	Year round	Fishing prohibited	82 FR 29772	Amendment 36
Warsaw Hole/50 Fathom Hole Spawning SMZ	2017	7/31/17	Ongoing	Both	Year round	Fishing prohibited	82 FR 29772	Amendment 36

Federal Harvest Restrictions – Spatial Restrictions – Gulf

Area	First Yr In Effect	Effective Date	End Date	Fishery	First Day Closed	Last Day Closed	Restriction in Area	FR Reference	Amendment Number or Rule Type
Gulf of Mexico Stressed Areas	1984	11/8/84	Ongoing	Both	Year round		Prohibited powerheads for Reef FMP	49 FR 39548	Original Reef Fish FMP
	1984	11/8/84	Ongoing	Both	Year round		Prohibited pots and traps for Reef FMP	49 FR 39548	Original Reef Fish FMP
EEZ, inside 50 fathoms west of Cape San Blas, FL	1990	2/21/90	Ongoing	Both	Year round		Prohibited longline and buoy gear for Reef FMP	55 FR 2078	Reef Fish Amendment 1
EEZ, inside 20 fathoms east of Cape San Blas, FL	1990	2/21/90	Ongoing	Both	Year round		Prohibited longline and buoy gear for Reef FMP	55 FR 2078	Reef Fish Amendment 1
Alabama Special Management Zones	1994	2/7/94	Ongoing	Both	Year round		Allow only hook-and line gear with three or less hooks per line and spearfishing gear for fish in Reef FMP	59 FR 966	Reef Fish Amendment 5
EEZ, inside 50 fathoms east of Cape San Blas, FL	2009	5/18/09	10/15/09	Both	18-May	28-Oct	Prohibited bottom longline for Reef FMP	74 FR 20229	Emergency Rule
EEZ, inside 35 fathoms east of Cape San Blas, FL	2009	10/16/09	5/25/10	Both	Year round		Prohibited bottom longline for Reef FMP	74 FR 53889	Sea Turtle ESA Rule
	2010	5/26/10	Ongoing	Rec	Year round		Prohibited bottom longline for Reef FMP	75 FR 21512	Reef Fish Amendment 31

	2010	5/26/10	Ongoing	Com	1-Jun	31-Aug	Prohibited bottom longline for Reef FMP	75 FR 21512	Reef Fish Amendment 31
Madison-Swanson	2000	6/19/00	6/2/04	Both	Year round		Fishing prohibited except HMS[1]	65 FR 31827	Reef Fish Regulatory Amendment
	2004	6/3/04	Ongoing	Both	1-May	31-Oct	Fishing prohibited except surface trolling	69 FR 24532	Reef Fish Amendment 21
								74 FR 17603	Reef Fish Amendment 30B
	2004	6/3/04	Ongoing	Both	1-Nov	30-Apr	Fishing prohibited	69 FR 24532	Reef Fish Amendment 21
								74 FR 17603	Reef Fish Amendment 30B
Steamboat Lumps	2000	6/19/00	6/2/04	Both	Year round		Fishing prohibited except HMS[1]	65 FR 31827	Reef Fish Regulatory Amendment
	2004	6/3/04	Ongoing	Both	1-May	31-Oct	Fishing prohibited except surface trolling	69 FR 24532	Reef Fish Amendment 21
								74 FR 17603	Reef Fish Amendment 30B
	2004	6/3/04	Ongoing	Both	1-Nov	30-Apr	Fishing prohibited	69 FR 24532	Reef Fish Amendment 21
								74 FR 17603	Reef Fish Amendment 30B
Madison-Swanson & Steamboat Lumps	2021	8/20/21	Ongoing	Both	Year round		Fishing prohibited except HMS[1]	86 FR 38416	Reef Fish Framework Action
The Edges	2010	7/24/09	Ongoing	Both	1-Jan	30-Apr	Fishing prohibited	74 FR 30001	Reef Fish Amendment 30B Supplement
20 Fathom Break	2014	7/5/13	Ongoing	Rec	1-Feb	31-Mar	Fishing for SWG prohibited[2]	78 FR 33259	Reef Fish Framework Action

Flower Garden	1992	1/17/92	Ongoing	Both	Year round		Fishing with bottom gears prohibited[3]	56 FR 63634	Sanctuary Designation
Riley's Hump	1994	2/7/94	8/18/02	Both	1-May	30-Jun	Fishing prohibited	59 FR 966	Reef Fish Amendment 5
Tortugas Reserves	2002	8/19/02	Ongoing	Both	Year round		Fishing prohibited	67 FR 47467	Tortugas Amendment
Pulley Ridge	2006	1/23/06	Ongoing	Both	Year round		Fishing with bottom gears prohibited[3]	70 FR 76216	Essential Fish Habitat (EFH) Amendment 3
DWH Oil Spill closure	2010	5/2/10	11/15/10	Both			All fishing prohibited in designated areas	75 FR 24822	

[1]HMS: highly migratory species (tuna species, marlin, oceanic sharks, sailfishes, and swordfish)

[2]SWG: shallow-water grouper (black, gag, red, red hind, rock hind, scamp, yellowfin, and yellowmouth)

[3]Bottom gears: Bottom longline, bottom trawl, buoy gear, pot, or trap

Federal Harvest Restrictions – Gear - South Atlantic
*Area specific gear restrictions are documented under spatial restrictions

Gear Type	First Yr In Effect	Effective Date	End Date	Gear/Harvesting Restrictions	Region Affected	FR Reference	Amendment Number or Rule Type
Poison	1983	9/28/83	ongoing	Prohibited	South Atlantic EEZ	48 FR 39463	SG FMP
Explosives	1983	9/28/83	ongoing	Prohibited	South Atlantic EEZ	48 FR 39463	SG FMP
Fish traps	1983	9/28/83	12/31/91	Prohibited shoreward of the 100 ft contour, south of Fowey Rocks Light (Miami). Restriction on pulling traps from one hour before sunset to one hour before sunrise south of Cape Canaveral. Gear specs (degradaable panel, degradable door fasteners, mesh size).	South Atlantic EEZ	48 FR 39463	SG FMP
Hand-held hook and line and spearfishing	1987	3/27/87	ongoing	Only gear allowed in Special Management Zones	SMZs within the South Atlantic EEZ	52 FR 9864	SG Regulatory Amendment 1
Trawl	1989	1/12/89	ongoing	Prohibited south of Cape Hatteras, NC and north of Cape Canaveral, FL	specified area within the South Atlantic EEZ	54 FR 1720	SG Amendment 1
Fish traps	1992	1/1/92	ongoing	Prohibited fish traps (except black sea bass pots) north of Cape Canaveral, FL	specified area within the South Atlantic EEZ	56 FR 56016	SG Amendment 4
Entanglement nets	1992	1/1/92	ongoing	Prohibited	South Atlantic EEZ	56 FR 56016	SG Amendment 4
Longline	1992	1/1/92	ongoing	Prohibited inside of 50 fathoms	specified area within the South Atlantic EEZ	56 FR 56016	SG Amendment 4
Powerheads and bangsticks	1992	1/1/92	ongoing	Prohibited in SMZs off South Carolina	specific areas off SC	56 FR 56016	SG Amendment 4

Allowable gear	1995	1/23/95	ongoing	Specified allowable gear in the SG fishery	South Atlantic EEZ	59 FR 66270	SG Amendment 7
Dehooking devices and venting	2009	7/29/09	ongoing	Both sectors required to use venting and dehooking tools while fishing for snapper grouper species in the South Atlantic EEZ	South Atlantic EEZ	74 FR 30964	SG Amendment 16
Non-stainless steel circle hooks	2011	3/3/11	ongoing	Required to fish for SG species with natural baits north of 28 deg N Lat.	specified area within the South Atlantic EEZ	75 FR 76874	SG Amendment 17A
Descending devices; non-offset, non-stainless steel circle hooks; and powerheads	2020	7/15/20	ongoing	Rigged and ready descending device required for all sectors to fish for or possess SG species; Non-offset, non-stainless steel circle hooks required to fish for SG species using hook and line gear and natural baits in the EEZ north of 28 deg N Lat.; powerheads are allowed to be used in harvesting SG species in the EEZ off South Carolina	South Atlantic EEZ	85 FR 36166	SG Regulatory Amendment 29

Federal Harvest Restrictions – Gear – Gulf

*Area specific gear restrictions are documented under spatial restrictions

Gear Type	First Yr In Effect	Effective Date	End Date	Gear/Harvesting Restrictions	Region Affected	FR Reference	Amendment Number or Rule Type
Poison	1984	11/8/84	Ongoing	Prohibited for Reef FMP	Gulf of Mexico EEZ	49 FR 39548	Original Reef Fish FMP
Explosives	1984	11/8/84	Ongoing	Prohibited for Reef FMP	Gulf of Mexico EEZ	49 FR 39548	Original Reef Fish FMP
Pots and Traps	1984	11/23/84	2/6/19994	Established fish trap permit	Gulf of Mexico EEZ	49 FR 39548	Original Reef Fish FMP
	1984	11/23/84	2/20/90	Set max number of traps fish by a vessel at 200	Gulf of Mexico EEZ	49 FR 39548	Original Reef Fish FMP
	1990	2/21/90	2/6/94	Set max number of traps fish by a vessel at 100	Gulf of Mexico EEZ	55 FR 2078	Reef Fish Amendment 1
	1994	2/7/94	2/7/97	Moratorium on additional commercial trap permits	Gulf of Mexico EEZ	59 FR 966	Reef Fish Amendment 5
	1997	4/24/97	2/7/07	Phase out of fish traps begins	Gulf of Mexico EEZ	62 FR 13983	Reef Fish Amendment 14
	1997	12/30/97	2/6/07	Prohibited harvest of reef fish from traps other than permitted reef fish, stone crab, or spiny lobster traps.	Gulf of Mexico EEZ	62 FR 67714	Reef Fish Amendment 15
	2007	2/8/07	Ongoing	Traps prohibited	Gulf of Mexico EEZ	62 FR 13983	Reef Fish Amendment 14
All	1992	5/8/92	12/31/95	Moratorium on commercial permits for Reef FMP	Gulf of Mexico EEZ	57 FR 11914	Reef Fish Amendment 4
						59 FR 39301	Reef Fish Amendment 9
	1994	2/7/94	Ongoing	Finfish must have head and fins intact through landing, can be eviscerated, gilled, and scaled but must otherwise be whole (HMS and bait exceptions)	Gulf of Mexico EEZ	59 FR 39301	Reef Fish Amendment 9

	1996	1/1/96	12/31/05	Moratorium on commercial permits for Gulf reef fish.	Gulf of Mexico EEZ	60 FR 64350 65 FR 41016	Interim Rule Reef Fish Amendment 17
	2006	9/8/06	Ongoing	Use of Gulf reef fish as bait prohibited.[1]	Gulf of Mexico EEZ	71 FR 45428	Reef Fish Amendment 18A
Vertical Line	2008	6/1/08	Ongoing	Requires non-stainless steel circle hooks and dehooking devices	Gulf of Mexico EEZ	73 FR 5117	Reef Fish Amendment 27
	2008	6/1/08	9/3/13	Requires venting tools	Gulf of Mexico EEZ	73 FR 5117 78 FR 46820	Reef Fish Amendment 27 Framework Action
Longline	2009	10/16/09	Ongoing	750 hooks fishing	Gulf of Mexico EEZ	74 FR 53889	Endangered Species Act and regulatory action

[1]Except when, purchased from a fish processor, filleted carcasses may be used as bait crab and lobster traps.

Federal Quota History

South Atlantic	First Yr In Effect	Effective Date	End Date	Sector	Quota or ACL	Region Affected	FR Reference	Amendment Number or Rule Type
	2012	4/16/12	7/16/13	Recreational	98,866 lbs ww	South Atlantic	77 FR 15916	Comp ACL Amendment (SG Am 25)
	2013	7/17/13	8/23/17	Recreational	85,355 lbs ww	South Atlantic	77 FR 36113	SG Regulatory Amendment 13
	2017	8/24/17	12/31/17	Recreational	15,689 fish	South Atlantic - EFL/FLK	82 FR 34584	SG Amendment 37
	2018	1/1/18	12/31/18	Recreational	18,617 fish	South Atlantic - EFL/FLK	82 FR 34584	SG Amendment 37
	2019	1/1/19	12/31/19	Recreational	21,574 fish	South Atlantic - EFL/FLK	82 FR 34584	SG Amendment 37
	2020	1/1/20	12/31/20	Recreational	25,086 fish	South Atlantic - EFL/FLK	82 FR 34584	SG Amendment 37
	2021	1/1/21	12/31/21	Recreational	29,096 fish	South Atlantic - EFL/FLK	82 FR 34584	SG Amendment 37
	2022	1/1/22	12/31/22	Recreational	33,358 fish	South Atlantic - EFL/FLK	82 FR 34584	SG Amendment 37
	2023	1/1/23	12/31/23	Recreational	37,671 fish	South Atlantic - EFL/FLK	82 FR 34584	SG Amendment 37
	2024	1/1/24	12/31/24	Recreational	41,934 fish	South Atlantic - EFL/FLK	82 FR 34584	SG Amendment 37
	2012	4/16/12	7/16/13	Commercial - SG Complex	48,772 lbs ww	South Atlantic	78 FR 15916	Comp ACL Amendment (SG Am 25)

	2013	7/17/13	8/23/17	Commercial - SG Complex	49,469 lbs ww	South Atlantic	77 FR 26113	SG Regulatory Amendment 13
	2017	8/24/17	12/31/17	Commercial - SG Complex	3,510 lbs ww	South Atlantic - EFL/FLK	82 FR 34584	SG Amendment 37
	2018	1/1/18	12/31/18	Commercial - SG Complex	4,524 lbs ww	South Atlantic - EFL/FLK	82 FR 34584	SG Amendment 37
	2019	1/1/19	12/31/19	Commercial - SG Complex	5,670 lbs ww	South Atlantic - EFL/FLK	82 FR 34584	SG Amendment 37
	2020	1/1/20	12/31/20	Commercial - SG Complex	6,926 lbs ww	South Atlantic - EFL/FLK	82 FR 34584	SG Amendment 37
	2021	1/1/21	12/31/21	Commercial - SG Complex	8,277 lbs ww	South Atlantic - EFL/FLK	82 FR 34584	SG Amendment 37
	2022	1/1/22	12/31/22	Commercial - SG Complex	9,703 lbs ww	South Atlantic - EFL/FLK	82 FR 34584	SG Amendment 37
	2023	1/1/23	12/31/23	Commercial - SG Complex	11,179 lbs ww	South Atlantic - EFL/FLK	82 FR 34584	SG Amendment 37
	2024	1/1/24	12/31/24	Commercial - SG Complex	12,677 lbs ww	South Atlantic - EFL/FLK	82 FR 34584	SG Amendment 37

Gulf	First Yr In Effect	Effective Date	End Date	Sector	Quota or ACL	Region Affected	FR Reference	Amendment Number or Rule Type
	2012	1/30/12	8/23/17	Combined	208,000 lbs ww	Gulf		Generic ACL/AM Amendment
	2017	8/24/17	4/3/19	Combined	219,000 lbs ww	Gulf		
	2019	4/4/19	12/31/19	Combined	129,500 lbs ww	Gulf	84 FR 7828	
	2020	1/1/20	12/31/20	Combined	141,300 lbs ww	Gulf		
	2021	1/1/21	present	Combined	150,400 lbs ww	Gulf		

Deep Water Horizon Spatial Closures (Gulf)

Closure Date	Area (sq mi)	Area (sq km)	% Coverage of Gulf EEZ	% Change in Coverage
2-May	6,817	17,648	2.8	N/A
7-May	10,807	27,989	4.5	58.5
11-May	16,027	41,511	6.6	48.3
12-May	17,651	45,717	7.3	10.1
14-May	19,377	50,187	8	9.8
17-May	24,241	62,784	10	25.1
18-May	45,728	118,435	18.9	88.6
21-May	48,005	124,333	19.8	5
25-May	54,096	140,109	22.4	12.7
28-May	60,683	157,169	25.1	12.2
31-May	61,854	160,200	25.6	1.9
1-Jun	75,920	196,633	31.4	22.7
2-Jun	88,522	229,270	36.6	16.6
4-Jun	78,182	202,491	32.3	-11.7
5-Jun	78,603	203,582	32.5	0.5
7-Jun	78,264	202,703	32.3	-0.4
16-Jun	80,806	209,286	33.4	3.2
21-Jun	86,985	225,290	35.9	7.6
23-Jun	78,597	203,564	32.5	-9.6
28-Jun	80,228	207,790	33.2	2.1
4-Jul	81,181	210,259	33.5	1.2
12-Jul	84,101	217,821	34.8	3.6
13-Jul	83,927	217,371	34.7	-0.2
22-Jul	57,539	149,026	23.8	-31.4
10-Aug	52,395	135,703	21.7	-8.9
27-Aug	48,114	124,614	19.9	-8.2
2-Sep	43,000	111,369	17.8	-10.6
3-Sep	39,885	103,303	16.5	-7.2
21-Sep	31,915	82,659	13.2	-20
1-Oct	26,287	68,083	10.9	-17.6
5-Oct	23,360	60,502	9.7	-11.1
15-Oct	16,481	42,686	6.8	-29.4
22-Oct	9,444	24,461	3.9	-42.7
15-Nov	1,041	2,697	0.4	-89

3 ASSESSMENT HISTORY AND REVIEW

SEDAR 6 and SAFMC (2004) analyzed fishery-dependent and fishery-independent data and reported evidence consistent with severe growth and recruitment overfishing in Florida Hogfish and had been ongoing for the previous two decades in Florida waters. The estimated total fishing mortality rate for 2001 was F = 0.57, which is four times greater than F_{MSY} = 0.13. However, the independent peer-review panel concluded that, while qualitative evidence suggested growth overfishing, the available information was insufficient to definitively determine stock status (SEDAR 6 and SAFMC 2004).

McBride and Murphy (2003) examined the status of the Hogfish fishery, particularly in reference to the effect of the 1994 minimum-size regulation on Hogfish landings in Florida, and explored some costs and benefits of increasing the minimum legal fish size to increase the yield-per- recruit of Hogfish. Results from this study indicated that, until 2000, the sizes of most Hogfish landed in Florida were very similar to the 12-inch (305mm) FL size limit. The observed maximum size is lower in south Florida, where mortality is greatest, suggesting that growth overfishing is occurring in this region. The yield-per-recruit analysis conducted by McBride and Murphy (2003) indicated that maximum yield-per-recruit for Hogfish would occur at a size larger than the current mean size of fish harvested. Evidence of significantly higher instantaneous mortality rates and smaller sizes/ages in regions of south Florida indicate size-selective fishing mortality of Hogfish in these areas (McBride and Richardson 2007).

It is important to note that the studies described above evaluated Hogfish under a single Florida-stock paradigm and therefore combined fish from the Florida Keys, SE Florida, and West Florida Shelf regions. Subsequent advances in genetic, life-history, fishery-dependent, and fishery-independent research demonstrated substantial spatial structuring and regional differences in population dynamics throughout Florida waters. Consequently, the findings from these earlier statewide analyses are not directly comparable to subsequent stock assessments conducted under the revised stock structure adopted in SEDAR 37 and retained in later assessments. In particular, evidence of growth overfishing, recruitment overfishing, or elevated fishing mortality reported in these earlier studies reflected conditions across a broader Florida stock complex and should not be interpreted as representing the status of any specific stock alone.

The first benchmark stock assessment for Hogfish using Stock Synthesis and the revised stock structure hypothesis was completed through SEDAR 37 (SEDAR 2014). New genetic, life-history, fishery-dependent, and fishery-independent information supported the delineation of three stocks: West Florida (WFL), Florida Keys/East Florida (FLK/EFL), and Georgia–North Carolina (GA–NC). The assessment incorporated commercial and recreational landings, fishery-dependent and fishery-independent indices of abundance, and age composition data through 2012. Results indicated substantial differences in productivity and exploitation among regions. The West Florida stock was determined to be neither overfished (SSB_{2012}/SSB_{MSY} > 1.0) nor experiencing overfishing (F_{2012}/F_{MSY} < 1.0) under most candidate MFMT definitions (F_{MSY}, $F_{30\%}$, and $F_{35\%}$). Under the more conservative $F_{40\%}$ SPR benchmark, the median estimate indicated overfishing was occurring, although the stock was not overfished. In contrast, the Florida Keys/East Florida stock was estimated to be overfished and experiencing overfishing

under all candidate MFMT definitions, with terminal-year spawning biomass estimated at approximately one-half of the biomass target (SSB_{2012}/SSB_{MSY} = 0.49) and fishing mortality (F_{2012}/F_{MSY} = 2.06) roughly twice the overfishing threshold. The base model predicted the population as being overfished and experiencing overfishing for nearly the entire time frame of the model runs. A few low years in F (2000, 2006, 2011) approached the F/MFMT ratio of 1.0, but in all cases the stock was depleted (SSB/MSST<1.0). Based on these results, the Florida Keys/East Florida stock was designated for rebuilding while the West Florida stock continued to support separate management under a stock-specific framework. The Georgia–North Carolina stock was considered data-limited and stock status could not be reliably determined because of substantial uncertainty in the available fishery data, particularly recreational landings, which resulted in a broad range of plausible model fits during the bootstrap analysis. SEDAR 37 also highlighted considerable uncertainty regarding stock productivity, recruitment dynamics, and historical depletion levels, particularly for the Florida Keys/East Florida stock.

Following completion of SEDAR 37, the South Atlantic Fishery Management Council implemented management measures intended to rebuild the Florida Keys/East Florida stock. Rebuilding projections developed from the SEDAR 37 assessment indicated that the stock could rebuild within approximately ten years under substantially reduced fishing mortality and were used to evaluate alternative rebuilding strategies and harvest regulations (Addis and Murphy 2015). The assessment represented a major advancement in the understanding of Hogfish population structure and established separate management approaches for stocks exhibiting markedly different status and exploitation histories.

The SEDAR 37 Update assessment (SEDAR 2018) of the West Florida stock was conducted to incorporate additional years of fishery-dependent and fishery-independent data into the benchmark assessment framework and provide updated estimates of stock status and management benchmarks. The update assessment used the same Stock Synthesis model structure and biological assumptions as the benchmark assessment while incorporating additional fishery and survey data through 2016. The update assessment estimated higher stock biomass than the original benchmark assessment and concluded that the West Florida stock remained neither overfished nor subject to overfishing. Based on an $F_{30\%SPR}$ proxy for F_{MSY}, fishing mortality was estimated to remain below the overfishing threshold and spawning stock biomass remained well above the minimum stock size threshold. Although retrospective patterns indicated increased uncertainty in terminal-year estimates, the review panel determined that the assessment represented the best scientific information available and was suitable for management advice.

References

Addis, D.T., and M.D. Murphy. 2015. *Projections of the South Florida/Florida Keys Hogfish Stock under Various Rebuilding Scenarios*. Revised report to the South Atlantic Fishery Management Council Scientific and Statistical Committee, October 2015. Florida Fish and Wildlife Research Institute, St. Petersburg, Florida.

McBride, R.S., and M.D. Murphy. 2003. Current and potential yield per recruit for hogfish, *Lachnolaimus maximus*, in Florida. Proceedings of the 54th Annual Meeting of the Gulf and

Caribbean Fisheries Institute. Providenciales, Turks and Caicos Islands. 12-17 November 2001. 54:513-525.

McBride, R.S., and A.K. Richardson. 2007. Evidence of size-selective fishing mortality from an age and growth study of hogfish (Labridae: Lachnolaimus maximus), a hermaphroditic reef fish. Bull. Mar. Sci. 80:401-417.

SEDAR (Southeast Data, Assessment, and Review) and South Atlantic Fishery Management Council. 2004. Complete stock assessment report of SEDAR 6: Hogfish Snapper. South Atlantic Fishery Management Council SEDAR6 Assessment Report 2, Charleston, S.C. 127p.

SEDAR. 2014. SEDAR 37 The 2013 Stock Assessment Report for Hogfish in the South Atlantic and Gulf of Mexico. SEDAR, North Charleston SC. 573 pp. available online at: https://sedarweb.org/assessments/sedar-37/

SEDAR. 2018. SEDAR 37U Stock Assessment of Hogfish in the West Florida Shelf Stock 1986-2016. SEDAR, North Charleston SC. 211 pp. available online at: https://sedarweb.org/assessments/sedar-37/

4 REGIONAL MAPS

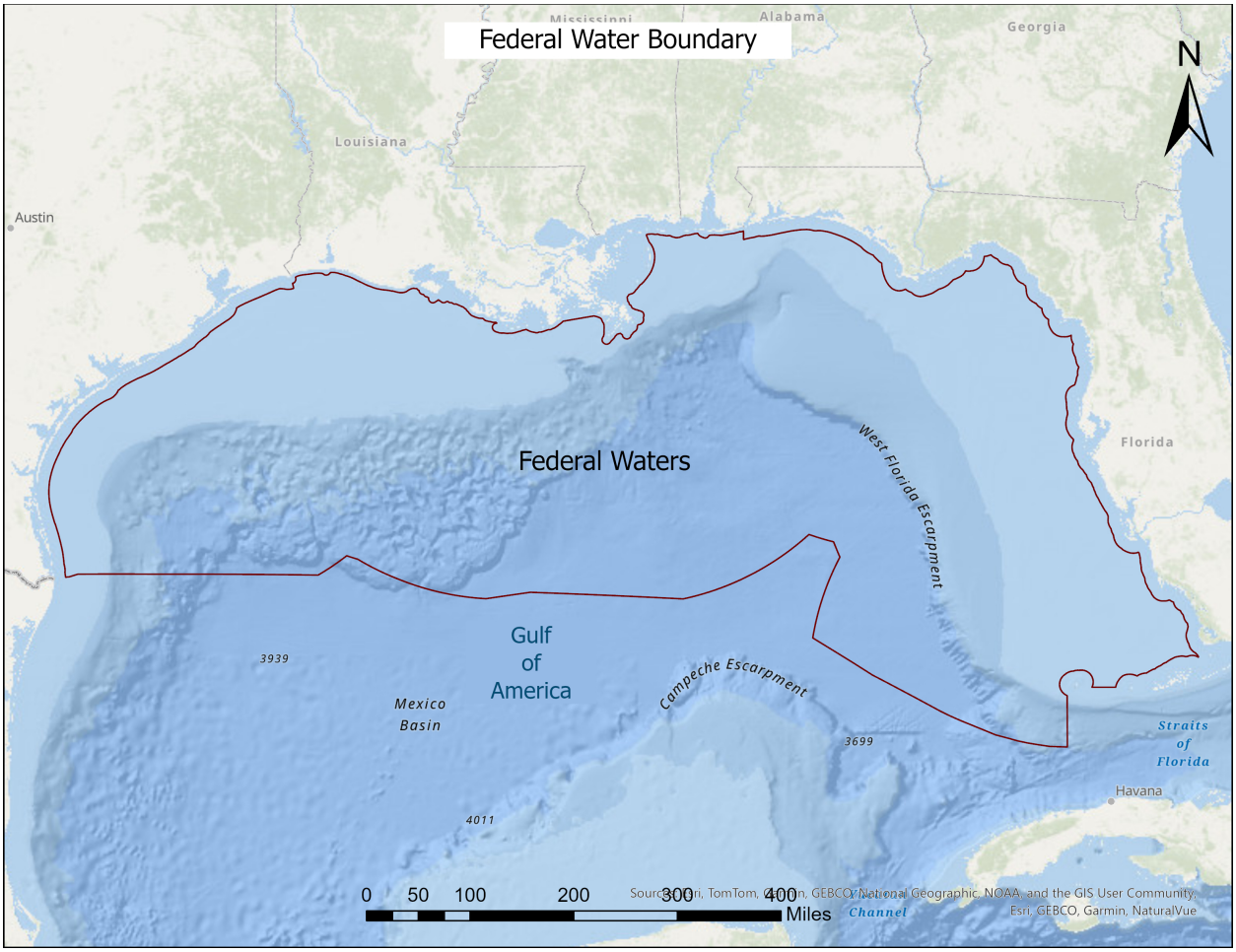


Figure 4.1 Gulf Council Fishery Management Boundaries.

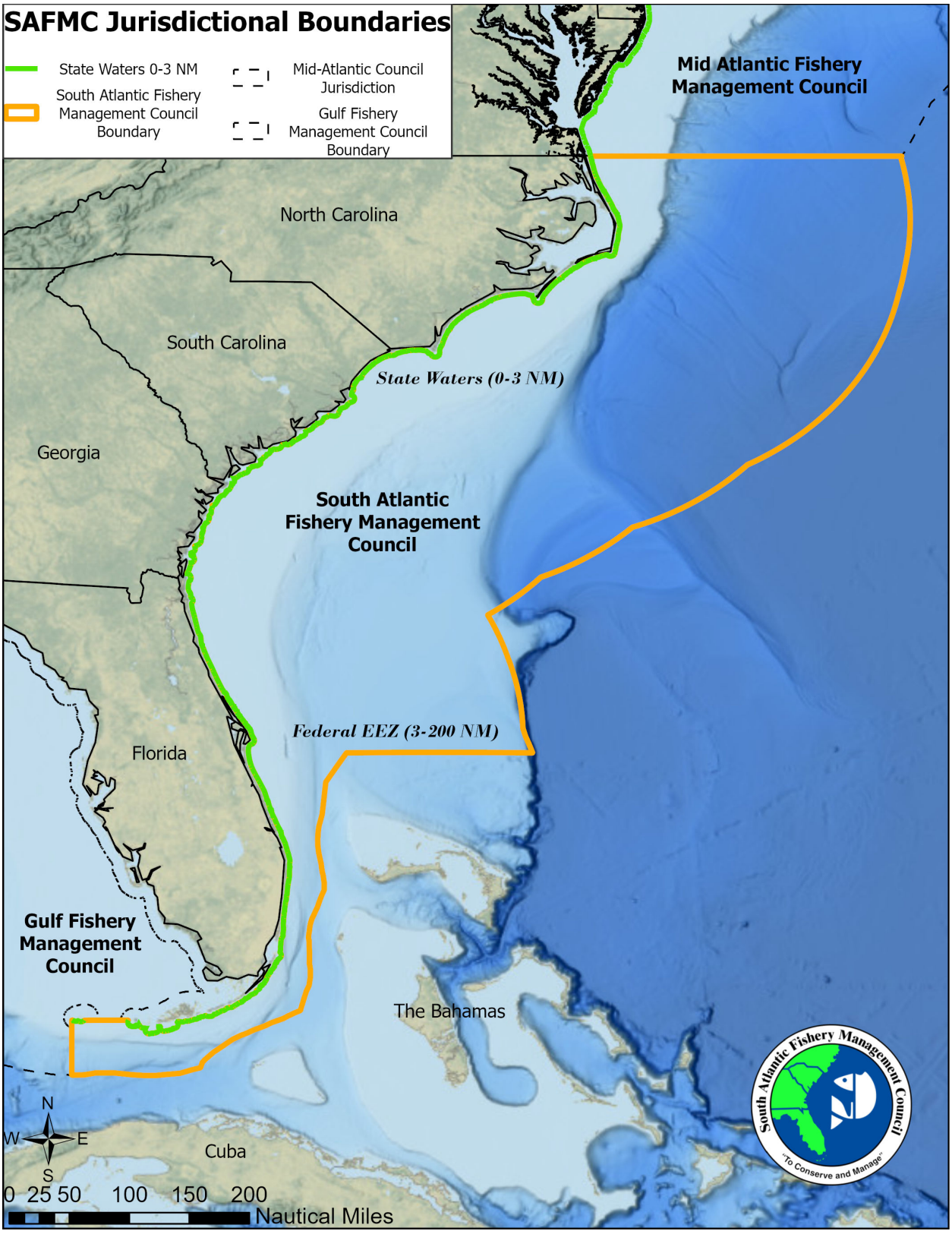


Figure 4.2 South Atlantic Fishery Management Council Boundaries.

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
APAIS	Access Point Angler Intercept Survey
ASMFC	Atlantic States Marine Fisheries Commission
B	Biomass (stock) level
BAM	Beaufort Assessment Model
B_{msy}	B capable of producing MSY on a continuing basis
BSIA	Best Scientific Information Available
CHTS	Coastal Household Telephone Survey
CFMC	Caribbean Fishery Management Council
CIE	Center for Independent Experts
CPUE	Catch Per Unit Effort
EEZ	Exclusive Economic Zone
F	Fishing mortality (instantaneous)
FES	Fishing Effort Survey
FIN	Fisheries Information Network
F_{MSY}	F to produce MSY under equilibrium conditions
F_{OY}	F rate to produce OY under equilibrium
$F_{XX\% SPR}$	F rate resulting in retaining XX% of the maximum spawning production under equilibrium conditions
F_{max}	F maximizing the average weight yield per fish recruited to the fishery
F_o	F close to, but slightly less than, Fmax
FL FWCC	Florida Fish and Wildlife Conservation Commission
FWRI	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)
MARFIN	Marine Fisheries Initiative
MARMAP	Marine Resources Monitoring, Assessment, and Prediction
MDMR	Mississippi Department of Marine Resources

MFMT	Maximum Fishing Mortality Threshold: value of F above which overfishing is deemed to be occurring
MRFSS	Marine Recreational Fisheries Statistics Survey: combines a telephone survey of households to estimate number of trips with creel surveys to estimate catch and effort per trip
MRIP	Marine Recreational Information Program
MSA	Magnuson Stevens Act
MSST	Minimum Stock Size Threshold: 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
OST	Office of Science and Technology, NOAA
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	Southeast Fisheries Science Center, NMFS
SERFS	Southeast Reef Fish Survey
SERO	Southeast Regional Office, NMFS
SRFS	State Reef Fish Survey (Florida)
SRHS	Southeast Region Headboat Survey
SPR	Spawning Potential Ratio: B relative to an unfished state of the stock
SSB	Spawning Stock Biomass
SS	Stock Synthesis
SSC	Scientific and Statistical Committee
TIP	Trip Interview Program: biological data collection program of the SEFSC and Southeast States
TPWD	Texas Parks and Wildlife Department
Z	total mortality (M+F)

SEDAR

Southeast Data, Assessment, and Review

SEDAR 94

Florida Hogfish

SECTION II: Data Workshop Report

October 2025

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

This information is distributed solely for the purpose of peer review. It does not represent and should not be construed to represent any agency determination or policy.

1 INTRODUCTION 5

1.1 WORKSHOP TIME AND PLACE 5

1.2 TERMS OF REFERNCE 5

1.3 LIST OF PARTICIPANTS 7

1.4 LIST OF DATA WORKSHOP WORKING PAPERS & REFERNCE DOCUMENTS 9

2 LIFE HISTORY 13

2.1 Work Group Membership 13

2.2 REVIEW OF WORKING PAPERS 13

2.3 STOCK DEFINITION AND DESCRIPTION 13
2.3.1 Classification and Identification Issues 14
2.3.2 Population Genetics 14
2.3.3 Stock Definition and Description 15

2.4 MOVEMENTS AND MIGRATIONS 16

2.5 MORPHOMETRICS AND CONVERSION FACTORS 17

2.6 AGE COMPOSITIONS 19
2.6.1 Available Age Data 19
2.6.2 Otolith Processing and Age Determination 22
2.6.3 Precision Calculations 23
2.6.4 Maximum Age 24
2.6.5 Growth 24

2.7 NATURAL MORTALITY 30
2.7.1 West Florida Shelf 31
2.7.2 Florida Keys/East Florida 32
2.7.3 Catch Curve Analysis 34
2.7.4 Sensitivity Analyses 35
2.7.5 Episodic Mortality Events 35

2.8 REPRODUCTION 36
2.8.1 Spawning Season 36
2.8.2 Female Age/Size at Maturity 37
2.8.3 Sexual Transition 38
2.8.4 Fecundity 39
2.8.5 Sex-ratio 40

2.9 COMMENTS ON THE ADEQUACY OF DATA FOR ASSESSMENT ANALYSES 40
2.9.1 Stock Definition 41
2.9.2 Movements and Migrations 41
2.9.3 Morphometrics and Conversion Factors 41
2.9.4 Age and Growth 41
2.9.5 Natural Mortality 43
2.9.6 Reproduction 43

2.10 RESEARCH RECOMMENDATIONS 43
2.10.1 Stock Definition 43
2.10.2 Age and Growth 44
2.10.3 Natural Mortality 44
2.10.4 Reproduction 45

2.11 LITERATURE CITED 45

2.12 TABLES 53

2.13 FIGURES 72

3 COMMERCIAL FISHERY STATISTICS 112

3.1 OVERVIEW 112
3.1.1 Commercial Workgroup Participants 112
3.1.2 Issues Discussed at the Data Workshop 112

3.2 REVIEW OF WORKING PAPERS 113

3.3 COMMERCIAL LANDINGS 114
3.3.1 Commercial Gears Considered 114
3.3.2 Misidentification of Hogfish 116
3.3.3 Commercial Landings by Gear and Stock 116
3.3.4 Uncertainty 116
3.3.5 Converting Landings in Weight to Landings to Numbers 117

3.4 COMMERCIAL DISCARDS 118

3.5 COMMERCIAL EFFORT 118

3.6 BIOLOGICAL SAMPLING 118
3.6.1 Length/Age Distribution 119
3.6.2 Adequacy for Characterizing Catch 120

3.7 COMMENTS ON ADEQUACY OF DATA FOR ASSESSMENT ANALYSES 120

3.8 LITERATURE CITED 120

3.9 RESEARCH RECOMMENDATIONS 121

3.10 TABLES 122

3.11 FIGURES 126

4 RECREATIONAL FISHERY STATISTICS 142

4.1 OVERVIEW 142
4.1.1 Recreational Workgroup Group (RWG) Membership 142
4.1.2 Recreational Terms of Reference 142
4.1.3 Recreational Issues Discusses at the Data Workshop 143

4.2 REVIEW OF WORKING PAPERS 144

4.3 RECREATIONAL LANDINGS 146

4.4 RECREATIONAL DISCARDS 150

4.5 BIOLOGICAL SAMPLING 151
4.5.1 Sampling Intensity Length/Age/Weight 151
4.5.2 Length – Age Distribution 152

4.6 RECREEATIONAL EFFORT 154
4.6.1 MRIP Effort 154
4.6.2 SRHS Effort 154

4.7 DISCARD MORTALITY 154

4.8 COMMENTS ON ADEQUACY OF DATA FOR ASSESSMENT ANALYSES 156

4.9 RECOMMENDATIONS 157
4.9.1 Research Recommendations 157
4.9.2 Other Recommendations 157

4.10 LITERATURE CITED 158

4.11 TABLES 160

4.12 FIGURES 187

5 INDICES OF POPULATION ABUNDANCE 204

5.1 OVERVIEW 204
5.1.1 Index Working Group (IWG) Members 205
5.1.2 Terms of Reference 205

5.2 CONSENSUS RECOMMENDATIONS AND SURVEY EVALUATIONS 206

5.3 REVIEW OF WORKING PAPERS 207

5.4 FISHERY-INDEPENDENT INDICES 208
5.4.1 Southeast Reef Fish Survey (SERFS, Cape Hatteras, NC to St. Lucie Inlet, FL) 208
5.4.2 SEAMAP-FWRI Shrimp/Groundfish Trawl Survey West Florida Shelf 209
5.4.3 FWRI FIM Polyhaline Seagrass Survey (Big Bend, Florida) 211
5.4.4 FWRI FIM Stratified Random Sampling Survey (Southern Indian River Lagoon, Florida) 213
5.4.5 Combined Stereo Video Survey 214
5.4.6 National Marine Fisheries Service's (NMFS) Reef Visual Census (RVC, Dry Tortugas and FL Keys) and Southeast Florida Coral Reef Initiative (SEFCRI, SE FL) 218
5.4.7 A Unified Reef Visual Census (RVC) and REEF Citizen Science Index 220

5.5 FISHERY-DEPENDENT INDICES 223
5.5.1 Commercial Spear 223
5.5.2 Commercial spear and hook and line (Florida Trip Ticket Landings) 225
5.5.3 Standardized Catch Rates of Hogfish (Lachnolaimus maximus) from the Marine Recreational Information Program (MRIP) for West Florida and the Keys-East Florida, 1991-2024 227

5.6 RESEARCH RECOMMENDATIONS 231

5.7 LITERATURE CITED 231

5.8 TABLES 233

5.9 FIGURES 239

1 INTRODUCTION

1.1 WORKSHOP TIME AND PLACE

The SEDAR 94 Data Workshop was held July 28 – August 1, 2025, in St. Petersburg, Florida. In addition to the in-person workshop, a series for webinars were held before (April and June 2025) and after (September 2025) the meeting.

1.2 TERMS OF REFERNCE

1. Review stock structure and unit stock definitions and consider whether changes are required.
2. Review, discuss, and tabulate available life history information available through 2024 as appropriate for inclusion in the stock assessment.
   - Evaluate age, growth, natural mortality, and reproductive characteristics.
   - Provide appropriate models to describe population growth, maturation, and fecundity by age, sex, and/or length by appropriate strata as feasible.
   - 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. Characterize discard mortality rates.
   - Review available research and published literature.
   - Consider research directed at hogfish as well as similar species from similar depths in the southeastern United States and other areas.
   - Provide estimates of discard mortality rate for each assessed stock by fishery, gear type, depth, and other feasible or appropriate strata, if possible.
   - Provide justification for any recommendations that deviate from the range of discard mortality provided in the last benchmark or other prior assessment.
   - Provide estimates of uncertainty around recommended discard mortality rates.
4. Provide measures of population abundance that are appropriate for stock assessment.
   - Consider and discuss all available and relevant fishery-dependent and -independent data sources using a terminal year of 2023.
   - Document all programs evaluated, address program objectives, methods, coverage, sampling intensity, and other relevant characteristics.
   - Provide maps of fishery and survey coverage.

- Develop fishery and survey CPUE indices by appropriate strata (e.g., age, size, area, and fishery) and include measures of precision and accuracy.
- Discuss the degree to which available indices adequately represent fishery and population conditions.
- Recommend which data sources adequately and reliably represent population abundance for use in assessment modeling.
- Provide appropriate measures of uncertainty for the abundance indices to be used in stock assessment models.
- Categorize the available indices with regard to their appropriateness for use in assessment modeling.

5. Provide commercial catch statistics through 2023, including both landings and discards in both pounds and number.
   - Evaluate and discuss the adequacy of available data for accurately characterizing harvest and discard by fishery sector or gear.
   - Provide length and age distributions for both landings and discards if feasible.
   - Provide maps of fishery effort and harvest and fishery sector or gear.
   - Provide estimates of uncertainty around each set of landings and discard estimates.
6. Provide recreational catch statistics through 2023, including both landings and discards in both pounds and number.
   - Evaluate and discuss the adequacy of available data for accurately characterizing harvest and discard by species and fishery sector or gear.
     - Explore the transition from MRIP-CHTS to MRIP-FES.
       - Discuss the Andrews 2022 investigation into telescoping error in MRIP FES
     - Explore the State Reef Fish Survey data from the State of Florida
     - Explore the Southeast For Hire Integrated Electronic Reporting (SEFHIER) data for potential inclusion in the Atlantic hogfish assessment
     - Explore whether the recreational fleet structure can be realigned into individual fleets as appropriate.
   - Provide length and age distributions for both landings and discards if feasible.
   - Provide maps of fishery effort and harvest and fishery sector or gear.
   - Provide estimates of uncertainty around each set of landings and discard estimates.
7. Identify and describe ecosystem, climate, species interactions, habitat considerations, and/or episodic events that would be reasonably expected to affect population dynamics.
   - Consider any known evidence regarding ecosystem, climate, species interactions (e.g. predation studies), habitat considerations, species range modifications (expansions or contractions), regime shifts, larval movement between stock boundaries, and/or episodic events (including red tide, upwelling events, and hypoxia) that would

reasonably be expected to affect Hogfish population dynamics and are appropriate for inclusion in the stock assessment.

8. Incorporate social and economic information that affect stock status and related fishing effort and catch levels as practicable.
9. Provide recommendations for future research in areas such as sampling, fishery monitoring, and stock assessment.
10. Review, evaluate, and report on the status and progress of all research recommendations listed in the last assessment, peer review reports, and SSC report concerning this stock.
11. Prepare the Data Workshop report providing complete documentation of workshop actions and decisions in accordance with project schedule deadlines (Section II of the SEDAR assessment report).

1.3 LIST OF PARTICIPANTS

Assessment Team

Chris Swanson ..... USF/FWC
Dustin Addis ..... FWC
Heather Christiansen ..... FWC/FWRI

Data Process Participants

Shanae Allen ..... FWC-FWRI
Luiz Barbieri ..... FWC-FWRI
Chris Bradshaw ..... FWC FWRI
Brittany Bottom ..... FWC-FWRI
Jessica Carroll ..... FWC-FWRI
Addy Carrigan ..... FWC-FWRI
Bridget Cermack ..... FWC-FWRI
Scott Childress ..... Industry
Ben Choi ..... FSDA
Angela Collins ..... UF
Kristen Cook ..... FWC-FWRI
Juan Cortes ..... FWC-FWRI
Sue DeMay ..... FWC-FWRI
Leo Eguia ..... FWC/UF
Robert Ellis ..... FWC-FWRI
Richard Gomez ..... Industry
Kiley Gray ..... FWC-FWRI
David Griffith ..... Gulf SSC
Bob Hilliard ..... Industry
Jeanette Huber ..... FWC-FWRI
Sean Keenan ..... FWRI
Brian Klimek ..... FWC-FWRI
Justin Lewis ..... FWC-FWRI
Genine McClair ..... FWC-FWRI

Maria McGirl .....FWC-FWRI
Dani Morley .....FWC-FWRI
Robert Muller .....FWC-FWRI
Halie O'Farrell .....FWC-FWRI
Jack Olson .....FWC-FWRI
Gregory Onorato .....FWC-FWRI
Erin Parker .....FWC-FWRI
Chloe Ramsey .....FWC-FWRI
Marcel Riechert ..... SA SSC
Michael Schram .....FWC-FWRI
Steven Scyphers .....Gulf SSC
Brice Semmens .....Scripps
Ted Switzer .....FWC-FWRI
Steve Turner ..... SA SSC
Olivia Wilms .....FWC-FWRI
Sean Wilms .....FWC-FWRI

Council Representation
Jessica McCawley ..... GFMC
Thomas Roller .....SAFMC

Staff
Julie Neer ..... SEDAR
Judd Curtis ..... SAFMC Staff
Sarah Gardiner ..... GFMC Staff
Dominique Lazarre .....NMFS/SERO
Emily Muehlstein .....GFMC Staff
Molly Olsen ..... NMFS/SERO
Ryan Rindone..... GFMC Staff
Charlotte Schiaffo ..... GFMC Staff

Workshop Observers via Webinar
Raymond Alexander .....FWC
Jordan Bajema .....
Jesse Buntin .....NOAA
Rob Cheshire .....SEFSC
Aleksandra Cison .....FWC
Challen Hyman ..... UF
Brent Kempton.....
Emily Ott .....SEDAR
Michaela Pawluk.....SEFSC
Megan Robbins .....FWC
Kevin Thompson.....SEFSC

Ed Walker..... GFMC
Taylor Zewen .....FWC

Other Data Webinar Observers
Sydney Alhale .....SEFSC
Sarina Atkinson.....SEFSC
Nate Bacheler .....SEFSC
Samantha Binion-Rock.....SEFSC
Matt Campbell.....SEFSC
Anna-Mai Christmas-Svajdlenka ..... ACCSP
Chip Collier .....SAFMC Staff
Ellie Corbett .....FWC
Chad Englert .....
Meaghan Emory.....
Kristin Foss .....FWC
Kim Johnson.....SEFSC
Kayla Kennedy .....FWC
Sue Lowerre-Barbieri..... UFL
Rich Malinowski .....NOAA
Vivian Matter .....SEFSC
Richard McBride .....NEFSC
Ryan Nichols .....SEFSC
Patrick Nuekam ..... Industry
Matthew Nuttall.....SEFSC
Kate Overly .....SEFSC
Julia Reeves .....FWC
Clay Shidler ..... Industry

1.4 LIST OF DATA WORKSHOP WORKING PAPERS & REFERNCE DOCUMENTS

Document #	Title	Authors	Date Submitted
Documents Prepared for the Data Workshop			
SEDAR94-DW-01	Standardized video counts of southeast US Atlantic hogfish (*Lachnolaimus maximus*) from the Southeast Reef Fish Survey	Nathan Bacheler, Rob Cheshire, and Kyle Shertzer	25 March 2025

SEDAR94-DW-02	Headboat Data for Hogfish in the Southeast U.S. Atlantic and Gulf of America	Robin T. Cheshire and Matthew E. Green	21 May 2025
SEDAR94-DW-03	Florida Keys and East Florida Hogfish Fishery Performance Report March 2024	SAFMC Snapper Grouper Advisory Panel	29 April 2025
SEDAR94-DW-04	Standardized catch rates of Hogfish (*Lachnolaimus maximus*) from the Southeastern U.S. commercial spear fishery, 1993-2024	Michaela Pawluk and Kevin Thompson	11 July 2025
SEDAR94-DW-05	General Recreational Survey Data for Hogfish in the Gulf of America and South Atlantic	Samantha M. Binion-Rock	11 July 2025
SEDAR94-DW-06	Historical Commercial Fishery Landings of Hogfish in the Southeastern U.S.	Christopher Bradshaw	8 July 2025 Updated: 1 August 2025
SEDAR94-DW-07	*Length frequency distributions for Hogfish collected by TIP in the Southeast from 1984 to 2024*	Christopher Bradshaw	8 July 2025
SEDAR94-DW-08	Social Dimensions of Hogfish (*Lachnolaimus maximus)*	David Griffith	8 July 2025
SEDAR94-DW-09	Commercial discard data limitations for Hogfish (*Lachnolaimus maximus*) in Florida for the Vertical Line and Spearfishing fleet	Kevin Thompson, Sarina Atkinson, Gary Decossas	11 July 2025
SEDAR94-DW-10	A Summary of Florida Hogfish Discard Length Data Collected from At-Sea Observers in For-Hire Fishery Surveys in Florida 2005-2024	Ellie Corbett and Leonardo Eguia	10 July 2025 Updated: 24 July 2025
SEDAR94-DW-11	Length and age composition of Florida Hogfish, *Lachnolaimus maximus*, collected in association with fishery-dependent projects	Maria McGirl, Jessica Carroll, and Bridget Cermak	17 July 2025 Updated: 24 July 2025

SEDAR94-DW-12	Hogfish Discard Mortality and Habitat Ecology on the West Florida Shelf	Robert D. Ellis, B. James Williams, Kerry Flaherty-Walia, and Philip Stevens	18 July 2025
SEDAR94-DW-13	Hogfish Index of Abundance form the Annual FWRI-SEAMAP Trawl Survey along the West Florida Shelf	Brian Klimek and Theodore Switzer	21 July 2025 Updated: 3 September 2025
SEDAR94-DW-14	Young of Year Hogfish Index of Abundance from Seagrass Trawl Surveys of the Florida Big Bend	Brian Klimek and Theodore Switzer	21 July 2025 Updated: 3 September 2025
SEDAR94-DW-15	Standardization of commercial catch per unit effort of Hogfish (*Lachnolaimus maximus*) from Florida Trip Ticket landings, 1994-2024	Dustin Addis	22 July 2025
SEDAR94-DW-16	Recreational For-Hire Trends in Release Methods and Barotrauma Assessment of Hogfish (*Lachnolaimus maximus*) using a Fisheries-Dependent At-Sea Observer Program	Leonardo Eguia, Zachary Siders, Debra Murie	18 July 2025 Updated: 31 July 2025 Updated: 2 September 2025
SEDAR94-DW-17	Standardized Catch Rates of Hogfish (*Lachnolaimus maximus*) from the Marine Recreational Information Program (MRIP) for West Florida and the Keys-East Florida, 1991-2024	Shanae Allen	23 July 2025 Addendum added: 22 August 2025
SEDAR94-DW-18	Hogfish (*Lachnolaimus maximus*) Lengths Sampled in the Biscayne National Park Creel Survey, 1993-2022 Updated Title: Hogfish (*Lachnolaimus maximus*) Lengths	Shanae Allen	25 July 2025 Updated: 22 August 2025

	Sampled in the Biscayne National Park Creel Survey, 1993-2024		
SEDAR94-DW-19	Indices of abundance for Gulf and Atlantic Hogfish (*Lachnolaimus maximus*) using data from multiple video surveys	Justin Lewis, Heather M. Christiansen, Sean F. Keenan, Katherine E. Overly, Matthew D. Campbell, Theodore S. Switzer	28 July 2025
SEDAR94-DW-20	Fisherman Feedback Report - Hogfish	Gulf Council Staff	29 July 2025
SEDAR94-DW-21	A ratio-based method for calibrating estimates of total landings (numbers and pounds of fish), and releases (numbers of fish) from MRIP-FCAL to SRFS for Hogfish (*Lachnolaimus maximus*) in Florida	Chloe Ramsay Updated Authors: Chloe Ramsay and Maria McGirl	31 July 2025 Updated: 17 August 2025
SEDAR94-DW-22	Standardized Reef Visual Census indices for Hogfish, *Lachnolaimus maximus*, for Southeast Florida (2013 - 2024), the Florida Keys (1997 – 2024), and Dry Tortugas (1999 - 2024)	Robert G. Muller and Halie O'Farrell	10 September 2025
SEDAR94-DW-23	Summary of Southeast For-Hire Integrated Electronic Reporting Program Records for Hogfish Catch in Southeast Region	LAPP/DM Branch, SERO	19 September 2025
SEDAR94-DW-24	Public comments received via the online comment form during the data process		10 October 2025
Reference Documents			
SEDAR94-RD01	Life history through the eyes of a hogfish trophic growth and	Meaghan E. Faletti, Christopher D. Stallings	

	differential juvenile habitat use from stable isotope analysis	
SEDAR94-RD02	Assessing the value of citizen scientist observations in tracking the abundance of marine fishes	Dan A. Greenberg, Christy V. Pattengill-Semmens, Brice X. Semmens

2 LIFE HISTORY

The Life History Workgroup (LHWG) reviewed and discussed data available for Hogfish from Florida waters on both Atlantic and Gulf of America (hereafter referred to as 'Gulf') coasts and offered recommendations. Information was examined on stock definition, movements and migrations, morphometrics, age and growth, natural mortality, and reproduction. A summary of the data presented, discussed, and recommendations made is presented below.

2.1 Work Group Membership

Chris Swanson (lead)	USF/FWRI, St. Petersburg, FL
Brittany Bottom	FWRI, St. Petersburg, FL
Jessica Carroll	FWRI, St. Petersburg, FL
Bridget Cermak	FWRI, St. Petersburg, FL
Angela Collins	UF/Sea Grant, Ruskin, FL
Kristin Cook	FWRI, St. Petersburg, FL
Kiley Gray	FWRI, St. Petersburg, FL
Dani Morley	FWRI, Marathon, FL
Jack Olson	FWRI, Marathon, FL
Marcel Reichert	SSC, SAFMC
Judd Curtis	SAFMC staff

2.2 REVIEW OF WORKING PAPERS

No working papers were submitted for review to the LHWG. Analyses performed were presented during the Data Workshop and are described herein below.

2.3 STOCK DEFINITION AND DESCRIPTION

2.3.1 Classification and Identification Issues

Nelson et al. (2006) assigned the following taxonomic classification to Hogfish:

Kingdom: Animalia (animals)
Phylum: Chordata (organisms with a notochord)
Subphylum: Vertebrata (animals with a backbone)
Class: Actinopterygii (ray-finned fishes)
Order: Perciformes
Family: Labridae (wrasses)
Genus: *Lachnolaimus*
Species: *maximus* (Walbaum 1792)

Common names include: Hogfish, Hog Snapper (English); Boquinete, Doncella de Pluma, Jaqueton Blanco, Pargo Gallo (Spanish); and Labre Capitaine (French). As of 2009, the species is listed on the IUCN Red List as 'Vulnerable' under criteria A2bd with a declining population trend (https://www.iucnredlist.org/species/11130/124708500).

This species is recognizable from other reef-dwelling wrasses (Family *Labridae*) by its deep body with a strongly arched dorsal profile. The first 3 dorsal spines are filamentous and it is the only wrasse with elongate dorsal spines and such a highly arched profile. Hogfish are variable in color but generally mottled brownish red with a black spot at rear base of dorsal fin (Figure 2.13.1).

2.3.2 Population Genetics

Analysis of 24 microsatellite loci from 719 fish collected between November 2005 and August 2013 were used to examine the genetic structure of Hogfish collected from the eastern Gulf (Florida Panhandle to the Florida Keys), the Florida Keys and southeast coast of Florida (Florida Keys to Jupiter), and off the coast of the Carolinas (North and South Carolina; Seyoum et al. 2015). Although there was a discontinuity in sample coverage between South Carolina and the central east coast of Florida, three distinct clusters emerged. Samples collected from the Panhandle of Florida south along the west Florida shelf through Naples were distinct and formed the West Florida Shelf cluster. Samples collected from the Florida Keys (including the Dry

Tortugas) and up the southeastern coast of Florida through Jupiter were distinct and formed the Florida Keys/East Florida cluster. Hogfish collected off the coast of the Carolinas fell into a third cluster and were genetically distinct from the two Florida groups. The clustering of samples near the Everglades region (off Cape Sable) indicated a genetic break point between the West Florida Shelf and the Florida Keys. Thus, these analyses supported the treatment of Hogfish as distinct stocks in the previous assessments (SEDAR 37 2014, SEDAR 37U 2017) and continued to be used for the two Florida stocks here.

No further genetic studies on the population structure of Hogfish within the southeastern U.S. have been published since the previous assessment and no genetic information is available for parts of the Florida Keys/East Florida stock inhabiting the central and northeastern coast of Florida. However, ongoing research by Alexis Janosik at the University of West Florida is analyzing mitochondrial DNA from 89 Hogfish collected from locations in Panama City and Jupiter, FL, Cape Lookout, NC, and Puerto Rico and St. Thomas in the Caribbean. Preliminary results suggest low haplotype diversity and potential bottlenecks, which may reflect historical reductions in genetic variation associated with high levels of harvest (A. Janosik, *pers. comm*. 5/15/25).

2.3.3 Stock Definition and Description

The Hogfish fishery has been managed in the U.S. by the South Atlantic Fishery Management Council (SAFMC) and the Gulf of Mexico Fishery Management Council (GMFMC). Initially, Hogfish were managed and treated as a single stock within the U.S. (Ault et al., 2003) where regulations were first implemented in 1994 by the State of Florida. Based on the available genetic evidence by Seyoum et al. (2015) and the SAFMC SSC's recommendations following SEDAR 37 (2014), the SAFMC passed the Snapper Grouper Amendment 37 in 2017 which defined the fishery management unit at the 25° 9' N latitudinal line off Cape Sable, FL (Figure 2.13.2). The stock north of that boundary is the West Florida Shelf (WFS) stock and is managed by the GMFMC; the stock south of that boundary line, around the Florida peninsula and north to the Florida/Georgia border is the Florida Keys/East Florida (FLK/EFL) stock and is managed by the SAFMC. The State of Florida also participates in the management of this species in state waters.

Given the information available on Hogfish genetics and stock connectivity, the LHWG considered the two unit-stocks identified within Florida waters to be at their functional population levels and are defined as the total number of individuals that use waters within their respective jurisdictions as put forth in the SAFMC SG Amendment 37. While an uncertain degree of connectivity may exist between the two Florida stocks, the assumption of a closed population for each stock within their respective jurisdictional boundaries was found reasonable by the LHWG for the purpose of stock assessment and management and is consistent with the previous benchmark and update assessments.

2.4 MOVEMENTS AND MIGRATIONS

Hogfish exhibit spatial separation of adult and juvenile members of the local population and therefore constitute a nursery species as defined by Beck et al. (2001). After a pelagic larval period of ca. 34 days, they settle in polyhaline estuarine seagrass beds or nearshore reef habitats (Davis 1976, Colin 1982, Acosta et al. 2007, Faletti and Stallings 2021). Individuals undergo ontogenetic shifts in habitat use from shallow vegetated habitats to alternative structures (e.g., the reef tract or hardbottom reefs) in response to changing exposure to predation with increasing body size (e.g., Dahlgren and Eggleston 2000). Recent stable isotope work focusing on trophic growth and differential juvenile habit use showed high variability in the life histories of Hogfish on the WFS and sought to challenge the viewpoint of a gradual offshore ontogenetic migration in Hogfish (Faletti and Stallings 2021). Rather, they propose that adult Hogfish in deeper habitats likely inhabited deeper juvenile habitats (i.e. nearshore reefs), while adult Hogfish inhabiting shallower adult habitats likely used shallower juvenile habitats (i.e. estuaries). In the data available for this assessment, juveniles (ages 0 and 1) have been observed inhabiting the seagrass beds in the Big Bend area of Florida (e.g., Klimek and Switzer 2025b) as well as on the nearshore reefs on the WFS (e.g., Klimek and Switzer 2025a). In the Florida Keys, they have been observed in the seagrass beds primarily in the Middle Keys north of U.S. Highway 1 (e.g., Acosta et al. 2007) and on the Florida Reef Tract (e.g., RVC diver surveys), as well as further north in the southern Indian River Lagoon (Brian Klimek and Ted Switzer, *pers. comm.,* 8/27/25), possibly lending support to this hypothesis. Healthy benthic invertebrate infauna and epifauna are critical diet items (e.g., bivalves, crustaceans, echinoderms; Randall and Warmke 1967) and recent unpublished gut content analyses by FWRI (as reported in Faletti and Stallings

2021) suggested that changes in juvenile and adult Hogfish diet are driven mainly by size and age rather than spatial differences.

The spatial partitioning of available habitat is an important factor when considering differences between Hogfish stocks. On the WFS, Collins and McBride (2011, 2015) showed how the available and more wide-spread offshore reef habitat (>30 m depth) may act as a *de facto* refuge for some of the faster-growing and larger individuals able to escape the more intense fishing pressure occurring in the nearshore waters. They also showed how this influenced life history characteristics (e.g., growth and reproduction). In contrast, the Florida Reef Tract in southeast Florida and the Florida Keys is largely <30 m depth and is situated towards the edge of the shelf. The larger absence of available offshore reef habitat may cause Hogfish in this region to experience limited refuge from fishing pressures and, in turn, must rely on management interventions such as areas prohibited from fishing (e.g., marine protected areas) or seasonal closures.

Data regarding the movement of Hogfish are sparse, but what is available shows consistent patterns. Hogfish tagged in the Florida Keys as part of a telemetry study were shown to have high site fidelity and restricted home ranges (Lindholm et al. 2006). Further, Colin (1982) and Muñoz et al. (2010) reported high site fidelity and restricted home ranges during the spawning season for Hogfish at specific sites in Puerto Rico and the Florida Keys, respectively. More recently, acoustically tagged Hogfish on the WFS near Tampa Bay, Florida were detected on average for 136 days (range = 1 – 288 days) and exhibited high site fidelity at their tagged reef sites with only one fish successfully moving from one monitored site to another (Ellis et al. 2025). Consistent sex ratios observed throughout the year (Collins and McBride 2011) also suggest that Hogfish maintain home ranges and territories for extended periods. Removal of the dominant male does not appear to necessitate harem relocation; rather it is more likely that one of the females will transition to male or that a nearby male will fill the void.

2.5 MORPHOMETRICS AND CONVERSION FACTORS

Morphometrics characterize the size and shape of an organism and reduce the idea of physical form to a series of measured variables (Ihssen et al. 1981). These include multiple types of length (standard [SL], fork [FL], and total [TL]) or weight (total [TW] or gutted [GW]) measurements. Morphometric data for Hogfish were collected by various fishery-dependent and

-independent data collection programs (e.g. Trip Interview Program [TIP], Marine Recreational Information Program [MRIP], Southeast Region Headboat Survey [SRHS], FWRI's Fisheries Dependent Monitoring [FWRI-FDM] program, and FWRI's Fisheries Independent Monitoring [FWRI-FIM] program) and help facilitate comparisons between the length and weight measurement data from other studies.

Ideally, the length type used within a stock assessment is consistent with the management regulations of that species. For Hogfish, the current management regulations on minimum legal size specifies a 16" fork length in the FLK/EFL region and a 14" fork length in the WFS region. Most data collection programs measured Hogfish using fork length; however, when programs measured using total length, methods were found to differ between data sources (i.e., a natural TL where the fish is measured with the tail flat in its normal shape instead of compressed to its maximum length) and necessitated a conversion.

Morphometric data from fishery-dependent and -independent sources were combined to estimate morphometric equations and conversion factors. Linear (for length-length conversion) and non-linear (for length-weight conversion) regressions were conducted in R (R Core Team 2025) where model residuals were z-scored and outliers were iteratively removed. The first iteration removed outliers whose z-scores were above 8; the model was then rerun and residuals were re-scored. The second iteration removed outliers whose z-scores were above 4. Linear regressions are in the form $Y = a + bX$ and non-linear regressions are in the form $W = aL^b$. Non-linear length-weight models in real space demonstrated less prediction error compared to linear length-weight models in lognormal space.

Updated length-length (linear regression) and length-weight (non-linear regression) equations were developed for Florda Hogfish and are presented in Table 2.12.1. Reported here is also the gutted weight to total (whole) weight conversion of 1.11 (SEDAR 37 2014).

A final fork length value was ascribed to all observations for use in all subsequent analyses and priority was given to all *in situ* measurements. Meaning, if a fish was measured with a FL it retained that measurement as the final length value; of the remaining observations without a FL, those having a SL were converted to FL as the final length value. Those remaining still had their natural TL converted to FL as the final value. None remained to utilize the maximum TL conversion. Likewise, all whole weight measurements taken *in situ* were

ascribed as a final whole weight value; those having only a gutted weight were converted using the 1.11 value. Those remaining without a weight measurement were iteratively converted as above using FL measurements first, then SL, then natural TL.

2.6 AGE COMPOSITIONS

2.6.1 Available Age Data

Age data were limited for Florida Hogfish and were primarily supplied by FWRI, the National Marine Fisheries Service's Southeast Fisheries Science Center (NMFS-SEFSC) laboratories (Panama City, and Beaufort), and the Gulf States Marine Fisheries Commission (GSMFC). Data were collected by federal and state biologists involved in fishery-dependent (e.g., TIP, SRHS, MRIP, SRFS, At-Sea Observer) and fishery-independent (e.g., FWRI's FIM and Fish Biology) biological data collection programs from 1996 – 2024 on both Atlantic and Gulf coasts.

Data were spatially delineated into 5 regions within Florida waters and based on where the sampled fish was landed: northeast Florida (Nassau County south to Brevard County), southeast Florida (Indian River County south to Miami-Dade County), Florida Keys (Monroe County), southwest Florida (Levy County south to Collier County), and northwest Florida (Escambia County south to Dixie County). The WFS stock contained the Northwest Florida and Southwest Florida regions while the FLK/EFL stock contained the Florida Keys, Southeast Florida, and Northeast Florida regions. Areas outside of Florida were defined as either "West of Florida" for states west of Florida through Texas along the Gulf or "North of Florida" for states north of Florida through North Carolina along the southeastern US Atlantic. The Dry Tortugas region (Monroe County west of longitude -82.25 and south of latitude 25) is also described here because it was an area sampled by both fishery-dependent and -independent sources, including various research studies of Hogfish life history. The gears defined for this assessment were grouped into hook and line (encompassing hook and line, bandit rigs, electric or hydraulic reels, and long line), spear, trap, trawl, and unknown.

Age data for Hogfish within Florida totaled 4,555 otoliths where 58.4% (n = 2,660 otoliths) of samples came from the southwest Florida region and 27.8% (n = 1,265 otoliths) came from the Florida Keys region (Table 2.12.2, Figure 2.13.3a – b). The number of samples from the northwest Florida region totaled 312 otoliths (6.8%) and similarly totaled 310 otoliths in the

southeast Florida region (6.8%). No ages were sampled in the northeast Florida region (Table 2.12.2, Figure 2.13.3a – b). Within the WFS stock, 89.3% of ages came from the southwest Florida region; in the FLK/EFL stock, 80.3% were sampled in the Florida Keys region.

Florida Keys/East Florida

In the FLK/EFL stock, a total of 1,576 otoliths (34.6%) were assigned ages from years 1996 – 2024 (Table 2.12.3). Half of the otoliths were found to be ages 2 to 4 (49.9%), ages 1 – 6 comprised 77.3%, and 95% of the otoliths were aged 8 years or less of the data (Table 2.12.3). Ages sampled from the commercial fishery (n = 490 otoliths, Tables 2.12.4 and 2.12.5, Figure 2.13.4a) constituted a total of 31.1% while ages sampled from the recreational fishery (n = 462 otoliths, Table 2.12.4, Figure 2.13.4a) made up 29.9%, predominantly from the private mode (n = 348 otoliths, Table 2.12.5, Figure 2.13.4b). Age data from fishery-independent sources totaled 505 otoliths (32.0%; Tables 2.12.4 and 2.12.5, Figure 2.13.4a). Spear was the dominant gear for capturing Hogfish and contained 75.4% of samples (n = 1,189 otoliths), followed by hook and line gear (n = 129 otoliths), and fishery-independent trawls (n = 154 otoliths; Table 2.12.6, Figure 2.13.5). The total number of ages sampled annually from fishery-dependent and -independent sources was very low throughout the whole timeseries with only a handful of years containing samples greater than 30 within each fishery sector. In the late 1990s, commercial ages were primarily sampled in connection with life history research studies (i.e., McBride and Murphy 2003, McBride and Johnson 2007, McBride and Richardson 2007, McBride et al. 2008) and then almost stop completely post-2017 when the new regulations become active. Ages sampled from the recreational fishery have been comparatively more consistent, coming largely from headboat and private modes in recent years. Increases in fishery-independent ages have recently come from Towne et al. (2021) who primarily sampled in southeast Florida in 2016 and 2017 and from D. Morley (FWRI *unpub. data*) who sampled the Dry Tortugas in 2022 and 2023.

The distribution of ages among fishery-dependent sources in the FLK/EFL stock was generally similar (Figure 2.13.6). Samples from the commercial sector had a mode at age-2 and of the 490 total samples, 435 (88.8%) were collected using spear gear (Figure 2.13.7). From the recreational sector, samples had a mode at age 3 and were influenced by gear used; from the 462 total samples, 341 (73.8%) were collected using spear gear and showed a mode at age-4 (Figure 2.13.8), whereas hook and line samples were 25.3% (n = 114 otoliths) with a mode at age-3 and

another peak at age-6 (Figure 2.13.8). From the 505 total fishery-independent samples, 313 (62.0%) were captured using spear gear with a mode at ages 2 – 4, while 154 (30.5%) were collected using trawls with a mode at age-0 (Figure 2.13.9). The southeast Florida region showed a mode at ages 3 and 4 (Figure 2.13.10) and contained the oldest fish aged from this stock (16 years). In the Florida Keys region, the distribution of Hogfish ages was slightly younger (mean = 3.66 years, median = 3 years) compared to the southeast Florida region (mean = 4.43 years, median = 4 years; Figure 2.13.10). Figure 2.13.11 shows the stock-wide age composition by year where discerning year classes was difficult given the low annual sample sizes. Figures 2.13.12 – 2.13.14 show the age compositions by year for each fishery and gear type.

West Florida Shelf

In the WFS stock, a total of 2,979 otoliths (65.4%) were assigned ages from years 1996 – 2024 (Table 2.12.7). A little over half of the otoliths were found to be ages 1 to 4 (58.5%), ages 1 – 7 comprised 86.2%, and 95% of the otoliths were aged 10 years or less (Table 2.12.7). Age data available on the WFS has been consistent from fishery-independent sources and totaled 1,183 otoliths (39.7%; Tables 2.12.8 and 2.12.9, Figure 2.13.15a). From the fisheries, ages were primarily sampled from the recreational sector (n = 1,038 otoliths, Table 2.12.8, Figure 2.13.15a) and constituted 34.8% while ages sampled from the commercial sector (n = 419 otoliths, Tables 2.12.8 and 2.12.9, Figure 2.13.15a) made up 14.1%. Recreational ages were largely from the private mode (n = 500 otoliths), followed by the headboat survey (n = 234 otoliths), and charter mode (n = 178 otoliths, Table 2.12.9, Figure 2.13.15b). On the WFS, Hogfish ages were primarily sampled using trawls (n = 1,165 otoliths, 39.1%) from fishery-independent surveys, by spear (n = 1,151 otoliths, 38.6%), then hook and line gear (n = 489 otoliths, 16.4%; Table 2.12.10, Figure 2.13.16). Similar to the FLK/EFL stock, the total number of ages sampled annually from fishery-dependent sources was often below 30 and larger sample sizes were influenced by various studies conducted on Hogfish life history. For example, sampling from both commercial and recreational sectors during 1996 – 2001 was largely conducted by McBride and Murphy (2003), McBride and Johnson (2007), McBride and Richardson (2007), and McBride et al. (2008). Sampling from 2005 – 2007 was driven by Collins and McBride (2008, 2011, 2015) and during 2016 – 2018 by Faletti and Stallings (2021).

On the WFS, the distribution of ages from the commercial sector was more uniform between ages 3 – 7 (Figure 2.13.17) and affected by differences in gear. Commercial spear samples (61.6%) were highest between ages 4 and 8 with a mode at age-6 and contained samples up to age-18; whereas samples from the trap gear (36.5%) were highest at ages 2 and 3 with a mode at age-3 (Figure 2.13.18). In the recreational sector, samples were greatest between ages 4 – 7 with a mode at age-4 (Figure 2.13.17) and were similarly influenced by gear used. Recreational spear samples (52.5%) were highest between ages 2 and 7 with fish collected up to age-19, while hook and line samples (46.9%) contained a mode at age-4 with fish observed up to age-11 (Figure 2.13.19). Ages from fishery-independent samples, were almost exclusively (98.5%) collected using trawl gear with a mode at age-1 and fish observed up to age-16 (Figure 2.13.20). In the southwest Florida region, samples reflect the influence of the fishery-independent trawl and fishery-dependent spear gears and showed a mode at age-1 with samples highest between ages 1 and 7 (Figure 2.13.21). Samples of Hogfish here were older (mean = 4.27 years, median = 4 years) and lived longer (max age = 23 years) compared to the northwest Florida region (mean = 3.09 years, median = 3 years, max age = 10 years; Figure 2.13.21). Figure 2.13.22 shows the stock-wide age composition by year with possibly stronger age-1 year classes occurring in 1997, 2006, and 2012. Figures 2.13.23 – 2.13.25 show the age compositions by year for each fishery and gear type.

2.6.2 Otolith Processing and Age Determination

Sectioned otoliths are the preferred structures for ageing Hogfish (McBride and Richardson 2007), and the left sagittal otolith was processed for age determination. Otoliths were embedded in epoxy resin using the methods described in VanderKooy et al. (2020). The embedded resin blocks were attached directly to cardstock using hot glue, then cut using a Buehler Isomet low-speed saw with a multiblade configuration to create three thin transverse sections (VanderKooy et al. 2020). Sections were then adhered to glass slides using a clear mounting medium. Otoliths were examined using stereo microscopes with objectives ranging from 0.63X–2.0X magnification and either transmitted or reflected light. Each otolith was read at least twice, either by an individual reader two times, or by two different readers. A third read was conducted to resolve any discrepancies between the two age estimates. All ages were determined without reader knowledge of fish length or sex (VanderKooy et al. 2020, McGirl et al. 2025).

Marginal increment analyses (McBride and Richardson 2007) have indirectly validated that Hogfish form an opaque annulus in the spring (May) on both coasts of Florida and deposition is assumed to be completed by July 1. Calendar ages were calculated using annulus count (number of opaque zones), degree of marginal completion, average date of otolith increment deposition, and date of capture. Using these criteria, age was assigned by readers to advance by one year if a large translucent zone (more than 2/3 translucence) was visible on the margin and the capture date was between January 1 and June 30. For fish collected after June 30, age was assigned to be annulus count (McGirl et al. 2025). Calendar ages were converted to biological (i.e., fractional) ages based on a January 1 hatch date (McBride and Richardson 2007) and month of capture for fitting growth curves.

2.6.3 Precision Calculations

Precision measurements are valuable for evaluating the structure's ease of age determination, the reproducibility of an individual's age, and the skill level of each reader in a laboratory (Campana 2001). Average percent error (APE) and coefficient of variation (CV) are the two most widely used precision calculations (Campana 2001) and are considered "age independent" methods for determining precision (Kimura and Lyons 1991). APE is calculated as:

$$APE_j = 100\% \times \frac{1}{R}\sum_{i=1}^{R}\frac{\left|x_{ij} - x_j\right|}{X_j}$$

for otoliths with multiple age determinations (R), Xij is the ith age estimate for the jth fish. Disagreement by one year between readers on a 2-year-old fish is weighted more heavily than a one year discrepancy of a 20-year-old fish (Kimura and Anderl 2005). When individual errors are averaged across all samples, the outcome is the average percent error for the data set (Beamish and Fournier 1981, Campana 2001).

CV is the ratio of standard deviation over the mean (Chang 1982) and is written as:

$$CV_j = 100\% \times \frac{\sqrt{\sum_{i=1}^{R}\frac{(X_{ij} - X_j)^2}{R-1}}}{X_j}$$

Precision estimates between readers were calculated using a random subsample from recreational and commercial collections. This quality control subsample of 653 fish included samples from

2011 – 2023 that were aged by all active Hogfish readers. APE and CV precision estimates were calculated on the entire age dataset (from individual first and second reads of all fish), as well as the quality control subsample.

Campana (2001) suggests an APE of 5% or less as an acceptable benchmark for precision, which corresponds to approximately a 7.6% CV calculation. The APE and CV of the Hogfish age dataset at the time of this precision evaluation (n = 2,166 otoliths) was 0.68% and 0.71%, while the quality control subsample (n = 653) was 1.8% and 2.5%, respectively. These values are well below the benchmark for acceptable precision standards indicating that Hogfish reads were highly precise.

2.6.4 Maximum Age

The current maximum observed age of Hogfish in Florida based on sectioned otoliths is 23 years for two fish collected by McBride and Richardson (2007) on the WFS in July and August, 1996. Both fish measured 715 mm FL and were captured using spear gear. On the WFS, other older fish were observed to be aged 19 (n = 4), 20 (n = 2), 21 (n = 1), and 22 (n = 1). In the FLK/EFL stock, the maximum age observed was 16 years for a fish (n =1) measuring 542 mm FL that was sampled in southeast Florida by FWRI samplers for the SRHS in 2005 using hook and line gear. The next oldest fish observed were sampled in the Dry Tortugas by McBride and Richarson (2007) for ages 12 (n = 3) and 13 (n = 2) and by D. Morley (*FWRI unpub. data*) for age 12 (n = 1) using spear gear. In addition, two fish sampled by Towne et al. (2021) in southeast Florida were aged 12 years and captured using spear gear.

2.6.5 Growth

When McBride and Richardson (2007) evaluated Hogfish growth in Florida, an underlying assumption was that the stock structure was genetically homogenous between coasts and regional differences in growth were attributed primarily to the intense levels of size-selective fishing mortality occurring in the Florida Keys. Although a new understanding from Seyoum et al. (2015), which showed two genetically distinct stocks between the WFS and FLK, and Collins and McBride (2011) which showed spatial variation in length-at-age on the WFS, growth in SEDAR 37 (2014) was modeled using only data available from the WFS and was assumed to be representative of all three stocks assessed at the time (i.e., WFS, FLK/EFL, and NC/GA).

Furthermore, parameters were treated as fixed inputs within all three assessment models. Since then, additional data has been collected in Florida and in parts of the Caribbean (e.g., Drake 2021) and the LHWG, therefore, felt it necessary to explore spatial variations in growth for this widely distributed reef fish species and reevaluate prior assumptions.

Length-at-age data were filtered to eliminate observations that included a known size or effort bias or if lengths were collected using a known non-random sampling method or were selected by quota sampling. Data were further restricted to records containing complete information on year, month, and state (or were assigned a state based on area fished or sample location if the area fished was unknown or unassigned). Finally, fork length observations were grouped by calendar age and iteratively Z-scored; outliers were removed using threshold values of ±8 in the first iteration and values of ±4 in the second iteration.

Length-at-age data based on biological (i.e., fractional) ages and fork length data were modeled using a size-truncated von Bertalanffy growth model (Diaz et al. 2004) executed in ADMB (Auto Differentiate Model Builder). This growth model accounts for minimum size restrictions (using a truncated normal distribution) which influence non-random sampling across ages (e.g., smaller fish not available to sample); however, it does not account for dome-shaped selectivity (e.g., larger fish not available to sample). It also allows for the exploration of alternative variance structures. Model options for variance structure used here were constant CV with age, CV changing linearly with age, and CV changing linearly with size at age. Growth models were applied to both unweighted data and data weighted by using the inverse (1/n) of the count of each calendar age (Burton et al. 2015). Model selection criteria were based on model convergence (maximum gradient < 0.0001), model objective function (minimized negative loglikelihood), Akaike Information Criteria (AIC), and model standardized-residual diagnostic plots.

Size truncation for the fishery-dependent data from the FLK/EFL stock, was set using the minimum size limits of 12” FL (305 mm FL) first implemented by the SAFMC Snapper-Grouper FMP amendment on 1/23/1995 and a 16” FL (406 mm FL) implemented on 8/24/2017 by the SAFMC Snapper-Grouper Amendment 37. On the WFS, fishery-dependent data were truncated using the minimum size limits of 12” FL (305 mm FL) from the Reef Fish Amendment 16B effective 11/1/1999 and 14” FL (356 mm FL) from the Reef Fish Amendment 43 effective

8/24/2017. In addition to truncation occurring at minimum size limits, Hogfish in both stocks experience top-down size selective fishing mortality in areas of higher fishing intensity (McBride and Richardson 2007, Collins and McBride 2011, Towne et al. 2021), predominantly from spearfishing where preference is given to the largest (and often male) individuals available (McBride and Richardson 2007). This process tends to remove faster growing individuals at a higher rate than slower growing ones, thereby leaving behind a population cumulatively comprised of slower growing individuals in the cohorts (i.e., "Lee's phenomenon" after Rosa Lee [1912]; McBride and Richardson 2007, Kraak et al. 2019). While the growth model used here cannot account for this form of top-down selectivity, the LHWG thought the use of inverse weighting would help via greater weight being added to the oldest (and often largest) age classes available in the data.

Florida Keys/East Florida

Hogfish length-at-age in the FLK/EFL stock (Figure 2.13.26a) displayed a more truncated profile where data were concentrated around the minimum size limit (305 mm FL) and between 300 – 400 mm. This pattern was more intense when isolating the data to the southeast Florida region (Figure 2.13.26b). The overall truncated pattern was similar between the commercial and recreational length-at-age data (Figure 2.13.27) and even more so when isolating the hook and line gear (Figure 2.13.28). Large variations of length-at-age were observed and likely resulted, in part, from sampling across areas of varying fishing intensity along the Florida Reef Tract (McBride and Richardson 2007) where 'Lee's phenomenon' may more readily be occurring. For example, fishery-independent data (Figures 2.13.27 and 2.13.28), primarily comprised of trawl samples largely below the minimum size limit and spear caught samples from the Dry Tortugas, were generally larger, showed less variation in size and age, and may be more representative of a population experiencing lower amounts of fishing pressure. Since the spear gear was assumed to be more reflective of flat-topped selectivity and fishery-independent samples generally do not have the bias associated with fishery-dependent sampling, the LHWG was further interested in isolating these data (Figure 2.13.29) to help account for limitations of the current growth model and to help better align with how the assessment model would internally estimate growth (e.g., through selectivity).

From the available age data, a total of 1,574 length-at-age observations were retained (99.9%) for modeling of growth. Unweighted and non-truncated models using these data

estimated L_∞ growth parameters at 421 mm FL, 414 mm FL, and 420 mm FL for each variance parameter configuration, respectively (Table 2.12.11). These estimates were also found to be similar to those provided by life history studies conducted within the FLK/EFL stock. For example, McBride and Richardson (2007) estimated L_∞ = 428 mm FL for all south Florida while Towne et al. (2021) estimated L_∞ = 414 mm FL for southeast Florida. While truncating the fishery-dependent data (n = 1,053) produced similar parameter estimates, inversely weighting the truncated data estimated larger L_∞ values and significantly improved model fit via negative log likelihood, AIC, and inspection of model residuals (Table 2.12.11). Under these configurations, L_∞ growth parameter estimates were 515 mm FL, 553 mm FL, and 527 mm FL for each variance parameter configuration, respectively, but still showed some patterns in the residuals.

Following the interest of the LHWG, the data were next isolated to those from the Dry Tortugas plus any from fishery-independent sources (n = 597; Figure 2.13.29); since the CVs-at-age for this data showed a more flattened trend, only the constant CV across age configuration was explored. In the unweighted model, L_∞ was estimated to be 501 mm FL (Table 2.12.12). To account for some fishery-dependent data from the Dry Tortugas region, the data were further truncated (n = 593) but produced similar growth parameter estimates given the difference of 4 fish. When the truncated data were inversely weighted, model fit improved and L_∞ was estimated to be 531 mm FL (Table 2.12.12).

McBride and Richardson (2007) reported an estimate of L_∞ in the Dry Tortugas to be 651 mm FL; however, they report a t_0 parameter estimate of -3.338 likely due to fewer observations of smaller individuals (min = 245 mm FL; mean = 432 mm FL) and low sample size (n = 93). More recently, estimates of Hogfish growth have become available from fishery-dependent data (n = 761) in the Caribbean (i.e., Puerto Rico and the U.S. Virgin Islands) by Drake (2021). Growth parameters were reported at L_∞ = 624 mm FL, k = 0.16, and t_0 = -0.61 with max age sampled at 20 years. In the FLK/EFL stock, fish larger than 600 mm FL have been measured in the northeast Florida region by TIP; however, no ages were ever sampled. The LHWG noted that inclusion of those larger fish would likely have contributed to a larger L_∞ estimate and may have increased the max age observed for this stock here.

The LHWG determined the best handling of the current length-at-age data for the FLK/EFL stock, in effort to account for differences in selectivity, minimum size limits in the

fishery, and top-down size-selective fishing mortality, while aiming to reflect a plausible population growth rate under lightly fished conditions was to use the data from the Dry Tortugas plus any fishery-independent data available for this stock. Furthermore, the LHWG agreed that it was appropriate to truncate the fishery-dependent data according to the SAFMC minimum size limits and that inversely weighting that data resulted in the best model fit to the data. The fit statistics for this model are provided in Table 2.12.12 and Figure 2.13.30) with equation:

$$L_t = 531\ (1-e^{(\ -0.223\ (\ t\ +0.571\ ))})$$

The residuals for this model indicate overall goodness of fit (Figure 2.13.31a – b) and by fishery (Figure 2.13.31c), by gear (Figure 2.13.31d), by sex (Figure 2.13.31e), by region (Figure 2.13.31f), and by calendar age (Figure 2.13.31g). Therefore, the LHWG recommended this model for use and for parameter values to act as starting values when estimating growth within the stock assessment model.

West Florida Shelf

On the WFS, Hogfish length-at-age (Figure 2.13.32a) showed that individuals were found to grow much larger and older than those observed within the FLK/EFL stock with asymptotic lengths-at-age largely occurring between 700 – 800 mm FL; this pattern specifically occurred in data from the southwest Florida region (Figure 2.13.32b) where length-at-age almost gave the appearance of containing multiple growth patterns (e.g., bi-phasic). Following Collins and McBride (2011), parsing the data by depth strata (nearshore <30 m and offshore >= 30 m) revealed a profile characterized by cross-shelf demographics (Figure 2.13.33); fish collected offshore were predominantly much larger and older, lending support to this stratum conceivably acting as a *de facto* refuge for faster growing and older fish who've escaped the nearshore stratum where the bulk of the fisheries operate. Length-at-age profiles were similar between commercial and recreational fisheries (Figure 2.13.34); spear gear from both fisheries operated in all depth strata but the recreational hook and line was primarily concentrated in the nearshore stratum and greatly influenced a truncated pattern around the GMFMC minimum size limits of 12" (305 mm FL) and 14" (356 mm FL; Figure 2.13.35). Hogfish captured by fishery-independent surveys primarily occurred in nearshore waters using trawl gears (Figure 2.13.34 and 2.13.35).

The LHWG discussed the gap observed in length-at-age data for fish aged 4 – 6 whose lengths were 500 – 600 mm FL which resulted in a 'bi-phasic' looking profile. The pattern in the data seems to occur predominantly from fish collected offshore by spear gear in both commercial and recreational fisheries. The behavioral peculiarities of Hogfish when interacting with spear fishermen along with the top-down size selective nature of spear fishing may suggest that the sampling gap is an artifact of selection for the larger fish, even if smaller individuals are available in the area. Another hypothesis suggested the sudden greater variation of length-at-age here could be result of Hogfish transitioning from female to male during this time (McBride et al. 2008, Collins and McBride 2011) when males undergo additional somatic change in their snout morphology (i.e., becomes longer). Despite these uncertainties, the LHWG determined the pattern most likely resulted from sampling or targeting bias as opposed to Hogfish truly exhibiting bi-phasic growth. Consequently, however, von Bertalanffy growth model fit to these data may exhibit patterns in residuals for these ages.

From the available age data, a total of 2,973 length-at-age observations were retained (99.9%) for the modeling of growth; CV was generally found to decrease with size or age. Unweighted and non-truncated models using these data estimated L_∞ growth parameters at 933 mm FL (for constant CV at age), 974 mm FL (when CV changes linearly with age), and 991 mm FL (when CV changes linearly with size at age; Table 2.12.13). These parameter estimates were found to be similar to McBride and Richardson (2007) who estimated L_∞ = 917 mm FL for the eastern Gulf and to Collins and McBride (2011) who estimated L_∞ = 896 mm FL in the offshore stratum of the eastern Gulf. When the fishery-dependent data were truncated (n = 2,799), all the unweighted models grossly overestimated L_∞ (e.g., 1,208 mm FL when CV was a linear function of age) with greater negative t_0 parameter values (Table 2.12.13). However, when these data were inversely weighted, model fit significantly improved via negative log likelihood, AIC, and inspection of model residuals (Table 2.12.13). Under this scenario, the three inversely weighted models were not significantly different in AIC and negative log-likelihood (i.e., less than two units difference) and estimated L_∞ values between 768 – 797 mm FL (Table 2.12.13).

Following the methods and reasoning discussed for the FLK/EFL stock above, the LHWG was interested in isolating the spear gear and any fishery-independent data (n = 2,317; Figure 2.13.36a – b) to model growth for the WFS; the spear gear was assumed to have flat-topped selectivity across both nearshore and offshore strata while the fishery-independent data,

which were predominantly nearshore trawl data would help inform the smaller and younger length-at-age samples not sampled by the spear gear. Only the CV as a linear function of age configuration was explored here. The resulting parameter estimates for these models were similar to those above when the data weren't isolated. In the unweighted model, L_∞ was estimated to be 965 mm FL (Table 2.12.14). When accounting for the fishery-dependent spear observations, the truncated data (n = 2,226) produced a larger growth parameter estimate (L_∞ = 1,083 mm FL) and the inversely weighted model estimated L_∞ to be 763 mm FL (Table 2.12.14).

The LHWG determined the best handling of the length-at-age data for the WFS stock was to use the isolated data from the spear gear plus any fishery-independent data available. This attempts to account for differences in selectivity, depth demographics, minimum size limits in the fishery, and top-down size-selective fishing mortality while aiming to reflect a reasonable population growth rate. The LHWG also agreed it was appropriate to truncate the fishery-dependent data according to the GMFMC minimum size limits and that inversely weighting that data resulted in the best model fit to the data. However, in the inversely weighted model, a pattern of residuals-at-age persisted which tended to overestimate length for ages 4 – 6 (see comments on sampling gap above) and underestimate length for ages 14 – 20. Since inverse weighting places greater weight on the lowest sample size at age (here, ages 21 and 22) and the lengths for ages 21 – 23 were observed to be generally smaller, a plus group for ages 20+ was created for the inversely weighted data. This model produced a significantly better fit to the data via AIC and negative log likelihood. The fit statistics for this model are provided in Table 2.12.14 and Figure 2.13.37) with equation:

$$L_t = 823\ (1-e^{(-0.112\,(t+0.954))})$$

The residuals for this model indicated overall goodness of fit (Figure 2.13.38a – b) and by fishery (Figure 2.13.38c), by gear (Figure 2.13.38d), by sex (Figure 2.13.38e), by region (Figure 2.13.38f), and by calendar age (Figure 2.13.38g). This model was also similar to the one produced in SEDAR 37 (2014) where growth parameter values were estimated to be L_∞ = 849 mm FL, k = 0.106, t_0 = -1.329. Therefore, the LHWG recommended this model for use and for parameter values to act as starting values when estimating growth within the stock assessment model.

2.7 NATURAL MORTALITY

Natural mortality, *M,* characterizes all causes of natural (i.e, non-fishing) mortality such as predation, starvation, disease, and senescence (Gulland 1983, Hilborn and Walters 1992) but may also include some forms of human-induced mortality not due to fishing (Maunder et al. 2023). While it is one of the most influential parameters within fisheries stock assessment, it is rarely observed or measured in fish populations; consequently, it is difficult to estimate and remains a large source of uncertainty within most stock assessment models (Vetter 1988, Hampton 2000, Maunder et al. 2023). *M* is commonly treated as a constant within stock assessment processes and textbooks (e.g., Hilborn and Walters 1992, Quinn and Deriso 1999, Haddon 2011), but application as a size-dependent or equivalent age-dependent function using a stock-specific growth function with constant *M* scaled to a fully selected age or range of ages (e.g., the 'Lorenzen *M'* model) has become more commonly practiced in stock assessments conducted in the southeastern United States (Lorenzen 2022, Lorenzen et al. 2022).

Constant as well as size- and age-dependent estimates of natural mortality of Hogfish were explored using the approaches and recommendations presented in the review of natural mortality estimation methods by Maunder et al. (2023) and the 'generalized length-inverse mortality (GLIM)' paradigm presented by Lorenzen (2022). Where relevant, all natural mortality models assumed stock-specific von Bertalanffy growth with a six-month offset applied to age-0 fish so that they were larger than 10% of L_∞ (i.e., after density dependence; Lorenzen and Camp 2019). Constant *M* estimates were calculated based on the longevity and empirical *K* models updated by Hamel and Cope (2022) and the revised $\text{Pauly}_{\text{nls-T}}$ model described in Then et al. (2015). These estimates of constant *M* were then converted to mortality-at-length and -age by applying the length-inverse equation described in Lorenzen (2022) and using age-3 as the reference age (i.e., fully selected) for the constant *M* estimate. In addition, allometric scaling models for mortality-at-weight and -length were explored using the mortality-weight model described in Lorenzen (1996). Longevity estimates were based on the observed maximum age for Hogfish in Florida and the mortality-weight model utilized the parameters of the non-linear length-weight model converting fork length (mm) to total weight (g). The estimation methods of natural mortality along with their respective equations are presented in Table 2.12.15.

2.7.1 West Florida Shelf

On the WFS, longevity estimates were based on the observed maximum age (t_{max} = 23 years) and the von Bertalanffy growth parameter values were based on the recommended growth model above (L_∞ = 823 mm FL, k = 0.112, t_0 = -0.954; Table 2.12.14). Length-weight model parameters used within the mortality-weight model were obtained from the non-linear length-weight model converting fork length (mm) to total weight (g) where a = 3.018E-5 and b = 2.927 (Table 2.12.1).

Constant mortality estimates based on longevity and empirical *K* models were found to be M = 0.235 yr^{-1} and 0.174 yr^{-1}, respectively. The revised $Pauly_{nls\text{-}T}$ model also estimated M = 0.194 yr^{-1}. Thus, estimates of constant *M* based on VB growth parameters anticipated a longer-lived species (~ age 30 years) than currently observed for the WFS. Converted mortality-at-age estimates ranged from 0.559 – 0.090 yr^{-1} for the longevity model, from 0.413 – 0.067 yr^{-1} for the empirical *K* model, from 0.463 – 0.075 yr^{-1} for the revised $Pauly_{nls\text{-}T}$ model, and from 0.514 – 0.110 yr^{-1} for the mortality-weight model (Table 2.12.16, Figure 2.13.39). Cumulative survival to the oldest age for these models is 2.3%, 6.2%, 4.5%, and 1.7% respectively.

The LHWG recommended estimates of natural mortality be size- or age-dependent and recommended using the Lorenzen (2022) length-inverse model with the Hamel and Cope (2022) longevity-based estimate of constant *M* for mortality-at-age in the stock assessment model.

In SEDAR 37 (2014), estimates of constant *M* were based on the Hoenig (1983) model and a maximum age of 25 years. Mortality-at-length and -age was created by applying the survival equations described in Lorenzen (2000, 2005) and the cumulative mortality rate was scaled across *all* ages so that it agreed with the constant *M* estimate. Based on these methods, *M* was 0.179 yr^{-1} and ranged from 0.597 – 0.109 yr^{-1}. While the Hoenig (1983) model may no longer be recommended (e.g., older data or lack of adequate transformation; see Maunder et al. 2023), the mortality-at-age estimates are similar in magnitude to the recommended longevity-based estimates provided here.

2.7.2 Florida Keys/East Florida

In the FLK/EFL stock, the LHWG thought greater uncertainty surrounded observations of maximum age based on sample sizes. For example, there was only one sample aged 16 years and two aged 13 years, but no samples aged 15 or 14 years (see above section 2.5.4). This

contrasts with the WFS which had samples for each age up to the maximum age observed. A recent study in the Caribbean (Drake 2021) recorded similar observed ranges in length and age in the US Virgin Islands where samples ranged from 245 – 595 mm FL with a maximum age of 17 years. However, length data available from TIP in northeast Florida in some years showed larger (e.g., 600 – 800 mm FL) and therefore assumed older fish than what has typically been observed in the southeast Florida and Florida Keys regions; thus, this lends to the possibility of fish occurring in this portion of the stock who are larger and older than what currently available length-at-age data indicate. Given this uncertainty, the LHWG explored using both ages 16 and 23 years as t_{max} in the longevity-based mortality models. Mortality models using von Bertalanffy growth parameter values were based on the recommended growth model above (L_∞ = 531 mm FL, k = 0.223, t_0 = -0.571; Table 2.12.12). Length-weight model parameters used within the mortality-weight model were obtained from the non-linear length-weight model converting fork length (mm) to total weight (g) where a = 3.018E-5 and b = 2.927 (Table 2.12.1).

The constant mortality estimate based on the longevity model (when t_{max} = 16) was M = 0.338 yr^{-1}. For the empirical K and revised $Pauly_{nls\text{-}T}$ models, constant mortality was 0.346 yr^{-1} and 0.371 yr^{-1}, respectively. Thus, all three models reflected a comparatively shorter-lived species with a higher growth rate. Converted mortality-at-age estimates ranged from 0.872 – 0.190 yr^{-1} for the longevity model, from 0.893 – 0.195 yr^{-1} for the empirical K model, from 0.959 – 0.209 yr^{-1} for the revised $Pauly_{nls\text{-}T}$ model, and from 0.621 – 0.172 yr^{-1} for the mortality-weight model (Table 2.12.17, Figure 2.13.40). Cumulative survival to the oldest age class for these models is 0.8%, 0.7%, 0.5%, and 1.8% respectively. When the maximum age of 23 was used, mortality-at-age was similar to the WFS and ranged from 0.561 – 0.132 yr^{-1} with cumulative survival to age-16 at 3.5%.

For the FLK/EFL stock, the LHWG recommended estimates of natural mortality be size- or age-dependent and thought the Lorenzen (1996) mortality-weight model may be more appropriate for use as mortality-at-age in the stock assessment model. The mortality-weight model circumvents the uncertainty associated with maximum age and growth by relying on the length-weight relationship. This model is also similar in magnitude to the longevity model when t_{max} = 23 and the mortality models developed for the WFS, reflecting the notion that the mortality-weight model anticipated a longer-lived species of more than 16 years.

2.7.3 Catch Curve Analysis

A catch curve analysis to estimate total mortality (*Z*) for each stock was performed on stock-specific catch data using the spear gear (McBride and Richardson 2007) from years 1996 – 2024. This gear was considered to exhibit flat-topped selectivity whereas other gears from the commercial and recreational sectors likely exhibited more dome-shaped selectivity. There are several assumptions within a catch curve analysis that warrant caution (e.g., the population is closed to emigration and immigration, recruitment is constant, total mortality and selectivity is constant across ages and years on the descending limb, and sampling isn't biased on any specific age group), but it's useful in providing context when comparing estimates of *M*.

On the WFS, there were 1,151 observations ranging from ages 0 – 23 years. The logarithmically transformed catch-at-age data appeared more uniform in distribution across ages 2 – 7 with a peak at age-7 and were considered fully selected by this gear for ages 7 – 20. In the FLK/EFL stock, there were 1,189 observations across ages 0 – 13 years with a peak at age-2 and were considered fully selected for ages 2 – 13.

Two methods were used to calculate *Z*, a weighted regression (Maceina and Bettoli 1998) and the Chapman-Robson estimate of the annual survival rate (Chapman and Robson 1960, Robson and Chapman 1961). For the WFS, the weighted regression estimated $Z = 0.310$ (LCI = 0.266, UCI = 0.354; Figure 2.13.41a) and $Z = 0.383$ (LCI = 0.314, UCI = 0.451) for the FLK/EFL stock (Figure 2.13.41b). The Chapman-Robson method estimated $Z = 0.370$ (LCI = 0.308, UCI = 0.433) for the WFS and $Z = 0.347$ (LCI = 0.282, UCI = 0.412) for the FLK/EFL stock. Thus, estimates of Z were found to overlap both between methods and between stocks. For comparison, McBride and Richarson (2007) used the Chapman-Robson method across ages 3 – 9 years and estimated a slightly lower $Z = 0.350$ for the eastern Gulf dataset and slightly higher $Z = 0.397$ for the south Florida dataset and found no significant differences in survival between the two stocks.

On the WFS, estimates of *Z* between both methods were higher than the Hamel and Cope (2022) longevity-based estimate ($M = 0.235$ yr^{-1}) and were significantly higher than the estimates correlated with growth (e.g., empirical *K*, $M = 0.194$ yr^{-1}; revised Pauly$_{nls\text{-}T}$, $M = 0.174$ yr^{-1}). For the FLK/EFL stock, the estimates of Z from both methods overlapped with all three constant *M*

models (i.e., longevity [16], $M = 0.338$ yr^{-1}; empirical K, $M = 0.346$ yr^{-1}; revised Pauly$_{nls\text{-}T}$, $M = 0.371$ yr^{-1}), lending further support for the use of the mortality-weight model for this stock.

2.7.4 Sensitivity Analyses

Sensitivity analyses on natural mortality are recommended by the SEDAR Best Practices (SEDAR 2015) given the uncertainty surrounding this life history component and its impact within the assessment model. Therefore, the LHWG recommended sensitivity analyses where the Lorenzen (1996) mortality-weight model (see above) be used for the mortality-at-age vector for the WFS stock assessment model and for the Hamel and Cope (2022) longevity model based on a maximum age of 23 years be used for mortality-at-age in the FLK/EFL stock assessment model. In this manner, the sensitivity runs of each stock can be compared to the methods used in the other.

Maunder et al. (2023) also recommends allowing M to be estimated within an integrated assessment model where estimation of a greater range of sampling processes (e.g., selectivity, effective sample size) may reduce bias and result in improved precision of estimated quantities. Internal estimation will also allow for data conflicts to be evaluated through processes such as likelihood component profiling on M. Therefore, the LHWG recommends exploring the estimation of M internally for both stocks using the Lorenzen method option within Stock Synthesis using the Hamel and Cope (2022) longevity-based constant M estimate as the initial value for the single input M parameter along with the recommended corresponding lognormal prior (sd = 0.31) for uncertainty, and age 3 as the reference age (unless a different fully selected age is later determined).

2.7.5 Episodic Mortality Events

No attempt was made to investigate episodic types of natural mortality (red tides, cold kills, oil spills, etc.) because data were insufficient on which to base such modifications to the M parameter. Red tide blooms are more commonly seen on Florida's Gulf Coast, usually occurring north of the Florida Keys, and may impact Hogfish on the WFS. A WFS ecosystem model ("RedTideVis") which explores the effects of red tide is available (https://redtidevis.shinyapps.io/redtideapp/) and contains Hogfish as a functional group. However, Hogfish in this model do not have any age structure and their habitat preferences are

not well parameterized, so caution is warranted in the confidence of these estimates (Dave Chagaris and Ted Switzer, *pers. comm.,* 8/26/25). Cold stuns and kills from water temperatures of perhaps 15ºC or lower (see discussion in Gilmore et al. 1978), while infrequent, may occur once or twice a decade in Florida. An extreme cold event during the winter of 2010 caused massive mortality of patch reefs in the Florida Keys (Colella et al. 2012) which may have impacted Hogfish habitat, but no specific reports on Hogfish mortalities were reported (Hallac et al. 2010).

The impact of algal blooms and decreased water quality on the mortality of young Hogfish within the Indian River Lagoon (IRL) system was also discussed as presented by the Index Working Group. Submerged aquatic vegetation, which is important for age-0 Hogfish abundance in both the Big Bend area of the WFS and in the Florida Keys, has been in decline in the IRL for the past decade. According to FWRI FIM data available since 1997, annual abundances, while generally low (i.e., <50 fish per year), have declined precipitously here post-2014 at or near 0 values (Brian Klimek and Ted Switzer, *pers. comm.,* 8/27/25).

2.8 REPRODUCTION

Hogfish are monandric, protogynous reef fish with territorial males and female-biased harems (Collins and McBride 2015). They mature first as females and are expected to eventually become male if they live long enough. A single male maintains harems of 5 – 15 females where spawning occurs in the afternoon as often as daily and for as long as 11 months of the year (Colin 1982, McBride and Johnson 2007, Collins and McBride 2008, Munoz et al. 2010, Collins and McBride 2015). The size and age range at which sexual transition occurs is wide-ranging (e.g., 197 – 727 mm FL and 1 – 11 yrs on the WFS) and indicates that transition is socially and environmentally mediated (Collins and McBride 2011). Sex change can take several months (McBride and Johnson 2007), so removal of the dominant male has the potential to significantly affect harem stability and decrease reproductive potential (Muñoz et al., 2010).

There were no new reproductive data for Hogfish available for this assessment; therefore, data from the life history research available during SEDAR 37 (2014) were re-analyzed for each stock. Ongoing research is being conducted in the Dry Tortugas (D. Morley, *pers. comm.*) but was unavailable at this time for inclusion.

2.8.1 Spawning Season

Peak spawning activity occurs during the winter and spring months predominantly from December through April and begins (and ends) slightly earlier in the Florida Keys (Davis 1976, Colin 1982, Claro et al. 1989, McBride and Johnson 2007, Collins and McBride 2008, McBride et al. 2008, Muñoz et al. 2010). On the WFS, larger Hogfish collected in deeper waters (> 30 m) have shown evidence of a more protracted spawning season where approximately 50% of females were reproductively active during all months except September (Collins and McBride 2008).

2.8.2 Female Age/Size at Maturity

A traditional approach to assigning maturity is to use histologically assigned reproductive phases where data within the core spawning season are isolated in effort to decrease the number of mature regenerating females misidentified as immature (Hunter and Macewicz 2003). This method works well for species with more confined spawning seasons, but Hogfish have a protracted spawning season, and regenerating females occur both within the spawning season and core spawning months. Therefore, a conservative approach was utilized which assigned female maturity based only on histologically confirmed reproductive phases of immature and mature active spawning (Lowerre-Barbieri et al. 2022, Lowerre-Barbieri and Friess 2023) females collected all months of the year. Reproductive phases for Hogfish followed McBride and Johnson (2007) where immature females were identified as class 1 and mature active spawning females were class 3. This updated methodology is a slight departure from the methods used in SEDAR 37 (2014) and from the life history studies which utilized all female maturity classes (i.e., 1 – 4). Female maturity was modeled using binomial generalized linear models with a logit link function (i.e. logistic regression), and model parameters can be translated to fit the logistic function form utilized in Stock Synthesis:

$$\text{Maturity} = \frac{1}{1+e^{-a*(y-b)}}$$

where a is the slope, b is the inflection point (age or length at 50% maturity), and y is length or age. Using the model intercept and slope parameters from the logistic regression, the inflection point (b) was calculated by dividing the negative value of the model intercept by the slope. The standard error for the inflection point (b) was calculated using the propagation of errors formula:

$$\text{SE } (b) = |b| * \sqrt{\left(\frac{SE(intercept)}{intercept}\right)^2 + \left(\frac{SE(slope)}{slope}\right)^2}$$

Immature females (class 1) were assigned a binomial maturity value of 0 and mature active spawning females (class 3) were assigned a binomial maturity value of 1.

In the FLK/EFL stock, female age at 50% maturity was estimated to be 2.08 years based on 231 observations (Table 2.12.18, Figure 2.13.42a) and size at 50% maturity was 232 mm (Table 2.12.19, Figure 2.13.42b) based on 285 observations. By isolating the data to reproductive classes 1 and 3, these values were found to be about 5 months older and 39 mm larger when compared to McBride et al. (2008) who estimated south Florida female age at 50% maturity to be 1.6 yrs and size at 50% maturity to be 193 mm FL using all female reproductive classes (1 – 4).

In the WFS stock, female age at 50% maturity was estimated to be 1.09 years based on 385 observations (Table 2.12.20, Figure 2.13.43a). These values were comparable to McBride et al. (2008) who similarly estimated female age at 50% maturity to be 1.1 years and Collins and McBride (2011) who estimated it at 0.9 years from the eastern Gulf. Female size at 50% maturity was 169 mm FL (n = 533; Table 2.12.21, Figure 2.13.43b) and was comparable with previous estimates by McBride et al. (2008) of 169 mm FL, 152 mm FL by Collins and McBride (2011), and 155 mm FL during SEDAR 37 (2014) who used all female reproductive classes (1 – 4).

Parameter estimates and standard errors from the logistic regression models by age and length for each stock are presented in Table 2.12.22.

2.8.3 Sexual Transition

The hermaphroditic transition from female to male followed the approach used in Stock Synthesis where the probability of transitioning to a male at each age class was modeled using a 3-parameter cumulative normal distribution function. This function uses inflection age (μ) and standard deviation (σ) parameters to model the cumulative normal, and an asymptotic rate parameter for situations where the max age (or plus group) in the model may still have some females (i.e., not 100% transition by the maximum age). Since Hogfish are expected to all become males if lived long enough, the asymptotic rate parameter was recommended to equal 1.0. Furthermore, in the cumulative normal function a penalty may also be applied which forces

the asymptote to be reached by a certain age (e.g., first age where fish are 100% male proportion) and was explored here. These parameters are therefore defining the proportion that *change* sex in a time step, not the proportion that *are* each sex (R. Methot, *pers. comm.* 9/4/25). As in the above analysis, reproductive phases for Hogfish followed McBride and Johnson (2007) where females were classes 1 – 4, transitional female-male were class 5, and males were classes 6 – 10. Here, immature and mature females (classes 1 – 4) were assigned a binomial maturity value of 0 while classes 5 – 10 (transitional female-male and immature and mature males) were assigned a binomial maturity value of 1 (following methods described in Collins and McBride 2011). This deviates from the binomial maturity assignment identified in the methods used during SEDAR 37 (2014) which modeled classes 1 – 6.0 (immature and mature females, transitional female-male, and immature male) as 0 and classes 6.7 – 10 (maturing first year males and mature males) as 1.

For Hogfish in the FLK/EFL stock (n = 721), the male transition probability at age was defined as $\mu = 6.08$ years and $\sigma = 2.33$ with an asymptote set at the first fully male proportion-at-age of 11 years (Figure 2.13.44a). On the WFS (n = 942), greater variability in the male transition probability at age was observed as driven by the underlying differences in demographics by depth reported by Collins and McBride (2011). They showed median size and age at sex change were significantly less nearshore (2.8 years) than offshore (7.8 years). Here, the male transition probability at age was defined by $\mu = 8.41$ years and $\sigma = 4.18$ with an asymptote set at the first fully male proportion-at-age of 13 years (Figure 2.13.44b).

2.8.4 Fecundity

Fecundity estimates were available for the WFS and FLK/EFL stocks during SEDAR 37 (2014) and, without any new data, remain unchanged here. Batch fecundities calculated from WFS samples ranged from 1,700 to 64,600 (n = 42 females, ranging 266 to 626 mm FL and 1 to 9 years old; Collins and McBride 2015) with highest estimates having occurred during the peak spawning season (February – April). The maximum batch fecundity estimated from this study (64,600 eggs) was almost three times larger than that estimated previously for the WFS region (McBride et al. 2008; estimate = 21,400, n = 23) and is likely a result of the larger, older females collected in the later study (626 mm FL and 10 years versus 442 mm FL and 7 years). Only a low number of batch fecundity estimates exist for the FLK/EFL region (n=10), but they ranged

from 138 – 10,800 (McBride et al. 2008). Batch fecundity is positively and significantly correlated with female weight and length in both stocks. Annual and lifetime fecundity for Hogfish in the FLK/EFL stock was notably lower than on the WFS for all age-classes (McBride et al. 2008).

For Hogfish, no information currently exists on the importance of sperm limitation, but sex transition can take a moderate amount of time (a few months; McBride and Murphy 2003; McBride and Johnson 2007). This delay in transition could lead to sperm limitation under high fishing pressure if males are targeted for removal and a female takes a substantial amount of time to transition and fill the male role in the harem (McBride and Johnson 2007; Muñoz et al., 2010). When uncertainty exists in the importance of sperm limitation, simulation studies suggest that including both male and female spawning stock biomass (SSB) in reference point calculations should be used for assessments of protogynous stocks (Brooks et al. 2008). Under this scenario, development of fecundity estimates, while informative, may not be appropriate as they do not account for the uncertainty in sperm limitation. During SEDAR 37 (2014), this approach to reference point calculation was utilized and was recommended for continued for use here.

2.8.5 Sex-ratio

Sex ratios are commonly used to indicate the numerical relationship between the sexes and is conventionally expressed as a proportion where the number of males is divided by the total number of individuals (Wilson and Hardy 2002). Other traditional formulations are expressed as the number of males divided by the number of females (Collins and McBride 2011). Using only data where sex was histologically assigned, there were 219 males, 645 females, and 14 transitional female-male fish identified in the FLK/EFL data set. The proportion male was therefore calculated to be 219/(219+645+14) = 0.249. On the WFS, there were 432 males, 916 females, and 52 transitional female-male fish resulting in a proportion male of 432/(432+916+52) = 0.308. These estimates were found to be a little higher than existing literature based upon visual survey data that had estimated sex ratios (i.e., males/ females) of 0.14 in WFL (Collins and McBride 2011), 0.10 Puerto Rico (Colin 1982); 0.20 in Cuba (Claro et al. 1989).

2.9 COMMENTS ON THE ADEQUACY OF DATA FOR ASSESSMENT ANALYSES

2.9.1 Stock Definition

Genetic analyses available for Hogfish currently indicate two genetically distinct stocks in Florida. However, since the prior assessment no additional analyses have been conducted in other parts of the FLK/EFL stock (e.g., central and northeastern Florida). New mitochondrial DNA data has been collected in areas similar to those reported in Seyoum et al. (2015) with the addition of some Caribbean samples and is currently being analyzed by Alexis Janosik and her lab at the University of West Florida. Despite this, the current assumption of there being two closed populations each within the SAMFC and GMFMC jurisdictions for the purpose of this stock assessment and management is considered reasonable and consistent with the previous SEDAR assessment; but the uncertainty associated with this assumption is unknown and therefore difficult to define or estimate.

2.9.2 Movements and Migrations

Available movement data on Hogfish show very high site fidelity and variability in nearshore-offshore ontogenetic migrations. Coupled with the characteristic of being a harem-forming species, Hogfish have not been observed to migrate to form large aggregations for spawning; therefore, genetic connectivity between stocks is likely driven more by oceanographic mechanisms during transport of pelagic larva.

2.9.3 Morphometrics and Conversion Factors

Programs from both fishery-dependent and fishery-independent sources provided adequate quantities of differing length and weight measurement types to create adequate length-length and length-weight equations and conversion factors. Since most Hogfish across data collection programs were measured in fork length and the management regulations at the federal and state levels are in fork length, this means the lengths within the model will largely be observed, rather than converted, values.

2.9.4 Age and Growth

The age data appeared to be moderate in representation of the landings and reflect a more opportunistic fishery for this species with assigned ages supported by the precision analyses

conducted. In both stocks, the total number of ages sampled annually from fishery-dependent and -independent sources was often below 30 and driven more by the various life history studies. Samples were also dominated by one particular region within each stock: the southwest FL region on the WFS and the Florida Keys region in the FLK/EFL stock but no ages were sampled in northeast FL. Despite these concerns, the LHWG characterized the data as the best available and recommended its use for stock assessment purposes.

A significant change explored here from the previous assessment was the difference in various life history characteristics between stocks. Regarding growth, the LHWG assumed differences in age-at-length between stocks were influenced by differences in exploitation (McBride and Richardson 2007), genetics (Seyoum et al. 2015), and habitat (Collins and McBride 2011, Faletti and Stallings 2021) and considered it reasonable to treat each stock separately rather than isolating data and analyses from one stock and applying it to all (SEDAR 37 2014). Furthermore, The LHWG noted the influence aging structure and growth model had on those differences. For example, length-at-age was similar between the nearshore stratum of the WFS and the FLK/EFL where fishing pressures were highest. But the availability of a refuge offshore stratum in the WFS led to fish growing larger and living longer and could only be assumed to co-occur in the northeast FL region of the FLK/EFL where only length data were available. In Puerto Rico and the USVI, Hogfish have been observed at sizes a little larger than those observed in the Dry Tortugas but not quite as large as on the WFS, yet they lived nearly as long as those observed on the WFS (Drake 2021). Interestingly, Hogfish in Cuba (Claro et al. 1989) were estimated to grow as large as those observed on the WFS despite individuals living only half as long (i.e., less than 12 years old as reported in McBride and Richardson 2007) and being described as a “relatively unfished population” by Collins and McBride (2011). However, the LHWG considered these growth estimates to have greater uncertainty as they were aged from unsectioned urohyal bones, not sectioned otoliths, and were reportedly found difficult to age for fish larger than 500 mm FL.

On the WFS, the size-truncated von Bertalanffy growth model fit to the inverse-weighted spear gear plus any fishery-independent data whose variance was estimated as the CV changing linearly with age was recommended. Similarly, in the FLK/EFL stock, the size-truncated von Bertalanffy growth model fit to the inverse-weighted Dry Tortugas plus any fishery-independent data whose variance was estimated as a constant CV was recommended. These estimated von

Bertalanffy parameter values should be considered for use in the development of age-length keys (e.g., for an ASAP model) and should be considered as initial values for internal estimation of growth within Stock Synthesis models. The LHWG also recommended the use of the platoons feature within Stock Synthesis to account for 'Lee's phenomenon' in the length-at-age data (Taylor and Methot 2013, Kraak et al. 2020).

2.9.5 Natural Mortality

Direct methods of estimating mortality (e.g., large scale mark-capture or acoustic telemetry tagging) for Hogfish were unavailable or insufficient; however, the empirical methods provided here represent 'good practices' and were based on the most recent research available and recommended for use within stock assessment models. Longevity-based estimators of *M* are considered the most informative (Then et al. 2015, Cope and Hamel 2022), are recommended by the SEDAR Best Practices (SEDAR 2015), and should be accompanied by measures of uncertainty (e.g., see the Natural Mortality Tool developed by Cope and Hamel [2022] and the standard deviations in lognormal space developed by Hamel and Cope [2022]). While the estimates of constant *M* correlated with growth differed in scale from those based on longevity, they are at least as likely to be correct as the longevity-based ones (Kai Lorenzen, *pers. comm.*) and should be explored via model sensitivity analyses.

2.9.6 Reproduction

While the reproductive data utilized here were the same as what was available for the previous update assessment (and is now at least 18 years old), the recently developed best practices permitted a re-analysis of that data. More recent histological data have been collected in the Dry Tortugas (D. Morley, *pers. comm.*) but were unavailable for inclusion here. Therefore, the LHWG found the information on size- and age-at-maturity and spawning seasonality sufficient for use but also stressed the need for more recent reproductive data.

2.10 RESEARCH RECOMMENDATIONS

2.10.1 Stock Definition

The LHWG recommended expanding genetic sampling in the currently defined unit stocks for Hogfish to reinforce or challenge respective boundaries. In the FLK/EFL stock, sampling does

not exist from central (e.g., Cape Canaveral area) and northeastern Florida; investigating this could provide insight into the assumed connection with southeastern Florida as well as any potential source and sink dynamics. Furthermore, no Hogfish have been sampled in GA or SC; any fish here are currently assumed to be defined with the stock sampled off NC, but uncertainty in that boundary exists and whether portions may be further spillover from south Florida. The group also recommends the use of updated genetic methods (e.g., RADseq derived genomic data, SNPS; see Wallace et al. *in prep*. for Spotted Seatrout in Florida) to better inform these biological and managerial boundaries. Lastly, there is no genetic data published from Hogfish in the Caribbean, but preliminary results from mitochondrial DNA samples in Puerto Rico and St. Thomas indicate some degree of genetic connectivity exists with those from the WFS and southeast FL (A. Janosik, *pers. comm*. 5/15/25).

2.10.2 Age and Growth

The LHWG expressed the need to increase the annual fishery-dependent and -independent age sampling of Hogfish. Current sample sizes make detecting and tracking year classes difficult or inadequate in most years without the reliance on data from life history studies. However, the LHWG recognizes the challenge of this as the fisheries tend to be more opportunistic for Hogfish. For the FLK/EFL stock, sampling also needs to expand to include more areas of refuge (e.g., marine no-take reserves; Muñoz et al. 2010) and areas currently unsampled (e.g., northeast FL) to better inform population demographics. Hogfish in both the heavily fished areas of the FLK/EFL and the nearshore areas of the WFS where fishing predominantly occurs exhibit truncated age-at-length data but can grow larger and live longer when able to escape to refuge.

2.10.3 Natural Mortality

The field of natural mortality is not yet in a position to establish ‘best practices’ (Maunder et al. 2023) and suggested ‘good practices’ are often trade-offs between reliability and availability of the data. More direct methods of estimating mortality, such as mark-recapture or acoustic telemetry tagging, are generally recommended over empirical methods but have largely been unavailable for Hogfish until recently. Ellis et al. (2025) conducted a pilot study to estimate discard mortality and successfully tagged 42 Hogfish (including 38 tagged with acoustic tags) from 45 trips on the WFS between May 2019 and February 2025, showing the viability for a

larger scale study. Effort into acoustic telemetry tagging requires a large enough array of detectors to minimize incomplete detections, but the high site fidelity of Hogfish seem to make it a good candidate as movement out of the array area for extended periods (i.e., are the change in numbers due to mortality or migration) may be minimized. Ellis et al. (2025) also reported 3 re-captured individuals, but none were reported by recreational anglers; rather, they were determined via acoustic detection which alleviates human reporting issues common in conventional tagging.

2.10.4 Reproduction

The LHWG commends the amount of histological data that has been available for Hogfish from life history research studies but also notes that all reproductive data used here were at least 18 years old. If the original histology slides are still available, it is recommended to re-analyze them following current best practices (Lowerre-Barbieri et al. 2022, Lowerre-Barbieri and Friess 2023) which would also allow comparison with any reproductive data collected in the future for determining size- and age-at-maturity and spawning seasonality. The LHWG also notes the impact of top-down size selective fishing mortality on harem-disruption, social breakdown, reproduction, and possible sperm limitation for Hogfish and recommends additional *in situ* sampling (e.g., diver surveys; Muñoz et al. 2010) to help evaluate recovery of these from the impacts of fishing.

2.11 LITERATURE CITED

Ault, J. S., S. G. Smith, G. A. Diaz, and E. Franklin. 2003. Florida Hogfish Fishery Stock Assessment. Florida Marine Research Institute Final Report No. FFWCC S 7701 617573.

Acosta, A., Bartels, C., Colvocoresses, J., and Greenwood, M.F.D. 2007. Fish assemblages in seagrass habitats of the Florida Keys, Florida: spatial and temporal characteristics. Bull Mar Sci. 81(1):1-19.

Beamish, R.J., and Fournier, D.A. 1981. A method for comparing the precision of a set of age-determinations. Canadian Journal of Fisheries and Aquatic Sciences 38:982-983.

Beck, M.W., Heck, K.L., Able, K.W., Childers, D.L., Eggleston, D.B., Gillanders, B.M., Halpern, B., Hays, C.G., Hoshino, K., Minello, T.J., Orth, R.J., Sheridan, P.F., and

Weinstein, M.R. 2001. The identification, conservation, and management of estuarine and marine nurseries for fish and invertebrates. Bioscience 51: 633-641.

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

Burton, M.L. 2002. Age, growth and mortality of mutton snapper, Lutjanus analis, from the east coast of Florida, with a brief discussion of management implications. Fishery Research 59:31-41.

Campana, S. 2001. Accuracy, precision and quality control in age determination, including a review of the use and abuse of age validation methods. J Fish Biol 59(2):197-242.

Chang, W.Y.B. 1982. A statistical method for evaluating the reproducibility of age-determination. Canadian Journal of Fisheries and Aquatic Sciences 39:1208-1210.

Chapman, D.G., and Robson, D.S. 1960. The analysis of a catch curve. Biometrics, 16:354-368.

Claro et al., R., Garcia-Cagide, A., and Fernández de Alaiza, R. 1989. Caracteristicas biológicas del pez perro, Lachnolaimus maximus (Walbaum), en el golfo de Batabanó, Cuba. Revista Investigaciones Marinas 10: 239-252.

Colella, M.A., Ruzicka, R.R., Kidney, J.A., Morrison, J.M., and Brinkhuis, V.B. 2012. Cold-water event of January 2010 results in catastrophic benthic mortality on patch reefs in the Florida Keys. Coral Reefs 31:621–632.

Colin, P. L. 1982. Spawning and larval development of the hogfish, Lachnolaimus maximus (Pisces: Labridae). Fishery Bulletin, U. S. 80 (4): 853-862.

Collins A.B., and McBride, R.S. 2008. Final report for integrating life history, mating system, fishing effects, and habitat of hogfish, Lachnolaimus maximus, a harem spawning fish in the southeast U.S. FWRI File Code F2541-05-07-F.

Collins, A.B. and McBride, R.S. 2011. Demographics by depth: Spatially explicit life-history dynamics of a protogynous reef fish. Fishery Bulletin, U. S., 109, 232–242.

Collins, A.B., McBride, R.S. 2015. Variations in reproductive potential between nearshore and offshore spawning contingents of hogfish in the eastern Gulf of Mexico. Fish Manag Ecol 22: 113−124.

Cope, J.M., and Hamel, O.S., 2022. Upgrading from M version 0.2: An application-based method for practical estimation, evaluation and uncertainty characterization of natural mortality. Fish. Res. https://doi.org/10.1016/j.fishres.2022.106493.

Dahlgren, C.P., and Eggleston, D.B. 2000. Ecological processes underlying ontogenetic habitat shifts in a coral reef fish. Ecology 81: 2227-2240.

Davis, J. C. 1976. Biology of the hogfish, Lachnolaimus maximus (Walbaum), in the Florida Keys. M. S. Thesis. University of Miami. Coral Gables, FL. pp: 86.

Diaz, G., Porch, C., and Ortiz, M. 2004. Growth models for red snapper in the US Gulf of Mexico waters estimated from landings with minimum size restrictions. Contribution SFD-2004038. Sustainable Fisheries Division, NOAA Fisheries.13p.

Drake, D. 2021. U.S Caribbean Hogfish (Lachnolaimus maximus) conservation and management: filling critical life history gaps. Master's thesis. University of Charleston, South Carolina at the College of Charleston.

Ellis, R.D., Williams. J.B., Flaherty-Walia, K., and Stevens, P. 2025. Hogfish Discard Mortality and Habitat Ecology on the West Florida Shelf. SEDAR94-DW-12. SEDAR, North Charleston, SC. 19 pp.

Faletti, M.E. and Stallings, C. 2021. Life history through the eyes of a hogfish: trophic growth and differential juvenile habitat use from stable isotope analysis. Mar Ecol-Prog Ser 666:183-202.

Gulland, J.A. 1983. Fish Stock Assessment. A Manual of Basic Method. FAO/Wiley Series on Food and Agriculture, Rome, 241 p.

Haddon, M. 2011. Modelling and Quantitative Methods in Fisheries, second ed. CRC Press, Boca Raton.

Hallac, D., Kline, J., Sadle, J., Bass, S., Ziegler, T., and Snow, S. 2010. Preliminary effects of the January 2010 cold weather on flora and fauna in Everglades National Park. Homestead,

FL: Biological Resources Branch, South Florida Natural Resources Center, Everglades and Dry Tortugas National Parks. 8 pp.

Hamel, O.S., and Cope, J.M. 2022. Development and considerations for application of a longevity-based prior for the natural mortality rate. Fish. Res. 256. 106477

Hampton, J. 2000. Natural mortality rates in tropical tunas: size really does matter. Canadian Journal of Fisheries and Aquatic Sciences, 57(5), 1002-1010.

Hilborn, R., and Walters, C.J. 1992. Quantitative Fisheries Stock Assessment: Choice, Dynamics and Uncertainty. Chapman & Hall, London, UK, p. 570.

Hoenig, J.M. 1983. Empirical use of longevity data to estimate mortality rates. Fishery Bulletin 81:898903.

Hunter, J. R., and Macewicz, B.J. 2003. Improving the accuracy and precision of reproductive information used in fisheries. Pages 57–68 in O. S. Kjesbu, J. R. Hunter, and P. R. Witthames, editors. Report of the working group on modern approaches to assess maturity and fecundity of warm- and cold-water fish and squids. Institute of Marine Research, Bergen, Norway.

Ihssen, P.E., Booke, H.E., Casselman, J.M., McGlade, J.M., Payne, N.R. and Utter, F.M. 1981. Stock identification: materials and methods. Canadian Journal of Fisheries and Aquatic Sciences, 38: 1838–1855.

Kimura, D.K., and Anderl, D.M. 2005. Quality control of age data at the Alaska Fisheries Science Center. Mar Freshw Res 56:783-789.

Kimura, D.K., and Lyons, J.J. 1991. Between-reader bias and variability in the age-determination process. Fishery Bulletin 89:53-60.

Klimek, B. and Switzer, T. 2025a. Hogfish Index of Abundance form the Annual FWRI-SEAMAP Trawl Survey along the West Florida Shelf. SEDAR94-DW-13. SEDAR, North Charleston, SC. 16 pp.

Klimek, B. and Switzer, T. 2025b. Young of Year Hogfish Index of Abundance from Seagrass Trawl Surveys of the Florida Big Bend. SEDAR94-DW-14. SEDAR, North Charleston, SC. 14 pp.

Kraak, S.B.M., Haase, S., Minto, C., and Santos, J. 2019. The Rosa Lee phenomenon and its consequences for fisheries advice on changes in fishing mortality or gear selectivity. – ICES Journal of Marine Science, 76: 2179–2192.

Lee, R.M. 1912. An investigation into the methods of growth determination in fishes. Conseil Permanent International pour l'Exploration de la Mer, Publications de Circonstance, 63. 35 pp.

Lindholm, J., Knight, A., Kaufman, L. and Miller, S. 2006. A pilot study of Hogfish (Lachnolaimus maximus Walbaum 1792) movement in the conch reef research only area (northern Florida Keys National Marine Sanctuary). National Marine Sanctuary Program NMSP06-06. U.S. Department of Commerce, NOAA, NMSP, Silver Spring, MD. 14 pp.

Lorenzen, K. 1996. The relationship between body weight and natural mortality in fish: a comparison of natural ecosystems and aquaculture. J. Fish. Biol. 49, 627–647.

Lorenzen, K. 2000. Allometry of natural mortality as a basis for assessing optimal release size in fish stocking programmes. Can. J. Fish. Aquat. Sci. 57, 2374–2381.

Lorenzen, K. 2005. Population dynamics and potential of fisheries stock enhancement: practical theory for assessment and policy analysis. Philos Trans R Soc B-Biol Sci 360:171-189.

Lorenzen, K. 2022. Size- and age-dependent natural mortality in fish populations: Biology, models, implications, and a generalized length-inverse mortality paradigm. Fish. Res. 255, 106454.

Lorenzen, K. and Camp, E.V. 2019. Density-dependence in the life history of fishes: When is a fish recruited? Fish. Res. 217, 5:10.

Lorenzen, K., Camp, E.V., and Garlock, T.M. 2022. Natural mortality and body size in fish populations. Fish. Res. 252, 106327.

Lowerre-Barbieri, S., Friess, C., Brown-Peterson, N., Moncrief-Cox, H., and Barnett, B. 2022. Best practices for standardized reproductive data and methodology to estimate reproductive parameters for Red Snapper in the Gulf of Mexico. SEDAR74-DW-36. SEDAR, North Charleston, SC. 43 pp.

Lowerre-Barbieri, S., and Friess, C. 2023. Mutton Snapper Reproduction. SEDAR79- DW-12. SEDAR, North Charleston, SC. 21 pp.

Maceina, M.J., and Bettoli, P.W. 1998. Variation in Largemouth Bass recruitment in four mainstream impoundments on the Tennessee River. North American Journal of Fisheries Management, 18:998-1003.

Maunder, M.N., Hamel, O.S., Lee, H., Piner, K.R., Cope, J.M., Punt, A.E., Ianelli, J.N., Castillo-Jordan, C., Kapur, M.S., and Methot, R.D. 2023. A review of estimation methods for natural mortality and their performance in the context of fishery stock assessment. Fish. Res. 257, 106489.

McBride, R.S. and Murphy, M.D. 2003. Current and potential yield per recruit of hogfish, Lachnolaimus maximus, in Florida. Proc. Gulf Carib. Fish. Inst. 54th Ann. Meeting, Providenciales, Turks and Caicos Islands: 513-525.

McBride, R.S. and Johnson, M. R. 2007. Sexual development and reproductive seasonality of hogfish (Labridae: Lachnolaimus maximus), an hermaphroditic reef fish. Journal of Fish Biology 71:1270-1292.

McBride, R.S. and Richardson, A.K. 2007. Evidence of size-selective fishing mortality from an age and growth study of hogfish (Labridae: Lachnolaimus maximus), a hermaphroditic reef fish. Bulletin of Marine Science 80: 401-417.

McBride, R. S., Thurman, P.E., and Bullock, L.H. 2008. Regional variations of hogfish (Lachnolaimus maximus) life history: Consequences for spawning biomass and egg production models. J. Northw. Atl. Fish. Sci. 41:1–12.

McGirl, M., Carroll, J., and Cermak, B. 2025. Length and age composition of Florida Hogfish, Lachnolaimus maximus, collected in association with fishery-dependent projects. SEDAR94-DW-11. SEDAR, North Charleston, SC. 15 pp.

Muñoz, R. C., M. L. Burton, K. J. Brennan, and R. O. Parker. 2010. Reproduction, habitat utilization, and movements of hogfish (Lachnolaimus maximus) in the Florida Keys, U.S.A.: comparisons from fished versus unfished habitats. Bull. Mar. Sci. 86:93–116.

Nelson, J.S. 2006. Fishes of the World. 4th Edition. Wiley, New Jersey.

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

R Core Team. 2025. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

Randall, J. A., and Warmke, G. L. 1967. The food habits of the hogfish (Lachnolaimus maximus), a labrid fish from the western Atlantic. Caribbean Journal of Science. 7: 141-144.

Robson, D.S., and Chapman, D.G. 1961. Catch curves and mortality rates. Transactions of the American Fisheries Society, 90:181-189.

SEDAR. 2014. SEDAR 37 The 2013 stock assessment report for Hogfish in the South Atlantic and Gulf of Mexico. SEDAR, North Charleston, SC. 573 pp.

SEDAR. 2015. SEDAR Procedural Workshop 7: Data Best Practices. SEDAR, North Charleston SC. 151 pp. available online at: http://sedarweb.org/pw-07

SEDAR. 2017. SEDAR 37 Update Stock Assessment of Hogfish in the West Florida Shelf. SEDAR, North Charleston, SC. 211 pp.

Seyoum, S., Collins, A.B., Puchulutegui, C., McBride, R.S., and Tringali, M.D. 2015. Genetically determined population structure of hogfish (Labridae: Lachnolaimus maximus) in the Southeastern United States. Fish Bull 113: 442−455.

Taylor, I.G., and Methot, R.D. Jr. 2013. Hiding or dead? A computationally efficient model of selective fisheries mortality. Fisheries Research, 142: 75–85.

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

Towne, I.A., Arena, P.T., Collins, A.B. and Kerstetter, D.W. 2007. Evidence of size-selective fishing mortality from an age and growth study of hogfish (Labridae: Lachnolaimus maximus), a hermaphroditic reef fish. Bulletin of Marine Science 80: 401-417

VanderKooy, S., Carroll, J., Elzey, S., Gilmore, J., and Kipp, J. 2020. A practical handbook for determining the ages of Gulf of Mexico and Atlantic Coast fishes, Gulf States Mar. Fish Comm Publ: 300.

Vetter, E.F. 1988. Estimation of natural mortality in fish stocks: a review. Fish. Bull. US 86, 25–43.

Wallace, E.M., Tringali, M.D., Austin J., and Vandine B. In prep. RADseq Genomic Analyses Support Weak Population Structure and Evidence of Adaptation in Spotted Seatrout (Cynoscion nebulosus) in Florida Waters.

Wilson, K., and Hardy, I.C., 2002. Statistical analysis of sex ratios: an introduction. *Sex ratios: concepts and research methods*, *1*, pp.48-92.

2.12 TABLES

Table 2.12.1. Length-length and length-weight relationships developed for Florida Hogfish. Linear length-length regressions are in the form of Y = $a + bX$ and non-linear length-weight regressions are in the form of $W = aL^b$. SL: standard length; FL: fork length; TL: total length; TW: total weight.

LENGTH- LENGTH

Y (mm)	a	b	X (mm)	n	Min X (mm)	Max X (mm)	Avg. X (mm)	MSE	Adj. r2
FL	10.11092	1.1825	SL	3,075	10	699	242.7	54.299	0.997
FL	12.18937	0.859848	$TL_{relaxed*}$	2,760	13	905	376.4	108.543	0.993
FL	17.00318	0.84076	TL_{max**}	1,909	85	890	339.0	70.470	0.991

LENGTH-WEIGHT (LINEAR)

Y (g)	a	b	X (mm)	n	Min X (mm)	Max X (mm)	Avg. X (mm)	MSE	Adj. r2
TW	-10.1134	2.876939	FL	9,452	28	852	357.0	0.014934	0.984
TW	-9.47971	2.875364	SL	2,035	22	699	265.5	0.019357	0.991
TW	-9.58398	2.735466	$TL_{relaxed*}$	2,979	28	905	379.1	0.022183	0.986
TW	-8.9141	2.619461	TL_{max**}	598	85	682	418.6	0.014909	0.962

LENGTH-WEIGHT (NON-LINEAR)

Y (g)	a	b	X (mm)	n	Min X (cm)	Max X (cm)	Avg. X (cm)	MSE	Adj. r2
TW	3.02E-05	2.927288	FL	9,452	28	852	357.0	32368.6	
TW	0.000191	2.718097	SL	2,035	22	699	265.5	29889	
TW	3.37E-05	2.854181	$TL_{relaxed*}$	2,979	28	905	379.1	46850.04	
TW	4.57E-05	2.797047	TL_{max**}	598	85	682	418.6	21410.08	

$TL_{relaxed*}$ - Tail flat, in its natural state

TL_{max**} - Tail compressed to its maximum length

Table 2.12.2. Number of Hogfish age samples collected by region within Florida waters from 1996 – 2024. Regions are defined as Northeast Florida (NE FL), Southeast Florida (SE FL), the Florida Keys (FL Keys), Southwest Florida (SW FL), and Northwest Florida (NW FL). The UNK_FL samples were collected by Falletti and Stallings (2021) on the WFS, but contained insufficient information to further allocate either NW FL or SW FL.

Year	NW FL	SW FL	FL KEYS	SE FL	NE FL	UNK_FL	Total
1996	0	108	47	0	0	0	155
1997	3	207	189	0	0	0	399
1998	57	69	222	0	0	0	348
1999	98	37	380	0	0	0	515
2000	0	0	6	0	0	0	6
2001	0	22	22	0	0	0	44
2002	0	1	1	0	0	0	2
2003	0	11	1	1	0	0	13
2004	0	0	0	3	0	0	3
2005	2	70	0	5	0	0	77
2006	0	375	0	1	0	0	376
2007	0	201	0	0	0	0	201
2008	10	14	0	0	0	0	24
2009	33	111	11	0	0	0	155
2010	1	91	18	1	0	0	111
2011	0	62	39	2	0	0	103
2012	27	150	30	1	0	0	208
2013	13	71	29	1	0	0	114
2014	10	72	23	15	0	0	120
2015	13	90	35	16	0	0	154
2016	2	100	52	149	0	6	309
2017	20	108	23	87	0	0	238
2018	8	52	5	1	0	2	68
2019	0	93	8	0	0	0	101
2020	0	118	8	0	0	0	126
2021	1	112	0	5	0	0	118
2022	13	127	60	13	0	0	213
2023	0	80	54	8	0	0	142
2024	1	108	2	1	0	0	112
Total	312	2,660	1,265	310	0	8	4,555

Table 2.12.3. Number of ages of Hogfish sampled by year from the FLK/EFL stock from 1996 – 2024.

	Age (years)																								
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	TOTAL
1996	4	0	9	8	7	5	6	3	2	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	47
1997	58	18	14	22	10	17	14	16	10	3	1	2	3	1	0	0	0	0	0	0	0	0	0	0	189
1998	6	57	24	24	34	12	22	17	11	7	4	3	0	1	0	0	0	0	0	0	0	0	0	0	222
1999	40	17	136	47	41	53	15	8	11	6	5	1	0	0	0	0	0	0	0	0	0	0	0	0	380
2000	0	1	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
2001	0	1	10	2	8	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22
2002	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
2003	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
2004	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
2005	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	5
2006	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
2009	0	0	2	0	0	4	1	1	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11
2010	0	0	3	5	3	1	3	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	19
2011	0	0	10	6	11	7	1	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	41
2012	0	2	4	6	6	4	5	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31
2013	0	5	7	2	5	2	3	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30
2014	0	10	7	2	1	1	5	6	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	38
2015	0	0	3	19	3	2	10	10	3	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	51
2016	0	9	22	53	68	15	5	13	6	6	3	1	1	0	0	0	0	0	0	0	0	0	0	0	202
2017	0	4	28	22	18	16	8	8	3	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	110
2018	0	0	1	3	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
2019	0	1	1	4	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
2020	0	5	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
2021	0	0	0	0	1	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
2022	0	5	13	11	6	10	14	6	1	4	1	1	1	0	0	0	0	0	0	0	0	0	0	0	73
2023	1	13	8	4	4	10	5	11	2	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	62
2024	0	0	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	3
Total Number	109	148	310	245	231	162	123	111	61	33	23	10	7	2	0	0	1	0	0	0	0	0	0	0	1576
Percent	6.916	9.391	19.670	15.546	14.657	10.279	7.805	7.043	3.871	2.094	1.459	0.635	0.444	0.127	0.000	0.000	0.063	0.000	0.000	0.000	0.000	0.000	0.000	0.000	

Table 2.12.4. Number of Hogfish age samples by commercial (COM), recreational (REC), and fishery independent (FI) sectors collected from the FLK/EFL stock from 1996 – 2024. The UNK FD samples were collected by McBride and Richardson (2007) whose samples were from a fishery dependent source, but with insufficient information for allocation to either COM or REC sectors.

Year	COM	REC	FI	UNK FD	Total
1996	2	34	4	7	47
1997	11	52	58	68	189
1998	50	151	6	15	222
1999	323	4	50	3	380
2000	0	0	0	6	6
2001	0	2	0	20	22
2002	0	1	0	0	1
2003	0	2	0	0	2
2004	0	3	0	0	3
2005	0	5	0	0	5
2006	0	1	0	0	1
2007	0	0	0	0	0
2008	0	0	0	0	0
2009	0	11	0	0	11
2010	14	4	1	0	19
2011	34	2	5	0	41
2012	14	15	2	0	31
2013	6	6	18	0	30
2014	6	11	21	0	38
2015	15	30	6	0	51
2016	14	55	133	0	202
2017	0	31	79	0	110
2018	0	6	0	0	6
2019	0	1	7	0	8
2020	0	2	6	0	8
2021	0	5	0	0	5
2022	1	13	59	0	73
2023	0	12	50	0	62
2024	0	3	0	0	3
Total	490	462	505	119	1,576

Table 2.12.5. Number of Hogfish age samples by Commercial (COM), Headboat (HB), Private (PRV), Charter (CH), fishery independent scientific surveys (SS), tournament (TOUR), and unknown (UNK) fishing modes collected from the FLK/EFL stock from 1996 – 2024. The UNK FD samples were collected by McBride and Richardson (2007) whose samples were from a fishery dependent source, but with insufficient information for allocation to either COM or PRV modes.

Year	COM	HB	PRV	CH	SS	TOUR	UNK	UNK_FD	Total
1996	2	0	34	0	4	0	0	7	47
1997	11	0	52	0	58	0	0	68	189
1998	50	0	151	0	6	0	0	15	222
1999	323	0	4	0	50	0	0	3	380
2000	0	0	0	0	0	0	0	6	6
2001	0	0	2	0	0	0	0	20	22
2002	0	0	1	0	0	0	0	0	1
2003	0	0	0	2	0	0	0	0	2
2004	0	0	3	0	0	0	0	0	3
2005	0	3	2	0	0	0	0	0	5
2006	0	1	0	0	0	0	0	0	1
2007	0	0	0	0	0	0	0	0	0
2008	0	0	0	0	0	0	0	0	0
2009	0	2	0	9	0	0	0	0	11
2010	14	1	2	1	1	0	0	0	19
2011	34	0	2	0	5	0	0	0	41
2012	14	15	0	0	2	0	0	0	31
2013	6	6	0	0	18	0	0	0	30
2014	6	11	0	0	21	0	0	0	38
2015	15	29	1	0	6	0	0	0	51
2016	14	15	37	3	133	0	0	0	202
2017	0	6	23	2	79	0	0	0	110
2018	0	0	6	0	0	0	0	0	6
2019	0	1	0	0	7	0	0	0	8
2020	0	0	2	0	6	0	0	0	8
2021	0	0	5	0	0	0	0	0	5
2022	1	1	11	1	59	0	0	0	73
2023	0	3	9	0	50	0	0	0	62
2024	0	2	1	0	0	0	0	0	3
Total	490	96	348	18	505	0	0	119	1,576

Table 2.12.6. Number of Hogfish age samples by spear, hook and line (H&L), trawl, trap, other, and unknown fishing gears collected from the FLK/EFL stock from 1996 – 2024.

Year	Spear	H&L	Trawl	Trap	Other	Unknown	Total
1996	39	0	4	2	0	2	47
1997	107	0	33	0	0	49	189
1998	214	0	5	0	0	3	222
1999	328	0	39	0	0	13	380
2000	6	0	0	0	0	0	6
2001	22	0	0	0	0	0	22
2002	0	1	0	0	0	0	1
2003	1	1	0	0	0	0	2
2004	1	2	0	0	0	0	3
2005	2	3	0	0	0	0	5
2006	0	1	0	0	0	0	1
2009	0	11	0	0	0	0	11
2010	3	7	0	9	0	0	19
2011	29	5	5	2	0	0	41
2012	8	16	2	5	0	0	31
2013	0	7	18	5	0	0	30
2014	13	11	14	0	0	0	38
2015	15	30	6	0	0	0	51
2016	177	15	0	0	0	10	202
2017	98	9	3	0	0	0	110
2018	6	0	0	0	0	0	6
2019	0	1	7	0	0	0	8
2020	0	2	6	0	0	0	8
2021	3	0	0	0	0	2	5
2022	70	1	0	0	0	2	73
2023	46	4	12	0	0	0	62
2024	1	2	0	0	0	0	3
Total	1,189	129	154	23	0	81	1,576

Table 2.12.7. Number of ages of Hogfish sampled by year from the WFS stock from 1996 – 2024.

	Age (years)																								
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total
1996	0	8	8	5	11	7	9	19	9	4	7	5	4	3	3	1	0	0	0	0	2	1	0	2	108
1997	14	50	18	24	10	25	5	15	14	4	2	10	8	3	3	2	1	0	1	0	0	0	1	0	210
1998	0	13	41	15	19	3	16	2	5	1	1	0	3	2	2	2	0	1	0	0	0	0	0	0	126
1999	0	0	22	69	16	12	2	11	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	135
2001	0	21	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22
2002	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
2003	0	0	0	5	5	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11
2005	3	1	0	7	5	10	27	0	9	4	0	0	0	0	2	1	2	1	0	0	0	0	0	0	72
2006	19	52	37	16	40	17	35	106	10	20	8	1	2	4	1	0	3	2	1	1	0	0	0	0	375
2007	1	34	61	6	7	8	17	5	36	2	7	9	0	2	0	0	1	0	3	2	0	0	0	0	201
2008	0	4	19	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24
2009	2	46	37	52	5	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	144
2010	0	19	41	15	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	92
2011	1	13	1	25	11	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	62
2012	3	85	15	12	27	16	18	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	177
2013	1	27	26	1	1	8	4	13	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	84
2014	1	14	11	27	6	5	4	4	3	2	1	2	0	0	0	2	0	0	0	0	0	0	0	0	82
2015	5	18	12	27	27	3	3	6	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	103
2016	0	5	7	15	26	33	3	0	2	7	4	1	1	1	0	1	0	0	0	1	0	0	0	0	107
2017	10	20	33	14	13	13	17	2	1	1	2	1	0	1	0	0	0	0	0	0	0	0	0	0	128
2018	3	12	6	8	9	6	8	7	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	62
2019	13	13	7	9	10	18	6	12	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	93
2020	0	15	5	4	19	30	31	5	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	118
2021	5	13	8	15	23	16	21	10	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	113
2022	9	15	2	8	48	23	15	13	6	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	140
2023	1	8	26	12	10	15	5	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	80
2024	1	1	3	18	14	31	27	7	4	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	109
Total Number	92	507	446	411	379	312	275	239	117	50	35	32	18	16	12	10	9	4	5	4	2	1	1	2	2979
Percent	3.088	17.019	14.971	13.797	12.722	10.473	9.231	8.023	3.927	1.678	1.175	1.074	0.604	0.537	0.403	0.336	0.302	0.134	0.168	0.134	0.067	0.034	0.034	0.067	

Table 2.12.8. Number of Hogfish age samples by commercial (COM), recreational (REC), and fishery independent (FI) sectors collected from the WFS stock from 1996 – 2024. The UNK FD samples were collected by McBride and Richardson (2007) whose samples were from a fishery dependent source, but with insufficient information for allocation to either COM or REC sectors.

Year	COM	REC	FI	UNK FD	Total
1996	0	0	0	108	108
1997	0	0	64	146	210
1998	57	1	7	61	126
1999	96	0	20	19	135
2000	0	0	0	0	0
2001	0	0	22	0	22
2002	0	1	0	0	1
2003	0	11	0	0	11
2004	0	0	0	0	0
2005	31	36	3	2	72
2006	80	240	52	3	375
2007	57	82	62	0	201
2008	0	1	23	0	24
2009	0	3	141	0	144
2010	1	1	90	0	92
2011	0	0	62	0	62
2012	9	10	158	0	177
2013	24	4	56	0	84
2014	12	12	58	0	82
2015	1	26	76	0	103
2016	0	85	22	0	107
2017	7	67	54	0	128
2018	0	29	33	0	62
2019	0	50	43	0	93
2020	34	64	20	0	118
2021	10	74	29	0	113
2022	0	112	28	0	140
2023	0	40	40	0	80
2024	0	89	20	0	109
Total	419	1,038	1,183	339	2,979

Table 2.12.9. Number of Hogfish age samples by Commercial (COM), Headboat (HB), Private (PRV), Charter (CH), fishery independent scientific surveys (SS), tournament (TOUR), and unknown (UNK) fishing modes collected from the FLK/EFL stock from 1996 – 2024. The UNK FD samples were collected by McBride and Richardson (2007) whose samples were from a fishery dependent source, but with insufficient information for allocation to either COM or PRV modes.

Year	COM	HB	PRV	CH	SS	TOUR	UNK	UNK_FD	Total
1996	0	0	0	0	0	0	0	108	108
1997	0	0	0	0	64	0	0	146	210
1998	57	0	1	0	7	0	0	61	126
1999	96	0	0	0	20	0	0	19	135
2000	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	22	0	0	0	22
2002	0	0	0	1	0	0	0	0	1
2003	0	0	11	0	0	0	0	0	11
2004	0	0	0	0	0	0	0	0	0
2005	31	0	4	0	3	32	2	0	72
2006	80	0	175	0	52	68	0	0	375
2007	57	0	53	0	62	29	0	0	201
2008	0	0	1	0	23	0	0	0	24
2009	0	0	3	0	141	0	0	0	144
2010	1	0	1	0	90	0	0	0	92
2011	0	0	0	0	62	0	0	0	62
2012	9	0	10	0	158	0	0	0	177
2013	24	1	0	3	56	0	0	0	84
2014	12	0	1	11	58	0	0	0	82
2015	1	3	0	23	76	0	0	0	103
2016	0	4	81	0	22	0	0	0	107
2017	7	0	65	2	54	0	0	0	128
2018	0	13	12	4	33	0	0	0	62
2019	0	36	1	13	43	0	0	0	93
2020	34	3	14	47	20	0	0	0	118
2021	10	41	16	17	29	0	0	0	113
2022	0	70	12	30	28	0	0	0	140
2023	0	17	16	7	40	0	0	0	80
2024	0	46	23	20	20	0	0	0	109
Total	419	234	500	178	1,183	129	2	334	2,979

Table 2.12.10. Number of Hogfish age samples by spear, hook and line (H&L), trawl, trap, other, and unknown fishing gears collected from the WFS stock from 1996 – 2024.

Year	Spear	H&L	Trawl	Trap	Other	Unknown	Total
1996	108	0	0	0	0	0	108
1997	146	0	64	0	0	0	210
1998	61	1	7	57	0	0	126
1999	19	0	20	96	0	0	135
2001	0	0	22	0	0	0	22
2002	0	1	0	0	0	0	1
2003	10	1	0	0	0	0	11
2005	67	0	3	0	0	2	72
2006	323	0	52	0	0	0	375
2007	139	0	62	0	0	0	201
2008	0	1	23	0	0	0	24
2009	0	3	140	0	1	0	144
2010	1	1	90	0	0	0	92
2011	0	0	61	0	1	0	62
2012	16	0	155	1	5	0	177
2013	24	4	56	0	0	0	84
2014	7	14	58	0	3	0	82
2015	1	26	76	0	0	0	103
2016	79	13	15	0	0	0	107
2017	76	2	49	1	0	0	128
2018	12	17	32	0	1	0	62
2019	1	49	43	0	0	0	93
2020	41	55	20	0	0	2	118
2021	11	73	29	0	0	0	113
2022	2	108	28	0	0	2	140
2023	4	36	40	0	0	0	80
2024	3	84	20	0	0	2	109
Total	1,151	489	1,165	155	11	8	2,979

Table 2.12.11. Parameter estimates from the size-truncated von Bertalanffy growth models used to predict length (fork length mm)-at-age (fractional, yr) for Hogfish in the FLK/EFL stock. Variance parameter(s) were modeled with constant coefficient of variation (CV) with age, CV changing linearly with age, and CV changing linearly with size at age. Growth models were applied to both unweighted (--) data and data weighted by using the inverse ($1/n$) of the count of each calendar age.

Data	Variance Parameter	Parameters	Weighting	N	NegLL	AIC	L_∞	K	t_0	Varpar[1]	Varpar[2]
Whole											
	Constant CV	4	--	1,574	8,590	17,187	421.1	0.3428	-0.452	0.1906	--
	CV as linear function of age	5	--	1,574	8,583	17,176	413.7	0.3601	-0.426	0.1704	0.2450
	CV as linear function of size at age	5	--	1,574	8,589	17,188	420.4	0.3436	-0.456	0.1797	0.1956
Truncated											
	Constant CV	4	--	1,053	5,532	11,073	427.1	0.3302	-0.389	0.1988	--
	CV as linear function of age	5	--	1,053	5,525	11,059	408.3	0.3718	-0.331	0.1699	0.2833
	CV as linear function of size at age	5	--	1,053	5,530	11,071	422.3	0.3368	-0.390	0.1759	0.2113
	Constant CV	4	Inverse	1,053	82.876	173.752	515.0	0.1943	-0.856	0.2088	--
	CV as linear function of age	5	Inverse	1,053	82.843	175.686	553.4	0.1579	-1.085	0.2442	0.1754
	CV as linear function of size at age	5	Inverse	1,053	82.867	175.733	526.8	0.1814	-0.930	0.2294	0.1983

Table 2.12.12. Parameter estimates from additional size-truncated von Bertalanffy growth models used to predict length (fork length mm)-at-age (fractional, yr) for Hogfish in the FLK/EFL stock. Data used are from the Dry Tortugas plus any from fishery-independent sources (DRTO+FI). The variance parameter was modeled with constant coefficient of variation (CV) with age. Growth models were applied to both unweighted (--) data and data weighted by using the inverse ($1/n$) of the count of each calendar age.

Data	Variance Parameter	Parameters	Weighting	N	NegLL	AIC	L_∞	K	t_0	Varpar[1]	Varpar[2]
Whole											
DRTO + FI	Constant CV	4	--	597	3,184	6,375.99	500.7	0.265	-0.433	0.1781	
Truncated											
DRTO + FI	Constant CV	4	--	593	3,149	6,305.20	498.2	0.262	-0.448	0.1819	
	Constant CV	4	Inverse	593	78.158	164.317	530.8	0.223	-0.571	0.1849	

Table 2.12.13. Parameter estimates from the size-truncated von Bertalanffy growth models used to predict length (fork length mm)-at-age (fractional, yr) for Hogfish in the WFS stock. Variance parameter(s) were modeled with constant coefficient of variation (CV) with age, CV changing linearly with age, and CV changing linearly with size at age. Growth models were applied to both unweighted (--) data and data weighted by using the inverse ($1/n$) of the count of each calendar age.

Data	Variance Parameter	Parameters	Weighting	N	NegLL	AIC	L_∞	K	t_0	Varpar[1]	Varpar[2]
Whole											
	Constant CV	4	--	2,973	16,262	32,533	932.4	0.0764	-1.774	0.1751	--
	CV as linear function of age	5	--	2,973	16,250	32,510	973.9	0.0720	-1.793	0.1924	0.1041
	CV as linear function of size at age	5	--	2,973	16,252	32,514	990.5	0.0701	-1.821	0.1962	0.1304
Truncated											
	Constant CV	4	--	2,799	14,851	29,710	1200.1	0.0511	-2.056	0.1789	--
	CV as linear function of age	5	--	2,799	14,849	29,708	1208.1	0.0509	-2.029	0.1868	0.1504
	CV as linear function of size at age	5	--	2,799	14,850	29,711	1219.8	0.0501	-2.050	0.1849	0.1643
	Constant CV	4	Inverse	2,799	136.396	280.792	796.6	0.1108	-1.129	0.1435	--
	CV as linear function of age	5	Inverse	2,799	135.116	280.232	768.3	0.1235	-0.925	0.1953	0.0894
	CV as linear function of size at age	5	Inverse	2,799	135.043	280.087	776.8	0.1233	-0.849	0.2492	0.0985

Table 2.12.14. Parameter estimates from the size-truncated von Bertalanffy growth models used to predict length (fork length mm)-at-age (fractional, yr) for Hogfish in the WFS stock. Data used were from fish collected using spear gear plus any fishery-independent sources (FI+SP). Variance parameters were modeled with the coefficient of variation (CV) changing linearly with age. Growth models were applied to both unweighted (--) data and data weighted by using the inverse ($1/n$) of the count of each calendar age.

Data	Variance Parameter	Parameters	Weighting	N	NegLL	AIC	L_∞	K	t_0	Varpar[1]	Varpar[2]
Whole											
FI + SP	CV as linear function of age	5	--	2,317	12,633.40	25,277	964.7	0.079	-1.511	0.2035	0.0895
Truncated											
FI + SP	CV as linear function of age	5	--	2,226	11,898.6	23,807	1,082.4	0.065	-1.600	0.1954	0.1151
	CV as linear function of age	5	Inverse	2,226	134.729	279.458	763.1	0.132	-0.811	0.1998	0.0905
	CV as linear function of age	5	Inverse (20+)	2,226	116.204	242.407	822.9	0.112	-0.954	0.2032	0.0692

Table 2.12.15. Constant and size- or age-dependent natural mortality models (assuming von Bertalanffy growth where relevant). L_∞ is the von Bertalanffy asymptotic length; K is the von Bertalanffy growth coefficient; $M(w)$ is the natural mortality rate at weight W; $M(a)$ and $M(L)$ is the natural mortality rate-at-age and -length, respectively; t_{max} is the observed maximum age; c is the allometric scaling with body length (c = -1).

Approach	Equation	Reference	Notes
Constant			
Longevity	$M = 5.4/t_{max}$	Hamel and Cope (2022)	Standard deviation in log space = 0.31
Empirical K	$M = 1.55\ K$	Hamel and Cope (2022)	Standard deviation in log space = 0.85
$Pauly_{nls-T}$ revised	$M = 4.118\ K^{0.73}\ L_\infty^{-0.33}$	Then et al. (2015)	L_∞ in units of cm
Allometric			
Weight	$M(w) = 3\ W^{-0.288}$	Lorenzen (1996)	Uses the non-linear model converting fork length (mm) to weight (g). p = 0.015
Length-inverse	$M(L) = M_{Lr}(L/L_r)^c$	Lorenzen (2022)	A constant M estimate used as M_{Lr}; length associated with age-3 as reference length (L_r)

Table 2.12.16. Natural mortality-at-age, *M(a)*, or -weight, *M(w)*, of Hogfish on the WFS with an observed maximum age of 23 years. 'Longevity', 'Empirical *K'*, and the 'Pauly$_{nls-T}$ revised' estimates of *M(a)* are derived following Lorenzen (2022) using their respective constant *M* estimates (0.235, 0.174, 0.194) as the reference *M* scaled to age 3 and the von Bertalanffy growth model parameters (L_∞ = 823; k = 0.112; t_0 = -0.954). Estimates of *M(w)* model followed Lorenzen (1996) and used length-weight parameters a = 3.018E-5 and b = 2.927.

Age (yr)	Length (mm)	Weight (g)	Weight M(w)	Longevity M(a)	Empirical *K* M(a)	Pauly$_{nls-T}$ rev M(a)
0.5	124	40.2	0.514	0.559	0.413	0.463
1	162	88.3	0.410	0.427	0.316	0.354
2	232	253.1	0.302	0.298	0.221	0.247
3	294	509.7	0.247	0.235	0.174	0.194
4	350	848.5	0.213	0.197	0.146	0.163
5	401	1,254.3	0.191	0.173	0.128	0.143
6	445	1,710.4	0.174	0.155	0.115	0.129
7	485	2,200.5	0.162	0.142	0.105	0.118
8	521	2,709.8	0.153	0.133	0.098	0.110
9	553	3,226.1	0.145	0.125	0.092	0.103
10	582	3,739.2	0.139	0.119	0.088	0.098
11	607	4,241.0	0.134	0.114	0.084	0.094
12	630	4,725.5	0.130	0.110	0.081	0.091
13	651	5,188.3	0.127	0.106	0.079	0.088
14	669	5,626.5	0.124	0.103	0.076	0.086
15	685	6,038.4	0.121	0.101	0.075	0.084
16	700	6,422.9	0.119	0.099	0.073	0.082
17	713	6,780.1	0.117	0.097	0.072	0.080
18	724	7,110.3	0.116	0.095	0.071	0.079
19	735	7,414.4	0.114	0.094	0.070	0.078
20	744	7,693.3	0.113	0.093	0.069	0.077
21	753	7,948.5	0.112	0.092	0.068	0.076
22	760	8,181.3	0.111	0.091	0.067	0.075
23	767	8,393.2	0.110	0.090	0.067	0.075

Table 2.12.17. Natural mortality-at-age, *M(a)*, or -weight, *M(w)*, of Hogfish in the FLK/EFL when maximum age was either 16 or 23 years. 'Longevity', 'Empirical *K'*, and the 'Pauly$_{nls-T}$ revised' estimates of *M(a)* are derived following Lorenzen (2022) using their respective constant *M* estimates (0.338 [16], 0.235[23], 0.346, 0.371) as the reference *M* scaled to age 3 and the von Bertalanffy growth model parameters (L_∞ = 531; k = 0.223; t_0 = -0.571). Estimates of *M(w)* model followed Lorenzen (1996) and used length-weight parameters a = 3.018E-5 and b = 2.927.

			Weight	Longevity (16)	Longevity (23)	Empirical *K*	Pauly$_{nls-T}$ rev
Age (yr)	Length (mm)	Weight (g)	M(w)	M(a)	M(a)	M(a)	M(a)
0.5	113	30.7	0.621	0.872	0.561	0.893	0.959
1	157	80.8	0.470	0.627	0.436	0.642	0.690
2	232	252.7	0.338	0.425	0.295	0.435	0.467
3	292	495.0	0.279	0.338	0.235	0.346	0.371
4	339	772.4	0.245	0.290	0.202	0.297	0.319
5	378	1,056.3	0.224	0.261	0.181	0.267	0.287
6	408	1,327.2	0.210	0.241	0.168	0.247	0.265
7	433	1,574.3	0.200	0.227	0.158	0.233	0.250
8	452	1,792.4	0.192	0.217	0.151	0.223	0.239
9	468	1,980.5	0.187	0.210	0.146	0.215	0.231
10	481	2,140.1	0.183	0.205	0.142	0.210	0.225
11	491	2,273.7	0.180	0.200	0.139	0.205	0.221
12	499	2,384.5	0.177	0.197	0.137	0.202	0.217
13	505	2,475.6	0.175	0.195	0.135	0.199	0.214
14	510	2,550.2	0.174	0.193	0.134	0.197	0.212
15	515	2,610.9	0.173	0.191	0.133	0.196	0.210
16	518	2,660.1	0.172	0.190	0.132	0.195	0.209

Table 2.12.18. Observed and predicted female maturity-at-age for Hogfish in the FLK/EFL described using a logistic model. Immature females (class 1) were assigned a binomial maturity value of 0 while mature active spawning females (class 3) were assigned a binomial maturity value of 1. Total N_{mat} = 231 and the estimated age at 50% maturity was 2.08 years.

Age	N_{mat}	Observed Prop Mature	Predicted Prop Mature
0	25	0.0400	0.0104
1	62	0.0484	0.2376
2	66	0.7727	0.5895
3	23	0.9130	0.9635
4	25	1.0000	0.9977
5	15	1.0000	0.9999
6	10	1.0000	1.0000
7-9	5	1.0000	1.0000

Table 2.12.19. Observed and predicted female maturity-at-length for Hogfish in the FLK/EFL described using a logistic model. Immature females (class 1) were assigned a binomial maturity value of 0 while mature active spawning females (class 3) were assigned a binomial maturity value of 1. Total N_{mat} = 285 and the estimated length at 50% maturity was 232 mm fork length.

Length bin (5cm)	N_{mat}	Observed Prop Mature	Predicted Prop Mature
5	5	0.0000	0.0370
10	29	0.0345	0.0901
15	30	0.1333	0.2493
20	90	0.5667	0.4699
25	87	0.6667	0.6889
30	20	0.8500	0.8579
35	13	0.8462	0.9553
40	5	1.0000	0.9885
45	6	1.0000	0.9951

Table 2.12.20. Observed and predicted female maturity-at-age for Hogfish on the WFS described using a logistic model. Immature females (class 1) were assigned a binomial maturity value of 0 while mature active spawning females (class 3) were assigned a binomial maturity value of 1. Total N_{mat} = 385 and the estimated age at 50% maturity was 1.09 years.

Age	N_{mat}	Observed Prop Mature	Predicted Prop Mature
0	31	0.0000	0.1184
1	97	0.7938	0.7573
2	65	1.0000	0.9980
3	48	1.0000	1.0000
4	33	1.0000	1.0000
5	17	1.0000	1.0000
6	22	1.0000	1.0000
7	41	1.0000	1.0000
8-10	31	1.0000	1.0000

Table 2.12.21. Observed and predicted female maturity-at-length for Hogfish on the WFS described using a logistic model. Immature females (class 1) were assigned a binomial maturity value of 0 while mature active spawning females (class 3) were assigned a binomial maturity value of 1. Total N_{mat} = 533 and the estimated length at 50% maturity was 169 mm fork length.

Length bin (5cm)	N_{mat}	Observed Prop Mature	Predicted Prop Mature
10	27	0.0370	0.1618
15	127	0.5984	0.5667
20	101	0.9604	0.9326
25	95	0.9579	0.9947
30	44	1.0000	0.9995
35	21	1.0000	1.0000
40	30	1.0000	1.0000
45	45	1.0000	1.0000
50	25	1.0000	1.0000
55	15	1.0000	1.0000
60	2	1.0000	1.0000
65	1	1.0000	1.0000

Table 2.12.22. Parameter estimates for Hogfish age- and length-at-maturity by stock based on logistic regression models. Note: logistic regression model intercept and slope parameters are on the logit scale where slope is also the slope (*a*) of the logistic model of the form maturity = 1/(1+exp(-a*(y-b))) and A_{50} or L_{50} is the inflection point (*b*) of the logistic model calculated as -intercept/slope.

Stock	Response	N	Parameter	Estimate	Std. Error
FLK/EFL	Age (yrs)	231	Intercept	-6.325	1.056
			Slope	3.034	0.515
			A50	2.085	0.496
	FL (mm)	285	Intercept	-5.299	0.780
			Slope	0.023	0.003
			L50	232.2	0.426
WFS	Age (yrs)	385	Intercept	-5.925	1.198
			Slope	5.450	0.992
			A50	1.087	0.296
	FL (mm)	533	Intercept	-8.730	1.135
			Slope	0.052	0.006
			L50	169.6	0.372

2.13 FIGURES



Figure 2.13.1. A Hogfish on live hard bottom reef habitat.

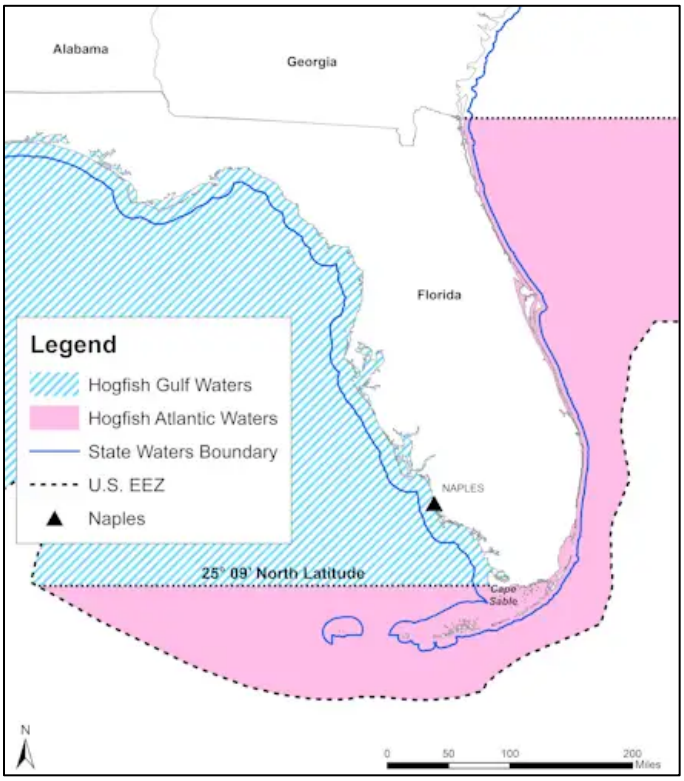


Figure 2.13.2. Jurisdictional boundaries for the South Atlantic Fishery Management Council and the Gulf of Mexico Fishery Management Council pertaining to Hogfish in Florida.

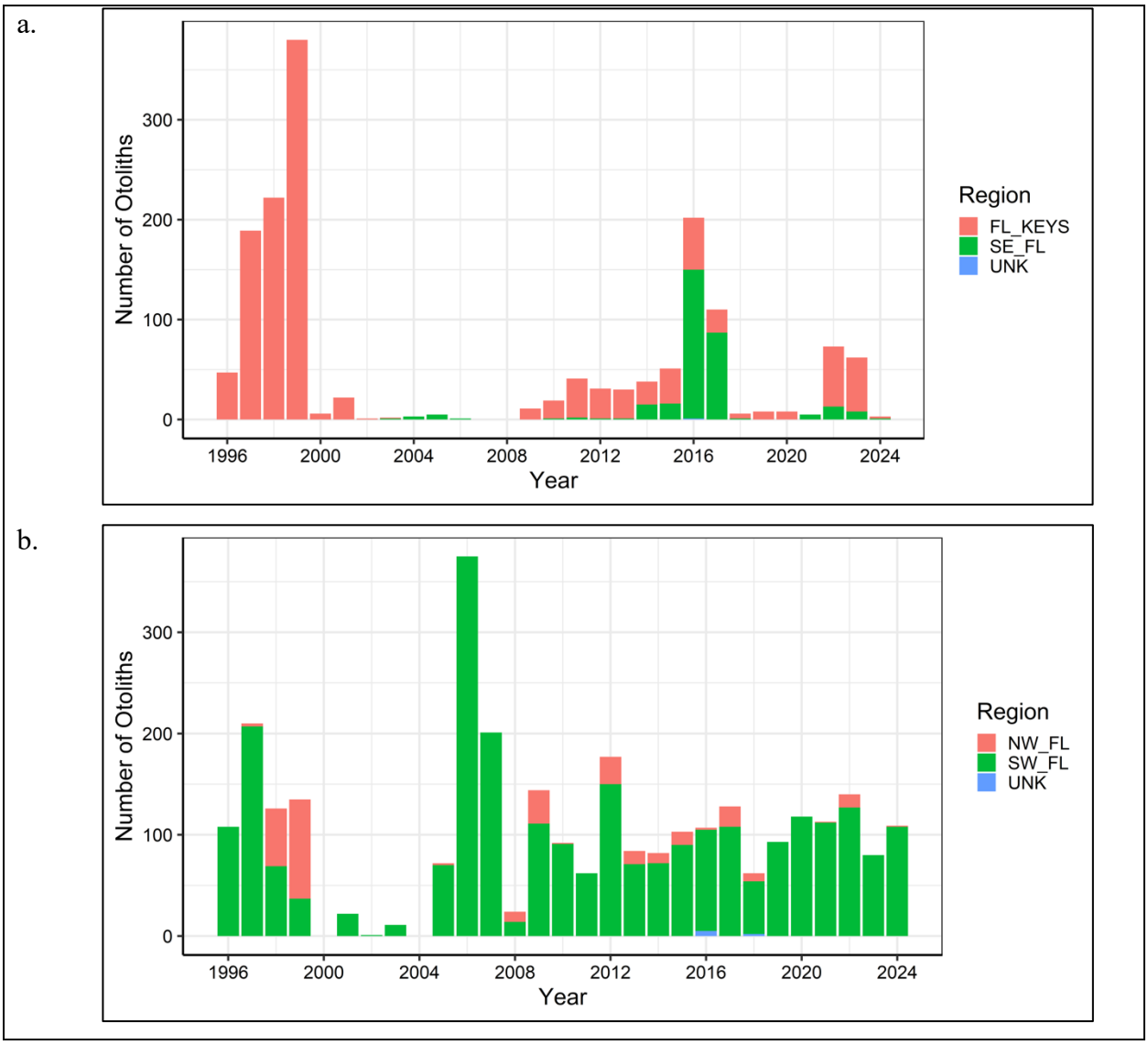


Figure 2.13.3. Number of Hogfish age samples collected by region within Florida from 1996 – 2024. Regions are defined as Northeast Florida (NE FL), Southeast Florida (SE FL), the Florida Keys (FL Keys), Southwest Florida (SW FL), Northwest Florida (NW FL) and Unknown (UNK).

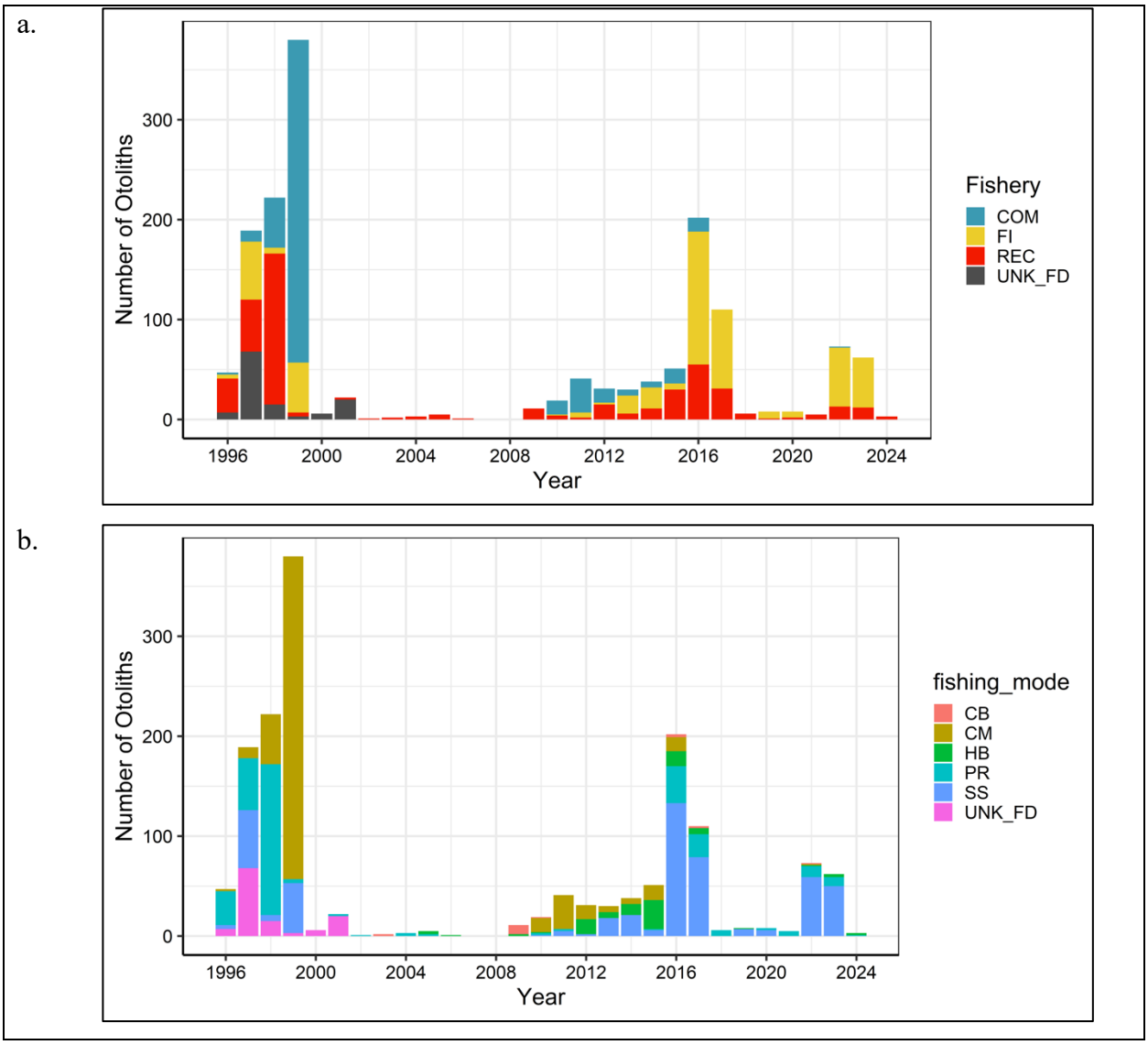


Figure 2.13.4. Number of Hogfish age samples collected per year from the FLK/EFL stock from 1996 – 2024. **(a)** Bar plots by commercial (COM), recreational (REC), and fishery independent (FI) sectors and **(b)** by commercial (CM), recreational (Headboat [HB], Charter [CB], Private [PR]), and fishery-independent (scientific surveys [SS]) fishing modes.

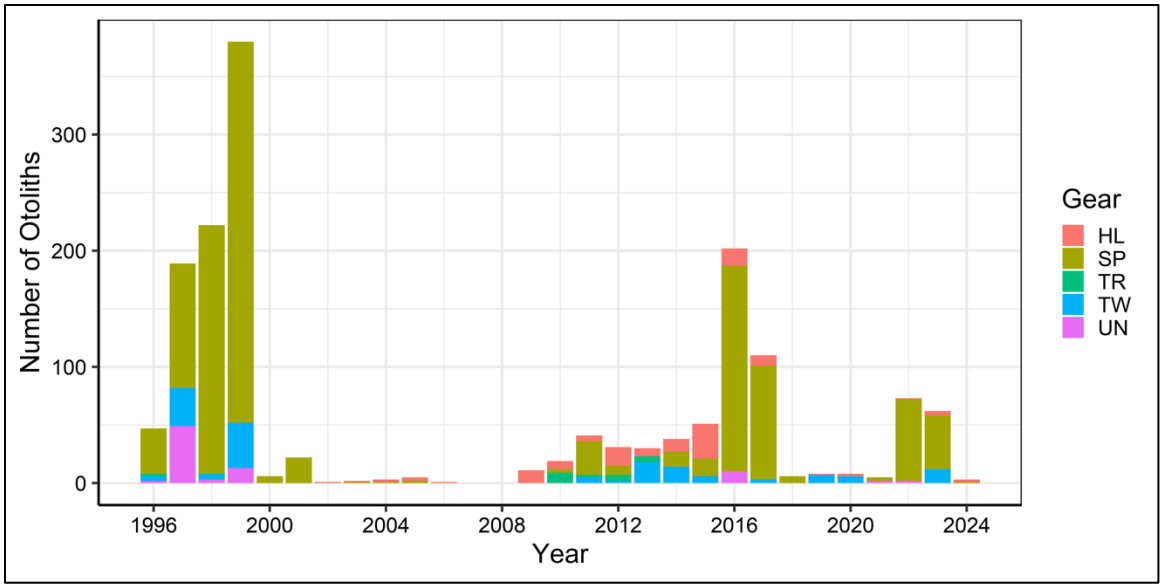


Figure 2.13.5. Number of Hogfish age samples by hook and line (HL), spear (SP), trap (TR), trawl (TW), and unknown (UN) fishing gears collected from the FLK/EFL stock from 1996 – 2024.

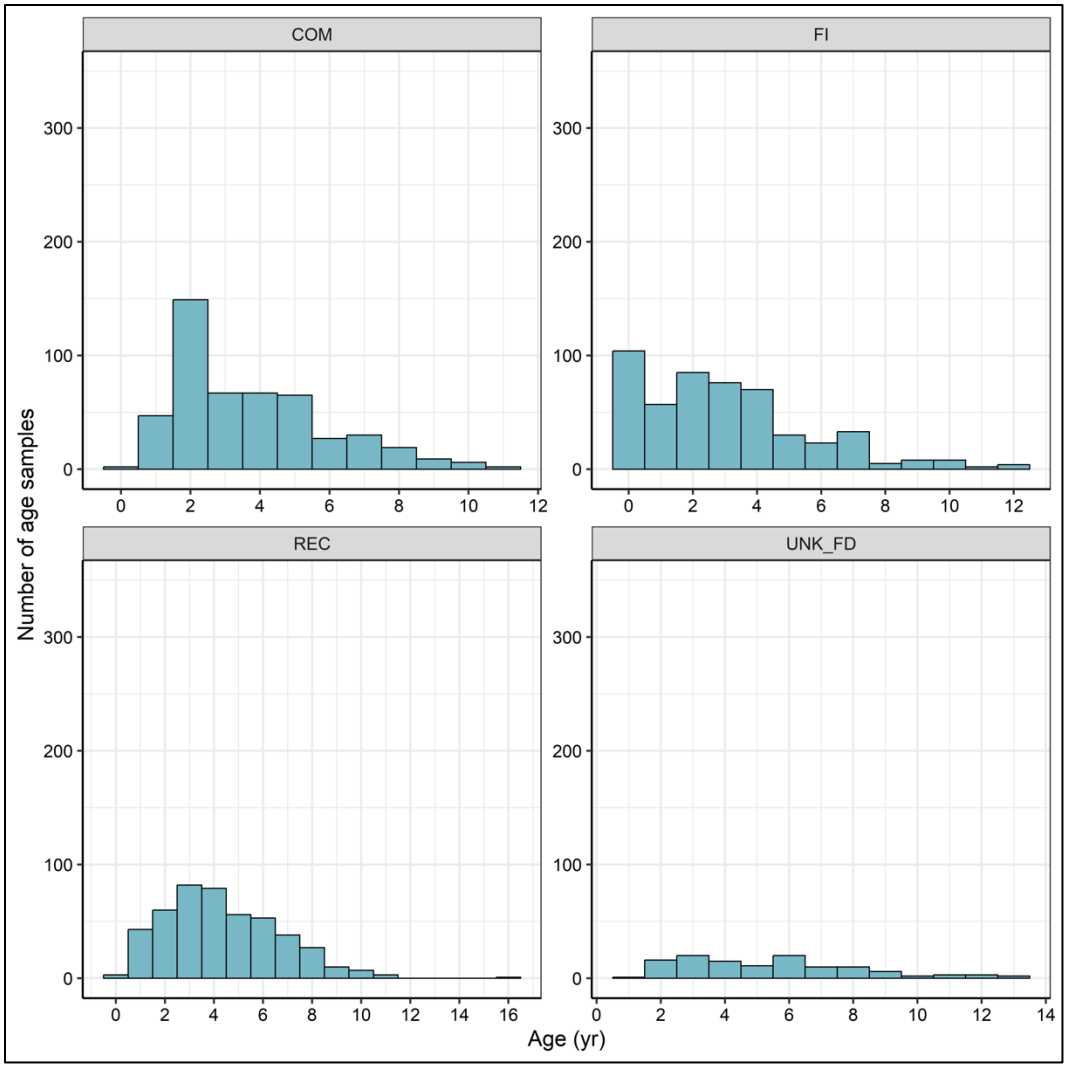


Figure 2.13.6. Histograms of Hogfish age samples collected by commercial (COM), recreational (REC), and fishery independent (FI) sectors within the FLK/EFL stock. Bin increments are equal to 1 year.

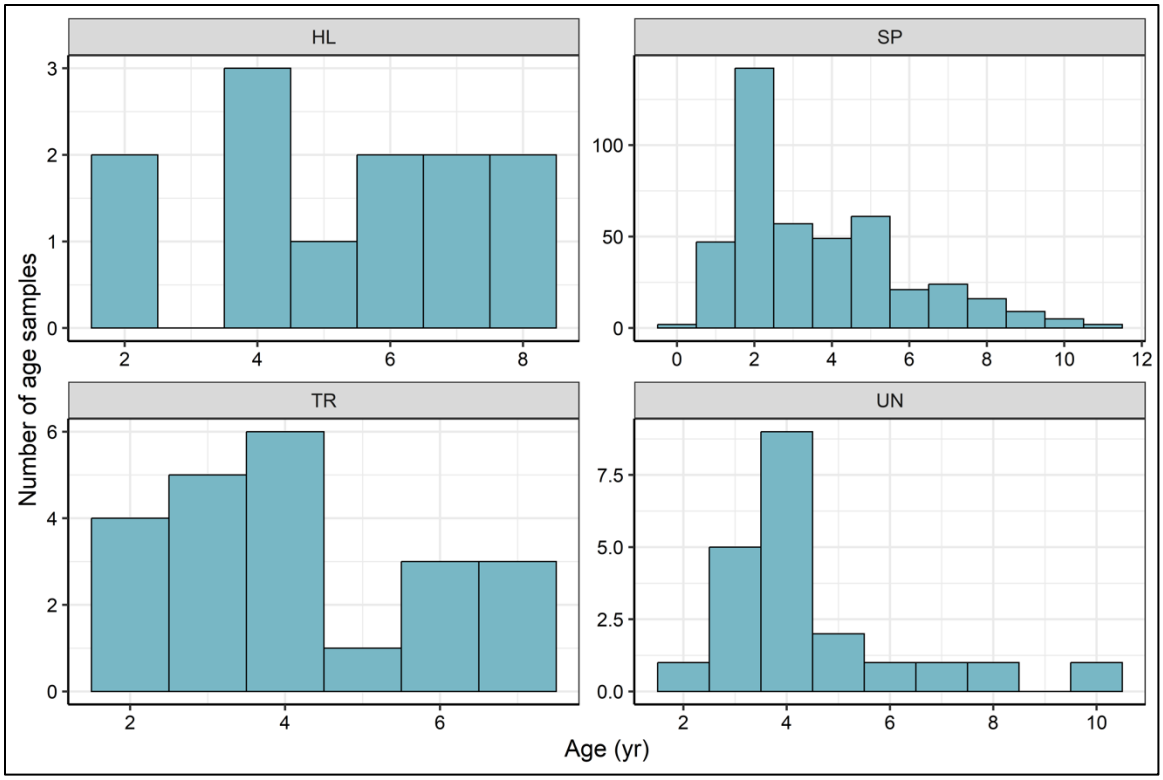


Figure 2.13.7. Histograms of Hogfish age samples from the commercial fishery by hook and line (HL), spear (SP), trap (TR), and unknown (UN) fishing gears collected from the FLK/EFL stock from 1996 – 2024. Bin increments are equal to 1 year.

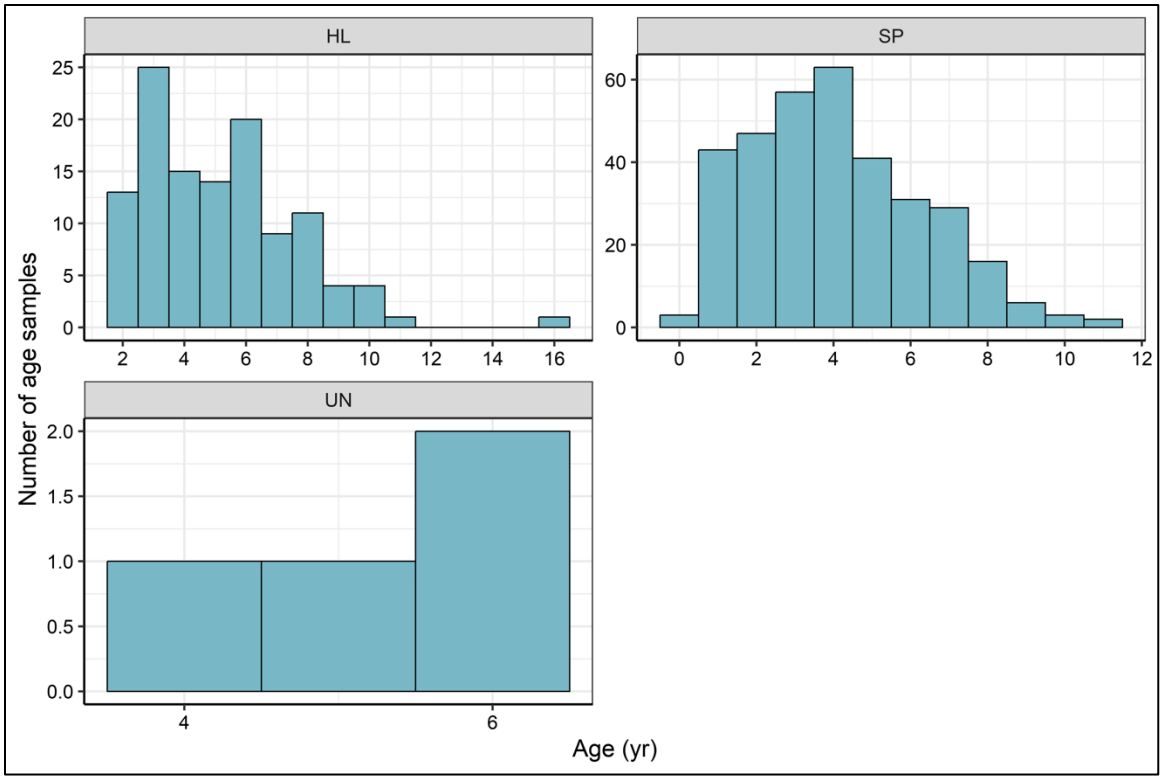


Figure 2.13.8. Histograms of Hogfish age samples from the recreational fishery by hook and line (HL), spear (SP), and unknown (UN) fishing gears collected from the FLK/EFL stock from 1996 – 2024. Bin increments are equal to 1 year.

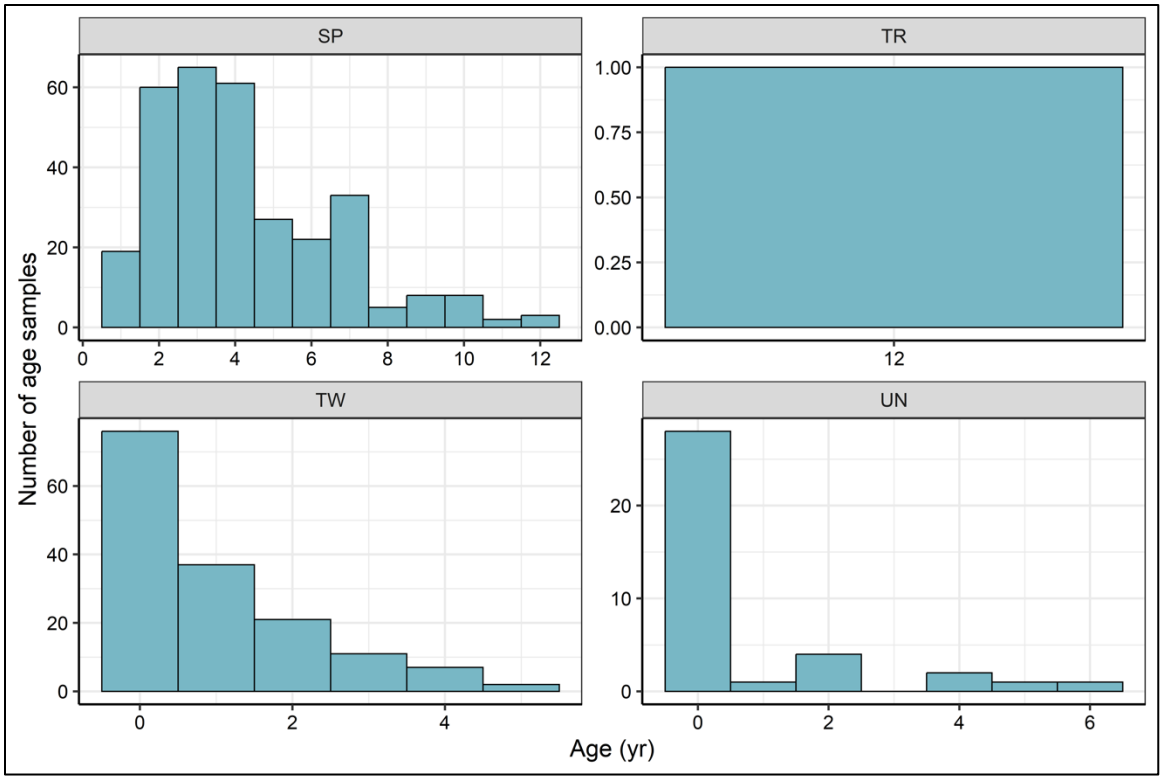


Figure 2.13.9. Histograms of Hogfish age samples from fishery-independent sources by spear (SP), trap (TR), trawl (TW), and unknown (UN) fishing gears collected from the FLK/EFL stock from 1996 – 2024. Bin increments are equal to 1 year.

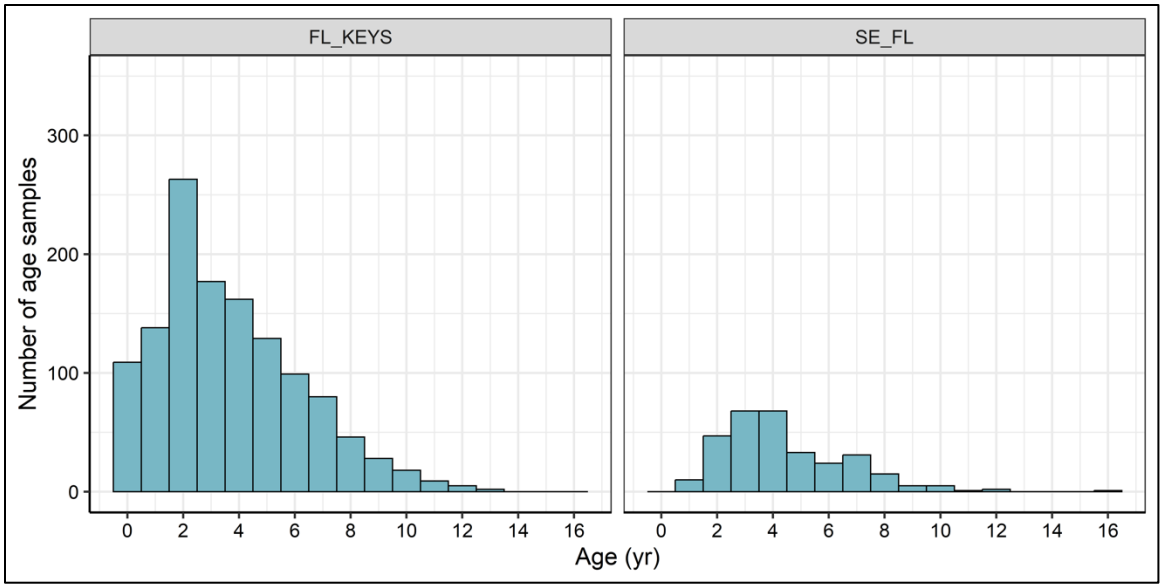


Figure 2.13.10. Histograms of Hogfish age samples collected by region within the FLK/EFL stock. Regions are defined as Southeast Florida (SE FL), and the Florida Keys (FL Keys). No age samples were available from the Northeast Florida region. Bin increments are equal to 1 year.

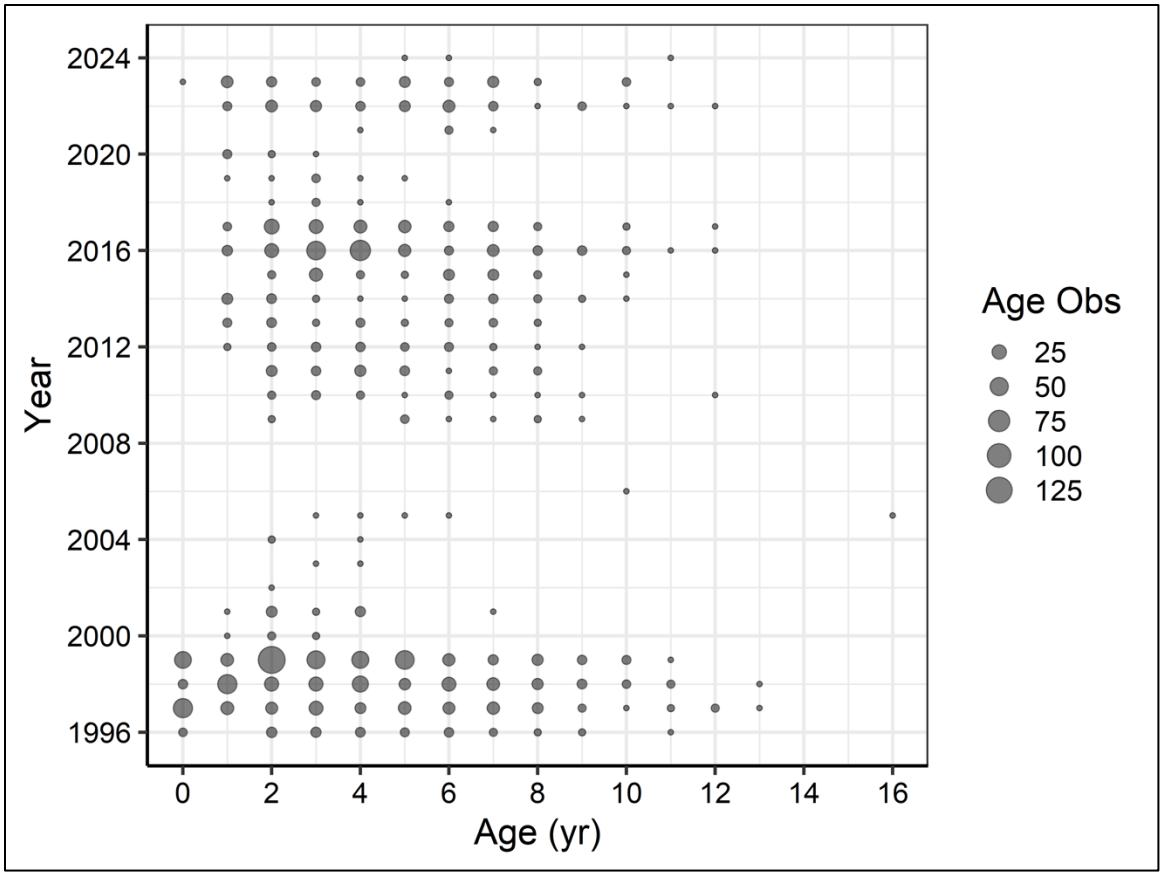


Figure 2.13.11. Bubble plot of Hogfish age samples collected by year per calendar age from the FLK/EFL stock from 1996 – 2024.

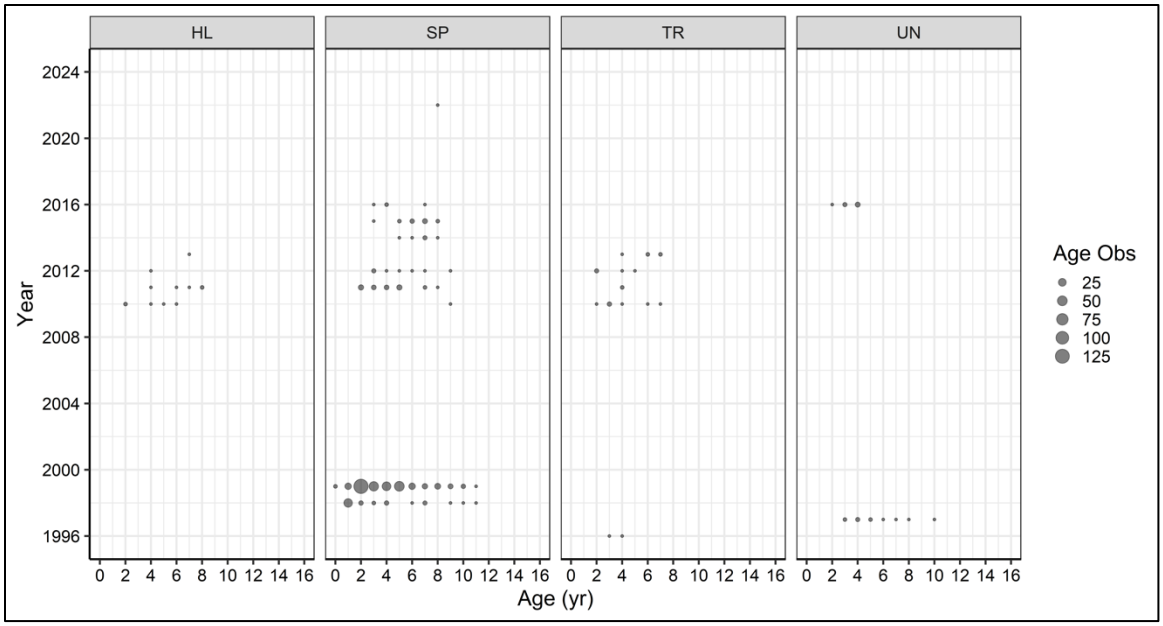


Figure 2.13.12. Bubble plot of Hogfish age samples from the commercial fishery by hook and line (HL), spear (SP), trap (TR), and unknown (UN) fishing gears collected from the FLK/EFL stock from 1996 – 2024.

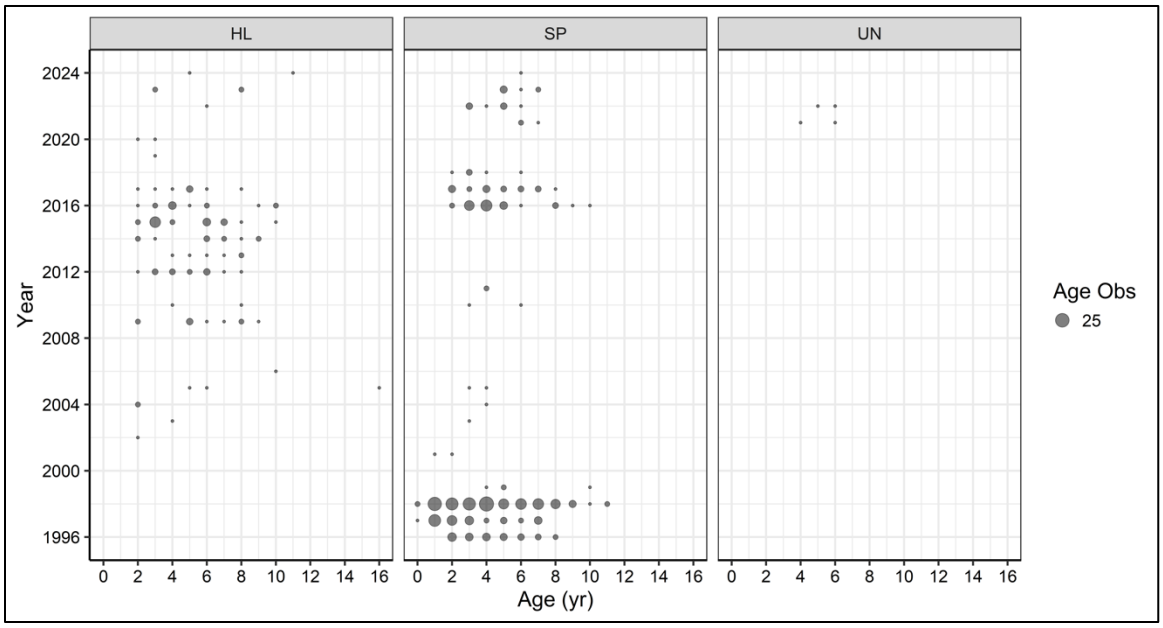


Figure 2.13.13. Bubble plot of Hogfish age samples from the recreational fishery by hook and line (HL), spear (SP), and unknown (UN) fishing gears collected from the FLK/EFL stock from 1996 – 2024.

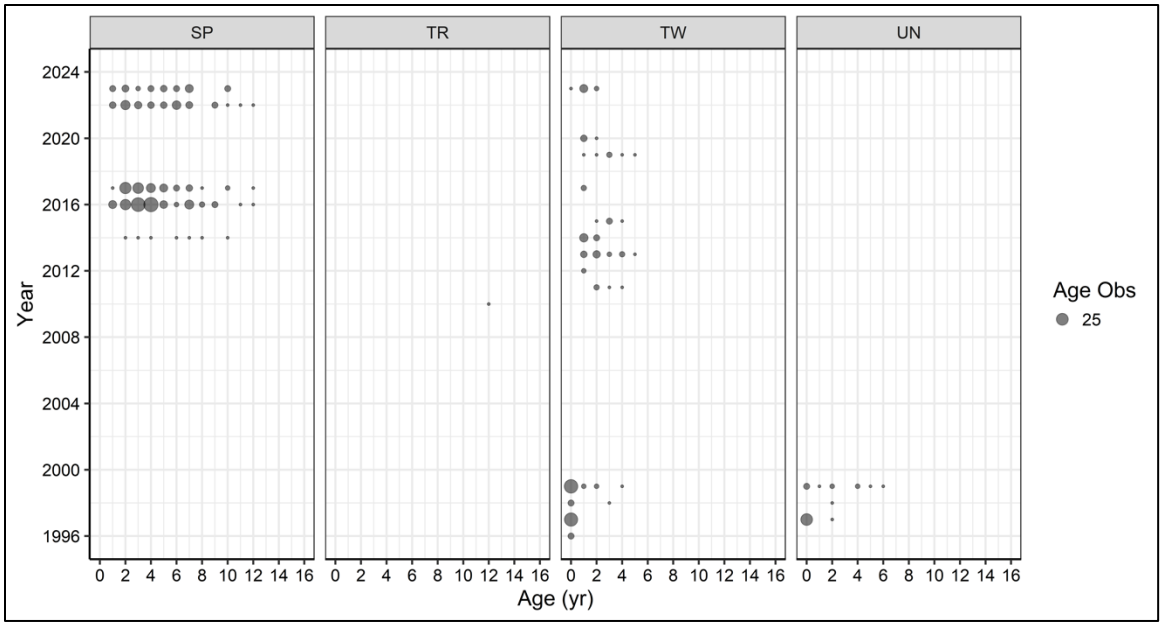


Figure 2.13.14. Bubble plot of Hogfish age samples from fishery-independent sources by spear (SP), trap (TR), trawl (TW), and unknown (UN) fishing gears collected from the FLK/EFL stock from 1996 – 2024.

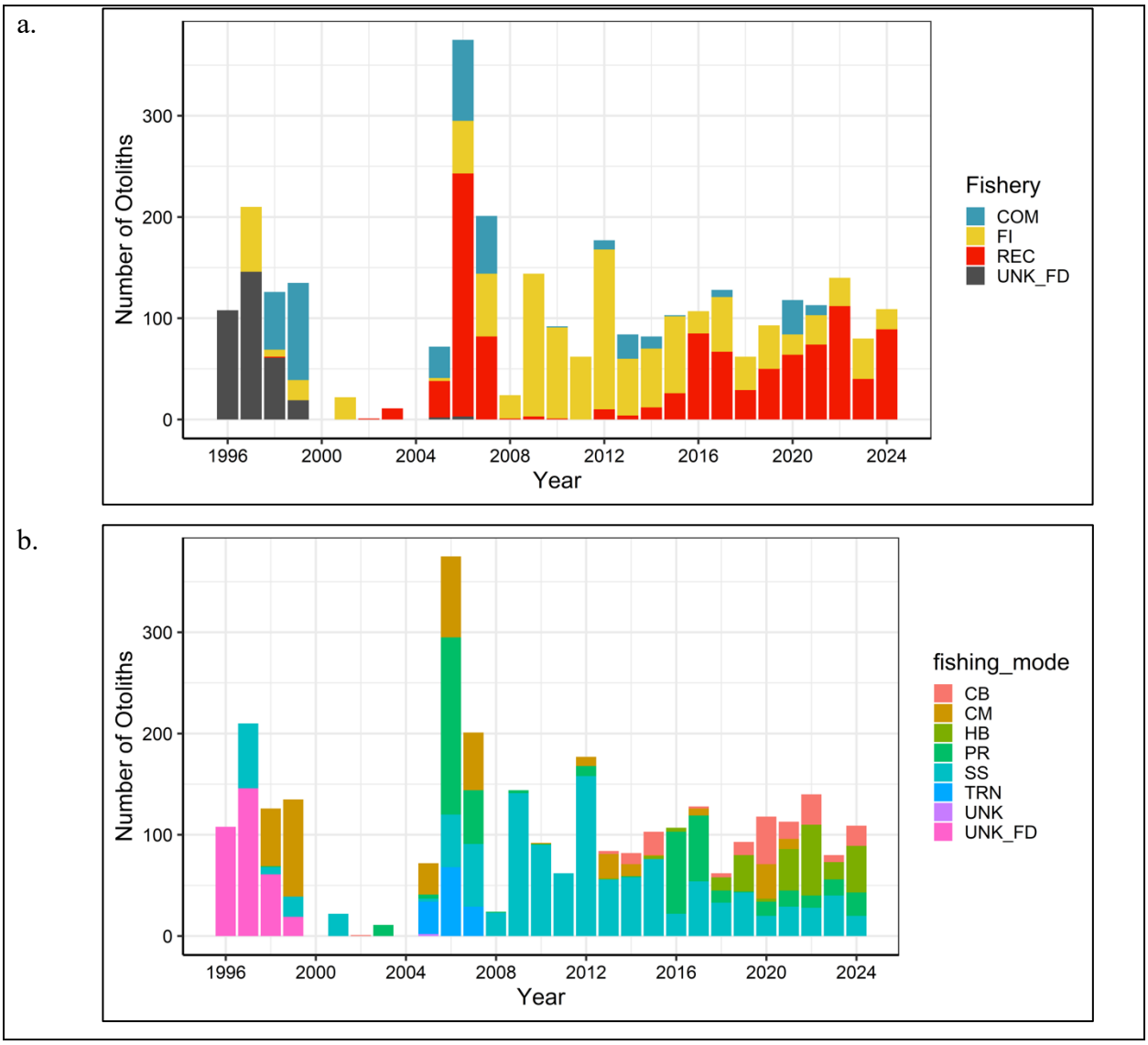


Figure 2.13.15. Number of Hogfish age samples collected per year from the WFS stock from 1996 – 2024. **(a)** Bar plots by commercial (COM), recreational (REC), and fishery independent (FI) sectors and **(b)** by commercial (CM), recreational (Headboat [HB], Charter [CB], Private [PR], tournament [TRN]), and fishery-independent (scientific surveys [SS]) fishing modes.

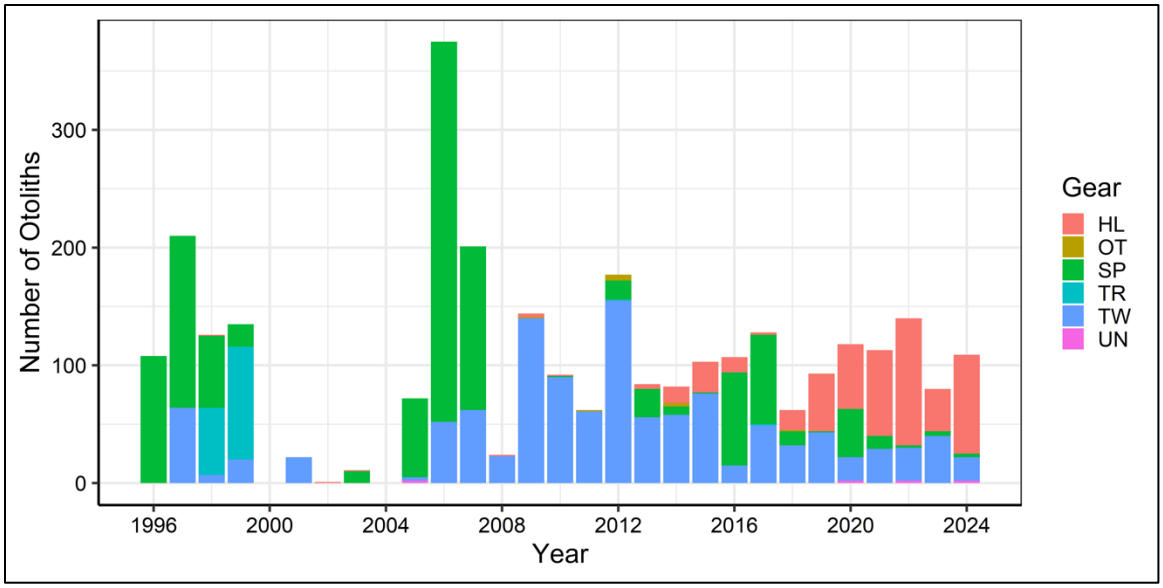


Figure 2.13.16. Number of Hogfish age samples by hook and line (HL), spear (SP), trap (TR), trawl (TW), other (OT), and unknown (UN) fishing gears collected from the WFS stock from 1996 – 2024.

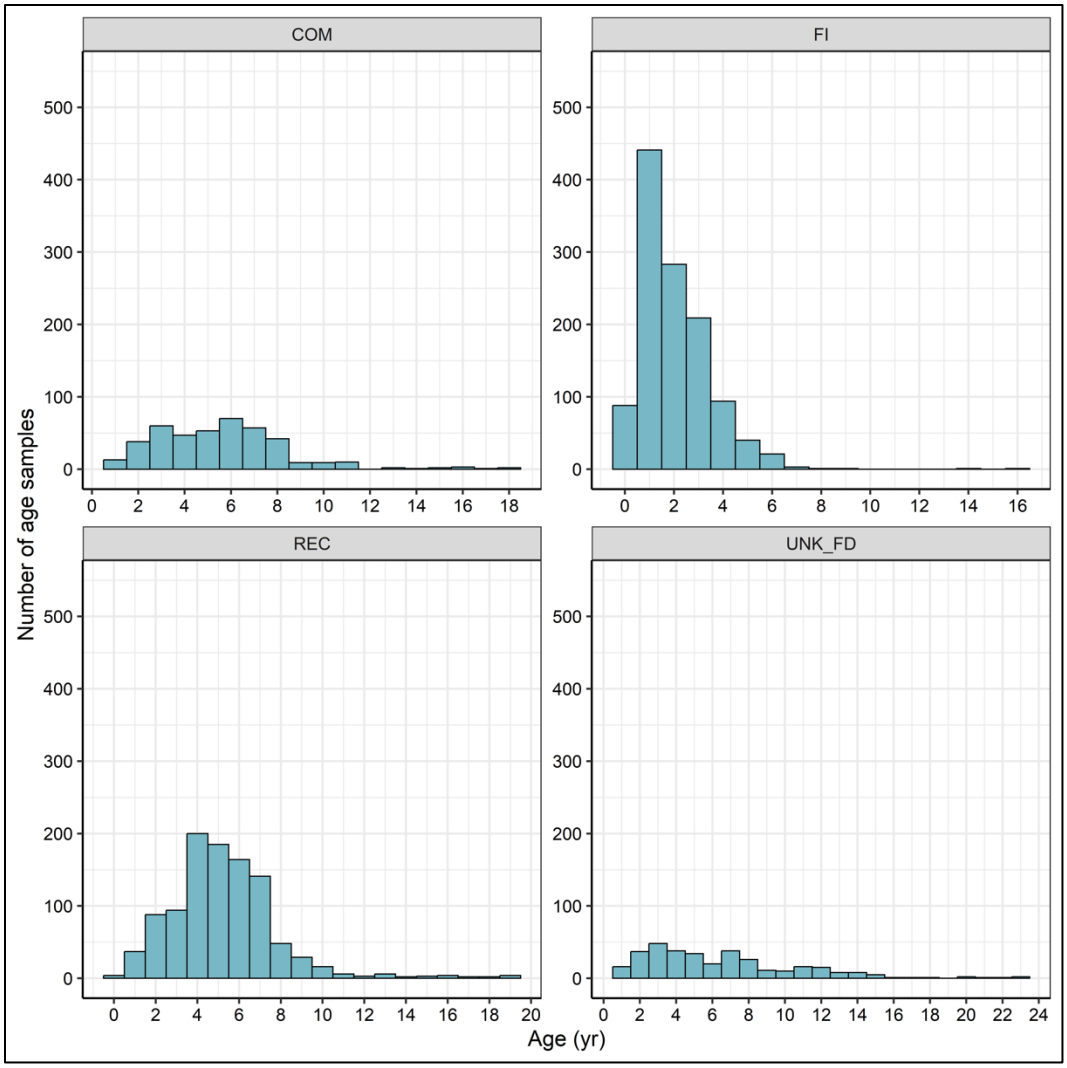


Figure 2.13.17. Histograms of Hogfish age samples collected by commercial (COM), recreational (REC), and fishery independent (FI) sectors within the WFS stock. Bin increments are equal to 1 year.

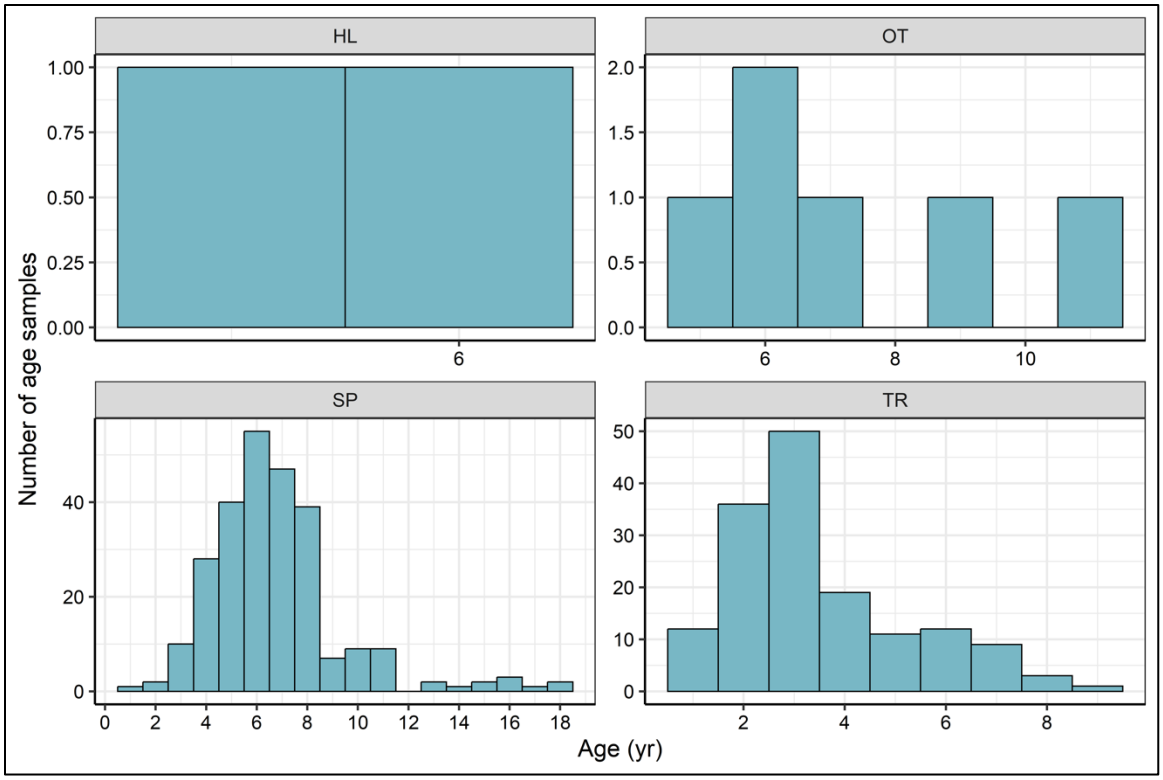


Figure 2.13.18. Histograms of Hogfish age samples from the commercial fishery by hook and line (HL), spear (SP), trap (TR), and other (OT) fishing gears collected from the WFS stock from 1996 – 2024. Bin increments are equal to 1 year.

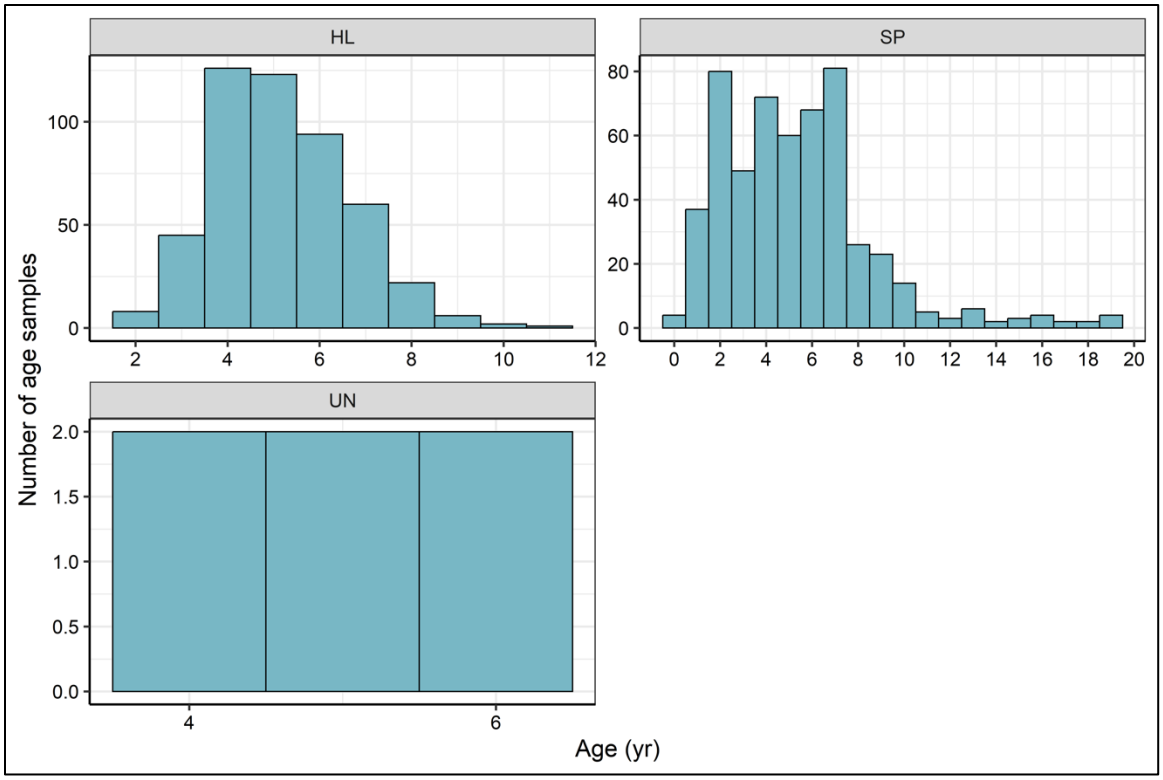


Figure 2.13.19. Histograms of Hogfish age samples from the recreational fishery by hook and line (HL), spear (SP), and unknown (UN) fishing gears collected from the WFS stock from 1996 – 2024. Bin increments are equal to 1 year.

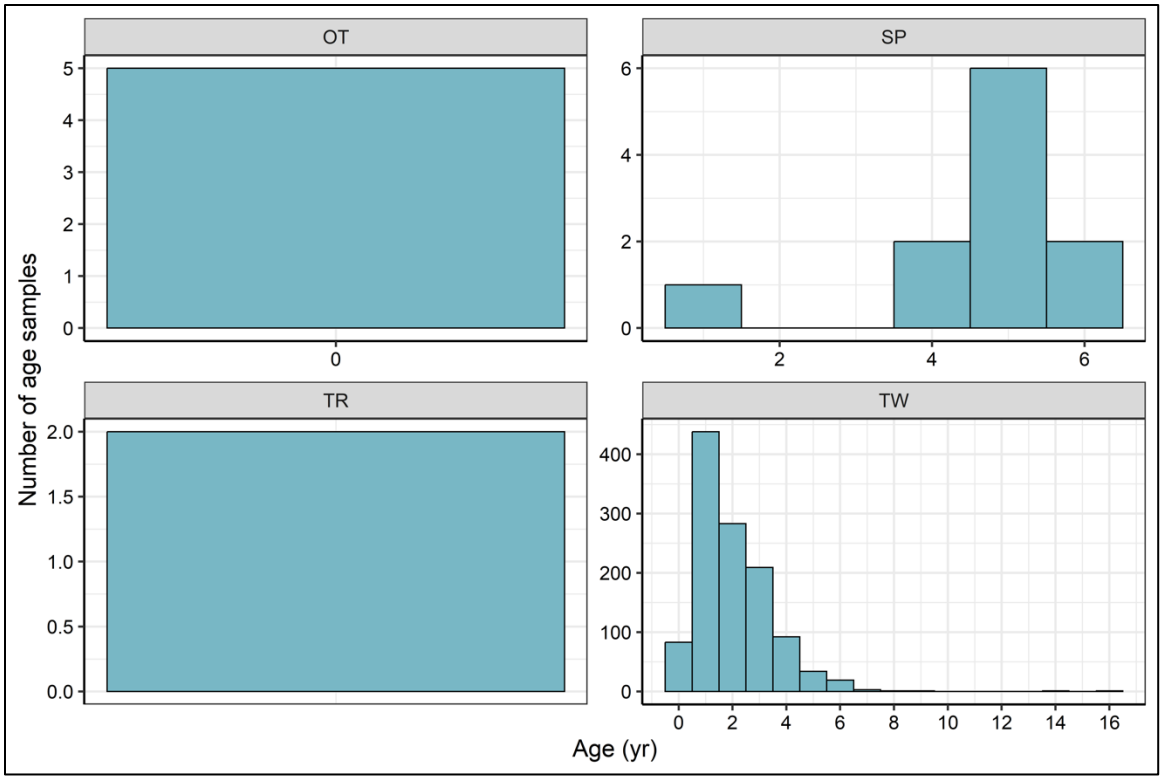


Figure 2.13.20. Histograms of Hogfish age samples from fishery-independent sources by spear (SP), trap (TR), trawl (TW), and other (OT) fishing gears collected from the WFS stock from 1996 – 2024. Bin increments are equal to 1 year.

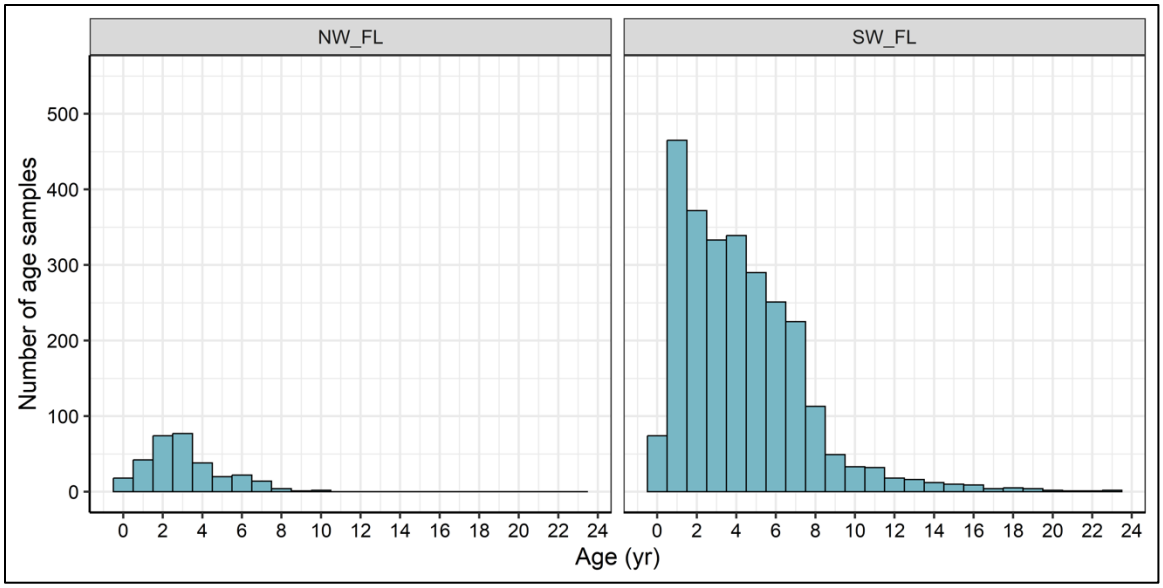


Figure 2.13.21. Histograms of Hogfish age samples collected by region within the WFS stock. Regions are defined as Northwest Florida (NW FL) and Southwest Florida (SW FL). Bin increments are equal to 1 year.

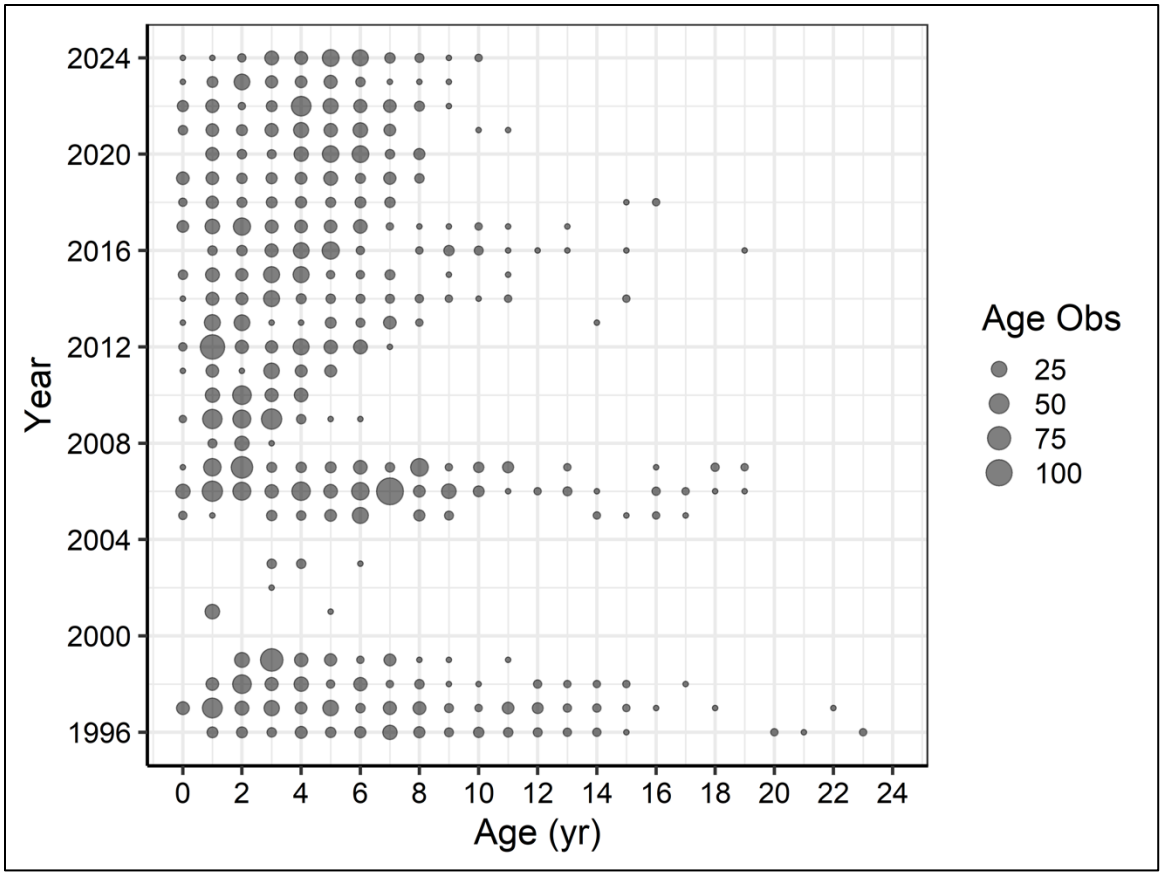


Figure 2.13.22. Bubble plot of Hogfish age samples collected by year per calendar age from the WFS stock from 1996 – 2024.

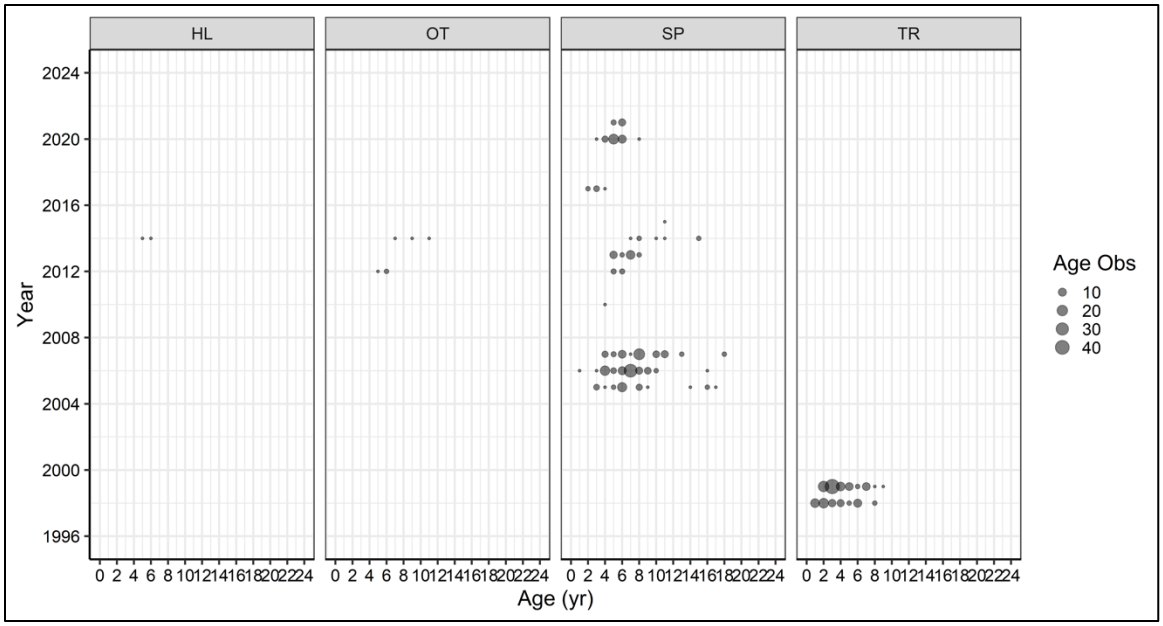


Figure 2.13.23. Bubble plot of Hogfish age samples from the commercial fishery by hook and line (HL), spear (SP), trap (TR), and other (OT) fishing gears collected from the WFS stock from 1996 – 2024.

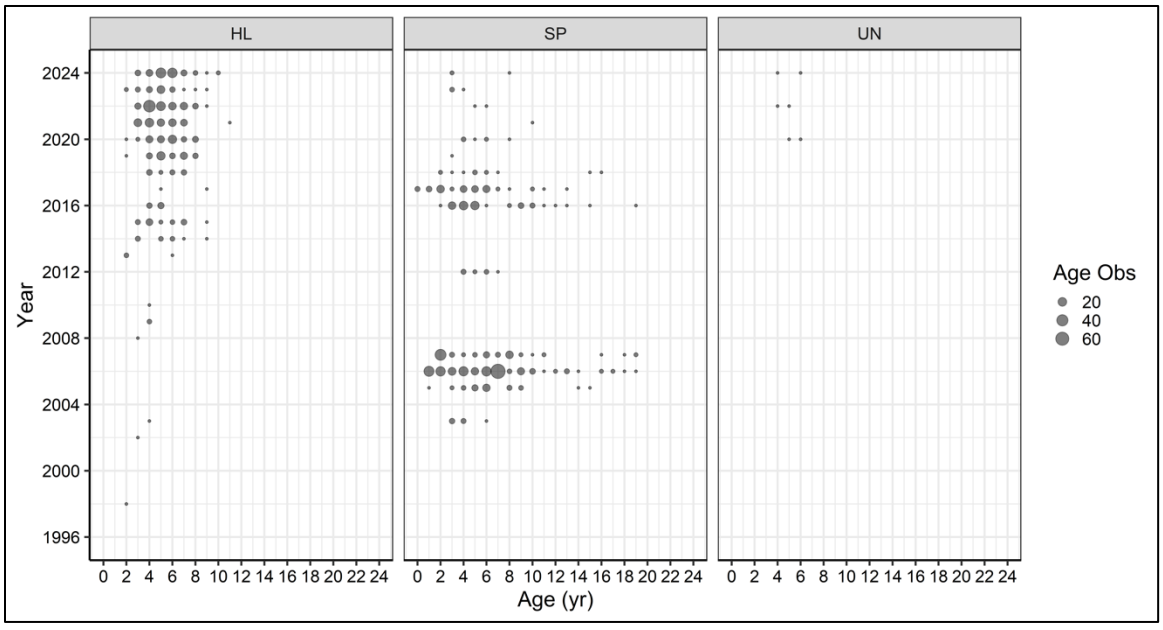


Figure 2.13.24. Bubble plot of Hogfish age samples from the recreational fishery by hook and line (HL), spear (SP), and unknown (UN) fishing gears collected from the WFS stock from 1996 – 2024.

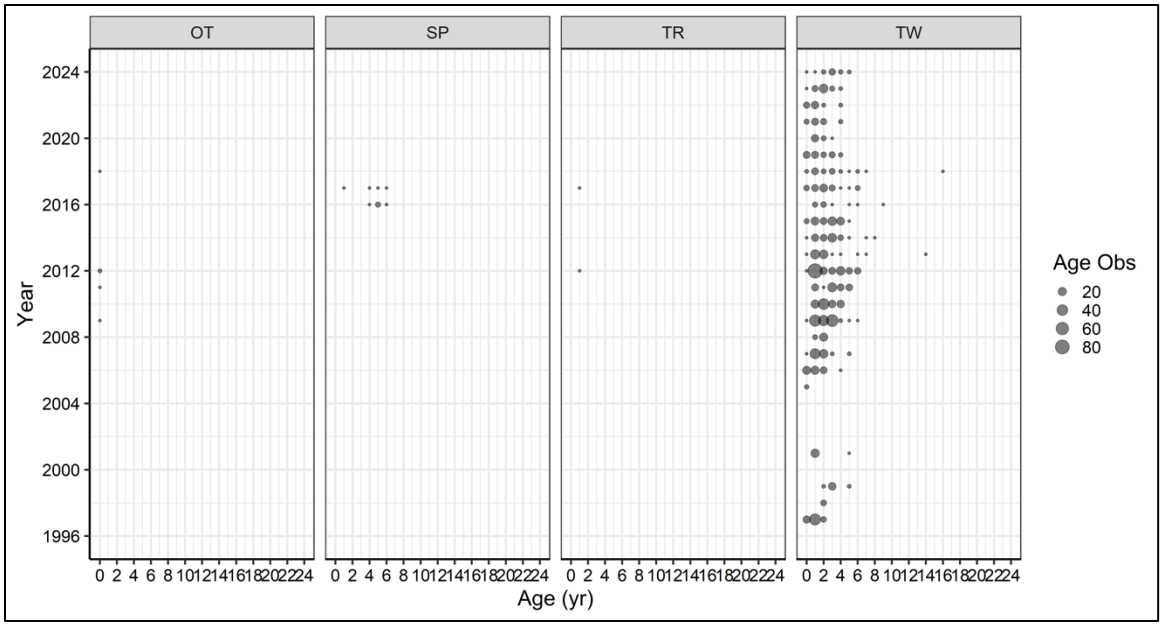
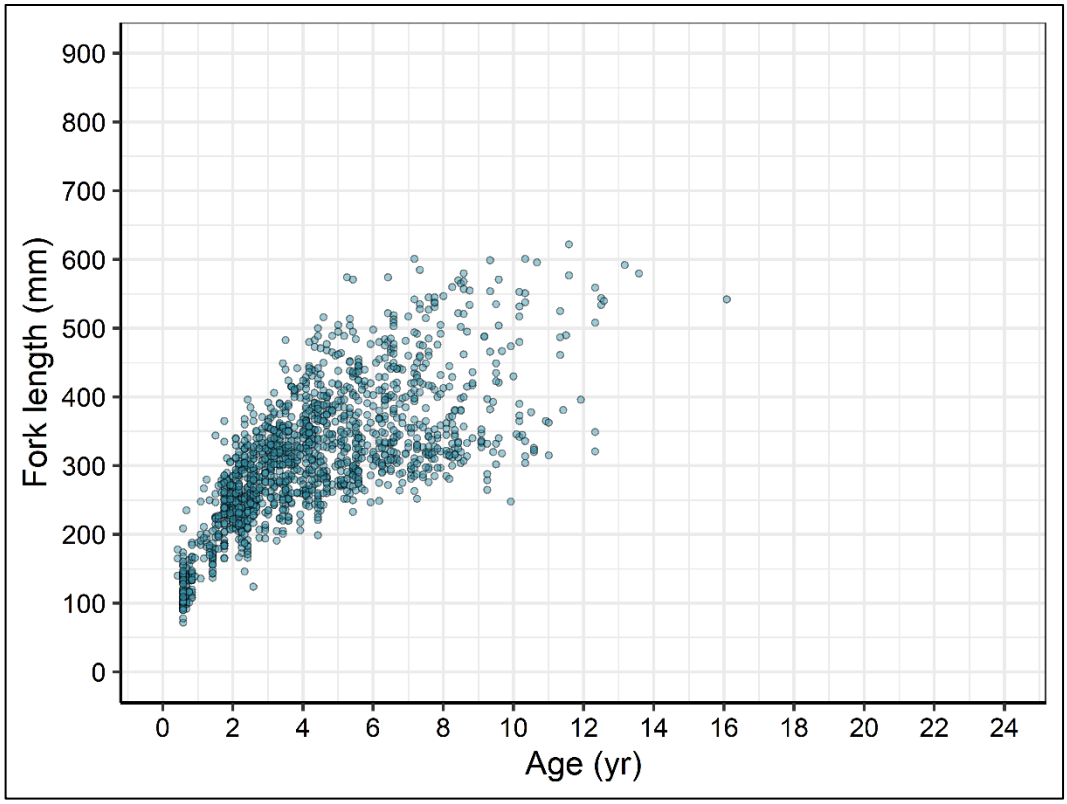


Figure 2.13.25. Bubble plot of Hogfish age samples from fishery-independent sources by spear (SP), trap (TR), trawl (TW), and other (OT) fishing gears collected from the WFS stock from 1996 – 2024.

a.



b.

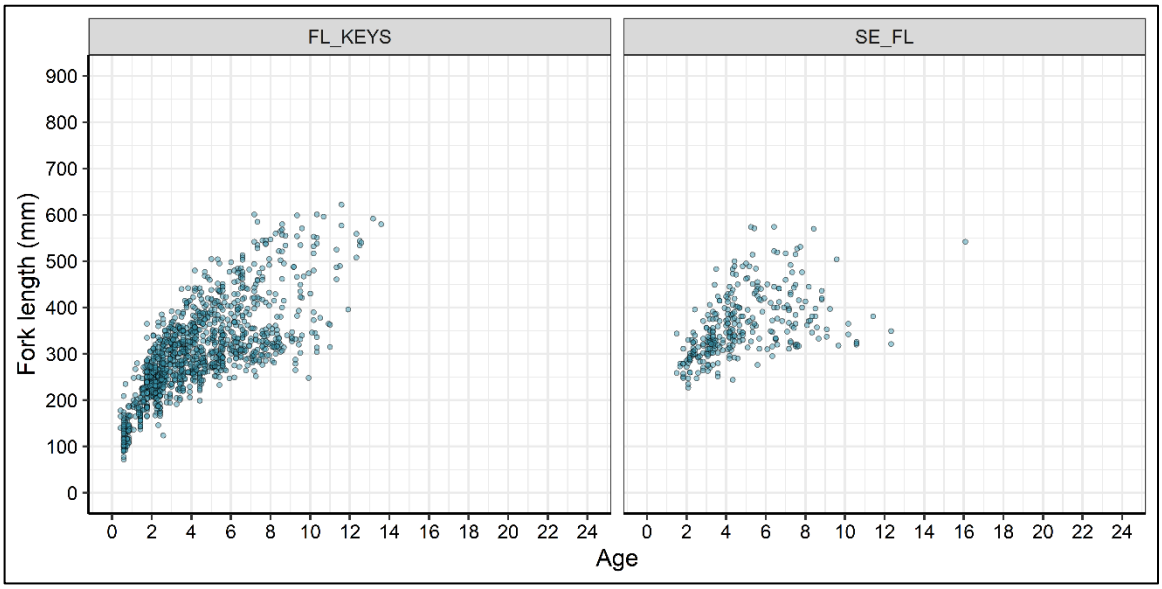


Figure 2.13.26. Hogfish length-at-age collected from the FLK/EFL stock (a) and by region (b) from fishery-dependent and -independent data sources between 1996 – 2024. Regions are defined as Southeast Florida (SE FL), and the Florida Keys (FL Keys). No age samples were available from the Northeast Florida region.

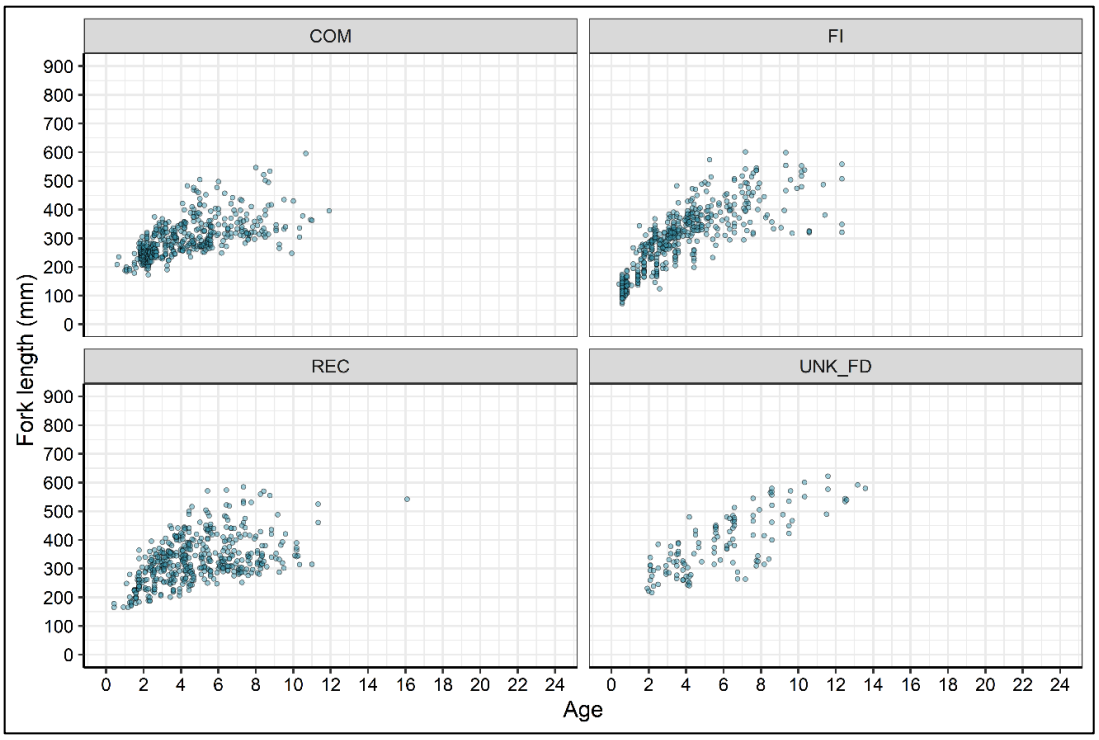


Figure 2.13.27. Hogfish length-at-age from the FLK/EFL stock by commercial (COM), recreational (REC), and fishery independent (FI) sectors between 1996 – 2024.

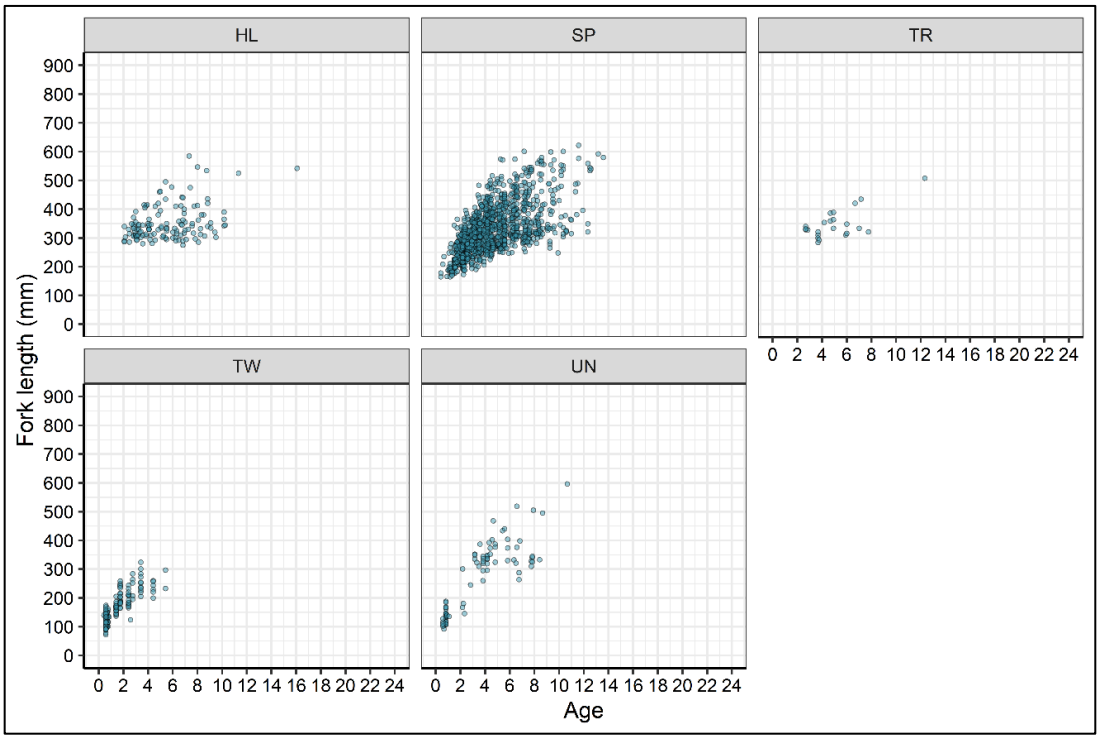
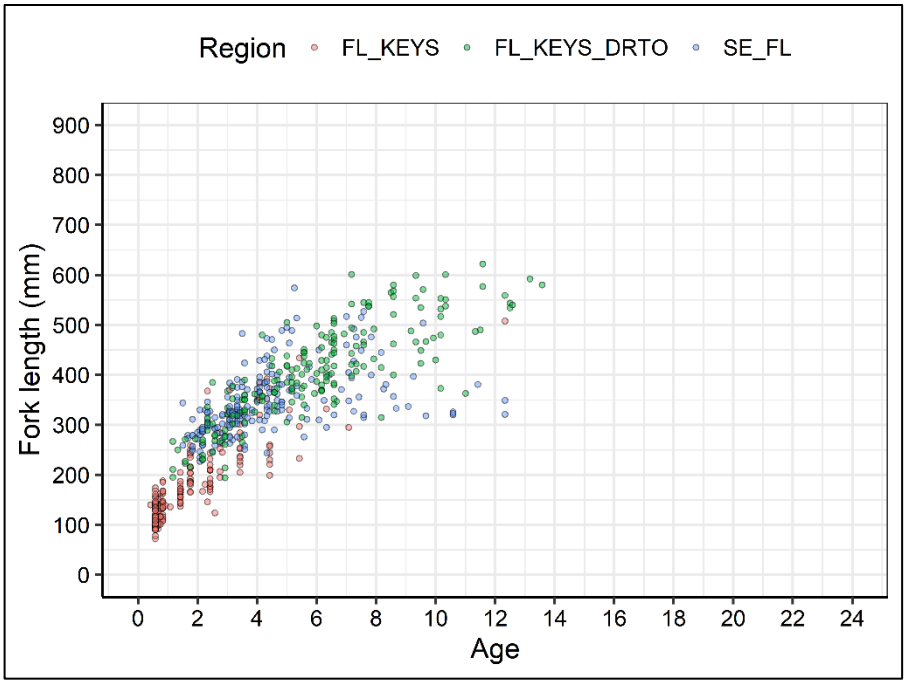


Figure 2.13.28. Hogfish length-at-age from the FLK/EFL stock by hook and line (HL), spear (SP), trap (TR), trawl (TW), and unknown (UN) fishing gears from fishery-dependent and -independent data sources between 1996 – 2024.

a.



b.

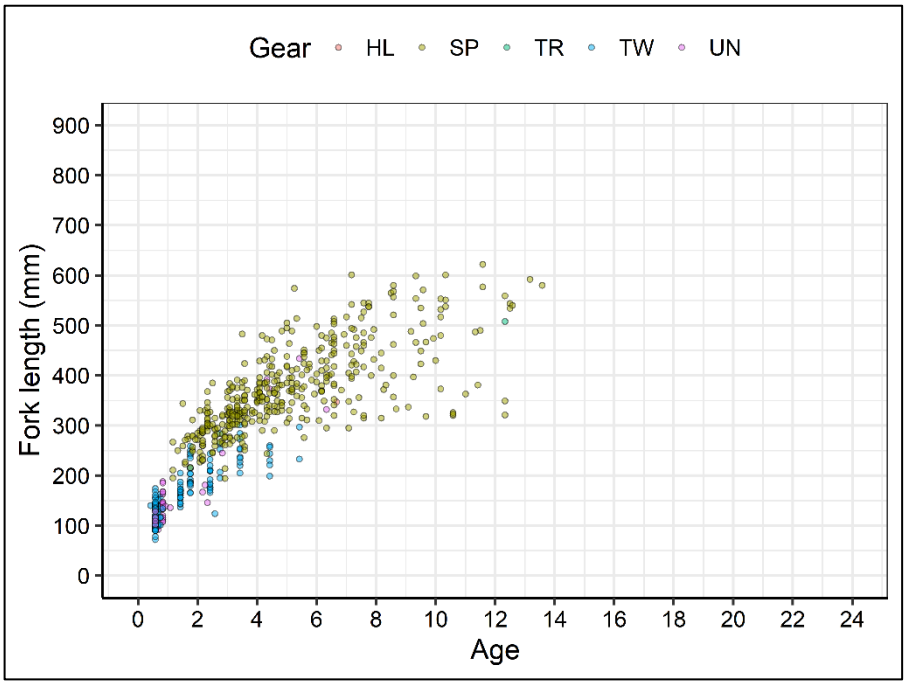


Figure 2.13.29. Hogfish length-at-age collected in the FLK/EFL stock and isolated by fishery-independent sources and from the Dry Tortugas between 1996 – 2024. Data are defined (a) by region as the Florida Keys (FL Keys), the Dry Tortugas (FL KEYS DRTO), and southeast Florida (SE FL) and (b) by hook and line (HL), spear (SP), trap (TR), trawl (TW), and unknown (UN) fishing gears.

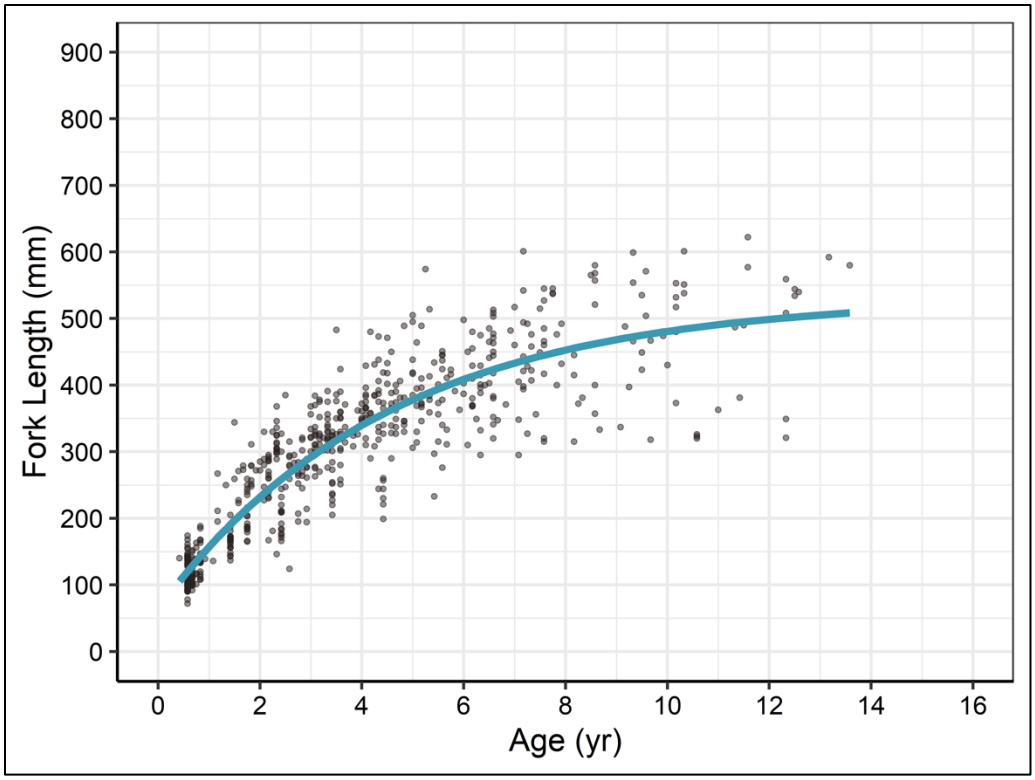


Figure 2.13.30. Size-truncated Hogfish length-at-age collected in the FLK/EFL stock and isolated by fishery-independent sources and from the Dry Tortugas between 1996 – 2024 (n = 593 otoliths). The blue line is the predicted length-at-age from the best fit size-truncated von Bertalanffy growth model applied to inverse-weighted data where CV was constant across age.

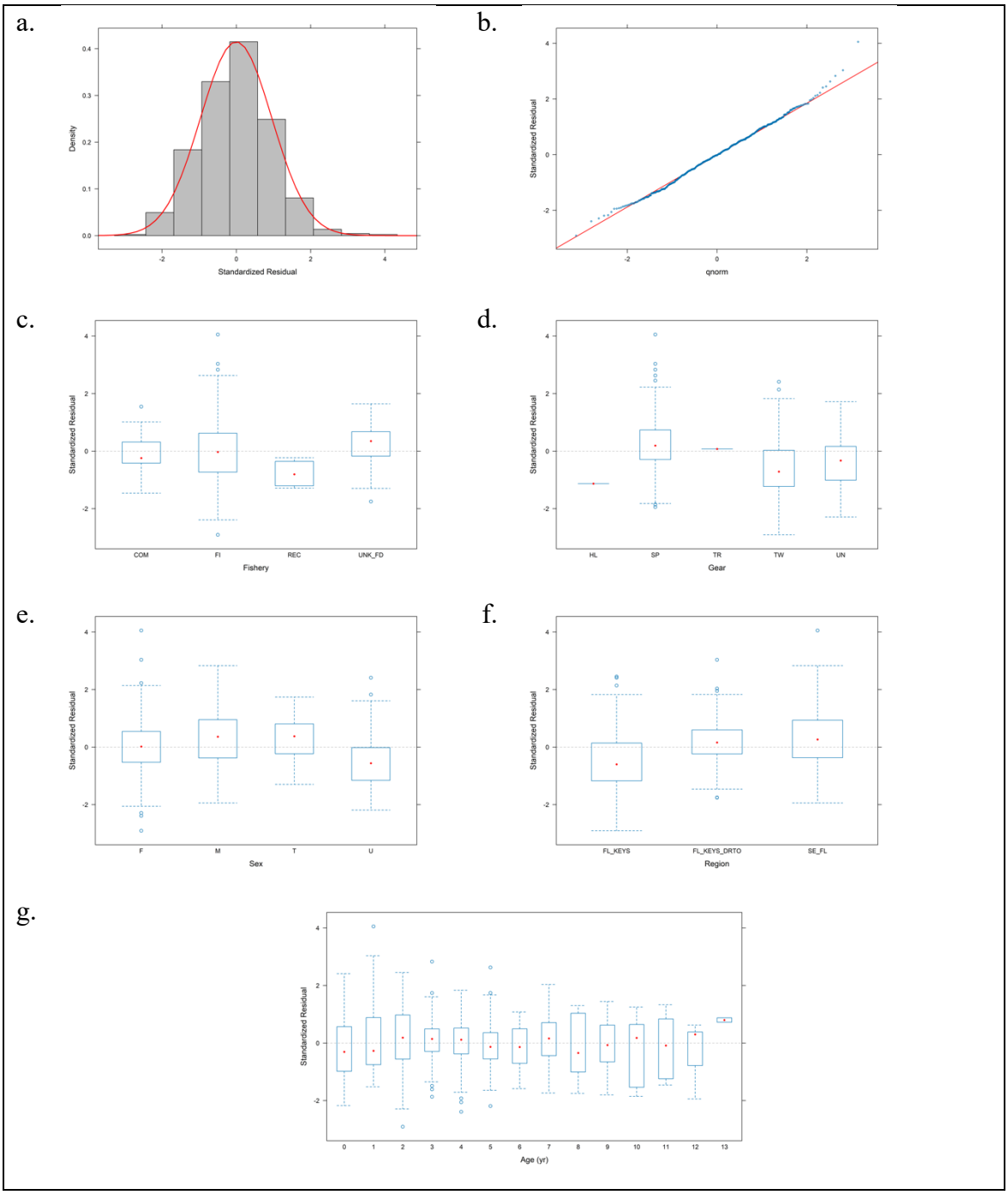
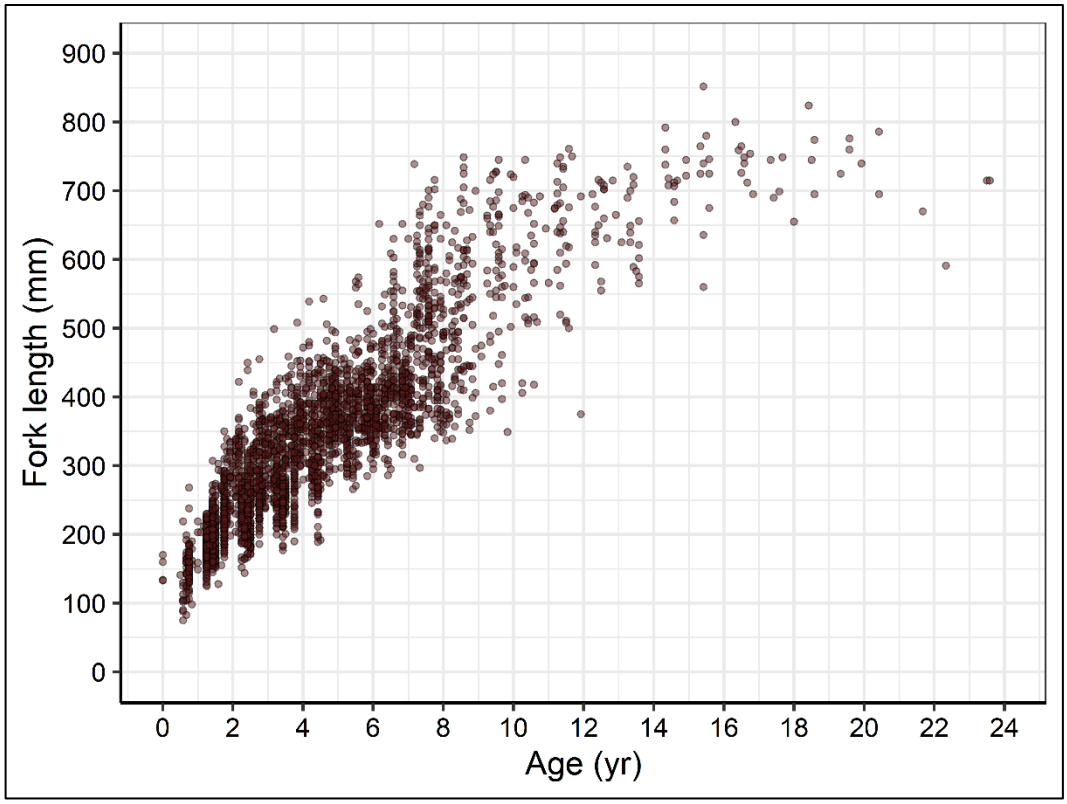


Figure 2.13.31. Standardized residual diagnostic plots for the size-truncated von Bertalanffy growth model applied to inverse-weighted data where CV was constant across age: a) density distribution, b) normal probability plot (quantiles vs standardized residuals), c) standardized residuals by fishery, d) standardized residuals by gear, e) standardized residuals by sex, f) standardized residuals by region, and g) standardized residuals by age. Boxplots include the median, upper and lower quartiles, and outliers (open circles).

a.



b.

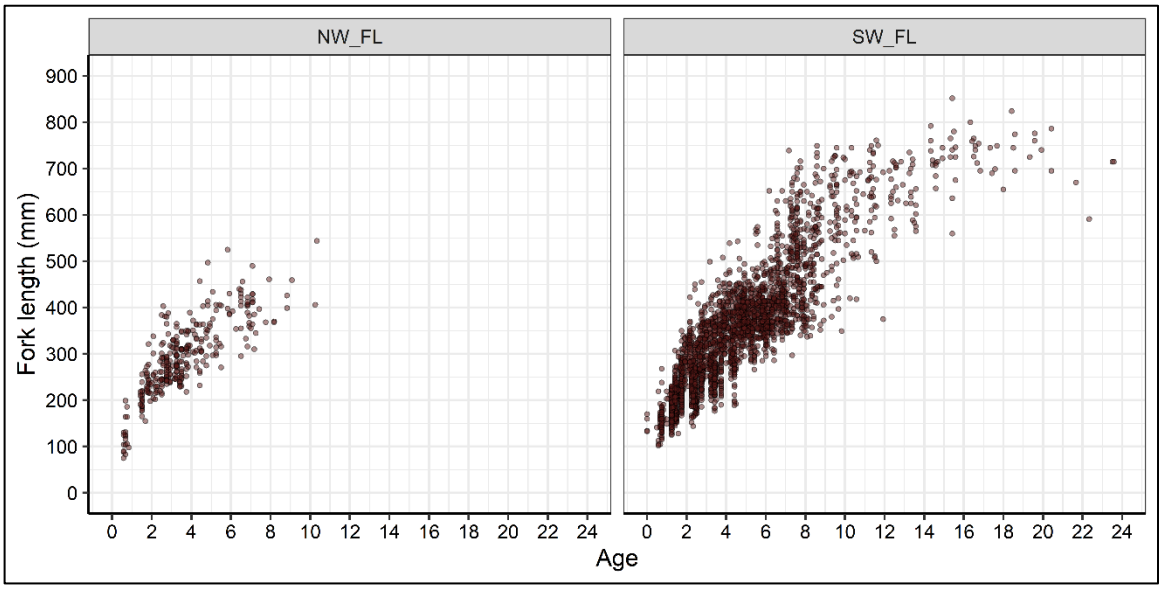


Figure 2.13.32. Hogfish length-at-age collected from the WFS stock (a) and by region (b) from fishery-dependent and -independent data sources between 1996 – 2024. Regions are defined as Northwest Florida (NW FL), and Southwest Florida (SW FL).

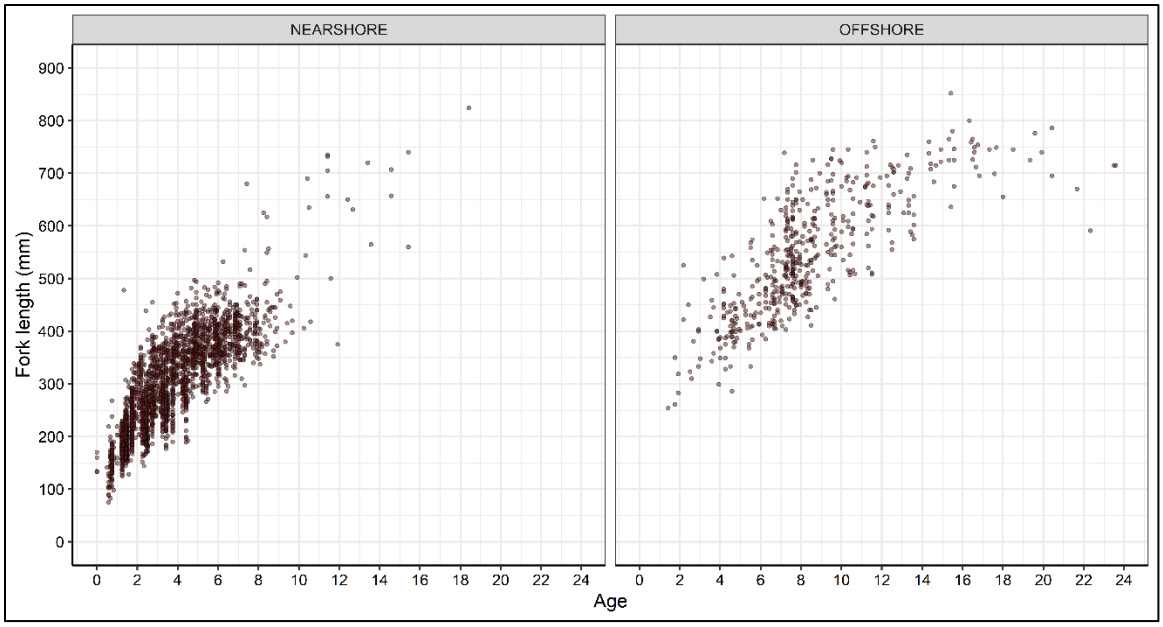


Figure 2.13.33. Hogfish length-at-age from the WFS stock by depth strata between 1996 – 2024. Depth strata were defined as nearshore if depths were < 30 m and offshore if depths were >= 30m.

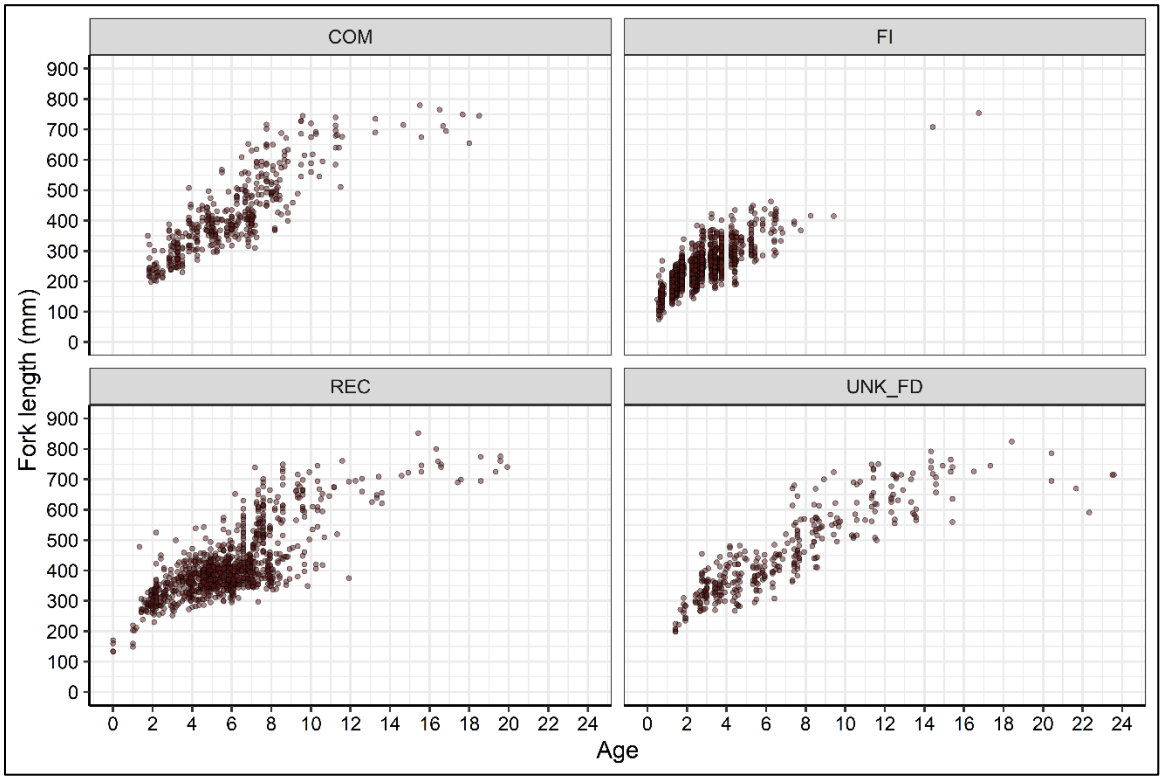


Figure 2.13.34. Hogfish length-at-age from the WFS stock by commercial (COM), recreational (REC), and fishery independent (FI) sectors between 1996 – 2024.

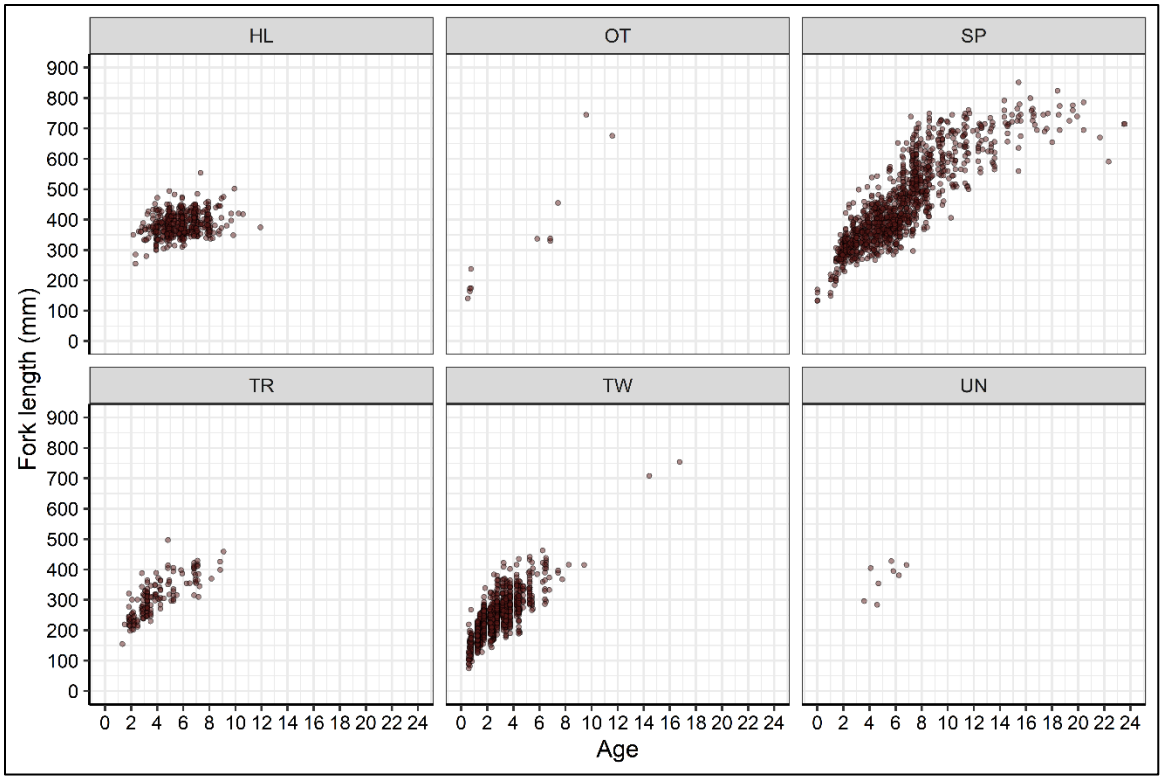
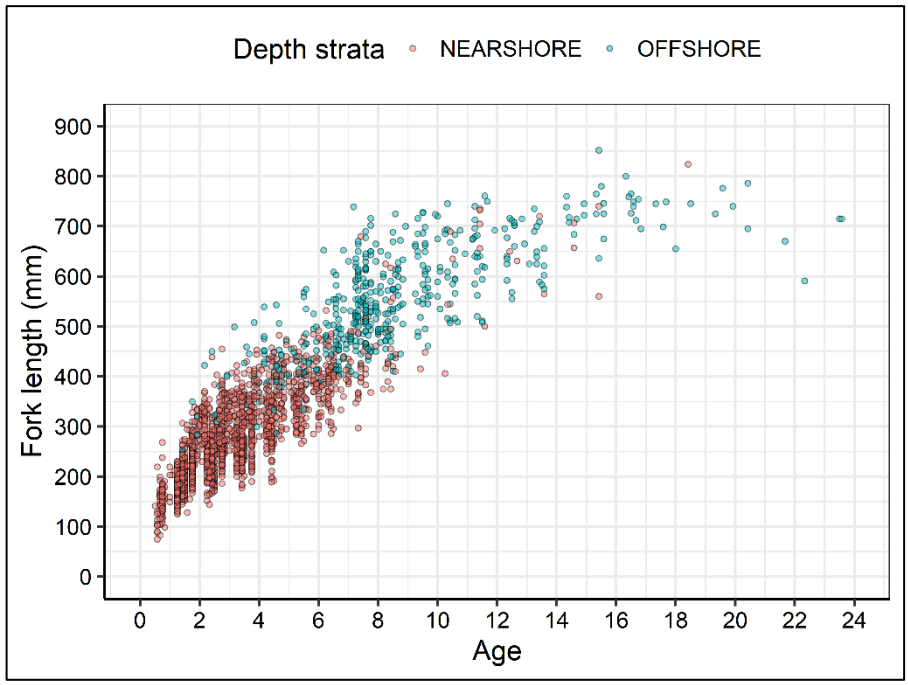


Figure 2.13.35. Hogfish length-at-age from the WFS stock by hook and line (HL), spear (SP), trap (TR), trawl (TW), other (OT), and unknown (UN) fishing gears from fishery-dependent and -independent data sources between 1996 – 2024

a.



b.

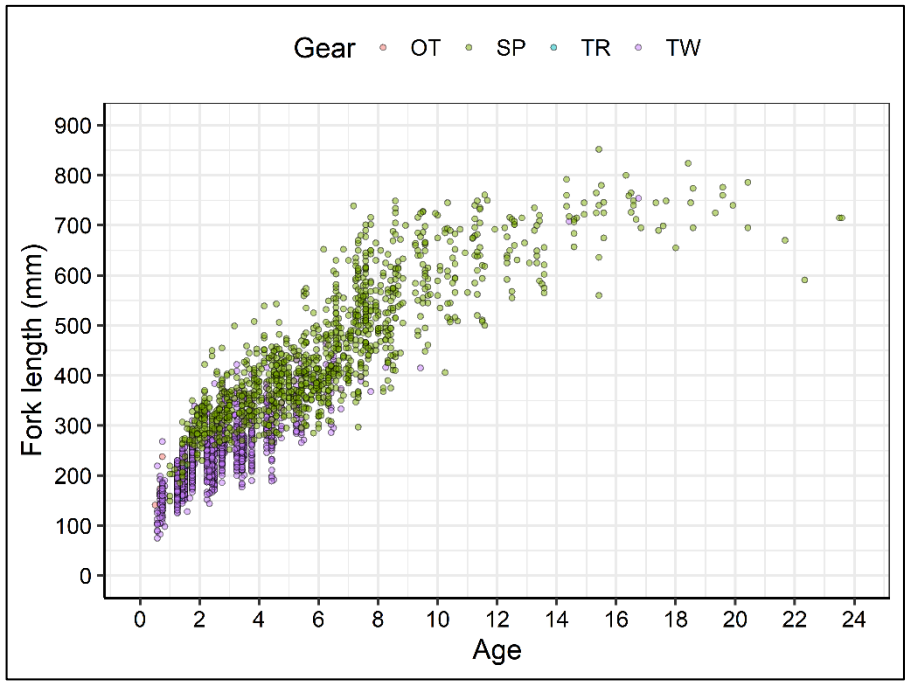


Figure 2.13.36. Hogfish length-at-age collected in the WFS stock and isolated by spear gear plus any fishery-independent sources between 1996 – 2024 (n = 2,317 otoliths). Data are defined (a) by depth strata as nearshore (< 30 m) and offshore (>= 30 m) and (b) by spear (SP), trap (TR), trawl (TW), and other (OT) fishing gears.

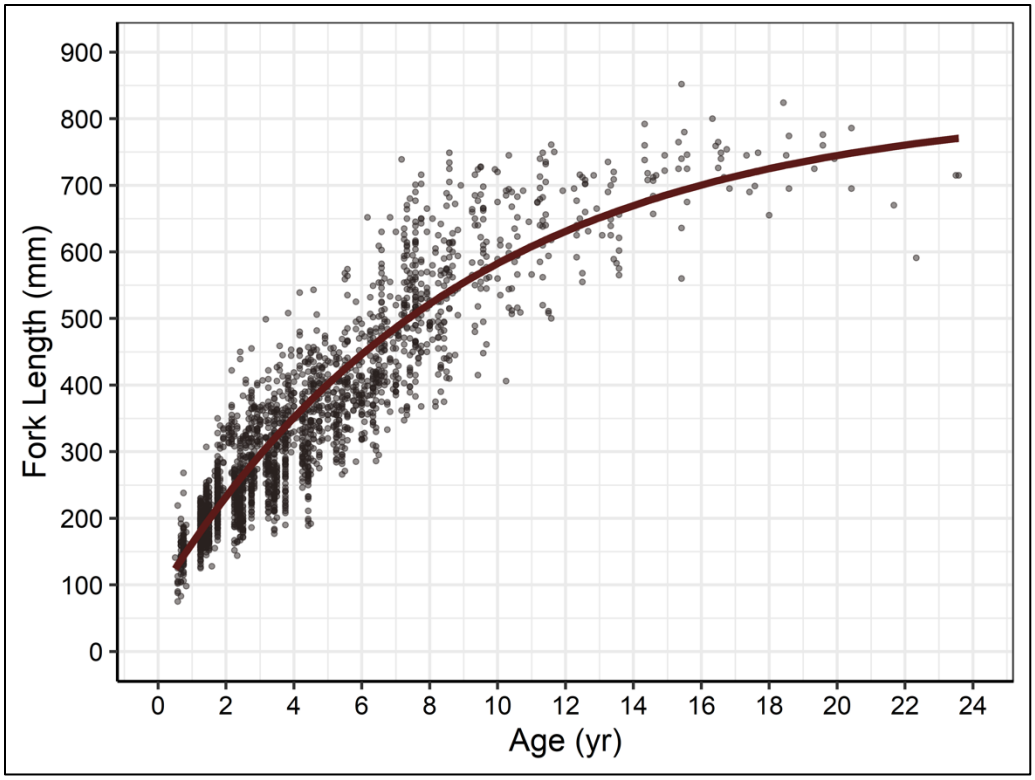


Figure 2.13.37. Size-truncated Hogfish length-at-age collected in the WFS stock and isolated by spear gear plus any fishery-independent sources between 1996 – 2024 (n = 2,226 otoliths). The red line is the predicted length-at-age from the best fit size-truncated von Bertalanffy growth model applied to inverse-weighted data where CV decreased linearly with age.

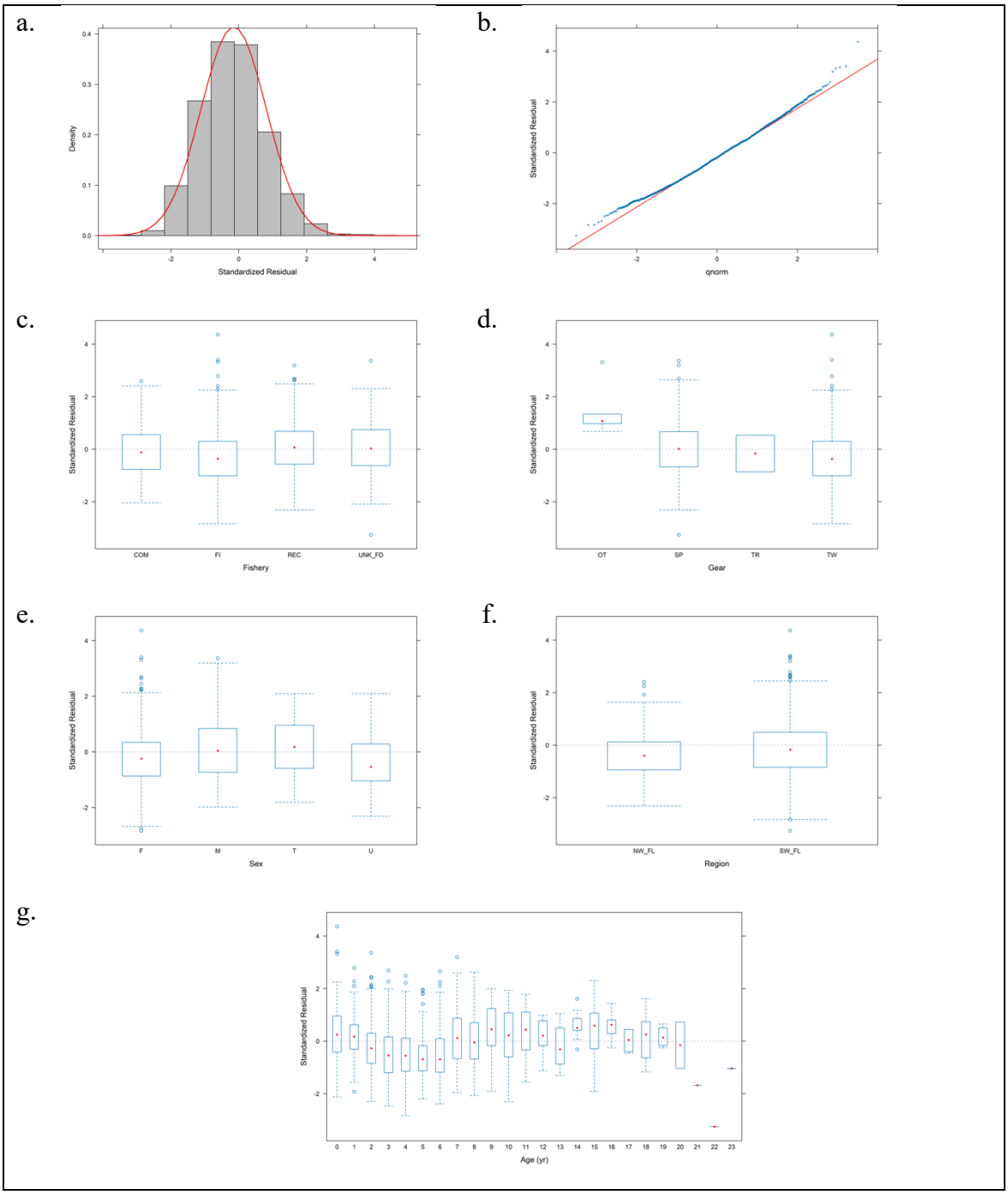


Figure 2.13.38. Standardized residual diagnostic plots for the recommended size-truncated von Bertalanffy growth model applied to inverse-weighted data where CV changed linearly with age: a) density distribution, b) normal probability plot (quantiles vs standardized residuals), c) standardized residuals by fishery, d) standardized residuals by gear, e) standardized residuals by sex, f) standardized residuals by region, and g) standardized residuals by age. Boxplots include the median, upper and lower quartiles, and outliers (open circles).

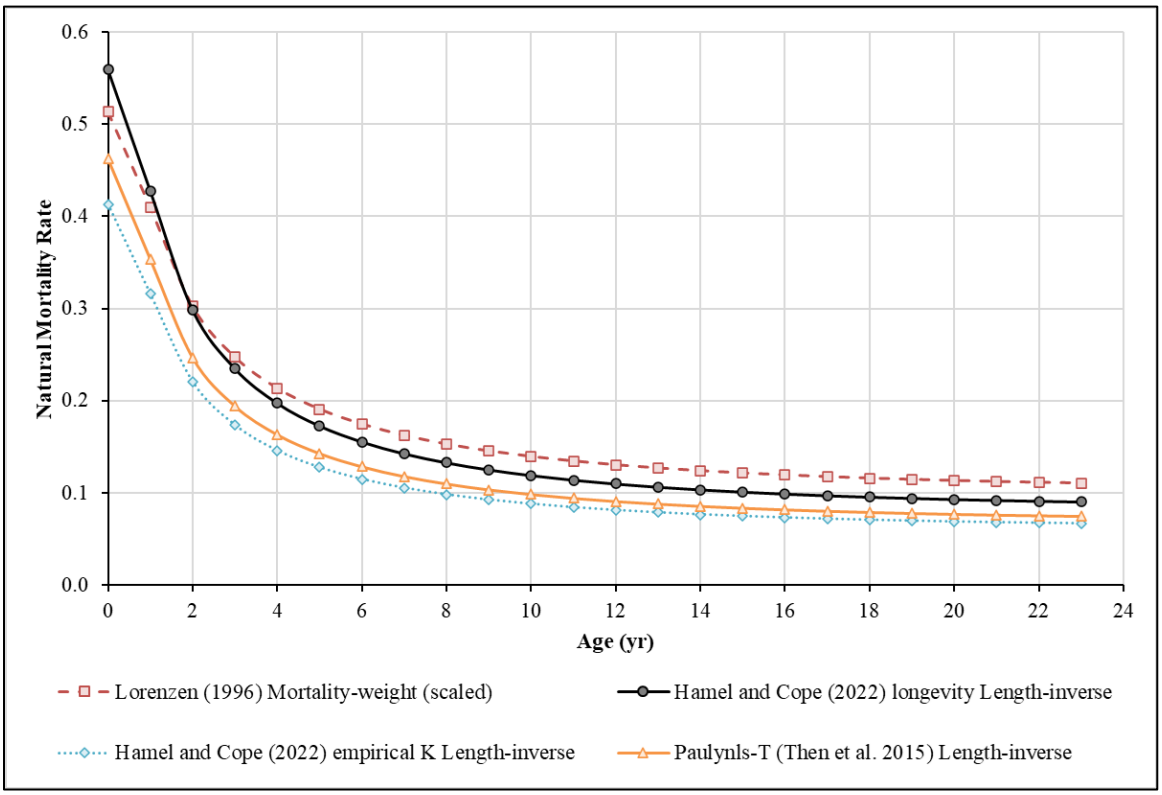


Figure 2.13.39. Natural mortality-at-age, *M(a)*, or -weight, *M(w)*, of Hogfish on the WFS with an observed maximum age of 23 years. 'Longevity', 'Empirical *K'*, and the 'Pauly$_{nls\text{-}T}$ revised' estimates of *M(a)* are derived following Lorenzen (2022) using their respective constant *M* estimates (0.235, 0.174, 0.194) as the reference *M* scaled to age 3 and the von Bertalanffy growth model parameters (L_∞ = 823; k = 0.112; t_0 = -0.954). Estimates of *M(w)* model followed Lorenzen (1996) and used length-weight parameters a = 3.018E-5 and b = 2.927.

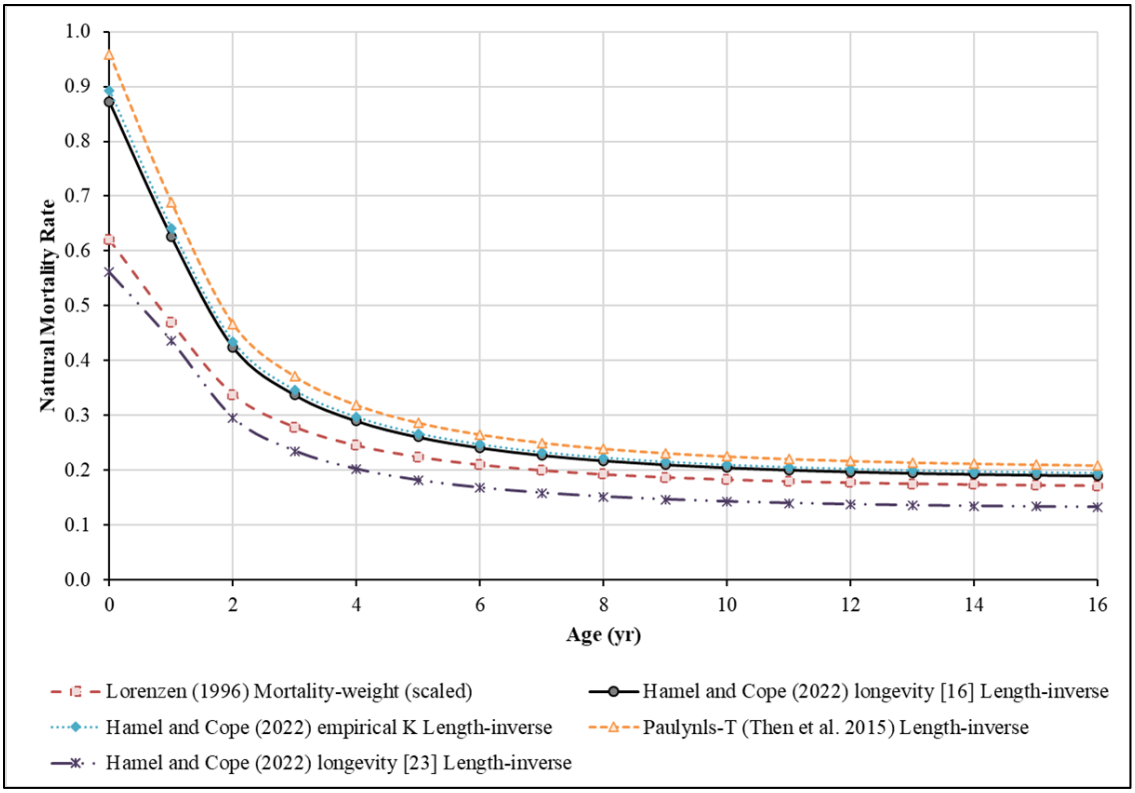
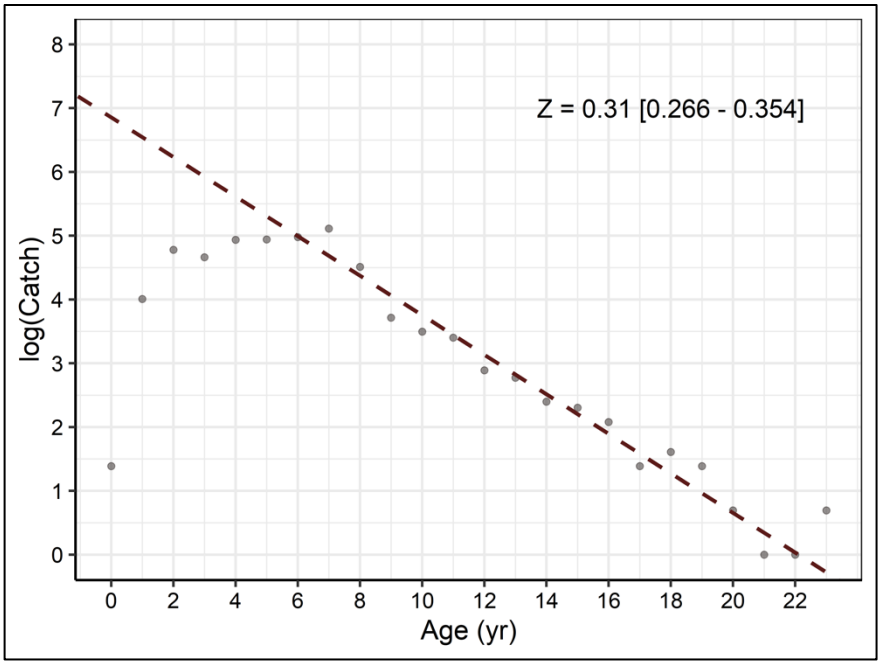


Figure 2.13.40. Natural mortality-at-age, *M(a)*, or -weight, *M(w)*, of Hogfish in the FLK/EFL when maximum age was either 16 or 23 years. 'Longevity', 'Empirical *K'*, and the '$Pauly_{nls\text{-}T}$ revised' estimates of *M(a)* are derived following Lorenzen (2022) using their respective constant *M* estimates (0.338 [16], 0.235[23], 0.346, 0.371) as the reference *M* scaled to age 3 and the von Bertalanffy growth model parameters (L_∞ = 531; k = 0.223; t_0 = -0.571). Estimates of *M(w)* model followed Lorenzen (1996) and used length-weight parameters a = 3.018E-5 and b = 2.927.

a.



b.

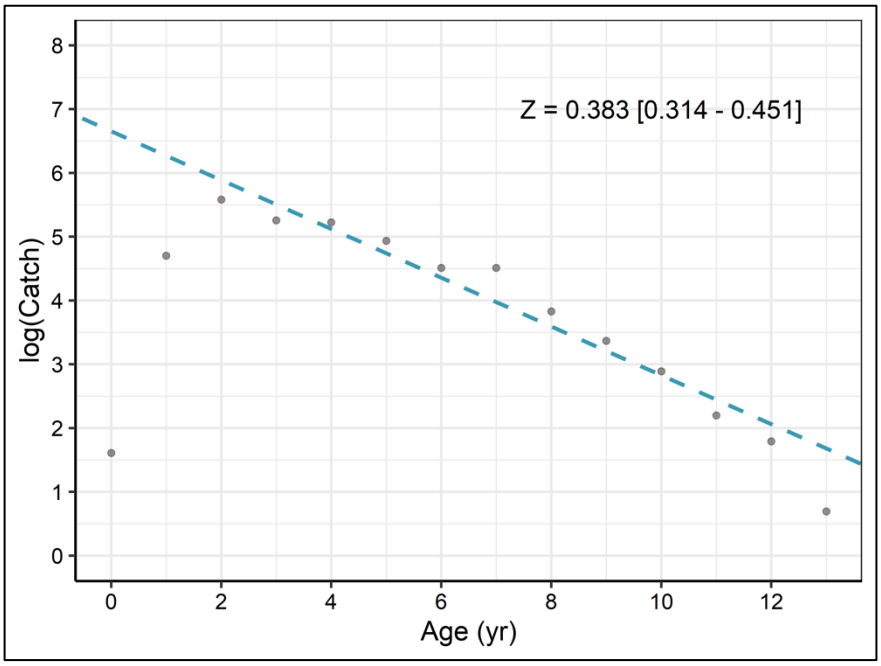
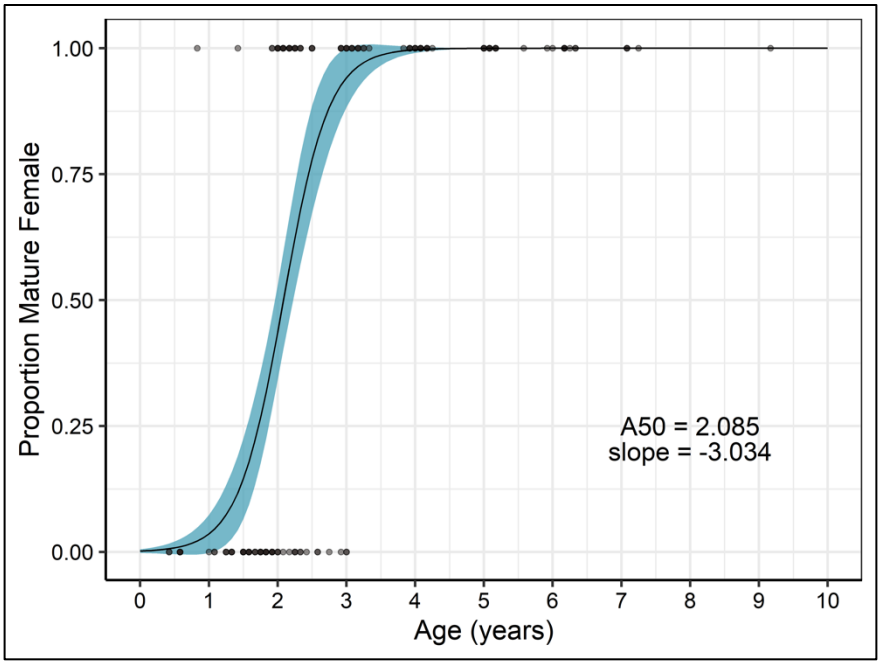


Figure 2.13.41. Catch-at-age data (log transformed) for Hogfish collected by the spear gear from 1996 – 2024 for catch curve analysis. Data were defined (a) by the WFS stock where the red dashed line is the weighted linear regression fit to ages 7 – 20 who are considered fully selected and (b) by the FLK/EFL stock where the blue dashed line is the weighted linear regression fit to ages 2 – 13 who are considered fully selected.

a.



b.

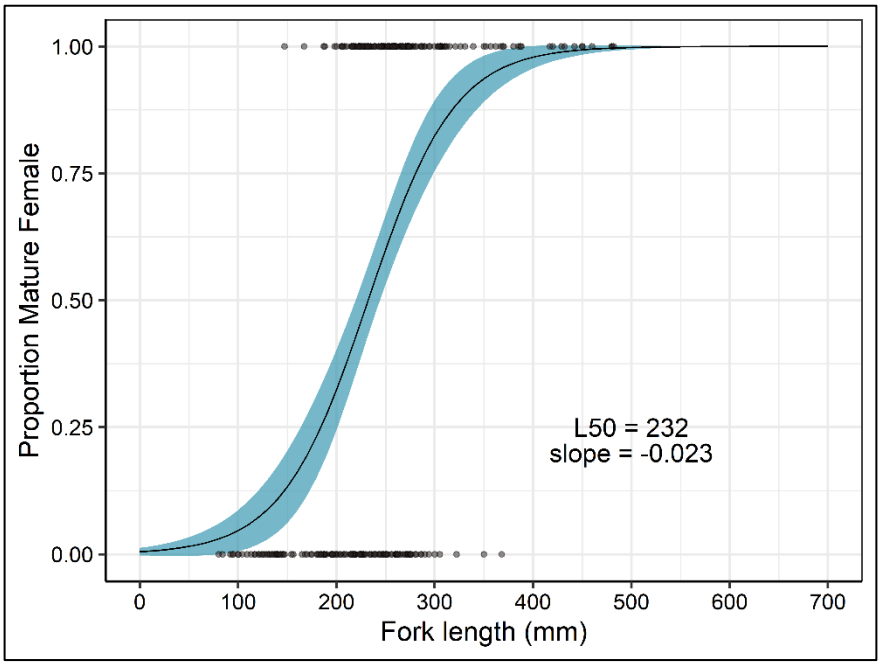
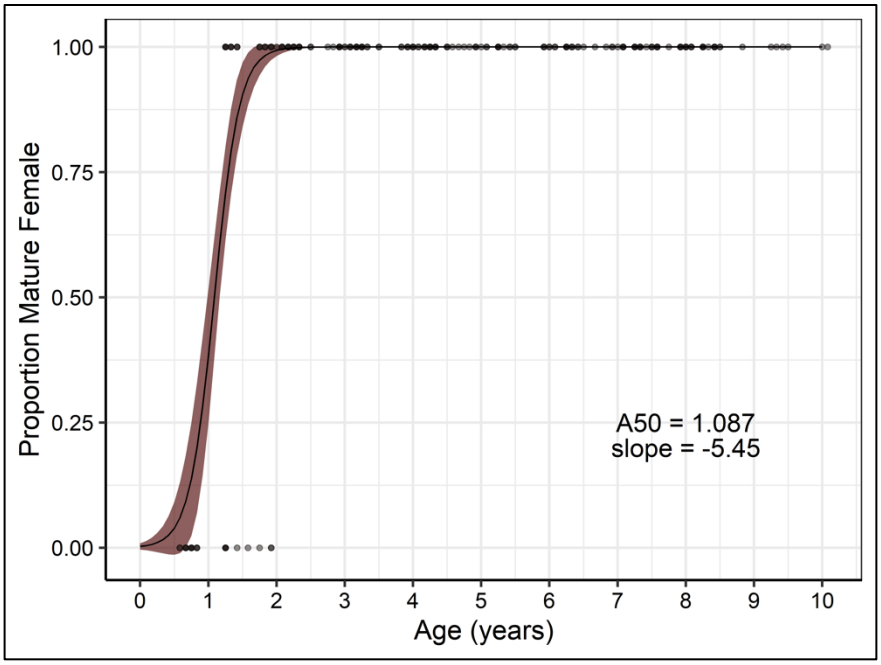


Figure 2.13.42. Observed (dots) and predicted (solid lines) female maturity-at-age (a) and -length (b) for Hogfish in the FLK/EFL described using logistic regression with 95% confidence intervals (blue shaded area). Immature females (class 1) were assigned a binomial maturity value of 0 while mature active spawning females (class 3) were assigned a binomial maturity value of 1. The estimated age at 50% maturity was 2.08 years and size at 50% maturity was 232 mm fork length.

a.



b.

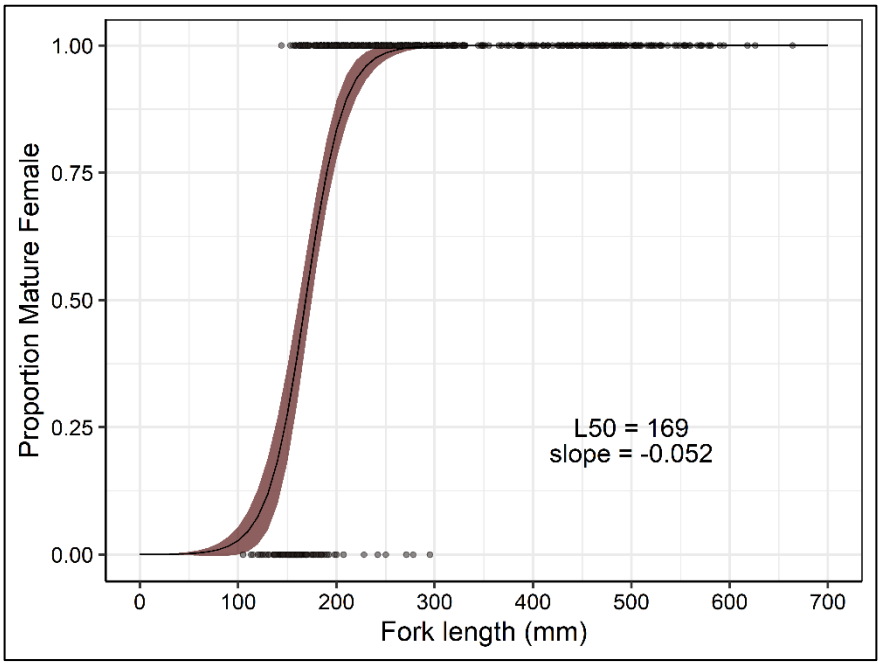
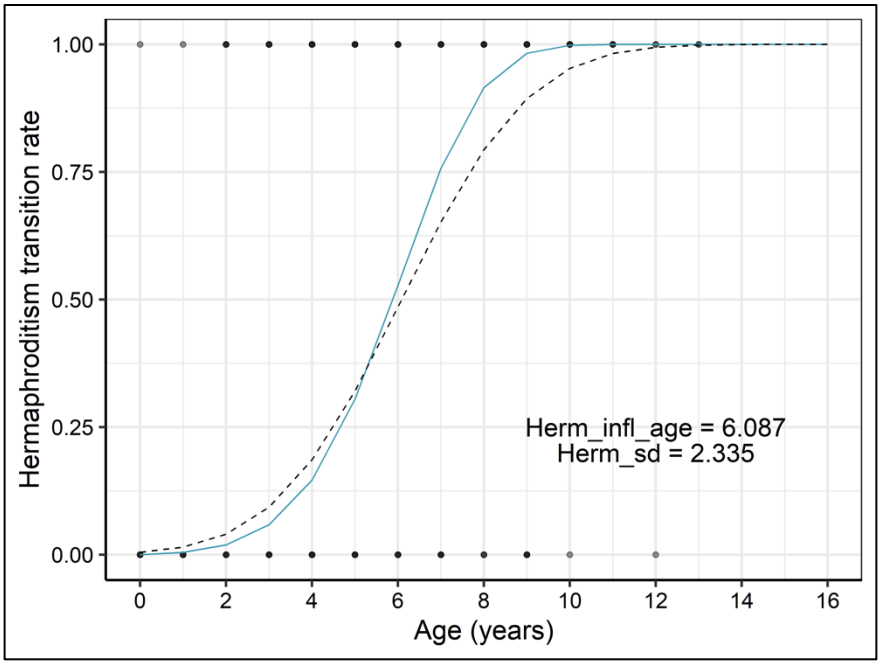


Figure 2.13.43. Observed (dots) and predicted (solid lines) female maturity-at-age (a) and -length (b) for Hogfish in the WFS described using logistic regression with 95% confidence intervals (red shaded area). Immature females (class 1) were assigned a binomial maturity value of 0 while mature active spawning females (class 3) were assigned a binomial maturity value of 1. The estimated age at 50% maturity was 1.09 years and size at 50% maturity was 169 mm fork length.

a.



b.

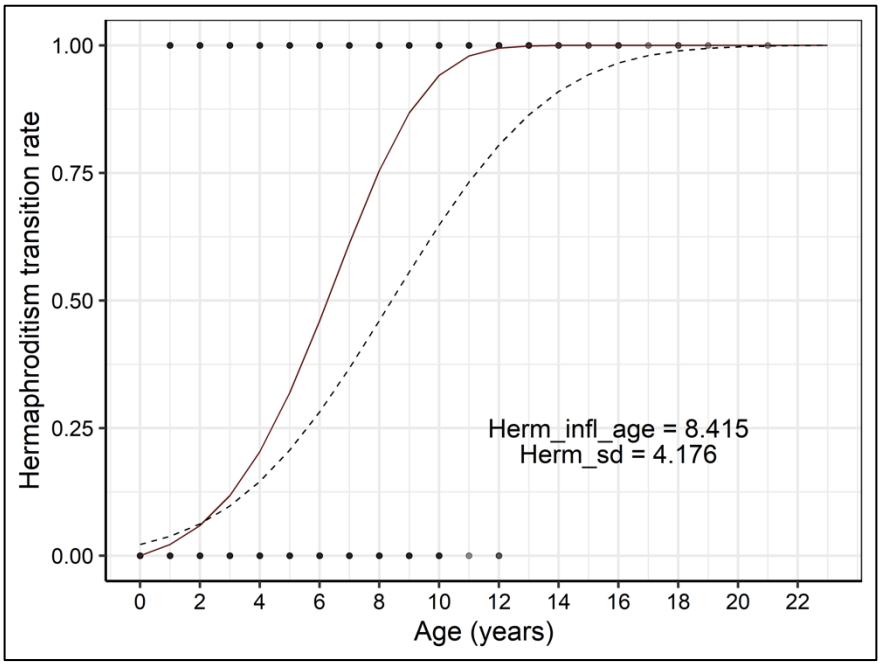


Figure 2.13.44. Female to male hermaphroditism transition probabilities (dashed lines) and the resulting proportion of males transitioned by age (solid lines) for Hogfish in the FLK/EFL (a) and WFS (b). Dots are the observed values where immature and mature females (classes 1 – 4) were assigned a binomial maturity value of 0 and classes 5 – 10 (transitional female-male and immature and mature males) were assigned a binomial maturity value of 1.

3 COMMERCIAL FISHERY STATISTICS

3.1 OVERVIEW

Commercial landings for the Hogfish stock were developed by gear (Hook and Line, Longline, Spearfishing, Trap, and Other) and fishing area in whole weight pounds for the period 1927-2024 based on federal and state database. Corresponding landings in numbers were based on mean weights estimated from the Trip Interview Program (TIP), aggregated by stock of fishing.

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

3.1.1 Commercial Workgroup Participants

Chris Bradshaw	Workgroup leader	FL FWC
Halie OFarrell	Rapporteur/Data	FL FWC
Abby Carrigan	Data Provider	FL FWC
David Griffith	Gulf SSC Member	Gulf Council
Scott Childress	Commercial	FL
Ben Choi	Commercial	FL
Kevin Thompson*	Data Provider	SEFSC
Michaela Pawluk*	Data Provider	SEFSC

*Did not attend workshop in person

3.1.2 Issues Discussed at the Data Workshop

Issues discussed included start and end years for landings and discards, spatial aggregations by stock, data sources, uncertainty estimates, proportioning landings with unknown gears, and discard mortality. There are no known species identification issues with Hogfish, both historically and in present day.

The group received invaluable feedback from multiple industry members. The information provided by industry experts was used to guide discussion and workgroup decisions and helped cross validate signals and trends in commercial data.

Specific industry feedback for the plenary were: Industry has seen differences between the coasts in fish size and want that to be reflected in the number of fish estimates (not letting the North of FL fish influence management of Florida fish), concern about the impact of the recreational hook

and line fishery and desire to consider limiting that fishery in some way, industry has seen a large reduction in commercial effort but not abundance observed on trips (outside of areas with high recreation fishing pressure), and industry indicates that Hogfish was never the sole/primary target when fishing but a welcome opportunistic catch.

Commercial landings, 1927 to 2024 were provided to assessment staff on 7/11/2025. The working group recommended using data from 1986-2024, matching the start year of previous assessments (SEDAR 37), if supported by the assessment model. The decisions were made after expert discussion on commercial uncertainty and available recreational data. The main driver in selecting 1986 was that the number of trips prior to that date are not available.

Data were aggregated, when possible, into the following stocks to inform the model to the greatest extent possible: West of Florida, West Florida, East Florida and the Keys, and North of Florida. Stocks are based on fishing area when available, and not on county landed as a primary method for stock assignment. If fishing area was not available, then county landed was used. If that was unavailable, then the waterbody was indicated in ALS data.

3.2 REVIEW OF WORKING PAPERS

SEDAR 94-DW-04: Standardized catch rates of Hogfish (*Lachnolaimus maximus*) from the Southeastern U.S. commercial spear fishery, 1993-2024: This document describes the development of the SEDAR 94 commercial logbook index for the Hogfish commercial spear fishery. Initial Hogfish indices of abundance using the Commercial Fisheries Logbook Program data were constructed through 2012 during SEDAR 37 (SEDAR 37WP-12) and updated through 2017 for the SEDAR 37 Update assessment (SEDAR 37U Assessment Report). The report focuses on the Florida regions, without consideration of the north of Florida or west of Florida Hogfish fisheries.

SEDAR 94-DW-06: Historical Commercial Fishery Landings of Hogfish in the Southeastern U.S.: This report compares and combines the NOAA Fisheries Accumulated Landings System and Florida Trip Ticket data as data sources for establishing appropriate commercial landings data by year, stock, and gear to be included in the stock assessment model for Hogfish.

SEDAR 94-DW-07: Length frequency distributions for Hogfish collected by TIP in the Southeast from 1984 to 2024: This report documents changes in the length frequency distributions (LFDs) of Hogfish samples collected from the Southeastern United States from 1984 to 2024. The 2017 Hogfish update for SEDAR 37 produced length frequency distributions (LFDs) for fork length (FL). In this document, LFDs for FL using Hogfish stocks were created for assessment staff to use in the assessment.

SEDAR 94-DW-09: Commercial discard data limitations for Hogfish (*Lachnolaimus maximus*) in Florida for the Vertical Line and Spearfishing fleet: This working paper presents the initial exploratory analyses of available observer data for Florida Hogfish discard estimates. It concludes that too little commercial data on discards exists to estimate discard mortality for Hogfish.

3.3 COMMERCIAL LANDINGS

DW ToR #5: *Provide commercial catch statistics through 2024, including both landings and discards in both pounds and number.*

- *Evaluate and discuss the adequacy of available data for accurately characterizing harvest and discard by fishery sector or gear*
- *Provide length and age distributions for both landings and discards if feasible*
- *Provide maps of fishery effort and harvest and fishery sector or gear*
- *Provide estimates of uncertainty around each set of landings and discard estimates*

Commercial landings of Hogfish were compiled from 1927 through 2024 for the SE US and Gulf. Sources for landings included the Florida Fish and Wildlife Conservation Commission Trip Ticket program (FWC) and Southeast Fisheries Science Center (SEFSC).

Comparisons were made between Florida's commercial Trip Ticket data (1986-2024) to the NMFS ALS (1927-2024). The Accumulative Landings System (ALS) data contained yearly (1927-1977) and monthly (1978- 2024) aggregated landings of Hogfish. The ALS data are of a longer time series than Florida Trip Ticket, but both datasets appear similar when comparing Florida landings from 1986-2024 with ALS landings for Florida (Figure 3.1). The workgroup decided to combine landings from Florida Trip Ticket and NMFS ALS for all states to establish final commercial landings by stock and gear for all years.

3.3.1 Commercial Gears Considered

Commercial gear was initially compiled into the following groups requested by assessment staff: Hook and Line, Longline, Traps, Spearfishing, and Other. The workgroup investigated reported landings for Hogfish and determined that the predominant commercial gears were Spearfishing and Hook and Line. However, the other gears were also reported throughout most of the time series. Hook and Line and Longline had similar length distributions and were excellent candidates for fleet consolidation in the model, particularly since Hogfish tend to be caught incidentally rather than directly targeted. The length distributions for the Other gear were different from all other gears and it was determined that they should be added to a general hooked Gear category because of their low contribution to landings. The work group's recommendation was to categorize landings into the following groups: Spearfishing, Hooked Gears (combination of Hook and Line, Longline, and Other), and Traps (Table 3.1).

Commercial landings data collected by NMFS before the FL Trip Ticket program's inception often contain unknown gear information. The Florida General Canvass dataset, within the ALS database, contains annual landings 1976-1996. These data were submitted by federal port agents responsible for a particular county within Florida (Gloeckner, 2014). The General Canvass data provides estimated proportions of the landings by gear and area. Those proportions are then used to apportion ALS or Trip Ticket landings by gear and area when gear or area information is missing for 1977-1985. For unknown gears in Florida Trip Ticket data, the group decided to use 1986-2003 Trip Ticket data with known gear were used to create proportions by year, stock, and gear which were then applied to landings with unknown gear.

A list of gears included in each category can be found in Table 3.2.

Decision: The work group recommended three gear groupings to characterize the Hogfish fishery: Spearfishing, Hooked Gears, and Trap.

The decision was approved by the plenary.

Commercial Stocks

Since most Hogfish landings occur in Florida, the stock assessment group asked that the landings be separated by the following stocks: north of Florida, East Florida and the Keys, West Florida,

and west of Florida. Data for all stocks were provided, and the current assessment decision is to use only the stocks that occur in Florida.

3.3.2 Misidentification of Hogfish

The workgroup discussed the potential for misidentification of Hogfish in the commercial sector. The opinion of the industry representatives and the workgroup was that misidentifications were unlikely based on the distinctive shape and coloration of Hogfish.

Decision: The Workgroup does not feel that there is a likelihood of misidentification of Hogfish in the commercial sector and no modifications are needed to commercial landings.

This decision was approved by the plenary.

3.3.3 Commercial Landings by Gear and Stock

Table 3.3 shows annual Hogfish landings in whole weight pounds by stock and gear. Although all data for stock and gear combinations were provided, Table 3.3 shows only non-confidential landings. Landings presented in this report that do not meet the rule of 3 are either removed or aggregated.

3.3.4 Uncertainty

After consultation with assessment biologists, the commercial workgroup estimated uncertainty in commercial fishery landings using a similar methodology and modifying the uncertainty estimates used in SEDAR 64 (Yellowtail Snapper), SEDAR 82 (South Atlantic Grey Triggerfish) and SEDAR 90 (Atlantic Red Snapper). These estimates of uncertainty are not coefficients of variation but are estimates of possible reporting error that represent the range in actual commercial landings relative to the reported landings.

Because of its unique appearance and that the conclusion that misidentification would be unlikely, a single assumption was used in establishing uncertainty estimates for commercial landings of Hogfish:

Landings may be underreported during all years; but underreporting was likely highest during the early years of the time series and landings were more accurate in recent years. Monthly landings summaries were collected during the period of 1978 to the beginning of Trip Ticket data collection (starting dates vary among states). The most recent landings data, collected through the Florida Trip Ticket program, were assumed to be the most reliable and inclusive of all commercial landings. Based on this information, Table 3.4 shows estimated uncertainties by multi-year blocks for Hogfish. A table of annual uncertainty estimates with rows for each year (an expanded version of Table 3.4 needed as a model input) will be provided to the assessment team.

This table was approved by the plenary.

3.3.5 Converting Landings in Weight to Landings to Numbers

The initial estimate of average weight of Hogfish, used to produce numbers of fish from landings of fish in whole pounds, was made using annual data from all stocks because of low sample sizes. Average weights were computed from surrounding years for years without TIP weights. Feedback from industry within the workgroup when discussing converting pounds landed into numbers of fish was that they were worried that TIP values from outside of Florida (North of Florida stock) would have too great an impact on the number of fish estimates. In response to this, and based on discussions at plenary, other methods were investigated: by year and stock, a single value for each stock using all years combined, dividing the samples up by management actions (year and stock), dividing the samples up by condensed management actions (year and stock), dividing the samples up by management actions (year and stock) median values instead of averages, and dividing the samples up by condensed management actions (year and stock) median values instead of averages.

Decision: The workgroup supports using average values by condensed management actions. The stocks were divided into two broad management categories: no size limit/12-inch size limit (before 2017) and current size limits [14” in the Gulf and 16” in the South Atlantic] (after 2017) Table 3.5. TIP data was not available for West of Florida, so values from West Florida were used as a proxy.

This decision was approved by the plenary.

3.4 COMMERCIAL DISCARDS

Methods used to explore commercial discards are described in document SEDAR 94-DW-09. Previously, Hogfish assessments in Florida calculated commercial discards for the vertical line (handline and electric/hydraulic "bandit" gear) and spearfishing fisheries using Southeast Fisheries Science Center (SEFSC) Discard Logbook Program data (SEDAR 37 Update). Since the SEDAR 37 update in 2018, analyses conducted by NOAA-SEFSC staff have indicated that the discard logbook data should no longer be used for assessments (Alhale et al. 2024). Given the lack of data and previously estimated minimal discards, the recommendation is to not calculate commercial discards for this species. Although it was discussed in Plenary that the recreational sector had a range for their hook and line discards, input from industry indicates that commercial gear has low to no discards due to how the commercial sector operates.

Decision: The Workgroup supports the exclusion of commercial discard data due to high uncertainty and low sample size as well as industry input about low levels of discards.

This decision was approved by the plenary.

3.5 COMMERCIAL EFFORT

The distribution of commercial effort in trips by aggregated gear and aggregated year block was compiled from the Florida Trip Ticket database for 1927-2024. The years were combined into 1927-1977 (annual ALS data), 1978-1985 (monthly ALS data), 1986-1995, 1996-2005, 2006-2015, and 2016-2024 to protect confidential data. Gear data were combined into Hooked Gears, Spearfishing, and Other gear to protect confidentiality. Effort (trips) aggregates are provided for informational purposes. These data are presented in Figure 3.2 (A. Hooked Gears, B. Spearfishing, and C. Other gear). The distribution of harvest by stock is displayed in Figure 3.3 (A. Hooked Gears, B. Spearfishing, and C. Other gear).

3.6 BIOLOGICAL SAMPLING

Commercial length data were available from the SEFSC Trip Interview Program for 1984-2024. TIP data were supplied by SEFSC staff. TIP data were pulled from the SEFSC TIPONLINE.TIP_MV table, which is a master view table that collapses the one-to many relational tables in the main TIP database tables. The TIP_MV table is audited weekly to ensure that the contents agree with the master data tables.

Data were assigned to a stock via a hierarchal procedure. If area fished was in the interview's effort information (e.g. usually derived from captain) this was used. If this information was not available, but area fished was provided in the interview's landings information (e.g. derived from the dealer's records), then the landings information was used. If area fished was in neither the effort nor the landings information, then the state and county of landing were used to make a stock assignment. When a single trip used multiple gears, the primary gear was assigned to each record with an assumption that the first gear recorded and entered by a sampler was the primary gear type used during the trip.

The group reviewed TIP catch length compositions, aggregated across all years and by stock (N FL and the Keys, W FL, W of FL, and N of FL). Low sample sizes in certain years and stocks required aggregations for display to the plenary and in public facing documentation.

3.6.1 Length/Age Distribution

Landings

All Hogfish lengths were converted to mm but kept within measured length types (fork length). Length and landings data were divided into stocks based on the area fished. Length compositions by length type, stock, and year will be provided for the SEDAR 94 Assessment Workshop.

Trends seen in length frequencies were validated by other work groups and industry representatives. North of Florida exhibits larger fish.

All Hogfish lengths were grouped by their length type measured in the field. Lengths in the data delivery were not converted using formulas from the SEDAR 94 Life History Group as assessment staff had indicated that they would prefer to do all conversions themselves. All Hogfish lengths were binned into two-centimeter groups. The length and landings data were divided into the same stock and gear groupings. Annual length compositions of Hogfish have been provided for the SEDAR 94 Assessment Workshop. Length was also not converted to weight (whole weight in pounds) using conversions provided by the SEDAR 94 Life History Group as the Assessment staff also wished to perform these conversions themselves.

Discards

Observer reported length data of discarded Hogfish were not provided.

3.6.2 Adequacy for Characterizing Catch

Length sampling are inadequate for stock/gear combinations in some years and aggregation will be needed. Particular attention to sample size needs to be paid when using the length compositions. The samples for some years, particularly more recent, are dominated by catch from North of Florida where individuals tend to be larger than the fish caught in Florida.

3.7 COMMENTS ON ADEQUACY OF DATA FOR ASSESSMENT ANALYSES

The workgroup asserts that the landings data are adequate for the assessment analyses. There is a clear landings history for the available time series. Commercial landings were relatively unsubstantial, and effort is not available prior to the 1980's, and the group asserts that the time series starting at 1986 would be best, provided it aligns with other aspects of data availability and modeling needs. There were no documented issues with species identification, nor any irregular or noticeably inaccurate reporting to state and federal agencies.

Commercial landings data were available north of Florida and were included in data sets provided to assessment staff.

Discard data were deemed to be inadequate and were not provided. Biological sampling data were deemed to be adequate. However, as mentioned, low sample sizes in certain years and stock combinations required aggregation.

3.8 LITERATURE CITED

Alhale, S., S. Atkinson, K. Thompson, G. Decossas, K. Dettloff. 2024. Reliability of the Discard Logbook for Use in Commercial Discard Estimates in the South Atlantic. SEDAR92-RD-05.

Bradshaw, Christopher. 2025. Historical Commercial Fishery Landings of Hogfish in the Southeastern U.S. SEDAR94-DW-06. SEDAR, North Charleston, SC. 7 pp.

Bradshaw, Christopher. 2025. Length frequency distributions for Hogfish collected by TIP in the Southeast from 1984 to 2024. SEDAR94-DW-07. SEDAR, North Charleston, SC. 22 pp.

Gloeckner, David. 2014. Description of Commercial Landings Programs in the Southeast and ALS Database. SEDAR-PW6-RD57. SEDAR, North Charleston, SC. 18 pp.

Pawluk, Michaela and Kevin Thompson. 2025. Standardized catch rates of Hogfish (Lachnolaimus maximus) from the Southeastern U.S. commercial spear fishery, 1993-2024. SEDAR94-DW-04. SEDAR, North Charleston, SC. 23 pp.

Thompson, Kevin, Sarina Atkinson, and Gary Decossas. 2025. Commercial discard data limitations for Hogfish (*Lachnolaimus maximus*) in Florida for the Vertical Line and Spearfishing fleet. SEDAR94-DW-09. SEDAR, North Charleston, SC. 6 pp.

SEDAR 37 Update. 2018. SEDAR 37 Update - The 2018 stock assessment update report for Hogfish in the South Atlantic and Gulf of Mexico. SEDAR, North Charleston, SC. 211 pp.

3.9 RESEARCH RECOMMENDATIONS

Landings

- Improve gear, area, and effort data reported for each trip on state Trip Ticket programs to ensure more accurate data for future assessments.

Discards

- Continue to research alternative methods and analyses for estimating total effort during the closed season of a fishery.

- Recommend the observer program investigate the allocation of some observer coverage for focused trips to aid in future SEDARs as a subset of existing strata.
    - For Hogfish, this may include allocating addition effort to increase the probability of Hogfish encounters in areas of higher population density (SE FL, FL Keys, West Florida)

Biosampling

- Hold more frequent TIP trainings and increase port agent buy-in through information exchange with assessment and SEDAR staff focused on the usage of data collected by TIP staff to continue to refine data quality.
- Increase the priority of Hogfish sampling throughout its' distribution (potentially allocating funds to purchase landed Hogfish to increase the number of aged fish)

3.10 TABLES

Table 3.1 Length measurements from TIP by combined gear groups and year.

Year	Spearfishing	Hooked Gear	Other Gear
1984	0	54	0
1985	0	79	0
1986	0	13	0
1987	0	50	0
1988	0	67	0
1989	0	80	0
1990	0	147	92
1991	8	91	40
1992	139	160	42
1993	44	166	120
1994	39	112	53
1995	2	192	9
1996	25	79	16
1997	31	168	57
1998	31	325	157
1999	176	535	29
2000	35	511	186
2001	17	317	74
2002	49	243	169
2003	35	188	79
2004	64	112	4
2005	44	101	9
2006	33	93	8
2007	3	64	0
2008	185	76	4
2009	188	85	0
2010	294	114	35
2011	204	74	40
2012	128	51	29
2013	209	36	68
2014	537	52	4
2015	223	62	89
2016	240	52	8
2017	385	20	83
2018	106	23	89
2019	62	78	93
2020	120	29	43
2021	91	6	44
2022	40	26	1
2023	64	56	0
2024	166	57	0
Total	**4017**	**4844**	**1774**

Table 3.2 Specific gears in each SEDAR gear category for Hogfish commercial landings.

SEDAR Gear	Gear Code	Description
Hook and Line	6110	ROD AND REEL
Hook and Line	6120	HAND REEL
Hook and Line	6130	ELECTRIC REEL
Hook and Line	6301	HEAD BOAT
Hook and Line	6302	GUIDE BOAT
Hook and Line	6770	BOUY DROP LINE
Hook and Line	Check box	HOOK AND LINE
Longline	6750	LONG LINE, SURFACE/MIDWATER
Longline	6760	LONG LINE, BOTTOM
Longline	Check box	LONGLINE
Other	1890	BUTTERFLY/WING NET
Other	2001	SINGLE TRAWL
Other	2002	DOUBLE TRAWL
Other	2003	TWIN TRAWL
Other	2004	ROLLER TRAWL
Other	2005	ROLLER FRAME TRAWL
Other	2007	QUAD RIG TRAWL
Other	6210	TROLL LINES, MANUAL
Other	6303	CHARTER BOAT
Other	8300	DREDGE
Other	9355	OTHER TROPICALS
Other	9435	BULLY NET
Other	9437	BY HAND
Other	9955	AQUACULTURE
Other	Check box	GILL NET
Other	Check box	TRAWL
Spearfishing	7600	GIG/SPEAR
Spearfishing	9430	CHEMICAL, QUINALDINE
Spearfishing	9431	CHEMICAL, OTHER
Spearfishing	9432	HAND NET
Spearfishing	9433	SCUBA
Spearfishing	9434	SNORKEL
Traps	3300	BLUE CRAB TRAP
Traps	3330	STONE CRAB TRAP
Traps	3450	FISH TRAP
Traps	3550	LOBSTER TRAP
Traps	3860	OTHER TRAP
Traps	Check box	TRAPS
Unknown	0	UNKNOWN

Table 3.3 Commercial Hogfish landings (whole pounds) by year, stock, and gear. Data from NOAA Fisheries ALS (blue) and FL Trip Ticket (green).

Year	North of Florida					East Florida & the Keys					West Florida					West of Florida				
	HL	LL	OT	TR	SP	HL	LL	OT	TR	SP	HL	LL	OT	TR	SP	HL	LL	OT	TR	SP
1977						11,381					32,852									
1978						2,260					37,472					522				
1979						2,024					48,094									
1980						19,658							46,650			966				
1981						18,050							44,459			709		10,430		
1982						2,267							29,921			4,659		11,521		
1983						4,624							32,403			2,526		7,340		
1984						2,317							36,843			2,486	61	425		
1985						4,437							42,553			5,843				
1986						47,928							6,634			6,668		44		1,328
1987						64,085							9,597			4,312	2,462			2,500
1988						64,458							11,612			6,741	1,725	47		1,654
1989						78,858							31,312			13,272	572		143	1,186
1990						76,460					29,423		5,044	1,164	4,505	14,051	983		12,828	
1991						25,330	18	88	29,568	15,120	27,910		4,783	1,104	4,271	12,182	572	17	11,115	
1992						45,529	758	663	21,163	24,877	14,587	172	1,797	2,909	7,569	25,872			4,290	2,077
1993			3,503			48,439	12	133	21,450	24,848	21,658	58	1,207	10,496	8,985	28,025			78	
1994	5		0	2	10	32,544		150	6,886	23,439	15,269	182	221	5,055	10,216	19,038	102		75	3,848
1995	708		57	6	1,432	22,334	1,303	327	6,367	17,731	8,820	156	35	1,726	6,472	32,112		31	1,627	1,007
1996	8,607			1,241		20,084	80	200	5,901	17,435	5,722	319	173	2,390	8,406	6,966			498	
1997	8,562			1,017	58	23,366	11	135	8,452	15,331	5,853	213		4,015	9,040	15,513				205
1998	11,422			504		11,454	19	174	7,363	15,576	2,684	158		3,185	7,020	9,953				
1999	12,175			116	83	8,941	2	208	15,769	9,644	4,568	148	2	3,459	4,922	16,812				
2000	7,370			299	67	8,093	14	6	11,218	11,666	8,654	197		1,851	7,782	16,368				
2001	6,515				1,684	9,235	156	3	2,271	12,083	6,835	40	6	2,801	12,476	4,118		1,732	129	
2002	7,558				3,094	9,035		88	1,890	12,952	5,156			3,594	17,616	7,579		61	1,522	
2003	6,325				2,997	14,581	219	38	2,687	8,571	5,646	80	25	1,331	16,206	7,281		608	302	
2004	9,181				7,651	13,488	89	58	2,404	12,383	2,086	52		781	17,831	2,029				562
2005	12,107				2,883	6,718		6	1,337	8,787	2,554	149		24	13,211	3,554				671
2006	16,820				5,796	4,114		22	1,892	8,191	1,184				11,939	349				
2007	15,443				6,509	5,415	314	10	1,315	7,466	1,695	34			13,726	1,484				
2008	18,580				16,772	4,317	14	1	1,397	7,491	1,991	108			20,328	1,472				
2009	17,584				11,647	5,309		8	1,653	7,355	2,829				27,416	3,176				
2010	8,664				33,606	5,337		5	995	5,381	5,357			144	27,998					
2011	12,129				23,829	4,916		61	1,273	6,292	5,441			20	38,327					
2012	5,978				14,931	3,820		12	2,136	8,227	3,877		18		37,178					
2013	5,640				15,482	4,395			1,824	10,882	2,476	56		87	19,002					
2014	7,481				13,942	5,102		57	3,066	13,328	1,463			154	33,016					
2015	5,316				9,234	4,434			3,361	14,201	3,763			42	23,016					
2016	5,372				11,484	3,979			1,941	11,708	3,606			424	24,701					
2017	6,676				19,184	1,862			693	8,066	752		4	374	15,360					
2018	7,868				14,149	824			169	3,549	448			154	10,024					
2019	6,956				13,697	273			262	1,795	875			74	9,527					2,267
2020	5,674				13,591	211			95	2,624	326			40	8,173					
2021	5,940				12,023	333			78	2,972	427				10,458					5,008
2022	4,470				12,191	349			81	2,619	66			9	8,715					835
2023	13,895			17	5,031	135			95	2,276	427	36		6	8,244	47				
2024	1,970				11799	181			54	2,220	586				6,734	227				

Table 3.4 Estimated uncertainties for landings by year and state.

Year Range	LA	AL	FL	GA	SC	NC	Uncertainty direction
1920-1961	0.25	0.25	0.25	0.25	0.25	0.25	High and Low
1962-1977	0.20	0.20	0.20	0.20	0.20	0.20	
1978-1985	0.10	0.10	0.10	0.10	0.10	0.10	High Only
1986-1989	0.10	0.10	0.05	0.10	0.10	0.10	
1990-1993	0.10	0.10	0.05	0.10	0.10	0.10	
1994-1998	0.10	0.10	0.05	0.10	0.10	0.05	
1999-2000	0.05	0.10	0.05	0.10	0.10	0.05	
2001	0.05	0.05	0.05	0.10	0.10	0.05	
2002-2003	0.05	0.05	0.05	0.05	0.10	0.05	
2004-Present	0.05	0.05	0.05	0.05	0.05	0.05	

Table 3.5 Mean weight, Median weight, and Sample Size of fish from TIP (pounds) by stock and management strategy. No TIP data for West of Florida so West Florida values were used.

Stock	Management Period	Mean Weight	Median Weight	Sample Size
North of Florida	No size limit/12 in	10.007	9.412	421
North of Florida	16 inches	6.332	5.217	571
East Florida & Keys	No size limit/12 in	2.840	1.762	664
East Florida & Keys	16 inches	4.223	2.932	76
West Florida	No size limit/12 in	3.894	2.166	241
West Florida	14 inches	3.065	2.496	226
West of Florida	No size limit/12 in	3.894	2.166	*
West of Florida	14 inches	3.065	2.496	*

3.11 FIGURES

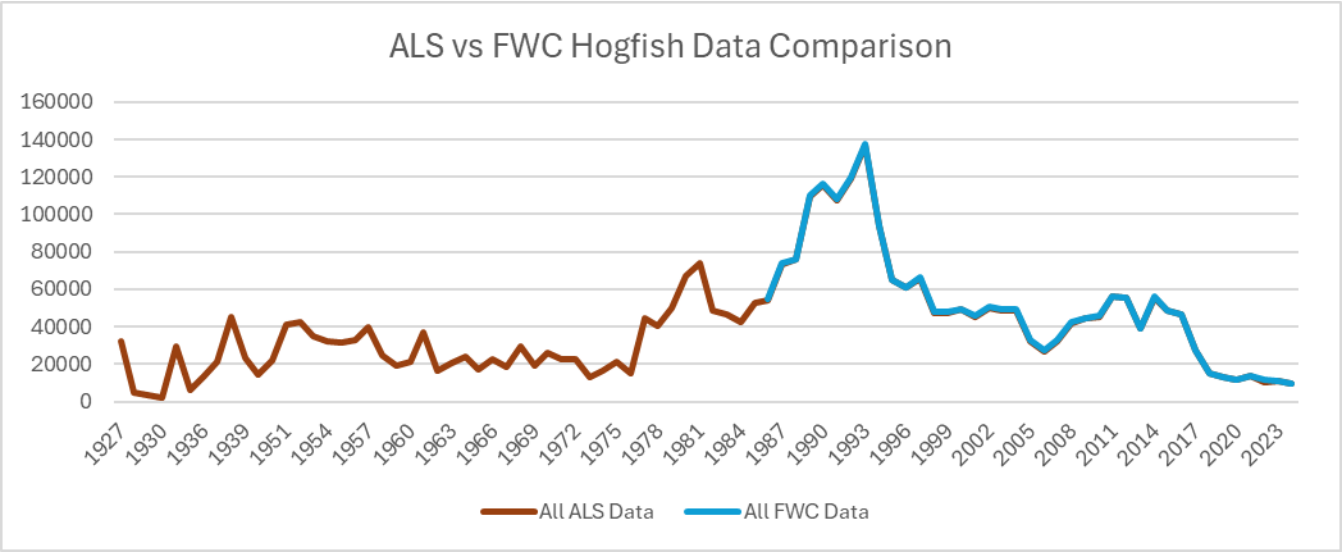
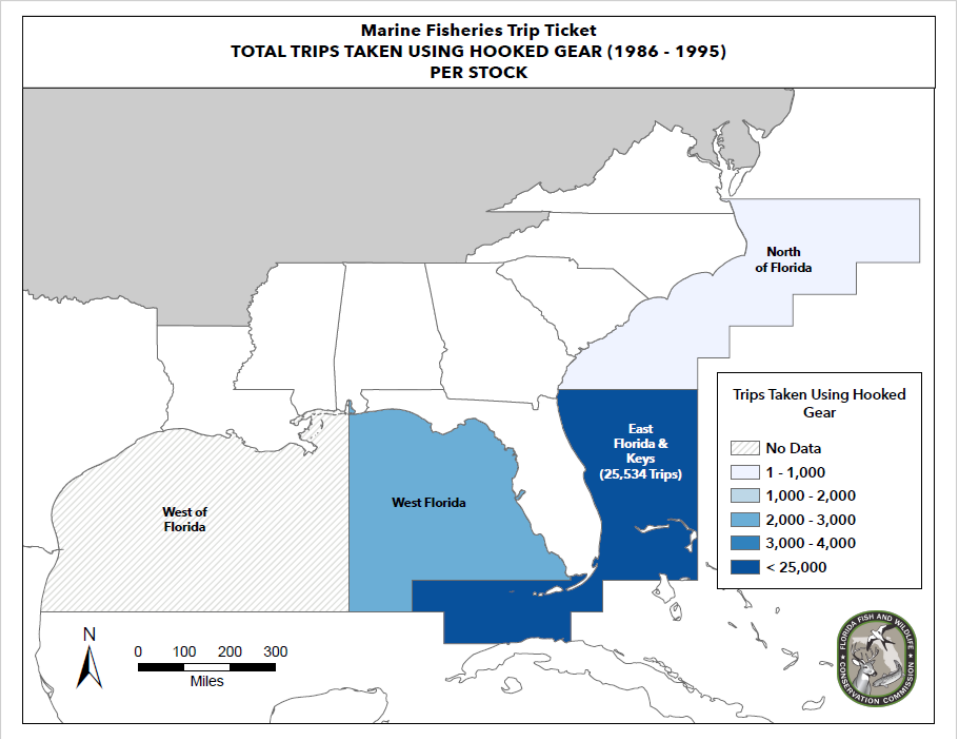
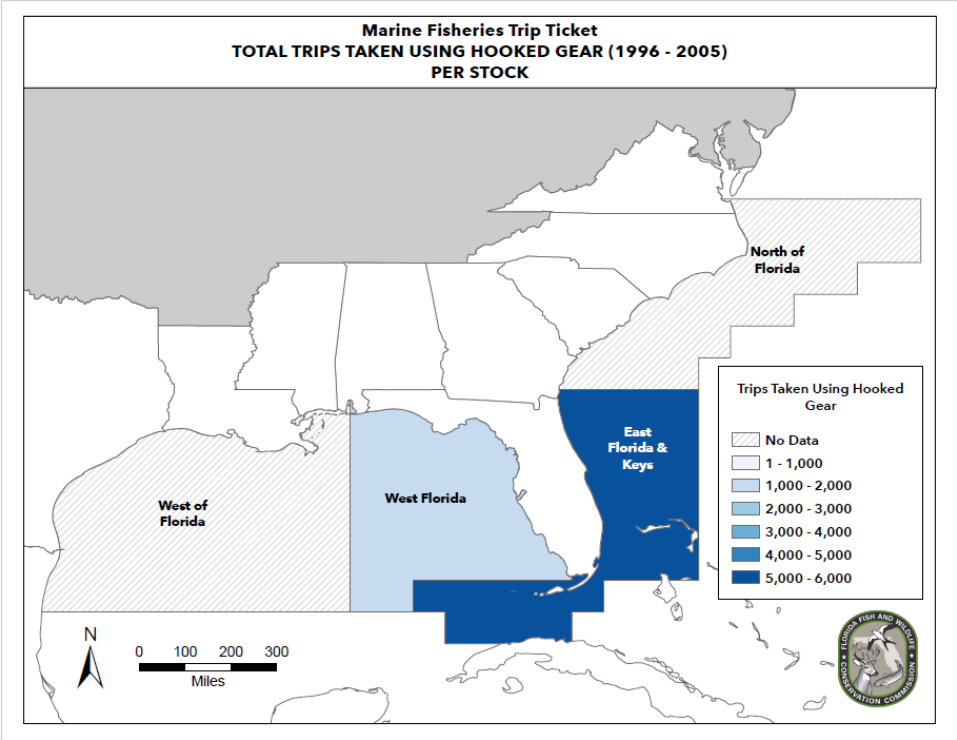
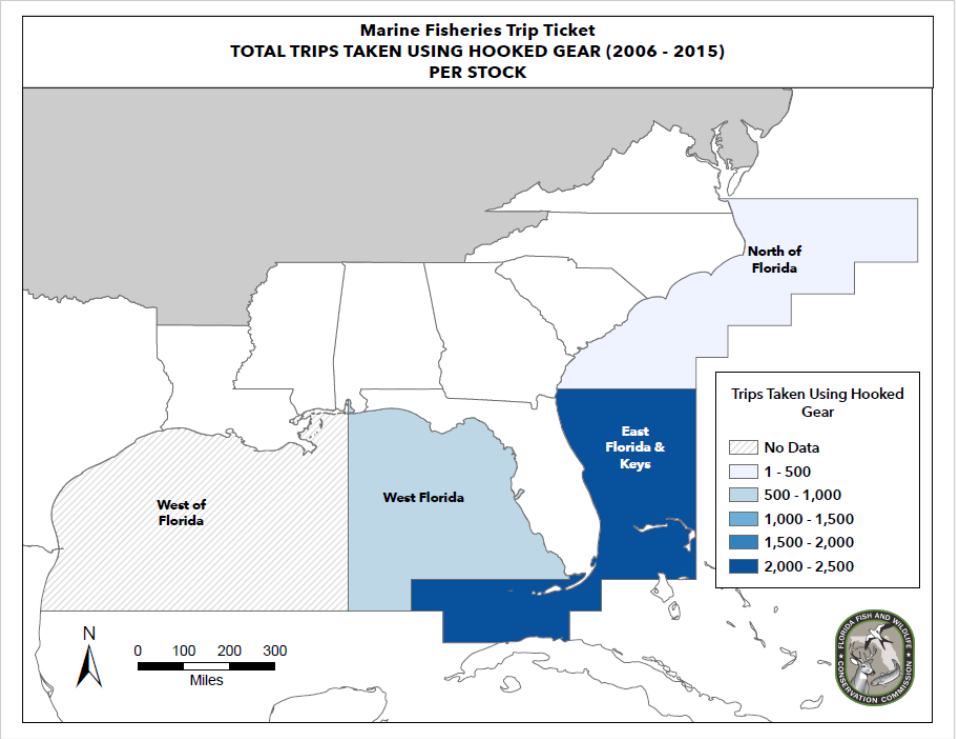


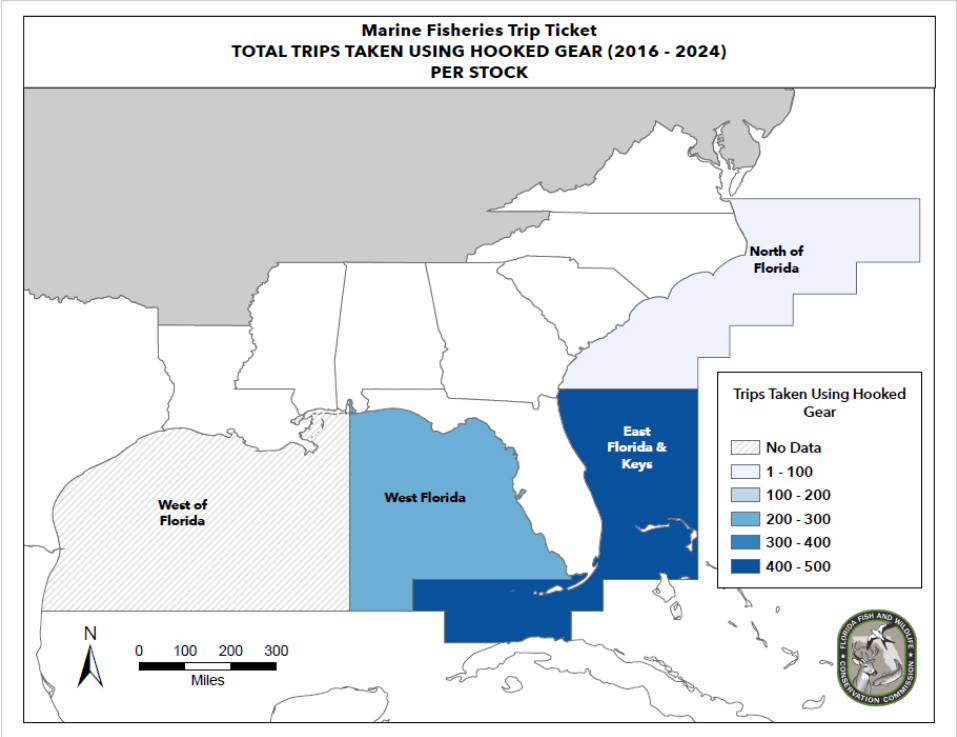
Figure 3.1 Comparison of total Hogfish landings for Florida between the Accumulative Landings System (All ALS Data) and Florida Trip Ticket Program (All FWC Data).

A.

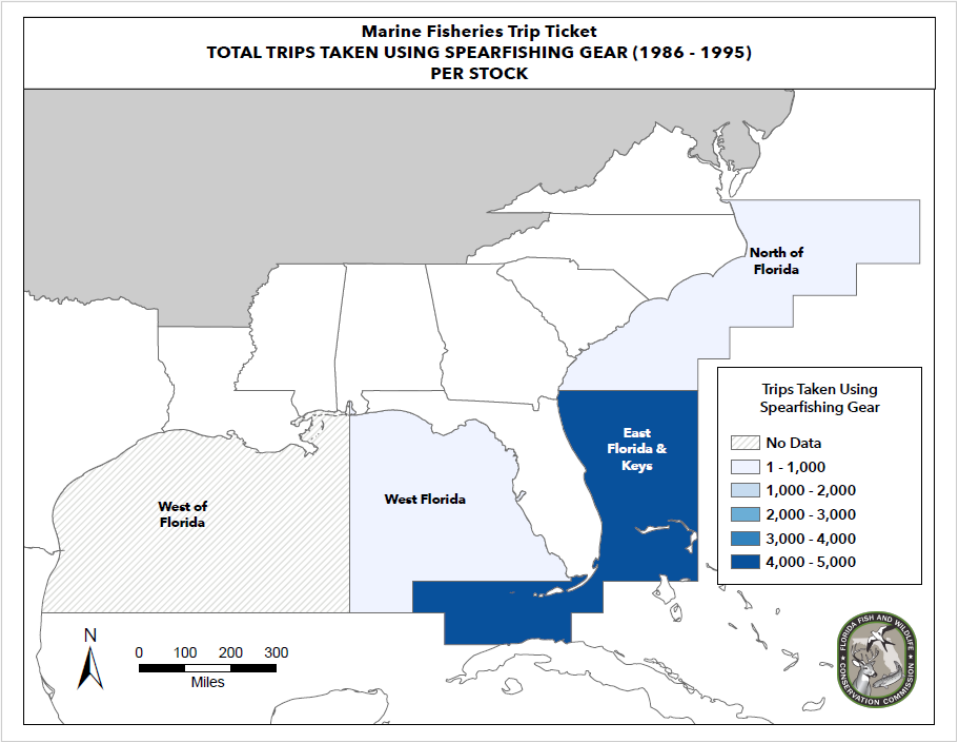

Marine Fisheries Trip Ticket
TOTAL TRIPS TAKEN USING HOOKED GEAR (1986 - 1995)
PER STOCK
North of Florida
East Florida & Keys (25,534 Trips)
West Florida
West of Florida
Trips Taken Using Hooked Gear
No Data
1 - 1,000
1,000 - 2,000
2,000 - 3,000
3,000 - 4,000
< 25,000
N
0 100 200 300
Miles

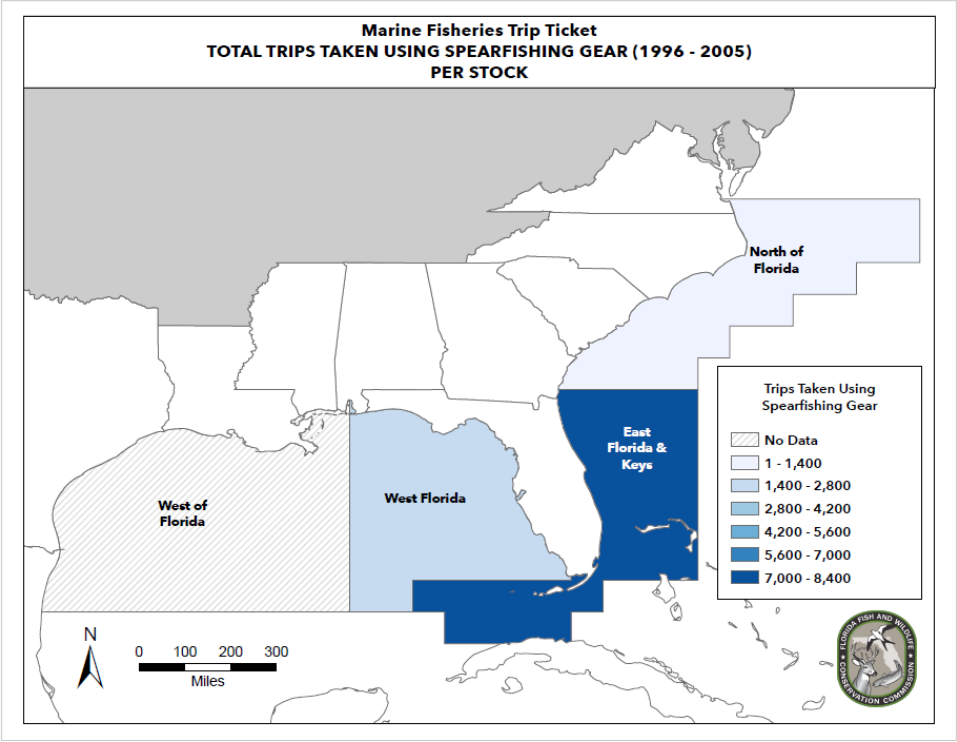

Marine Fisheries Trip Ticket
TOTAL TRIPS TAKEN USING HOOKED GEAR (1996 - 2005)
PER STOCK
North of Florida
East Florida & Keys
West Florida
West of Florida
Trips Taken Using Hooked Gear
No Data
1 - 1,000
1,000 - 2,000
2,000 - 3,000
3,000 - 4,000
4,000 - 5,000
5,000 - 6,000
N
0 100 200 300
Miles

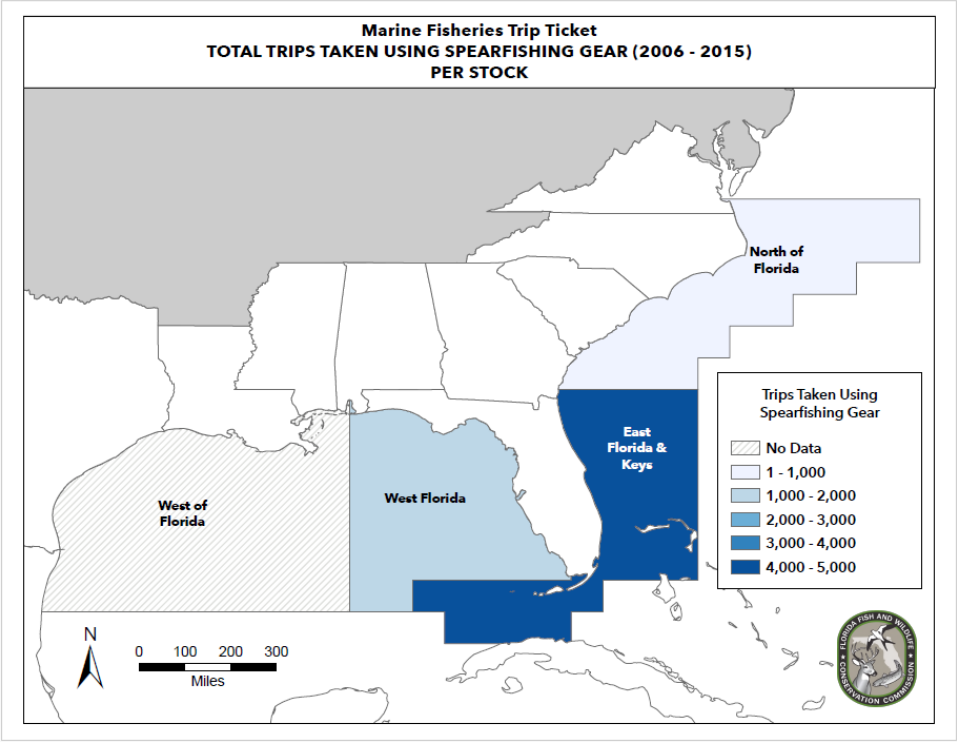

Marine Fisheries Trip Ticket
TOTAL TRIPS TAKEN USING HOOKED GEAR (2006 - 2015)
PER STOCK
North of Florida
East Florida & Keys
West Florida
West of Florida
Trips Taken Using Hooked Gear
No Data
1 - 500
500 - 1,000
1,000 - 1,500
1,500 - 2,000
2,000 - 2,500
N
0 100 200 300
Miles

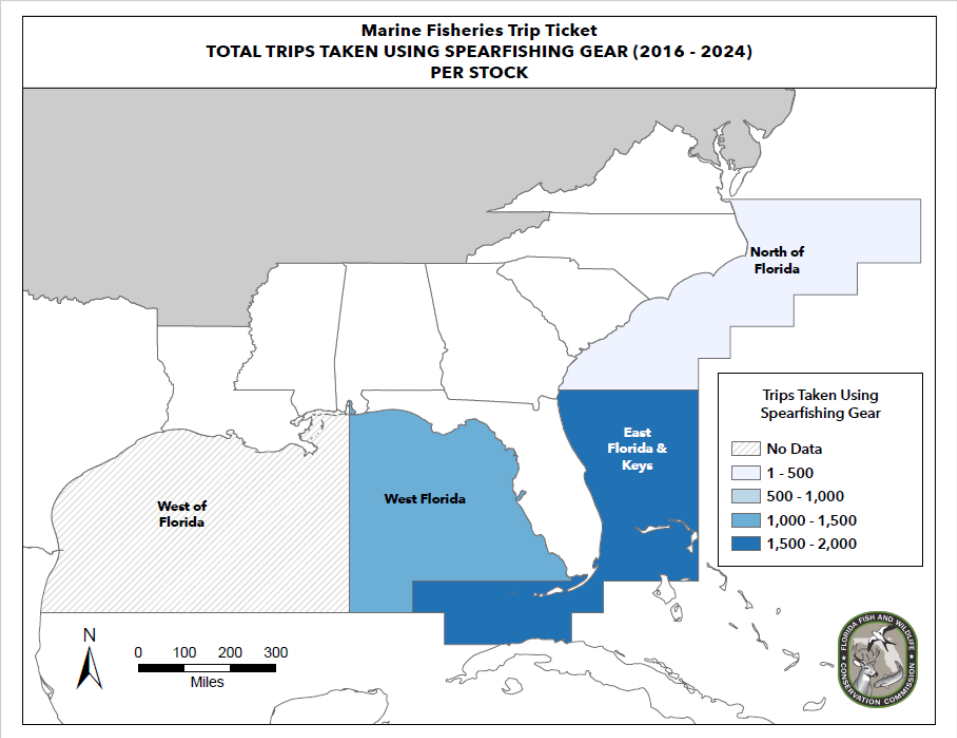

Marine Fisheries Trip Ticket
TOTAL TRIPS TAKEN USING HOOKED GEAR (2016 - 2024)
PER STOCK
North of Florida
East Florida & Keys
West Florida
West of Florida
Trips Taken Using Hooked Gear
No Data
1 - 100
100 - 200
200 - 300
300 - 400
400 - 500
N
0 100 200 300
Miles

B.

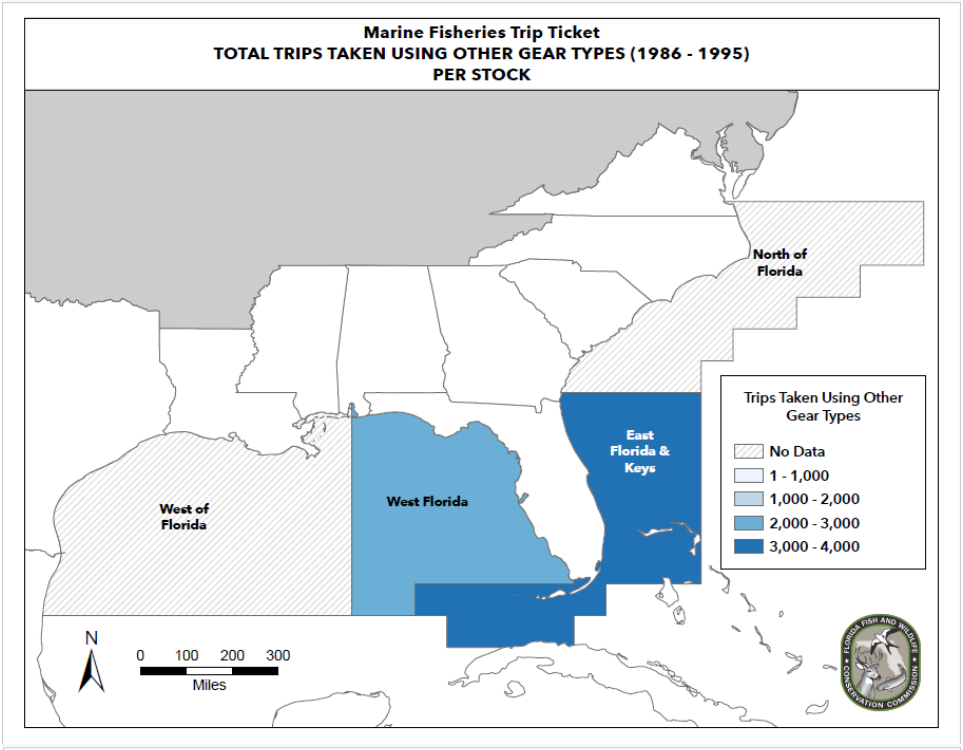

Marine Fisheries Trip Ticket
TOTAL TRIPS TAKEN USING SPEARFISHING GEAR (1986 - 1995)
PER STOCK
North of Florida
East Florida & Keys
West Florida
West of Florida
Trips Taken Using Spearfishing Gear
No Data
1 - 1,000
1,000 - 2,000
2,000 - 3,000
3,000 - 4,000
4,000 - 5,000
N
0 100 200 300
Miles

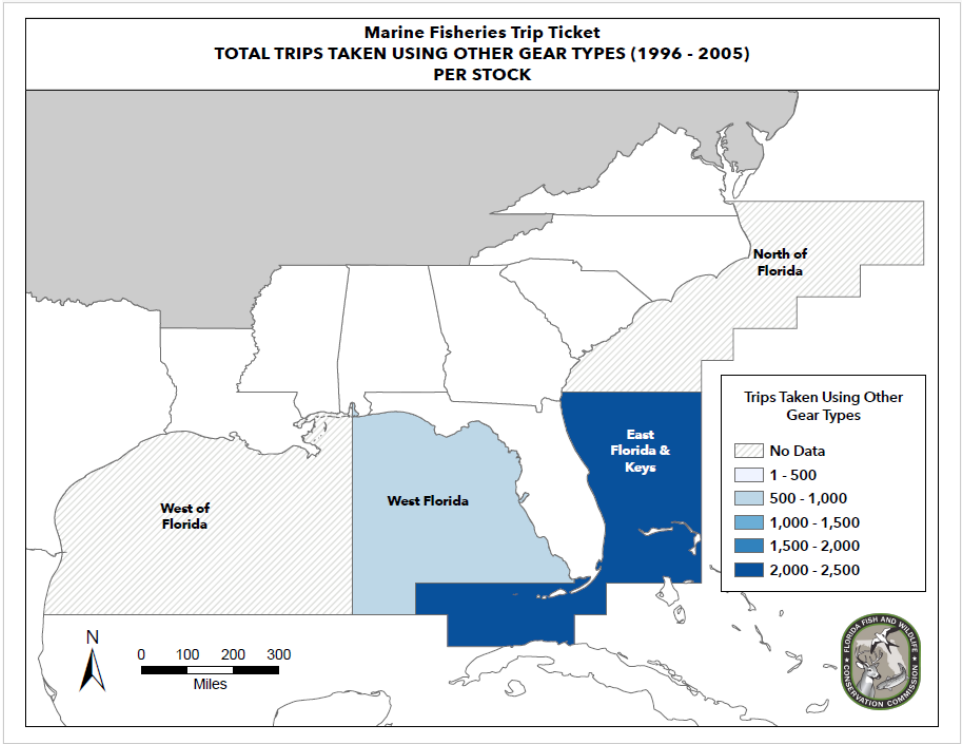

Marine Fisheries Trip Ticket
TOTAL TRIPS TAKEN USING SPEARFISHING GEAR (1996 - 2005)
PER STOCK
North of Florida
East Florida & Keys
West Florida
West of Florida
Trips Taken Using Spearfishing Gear
No Data
1 - 1,400
1,400 - 2,800
2,800 - 4,200
4,200 - 5,600
5,600 - 7,000
7,000 - 8,400
N
0 100 200 300
Miles


Marine Fisheries Trip Ticket
TOTAL TRIPS TAKEN USING SPEARFISHING GEAR (2006 - 2015)
PER STOCK
North of Florida
East Florida & Keys
West Florida
West of Florida
Trips Taken Using Spearfishing Gear
No Data
1 - 1,000
1,000 - 2,000
2,000 - 3,000
3,000 - 4,000
4,000 - 5,000
N
0 100 200 300
Miles


Marine Fisheries Trip Ticket
TOTAL TRIPS TAKEN USING SPEARFISHING GEAR (2016 - 2024)
PER STOCK
North of Florida
East Florida & Keys
West Florida
West of Florida
Trips Taken Using Spearfishing Gear
No Data
1 - 500
500 - 1,000
1,000 - 1,500
1,500 - 2,000
N
0 100 200 300
Miles

C.


Marine Fisheries Trip Ticket
TOTAL TRIPS TAKEN USING OTHER GEAR TYPES (1986 - 1995)
PER STOCK
North of Florida
East Florida & Keys
West Florida
West of Florida
Trips Taken Using Other Gear Types
No Data
1 - 1,000
1,000 - 2,000
2,000 - 3,000
3,000 - 4,000
N
0 100 200 300
Miles


Marine Fisheries Trip Ticket
TOTAL TRIPS TAKEN USING OTHER GEAR TYPES (1996 - 2005)
PER STOCK
North of Florida
East Florida & Keys
West Florida
West of Florida
Trips Taken Using Other Gear Types
No Data
1 - 500
500 - 1,000
1,000 - 1,500
1,500 - 2,000
2,000 - 2,500
N
0 100 200 300
Miles

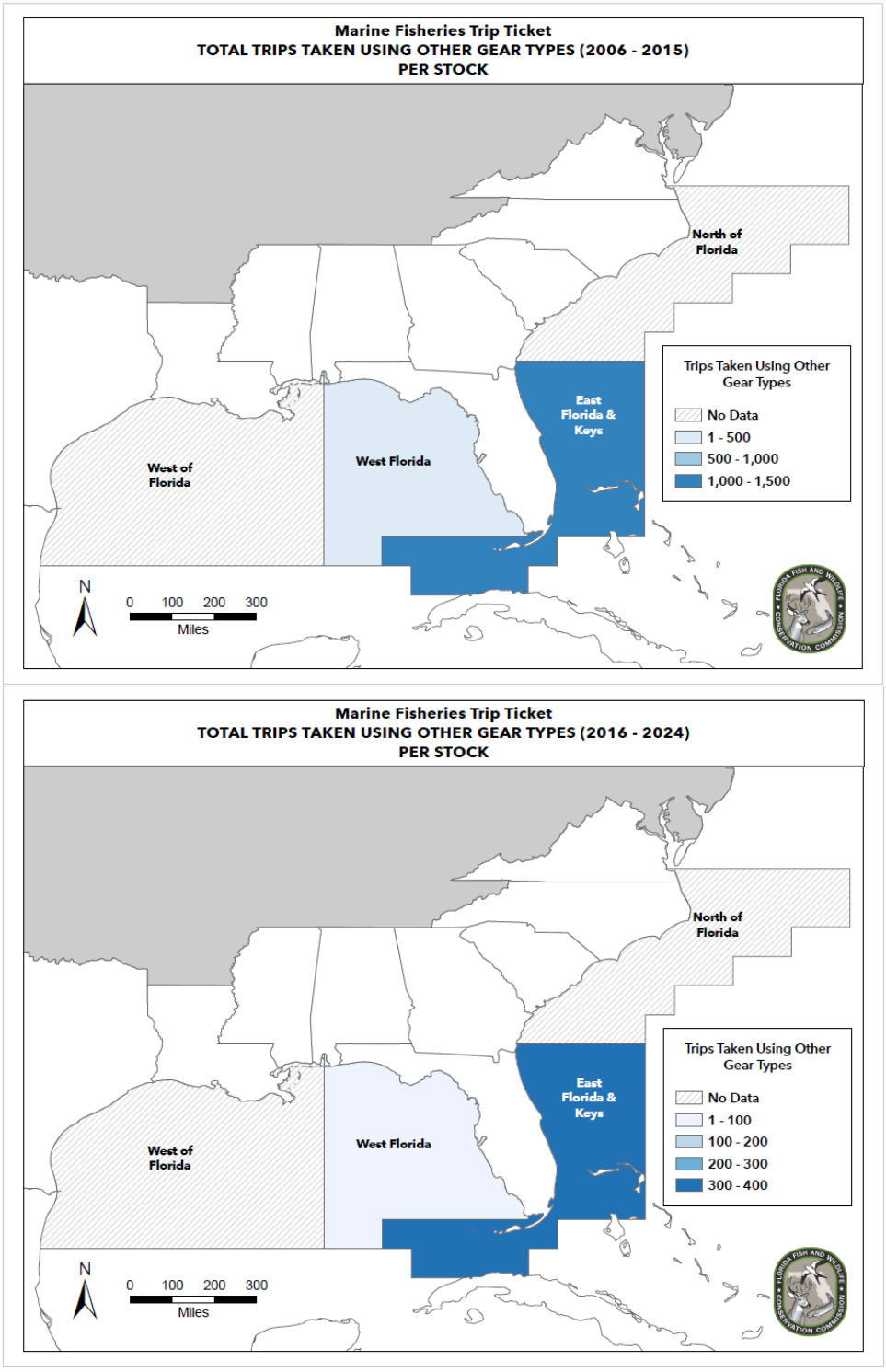
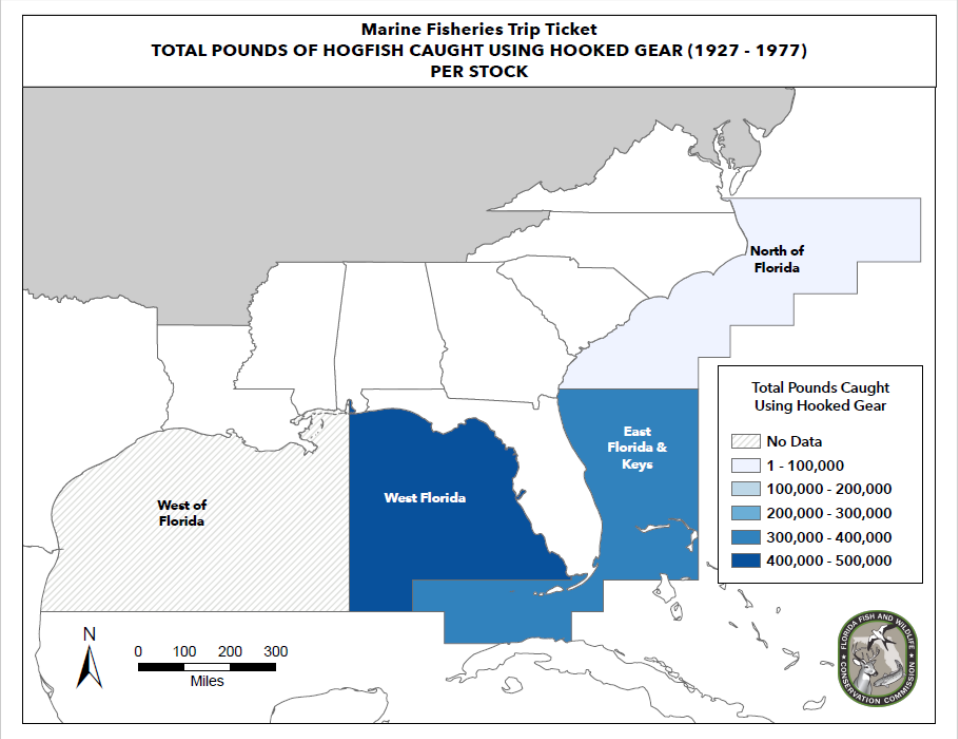
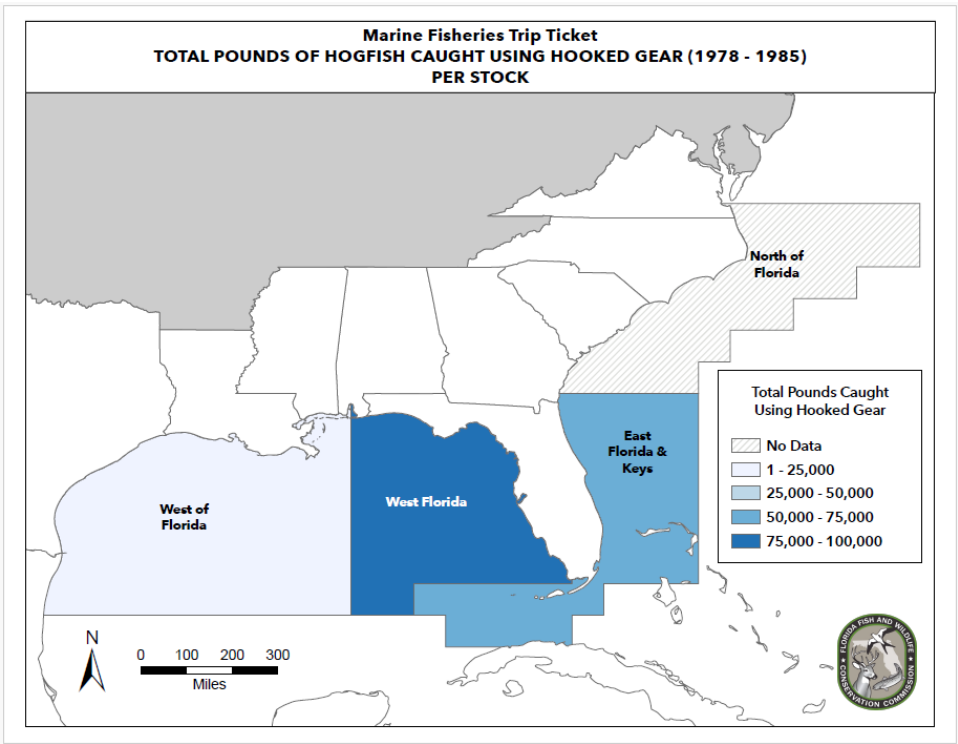
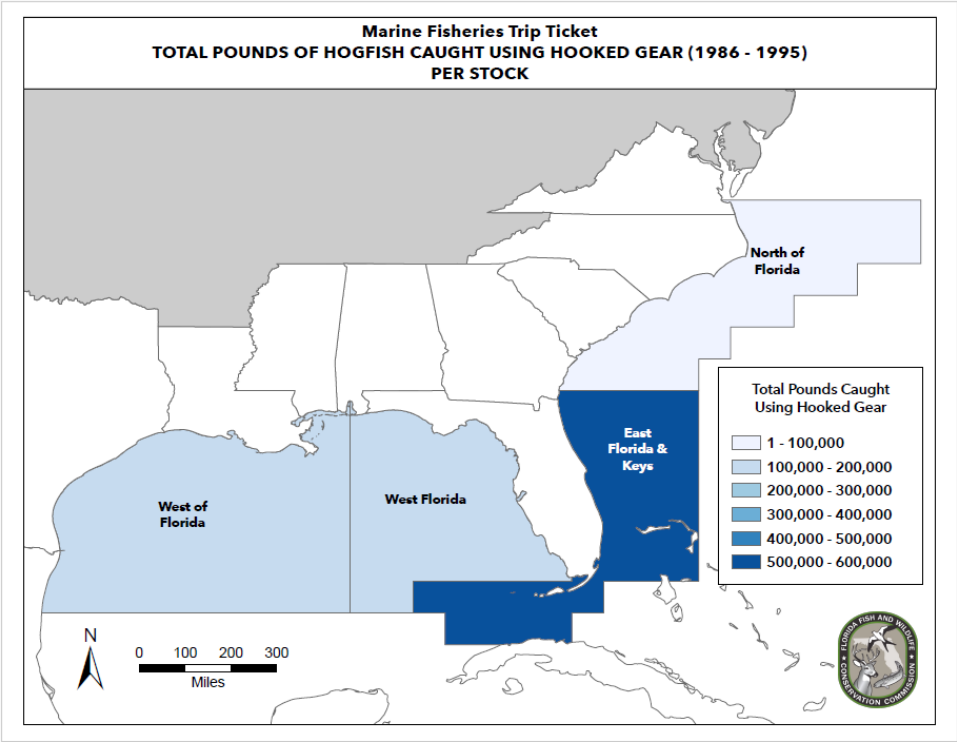


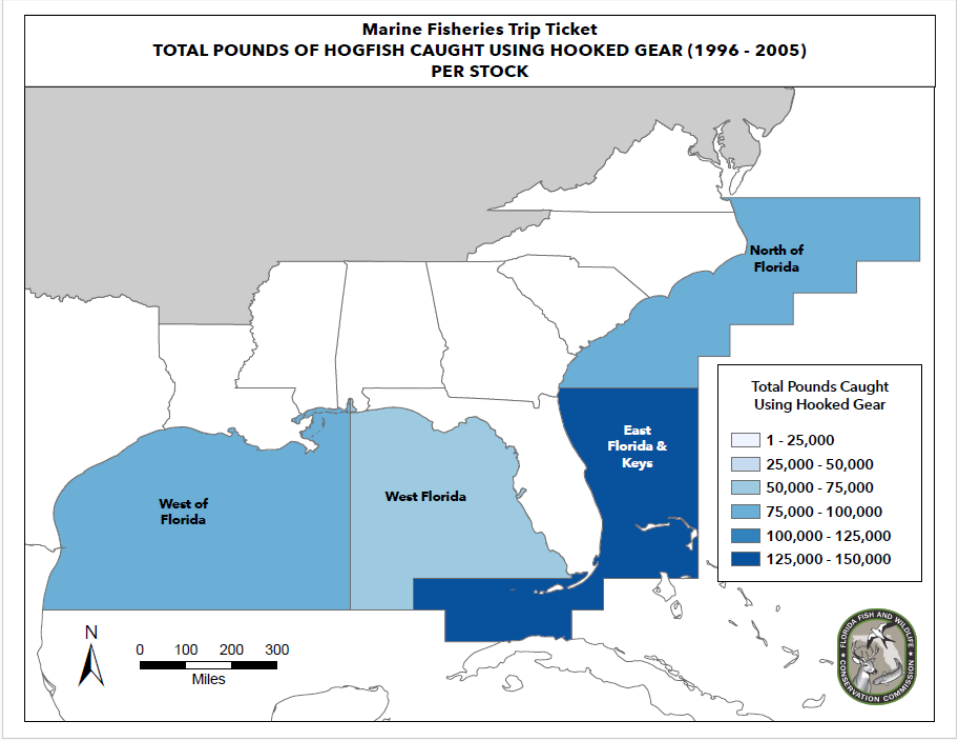
Figure 3.2 Effort data by aggregated year: 1986-1995, 1996-2005, 2006-2015, and 2016-2024. Gear data were aggregated into A. Hooked Gears, B. Spearfishing, and C. Other gear.

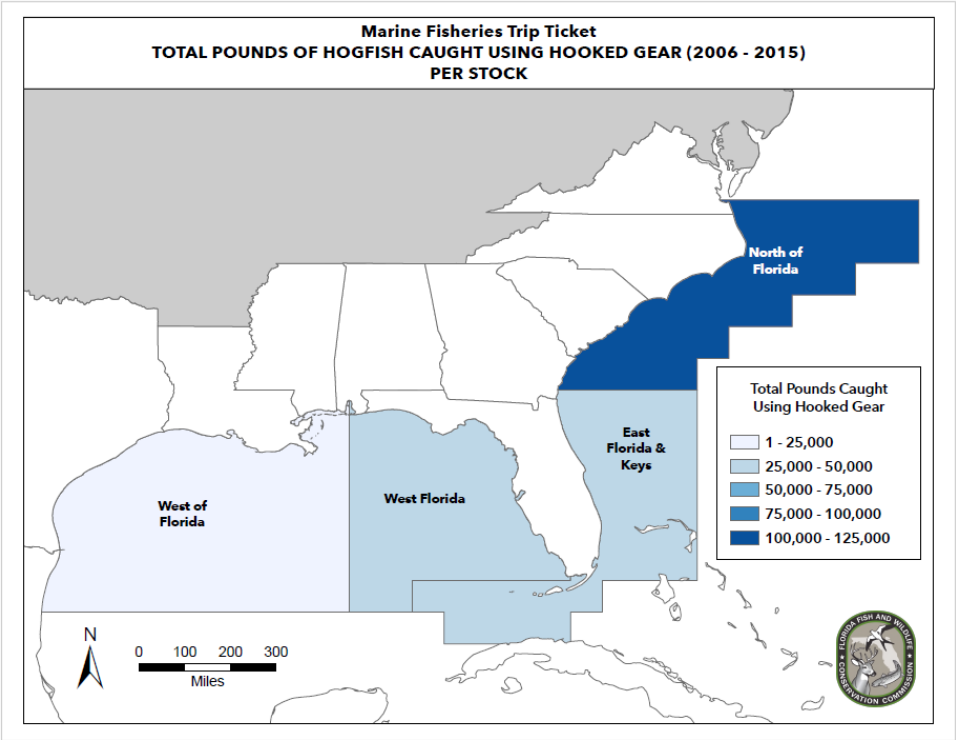
A.

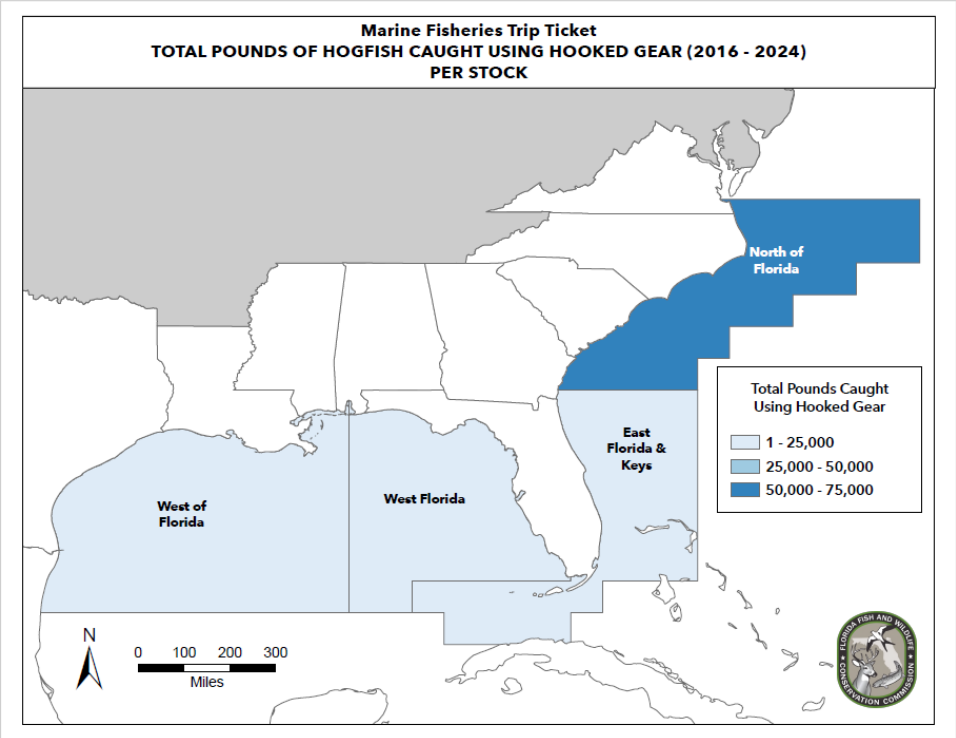

Marine Fisheries Trip Ticket
TOTAL POUNDS OF HOGFISH CAUGHT USING HOOKED GEAR (1927 - 1977)
PER STOCK
North of Florida
East Florida & Keys
West Florida
West of Florida
Total Pounds Caught Using Hooked Gear
No Data
1 - 100,000
100,000 - 200,000
200,000 - 300,000
300,000 - 400,000
400,000 - 500,000
N
0 100 200 300
Miles


Marine Fisheries Trip Ticket
TOTAL POUNDS OF HOGFISH CAUGHT USING HOOKED GEAR (1978 - 1985)
PER STOCK
North of Florida
East Florida & Keys
West Florida
West of Florida
Total Pounds Caught Using Hooked Gear
No Data
1 - 25,000
25,000 - 50,000
50,000 - 75,000
75,000 - 100,000
N
0 100 200 300
Miles

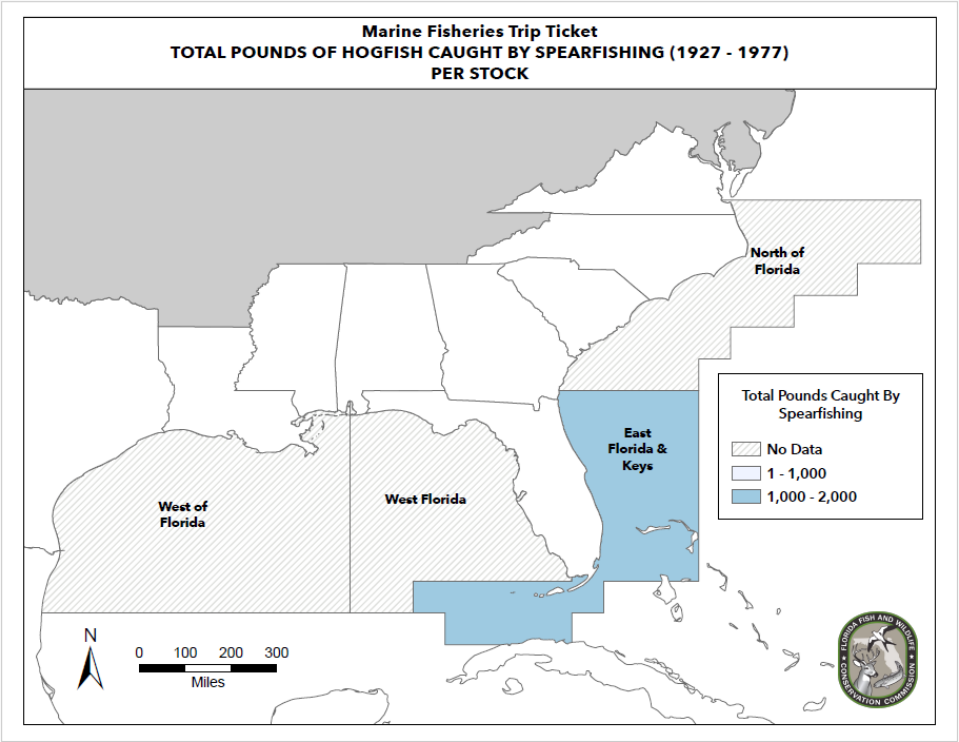

Marine Fisheries Trip Ticket
TOTAL POUNDS OF HOGFISH CAUGHT USING HOOKED GEAR (1986 - 1995)
PER STOCK
North of Florida
East Florida & Keys
West Florida
West of Florida
Total Pounds Caught Using Hooked Gear
1 - 100,000
100,000 - 200,000
200,000 - 300,000
300,000 - 400,000
400,000 - 500,000
500,000 - 600,000
N
0 100 200 300
Miles

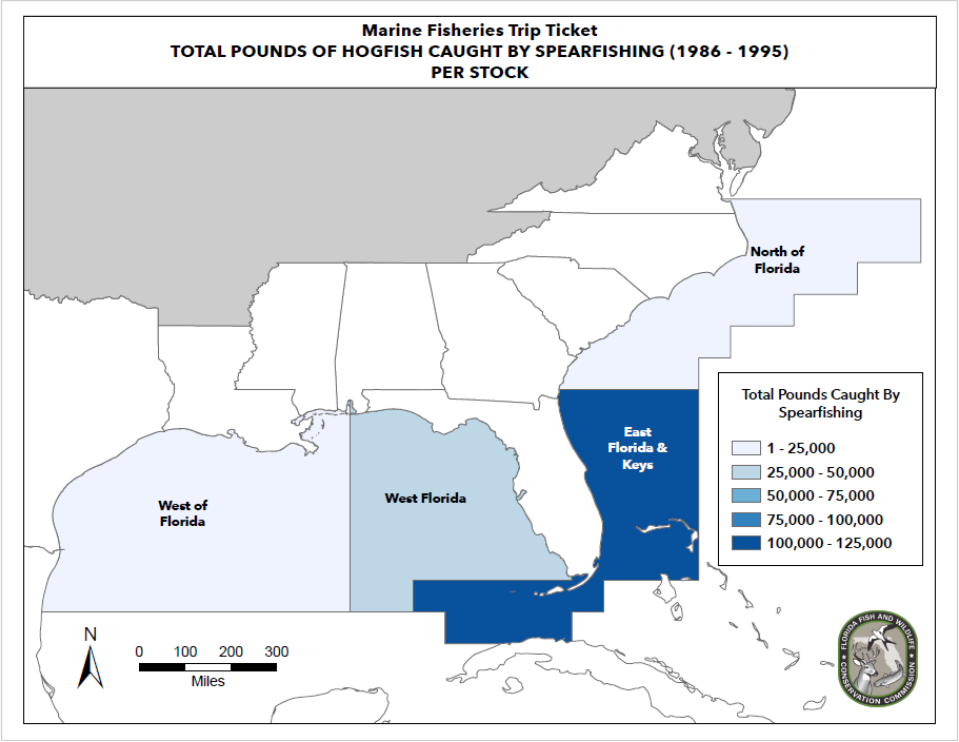

Marine Fisheries Trip Ticket
TOTAL POUNDS OF HOGFISH CAUGHT USING HOOKED GEAR (1996 - 2005)
PER STOCK
North of Florida
East Florida & Keys
West Florida
West of Florida
Total Pounds Caught Using Hooked Gear
1 - 25,000
25,000 - 50,000
50,000 - 75,000
75,000 - 100,000
100,000 - 125,000
125,000 - 150,000
N
0 100 200 300
Miles

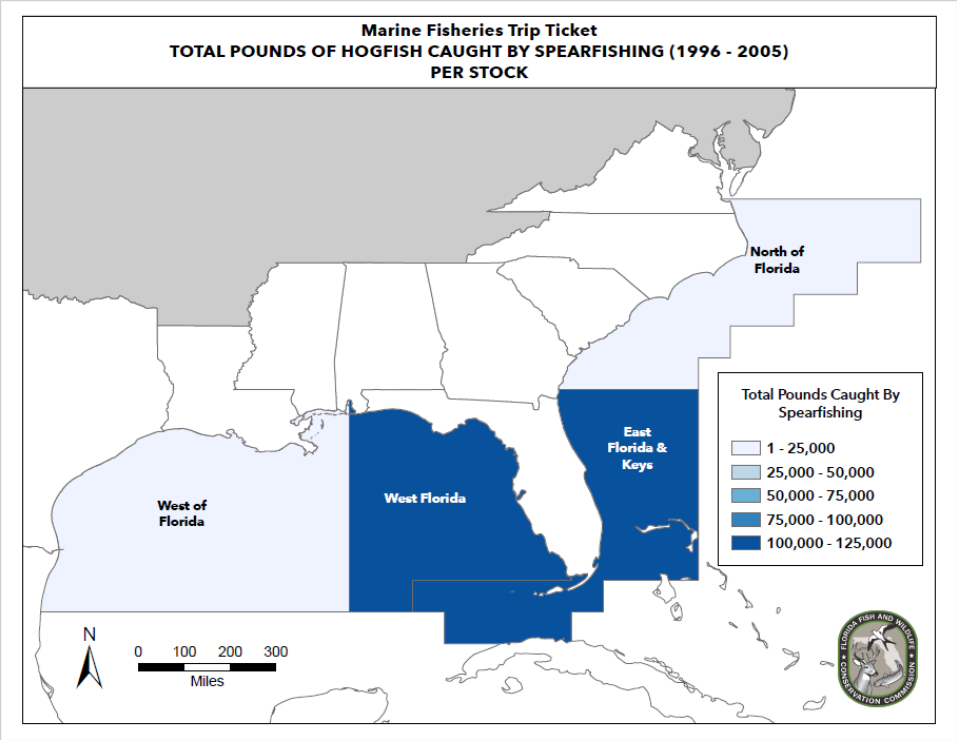

Marine Fisheries Trip Ticket
TOTAL POUNDS OF HOGFISH CAUGHT USING HOOKED GEAR (2006 - 2015)
PER STOCK
North of Florida
East Florida & Keys
West Florida
West of Florida
Total Pounds Caught Using Hooked Gear
1 - 25,000
25,000 - 50,000
50,000 - 75,000
75,000 - 100,000
100,000 - 125,000
N
0 100 200 300
Miles

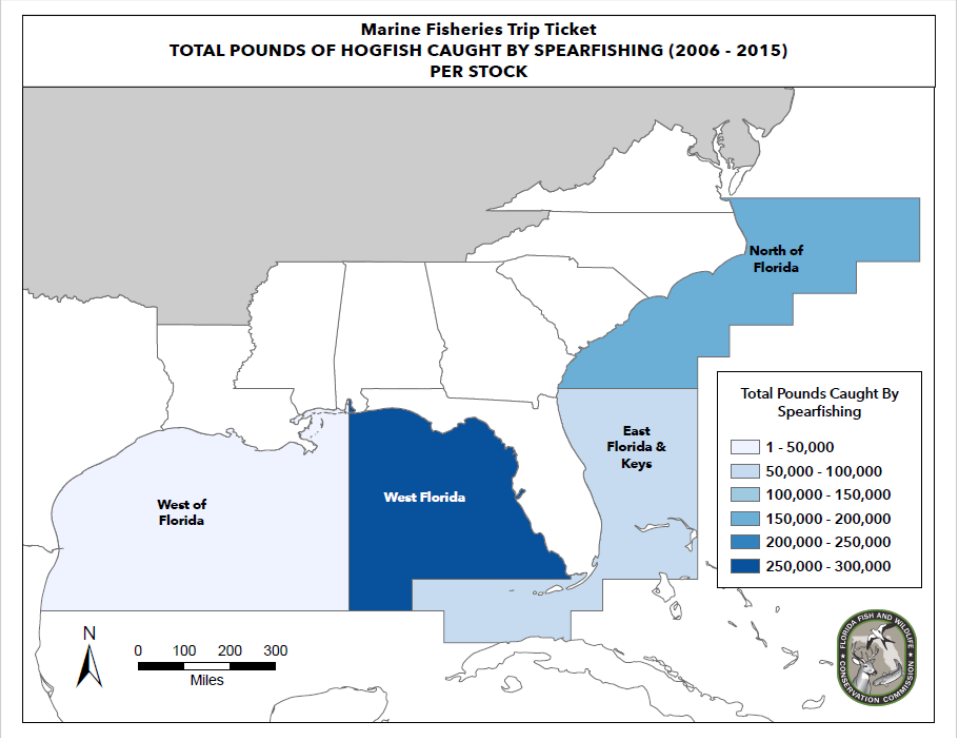

Marine Fisheries Trip Ticket
TOTAL POUNDS OF HOGFISH CAUGHT USING HOOKED GEAR (2016 - 2024)
PER STOCK
North of Florida
East Florida & Keys
West Florida
West of Florida
Total Pounds Caught Using Hooked Gear
1 - 25,000
25,000 - 50,000
50,000 - 75,000
N
0 100 200 300
Miles

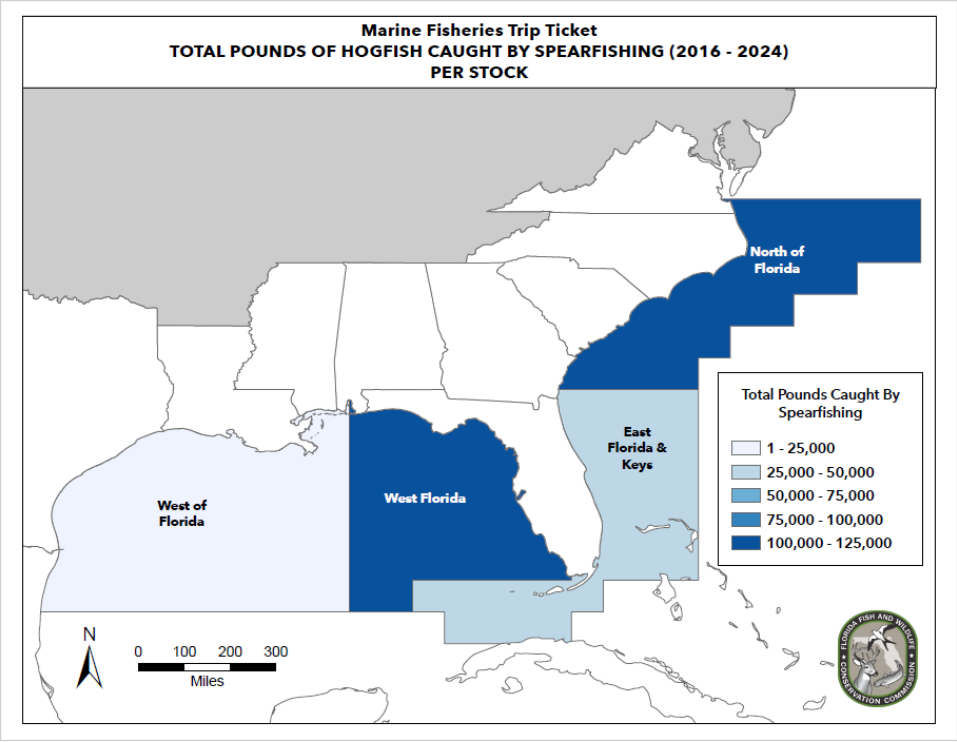
B.


Marine Fisheries Trip Ticket
TOTAL POUNDS OF HOGFISH CAUGHT BY SPEARFISHING (1927 - 1977)
PER STOCK
North of Florida
East Florida & Keys
West Florida
West of Florida
Total Pounds Caught By Spearfishing
No Data
1 - 1,000
1,000 - 2,000
N
0 100 200 300
Miles

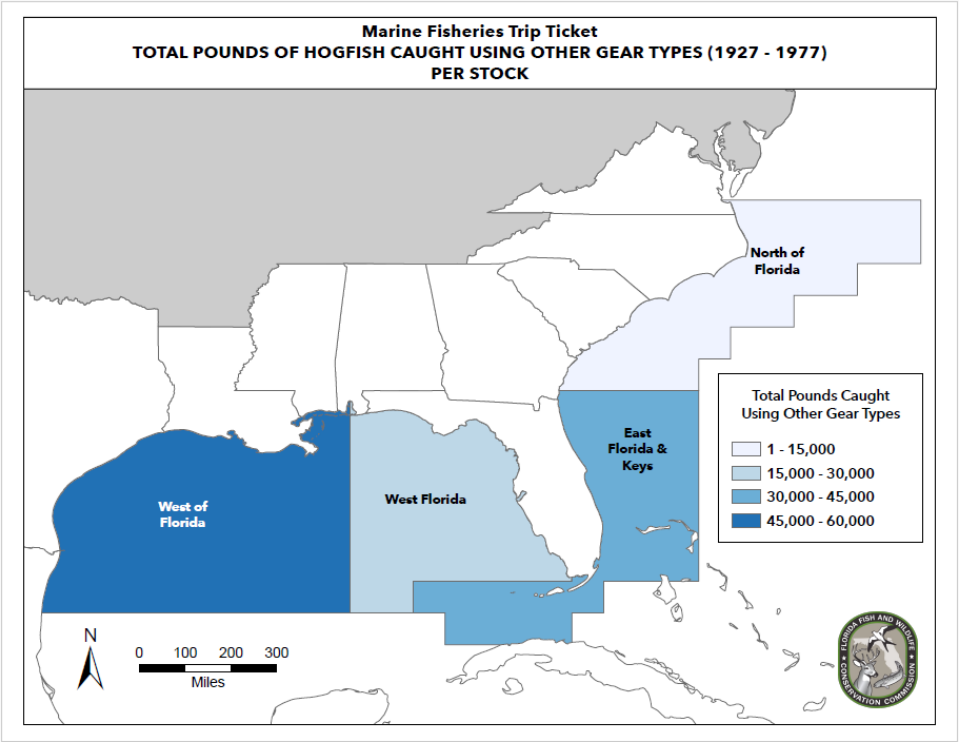

Marine Fisheries Trip Ticket
TOTAL POUNDS OF HOGFISH CAUGHT BY SPEARFISHING (1986 - 1995)
PER STOCK
North of Florida
East Florida & Keys
West Florida
West of Florida
Total Pounds Caught By Spearfishing
1 - 25,000
25,000 - 50,000
50,000 - 75,000
75,000 - 100,000
100,000 - 125,000
N
0 100 200 300
Miles

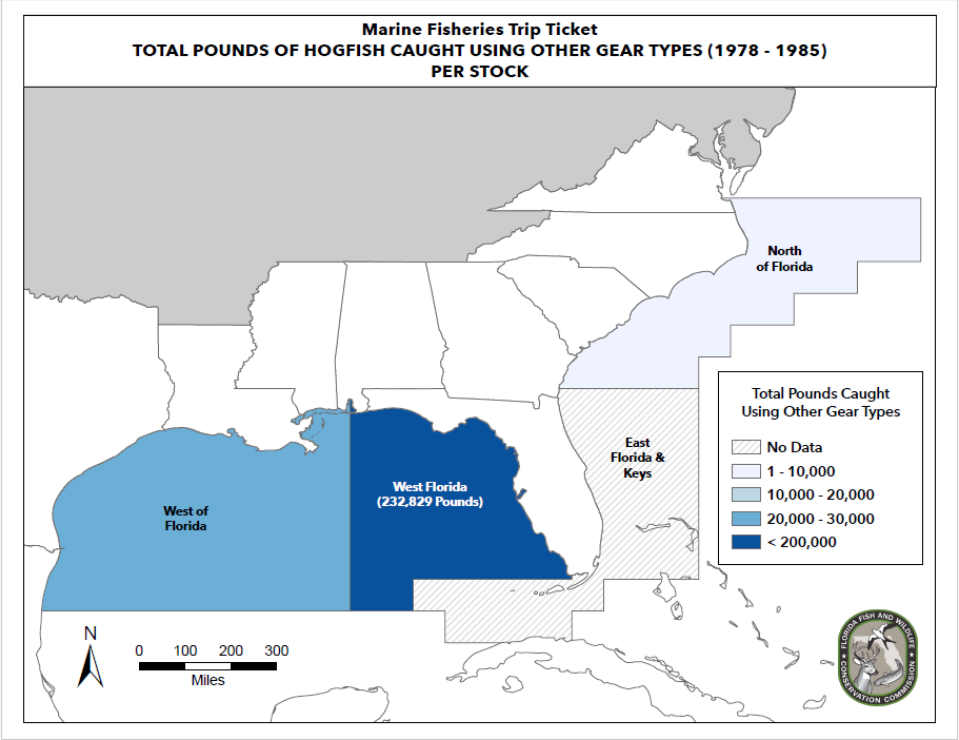

Marine Fisheries Trip Ticket
TOTAL POUNDS OF HOGFISH CAUGHT BY SPEARFISHING (1996 - 2005)
PER STOCK
North of Florida
East Florida & Keys
West Florida
West of Florida
Total Pounds Caught By Spearfishing
1 - 25,000
25,000 - 50,000
50,000 - 75,000
75,000 - 100,000
100,000 - 125,000
N
0 100 200 300
Miles

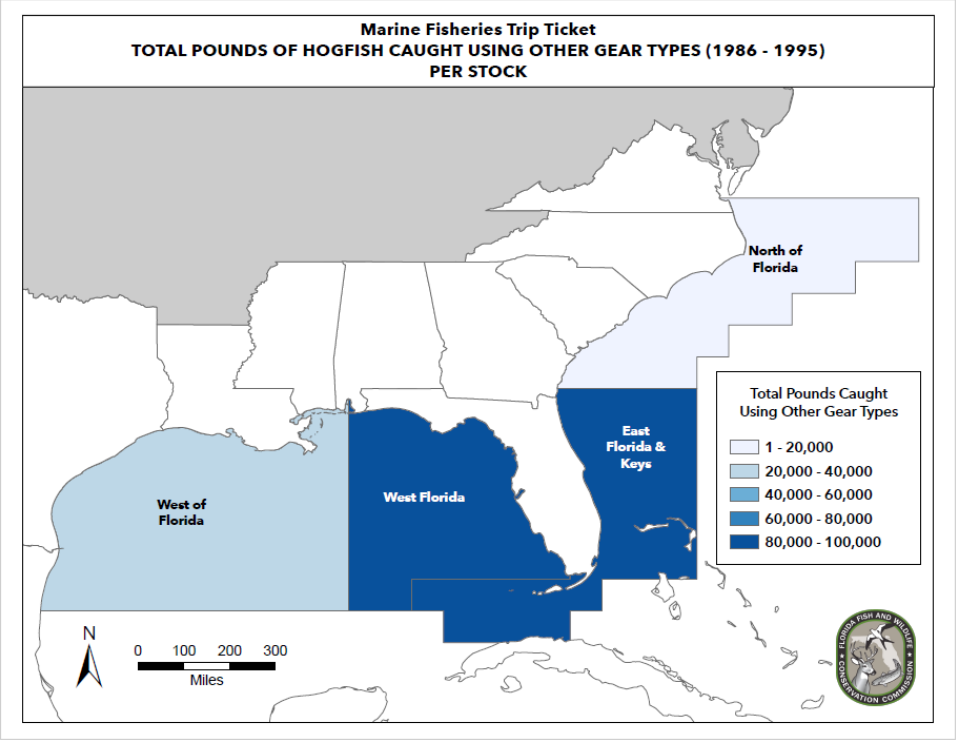

Marine Fisheries Trip Ticket
TOTAL POUNDS OF HOGFISH CAUGHT BY SPEARFISHING (2006 - 2015)
PER STOCK
North of Florida
East Florida & Keys
West Florida
West of Florida
Total Pounds Caught By Spearfishing
1 - 50,000
50,000 - 100,000
100,000 - 150,000
150,000 - 200,000
200,000 - 250,000
250,000 - 300,000
N
0 100 200 300
Miles

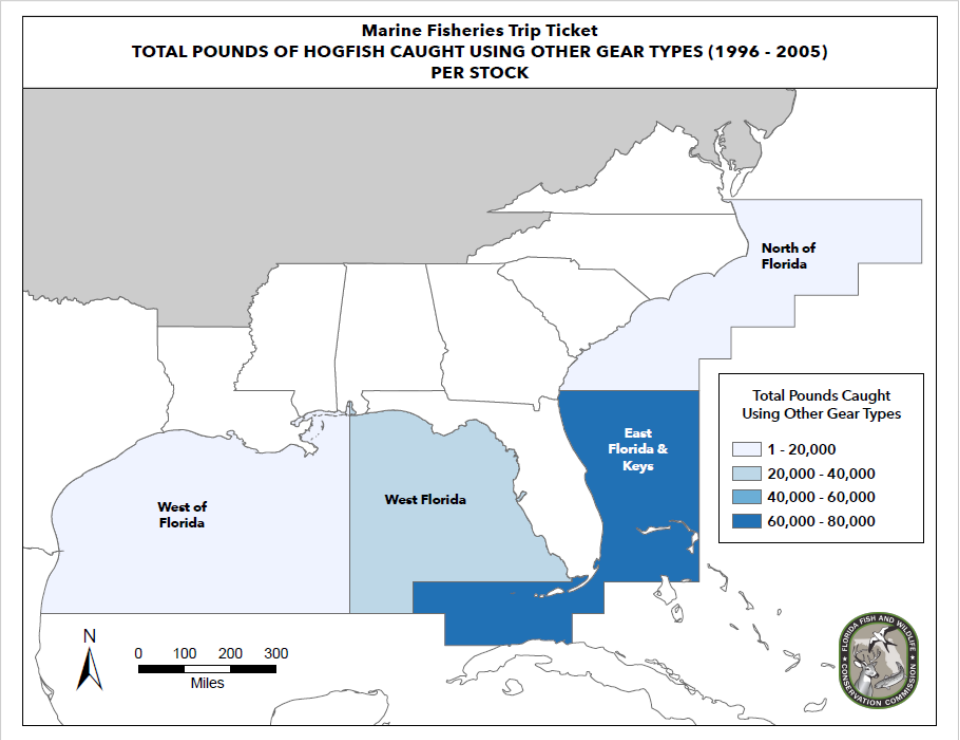

Marine Fisheries Trip Ticket
TOTAL POUNDS OF HOGFISH CAUGHT BY SPEARFISHING (2016 - 2024)
PER STOCK
North of Florida
East Florida & Keys
West Florida
West of Florida
Total Pounds Caught By Spearfishing
1 - 25,000
25,000 - 50,000
50,000 - 75,000
75,000 - 100,000
100,000 - 125,000
N
0 100 200 300
Miles

C.


Marine Fisheries Trip Ticket
TOTAL POUNDS OF HOGFISH CAUGHT USING OTHER GEAR TYPES (1927 - 1977)
PER STOCK
North of Florida
East Florida & Keys
West Florida
West of Florida
Total Pounds Caught Using Other Gear Types
1 - 15,000
15,000 - 30,000
30,000 - 45,000
45,000 - 60,000
N
0 100 200 300
Miles


Marine Fisheries Trip Ticket
TOTAL POUNDS OF HOGFISH CAUGHT USING OTHER GEAR TYPES (1978 - 1985)
PER STOCK
North of Florida
East Florida & Keys
West Florida (232,829 Pounds)
West of Florida
Total Pounds Caught Using Other Gear Types
No Data
1 - 10,000
10,000 - 20,000
20,000 - 30,000
< 200,000
N
0 100 200 300
Miles


Marine Fisheries Trip Ticket
TOTAL POUNDS OF HOGFISH CAUGHT USING OTHER GEAR TYPES (1986 - 1995)
PER STOCK
North of Florida
East Florida & Keys
West Florida
West of Florida
Total Pounds Caught Using Other Gear Types
1 - 20,000
20,000 - 40,000
40,000 - 60,000
60,000 - 80,000
80,000 - 100,000
N
0 100 200 300
Miles


Marine Fisheries Trip Ticket
TOTAL POUNDS OF HOGFISH CAUGHT USING OTHER GEAR TYPES (1996 - 2005)
PER STOCK
North of Florida
East Florida & Keys
West Florida
West of Florida
Total Pounds Caught Using Other Gear Types
1 - 20,000
20,000 - 40,000
40,000 - 60,000
60,000 - 80,000
N
0 100 200 300
Miles

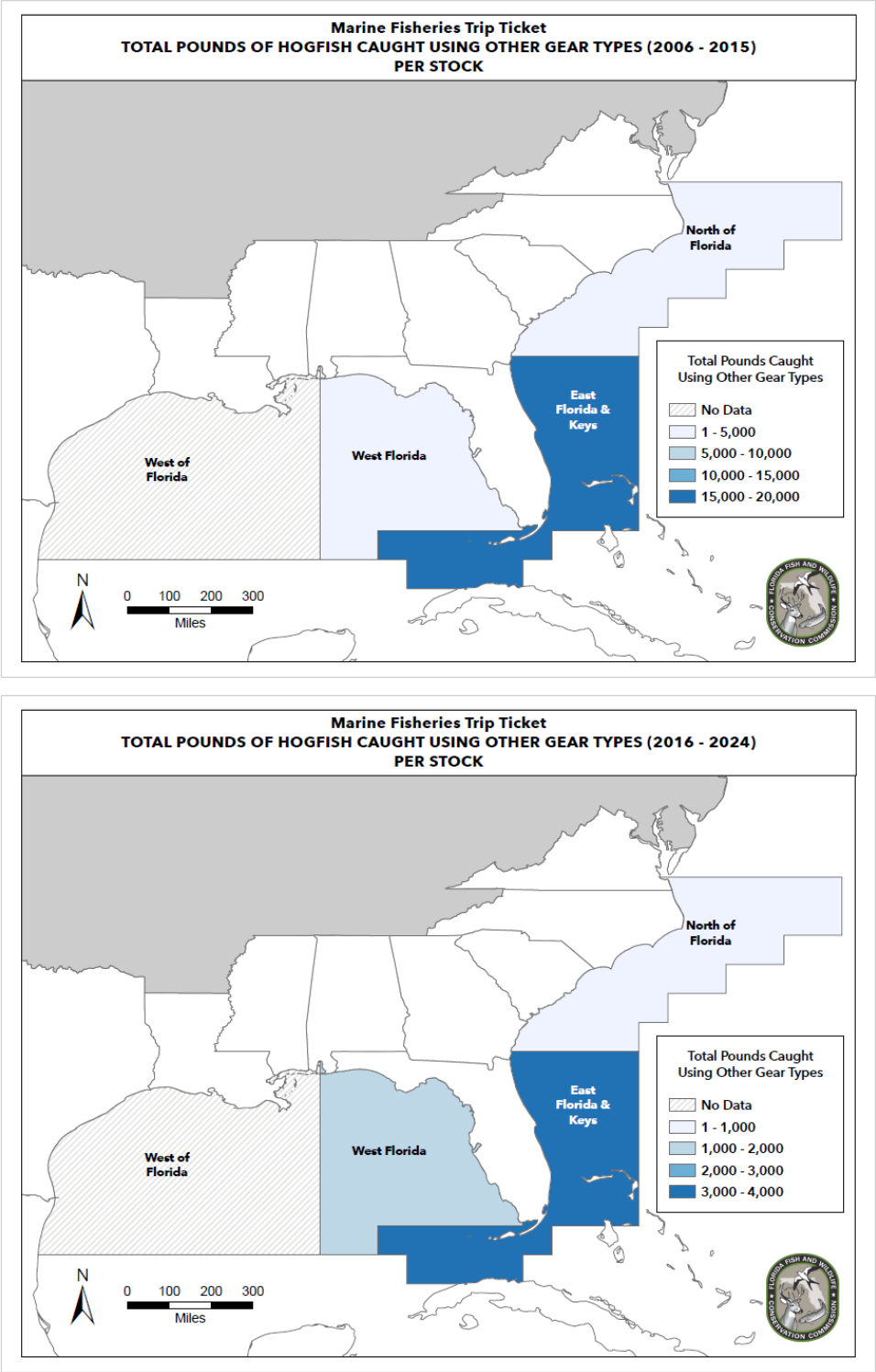


Figure 3.3 Landings data by aggregated year: 1927-1977 (annual ALS data), 1978-1985 (monthly ALS data), 1986-1995, 1996-2005, 2006-2015, and 2016-2024. Gear data were aggregated into A. Hooked Gears, B. Spearfishing, and C. Other gear.

4 RECREATIONAL FISHERY STATISTICS

4.1 OVERVIEW

The Recreational Workgroup (RWG) compiled and evaluated recreational fishery data to support the stock assessment of Florida Hogfish. The RWG reviewed landings, discards, biological sampling, and effort data from multiple sources, including, but not limited to, the Marine Recreational Information Program (MRIP), the State Reef Fish Survey (SRFS), and the Southeast Region Headboat Survey (SRHS). Key objectives included evaluating the adequacy of recreational data, assessing SRFS and the Southeast For-Hire Integrated Electronic Reporting (SEFHIER) for potential use, and providing recommendations on anomalous years for landings and releases, gear-specific estimates, and discard mortality rates. The RWG concluded that estimates for Florida Hogfish landings and discards for recreational private mode be provided by SRFS, landings and release estimates for shore and charter modes be provided by MRIP, and landings and release estimates for headboats be provided by SRHS. The RWG also determined that recent discard mortality research offered improved estimates for use in the assessment.

4.1.1 Recreational Workgroup Group (RWG) Membership

FWCC: Dustin Addis (RWG Lead), Chloe Ramsay, Maria McGirl, Leo Eguia, Jeanette Huber, Sean Wilms, Bob Ellis, Olivia Wilms, Luiz Barbieri, Chris Swanson, Juan Cortes, Erin Parker, Sue DeMay
NOAA: Rob Cheshire (SEFSC), Samantha Binion-Rock (SEFSC), Dominique Lazarre (SERO), Molly Olson (SERO)
Gulf Council Staff: Ryan Rindone, Sara Gardner
SAFMC: Tom Roller
GMFMC: Jessica McCawley
GMFMC SSC: Steven Scyphers
Recreational Anglers: Bob Hilliard, Richard Gomez, Ben Choi

4.1.2 Recreational Terms of Reference

Provide recreational catch statistics through 2024, including both landings and discards in both pounds and number.

- Evaluate and discuss the adequacy of available data for accurately characterizing harvest and discard by species and fishery sector or gear
    - Explore the transition from MRIP-CHTS to MRIP-FES
    - Explore the State Reef Fish Survey (SRFS) data from the State of Florida
    - Explore the Southeast For-Hire Integrated Electronic Reporting (SEFHIER) data for potential inclusion in the Atlantic Hogfish assessment
    - Explore whether the recreational fleet structure can be realigned into individual fleets as appropriate.
- Provide length and age distributions for both landings and discards if feasible
- Provide maps of fishery effort and harvest and fishery sector or gear
- Provide estimates of uncertainty around each set of landings and discard estimates

4.1.3 Recreational Issues Discusses at the Data Workshop

1) Compare MRIP calibrations
2) Recommendations for anomalous years for MRIP landings and releases
3) The separation of MRIP landings and discards by gear (e.g. spear, hook and line) and the resulting uncertainty.
4) Evaluation of the State Reef Fish Survey (SRFS) as an appropriate data source for recreational private mode landings and releases of Florida Hogfish
5) Evaluate if the full years available (2021-2024) for SRFS data are appropriate for calibrating MRIP using the ratio-based method.
6) The separation of SRFS calibrated landings and discards by gear (e.g. spear, hook and line) and the resulting uncertainty.
7) Southeast For-Hire Integrated Electronic Reporting Program (SEFHIER) data availability its viability of use.
8) Evaluation of headboat discard estimates from the Southeast Region Headboat Survey (SRHS) between 2004-2024 and back-calculation of discard estimates prior to 2007.
9) Biscayne National Park (BNP) Creel Survey length composition data and its viability of use.
10) Evaluate studies on Hogfish release mortality to inform a release mortality rate for Recreational hook and line gear for the WFS and SEFL/Keys stocks

11) Potential model start year recommendation according to recreational data availability and uncertainty.

4.2 REVIEW OF WORKING PAPERS

SEDAR 94-DW-02: Headboat Data for Hogfish in the Southeast U.S. Atlantic and Gulf of America. Robin T. Cheshire and Matthew E. Green.

This report documents the Southeast Region Headboat Survey (SRHS) which estimates landings and effort for headboats operating in the southeast U.S. Atlantic and Gulf of America based on electronic logbook reporting.

SEDAR 94-DW-03: Florida Keys and East Florida Hogfish Fishery Performance Report March 2024. SAFMC Snapper Grouper Advisory Panel.

At their March 2024 meeting, the South Atlantic Fishery Management Council's (Council) Snapper Grouper Advisory Panel (AP) reviewed fishery information for Florida Keys and East Florida (FLK/EFL) Hogfish and developed this fishery performance report (FPR). The purpose of the FPR is to assemble information from AP members' experience and observations on the water and in the marketplace to complement scientific and landings data.

SEDAR 94-DW-05: General Recreational Survey Data for Hogfish in the Gulf of America and South Atlantic. Samantha Binion-Rock.

General recreational survey data for Hogfish from the Marine Recreational Information Program (MRIP), Texas Parks and Wildlife Department (TPWD), and Louisiana Creel Survey (LA Creel) are summarized from 1981 to 2024 for Gulf of America and Atlantic states from Texas to North Carolina. Charter, Headboat, Private, and Shore fishing modes are presented. These fully calibrated MRIP estimates consider 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.

SEDAR 94-DW-10: A Summary of Florida Hogfish Discard Length Data Collected from At-Sea Observers in For-Hire Fishery Surveys in Florida 2005-2024. Ellie Corbett and Leonardo Eguia.

This report details the at-sea for-hire observer surveys conducted by the state of Florida Fishery Dependent Monitoring Program that allow for the collection of supplemental discard biological data.

SEDAR 94-DW-11: Length and age composition of Florida Hogfish, *Lachnolaimus maximus*, collected in association with fishery-dependent projects. Maria McGirl, Jessica Carroll, and Bridget Cermak.

This report analyzes the length and age composition of Florida Hogfish (*Lachnolaimus maximus*) collected from various commercial and recreational fishery-dependent monitoring programs between 2002 and 2024.

SEDAR 94-DW-12: Hogfish Discard Mortality and Habitat Ecology on the West Florida Shelf. Robert D. Ellis, B. James Williams, Kerry Flaherty-Walia, and Philip Stevens

This report explores Hogfish (*Lachnolaimus maximus*) discard mortality and habitat ecology on the West Florida Shelf using acoustic telemetry tagging. It assesses post-release survival of recreationally caught Hogfish and characterizes their fine-scale movement and habitat use.

SEDAR 94-DW-16: Recreational For-Hire Trends in Release Methods and Barotrauma Assessment of Hogfish (*Lachnolaimus maximus*) using a Fisheries-Dependent At-Sea Observer Program. Leonardo Eguia, Zachary Siders, and Debra Murie.

This report investigates trends in release methods and barotrauma among Hogfish (*Lachnolaimus maximus*) caught in Florida's recreational for-hire fishery. It uses data from the FWC At-Sea Observer Program to assess how environmental and biological factors, such as depth, temperature, and fish size, relate to barotrauma condition, with the goal of informing discard mortality estimates.

SEDAR 94-DW-18: Hogfish (*Lachnolaimus maximus*) lengths sampled in the Biscayne National Park Creel Survey, 1993-2024. Shanae Allen

This report analyzes Biscayne National Park Creel Survey records from 1993-2024 for recreational retained length information by gear.

SEDAR 94-DW-21: A ratio-based method for calibrating estimates of total landings (numbers and pounds of fish), releases (numbers of fish), and total trips from MRIP-FCAL to SRFS for Florida Hogfish (*Lachnolaimus maximus*). Chloe Ramsay and Maria McGirl

This report develops conversion factors that are applied to annual, fully calibrated MRIP landings and release estimates to produce a historic time series in the same currency as the SRFS for Florida Hogfish (*Lachnolaimus maximus*).

SEDAR 94-DW-23: Summary of Southeast For-Hire Integrated Electronic Reporting Program Records for Hogfish Catch in the Southeast Region. LAPP/DM Branch – NOAA SERO

This report summarized and discussed the utility of the available Southeast For-Hire Integrated Electronic Reporting program hogfish catch data from 2022-2024.

4.3 RECREATIONAL LANDINGS

Recreational landings of Hogfish were compiled from 1981 through 2024 for the U.S. Atlantic and Gulf of America (SEDAR 94-DW-05). Sources for landings include the Southeast Region Headboat Survey (SRHS), Marine Recreational Information Program (MRIP), Texas Parks and Wildlife Department (TPWD), and Louisiana Creel survey program (LA Creel), and Florida's State Reef Fish Survey (SRFS). Recreational landings outside of Florida comprise less than 0.9% of the total recreational landings. Tables 4.11.1-4.11.2 present landings and CVs from all data sources (MRIP, TPWD, and LACreel) by domain (WFS and Keys_EFL) and Tables 4.11.3-4.11.4 present by fishing mode. Figures 4.12.1 and 4.12.2 illustrate the number of fish landed by region and mode, respectively. These figures show that the majority of landings originate from the private and charter modes for all regions (Figure 4.12.2).

Landings from SRFS and MRIP-FCAL calibrated into SRFS currency are summarized in working paper SEDAR 94-DW-21. Table 4.11.5 displays the sample sizes of total confirmed trip interviews for SRFS by region and gear. Maps showing the spatial distribution of the number of interviews conducted where anglers caught or targeted Hogfish and the spatial distribution of the number of Hogfish landed per year are presented in Figure 2 within SEDAR 94-DW-21. Annual SRFS estimates and error by year (2021-2024), region (SEFL, WFS), and gear (hook and line, spear, or combined) are shown in Table 4.11.6. MRIP estimates and their uncertainty as well as the MRIP calibrated to SRFS estimates and their uncertainty are shown in Tables 4.11.7-4.11.8 for both regions. MRIP estimates, MRIP calibrated to SRFS estimates, and their uncertainty are included in tables 4.11.9-4.11.12 by gear type. Landing estimates from the Southeast region are

primarily from Monroe and Miami-Dade counties. Landings estimates from the West Florida shelf are concentrated in Pinellas county. Recent years (2021-2024) of SRFS estimates show larger catch values in the West Florida shelf than in SEFL. Differences between SRFS and MRIP estimates in the West Florida Shelf are larger than the differences in Southeast Florida, generating smaller calibration ratios (WFL ratios: lbs of fish = 0.50, numbers of fish = 0.46, and releases=0.52; SEFL ratios: lbs of fish = 0.81, numbers of fish = 0.68, and releases= 0.97) (SEDAR 94-DW-21, Ramsay and McGirl 2025). Broken down by gear, the major differences between the SRFS and MRIP estimates are seen in the hook and line fishery in the West Florida shelf.

Further discussion of how landings were compiled from the SRHS can be found in the working paper (SEDAR 94-DW-02) in the Methods section and associated tables and figures are presented here. Tables 4.11.13 and Figure 4.12.11 presents landings in numbers by region.

Issue: Compare MRIP calibrations.

Recommendation:
To maintain a consistent time series, charter estimates were calibrated on the Gulf coast prior to 2000 and the Atlantic coast prior to 2004 (Dettloff and Matter 2019, SEDAR64-RD-12). CHTS and calibrated FHS charter catch estimates for Hogfish from 1981 to 2003 are shown in Figure 1 of SEDAR 94-DW-05. Calibrated APAIS and FES estimates for Hogfish from 1981 to 2017 are shown in Figure 2 of SEDAR 94-DW-05.

Issue: Recommendations for anomalous years for MRIP landings and releases
Recommendation: MRIP estimated annual landings and releases that appear relatively large/small compared to adjacent years were further investigated within SEDAR 94 DW-05 by identifying and summarizing which strata were disproportionately contributing to the estimate:

Generally speaking, the strata investigated above from 1981-2005 are associated with years where there were lower numbers on intercepted trips where anglers reported Hogfish landings and discards. Variability in these estimates may be more reflective of the MRIP survey rather

than capturing the true landings and discards trends. The strata investigated after 2005 appear to be well-sampled and have large numbers of intercepts reporting Hogfish landings and discards. Elevated catches in these years do appear to reflect the true trends and variability associated with Hogfish landings and discards.

Due to the RWG suggestion (see below) of a model start year of 1986 based on the availability and quality of recreational data, and the conclusion of post 2005 MRIP data being well-sampled and having adequate numbers of intercepts from SEDAR 94 DW-05 (above), the anomalous years to provide recommendations would be:

- The 1988 release estimate of 238,584 fish (CV = 0.99) for SEFL/Keys stock (Stratum: SEFL/Keys, Private, Wave 1, Ocean ≤ 10 miles), which had a total of 3 angler trips (7 releases, 7 releases, 6 releases) with elevated sample weighting that resulted in a discard estimate of 236,072 fish (99% of the total annual estimate). There was only one other intercept in 1988 with reported discarded fish (1 release).

- The 2005 release estimate of 151,184 fish (CV = 0.76) for SEFL/Keys stock (Stratum: SEFL/Keys, Private, Wave 1, Ocean ≤ 10 miles), which had a total of 2 angler trips (10 releases, 10 releases) that resulted in a discard estimate of 108,552 fish (69% of the total annual estimate). There were only 13 intercepted trips that reported released Hogfish in 2005.

The analyst may consider inputting these anomalous data as is or treating them, which could include adjusting or averaging the year estimate using surrounding years data, excluding these year estimates entirely, etc. The estimates have very high uncertainty, which could also give the assessment model flexibility in fitting these high estimates.

Issue: The gear separation of MRIP landings and discards by spear and hook and line and the resulting uncertainty.

Recommendation: MRIP estimates broken down by gear are often above the 30 or 50% thresholds (Tables 4.11.9-4.11.12). While analysts can explore modeling the recreational fleet by gear type, consideration should be taken of the large uncertainty of these estimates.

Issue: Evaluation of the State Reef Fish Survey (SRFS) as an appropriate data source for recreational landings and releases of Florida Hogfish

Recommendation: We considered SRFS as a data source of recreational landings & discards for Florida Hogfish. SRFS is recommended for use for recreational landings and releases in private boat mode. No data gaps or biases were identified and the whole timeseries is available.

Issue: Evaluate if the full years available (2021-2024) for SRFS data are appropriate for calibrating MRIP using the ratio-based method.

Recommendation: Hogfish was added to SRFS in July 2020 and has a short, but adequate time-series for use in a ratio-based method for calibrating MRIP-SRFS recreational fisheries estimates. No issues with the accepted and peer-reviewed calibration method were identified.

Issue: The gear separation of SRFS calibrated landings and discards by spear and hook and line and the resulting uncertainty.

Recommendation: SRFS estimates can be generated by gear type. However, breaking down the landings and release estimates by gear type increases the uncertainty around the estimates. Landings estimates still remain primarily under the 30% PSE threshold for SRFS estimates, but release estimates are generally more uncertain. Spear release estimates have uncertainty values over 50% for all years where estimates are available. MRIP estimates broken down by gear are often above the 30 or 50% thresholds and therefore the SRFS calibrated estimates also have large uncertainty, especially in earlier years. While analysts can explore modeling the recreational fleet by gear type, consideration should be taken of the large uncertainty of these estimates.

Issue: Southeast For-Hire Integrated Electronic Reporting Program (SEFHIER) available data and its viability of use.

Recommendation: The SEFHIER time series is only available for 2022-2024, with no available calibration back in time. Additionally, data from all SEFHIER participants cannot be aggregated to align with the two stock boundaries of the assessment as some of the data from Monroe County are not available due to the Gulf SEFHIER program being set aside by court decision. SEDAR 94-WP-23 provides a more full description of both the available catch values and data limitations associated with SEFHIER logbook reports. There is no recommendation to use SEFHIER data for the current assessment, but it could be reconsidered in future assessments if the above issues are addressed.

4.4 RECREATIONAL DISCARDS

Recreational discards of Hogfish were compiled from 1981 through 2024 for the U.S. Atlantic and Gulf of America. Sources for discards include the Marine Recreational Information Program (MRIP), Florida State Reef Fish Survey (SRFS), Southeast Region Headboat Survey (SRHS), Texas Parks and Wildlife Department (TPWD), and Louisiana Creel survey program (LA Creel).

Discards from MRIP, TPWD, and LACreel are summarized in the working paper SEDAR 94-DW-05. Tables 4.11.1 and 4.11.2 present discard estimates with associated coefficients of variance (CVs) from 1981-2024 by region for all modes.

Discards from SRFS and MRIP-FCAL calibrated into SRFS currency are summarized in working paper SEDAR 94-DW-21. Table 4.11.6 and Figure 4.12.3-4.12.4 outlines the overlapping data years between MRIP and SRFS that are used for the ratio calibration method. MRIP estimates and their uncertainty as well as the MRIP calibrated to SRFS estimates and their uncertainty are shown in Tables 4.11.7-4.11.8 and Figures 4.12.5-4.12.6 for both regions. MRIP estimates, MRIP calibrated to SRFS estimates, and their uncertainty are included in Tables 4.11.9-4.11.12 and Figures 4.12.7-4.12.10 by gear type.

Headboat discards (SRHS) were estimated according to methods from the working paper (SEDAR 94-DW-02). Annual discards-in-numbers by region are presented in Tables 4.11.14 and Figure 4.12.12.

The summaries of MRIP and headboat working papers show that there is an increase in discards in WFS starting in about 2017, with the vast majority of discards originating from the private and charter modes operating in Florida. The discards in SEFL/Keys have historically been highly variable but have shown consistency in recent years largely coming from shore and private modes (Figure 4.11.1).

Issue: Evaluation of headboat discard estimates from the Southeast Region Headboat Survey (SRHS) between 2004-2024 and back-calculation of discard estimates prior to 2007.

Recommendation: RWG chose not to consider proxy discards in years prior to 2007 due to the negligible nature of these discards for both WFL and SEFL/Keys stocks. Historically, discard numbers were very low < 200/year. Additionally, proxy discards would also be based on MRIP data so the error would be inflated (pers comm Rob Cheshire NOAA-SEFSC).

4.5 BIOLOGICAL SAMPLING

4.5.1 Sampling Intensity Length/Age/Weight

Biological samples of Hogfish were compiled from 1981 through 2024 for the WFS and the Keys/EFL. Recreational sources for length, weight, and age data were collected by the biological sampling programs of the SRHS, MRIP, TPWD, Florida's At-Sea Observer Program, and other data collection programs (e.g., FWRI Representative Biological Sampling Program, SRFS, MARFIN, GulfFIN).

MRIP measured Hogfish for length information caught by recreational anglers in Florida from 1981-2024. Tables 4.11.15 and 4.11.16 present the number of measured lengths, minimum and maximum length, mean length, and associated standard deviation by year and region.

The FWC-FWRI Fishery Dependent Monitoring (FDM) at-sea observers have collected length and discard information from reef fish species caught by the for-hire fleet in Florida from 2005-2024. Survey design and data related to Hogfish are described in detail in the working papers

(SEDAR 94-DW-10, SEDAR 94-DW-11, SEDAR 94-DW-16). At-sea observer spatial coverage is presented in Table 1 of SEDAR 94-DW-10 and Tables 2 and 3 presents the number of trips by stock, year, and trip duration for the Headboat and Charter recreational fleets, respectively. Tables 5 and 6 contain the number of discarded and harvested fish observed on Headboat and Charter boat trips, respectively, by stock and year. The depth of capture, barotrauma scores, and release method for released fish are also summarized in Tables 3 and 4 within SEDAR 94-DW-16.

Other FWC-FWRI FDM survey programs, including SRFS dockside intercept survey, GulfFIN funded opportunistic sampling, and Representative Biological Sampling (RepBio), have collected length, weight, and age information from reef fish species caught by the private and charter boat fleets in Florida from 2000-2024. Survey designs and data relating to Hogfish are described in detail in the working papers (SEDAR 94-DW-11, SEDAR 94-DW-21). Private fleet (all modes) sampling spatial coverage is presented in Table 1 of SEDAR 94-DW-11 and Table 2 presents the number and mean (± SD) age and length (FL) of fish aged by stock and year.

SRHS biological sampling effort by region is presented in SEDAR 94-DW-02. Annual numbers of Hogfish measured for lengths in the headboat fleet by region are given in Table 21. The number of trips from which Hogfish were measured by stock is summarized in Table 23. Mean total lengths (mm) and weight (g) and associated CVs for the headboat fishery are tabulated by state and region in Tables 24–31. Patterns in length and weight by year and region are shown in Figures 10 and 11.

Annual summary statistics for MRIP intercepted Hogfish weight (lbs, whole weight) for all regions combined are presented in Table 8 in the working paper (SEDAR 94-DW-05). Similarly, Tables 7.2 and 7.3 present summary statistics for weights of Hogfish in WFS and Keys/EFL, respectively. Sample sizes in these tables include imputed (i.e., predicted) lengths and weights. Summary statistics for outside of Florida intercepted Hogfish weights (lbs, whole weight) by mode and year are presented in Table 7.1 in the working paper (SEDAR 94-DW-05).

4.5.2 Length – Age Distribution

Summaries of length and age information (number, minimum, mean, and maximum lengths; fork length) were provided in working papers for each data source by year and stock. Tables 1 (Table 4.11.17 presented here) and 2 in SEDAR 94-DW-11 presents this information for charter, headboat, private, and tournament sector sampling from FDM programs. Table 4.11.18 and Figure 4.12.13 in this report show the number of aged Hogfish by stock, year block, and gear type. Table 3 (Table 4.11.19 presented here) shows the number of measured Hogfish and mean (± SD) age and length (FL) by stock, fleet, and gear type. Weighted length frequency of harvested and released Hogfish measured by at-sea observers in the headboat and charter sectors from WFS and Keys/EFL are shown in Figures 1 and 3 of SEDAR 94-DW-10 (Figures 4.12.14-4.12.15 presented here).

A summary of retained lengths were provided for the BNP Creel Survey in SEDAR 94-DW-18. BNP creel survey records from 1993–2024 were filtered to include only Hogfish, which totaled 3,244 valid length records. Two major gear group classifications were inferred from party composition (Spear/Diving and Other/Unknown). Fork lengths of retained Hogfish ranged from 12 to 69 cm, with an interquartile range of 30–35 cm, a mean of 33.4 cm, and a median of 32 cm. Table 4.11.20 presents the number of fork length measurements by year and gear group. Since 2018 sample sizes have been very low and there were no Hogfish sampled in 2019 and 2020. Gear specific cumulative distribution functions (Figure 4.12.16) of landed Hogfish sampled by the BNP creel survey suggest that gear selectivity is similar between hook and line and spear/diving. A visual comparison of cumulative distributions of sampled fork lengths of landed Hogfish in the BNP creel survey and MRIP landed Hogfish overall and specifically within Monroe and Miami-Dade counties suggest that MRIP intercepts larger individuals (Figure 4.12.17 and 4.12.18 respectively).

Issue: Biscayne National Park Creel Survey length composition data and its viability of use.

Recommendation: The RWG notes the BNP creel survey's spatial extent is limited, however agrees that retained lengths from the BNP survey could address recreational data gaps in the private mode for SEFL/Keys stock. The RWG recommends combining these lengths with MRIP and headboat lengths without over-representing BNP lengths, which have a high cumulative sample size (n = 3,244) from 1993-2024 and generally catch smaller individuals. It should be

noted that in recent years (post 2017), sample sizes are significantly lower and may not be representative. It is unclear whether this is due to reduced sampling effort at park access sites or a decline in observed retained fish from size limit regulatory changes in 2017. The report's findings of strong similarity of cumulative distribution functions (CDFs) of fork lengths (SEDAR 94-DW-18, Figure 2) between gear groups suggests similar selectivity of gears supporting the combination of gears into a single recreational fleet. MRIP retaining larger individuals should be considered with combining BNP lengths. If combined, BNP length data should be aligned with MRIP interviews conducted in close geographic proximity to BNP to ensure appropriate representation.

4.6 RECREEATIONAL EFFORT

4.6.1 MRIP Effort

Total effort estimates by region and mode from the MRIP, TPWD, and LACreel survey programs are provided in the working paper (SEDAR 94-DW-05, Tables 10.1-10.3) by year, region, and mode. Total effort estimates depict all (general) recreational fishing activity in angler trips and are not specific to Hogfish.

4.6.2 SRHS Effort

Details on total effort estimation and tables and figures of non-directed effort are presented in the SEDAR 94-DW-02 working paper in angler-days (Table 14), angler-trips (Table 15), angler-days by region (Table 16), angler-trips by region (Table 17), angler-days by sub-region (Table 18), and angler-trips by subregion (Table 19).

4.7 DISCARD MORTALITY

Discard mortality rates for the recreational hook and line fleet were discussed at length due to the availability of new information since the last assessment (Eguia et al. 2025; Ellis et al. 2025). Discard mortality rates used in SEDAR 37 were assumed to be 10% for hook and line and 100% for spear gear releases. These rates were based on the assumption that most Hogfish being caught by spear gear and by hook and line were of legal size (12 inch FL) at the time (SEDAR 37). This assumption was made for fish caught by hook and line because Hogfish caught by this gear are

generally in shallower water where barotrauma occurs less frequently in reef fishes. Currently, this hook and line discard mortality estimate is thought to be too low given the assumed susceptibility of Hogfish to barotrauma, their laterally-compressed physiology, and information about discard mortality in similar species (e.g., Gray Triggerfish; Runde et al. 2019; McKinzie and Szedlmayer 2022). New information from a study that used acoustic telemetry to assess immediate and delayed discard mortality was presented to the RWG. Ellis et al. (2025) used recreational hook and line methods to capture Hogfish at natural hardbottom sites along the West Florida Shelf offshore of Tampa Bay, FL, between 2019-2024. Hogfish were targeted throughout the year and at a range of depths to develop a single overall estimate of discard mortality and a range of estimates based on capture depth by surface temperatures (Table 4.11.21). The RWG felt that this study represented the Best Available Science for Hogfish discard mortality rates and recommended that the overall rate of 23.8% be used as a lower bound for discard mortality in the assessment. Given the low rate of recompression device usage in the Gulf recreational fisheries (Eguia et al. 2025), and the fact that all fish in the study were recompressed with descending devices, the RWG felt this rate should be considered a "best-case scenario" for released Hogfish. The recreational anglers on the RWG all agreed the "true" discard morality rate for released Hogfish is likely much higher.

Information on the incidence of barotrauma in Hogfish caught by the Gulf for-hire fleet was presented to the RWG, using the FWC/FWRI At-Sea Observer Survey (Eguia et al. 2025). 89% of Hogfish observations aboard for-hire vessels occurred in 10 to 20 m, yet 59% of discarded Hogfish exhibited catastrophic levels of barotrauma (i.e. scales bubbling, severe exophthalmia, blood leaching, evidence of exploded swim bladder, Table 4.11.22). Despite severe and catastrophic symptoms of barotrauma observed in 79% of discarded Hogfish, 80% of discards were released with no barotrauma mitigation, 13% were vented, and 7% were recompressed with descending devices or cages from 2009-2024 (Table 4.11.23). In addition, at-sea observers opportunistically tagged a total of 650 Hogfish since 2009 with conventional dart tags and have only received 7 reliable Hogfish recapture reports (~1%). Small sample size constrains the utility of conventional dart tag data usage for Hogfish discard mortality, but the panel noted the unusually low recapture rate for such a shallow water fishery. Other reef species are tagged in the At-Sea Observer Program have higher recapture rates in the same depths and regions, including Gray Triggerfish (*Balistes capriscus*), which has a ~7% recapture reporting rate and

Red Grouper (*Epinephelus morio*) which has a ~11% recapture reporting rate (Eguia, unpublished research). Using the at-sea observer data for Hogfish observed in the Tampa Bay region, a model predicting barotrauma scores using different environmental and biological parameters was presented to the panel. Depth did not have a significant effect on barotrauma for Hogfish, but fork length was significant, estimating high probabilities of severe and catastrophic barotrauma for sub-legal Hogfish (Eguia et al. 2025). Given these results, the plenary recommended using 59% as the upper bound for discard mortality, assuming fish with catastrophic barotrauma symptoms are highly unlikely to survive post-release (Table 4.11.22).

Issue: Evaluate studies on Hogfish release mortality to inform a release mortality rate for recreational hook and line gear for the WFS and SEFL/Keys stocks

Recommendation: The RWG recommends using a rate of 23.8% to be used as a lower bound and 59% as the upper bound for discard mortality in the assessment. An average of the low and high bounds results in a recommended base model estimate of release mortality for hook and line caught Hogfish of 41.4%. The RWG recommends retaining the 100% release mortality estimate for spear caught Hogfish. If gears are combined, the RWG recommends using the hook and line release mortality estimate to be representative of the combined gear releases. Spear gear releases are estimated to be low or zero in most years. If an additional analysis is conducted using weighting methods on existing data to produce an alternative base model estimate, the resulting value would be considered by the RWG.

4.8 COMMENTS ON ADEQUACY OF DATA FOR ASSESSMENT ANALYSES

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

The recreational landings estimates represented in this report appear to be adequate for Florida Hogfish for the time period covered, although the RWG did identify some years with exceptionally high landings and release estimates (with high associated uncertainty). Generally, discard estimates are highly uncertain when stratified at the gear level and aren't estimated for some early years due to low number of interviews and the lack of size/bag limit regulations at the time.

The RWG recommends SRFS estimated landings and releases for recreational private boat mode, MRIP FES estimated landings and releases for shore mode, MRIP FHS calibrated landings and releases for charter mode, and SRHS for landings and releases for headboats for both Florida Hogfish stocks (WFS, SEFL/Keys).

There were no species misidentification issues for SEDAR 94.

4.9 RECOMMENDATIONS

4.9.1 Research Recommendations

- Additional release mortality research specially investigating mortality of surface released fish and/or vented fish caught by hook and line in the recreational fishery. This should include research into the incidence of barotrauma, its causes, and its relationship to release mortality.
- Improve precision of MRIP and SRFS estimates for all modes through increased sampling
- Additional age data collection from all recreational sources by region (WFS, FLK/Keys), by gear (spear, hook and line), and by fishing area
- Increasing sampling to intercept and collect biological information from private recreational Hogfish anglers
- Explore methods to acquire catch information from private boat anglers returning to private docks in addition to public access points

4.9.2 Other Recommendations

Issue: Providing a potential model start year recommendation according to recreational data availability and uncertainty. The RWG discussed a potential recommendation to start the assessment model in 1986, as has been done in the previous Hogfish assessment (SEDAR 37) and other SEDAR stock assessments for reef fishes.

Recommendation: Catch estimates from the early years of the MRIP survey (e.g., 1981-1985) are highly variable and tend to result in higher CVs than those estimated in subsequent years. Additionally, some early years (1984-1985) in the WFS have zero estimated landings. The group

has no particular concerns with retaining and using the recreational data in these early years as inputs into the assessment model but recognizes the above reasons could be used for justification of removal. The RWG concluded that both options are valid and supported and recommends this decision be made during the assessment process based on other aspects of data availability and modeling needs.

4.10 LITERATURE CITED

Allen, S. 2025. Hogfish (Lachnolaimus maximus) Lengths Sampled in the Biscayne National Park Creel Survey, 1993-2024. SEDAR 94-DW-18. SEDAR, North Charleston, SC. 12 pp.

Andrews, W.R. (2022). Evaluating Measurement Error in the MRIP Fishing Effort Survey: The Effect of Question Sequence on Reporting of Fishing Activity. NOAA Fisheries Service, Office of Science and Technology.

Andrews, W.R., Papacostas, K.J. and Foster, J. (2018), A Comparison of Recall Error in Recreational Fisheries Surveys with One- and Two-Month Reference Periods. North Am J Fish Manage, 38: 1284 -1298. https://doi.org/10.1002/nafm.10233.

Binion-Rock, S.M. and A. Cathey. 2025. General Recreational Survey Data for Hogfish in the Gulf of America and South Atlantic. SEDAR94-DW-05. SEDAR, North Charleston, SC. 83 pp.

Cheshire, R.T. and M.E. Green. 2025. Headboat Data for Hogfish in the Southeast U.S. Atlantic and Gulf of America. SEDAR94-DW-02. SEDAR, North Charleston, SC. 50 pp.

Corbett, E. and L. Eguia. 2025. A summary of Florida Hogfish discard length data collected from at-sea observers in for-hire fishery surveys in Florida 2005-2024. SEDAR94-DW-10. SEDAR, North Charleston, SC. 20 pp.

Dettloff, K. and V.M. Matter 2019. SEDAR61-WP19: Model-estimated conversion factors for calibrating Coastal Household Telephone Survey (CHTS) charterboat catch and effort estimates with For-Hire Survey estimates in the Atlantic and Gulf of Mexico with application to red grouper and greater amberjack. National Marine Fisheries Service Southeast Fisheries Science Center, Fisheries Statistics Division, Miami, FL., National Marine Fisheries Service Southeast Fisheries Science Center, Sustainable Fisheries Division, Miami, FL.

Dettloff, K., VM Matter, and MA 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.

Eguia, L., Z. Siders, and D. Murie. 2025. SEDAR 94-DW-16. Recreational For-Hire Trends in Release Methods and Barotrauma Assessment of Hogfish (*Lachnolaimus maximus*) using a Fisheries-Dependent At-Sea Observer Program. SEDAR, North Charleston, SC. 31 pp.

Ellis, R.D., B. J. Williams, K. Flaherty-Walia, and P. Stevens. 2025. SEDAR 94-DW-12. Hogfish Discard Mortality and Habitat Ecology on the West Florida Shelf. SEDAR, North Charleston, SC. 21 pp.

NOAA-SERO. 2025. Summary of Southeast For-Hire Integrated Electronic Reporting Program Records for Hogfish Catch in Southeast Region. Limited Access Privilege Programs/Data Management Branch. SEDAR 94-DW-23. SEDAR, North Charleston, SC. 7 pp.

McGirl, M., J. Carroll, and B. Cermak. 2025. SEDAR94-DW-11. Length and age composition of Florida Hogfish, Lachnolaimus maximus, collected in association with fishery-dependent projects. SEDAR, North Charleston, SC. 18 pp.

McKinzie, M. K. and S.T. Szedlmayer. 2022. Mortality estimates for gray triggerfish (*Balistes capriscus*) in the northern Gulf of Mexico based on acoustic telemetry. Fishery Bulletin, 120(2).

Ramsay, C. and M. McGirl. 2025. A ratio-based method for calibrating estimates of total landings (numbers and pounds of fish), and releases (numbers of fish) from MRIP-FCAL to SRFS for Hogfish (Lachnolaimus maximus) in Florida. SEDAR94-DW-21. SEDAR, North Charleston, SC. 26 pp.

Runde, B.J., P.J. Rudershausen, B. Sauls, C.S. Mikles, and J.A. Buckel. 2019. Low discard survival of gray triggerfish in the southeastern US hook-and-line fishery. Fisheries Research 219:105313.

SAFMC Snapper Grouper Advisory Panel. 2025. Florida Keys and East Hogfish Fishery Performance Report. SEDAR 94-DW-03. SEDAR, North Charleston, SC. 5 pp.

SEDAR 37. 2013. The 2013 Stock Assessment Report for Hogfish in the South Atlantic and Gulf of Mexico. SEDAR, North Charleston, SC. 573 pp.

4.11 TABLES

Table 4.11.1. Hogfish landings (AB1) and discards (B2), in numbers of fish, with associated coefficients of variation (CV; Dettloff et al. 2020) by year for all modes combined from all data sources (MRIP) for the **WFS** domain (the Florida panhandle through western Florida). Sample size is provided both as the total number of primary sampling units (PSU) and angler trips (TRP) intercepted by dockside samplers and, in parentheses, the number of PSUs and TRPs that intercepted Hogfish.

	AB1				B2			
Year	**Total**	**CV**	**PSU**	**Trp**	**Total**	**CV**	**PSU**	**Trp**
1981	58,163	0.65	387 (3)	2,695 (5)	0	0.00	387 (0)	2,695 (0)
1982	13,187	0.67	530 (3)	4,107 (4)	0	0.00	530 (0)	4,107 (0)
1983	19,922	0.73	287 (2)	2,663 (2)	0	0.00	287 (0)	2,663 (0)
1984	0	0.00	306 (0)	3,024 (0)	0	0.00	306 (0)	3,024 (0)
1985	0	0.00	415 (0)	3,861 (0)	0	0.00	415 (0)	3,861 (0)
1986	49,587	0.69	864 (4)	5,082 (6)	0	0.00	864 (0)	5,082 (0)
1987	99,746	0.56	1,083 (9)	7,013 (15)	6,828	1.00	1,083 (1)	7,013 (1)
1988	59,417	0.33	1,229 (14)	8,478 (16)	0	0.00	1,229 (0)	8,478 (0)
1989	109,262	0.53	736 (10)	5,606 (12)	3,471	1.00	736 (1)	5,606 (1)
1990	59,179	0.65	558 (3)	4,526 (3)	0	0.00	558 (0)	4,526 (0)
1991	148,305	0.44	539 (7)	4,424 (12)	0	0.00	539 (0)	4,424 (0)
1992	78,425	0.51	993 (12)	11,223 (15)	4,522	1.00	993 (1)	11,223 (1)
1993	91,847	0.37	1,050 (14)	11,930 (21)	0	0.00	1,050 (0)	11,930 (0)
1994	54,325	0.34	1,091 (15)	14,176 (20)	0	0.00	1,091 (0)	14,176 (0)
1995	104,008	0.33	950 (16)	12,691 (18)	4,797	0.71	950 (2)	12,691 (2)
1996	32,345	0.35	1,062 (13)	12,420 (16)	14,295	0.78	1,062 (2)	12,420 (2)
1997	68,428	0.30	1,113 (18)	13,054 (18)	758	1.00	1,113 (1)	13,054 (1)
1998	75,830	0.30	1,398 (23)	16,912 (30)	7,171	0.67	1,398 (4)	16,912 (7)
1999	97,333	0.25	1,940 (31)	24,152 (34)	9,699	0.86	1,940 (3)	24,152 (3)
2000	50,080	0.37	1,723 (11)	21,853 (13)	1,731	1.00	1,723 (1)	21,853 (1)
2001	94,891	0.36	1,631 (19)	22,453 (23)	0	0.00	1,631 (0)	22,453 (0)

2002	45,361	0.47	1,736 (15)	24,465 (16)	703	1.00	1,736 (1)	24,465 (1)
2003	120,509	0.28	2,064 (29)	25,045 (36)	964	1.00	2,064 (1)	25,045 (1)
2004	95,699	0.48	1,538 (14)	23,288 (15)	1,557	1.00	1,538 (1)	23,288 (1)
2005	57,482	0.55	1,375 (13)	20,750 (14)	5,687	0.71	1,375 (2)	20,750 (4)
2006	61,644	0.48	1,326 (13)	20,082 (13)	2,122	0.81	1,326 (2)	20,082 (2)
2007	75,683	0.39	1,296 (15)	19,818 (18)	549	1.00	1,296 (1)	19,818 (1)
2008	206,453	0.30	1,387 (24)	18,667 (28)	10,819	0.55	1,387 (5)	18,667 (5)
2009	115,761	0.28	1,446 (24)	20,051 (33)	6,632	0.50	1,446 (5)	20,051 (5)
2010	215,686	0.35	1,444 (20)	20,182 (24)	12,481	0.67	1,444 (3)	20,182 (4)
2011	107,647	0.29	1,519 (22)	21,311 (28)	1,512	1.00	1,519 (1)	21,311 (1)
2012	170,360	0.33	1,725 (24)	23,234 (40)	0	0.00	1,725 (0)	23,234 (0)
2013	241,845	0.42	1,316 (25)	15,968 (34)	7,081	0.56	1,316 (4)	15,968 (7)
2014	115,190	0.27	1,555 (40)	19,503 (55)	13,415	0.81	1,555 (5)	19,503 (20)
2015	104,062	0.39	1,652 (32)	18,818 (42)	1,373	0.67	1,652 (4)	18,818 (6)
2016	295,019	0.34	1,888 (43)	19,541 (57)	24,844	0.62	1,888 (6)	19,541 (7)
2017	113,078	0.29	1,452 (37)	16,538 (55)	37,274	0.47	1,452 (17)	16,538 (33)
2018	58,938	0.34	1,349 (27)	13,600 (37)	38,017	0.38	1,349 (12)	13,600 (27)
2019	62,472	0.26	1,326 (24)	12,779 (31)	42,949	0.55	1,326 (10)	12,779 (27)
2020	63,401	0.37	1,534 (23)	13,745 (31)	39,091	0.35	1,534 (14)	13,745 (35)
2021	68,174	0.43	1,654 (28)	13,440 (35)	60,485	0.28	1,654 (28)	13,440 (64)
2022	46,856	0.42	1,493 (19)	10,639 (27)	110,727	0.55	1,493 (14)	10,639 (45)
2023	154,142	0.30	1,716 (37)	14,108 (46)	189,913	0.42	1,716 (29)	14,108 (74)
2024	152,845	0.32	1,702 (45)	15,139 (62)	70,514	0.40	1,702 (32)	15,139 (94)

Table 4.11.2. Hogfish landings (AB1) and discards (B2), in numbers of fish, with associated coefficients of variation (CV; Dettloff et al. 2020) by year for all modes combined from all data sources (MRIP) for the **Keys_EFL** domain (Monroe County and Florida Atlantic coast). Sample size is provided both as the total number of primary sampling units (PSU) and angler trips (TRP) intercepted by dockside samplers and, in parentheses, the number of PSUs and TRPs that intercepted Hogfish.

	AB1				B2			
Year	**Total**	**CV**	**PSU**	**Trp**	**Total**	**CV**	**PSU**	**Trp**
1981	1,876,238	0.66	52 (7)	456 (18)	0	0.00	52 (0)	456 (0)
1982	155,783	0.53	88 (7)	699 (8)	0	0.00	88 (0)	699 (0)
1983	282,604	0.66	60 (3)	556 (4)	0	0.00	60 (0)	556 (0)
1984	9,679,484	0.92	106 (9)	670 (17)	0	0.00	106 (0)	670 (0)
1985	253,464	0.96	37 (2)	289 (6)	0	0.00	37 (0)	289 (0)
1986	197,914	0.45	81 (7)	386 (8)	0	0.00	81 (0)	386 (0)
1987	399,899	0.29	173 (25)	948 (34)	2,809	1.00	173 (1)	948 (1)
1988	302,578	0.46	111 (10)	646 (15)	238,584	0.99	111 (2)	646 (4)
1989	245,769	0.43	102 (11)	597 (15)	5,558	1.00	102 (1)	597 (1)
1990	358,954	0.39	120 (11)	640 (20)	16,659	0.67	120 (3)	640 (3)
1991	128,420	0.69	222 (3)	1,090 (4)	0	0.00	222 (0)	1,090 (0)
1992	342,136	0.28	311 (23)	1,855 (34)	35,111	0.63	311 (5)	1,855 (6)
1993	391,776	0.32	457 (20)	2,440 (25)	5,496	1.00	457 (1)	2,440 (1)
1994	284,153	0.35	356 (21)	2,171 (28)	22,660	0.64	356 (3)	2,171 (4)
1995	229,790	0.49	331 (13)	2,027 (20)	70,639	0.54	331 (6)	2,027 (13)
1996	158,963	0.37	356 (13)	2,412 (13)	26,752	0.63	356 (3)	2,412 (6)
1997	95,458	0.43	390 (13)	2,669 (14)	11,748	0.48	390 (4)	2,669 (5)
1998	69,212	0.46	372 (10)	3,095 (10)	31,580	0.50	372 (6)	3,095 (8)
1999	139,890	0.52	501 (10)	4,823 (10)	32,529	0.50	501 (8)	4,823 (8)
2000	50,766	0.61	481 (4)	5,304 (4)	14,405	1.00	481 (1)	5,304 (1)
2001	101,096	0.69	351 (4)	4,955 (4)	10,052	0.99	351 (2)	4,955 (3)
2002	114,597	0.65	326 (6)	4,192 (7)	3,258	1.00	326 (1)	4,192 (1)
2003	193,892	0.43	313 (19)	4,522 (24)	25,737	0.70	313 (4)	4,522 (6)
2004	237,706	0.48	223 (20)	3,206 (24)	73,475	0.54	223 (5)	3,206 (11)
2005	234,173	0.64	197 (10)	2,852 (12)	151,184	0.76	197 (5)	2,852 (8)

2006	181,111	0.33	148 (16)	2,052 (17)	36,582	0.69	148 (4)	2,052 (7)
2007	261,697	0.34	247 (18)	2,427 (23)	57,568	0.70	247 (4)	2,427 (6)
2008	518,171	0.51	340 (23)	3,229 (36)	36,833	0.55	340 (6)	3,229 (8)
2009	357,516	0.39	204 (14)	1,920 (15)	10,374	0.99	204 (3)	1,920 (3)
2010	280,313	0.62	235 (11)	2,425 (14)	9,086	0.97	235 (2)	2,425 (5)
2011	117,795	0.51	248 (10)	2,270 (10)	3,767	0.95	248 (3)	2,270 (3)
2012	562,527	0.68	281 (16)	2,410 (24)	52,879	0.74	281 (5)	2,410 (16)
2013	201,095	0.35	250 (26)	1,860 (37)	55,287	0.62	250 (11)	1,860 (16)
2014	407,725	0.31	379 (47)	3,062 (75)	93,108	0.33	379 (18)	3,062 (28)
2015	708,554	0.26	386 (51)	2,620 (69)	62,309	0.59	386 (11)	2,620 (24)
2016	333,598	0.27	317 (32)	1,631 (41)	38,963	0.57	317 (7)	1,631 (7)
2017	113,203	0.37	237 (15)	1,286 (19)	57,745	0.80	237 (9)	1,286 (15)
2018	27,027	0.63	278 (3)	1,747 (3)	43,049	0.74	278 (5)	1,747 (7)
2019	8,311	0.00	275 (0)	1,386 (0)	43,937	0.87	275 (5)	1,386 (5)
2020	13,122	0.72	301 (3)	1,529 (3)	44,619	0.60	301 (9)	1,529 (13)
2021	35,679	0.64	364 (3)	2,272 (3)	87,872	0.34	364 (19)	2,272 (23)
2022	29,835	0.63	308 (3)	1,391 (3)	77,594	0.43	308 (12)	1,391 (14)
2023	22,887	0.99	382 (2)	2,270 (2)	115,873	0.31	382 (18)	2,270 (22)
2024	22,904	0.00	397 (0)	2,802 (0)	47,160	0.34	397 (16)	2,802 (21)

Table 4.11.3. Hogfish landings in numbers of fish (AB1) with associated coefficients of variation (CV; Dettloff et al. 2020) by mode and year from all data sources (MRIP) for the **WFS** domain (the Florida panhandle through western Florida). Sample size is provided both as the total number of primary sampling units (PSU) and angler trips (TRP) intercepted by dockside samplers and, in parentheses, the number of PSUs and TRPs that intercepted Hogfish.

	Cbt				Hbt				Priv				Shore			
Year	AB1	CV	PSU	Trp	AB1	CV	PSU	Trp	AB1	CV	PSU	Trp	AB1	CV	PSU	Trp
1981	0	0.00	46 (0)	441 (0)	0	0.00	46 (0)	441 (0)	58,163	0.66	116 (3)	921 (5)	0	0.00	225 (0)	1,333 (0)
1982	0	0.00	42 (0)	309 (0)	0	0.00	42 (0)	309 (0)	13,187	0.67	220 (3)	1,760 (4)	0	0.00	268 (0)	2,038 (0)
1983	0	0.00	52 (0)	681 (0)	0	0.00	52 (0)	681 (0)	19,922	0.73	87 (2)	793 (2)	0	0.00	148 (0)	1,189 (0)
1984	0	0.00	43 (0)	707 (0)	0	0.00	43 (0)	707 (0)	0	0.00	81 (0)	888 (0)	0	0.00	182 (0)	1,429 (0)
1985	0	0.00	46 (0)	795 (0)	0	0.00	46 (0)	795 (0)	0	0.00	122 (0)	1,018 (0)	0	0.00	247 (0)	2,048 (0)
1986	4,638	0.71	143 (2)	913 (4)	0	0.00	0 (0)	0 (0)	44,949	0.76	507 (2)	3,139 (2)	0	0.00	214 (0)	1,030 (0)
1987	1,163	0.84	142 (2)	944 (4)	0	0.00	0 (0)	0 (0)	98,583	0.57	722 (7)	4,964 (11)	0	0.00	219 (0)	1,105 (0)
1988	0	0.00	133 (0)	771 (0)	0	0.00	0 (0)	0 (0)	59,417	0.33	724 (14)	5,410 (16)	0	0.00	372 (0)	2,297 (0)
1989	1,962	0.88	64 (2)	423 (2)	0	0.00	0 (0)	0 (0)	107,300	0.54	432 (8)	3,513 (10)	0	0.00	240 (0)	1,670 (0)
1990	0	0.00	40 (0)	260 (0)	0	0.00	0 (0)	0 (0)	59,179	0.66	341 (3)	2,963 (3)	0	0.00	177 (0)	1,303 (0)
1991	0	0.00	46 (0)	269 (0)	0	0.00	0 (0)	0 (0)	148,305	0.45	308 (7)	2,885 (12)	0	0.00	185 (0)	1,270 (0)
1992	0	0.00	71 (0)	451 (0)	0	0.00	0 (0)	0 (0)	78,425	0.51	567 (12)	7,550 (15)	0	0.00	355 (0)	3,222 (0)

1993	0	0.00	73 (0)	484 (0)	0	0.00	0 (0)	0 (0)	91,847	0.37	460 (14)	6,225 (21)	0	0.00	517 (0)	5,221 (0)			
1994	0	0.00	71 (0)	545 (0)	0	0.00	0 (0)	0 (0)	54,325	0.34	493 (15)	7,456 (20)	0	0.00	527 (0)	6,175 (0)			
1995	0	0.00	68 (0)	420 (0)	0	0.00	0 (0)	0 (0)	104,008	0.34	401 (16)	6,561 (18)	0	0.00	481 (0)	5,710 (0)			
1996	0	0.00	83 (0)	458 (0)	0	0.00	0 (0)	0 (0)	32,345	0.36	572 (13)	8,163 (16)	0	0.00	407 (0)	3,799 (0)			
1997	0	0.00	193 (0)	1,031 (0)	0	0.00	0 (0)	0 (0)	61,863	0.31	528 (17)	8,070 (17)	6,566	1.00	392 (1)	3,953 (1)			
1998	5,735	0.59	341 (6)	2,503 (6)	0	0.00	0 (0)	0 (0)	70,095	0.33	610 (17)	9,738 (24)	0	0.00	447 (0)	4,671 (0)			
1999	803	0.70	491 (4)	4,932 (4)	0	0.00	0 (0)	0 (0)	96,530	0.25	898 (27)	12,806 (30)	0	0.00	551 (0)	6,414 (0)			
2000	0	0.00	491 (0)	6,465 (0)	0	0.00	0 (0)	0 (0)	50,080	0.37	752 (11)	10,170 (13)	0	0.00	480 (0)	5,223 (0)			
2001	335	0.66	407 (3)	5,052 (3)	0	0.00	0 (0)	0 (0)	87,355	0.39	748 (15)	12,061 (19)	7,201	1.00	476 (1)	5,340 (1)			
2002	454	0.70	440 (3)	5,445 (3)	0	0.00	0 (0)	0 (0)	43,270	0.51	847 (11)	13,517 (12)	1,638	1.00	449 (1)	5,503 (1)			
2003	675	0.54	597 (5)	6,564 (5)	0	0.00	0 (0)	0 (0)	119,835	0.29	918 (24)	12,475 (31)	0	0.00	549 (0)	6,006 (0)			
2004	166	0.72	559 (2)	7,571 (2)	0	0.00	0 (0)	0 (0)	95,533	0.48	661 (12)	11,044 (13)	0	0.00	318 (0)	4,673 (0)			
2005	353	0.88	461 (2)	6,114 (2)	0	0.00	0 (0)	0 (0)	57,129	0.56	614 (11)	10,287 (12)	0	0.00	300 (0)	4,349 (0)			
2006	49	1.00	342 (1)	4,559 (1)	0	0.00	0 (0)	0 (0)	61,595	0.49	685 (12)	11,002 (12)	0	0.00	299 (0)	4,521 (0)			
2007	936	0.67	327 (3)	4,253 (3)	0	0.00	0 (0)	0 (0)	74,747	0.39	677 (12)	11,109 (15)	0	0.00	292 (0)	4,456 (0)			
2008	427	0.71	304 (2)	3,202 (2)	0	0.00	0 (0)	0 (0)	196,342	0.32	762 (20)	11,196 (24)	9,684	0.71	321 (2)	4,269 (2)			
2009	802	0.71	282 (2)	2,963 (2)	0	0.00	0 (0)	0 (0)	112,822	0.29	804 (20)	12,230 (29)	2,137	0.90	360 (2)	4,858 (2)			

2010	24,945	0.81	301 (2)	3,255 (2)	0	0.00	0 (0)	0 (0)	190,741	0.38	770 (18)	11,628 (22)	0	0.00	373 (0)	5,299 (0)
2011	2,783	0.76	352 (5)	4,433 (5)	0	0.00	0 (0)	0 (0)	104,864	0.30	821 (17)	11,792 (23)	0	0.00	346 (0)	5,086 (0)
2012	5,443	0.47	449 (8)	5,377 (17)	0	0.00	0 (0)	0 (0)	164,917	0.34	892 (16)	12,218 (23)	0	0.00	384 (0)	5,639 (0)
2013	490	0.89	205 (2)	1,816 (2)	0	0.00	0 (0)	0 (0)	241,355	0.43	801 (23)	9,828 (32)	0	0.00	310 (0)	4,324 (0)
2014	3,401	0.55	362 (9)	3,499 (14)	0	0.00	0 (0)	0 (0)	103,594	0.30	945 (30)	12,686 (40)	8,195	1.00	248 (1)	3,318 (1)
2015	4,194	0.54	395 (9)	3,540 (15)	0	0.00	0 (0)	0 (0)	99,868	0.41	1,005 (23)	12,482 (27)	0	0.00	252 (0)	2,796 (0)
2016	11,981	0.71	421 (11)	3,654 (13)	0	0.00	0 (0)	0 (0)	283,038	0.35	1,020 (32)	12,284 (44)	0	0.00	447 (0)	3,603 (0)
2017	7,732	0.48	340 (15)	3,217 (23)	0	0.00	0 (0)	0 (0)	105,345	0.32	771 (22)	10,281 (32)	0	0.00	341 (0)	3,040 (0)
2018	15,762	0.40	329 (14)	2,966 (21)	0	0.00	0 (0)	0 (0)	43,175	0.44	704 (13)	7,825 (16)	0	0.00	316 (0)	2,809 (0)
2019	6,726	0.52	315 (8)	2,551 (9)	0	0.00	0 (0)	0 (0)	55,747	0.31	680 (16)	7,573 (22)	0	0.00	331 (0)	2,655 (0)
2020	10,161	0.40	344 (11)	2,239 (17)	0	0.00	0 (0)	0 (0)	53,240	0.44	807 (12)	8,503 (14)	0	0.00	383 (0)	3,003 (0)
2021	14,957	0.38	414 (24)	3,292 (29)	0	0.00	0 (0)	0 (0)	53,217	0.54	735 (4)	6,077 (6)	0	0.00	505 (0)	4,071 (0)
2022	8,234	0.44	326 (10)	2,400 (16)	0	0.00	0 (0)	0 (0)	38,622	0.50	693 (9)	5,067 (11)	0	0.00	474 (0)	3,172 (0)
2023	36,973	0.51	440 (21)	3,671 (26)	0	0.00	0 (0)	0 (0)	117,169	0.36	753 (16)	6,174 (20)	0	0.00	523 (0)	4,263 (0)
2024	15,546	0.46	459 (28)	3,843 (38)	0	0.00	0 (0)	0 (0)	137,299	0.35	734 (17)	6,591 (24)	0	0.00	509 (0)	4,705 (0)

Table 4.11.4. Hogfish landings in numbers of fish (AB1) with associated coefficients of variation (CV; Dettloff et al. 2020) by mode and year from all data sources (MRIP) for the **Keys_EFL** domain (Monroe County and Florida Atlantic coast). Sample size is provided both as the total number of primary sampling units (PSU) and angler trips (TRP) intercepted by dockside samplers and, in parentheses, the number of PSUs and TRPs that intercepted Hogfish.

	Cbt				Priv				Shore			
Year	**AB1**	**CV**	**PSU**	**Trp**	**AB1**	**CV**	**PSU**	**Trp**	**AB1**	**CV**	**PSU**	**Trp**
1981	0	0.00	9 (0)	96 (0)	1,876,238	0.67	22 (7)	193 (18)	0	0.00	21 (0)	167 (0)
1982	0	0.00	12 (0)	76 (0)	155,783	0.65	42 (7)	378 (8)	0	0.00	34 (0)	245 (0)
1983	0	0.00	26 (0)	269 (0)	282,604	0.66	19 (3)	151 (4)	0	0.00	15 (0)	136 (0)
1984	40	1.00	41 (1)	323 (1)	9,620,456	0.93	22 (5)	123 (11)	58,989	0.68	43 (3)	224 (5)
1985	0	0.00	21 (0)	120 (0)	243,017	1.00	10 (1)	96 (4)	10,447	1.00	6 (1)	73 (2)
1986	0	0.00	29 (0)	155 (0)	182,479	0.49	46 (6)	205 (7)	15,435	1.00	6 (1)	26 (1)
1987	10,173	1.00	36 (1)	176 (1)	357,124	0.32	108 (22)	607 (31)	32,602	0.71	29 (2)	165 (2)
1988	0	0.00	40 (0)	225 (0)	302,578	0.46	45 (10)	259 (15)	0	0.00	26 (0)	162 (0)
1989	86	1.00	35 (1)	186 (1)	245,683	0.43	51 (10)	287 (14)	0	0.00	16 (0)	124 (0)
1990	0	0.00	26 (0)	151 (0)	358,954	0.40	60 (11)	346 (20)	0	0.00	34 (0)	143 (0)
1991	0	0.00	60 (0)	315 (0)	128,420	0.69	103 (3)	490 (4)	0	0.00	59 (0)	285 (0)
1992	75	1.00	78 (1)	456 (1)	311,542	0.31	160 (18)	983 (28)	30,519	0.53	73 (4)	416 (5)
1993	0	0.00	68 (0)	463 (0)	381,828	0.34	208 (18)	1,066 (23)	9,949	0.82	181 (2)	911 (2)
1994	0	0.00	64 (0)	441 (0)	274,170	0.37	167 (17)	1,053 (24)	9,982	0.53	125 (4)	677 (4)
1995	0	0.00	63 (0)	474 (0)	228,425	0.50	136 (13)	796 (20)	1,366	0.00	132 (0)	757 (0)
1996	0	0.00	68 (0)	576 (0)	158,963	0.38	168 (13)	1,119 (13)	0	0.00	120 (0)	717 (0)
1997	363	1.00	158 (1)	1,038 (1)	93,646	0.45	144 (11)	1,109 (12)	1,449	1.00	88 (1)	522 (1)
1998	33	0.72	214 (3)	1,985 (3)	69,179	0.47	98 (7)	699 (7)	0	0.00	60 (0)	411 (0)
1999	75	0.79	328 (2)	3,655 (2)	130,240	0.60	112 (6)	781 (6)	9,575	0.80	61 (2)	387 (2)

2000	14	1.00	384 (1)	4,674 (1)	46,634	0.72	73 (2)	500 (2)	4,118	1.00	24 (1)	135 (1)
2001	157	1.00	265 (1)	4,248 (1)	97,981	0.69	53 (3)	421 (3)	2,958	0.00	33 (0)	286 (0)
2002	152	0.61	261 (3)	3,732 (3)	105,024	0.71	44 (3)	297 (4)	9,421	0.00	21 (0)	163 (0)
2003	1,779	0.77	230 (9)	3,707 (11)	183,309	0.43	54 (10)	567 (13)	8,804	0.00	29 (0)	248 (0)
2004	3,404	0.53	174 (10)	2,687 (10)	219,187	0.57	31 (7)	375 (11)	15,114	0.59	18 (3)	144 (3)
2005	674	0.53	167 (4)	2,589 (4)	223,138	0.66	17 (5)	159 (7)	10,361	1.00	13 (1)	104 (1)
2006	1,345	0.53	117 (5)	1,774 (5)	168,271	0.42	25 (10)	251 (11)	11,495	1.00	6 (1)	27 (1)
2007	418	0.71	175 (2)	1,924 (3)	261,279	0.34	56 (16)	395 (20)	0	0.00	16 (0)	108 (0)
2008	6,140	0.72	239 (12)	2,641 (12)	507,684	0.52	72 (11)	406 (24)	4,347	0.00	29 (0)	182 (0)
2009	64	1.00	148 (1)	1,647 (1)	355,757	0.41	41 (13)	211 (14)	1,695	0.00	15 (0)	62 (0)
2010	1,316	0.46	176 (6)	2,122 (6)	278,997	0.63	47 (5)	256 (8)	0	0.00	12 (0)	47 (0)
2011	368	0.57	194 (4)	2,042 (4)	109,994	0.56	36 (5)	147 (5)	7,432	1.00	18 (1)	81 (1)
2012	1,359	0.75	194 (5)	1,962 (5)	559,152	0.69	60 (10)	338 (18)	2,016	1.00	27 (1)	110 (1)
2013	673	0.41	111 (7)	1,088 (7)	197,107	0.36	105 (17)	579 (28)	3,315	0.74	34 (2)	193 (2)
2014	4,840	0.43	136 (9)	1,316 (14)	389,256	0.33	199 (37)	1,547 (60)	13,629	1.00	44 (1)	199 (1)
2015	3,358	0.52	149 (7)	1,053 (10)	621,796	0.30	182 (41)	1,332 (52)	83,400	0.62	55 (3)	235 (7)
2016	5,691	0.48	115 (6)	714 (6)	299,489	0.29	154 (24)	749 (33)	28,418	0.95	48 (2)	168 (2)
2017	2,577	0.60	90 (6)	594 (7)	110,626	0.42	115 (9)	575 (12)	0	0.00	32 (0)	117 (0)
2018	0	0.00	107 (0)	848 (0)	27,027	0.63	133 (3)	725 (3)	0	0.00	38 (0)	174 (0)
2019	0	0.00	89 (0)	534 (0)	8,311	0.00	145 (0)	704 (0)	0	0.00	41 (0)	148 (0)
2020	10	1.00	100 (1)	673 (1)	13,112	0.72	153 (2)	641 (2)	0	0.00	48 (0)	215 (0)
2021	0	0.00	148 (0)	1,229 (0)	35,679	0.65	140 (3)	696 (3)	0	0.00	76 (0)	347 (0)
2022	317	0.00	106 (0)	623 (0)	22,229	0.71	127 (2)	481 (2)	7,289	1.00	75 (1)	287 (1)
2023	951	1.00	138 (1)	1,034 (1)	21,935	1.00	158 (1)	837 (1)	0	0.00	86 (0)	399 (0)
2024	2,038	0.00	144 (0)	1,137 (0)	20,866	0.00	156 (0)	934 (0)	0	0.00	97 (0)	731 (0)

Table 4.11.5. The sample sizes of the number of assignments, confirmed trip interviews, and the total confirmed trip interviews where anglers harvested or released a Hogfish (*Lachnolaimus maximus*) from the Florida State Reef Fish Survey (SRFS) completed by dockside samplers during APAIS or SRFS supplemental sampling are shown. Sample sizes are split by year, the Southeast FL (SEFL) or West Florida Shelf (WFS) regions, and by gear type (SP=spear and HL=hook and line).

Region	Year	Assignments	Interviews	Hogfish Trips	Hogfish Trips SP	Hogfish Trips HL
SEFL	2021	587	1538	56	23	33
	2022	649	1688	61	20	41
	2023	757	2256	67	22	45
	2024	640	1763	47	21	26
WFS	2021	607	1561	67	9	58
	2022	316	690	61	14	47
	2023	405	938	100	17	83
	2024	372	915	95	21	74

Table 4.11.6. Annual SRFS estimates and error by year (2021-2024), region (southeast Florida [SEFL] or the west Florida shelf [WFS]), and gear type (hook and line, spear, or combined).

Gear	Region	Year	Landings (no.fish) Estimate	Landings (no.fish) PSE	Landings (lbs fish) Estimate	Landings (lbs fish) PSE	Releases (no. fish) Estimate	Releases (no. fish) PSE
Combined	SEFL	2021	37,706	25.2	119,049	15.8	27,592	26.2
		2022	10,809	27.7	32,443	19.3	29,573	25.7
		2023	9,164	29.4	25,707	18.3	82,070	56.9
		2024	11,258	28.4	48,457	21.3	8,083	32.4
	WFS	2021	22,103	19.9	53,846	13.8	25,338	25.5
		2022	25,989	31.8	72,288	21.2	14,287	23.9
		2023	70,503	17.4	176,351	11.6	80,030	17.1
		2024	39,019	16.9	104,316	12.4	34,952	29.4
Hook and Line	SEFL	2021	5,756	54.0	17,102	37.9	16,781	28.6
		2022	6,192	50.7	17,147	35.7	21,482	29.4
		2023	3,959	50.2	8,730	33.2	55,812	49.2
		2024	3,700	53.7	11,848	40.1	6,868	32.7
	WFS	2021	13,641	22.4	31,995	15.4	21,240	27.4
		2022	10,045	37.4	26,522	25.9	14,278	23.4
		2023	28,256	22.5	68,658	14.7	50,132	21.1
		2024	28,403	19.8	70,703	14.2	33,793	30.3
Spear	SEFL	2021	27,456	23.5	93,013	15.8	6,089	78.0
		2022	6,544	28.7	19,460	19.0	0	NA
		2023	10,302	25.5	30,719	15.2	165	90.0
		2024	7,558	33.1	36,609	25.1	928	125.6
	WFS	2021	4,786	39.8	12,294	26.5	673	150.7
		2022	13,759	53.3	39,600	34.9	0	NA
		2023	18,477	32.3	48,910	21.4	0	NA
		2024	12,064	30.1	37,196	22.7	0	NA

Table 4.11.7. Original and calibrated MRIP-FCAL annual estimates for Hogfish (*Lachnolaimus maximus*) landing and release estimates in Florida from 1981-2020 on the **West Florida Shelf**.

Year	MRIP-FCAL		SRFS-FCAL calibration		MRIP-FCAL		SRFS-FCAL calibration		MRIP-FCAL		SRFS-FCAL calibration	
	Landings (no.fish)	PSE	Landings (no. fish)	PSE	Landings (pounds)	PSE	Landings (pounds)	PSE	Releases (no.fish)	PSE	Releases (no. fish)	PSE
1981	58,163	66	26,472	70	78,568	68	39,124	72	0	NA	0	NA
1982	13,187	67	6,002	71	24,280	71	12,090	75	0	NA	0	NA
1983	19,922	73	9,067	77	41,438	78	20,635	81	0	NA	0	NA
1984	0	NA	0	NA	NA	NA	0	NA	0	NA	0	NA
1985	0	NA	0	NA	NA	NA	0	NA	0	NA	0	NA
1986	44,949	76	20,458	80	117,873	78	58,697	81	0	NA	0	NA
1987	98,583	57	44,868	62	214,772	63	106,949	67	6,828	100	3,528	106
1988	59,417	33	27,042	41	140,540	37	69,984	44	0	NA	0	NA
1989	107,300	54	48,835	59	247,925	54	123,459	59	3,471	100	1,794	106
1990	59,179	66	26,934	70	118,390	67	58,954	71	0	NA	0	NA
1991	148,305	45	67,498	51	268,388	50	133,649	55	0	NA	0	NA
1992	78,425	51	35,693	56	193,698	61	96,455	65	4,522	100	2,337	106
1993	91,847	37	41,802	44	170,043	40	84,676	46	0	NA	0	NA
1994	54,325	34	24,725	41	95,668	37	47,639	44	0	NA	0	NA
1995	104,008	34	47,337	41	225,326	57	112,205	61	2,149	100	1,110	106
1996	32,345	36	14,721	43	52,916	40	26,351	46	10,420	100	5,385	106
1997	61,863	31	28,155	39	112,034	36	55,789	43	758	100	392	106
1998	70,095	33	31,902	41	132,155	38	65,809	44	1,005	100	519	106
1999	96,530	25	43,933	34	196,016	32	97,610	39	9,699	86	5,012	93
2000	50,080	37	22,793	44	138,954	37	69,195	44	1,731	100	895	106
2001	87,355	39	39,758	46	153,232	43	76,305	48	0	NA	0	NA
2002	43,270	51	19,693	56	98,596	53	49,098	58	703	100	363	106
2003	119,835	29	54,540	37	236,133	31	117,587	39	964	100	498	106
2004	95,533	48	43,480	53	195,716	49	97,460	54	1,557	100	805	106
2005	57,129	56	26,001	61	158,673	58	79,014	63	5,687	71	2,939	79
2006	61,595	49	28,034	54	104,304	54	51,940	59	457	100	236	106
2007	74,747	39	34,020	46	114,035	41	56,786	47	0	NA	0	NA
2008	196,342	32	89,361	40	374,830	34	186,653	41	5,571	50	2,879	61
2009	112,822	29	51,349	37	246,725	32	122,861	40	4,576	58	2,364	67
2010	190,741	38	86,812	45	484,076	38	241,054	45	11,815	71	6,106	79
2011	104,864	30	47,726	38	219,463	32	109,285	39	1,512	100	781	106
2012	164,917	34	75,058	41	430,857	38	214,553	44	0	NA	0	NA
2013	241,355	43	109,847	49	556,828	46	277,282	52	7,081	56	3,659	66
2014	103,594	30	47,149	38	209,496	32	104,322	39	11,501	94	5,943	100
2015	99,868	41	45,453	47	244,715	42	121,860	48	833	100	430	106
2016	283,038	35	128,819	42	633,307	38	315,366	44	24,766	62	12,797	71
2017	105,345	32	47,946	40	303,440	36	151,103	43	32,367	54	16,725	64
2018	43,175	44	19,650	50	92,924	46	46,273	51	25,008	49	12,923	60
2019	55,747	31	25,372	39	125,548	35	62,519	42	35,194	66	18,186	74
2020	53,240	44	24,231	50	109,428	44	54,492	50	27,653	48	14,289	59

Table 4.11.8. Original and calibrated MRIP-FCAL annual estimates for Hogfish (*Lachnolaimus maximus*) landing and release estimates in Florida from 1981-2020 in **Southeast Florida**.

Year	MRIP-FCAL		SRFS-FCAL calibration		MRIP-FCAL		SRFS-FCAL calibration		MRIP-FCAL		SRFS-FCAL calibration	
	Landings (no.fish)	PSE	Landings (no. fish)	PSE	Landings (pounds)	PSE	Landings (pounds)	PSE	Releases (no.fish)	PSE	Releases (no. fish)	PSE
1981	1,876,238	67	1,284,306	77	2,691,775	69	2,169,061	77	0	NA	0	NA
1982	155,783	65	106,635	76	346,218	69	278,986	77	0	NA	0	NA
1983	282,604	66	193,446	77	773,394	73	623,209	80	0	NA	0	NA
1984	9,620,456	93	6,585,310	101	11,030,951	93	8,888,857	99	0	NA	0	NA
1985	243,017	100	166,348	107	325,370	100	262,187	106	0	NA	0	NA
1986	182,479	49	124,909	62	373,179	54	300,712	64	0	NA	0	NA
1987	357,124	32	244,456	50	713,469	45	574,921	56	2,809	100	2,714	109
1988	302,578	46	207,118	60	719,516	49	579,793	59	238,584	99	230,511	108
1989	245,683	43	168,173	58	457,178	44	368,399	55	5,558	100	5,370	109
1990	358,954	40	245,708	56	744,966	44	600,301	55	16,659	67	16,095	80
1991	128,420	69	87,905	79	239,892	71	193,307	79	0	NA	0	NA
1992	311,542	31	213,254	50	671,28	48	540,923	58	18,394	64	17,771	78
1993	381,828	34	261,365	52	722,833	38	582,466	51	5,496	100	5,310	109
1994	274,170	37	187,673	54	452,241	40	364,421	52	22,660	64	21,894	78
1995	228,425	50	156,359	63	610,499	65	491,947	73	70,639	54	68,249	70
1996	158,963	38	108,812	54	312,650	42	251,936	54	25,247	71	24,392	83
1997	93,646	45	64,102	59	189,969	48	153,079	59	11,748	51	11,350	67
1998	69,179	47	47,354	61	124,010	50	99,928	61	25,364	59	24,506	73
1999	130,240	60	89,151	71	286,833	62	231,133	71	19,709	61	19,043	75
2000	46,634	72	31,922	82	125,116	72	100,820	80	1,411	0	1,363	44
2001	97,981	69	67,069	79	203,240	70	163,773	78	9,942	100	9,605	109
2002	105,024	71	71,890	81	239,830	72	193,258	80	3,258	100	3,148	109
2003	183,309	43	125,477	58	347,298	45	279,856	56	11,505	100	11,116	109
2004	219,187	57	150,036	69	453,444	58	365,390	67	73,114	72	70,640	84
2005	223,138	66	152,741	77	580,170	68	467,507	76	108,552	100	104,879	109
2006	168,271	42	115,183	57	340,287	48	274,207	59	35,917	70	34,702	83
2007	261,279	34	178,848	52	485,750	36	391,423	49	57,509	70	55,563	83
2008	507,684	52	347,516	65	1,000,049	53	805,850	63	30,705	59	29,666	73
2009	355,757	41	243,519	56	794,482	43	640,202	55	10,293	100	9,945	109
2010	278,997	63	190,977	74	595,535	63	479,889	72	6,353	100	6,138	109
2011	109,994	56	75,292	68	217,116	57	174,954	66	3,661	100	3,537	109
2012	559,152	69	382,746	79	1,242,235	70	1,001,006	78	43,971	87	42,483	97
2013	197,107	36	134,922	53	463,587	40	373,564	53	34,640	51	33,468	67
2014	389,256	33	266,450	51	723,016	35	582,614	49	44,804	54	43,288	70
2015	621,796	30	425,626	49	1,160,308	32	934,988	47	46,286	77	44,720	89
2016	299,489	29	205,004	48	581,265	32	468,390	47	38,893	57	37,577	72
2017	110,626	42	75,724	57	201,055	45	162,012	56	54,686	82	52,836	93
2018	27,027	63	18,500	74	65,145	64	52,494	72	3,932	100	3,799	109
2019	8,311	0	5,689	39	20,198	17	16,276	38	9,381	100	9,063	109
2020	13,112	72	8,975	82	30,036	72	24,203	80	32,406	80	31,309	91

Table 4.11.9. Original and calibrated MRIP-FCAL annual estimates for Hogfish (*Lachnolaimus maximus*) landing and release estimates in Florida from 1981-2020 on the **West Florida Shelf** for the **hook and line** gear type.

Year	MRIP-FCAL		SRFS-FCAL calibration		MRIP-FCAL		SRFS-FCAL calibration		MRIP-FCAL		SRFS-FCAL calibration	
	Landings (no.fish)	PSE	Landings (no. fish)	PSE	Landings (pounds)	PSE	Landings (pounds)	PSE	Releases (no.fish)	PSE	Releases (no. fish)	PSE
1981	12,893	100	5,868	103	9,669	100	4,815	103	0	NA	0	NA
1982	0	NA	0	NA	0	NA	0	NA	0	NA	0	NA
1983	0	NA	0	NA	0	NA	0	NA	0	NA	0	NA
1984	0	NA	0	NA	0	NA	0	NA	0	NA	0	NA
1985	0	NA	0	NA	0	NA	0	NA	0	NA	0	NA
1986	0	NA	0	NA	0	NA	0	NA	0	NA	0	NA
1987	3,002	100	1,366	103	12,412	100	6,181	103	6,828	100	3,528	106
1988	3,222	100	1,467	103	3,588	100	1,787	103	0	NA	0	NA
1989	15,113	100	6,878	103	14,358	100	7,150	103	3,471	100	1,794	106
1990	30,984	100	14,102	103	41,053	100	20,443	103	0	NA	0	NA
1991	0	NA	0	NA	0	NA	0	NA	0	NA	0	NA
1992	16,361	43	7,446	49	26,213	43	13,053	49	4,522	100	2,337	106
1993	14,450	51	6,577	56	13,701	51	6,822	56	0	NA	0	NA
1994	20,307	45	9,242	51	14,348	38	7,145	44	0	NA	0	NA
1995	34,457	46	15,682	51	24,739	49	12,319	54	2,149	100	1,110	106
1996	11,154	55	5,077	59	8,625	54	4,295	59	10,420	100	5,385	106
1997	11,327	46	5,155	51	11,011	48	5,483	53	758	100	392	106
1998	8,998	71	4,095	75	5,465	66	2,721	70	1,005	100	519	106
1999	9,109	49	4,146	54	8,893	49	4,428	54	9,699	86	5,012	93
2000	28,013	41	12,749	47	32,781	44	16,324	49	1,731	100	895	106
2001	20,029	58	9,116	62	18,560	60	9,242	65	0	NA	0	NA
2002	15,948	66	7,259	70	18,287	66	9,106	70	703	100	363	106
2003	64,826	43	29,504	49	63,067	41	31,405	47	964	100	498	106
2004	1,331	100	606	103	1,038	100	517	103	1,557	100	805	106
2005	11,550	57	5,257	61	13,476	57	6,710	62	5,687	71	2,939	79
2006	22,521	100	10,250	103	15,258	100	7,598	103	457	100	236	106
2007	15,252	53	6,942	58	14,255	57	7,098	62	0	NA	0	NA
2008	15,304	62	6,965	66	12,427	63	6,188	67	5,571	50	2,879	61
2009	19,818	55	9,020	60	18,163	57	9,044	62	4,576	58	2,364	67
2010	38,602	51	17,569	56	48,772	51	24,287	56	11,815	71	6,106	79
2011	33,307	56	15,159	60	31,649	58	15,760	62	1,512	100	781	106
2012	24,255	64	11,039	69	33,760	68	16,811	71	0	NA	0	NA
2013	44,991	93	20,477	95	40,185	91	20,011	94	3,071	83	1,587	90
2014	41,480	58	18,879	62	41,343	56	20,587	61	11,501	94	5,943	100
2015	21,847	60	9,943	65	19,507	60	9,714	64	833	100	430	106
2016	54,955	54	25,012	59	42,077	51	20,953	56	24,766	62	12,797	71
2017	36,556	52	16,638	57	46,813	64	23,311	68	32,367	54	16,725	64
2018	10,586	43	4,818	49	11,011	43	5,483	49	25,008	49	12,923	60
2019	30,572	39	13,914	46	24,883	49	12,391	54	35,194	66	18,186	75
2020	24,773	48	11,275	53	22,381	50	11,145	55	27,653	46	14,289	58

Table 4.11.10. Original and calibrated MRIP-FCAL annual estimates for Hogfish (Lachnolaimus maximus) landing and release estimates in Florida from 1981-2020 in **Southeast Florida** by **hook and line** gear type.

Year	MRIP-FCAL		SRFS-FCAL calibration		MRIP-FCAL		SRFS-FCAL calibration		MRIP-FCAL		SRFS-FCAL calibration	
	Landings (no.fish)	PSE	Landings (no. fish)	PSE	Landings (pounds)	PSE	Landings (pounds)	PSE	Releases (no.fish)	PSE	Releases (no. fish)	PSE
1981	33,144	48.8	22,688	62	14,386	48	11,593	59	0	NA	0	NA
1982	0	NA	0	NA	0	NA	0	NA	0	NA	0	NA
1983	15,303	84	10,475	93	8,979	72	7,235	79	0	NA	0	NA
1984	9,073,189	98	6,210,699	105	4,716,782	98	3,800,832	104	0	NA	0	NA
1985	243,017	95	166,348	103	212,930	94	171,581	100	0	NA	0	NA
1986	42,772	74	29,278	83	24,397	54	19,659	63	0	NA	0	NA
1987	112,792	38	77,208	54	89,039	38	71,748	51	2,809	100	2,714	109
1988	96,489	71	66,048	81	64,191	76	51,726	84	236,074	100	228,086	109
1989	156,345	39	107,020	55	89,026	39	71,738	51	5,558	100	5,370	109
1990	137,631	53	94,210	66	132,174	53	106,507	63	14,924	74	14,419	86
1991	87,323	71	59,774	80	73,350	67	59,106	75	0	NA	0	NA
1992	113,111	49	77,426	63	125,337	53	100,998	63	15,292	56	14,775	71
1993	251,685	36	172,281	53	183,474	40	147,845	52	5,496	100	5,310	109
1994	90,256	36	61,781	53	65,589	44	52,852	56	22,660	62	21,894	76
1995	134,549	37	92,101	53	176,532	40	142,252	53	68,495	54	66,178	70
1996	89,887	41	61,529	56	72,548	41	58,460	53	23,112	52	22,330	68
1997	37,954	35	25,980	52	30,028	37	24,197	50	11,748	50	11,350	67
1998	22,602	33	15,472	51	18,924	34	15,249	48	25,364	49	24,506	66
1999	15,833	49	10,838	62	14,472	53	11,661	63	19,044	51	18,400	67
2000	11,839	82	8,104	91	12,468	82	10,047	89	0	NA	0	NA
2001	67,145	46	45,961	60	55,366	48	44,614	59	9,942	82	9,605	93
2002	20,536	69	14,057	79	21,211	69	17,092	77	0	NA	0	NA
2003	56,064	66	38,376	77	47,531	68	38,301	76	11,505	87	11,116	98
2004	128,768	73	88,143	83	82,656	69	66,605	77	72,632	72	70,174	84
2005	21,592	56	14,780	68	20,482	57	16,505	66	108,552	100	104,879	109
2006	55,613	42	38,068	57	51,524	44	41,518	56	33,710	74	32,570	86
2007	91,863	47	62,881	61	77,999	44	62,853	55	49,991	73	48,300	85
2008	30,940	63	21,179	74	31,462	70	25,352	78	30,705	60	29,666	74
2009	136,490	67	93,429	78	99,143	60	79,890	69	10,293	100	9,945	109
2010	41,287	82	28,261	91	31,959	80	25,753	87	6,353	100	6,138	109
2011	41,899	78	28,681	87	51,082	77	41,162	84	3,661	66	3,537	79
2012	56,856	49	38,919	62	60,857	53	49,039	62	43,971	84	42,483	94
2013	86,062	47	58,910	60	76,197	53	61,400	63	32,070	75	30,985	87
2014	46,540	39	31,857	55	29,766	39	23,985	52	40,564	42	39,191	61
2015	54,419	36	37,250	53	48,247	40	38,878	52	46,286	55	44,720	70
2016	47,255	39	32,347	55	43,545	38	35,089	51	36,872	54	35,624	69
2017	21,390	52	14,642	65	13,965	51	11,253	61	54,686	79	52,836	91
2018	1,965	82	1,345	90	3,492	90	2,814	96	3,932	65	3,799	78
2019	8,311	100	5,689	107	3,906	100	3,148	106	9,381	52	9,063	68
2020	13,112	53	8,975	66	12,531	48	10,098	59	32,406	73	31,309	85

Table 4.11.11. Original and calibrated MRIP-FCAL annual estimates for Hogfish (Lachnolaimus maximus) landing and release estimates in Florida from 1981-2020 on the **West Florida Shelf** for the **spear** gear type.

Year	MRIP-FCAL		SRFS-FCAL calibration		MRIP-FCAL		SRFS-FCAL calibration		MRIP-FCAL		SRFS-FCAL calibration	
	Landings (no.fish)	PSE	Landings (no. fish)	PSE	Landings (pounds)	PSE	Landings (pounds)	PSE	Releases (no.fish)	PSE	Releases (no. fish)	PSE
1981	45,271	78	20,604	82	53,777	69	26,779	73	0	NA	0	NA
1982	13,187	67	6,002	71	20,766	61	10,341	65	0	NA	0	NA
1983	19,922	73	9,067	77	9,392	76	4,677	79	0	NA	0	NA
1984	0	NA	0	NA	0	NA	0	NA	0	NA	0	NA
1985	0	NA	0	NA	0	NA	0	NA	0	NA	0	NA
1986	44,949	76	20,458	79	54,183	74	26,981	77	0	NA	0	NA
1987	95,581	59	43,502	63	84,635	51	42,145	56	0	NA	0	NA
1988	18,052	50	8,216	55	25,350	51	12,624	56	0	NA	0	NA
1989	92,187	60	41,957	65	116,240	60	57,883	64	0	NA	0	NA
1990	28,195	84	12,833	87	27,450	85	13,669	88	0	NA	0	NA
1991	143,377	46	65,255	51	112,545	46	56,044	51	0	NA	0	NA
1992	44,715	79	20,351	82	36,720	67	18,285	71	0	NA	0	NA
1993	77,397	43	35,225	49	73,709	42	36,705	48	0	NA	0	NA
1994	34,018	46	15,482	51	35,281	51	17,569	56	0	NA	0	NA
1995	64,518	47	29,364	53	48,362	46	24,083	51	0	NA	0	NA
1996	21,190	46	9,644	51	17,184	50	8,557	55	0	NA	0	NA
1997	50,535	37	23,000	44	43,815	42	21,818	48	0	NA	0	NA
1998	61,097	35	27,807	42	55,772	35	27,772	42	0	NA	0	NA
1999	87,420	27	39,788	36	87,817	27	43,730	35	0	NA	0	NA
2000	22,067	65	10,043	69	32,543	74	16,205	77	0	NA	0	NA
2001	67,326	47	30,642	53	56,223	40	27,997	46	0	NA	0	NA
2002	27,321	70	12,435	74	27,555	71	13,722	74	0	NA	0	NA
2003	55,008	35	25,036	42	49,625	36	24,712	43	0	NA	0	NA
2004	94,202	48	42,874	54	85,472	47	42,562	53	0	NA	0	NA
2005	45,579	68	20,744	72	55,435	73	27,605	76	0	NA	0	NA
2006	39,074	50	17,784	56	32,164	51	16,017	56	0	NA	0	NA
2007	59,495	47	27,078	53	43,489	47	21,656	53	0	NA	0	NA
2008	181,038	33	82,396	41	161,241	33	80,293	40	0	NA	0	NA
2009	93,004	33	42,329	40	88,312	34	43,976	41	0	NA	0	NA
2010	152,139	43	69,243	49	186,525	43	92,883	49	0	NA	0	NA
2011	71,556	35	32,567	42	72,901	34	36,302	41	0	NA	0	NA
2012	140,662	37	64,019	44	186,325	45	92,784	50	0	NA	0	NA
2013	196,364	48	89,371	53	202,058	42	100,618	48	4,010	75	2,072	83
2014	62,114	28	28,270	36	57,978	28	28,871	36	0	NA	0	NA
2015	78,021	50	35,510	55	95,214	52	47,413	57	0	NA	0	NA
2016	228,083	42	103,807	48	248,515	44	123,752	50	0	NA	0	NA
2017	68,790	38	31,308	44	88,888	36	44,263	43	0	NA	0	NA
2018	32,590	57	14,833	61	32,252	57	16,061	61	0	NA	0	NA
2019	25,175	39	11,458	45	26,768	38	13,330	44	0	NA	0	NA
2020	28,468	68	12,956	72	26,254	68	13,073	71	0	NA	0	NA

Table 4.11.12. Original and calibrated MRIP-FCAL annual estimates for Hogfish (Lachnolaimus maximus) landing and release estimates in Florida from 1981-2020 in **Southeast Florida** by **spear** gear type.

Year	MRIP-FCAL		SRFS-FCAL calibration		MRIP-FCAL		SRFS-FCAL calibration		MRIP-FCAL		SRFS-FCAL calibration	
	Landings (no.fish)	PSE	Landings (no. fish)	PSE	Landings (pounds)	PSE	Landings (pounds)	PSE	Releases (no.fish)	PSE	Releases (no. fish)	PSE
1981	1,843,094	51	1,261,618	64	1,275,648	49	1,027,931	59	0	NA	0	NA
1982	72,402	44	49,560	58	85,244	56	68,690	66	0	NA	0	NA
1983	267,302	70	182,971	80	311,609	81	251,098	88	0	NA	0	NA
1984	547,267	52	374,610	65	296,580	52	238,988	62	0	NA	0	NA
1985	0	NA	0	NA	0	NA	0	NA	0	NA	0	NA
1986	139,707	63	95,631	74	132,331	66	106,633	74	0	NA	0	NA
1987	244,332	39	167,248	55	226,828	39	182,781	51	0	NA	0	NA
1988	3,493	100	2,391	107	17,010	100	13,706	106	0	NA	0	NA
1989	89,338	87	61,153	96	94,068	87	75,801	94	0	NA	0	NA
1990	221,323	55	151,498	67	167,264	51	134,783	61	1,736	100	1,677	109
1991	41,096	78	28,131	87	24,268	65	19,556	73	0	NA	0	NA
1992	184,989	30	126,627	49	165,426	33	133,302	47	3,101	100	2,996	109
1993	130,142	38	89,084	54	123,394	39	99,432	52	0	NA	0	NA
1994	183,914	36	125,891	53	133,929	36	107,922	49	0	NA	0	NA
1995	93,875	51	64,259	64	130,122	69	104,853	76	2,144	100	2,072	109
1996	69,076	39	47,283	55	72,642	46	58,536	57	2,135	100	2,062	109
1997	55,693	53	38,122	66	61,046	53	49,191	63	0	NA	0	NA
1998	46,577	38	31,882	54	35,494	36	28,601	49	0	NA	0	NA
1999	114,407	37	78,313	54	115,114	35	92,760	49	665	100	643	109
2000	34,795	55	23,817	67	46,128	51	37,171	61	1,411	100	1,363	109
2001	30,836	34	21,108	52	39,025	36	31,447	50	0	NA	0	NA
2002	84,488	41	57,833	56	90,820	40	73,184	53	3,258	86	3,148	97
2003	127,245	32	87,101	50	105,066	32	84,663	47	0	NA	0	NA
2004	90,419	36	61,893	53	133,097	36	107,251	49	483	100	466	109
2005	201,546	63	137,961	74	236,963	66	190,947	74	0	NA	0	NA
2006	112,658	47	77,115	61	116,168	49	93,610	59	2,207	100	2,132	109
2007	169,416	28	115,967	48	151,817	24	122,336	42	7,518	100	7,263	109
2008	476,744	52	326,337	65	413,257	54	333,007	63	0	NA	0	NA
2009	219,266	37	150,090	53	222,569	41	179,348	53	0	NA	0	NA
2010	237,710	56	162,715	68	199,914	56	161,093	65	0	NA	0	NA
2011	68,095	44	46,612	59	55,179	44	44,464	56	0	NA	0	NA
2012	502,296	69	343,828	79	487,215	67	392,603	75	0	NA	0	NA
2013	111,045	26	76,012	46	108,124	26	87,128	43	2,570	100	2,483	109
2014	342,717	29	234,593	48	289,769	29	233,499	45	4,240	72	4,097	85
2015	567,378	48	388,376	62	461,013	45	371,489	56	0	NA	0	NA
2016	252,234	23	172,657	45	231,092	24	186,216	41	2,021	100	1,953	109
2017	89,235	36	61,083	53	73,493	36	59,222	49	0	NA	0	NA
2018	25,062	70	17,155	80	23,943	63	19,294	71	0	NA	0	NA
2019	0	NA	0	NA	0	NA	0	NA	0	NA	0	NA
2020	0	NA	0	NA	0	NA	0	NA	0	NA	0	NA

Table 4.11.13. Southeast Region Headboat Survey (SRHS) Hogfish landings by region in number. Non-Florida landings were excluded.

Year	East	West	Total
1981	1063	0	1063
1982	105	0	105
1983	314	0	314
1984	567	0	567
1985	273	0	273
1986	589	117	706
1987	562	34	596
1988	512	187	699
1989	392	41	433
1990	226	147	373
1991	239	94	333
1992	383	213	596
1993	251	167	418
1994	188	654	842
1995	414	465	879
1996	230	13	243
1997	226	7	233
1998	236	25	261
1999	207	40	247
2000	166	66	232
2001	200	57	257
2002	152	61	213
2003	146	80	226
2004	467	53	520
2005	543	123	666
2006	608	41	649
2007	336	76	412
2008	203	61	264
2009	134	125	259
2010	71	430	501
2011	95	2945	3040
2012	106	4137	4243
2013	124	1975	2099
2014	181	2030	2211
2015	283	1272	1555
2016	167	2553	2720

2017	78	2155	2233
2018	12	1405	1417
2019	0	1645	1645
2020	15	1622	1637
2021	7	2331	2338
2022	6	2168	2174
2023	43	2730	2773
2024	12	2121	2133

Table 4.11.14. Southeast Region Headboat Survey (SRHS) Hogfish discards by region in number of fish. Non-Florida discards were excluded.

Year	East	West	Total
2004	23	3	26
2005	99	99	198
2006	178	93	271
2007	115	12	127
2008	175	5	180
2009	73	6	79
2010	39	22	61
2011	32	402	434
2012	86	522	608
2013	110	126	236
2014	109	128	237
2015	155	282	437
2016	112	487	599
2017	149	777	926
2018	118	1857	1975
2019	66	2621	2687
2020	99	2393	2492
2021	258	4001	4259
2022	132	3587	3719
2023	213	3786	3999
2024	130	2452	2582

Table 4.11.15. Summary of Hogfish measured for fork length (mm) from MRIP in the **West Florida Shelf** region

Year	N	Min	Mean	Max	Stdev
1981	6	315	398	500	64
1982	5	265	407	515	111
1983	4	240	258	285	22
1986	42	215	344	500	87
1987	55	230	365	945	116
1988	33	238	394	635	72
1989	29	264	396	477	54
1990	9	281	382	481	69
1991	37	233	337	515	75
1992	34	249	379	642	85
1993	60	256	352	675	63
1994	51	275	357	505	59
1995	60	250	330	605	63
1996	28	217	316	431	74
1997	45	218	338	517	73
1998	66	250	345	496	53
1999	75	220	356	500	55
2000	30	274	399	533	64
2001	52	265	340	460	52
2002	38	284	382	565	57
2003	106	275	362	451	42
2004	56	262	358	600	72
2005	37	305	399	550	57
2006	30	302	349	430	44
2007	46	280	333	418	35
2008	89	270	356	450	44
2009	85	275	369	461	48
2010	100	297	387	493	39
2011	104	256	378	492	53
2012	133	291	391	564	53
2013	106	294	377	532	56
2014	162	277	362	472	48
2015	133	276	368	489	52

Year	N	Min	Mean	Max	Stdev
2016	189	284	372	555	52
2017	185	280	372	551	55
2018	93	290	376	456	32
2019	79	230	377	518	47
2020	86	327	367	456	26
2021	117	320	368	455	26
2022	54	320	385	452	33
2023	115	329	376	526	36
2024	151	330	385	723	40

Table 4.11.16. Summary of Hogfish measured for fork length (mm) from MRIP in the **East Florida/Keys** region.

Year	N	Min	Mean	Max	Stdev
1981	136	210	318	610	59
1982	42	210	344	610	109
1983	28	220	354	610	106
1984	57	235	308	460	52
1985	13	190	342	470	79
1986	36	185	325	500	92
1987	115	195	354	575	86
1988	59	238	356	660	78
1989	39	210	312	478	70
1990	49	250	335	560	68
1991	37	220	318	597	74
1992	132	208	333	597	81
1993	121	215	328	556	60
1994	150	243	329	545	45
1995	79	241	380	610	85
1996	91	241	338	517	56
1997	62	218	369	630	92
1998	58	260	331	480	49
1999	102	260	358	580	72
2000	33	300	391	500	55
2001	68	270	374	590	74
2002	73	270	366	590	61
2003	117	280	341	451	36
2004	116	270	389	553	70
2005	67	250	388	550	64
2006	56	295	368	510	57
2007	135	280	363	489	45
2008	112	269	344	450	48
2009	105	257	344	554	52
2010	72	290	347	439	41
2011	59	269	350	530	53
2012	132	260	364	551	63
2013	122	263	360	496	51
2014	266	265	342	496	43
2015	301	242	353	520	45
2016	180	270	353	515	52

Year	N	Min	Mean	Max	Stdev
2017	86	267	347	508	53
2018	12	305	366	468	58
2019	1	276	276	276	NA
2020	9	134	369	489	106
2021	16	383	415	463	29
2022	23	299	406	509	48
2023	23	349	404	491	29
2024	29	326	449	556	46

Table 4.11.17. Number of aged Hogfish, mean (± SD) age and length by stock and fishing fleet (2002-2024) from fishery dependent projects (SEDAR 94-DW-11).

	WFS			**KEYS/EFL**		
Fishing Fleet	# Fish	Mean Age (y)	Mean FL (mm)	# Fish	Mean Age (y)	Mean FL (mm)
Charter	178	5.45 ± 1.51	380.90 ± 40.41	18	4.5 ± 1.86	349 ± 57.47
Commercial	98	5.94 ± 2.11	405 ± 84.17	104	4.79 ± 1.94	349.70 ± 49.34
Headboat	234	5.14 ± 1.48	384.80 ± 30.24	12	8.33 ± 2.87	409.5 ± 63.66
Private	118	4.63 ± 1.38	382.56 ± 43.57	52	4.19 ± 1.62	395.08 ± 57.28
Tournament	29	5.90 ± 2.60	425.83 ± 113.89	4	4.5 ± 1	440.25 ± 43.76

Table 4.11.18. Number of aged Hogfish, mean (± SD) age and length by stock, year block, and gear type from fishery dependent projects (2002-2024, SEDAR 94-DW-11).

		WFS			KEYS/EFL		
Year Block	Gear Type	# Fish	Mean Age (y)	Mean FL (mm)	# Fish	Mean Age (y)	Mean FL (mm)
2002-2017	HOOK/LINE	64	4.75 ± 1.62	375.45 ± 55.27	29	5.72 ± 3.22	360.62 ± 62.79
	SPEARS	35	5.23 ± 2.43	397.14 ± 107.66	18	3.56 ± 1.15	374.17 ± 65.14
2018-2024	HOOK/LINE	422	5.24 ± 1.45	384.69 ± 32.95	4	5.25 ± 3.20	371.25 ± 52.43
	SPEARS	36	5.08 ± 1.78	396.39 ± 37.97	35	4.74 ± 1.34	423.51 ± 41.62

Table 4.11.19. Number of fish aged, mean age and length by stock, fleet, and gear type from fishery dependent projects (SEDAR 94-DW-11).

WFS						
FISHING FLEET	GEAR TYPE	# FISH	MEAN AGE (y)	SD AGE	MEAN FL (mm)	SD FL
CHARTER	HOOK/LINE	178	5.45	1.52	381.90	40.41

COMMERCIAL	BANDIT RIG	2	5.50	0.71	383.50	12.02
	CAST NETS	6	7.33	2.25	480.17	185.68
	DIVING OTHER	22	5.27	0.70	380.36	19.90
	SPEARS	68	6.04	2.37	406.97	82.68
HEADBOAT	HOOK/LINE	234	5.14	1.48	384.80	30.24
PRIVATE	HOOK/LINE	74	4.60	1.24	383.07	45.51
	MULTI GEAR	6	5.00	0.89	396.33	26.29
	SPEARS	38	4.63	1.68	379.40	42.21
TOURNAMENT	SPEARS	29	5.90	2.60	425.83	113.89

KEYS/EFL

FISHING FLEET	GEAR TYPE	# FISH	MEAN AGE (y)	SD AGE	MEAN FL (mm)	SD FL
CHARTER	HOOK/LINE	13	4.85	2.04	330.39	43.00
	SPEARS	5	3.60	0.89	397.40	66.59
COMMERCIAL	DIVING OTHER	9	5.33	2.29	332.22	40.20
	ELECTRIC H/L	1	7.00	.	355.00	.
	HOOK/LINE	11	5.09	2.12	422.73	78.70
	POTS/TRAPS	8	4.25	2.05	333.88	17.18
	SPEARS	53	5.06	1.98	343.81	38.74
	TRAP	12	4.17	1.64	347.00	46.30
	UNKNOWN	10	3.50	0.71	331.70	19.98
HEADBOAT	HOOK/LINE	12	8.33	2.87	409.50	63.66
PRIVATE	HOOK/LINE	8	3.00	2.07	341.75	35.69
	MULTI GEAR	4	5.25	0.96	434.25	62.31
	SPEARS	40	4.33	1.47	401.83	54.52
TOURNAMENT	SPEARS	4	4.50	1.00	440.25	43.76

Table 4.11.20. Number of fork length measurements per year and gear group for the Biscayne National Park (BNP) creel survey within the **East Florida/Keys** region.

Year	Gear		Total
	Other_Unk	Spear_Dive	
1993	31	164	195
1994	31	412	443
1995	21	105	126
1996	15	195	210
1997	15	96	111
1998	33	114	147
2000	5	31	36
2001	11	26	37
2002	134	129	263
2003	193	151	344
2004	16	33	49
2005	20	29	49
2006	10	36	46
2007	20	25	45
2008	39	42	81
2009	46	101	147
2010	43	153	196
2011	50	100	150
2012	17	85	102
2013	7	31	38
2014	14	15	29
2015	21	109	130
2016	1	97	98
2017	45	83	128
2018	4	5	9
2021	6	8	14
2022	1	4	5
2023	1	4	5
2024	7	4	11
Total	857	2,387	3,244

Table 4.11.21. Hogfish size, numbers landed, and post-release mortality of Hogfish across temperature regimes and depth zones (Ellis et al. 2025).

Temperature / depth zone	Hogfish size (FL, mm)	Surface temp (mean ± SE)	Depth (mean ± SE)	Total number	Number that died	Percent mortality
Cool / shallow	302 ± 12.2	20.0 ± 0.6	13.2 ± 0.4	11	1	9.1
Cool / deep	357 ± 12.7	20.1 ± 0.3	16.5 ± 0.3	12	3	25.0
Warm / shallow	285 ± 13.0	30.3 ± 0.3	12.2 ± 0.9	8	2	25.0
Warm / deep	359 ± 21.1	27.4 ± 0.5	16.9 ± 0.4	11	4	36.3
Cool combined	331 ± 10.5	20.0 ± 0.3	14.9 ± 0.4	23	4	17.3
Warm combined	328 ± 15.8	28.6 ± 0.4	14.9 ± 0.7	19	6	31.6
Shallow combined	295 ± 9.2	24.4 ± 1.2	11.8 ± 0.3	19	3	15.8
Deep combined	358 ± 12.1	23.6 ± 0.8	16.7 ± 0.4	23	7	30.4
Overall	329 ± 9.2	23.9 ± 0.7	14.9 ± 0.4	42	10	23.8

Table 4.11.22. Barotrauma score as a function of depth of capture of only discarded Hogfish reported by FWRI's at-sea observers from July 2022 through December 2024. Barotrauma score was based on ranked scores described in Table 1 in SEDAR 94-DW-16 (Eguia et al. 2025).

	Depth of Capture (m)									
	0-10		**10-20**		**20-30**		**>30**		**Total**	
Barotrauma	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Absent	6	28.57	2	0.50	0	0.00	0	0.00	***8***	***1.78***
Minor	6	28.57	24	5.97	2	8.33	0	0.00	***32***	***7.11***
Intermediate	6	28.57	46	11.44	2	8.33	1	33.33	***55***	***12.22***
Severe	3	9.52	77	19.15	8	33.33	2	66.67	***89***	***19.78***
Catastrophic	2	4.76	253	62.94	12	50.00	0	0.00	***266***	***59.11***
Total	**23**	**3.76**	**402**	**89.33**	**24**	**5.33**	**3**	**0.67**	***450***	***100***

Table 4.11.23. Release methods for Hogfish (*Lachnolaimus maximus*) reported by FWRI at-sea observers in the Tampa Bay region during 2009-2024. Surface release meant that no barotrauma mitigation tools were used when releasing the fish, venting involved puncturing the gas bladder prior to release, and recompressed was for fish that were descended using various devices. *One discarded Hogfish in 2024 was vented prior to recompression. Percentages for release methods represent annual percent, while total percent represents total percent of entire time series (Eguia et al. 2025).

	Surface Released		***Vented***		***Recompressed***		***Total***	
Year	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
2009	1	100	0	0	0	0	*1*	*0.09*
2010	0	0	0	0	0	0	*0*	*0*
2011	1	100	0	0	0	0	*1*	*0.09*
2012	2	66.67	1	33.33	0	0	*3*	*0.28*
2013	7	100	0	0	0	0	*7*	*0.66*
2014	42	93.33	3	6.67	0	0	*45*	*4.23*
2015	38	95	2	5	0	0	*40*	*3.76*
2016	42	95.45	2	4.55	0	0	*44*	*4.14*
2017	39	86.67	6	13.33	0	0	*45*	*4.23*
2018	78	96.3	3	3.7	0	0	*81*	*7.62*
2019	94	92.16	8	7.84	0	0	*102*	*9.60*
2020	8	88.89	1	11.11	0	0	*9*	*0.85*
2021	110	78.01	30	21.28	1	0.71	*141*	*13.3*
2022	185	73.71	26	10.36	40	15.94	*251*	*23.6*
2023	87	73.73	19	16.1	12	10.17	*118*	*11.1*
2024	119	68	36	20.57	20*	11.43	*175*	*16.5*
Total	**853**	**80.24**	**137**	**12.89**	**73**	**6.87**	**1063**	**100**

4.12 FIGURES

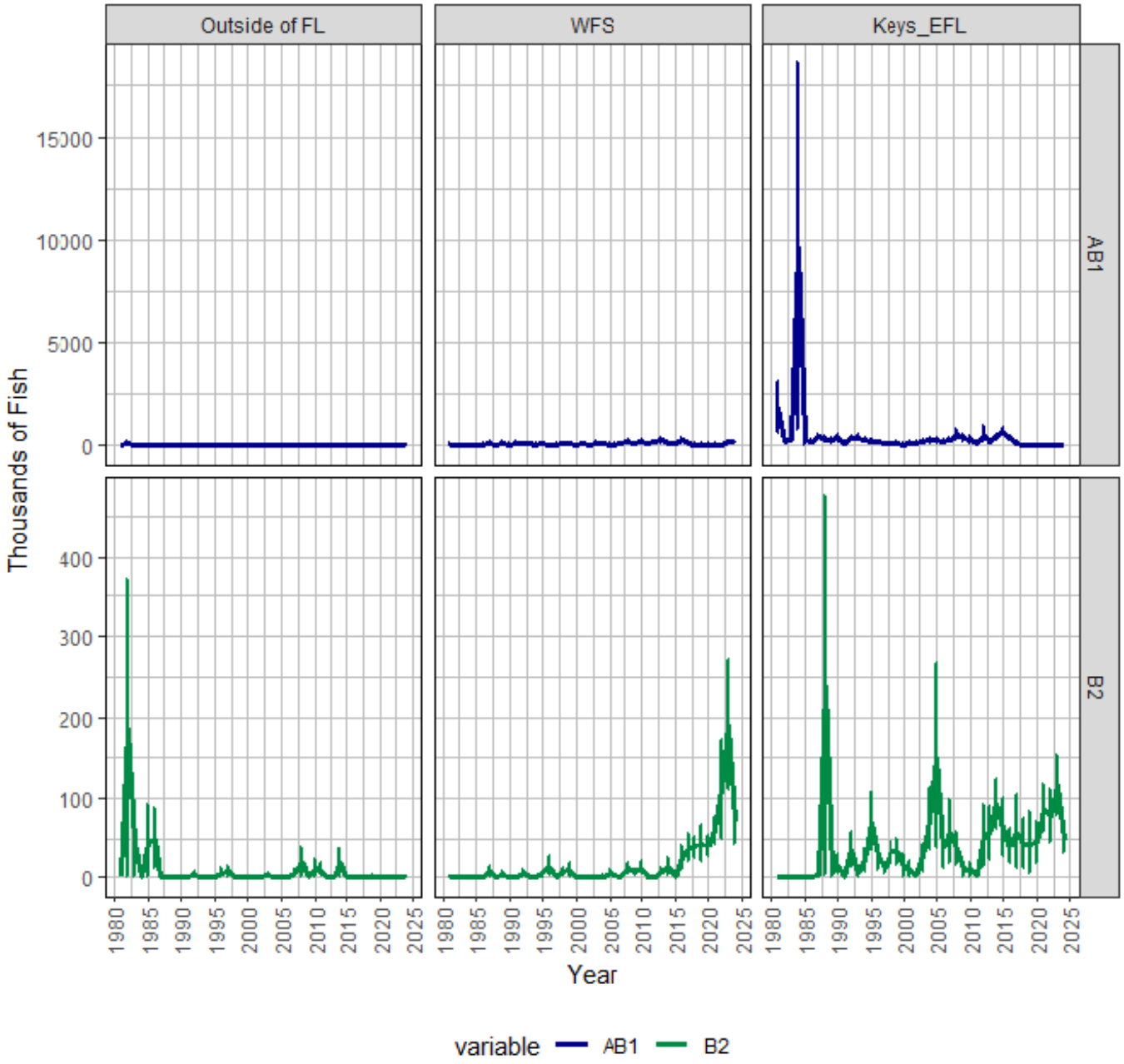


Figure 4.12.1. Hogfish landings (AB1) and discards (B2), in numbers of fish, with associated coefficients of variation (CV; Dettloff et al. 2020) by year for all modes combined (MRIP, LACreel 2014+, TPWD, SRHS).

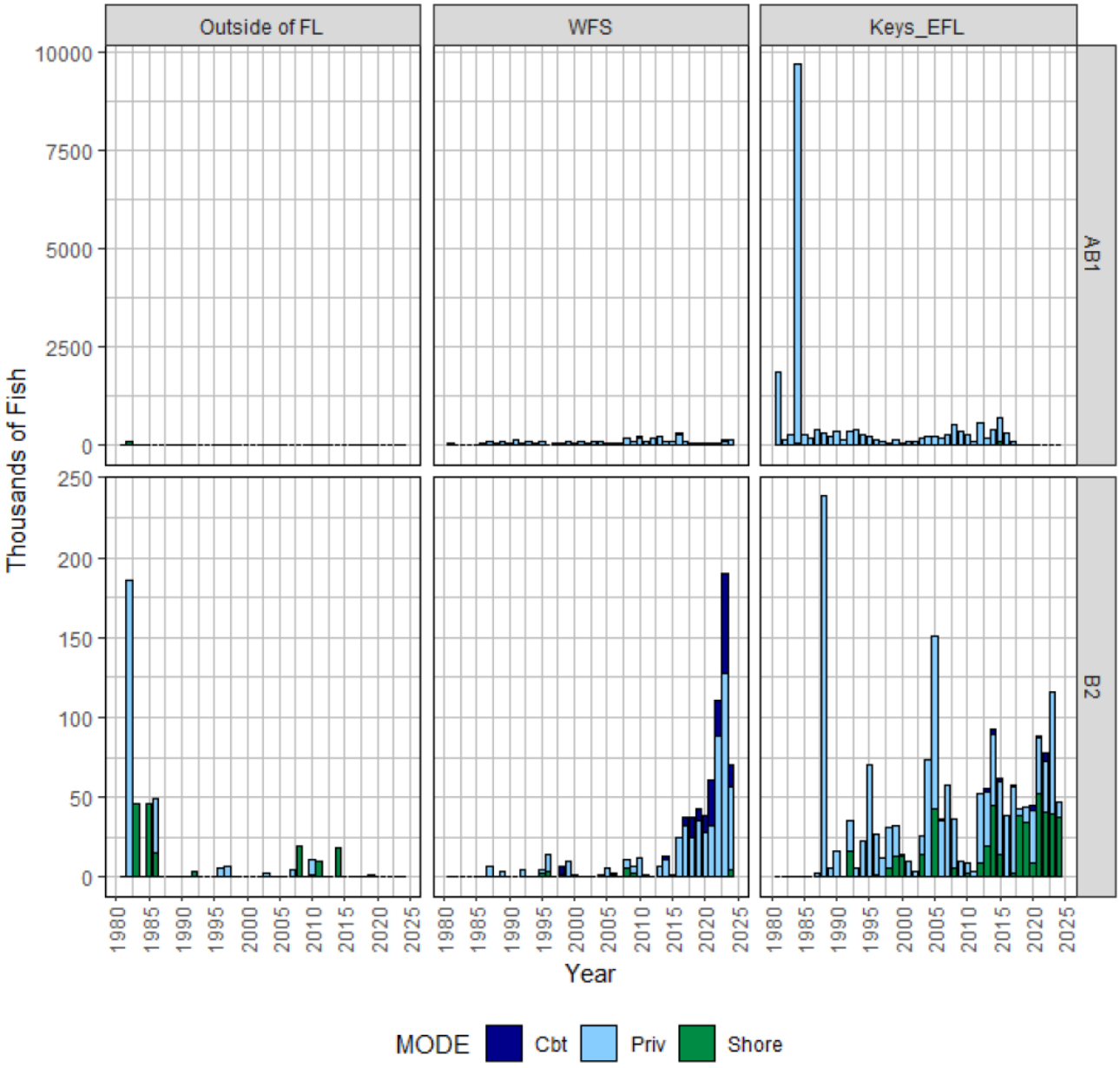


Figure 4.12.2. Annual Hogfish landings (AB1) and discards (B2), in thousands of fish, by region and mode from 1981 to 2024 (MRIP, LACreel 2014+, TPWD). Note catch from the combined Private-Shore fishing mode in the LA Creel survey has been added to the Private mode. This does not include estimates from SRHS.

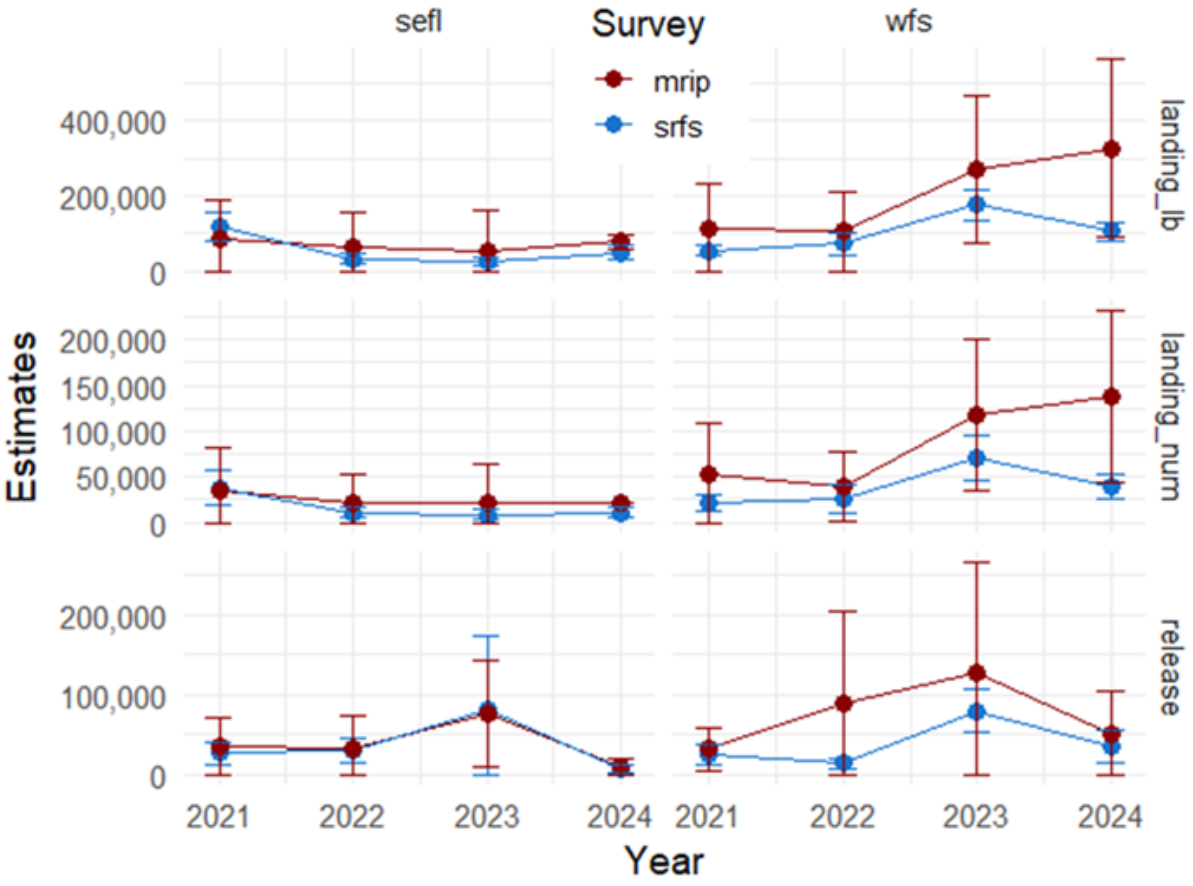


Figure 4.12.3. Estimates of landings and releases of Hogfish (*Lachnolaimus maximus*) across years in the Southeast Florida (sefl) or the West Florida Shelf (wfs) regions. Estimates generated by SRFS are shown in blue and estimates generated by MRIP are shown in red. Error bars depict 95% confidence limits.

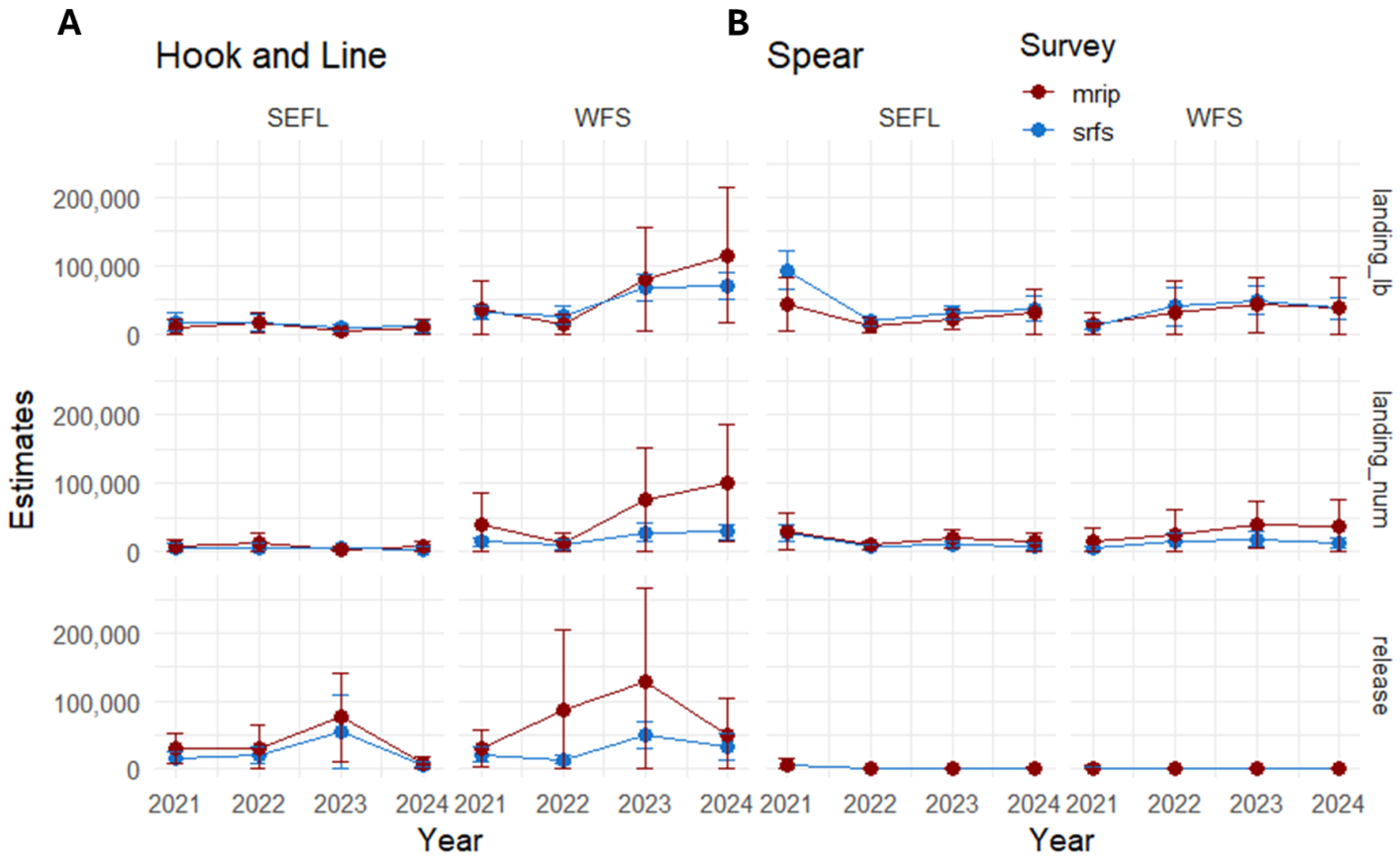


Figure 4.12.4. Estimates of landings and releases of Hogfish (*Lachnolaimus maximus*) across years in the Southeast Florida (sefl) and the West Florida Shelf (wfs) regions. Estimates are shown by gear type, either hook and line (A) or spear (B). Estimates generated by SRFS are shown in blue and estimates generated by MRIP are shown in red. Error bars depict 95% confidence limits.

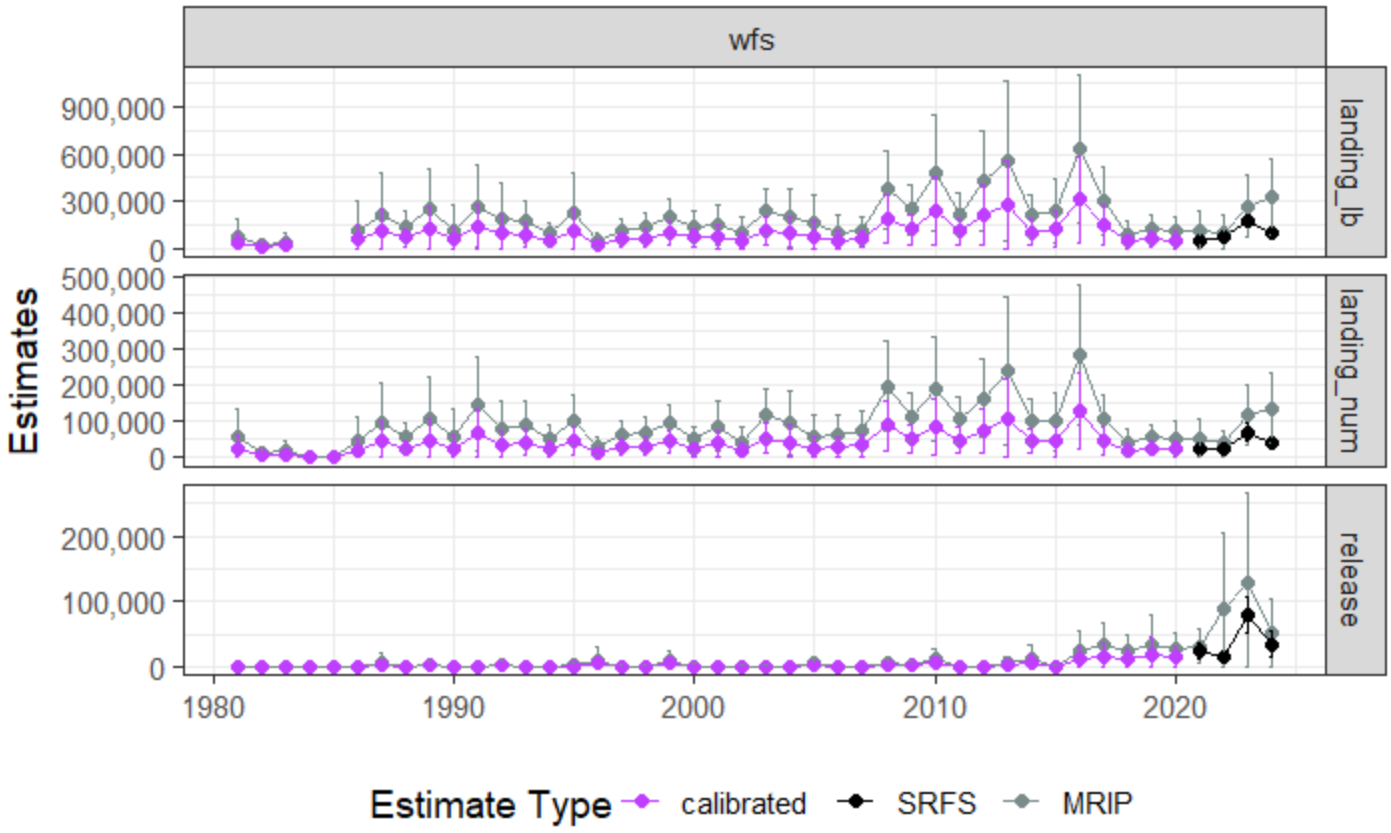


Figure 4.12.5. Hogfish (*Lachnolaimus maximus*) annual estimates on the **West Florida Shelf** (wfs), including original MRIP-FCAL time-series (MRIP), SRFS estimates (SRFS), and the MRIP-FCAL time-series calibrated to SRFS currency (calibrated). Estimates are shown from 1981-2024. Landings in pounds (landing_lb), landings in numbers of fish (landing_num), and releases in numbers of fish (release) are shown. Error bars are 95% confidence limits.

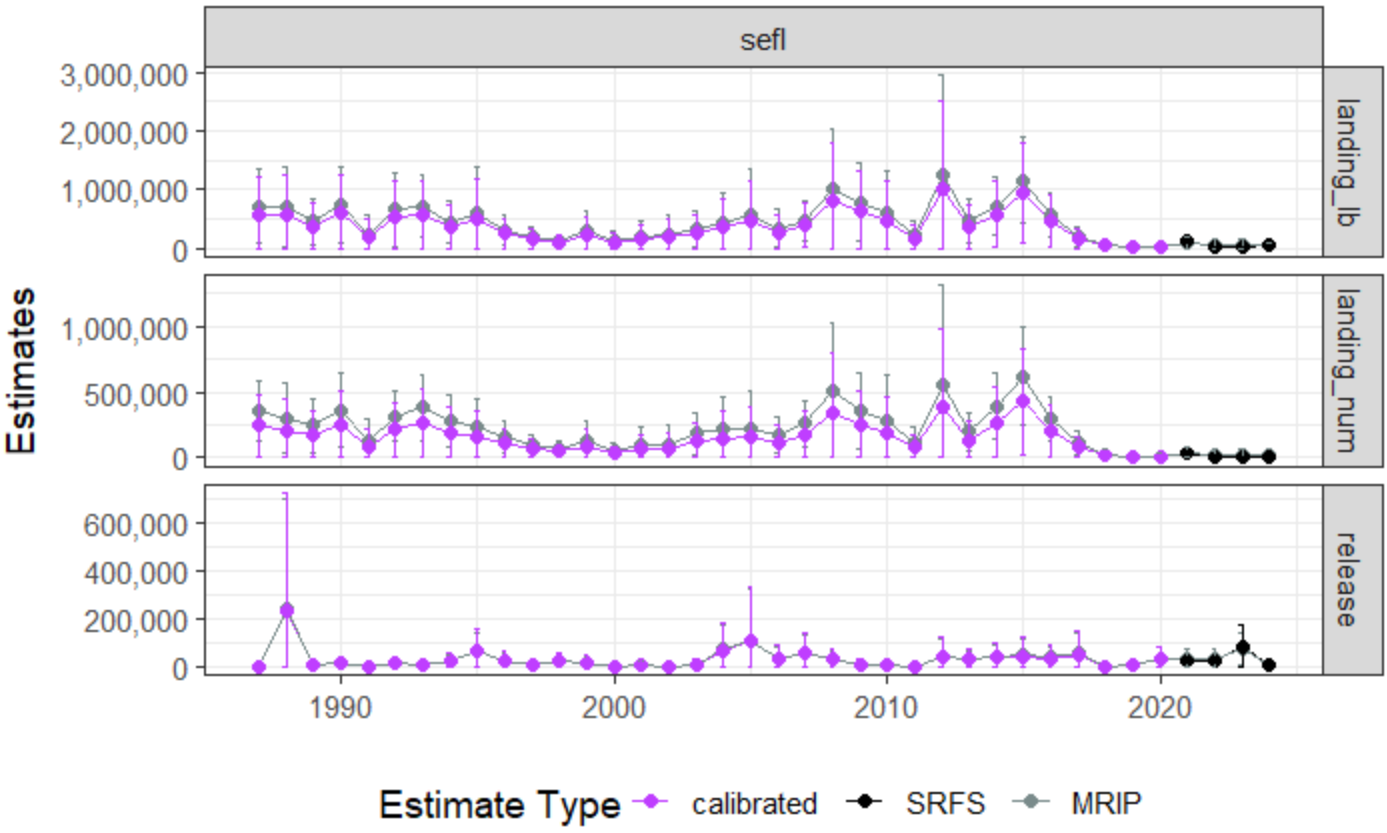


Figure 4.12.6. Hogfish (*Lachnolaimus maximus*) annual estimates in **Southeast Florida** (sefl), including original MRIP-FCAL time-series (MRIP), SRFS estimates (SRFS), and the MRIP-FCAL time-series calibrated to SRFS currency (calibrated). Estimates are shown from 1987-2024. Particularly high values in the early to mid-1980s are not shown. Landings in pounds (landing_lb), landings in numbers of fish (landing_num), and releases in numbers of fish (release) are shown. Error bars are 95% confidence limits.

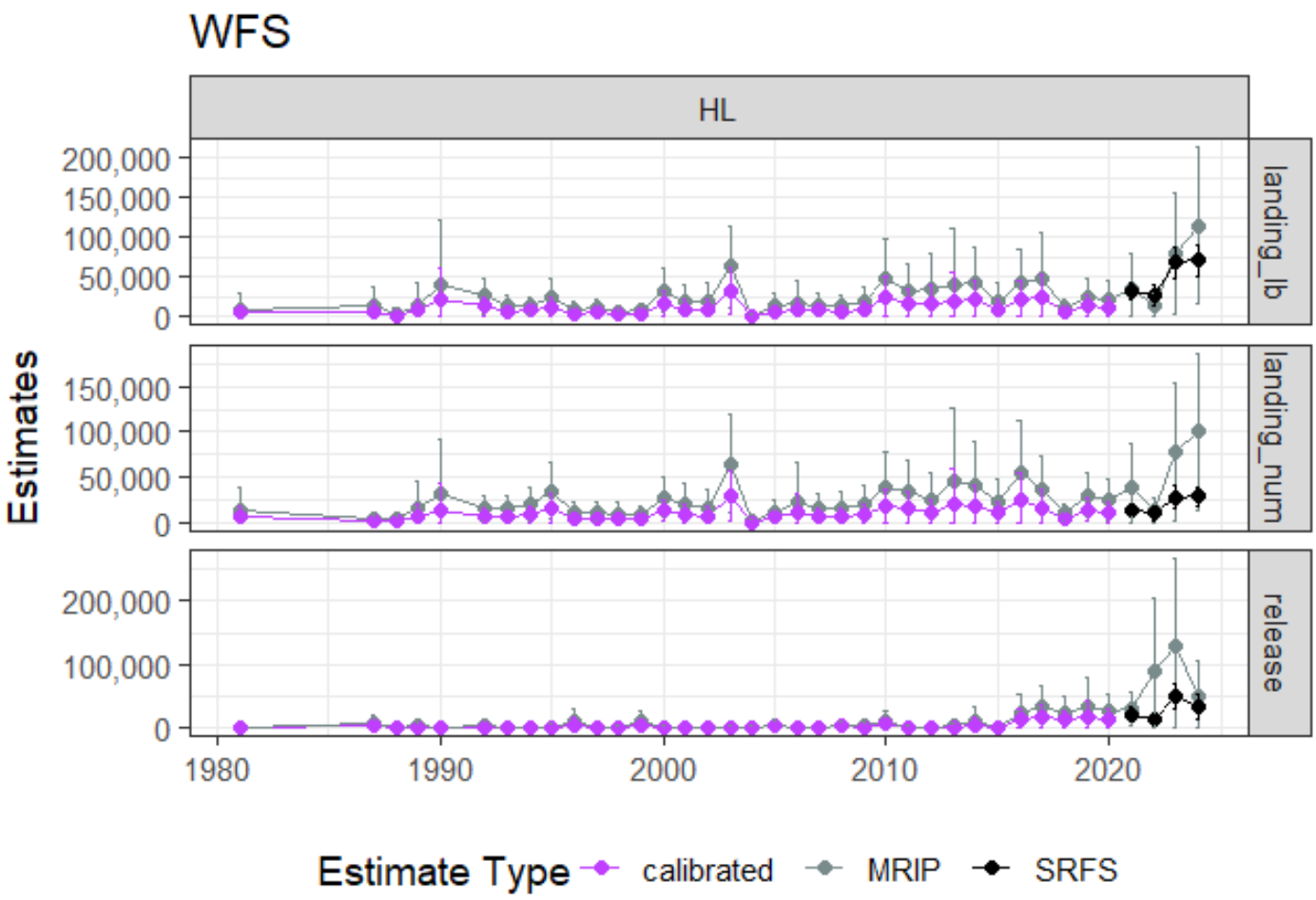


Figure 4.12.7. Hogfish (*Lachnolaimus maximus*) annual estimates on the **West Florida Shelf** (wfs) for only the **hook and line** (HL) gear type. Annual estimates shown include original MRIP-FCAL time-series (MRIP), SRFS estimates (SRFS), and the MRIP-FCAL time-series calibrated to SRFS currency (calibrated). Estimates are shown from 1981-2024. Landings in pounds (landing_lb), landings in numbers of fish (landing_num), and releases in numbers of fish (release) are shown. Error bars are 95% confidence limits. No Hogfish caught by hook and line were intercepted by MRIP-FCAL in years with missing points.

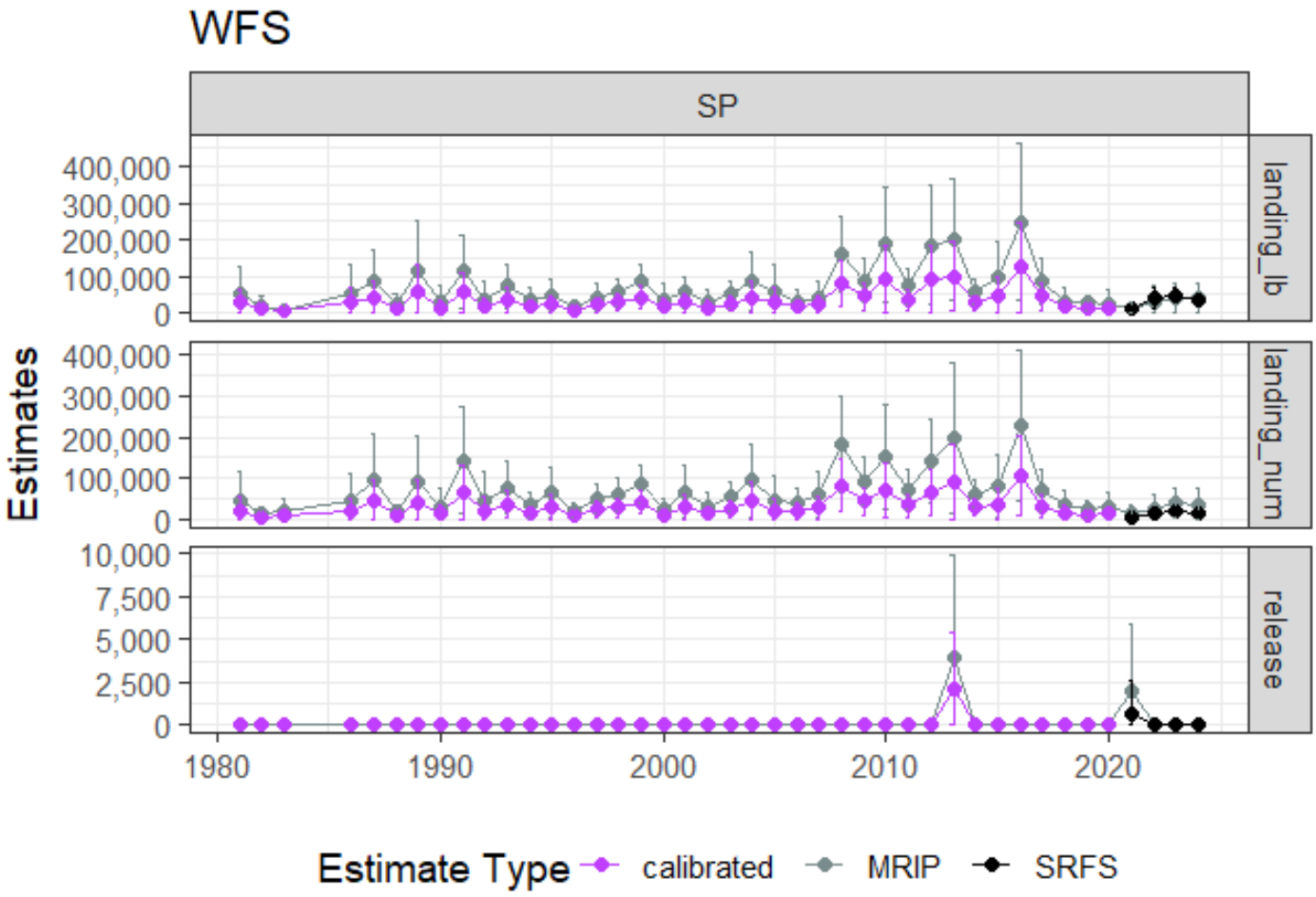


Figure 4.12.8. Hogfish (*Lachnolaimus maximus*) annual estimates on the **West Florida Shelf** (wfs) for only the **spear** (SP) gear type. Annual estimates shown include original MRIP-FCAL time-series (MRIP), SRFS estimates (SRFS), and the MRIP-FCAL time-series calibrated to SRFS currency (calibrated). Estimates are shown from 1981-2024. Landings in pounds (landing_lb), landings in numbers of fish (landing_num), and releases in numbers of fish (release) are shown. Error bars are 95% confidence limits. No Hogfish caught by spear were intercepted by MRIP-FCAL in years with missing points.

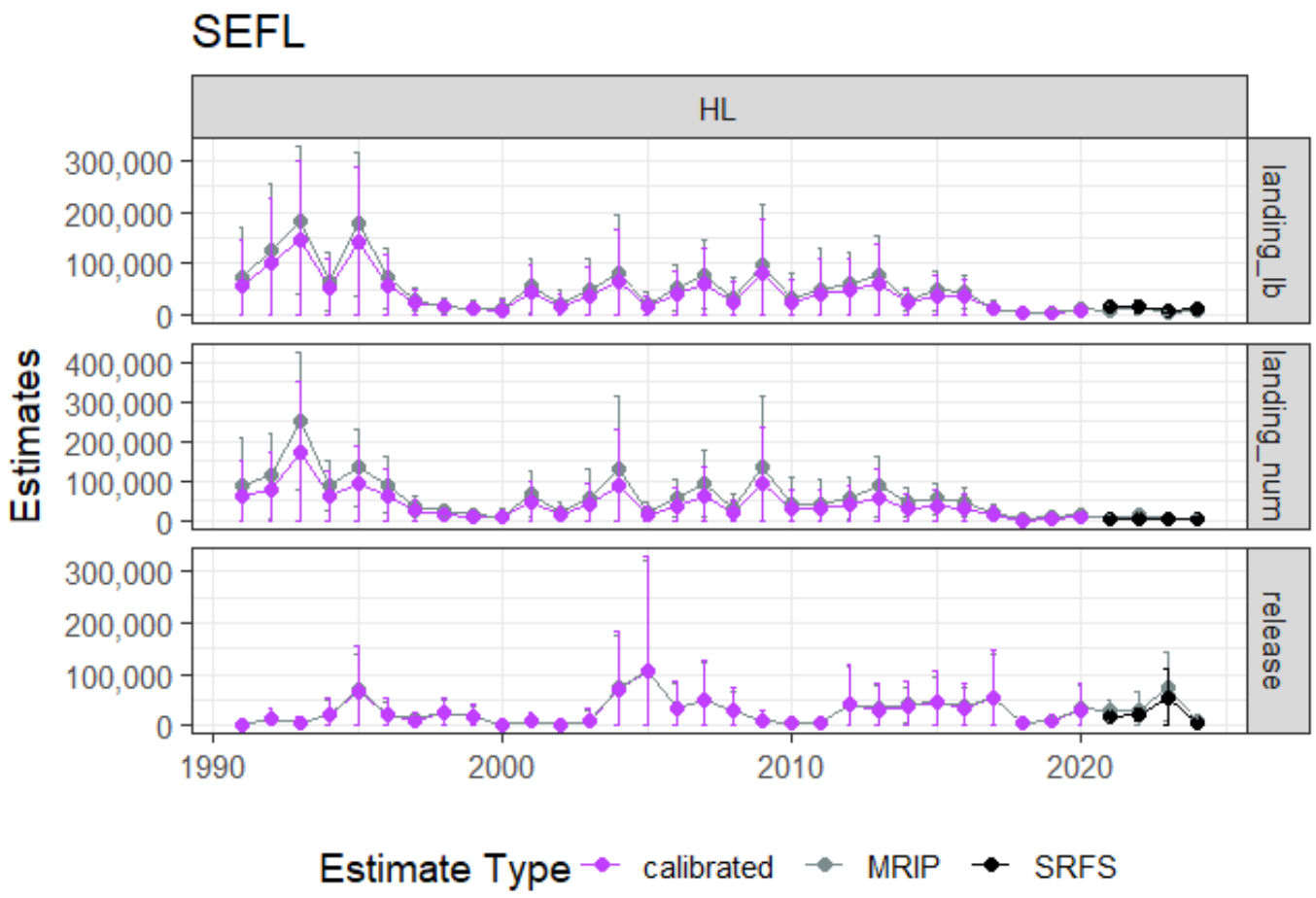


Figure 4.12.9. Hogfish (*Lachnolaimus maximus*) annual estimates in Southeast Florida (sefl) by gear type. Data shown are only for the hook and line (HL) gear type. Annual estimates shown include original MRIP-FCAL time-series (MRIP), SRFS estimates (SRFS), and the MRIP-FCAL time-series calibrated to SRFS currency (calibrated). Estimates are shown from 1991-2024. Particularly high values in the 1980s are not shown. Landings in pounds (landing_lb), landings in numbers of fish (landing_num), and releases in numbers of fish (release) are shown. Error bars are 95% confidence limits.

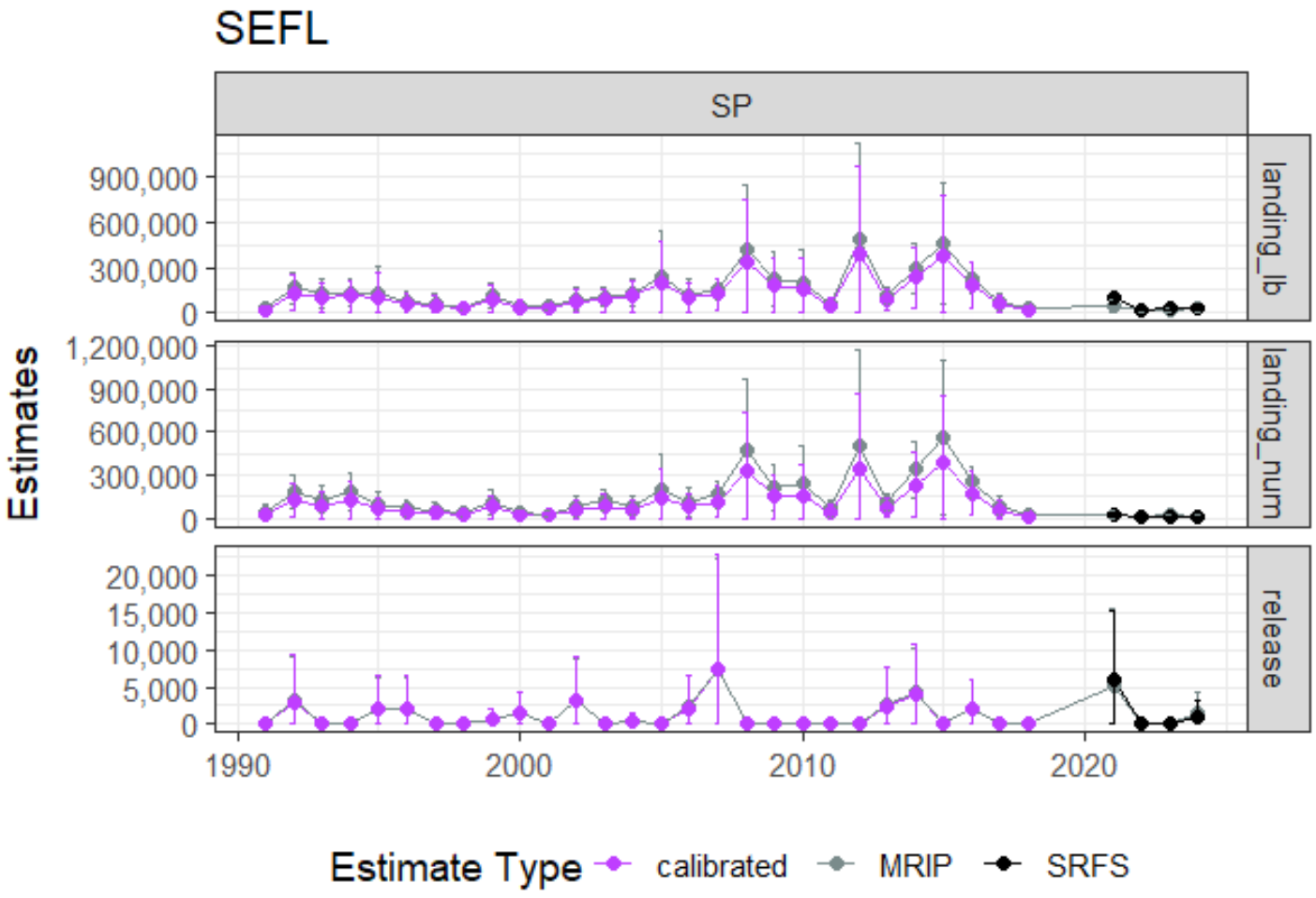


Figure 4.12.10. Hogfish (*Lachnolaimus maximus*) annual estimates in Southeast Florida (sefl) by gear type. Data shown are only for the spear (SP) gear type. Annual estimates shown include original MRIP-FCAL time-series (MRIP), SRFS estimates (SRFS), and the MRIP-FCAL time-series calibrated to SRFS currency (calibrated). Estimates are shown from 1991-2024. Particularly high values in the 1980s are not shown. Landings in pounds (landing_lb), landings in numbers of fish (landing_num), and releases in numbers of fish (release) are shown. Error bars are 95% confidence limits. No Hogfish caught by spear were intercepted by MRIP-FCAL in years with missing points.

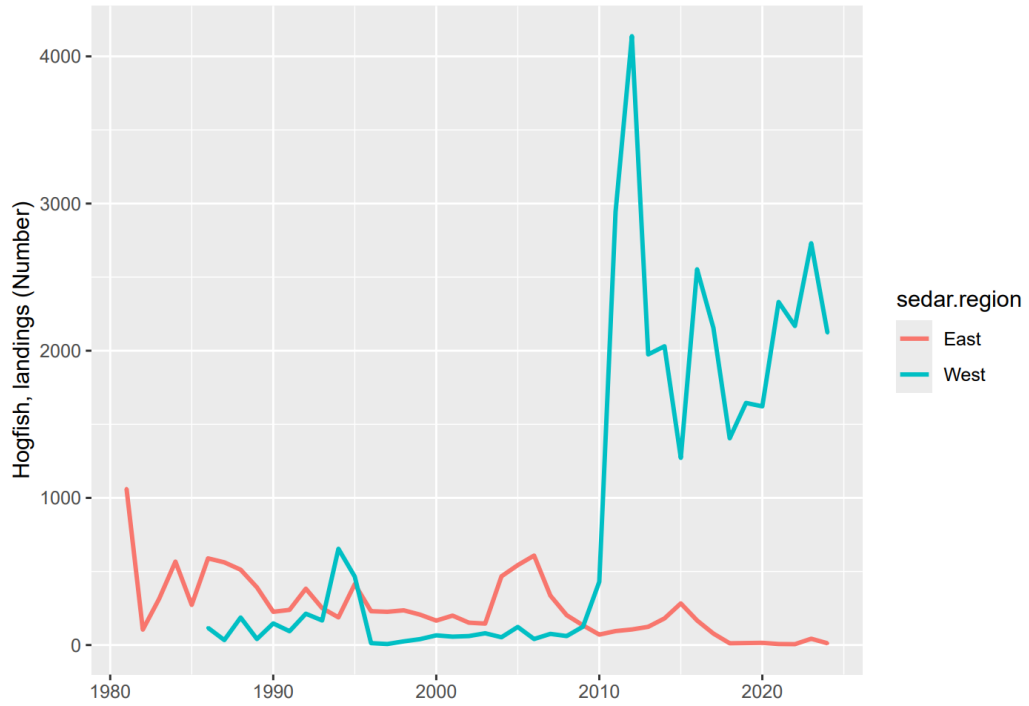


Figure 4.12.11. Southeast Region Headboat Survey (SRHS) estimated Hogfish landings in number by region. Non-Florida areas excluded.

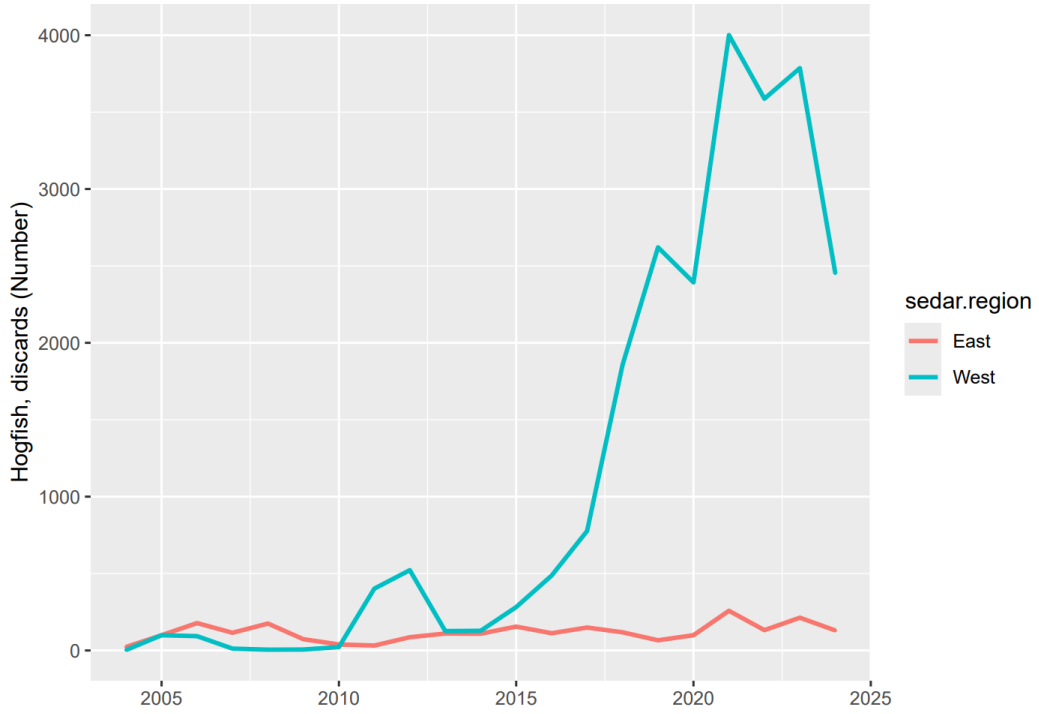


Figure 4.12.12. Southeast Region Headboat Survey (SRHS) estimated Hogfish discards in number by region. Non-Florida areas excluded.

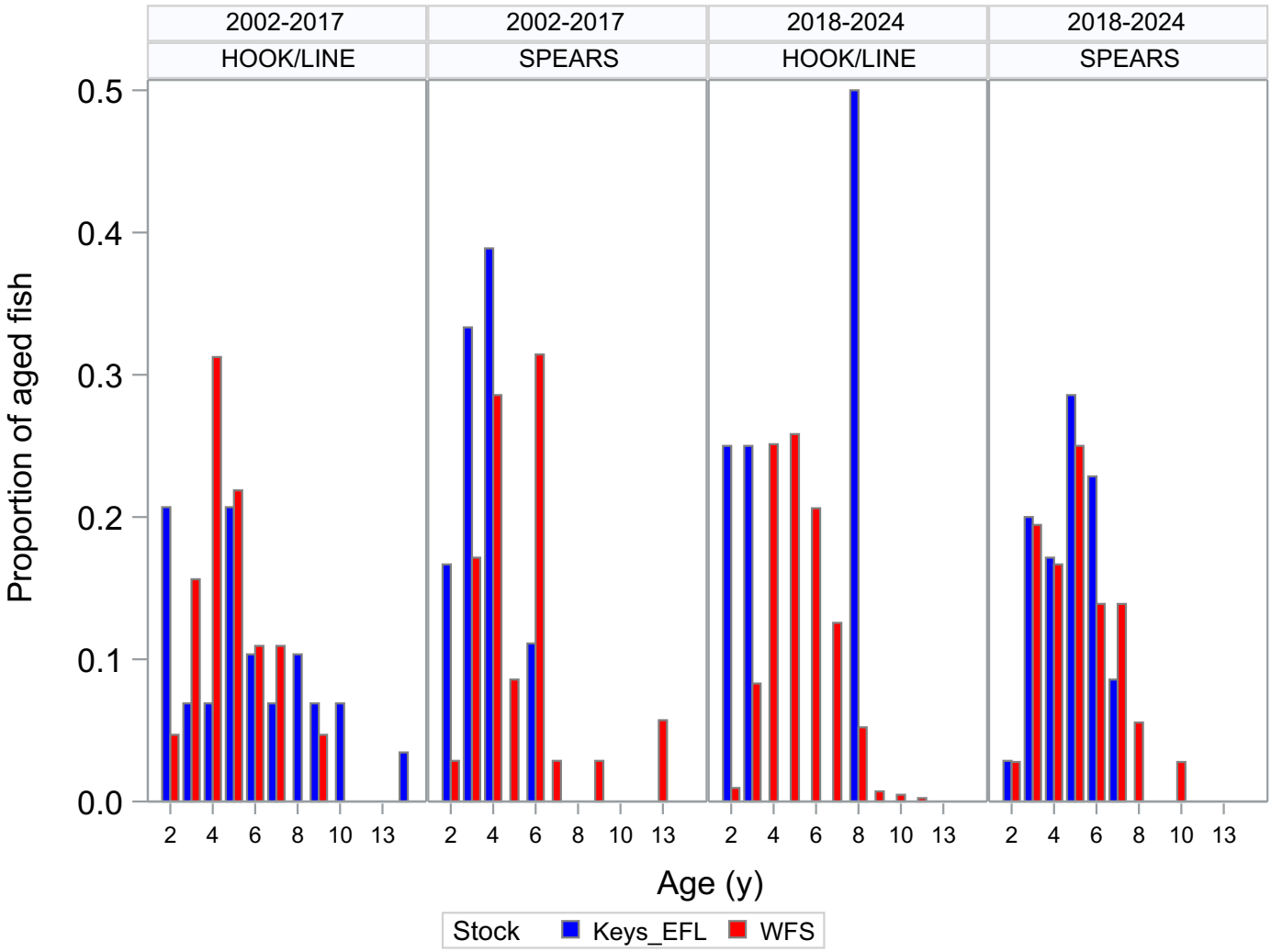


Figure 4.12.13. Proportion of aged Hogfish of the general recreational fleet by stock, year block, and gear type.

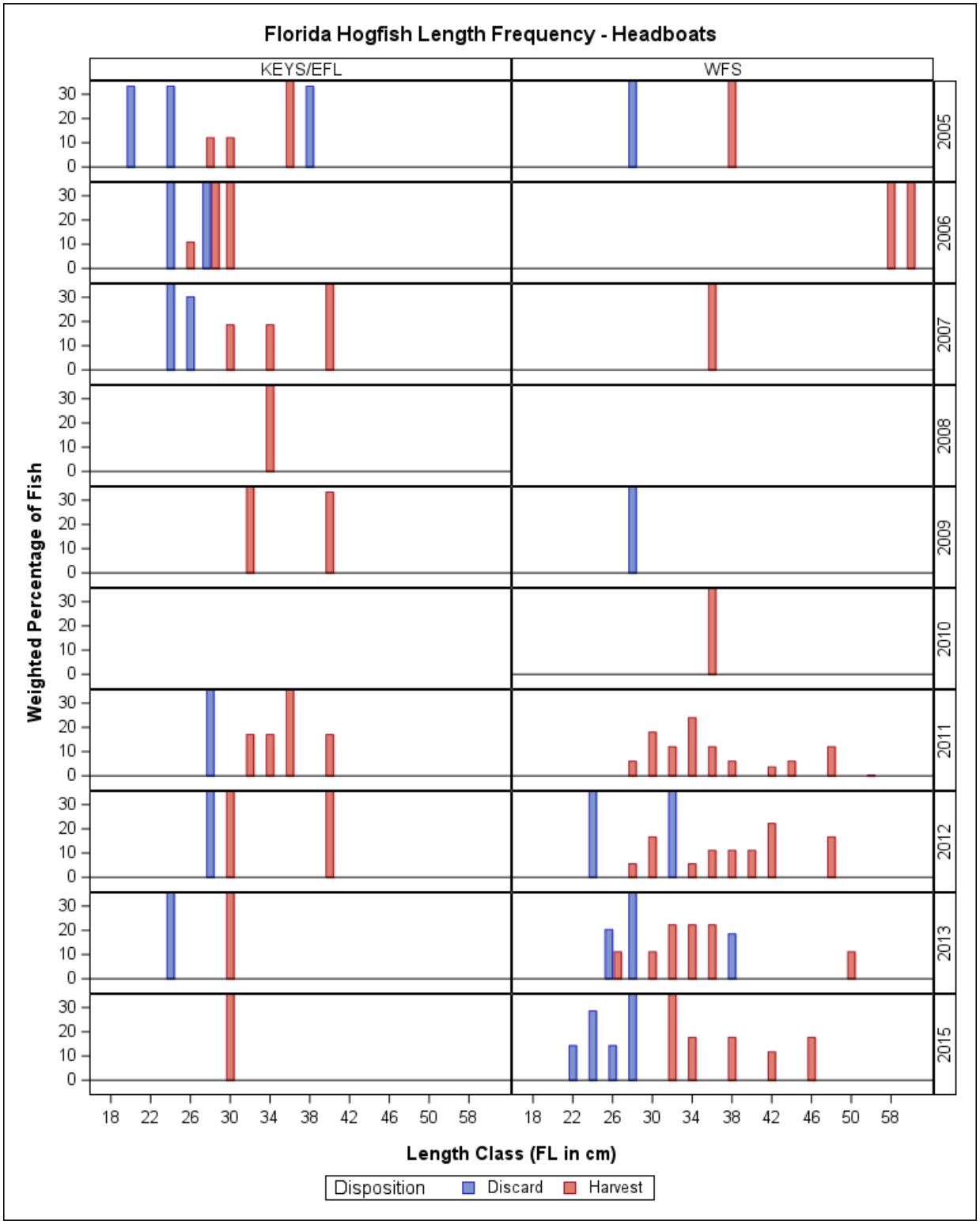


Figure 4.12.14. Weighted length frequencies of harvested and released Hogfish measured by at-sea observers on HEADBOATS in Florida from 2005-2024. Some plots are truncated to improve resolution. Harvest includes fish that were released dead.

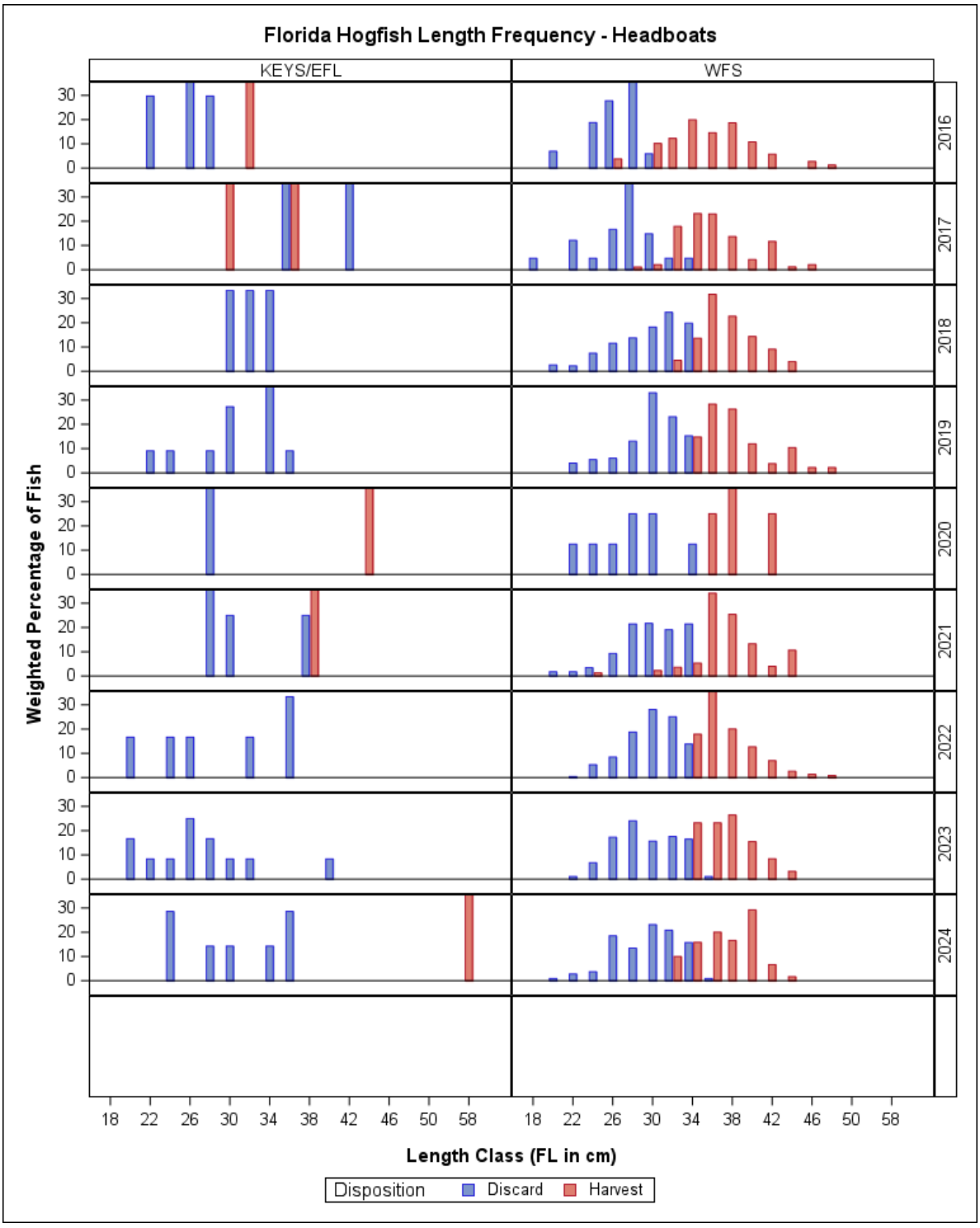


Figure 4.12.14 (cont.). Weighted length frequencies of harvested and released Hogfish measured by at-sea observers on HEADBOATS in Florida from 2005-2024. Some plots are truncated to improve resolution. Harvest includes fish that were released dead.

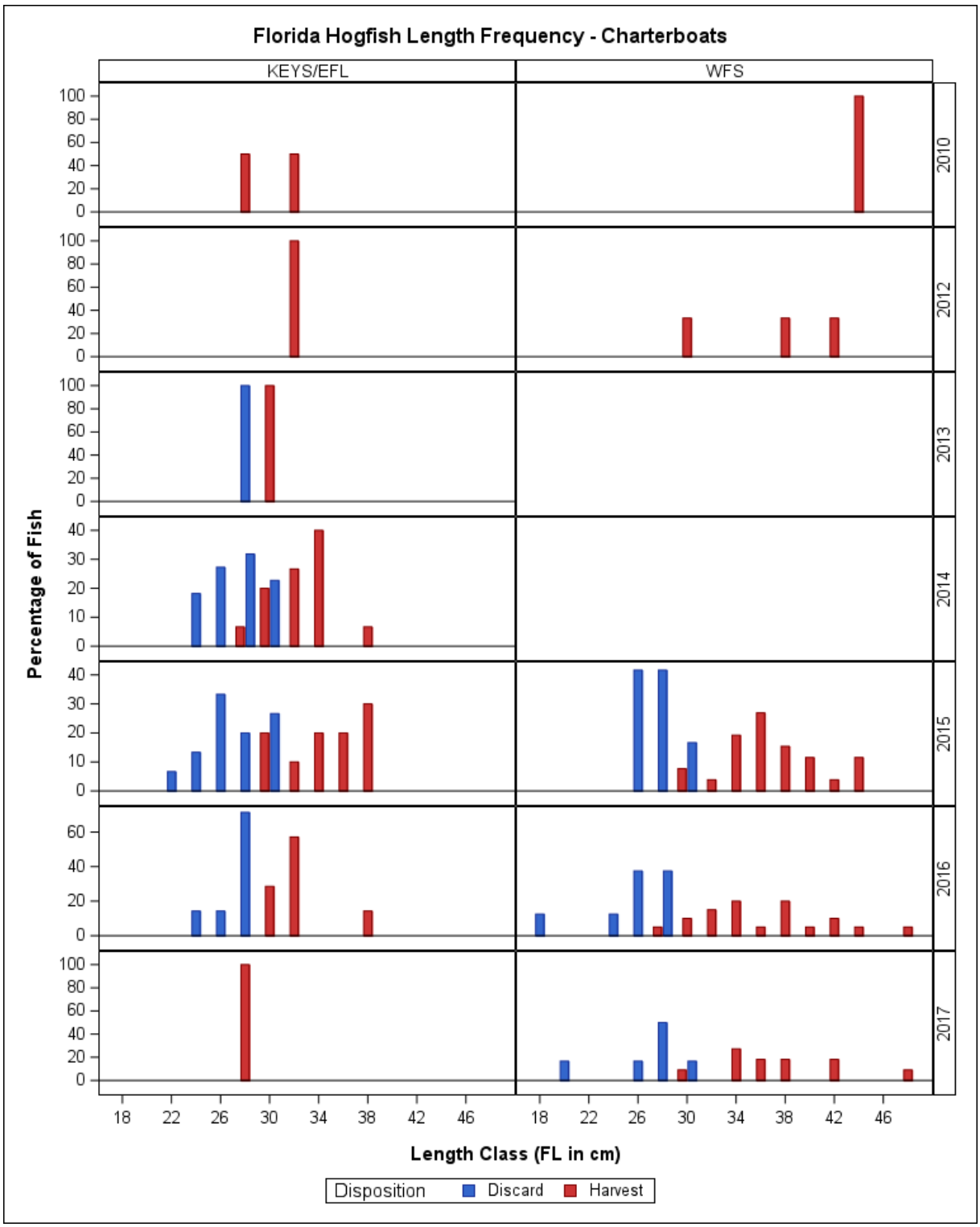


Figure 4.12.15. Length frequency of harvested and released Hogfish measured by at-sea observers on CHARTER BOATS in Florida from 2010-2024. Harvest includes fish that were released dead (SEDAR 94-DW-10).

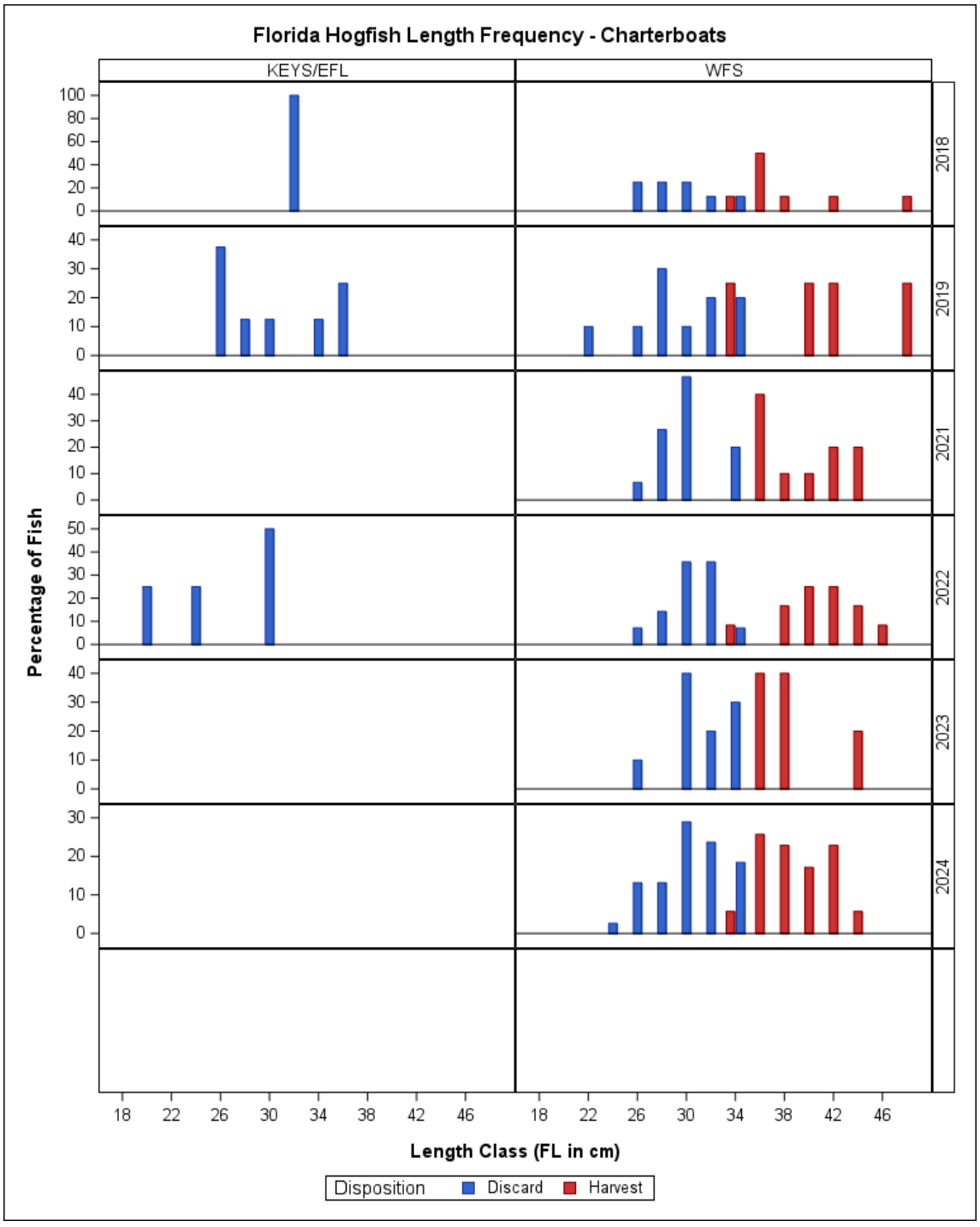


Figure 4.12.15 (Cont.). Length frequency of harvested and released Hogfish measured by at-sea observers on CHARTER BOATS in Florida from 2010-2024. Harvest includes fish that were released dead (SEDAR 94-DW-10).

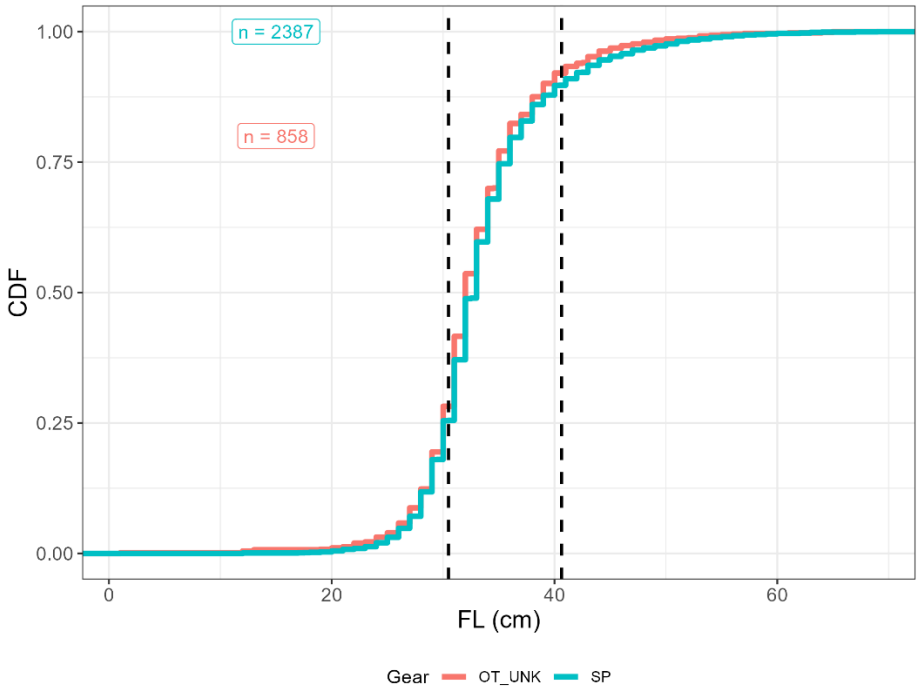


Figure 4.12.16. Cumulative distribution function (CDF) of sampled fork lengths [FL] in cm of landed Hogfish in Biscayne NP Creel Survey. The state of Florida enacted a 12-inch (30.5 cm) minimum size limit (in fork length) in 1994 and a 16 inch (40.6 cm) minimum size limit in 2017 (black dashed lines).

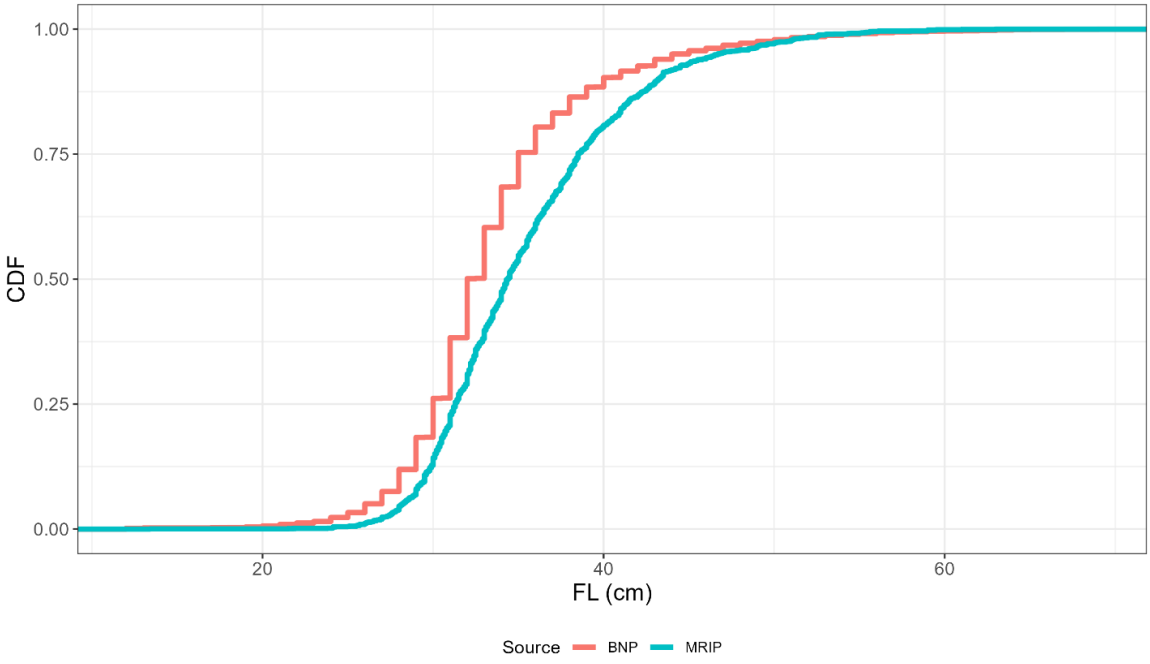


Figure 4.12.17. Cumulative distribution function (CDF) of sampled fork lengths [FL] in cm of landed hogfish in Biscayne NP Creel Survey (BNP) and MRIP.

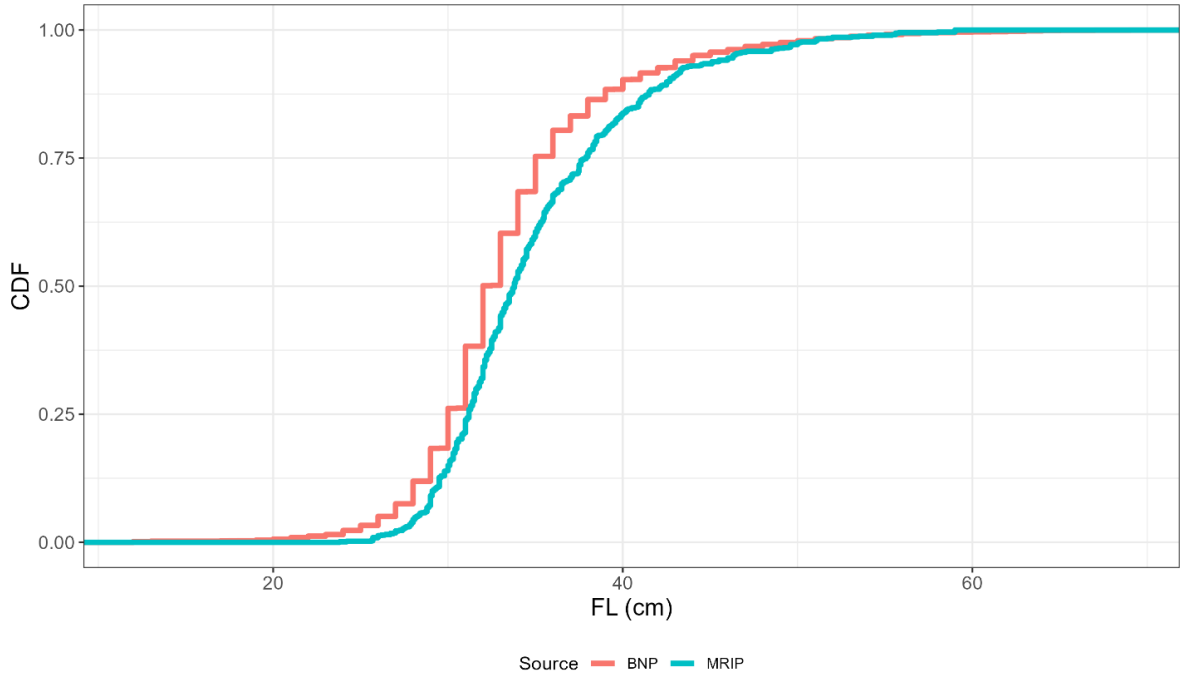


Figure 4.12.18. Cumulative distribution function (CDF) of sampled fork lengths [FL] in cm of landed hogfish in Biscayne NP and Miami-Dade C

5 INDICES OF POPULATION ABUNDANCE

5.1 OVERVIEW

The Index Working Group (IWG) reviewed indices and the accompanying analyses from nine fishery-independent and three fishery-dependent datasets from the West Florida Shelf and the Florida Keys/East Florida regions as defined in SEDAR 94. The IWG reviewed and evaluated each index following the criteria listed in Section 5.2. Section 5.3 lists all the working papers reviewed by the IWG, which contain full descriptions of the datasets, analytical methods, and model diagnostics.

For the West Florida Shelf one fishery-dependent and three fishery-independent indices of abundance were deemed "Suitable and Recommended" by the IWG (Table 5.8.1). For Florida Keys/East Florida four fishery-independent indices of abundance were deemed "Suitable and Recommended" by the IWG (Table 5.8.2). Rationalizations for the recommendation or exclusion of an index are given in the 'Comments on Adequacy for Assessment' in Sections 5.4 (fishery-independent) and 5.5 (fishery-dependent). Annual sampling effort, proportion positive, relative abundance and coefficient of variation on the mean (CV, standard error/mean) for

"Suitable and Recommended" indices are shown in Table 5.8.3 and 5.8.4. Spatial coverage and overall trends of these indices are presented in Figures 5.9.1 and 5.9.2, respectively for the West Florida Shelf and 5.9.1 and 5.9.3 for the Florida Keys/East Florida region.

5.1.1 Index Working Group (IWG) Members

Heather Christiansen (lead)	FWRI, St. Petersburg, FL
Dustin Addis	FWRI, St. Petersburg, FL
Shanae Allen	USF and FWRI, St. Petersburg, FL
Sean Keenan	FWRI, St. Petersburg, FL
Brian Klimek	FWRI, Cedar Key, FL
Justin Lewis	FWRI, Cedar Key, FL
Robert Muller	FWRI, St. Petersburg, FL
Greg Onorato	FWRI, St. Petersburg, FL
Michaela Pawluk	SEFSC
Michael Schram	FWRI, St. Petersburg, FL
Brice Semmens	Scripps Institution of Oceanography, La Jolla, CA
Ted Switzer	FWRI, St. Petersburg, FL
Steve Turner	SAFMC SSC

5.1.2 Terms of Reference

The IWG was tasked with completing objectives associated with the following Terms of Reference:

DW ToR #4: Provide measures of population abundance that are appropriate for stock assessment.

- Consider and discuss all available and relevant fishery-dependent and -independent data sources using a terminal year of 2024.
- Document all programs evaluated, address program objectives, methods, coverage, sampling intensity, and other relevant characteristics.

- Provide maps of fishery and survey coverage.
- Develop fishery and survey CPUE indices by appropriate strata (e.g., age, size, area, and fishery) and include measures of precision and accuracy.
- Discuss the degree to which available indices adequately represent fishery and population conditions.
- Recommend which data sources adequately and reliably represent population abundance for use in assessment modeling.
- Provide appropriate measures of uncertainty for the abundance indices to be used in stock assessment models.
- Categorize the available indices with regard to their appropriateness for use in assessment modeling.

5.2 CONSENSUS RECOMMENDATIONS AND SURVEY EVALUATIONS

All indices presented to the IWG were evaluated based on the following criteria:

- Fishery Dependent or Independent
- Data Sources
- Temporal Range
- Spatial Range
- Survey Design (e.g., fixed sampling sites, stratified random etc.)
- Sampling Methodology (e.g., gear, vessels, effort etc.)
- Ages and/or sizes represented
- Analytical Methods Appropriate?

After the index was evaluated, it was deemed either Suitable or Not Suitable, following the guidance in the Terms of Reference (see section 5.1.2). Once all the indices were evaluated on their own merits and determined to be Suitable / Not Suitable, suitable indices then entered the second stage of review that determined whether they would be recommended for use in the assessment. Indices were then assigned to one of the following categories.

- Suitable and Recommended: Based on the criteria listed above, the index met the minimum requirements for being considered for use in the assessment and was deemed to be a representative example of the population trends for a given area.

- Suitable and Not Recommended: Based on the criteria listed above, the index met the minimum requirements for being considered for use in the assessment but was not deemed to be a representative example of the population trends for a given area.
- Not Suitable (Not Recommended): Based on the criteria listed above, the index did not meet the minimum requirements for being considered for use in the assessment.

5.3 REVIEW OF WORKING PAPERS

Nine working papers were submitted for review to the IWG:

SEDAR94-DW-01: Standardized video counts of southeast US Atlantic hogfish (*Lachnolaimus maximus*) from the Southeast Reef Fish Survey

SEDAR94-DW-04: Standardized catch rates of Hogfish (*Lachnolaimus maximus*) from the Southeastern U.S. commercial spear fishery, 1993-2024

SEDAR94-DW-13: Hogfish Index of Abundance from the Annual FWRI-SEAMAP Trawl Survey along the West Florida Shelf

SEDAR94-DW-14: Young of Year Hogfish Index of Abundance from Seagrass Trawl Surveys of the Florida Big Bend

SEDAR94-DW-15: Standardization of commercial catch per unit effort of Hogfish (*Lachnolaimus maximus*) from Florida Trip Ticket landings, 1994-2024

SEDAR94-DW-17: Standardized Catch Rates of Hogfish (*Lachnolaimus maximus*) from the Marine Recreational Information Program (MRIP) for West Florida and the Keys-East Florida, 1991-2024

SEDAR94-DW-19: Indices of abundance for Gulf and Atlantic Hogfish (*Lachnolaimus maximus*) using data from multiple video surveys

SEDAR94-DW-22 Standardized Reef Visual Census indices for Hogfish, *Lachnolaimus maximus*, for Southeast Florida (2013 - 2024), the Florida Keys (1997 – 2024), and Dry Tortugas (1999 - 2024)

SEDAR94-DW-XX A Unified Reef Visual Census (RVC) and REEF Citizen Science Index

5.4 FISHERY-INDEPENDENT INDICES

5.4.1 Southeast Reef Fish Survey (SERFS, Cape Hatteras, NC to St. Lucie Inlet, FL)

The Southeast Reef Fish Survey is a collaborative trap and video survey conducted by NOAA Fisheries and the South Carolina Department of Natural Resources. SERFS has been conducted since 1990 using baited chevron traps, and video cameras were attached to traps regionwide in 2011. The spatial extent of the survey ranges from Cape Hatteras, NC, to St. Lucie Inlet, FL, from approximately 15 to 115 m deep. SERFS is conducted from late spring through early fall each year. The survey uses a simple random sampling design, selecting approximately 1,500 stations to sample out of a sampling universe of approximately 4,300 stations, all on reef habitat. Hogfish were rarely caught in traps, so we used video counts only here.

Methods of Estimation

Working Paper Number: SEDAR94-DW-01

Data Type: Fishery Independent

Time Series: 2011–2023

Sampling Intensity: Table 1 and Figure 2 in working paper.

Size/Age Data: No size or age data from videos, selectivity must be assumed.

Data Filtering Techniques: Standard filtering to remove videos that did not record properly.

Standardization: Zero-inflated negative binomial model. A step-wise backwards model selection procedure based on AIC was used to systematically exclude unnecessary parameters from the full model formulation.

Submodel Variables- FL Keys/ East Florida

Binomial Model: Presence/Absence = Year + Season + Depth + Latitude + Turbidity + Substrate Composition

Count Model: SumCount = Year + Season + Latitude + Water Temperature + Turbidity + Substrate Composition

Abundance Indices: Table 3 and Figure 7 in the working paper

Uncertainty and Measures of Precision: Uncertainty in the index was computed using a bootstrap procedure with n = 1,000 replicates. In each replicate, a data set of the original size was created by drawing observations (rows) at random with replacement. This was done by year, to maintain the same annual sample size as in the original data. The model was fitted to each data set, and uncertainty (CVs) was computed. All the 1,000 runs converged.

Uncertainty in the calibration factor was included in the bootstrap procedure by drawing a random value from a normal distribution with a mean of 1.129 and a standard error of 0.089 (estimates from the regression using trimmed data). These values, one for each bootstrap replicate, were used to scale up the 2011–2014 index estimates. Thus, this method accounts for the adjustment in the 2011–2014 estimates, as well as the corresponding CVs.

Comments on Adequacy for Assessment: The SERFS index was deemed Suitable by the IWG because it is a fishery independent survey that primarily uses a random sampling design. However, the IWG does not recommend this index for inclusion in the assessment as the majority of the survey occurs north of the Florida Keys/ East Florida region. Hogfish are rarely observed in the Florida Keys and East Florida region (1.2% presence in available videos; Figure 2 in the working paper) and models developed from data isolated to this region did not converge (N. Bachelor, *pers. comm.* 4/30/25).

5.4.2 SEAMAP-FWRI Shrimp/Groundfish Trawl Survey West Florida Shelf

The Southeast Area Monitoring and Assessment Program (SEAMAP) was established in 1981 to conduct fishery-independent surveys within the Gulf of America. The summer shrimp/groundfish trawl survey began in 1982, and the fall survey began in 1986. Both surveys used a 12.8 m shrimp trawl towed for 30 minutes at ~3 kts. Sampling was initially conducted mostly in the western Gulf but in 2008 it was extended into the eastern Gulf via a collaboration with the Florida Fish and Wildlife Conservation Commission's Fish and Wildlife Research Institute (FWRI). Also, in 2008 site selection switched to a stratified random survey design wherein each statistical zone was subdivided into two depth strata (10 to 36.6 m and 36.6 to 110 m). Sampling locations were randomly selected and allocated based on the proportion of area of each depth stratum and statistical zone. Prior to the SEAMAP/FWRI collaboration Hogfish had

never been caught in either the summer or fall surveys. Following the expansion in 2008, Hogfish were caught frequently in statistical zones 3-7.

Methods of Estimation

Working Paper Number: SEDAR94-DW-13

Data Type: Fishery Independent

Time Series: 2010-2024

Sampling Intensity: Twice a year, summer and fall seasons (Table 5.8.3; Table 2 and Figure 2 in working paper)

Major Changes to Sampling Design/Gear Changes: No design or gear changes were implemented during the time series used for this index.

Size/Age Data: Hogfish ranged from 47 – 760 mm standard length, with a mean of 188 mm standard length. The majority of Hogfish ranged between ages 0-6 with age-1 being the most common (Figure 4 in the working paper).

Data Filtering Techniques: Statistical zones 8-22 (West of Cape San Blas) were removed due to no Hogfish catches. The year of 2010 was chosen as the start of the time series as it represented the first year in which all statistical zones with Hogfish catches were sampled. Hogfish were rarely caught at depths greater than 40 m leading to trawls towed at depths greater than 40 m being removed from analysis. The West Florida stock is delineated from the Florida Keys/East Florida stock at 25° 9.00’ N so all trawl sites south of that latitude were removed from analysis. This included all of statistical zone 1 and 2 and part of statistical zone 3.

Standardization: A generalized linear model with a negative binomial distribution was constructed to model catch of Hogfish using statistical zone, month and season as variables and temperature, depth, salinity and sponge bycatch as covariates. Stepwise selection based on AIC was used to determine variable/covariate inclusion in the final model.

Submodel Variables:

Negative Binomial: Catch per set = Year + Statistical zone + Depth + Sponge bycatch

Abundance Indices: Table 5.8.3, Figure 5.9.2; Table 5 and Figure 6 in working paper.

Uncertainty and Measures of Precision: Least squares means and standard errors were calculated for each year along with annual coefficients of variation (CV). These annual CVs were determined by multiplying the standard error of the model by deviates derived from a standard normal distribution (n=10,000) and adding these values to the calculated least squares mean. This new sampling distribution was then used to calculate the standard deviations from which the annual CVs could be derived (Table 3 in the working paper).

Comments on Adequacy for Assessment: This index was deemed suitable and recommended. This was a fisheries independent index that covered almost the entirety of the spatial range for the West Florida Shelf Hogfish stock. The increasing trend post-2018 coincides with the same trend from the video index over the same temporal and spatial scales. There is also age data associated with this index for use in the stock assessment.

5.4.3 FWRI FIM Polyhaline Seagrass Survey (Big Bend, Florida)

The Florida Fish and Wildlife Conservation Commission's Fisheries Independent Monitoring (FIM) conducts annual monitoring of marine species throughout the state of Florida. In 2008, FIM began a polyhaline seagrass survey (WI) targeting seagrass beds in five estuaries along Florida's gulf coast (St. Andrew Bay, Apalachicola Bay, Big Bend, Tampa Bay and Charlotte Harbor). Sampling locations are randomly selected based on $0.1nm^2$ x $0.1nm^2$ sampling units within larger geographic zones. These sampling locations are assessed for seagrass coverage (minimum 50% coverage) and depth (between 1.0 and 7.6 m). The site is sampled with a 6.1 m wide otter trawl with 38 mm stretched nylon mesh netting and a 3.2 mm knotless nylon Delta mesh cod-end liner which is towed for 5 minutes at 1.2 kts. Hogfish catches were rare in most surveys and estuaries, however Hogfish catches were plentiful in the Big Bend WI survey and were used to create an index of abundance.

Methods of Estimation

Working Paper Number: SEDAR94-DW-14
Data Type: Fishery Independent
Time Series: 2008-2024
Sampling Intensity: Seasonal Sampling May-November (Table 5.8.3; Table 2 and Figure 1 in working paper)

Major Changes to Sampling Design/Gear Changes: Sampling gear has been consistent since inception (6.1 m otter trawl). Sampling in two of the four zones were discontinued in 2009 (Zone C) and 2019 (Zone A) respectively. Samplig effort for zone A was reallocated to the remaining zones of B and D. May sampling was discontinued in 2016 for all zones. Sampling halved in 2020 due to Covid-19 pandemic.

Size/Age Data: Primarily age-0 fish from 14 – 213 mm standard length, mean 77 mm standard length (Figure 2 in working paper).

Data Filtering Techniques: Zones A and C were not considered for analysis due to their sampling being discontinued during the time series. The month of May was also not considered due to being discontinued. The month of November was also removed from analysis due to low catches (<30 fish).

Standardization: A generalized linear model with a negative binomial distribution was constructed to model catch of age-0 Hogfish using geographic zone, month, and year as variables and temperature, depth, dissolved oxygen, pH, bycatch, effort and salinity as covariates. Stepwise selection based on AIC was used to determine variable/covariate inclusion in the final model.

Submodel Variables:

Negative Binomial: Catch per set = Month + Year + Zone + Bycatch + Effort

Abundance Indices: Table 5.8.3, Figure 5.9.2; Table 5 and Figure 5 in working paper.

Uncertainty and Measures of Precision: Least squares means and standard errors were calculated for each year along with annual coefficients of variation (CV). These annual CVs were determined by multiplying the standard error of the model by deviates derived from a standard normal distribution (n=10,000) and adding these values to the calculated least squares mean. This new sampling distribution was then used to calculate the standard deviations from which the annual CVs could be derived (Table 3 in the working paper).

Comments on Adequacy for Assessment: This index was deemed suitable and recommended. The length of the time series, independent nature of the data, and fact that the survey sampled a known Hogfish recruitment area for the West Florida Shelf stock supports the use of this index in the assessment. It is also the only age-0 index for the West Florida Shelf Hogfish stock. Age-0

abundance varied by year with both strong and weak year classes present in the time series with some strong year classes being associated with higher juvenile and sub-adult abundances in other indices. The CV exceeded 0.50 in 2014 (Table 5.8.3).

5.4.4 FWRI FIM Stratified Random Sampling Survey (Southern Indian River Lagoon, Florida)

The Florida Fish and Wildlife Conservation Commission's Fisheries Independent Monitoring (FIM) program conducts annual monitoring of marine species throughout the state of Florida. In 1996, monthly stratified random sampling (SRS) was established in seven estuaries throughout the state (Apalachicola Bay, Cedar Key, Tampa Bay, Charlotte Harbor, Northeast Florida, Northern Indian River Lagoon and Southern Indian River Lagoon). This survey uses a multitude of gear types designed to target young of year up to adult sportfishes. The primary gear for this survey is an 183 m center bag seine with 37.5 mm stretched mesh. Sampling locations are randomly selected based on $0.1nm^2$ x $0.1nm^2$ sampling units within larger geographic zones. Hogfish were caught in low numbers in the Southern Indian River Lagoon via the 183 m center bag haul seine from 1997 to 2015 and have largely been absent from catches for the last decade.

Methods of Estimation

Working Paper Number: SEDAR94-DW-14

Data Type: Fishery Independent

Time Series: 1997-2024

Sampling Intensity: Monthly (Table 1 in working paper)

Major Changes to Sampling Design/Gear Changes: Number of sets per month varied in 1997 and 1998 as gears and gear distribution were being tested. From 1999 to present sampling has not changed.

Size/Age Data: Primarily age-0 fish from 43-318 mm standard length, mean 101.4 mm standard length.

Data Filtering Techniques: Zone TQT which covers the St. Lucie River was removed as no Hogfish were ever caught during the time series. Only the months of July-October were incorporated as all other months had low catches (<30 fish). Due to numerous low or no catch

years in the data three datasets were created: 1997-2015 (all years), 1997-2015 (no 2005 or 2009) and no zero years (1997-2004, 2006-2008, 2010-2015, 2017, 2022, and 2023).

Standardization: A generalized linear model with a negative binomial distribution was constructed to model catch of age-0 Hogfish using geographic zone, month and year as variables and temperature, depth, dissolved oxygen, pH, bycatch, effort and salinity as covariates. Stepwise selection based on AIC was used to determine variable/covariate inclusion in the final model. Several attempts were made using the different distributions, time series and variable selection but no representative index could be made.

Submodel Variables:

Negative Binomial: N/A

Abundance Indices: N/A

Uncertainty and Measures of Precision: N/A

Comments on Adequacy for Assessment: While several indices were attempted, lack of convergence, unrealistic means and confidence limits or high CVs (>0.8) led to any potential index being deemed not suitable nor recommended. The low overall catches, and even lower frequency of occurrence of Hogfish in the Southern Indian River Lagoon make index construction impractical. However, based on sizes measured, Hogfish caught by the survey were mostly comprised of age-0 fish and could be useful information for the Florida Keys/East Florida stock. Additionally, the decline in catches of Hogfish from 2016-present coincides with a loss of seagrass habitat in the lagoon which could imply a potential link between habitat degradation and reduced Hogfish abundance or availability.

5.4.5 Combined Stereo Video Survey

Historically, three different stationary video surveys were conducted to assess trends in reef fish relative abundance in the Gulf of America (GOA). The NMFS SEAMAP reef fish video survey (SFRV), carried out by NMFS Mississippi Laboratory, has the longest running time series (1993-1997, 2002, and 2004+), followed by the NMFS Panama City lab survey (PC; 2005+), with the most recent survey being the Florida Fish and Wildlife Research Institute video survey (FWRI, starting year 2010). Survey efforts were integrated under a unified design as the Gulf Fishery

Independent Survey of Habitat and Ecosystem Resources (G-FISHER) beginning in 2020. Given the surveys use standardized deployment, camera field of view, and fish abundance methods to assess fish abundances on reef or structured habitat, combining indices across datasets allows for the largest possible sample sizes in model fitting and encompassing a greater proportion of the distribution of the stock. As such, we used a habitat-based approach to combine relative abundance data for generating annual trends for Hogfish (*Lachnolaimus maximus*) throughout the eastern GOA for the West Florida Shelf and Florida Keys/East Florida regions.

Methods of Estimation

Working Paper Number: SEDAR94-DW-19

Data Type: Fishery Independent

Time Series: 1993-2023

Sampling Intensity: Table 5.8.3, Tables 4 and 6 in working paper

Major Changes to Sampling Design/Gear Changes: Data used to generate this index were derived from several video surveys each initiated to derive abundance estimates of important reef fish stocks. The longest running survey was the SEAMAP reef fish video (SRFV) survey initiated by the NMFS Mississippi Laboratory in 1992, followed in 2005 by the NMFS Panama City laboratory (PC) survey, and finally the Florida Fish and Wildlife Research Institute (FWRI) video survey, which started in 2010. From 2020 onward, video survey efforts were unified under the Gulf Fishery Independent Survey of Habitat and Ecosystem Resources (G-FISHER) program. The most notable changes to sampling design are the result of new surveys coming online (e.g., PC in 2006, FWRI in 2010, and FWRI-AR in 2016), the spatial expansion associated with the FWRI survey from 2010 to 2016, and the unification under the G-FISHER program. The only notable gear change was the transition from laser (SRFV sites prior to 2006) to stereo camera measurements (2006 onward for all surveys).

Size/Age Data: Represents sub-adult through adult biomass. Fork length ranges were 8-104 cm and 14-68 cm for Gulf and Atlantic stocks respectively. Fish were assigned to 2-cm size bins, ranging from 2-80 cm fork length, with the largest bin representing plus groups (Figures 16 and 17 in working paper). No ages are collected by this survey.

Data Filtering Techniques: For all surveys, video reads were excluded if they were unreadable due to turbidity or deployment errors. Sites west of NMFS statistical zone 9 were also excluded from all survey data sets because of a lack of Hogfish observations and portioned into Gulf and Atlantic data sets along the Cape Sable boundary. Data from the SRFV survey collected in 1992 were excluded from index calculations because of differences in counting methods in this first year, and no survey data are available for years 1998-2001 and 2003. For the Atlantic index, data from 2013 and 2015 were also removed because fewer than 10 sites were sampled. Panama City survey data from 2005 was excluded because of an incomplete survey. For both FWRI and G-FISHER, data from both natural and artificial reefs were used but treated as separate surveys for index construction denoted by the suffix "-AR". Because of sporadic effort and few Hogfish observations, data from the FWRI-AR survey prior to 2015 was omitted from the Gulf index and not used for the Atlantic index. For natural reefs, data from 2010 to 2019 was retained for both the Gulf and Atlantic stocks. In the case of G-FISHER, data from both natural and artificial reefs were available for all years (i.e., 2020-2023). Again, however, artificial reef data were excluded from the Atlantic index because of low sample sizes and a lack of Hogfish observations.

Standardization: Relative abundance indices were generated using a stepwise approach. First, a standardized habitat variable was created by conducting a classification and regression tree (CART) analysis for each lab to determine which lab-specific explanatory variables were important determinants of presence/absence. Terminal nodes were then assigned a habitat class of High (more than twice the nominal frequency of occurrence), Low (less than half the nominal frequency of occurrence), or Medium (all values that fall between High and Low). All individual observations were then assigned values of the newly defined habitat variable. Second, annual estimates of relative abundance and standard error were produced for each combination of survey and habitat classes. Finally, abundance and variance estimates were then calculated following a post-stratified design-based approach whereby estimates of each stratum mean and variance were weighted by the proportion of survey area that contained reef and the overall proportion of each habitat class sampled by a given survey. This same habitat-area weighting scheme was also applied to the annual length compositions.

Sub-model Variables (i.e. CART input variables by stock for each survey):

West Florida Shelf Stock

SRFV: Latitude, Longitude, Depth, Combo max relief, Algae (P/A), Soft coral (P/A), Unknown sessile invertebrates (P/A), and Attached epifauna (P/A)

PC: Latitude, Longitude, depth, Genhab, Rock (P/A), Algae (P/A), and Sponge (P/A)

FWRI: Latitude, Longitude, Depth, Substrate max relief, Algae (P/A), Soft coral (P/A), and Sponge (P/A)

FWRI-AR: Latitude, Longitude, Depth, Geoform code, Algae (P/A), and Sponge (P/A)

GFISHER: Latitude, Longitude, Depth, Substrate max relief, Rock (P/A), Algae (P/A), and Soft coral (P/A)

GFISHER-AR: Latitude, Longitude, Depth, Habitat strata, Substrate max relief, Geoform code, and Algae (P/A)

Florida Keys/East Florida Stock

SRFV: Latitude, Longitude, Depth, Combo max relief, Silt/sand/clay (P/A), Soft coral (P/A), and Sponge (P/A)

FWRI: Latitude, Longitude, Depth, Geoform code, Rock (P/A), and Soft coral (P/A)

GFISHER: Longitude, Depth, Habitat strata, Geoform code, Substrate max relief, Relief (P/A), and Rock (P/A)

Abundance Indices: Tables 5.8.3 and 5.8.4, Figures 5.9.2 and 5.9.3. See working paper for Gulf index (Table 8 and Figure 12) and Atlantic index (Table 9 and Figure 13).

Uncertainty and Measures of Precision: The misclassification rates for the Gulf stock CART models were 33%, 20%, 29%, 20%, 0%, and 25% for the SRFV, PC, FWRI, FWRI-AR, GFISHER, and GFISHER-AR surveys. The coefficients of variation (CVs) ranged from 0.11 to 0.46 (Table 8 of working paper). For the Atlantic stock, the misclassification rates for all three survey CART models was 0%. The CVs for the Atlantic index ranged from 0.15 to 0.58 (Table 9 in working paper).

Comments on Adequacy for Assessment: After review by the IWG, the Gulf and Atlantic indices were deemed both suitable and recommended for Hogfish. It was recommended that the Gulf index be truncated to 2006, when the PC survey comes online, because of potential differences in Hogfish catchability compared to the SRFV survey. However, it was also recommended to include the full index as a sensitivity run.

5.4.6 National Marine Fisheries Service's (NMFS) Reef Visual Census (RVC, Dry Tortugas and FL Keys) and Southeast Florida Coral Reef Initiative (SEFCRI, SE FL)

The National Marine Fisheries Service's (NMFS) Reef Visual Census (RVC) began in 1979 with divers identifying and counting fish along Florida's reef track. The program evolved into gridding the entire reef track into 50m x 50m blocks (originally 200 m x 200 m blocks) and listing the habitats in each block (Primary Sampling Units, PSU). Primary Sampling Units are randomly sampled by habitat with the number of samples depending upon the variability of the strata. Depths sampled range from approximately 1 to 33 meters across all regions.

Methods of Estimation

Working Paper Number: SEDAR94-DW-22

Data Type: Fishery Independent

Time Series: 2013 – 2024 (Southeast Florida), 1997 – 2024 (Florida Keys), and 1999 – 2024 (Dry Tortugas)

Sampling Intensity: Table 5.8.4; Tables 2a (Southeast Florida), 2b (Florida Keys), 2c (Dry Tortugas) in the working paper.

Size/Age Data: In southeast Florida, the median size of Hogfish was 24 cm FL and the interquartile range was 20 to 30 cm FL (full range: 3 to 77 cm FL). In the Florida Keys, the median size was 23 cm FL and the interquartile range was 18 to 29 cm FL (full range: 2 to 85 cm FL). The median size of Hogfish observed in the Dry Tortugas was 32 cm FL with an interquartile range of 24 to 42 cm FL. There were no ages collected in this survey because the divers only observe and measure the fish *in situ* and do not capture them.

Data Filtering Techniques: The data were filtered to remove habitats that were not on the reef track in all regions, stations with missing explanatory variables were deleted, data from months

with few observations were deleted such that the Florida Keys only included data from June through September and the Dry Tortugas only included data from May through July, and southeast Florida included data from June through October. The final data set contained 3,809 stations/ 1,243 positive stations (33%, Southeast Florida), 9,616 stations/ 5,302 positive stations (55%, Florida Keys), and 6,379 stations/2,874 positive stations (47%, Dry Tortugas).

Standardization: Six model configurations were developed for each of the regions including a design model and five model based configurations, all five of which used a log link. The model-based configurations included a negative binomial distribution model, a Poisson distribution model, and three hurdle models. Each of the hurdle models used the same binomial model with a logit link for the proportion positive estimation and the mean number of Hogfish observed were model with either a gamma, Poisson, or log-normal distribution indices. The final model was the model which had the lowest root mean square error term.

Model/Submodel Variables:

Southeast Florida

Binomial: Presence/Absence = Year + Month + Stratum + Subregion

Poisson: Number observed per station = Year + Habitat + Subregion + Month + Depth class + Rugosity class

Florida Keys

Poisson: Number observed per station = Year + Habitat + Rugosity class

Dry Tortugas

Binomial: Presence/Absence = Year + Protected status + Rugosity class

Gamma: Number observed per station = Year + Habitat

Abundance Indices: Table 5.8.4, Figure 5.9.3; In the working paper - Southeast Florida: Table 2a/Figure 2a, Lengths - Figure 7a, Florida Keys: Table 2b/Figure 2b, Lengths - Figure 7b, Dry Tortugas: Table 2c/Figure 2c, Lengths - Figure 7c. All the regional indices showed increases in recent years.

Uncertainty and Measures of Precision: The variability in the estimated annual index values was estimated using a Monte Carlo simulation approach with 10,000 iterations that used the

least-squares mean estimates and their standard errors. Each iteration used the annual least-squares mean estimate on the linear scale and uncertainty was added by multiplying the annual least-squares mean estimate's standard error by a random normal deviate ($\mu=0$, $\sigma=1$). After the two estimates were transformed back from their linear scales, they were multiplied together to form the annual index value. For the negative binomial model, and the Poisson model, the process was simpler because these configurations only involved a single distribution.

Comments on Adequacy for Assessment: The IWG deemed these indices Suitable and Recommended because the regional indices are Fishery Independent and RVC uses a stratified-random sampling design. The IWG accepted the use of separate indices because the lengths of the Hogfish observed in the Dry Tortugas were typically larger and those observed in Southeast Florida and the Florida Keys. Additionally, there were only four years for which sampling occurred in all regions.

5.4.7 A Unified Reef Visual Census (RVC) and REEF Citizen Science Index

The Reef Environmental Education Foundation (REEF) Volunteer Fish Survey Project is a citizen science initiative that collects opportunistic fish sightings from thousands of volunteer recreational divers, resulting in a dataset with unparalleled spatial and temporal extent. This index uses the state-space modeling approach from Greenberg et al. (2024) to formally integrate the REEF citizen science data with the scientifically structured Reef Visual Census (RVC) data. This integrated approach leverages the extensive coverage of the REEF data to augment and fill gaps in the more spatially or temporally limited RVC data, creating a single, cohesive, and augmented index for each management region.

Methods of Estimation

Working Paper Number: SEDAR94-WP-XX

Data Type: Fishery Independent

Time Series: 1999-2024

Sampling Intensity: The REEF survey is an opportunistic citizen science program where sampling intensity varies based on volunteer diver effort. The RVC survey is a scientifically rigorous survey employing a probabilistic, stratified-random sampling design. The combined

survey effort for both programs in the Southeast Florida and Dry Tortugas regions is detailed in Tables 1 and 2 of the working paper.

Major Changes to Sampling Design/Gear Changes: The methodologies for the RVC and REEF surveys have been consistent over the time series. The significant change is the novel modeling framework that integrates these two disparate datasets to produce a single, unified index of abundance.

Size/Age Data: The RVC program collects both fish counts and associated length-frequency measurements. A key strength of the integrated model is that it preserves the link between the final abundance index and this essential RVC length data. REEF has recently begun collecting length data via the SMILE project, but there are currently limited Hogfish measurements available from this initiative.

Data Filtering Techniques: REEF survey data were filtered prior to analysis using the following procedures:

- Dives shorter than 20 minutes or longer than 120 minutes were excluded.
- Night dives (surveys starting before 5:00 AM or after 8:00 PM) were removed.
- Only surveys from experienced divers were included.
- Only data from well-surveyed sites were retained.
- Zero-observation records were generated to ensure a complete presence/absence record for each survey.

Standardization & Modeling

A multivariate Bayesian state-space model, based on the framework of Greenberg et al. (2024), was used to generate the index. This approach assumes that the true population abundance for each survey changes from year to year according to a random walk. The model estimates two separate, latent population trajectories (state vectors), one informed by the RVC data ($x_{RVC,t}$) and the other by the REEF data ($x_{REEF,t}$).

A key feature of the model is that it simultaneously estimates the temporal correlation (ρ) between the year-to-year fluctuations of these two state vectors. This correlation term allows the model to "borrow information" between the two timeseries. The contribution of the REEF

timeseries to the RVC state estimates is up- or down-weighted based on the extent to which the two observation programs agree, as measured by ρ. The primary goal of this analysis is to generate augmented annual state estimates from the RVC survey, using REEF observations to improve precision and fill in data gaps, which is particularly valuable in years and locations where RVC surveys are missing.

Submodel Variables

The overall model is composed of two observation models linked to a shared, correlated process model.

- **Process Model**: The two latent population states are assumed to evolve based on a correlated random walk process:
- $$\begin{bmatrix} x_{RVC} \\ x_{REEF} \end{bmatrix}_t = \begin{bmatrix} x_{RVC} \\ x_{REEF} \end{bmatrix}_{t-1} + \begin{bmatrix} w_{RVC} \\ w_{REEF} \end{bmatrix}_t, \text{ where } \begin{bmatrix} w_{RVC} \\ w_{REEF} \end{bmatrix}_t \sim \text{MVNormal}\left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \Sigma \right)$$
  The covariance matrix Σ contains the process variances for each survey and the covariance, which is a function of the correlation parameter ρ.
- **RVC Observation Model**: RVC count data were modeled using a **Negative Binomial** distribution. The expected count for a given survey was linked to the RVC-specific latent state vector ($x_{RVC,t}$) and standardized using covariates for **habitat type, depth, month of sampling, and reef stratum (PSU)**.
- **REEF Observation Model**: REEF's ordinal abundance data were modeled using an **ordinal logistic regression**. A latent continuous abundance for each survey was linked to the REEF-specific state vector ($x_{REEF,t}$) and standardized using a comprehensive set of covariates, including **dive site, diver identity, habitat type, diver experience level, month, dive duration, depth, and visibility**.

Abundance Indices: The final augmented annual indices of abundance for the Dry Tortugas and Southeast Florida are presented in the working paper.

Uncertainty and Measures of Precision: Uncertainty in the annual abundance estimates is quantified using Bayesian credible intervals derived from the posterior distributions of the state-space model.

Comments on Adequacy for Assessment: The IWG found that the unified REEF/RVC index provided several advantages as opposed to the stand-alone RVC indices:

1. **Resolves Data Gaps**: It resolves a critical issue by creating a single, continuous index for the Southeast Florida management unit, using the REEF data to refine annual abundance estimates and bridge temporal gaps in the RVC survey series.
2. **Improves Precision**: The integration of REEF data enhances the spatiotemporal coverage of the index, which can reduce uncertainty and provide a more complete picture of population trends
3. **Preserves Key Data Linkages**: The model augments, rather than replaces, the RVC index, preserving the vital connection to the RVC's scientifically collected length-frequency data needed for the stock assessment model.
4. **Ecologically Meaningful**: Because the RVC data are density-based (counts per unit area), the final augmented index can be interpreted as an indicator of population density, providing a more tangible metric for management.

At this time, the IWG determined that while the unified index holds promise as an index of abundance, it is still under development. Given satisfactory model diagnostics and sufficient correlations between the RVC and REEF data, it is recommended for use as a sensitivity run in the SEDAR 94 stock assessment.

5.5 FISHERY-DEPENDENT INDICES

5.5.1 Commercial Spear

Landings and fishing effort of commercial vessels operating in the Gulf of America and southeast U.S. Atlantic are monitored by the NMFS Southeast Fisheries Science Center through the Coastal Fisheries Logbook Program (CFLP). The program collects trip-level information from all vessels holding federal permits to fish in waters managed by the regional Fishery Management Councils. The available data span the period of 1993 (when the CFLP is considered to be fully implemented) – 2024 (the terminal year for this assessment), and span the Gulf of America, and the southeast US Atlantic.

Methods of Estimation

Working Paper Number: SEDAR94-DW-04

Data Type: Fishery Dependent

Time Series: 1993-2024 (Truncated to 2017)

Sampling Intensity: This index is based on the Commercial Fisheries Logbook which is considered to be a census.

Major Changes to Sampling Design/Gear Changes: Logbook reporting is considered consistent starting in 1993, therefore there are no changes to sampling design or gear in this case.

Size/Age Data: No size/age data available within the logbook, however, the size/age range covered by this index is that of the commercial dive/spear fishery.

Data Filtering Techniques: Data were filtered to remove extreme outliers, trips fishing in multiple areas or with multiple gears, and trips that were reported more than 45 days after fishing occurred. Data were further filtered first to only include snapper-grouper complex species and then filtered using the Stephens and MacCall procedure to only include trips that were predicted to have occurred over Hogfish habitat.

Standardization: Two indices were constructed, one for the East Florida – Keys region, and one for the West Florida Shelf region. For each region, a delta-lognormal model was constructed with a binomial model for presence absence and a generalized linear model with either a lognormal (EFL-Keys) or gamma (WFL) distribution for the catch per unit effort model. The Akaike information criterion (AIC) was used for selecting the best distribution for the positive catch submodel. Covariates included in the positive catch submodel included trip length in days (WFL only), crew size, season, subarea, management period, and year. Backwards selection based on AIC was used to determine covariate inclusion in the final models.

Positive catch Submodel Variables:

EFL-Keys: Catch per diver hour = Year + Season + Subarea + Crew

WFL: Catch per diver hour = Year + Season + Crew + Trip length

Abundance Indices: Tables 1 and 2, Figures 12 - 15 in the working paper.

Uncertainty and Measures of Precision: Estimates of variance (CVs) were based on 1,000 bootstrap runs where trips were chosen randomly with replacement. The CVs are shown in Tables 1 and 2 in the working paper.

Comments on Adequacy for Assessment: The indices were determined to be suitable through 2017 but were not recommended due to the availability of fishery-independent indices covering a similar size and spatial range.

5.5.2 Commercial spear and hook and line (Florida Trip Ticket Landings)

All sales of seafood products from the waters of Florida must be reported on a Marine Fisheries Trip Ticket at the time of sale. Trip tickets include information about the harvester, the dealer purchasing the product, the date of the transaction, the county in which the species was landed, area fished, gear used, time fished, and pounds and/or numbers of each species landed for each trip.

Methods of Estimation

Working Paper Number: SEDAR94-DW-15

Data Type: Fishery Dependent

Time Series: 1994–2024, (1994-2017 truncated time-series)

Sampling Intensity: Tables 1 and 2 in working paper

Size/Age Data: No size/age data provided.

Data Filtering Techniques: The data was filtered to remove all uncommon species that occurred on only a small proportion of the total trips and in particular those species that were rarely caught with hogfish. For both gear types, species caught on less than 1% of the total trips that caught hogfish were removed. Affinity propagation clustering (APC) was chosen to determine associated species, because it has been shown to perform well relative to other cluster techniques and does not require that the number of cluster be prespecified (Frey and Dueck 2007). APC automatically chooses an optimal number of clusters in the dataset, thereby providing an objective criterion for which to group associated species. For the APC procedure, the Bray measure of similarity was used where data were converted to presence/absence of landings for each species and fishing trip. Once the associated species within the hogfish cluster

were identified for each of the stocks and gear types, all trips on which these species were caught for a specific gear type were used as suitable valid trips in the subsequent analyses. The APC technique was done in R 4.4.3 (R Core Team 2025) using the apcluster package (Bodenhofer et al. 2011).

Standardization: Standardized indices of abundance were calculated using a generalized linear modeling procedure that combined the analysis of the binomial information on presence/absence with the lognormal-distributed positive catch data.

Submodel Variables- West Florida Shelf

Spear 1994-2024

Binomial: Presence/Absence = Year + Depth + Days_fish + Month

Positive: CPUE = Year + Days_fish + Depth + Month

Spear 1994-2017

Binomial: Presence/Absence = Year + Days_fish + Depth + Month

Positive: CPUE = Year + Days_fish + Depth + Month

Hook and Line 1994-2024

Binomial: Presence/Absence = Year + Depth + Days_fish

Positive: CPUE = Year + Days_fish + Month + Depth

Hook and Line 1994-2017

Binomial: Presence/Absence = Year + Depth + Days_fish + Month

Positive: CPUE = Year + Days_fish + Month + Depth

FL Keys/ East Florida

Spear 1994-2024

Binomial: Presence/Absence = Year + Depth + Month + Days_fish

Positive: CPUE = Year + Days_fish + Month + Depth

Spear 1994-2017

Binomial: Presence/Absence = Year + Depth + Month + Region + Days_fish

Positive: CPUE = Year + Days_fish + Month + Depth

Hook and Line 1994-2024

Binomial: Presence/Absence = Year + Depth + Region + Month + Days_fish

Positive: CPUE = Year + Days_fish + Depth + Region + Month

Hook and Line 1994-2017

Binomial: Presence/Absence = Year + Region + Depth + Month + Days_fish

Positive: CPUE = Year + Days_fish + Depth + Region + Month

Abundance Indices: Table 15 – 22 in working paper**,**

Uncertainty and Measures of Precision: Final year specific marginal means estimates and standard errors of the two sub-models were used to generate distributions of estimates for each sub-model from a Monte Carlo simulation (5,000 Student's t distributed realizations). The product of these distributions (eq. 1) provided an estimate of the median catch rate with year-specific variability. All analyses were done using R 4.4.3 (R Core Team 2025).

Comments on Adequacy for Assessment: Due to changes in management regulations the indices were determined to be suitable through 2017 but were not recommended due to the availability of fishery-independent indices covering a similar size and spatial range.

5.5.3 Standardized Catch Rates of Hogfish (Lachnolaimus maximus) from the Marine Recreational Information Program (MRIP) for West Florida and the Keys-East Florida, 1991-2024

Hogfish are caught by recreational anglers primarily in West Florida (WFL; Franklin to Collier counties) and the Keys-East Florida (Keys-EFL; Indian River to Monroe counties) via hook and line and/or spear. The Marine Recreational Fisheries Statistics Survey (MRFSS) was initiated in 1981 to collect catch, effort, and participation estimates from the recreational sector. Then in 2008, the Marine Recreational Information Program (MRIP) officially replaced MRFSS as a

more precise and accurate method for estimating recreational catch and effort. The access point angler intercept survey (APAIS) of angler catch was improved in 2013.

Indices of abundance were developed for WFL and Key-EFL for each gear type (spear, hook and line [H&L], and combined), as well as two additional scenarios identified at the data workshop, by standardizing trip-level catch-per-unit effort (defined as average catch per contributor) of hogfish using a delta-GLM approach (Lo, Jacobson, and Squire 1992; Dick 2004; Maunder and Punt 2004). A suite of co-occurring species was identified for each region and gear to serve as a proxy for favorable hogfish conditions (Shertzer and Williams 2008). An agglomerative hierarchical cluster analysis was performed for each region and gear with average linkage on the Bray-Curtis similarity measure applied to catch/abundance data for each species (i.e., total catch [landed+released] of a species per trip).

Methods of Estimation

Working Paper Number: SEDAR94-DW-17

Data Type: Fishery Dependent

Time Series: WFL Private Mode H&L 1992 – 2024; WFL H&L 1991-2024; WFL Spear 1992-2024; WFL H&L/Spear 1991-2024; Keys-EFL H&L 1991-2016; Keys-EFL H&L 1991-2024; Keys-EFL Spear 1991 – 2024; Keys-EFL H&L/Spear 1991-2024

Sampling Intensity: Table 5.8.3, Tables A1, 4, 9, 14, A6, 19, 24, and 29 in the working paper.

Size/Age Data: The interquartile range of retained lengths sampled from the APAIS program and weighted by the survey design weights (i.e., wp_size) for the WFL stock is approximately 33 cm to 41 cm fork length (FL), with a median of 36.6 cm FL. For the Keys-EFL stock, the interquartile range is approximately 30 cm to 35.5 cm, with a median of 31.3 cm.

Data Filtering Techniques: Data were limited to interviews that took place in WFL and Keys-EFL during wave 1, 1991 through wave 6, 2024. Trips were first removed if none of the species in the cluster were encountered. Trips were also removed if median hours fished, number of contributors, or median avidity were not available, or if median hours fished exceeded 24 hours. There were few positive trips in inland waters, and few reported using gears other than H&L and spear, therefore data from inland waters and other gears were removed. For WFL (H&L and

spear) and Keys-EFL (spear), shore mode was removed. Interviews that reached bag limits for hogfish were retained.

Prior to standardizing the CPUE, years with 3 or less positive or zero observations were removed to allow the estimation of year effects for both the binomial and positive submodels.

Standardization: Delta-Lognormal GLM. Explanatory variables were selected using stepwise forward selection based on a reduction in mean deviance by at least 0.5%.

Model/Submodel Variables:

WFL H&L (Private Mode):

Binomial: Presence/Absence = Year + Median hours fished

Positive Normal: log(Catch/Number of contributors) = Year + Median avidity + Median hours fished + Season

WFL H&L (Private and Charter Mode):

Binomial: Presence/Absence = Year + Number of contributors

Positive Normal: log(Catch/Number of contributor) = Year + Median avidity + Fishing mode

WFL Spear (Private and Charter Mode):

Binomial: Presence/Absence = Year + Number of contributors

Positive Normal: log(Catch/Number of contributor) = Year + Median avidity + Fishing mode

WFL H&L/Spear (Private and Charter Mode):

Binomial: Presence/Absence **=** Year + Gear + Waters fished + Season

Positive Normal: log(Catch/Number of contributor) = Year + Gear + Median avidity + Season

Keys-EFL H&L (Private, Charter, and Shore Mode):

Binomial: Presence/Absence **=** Year + Fishing mode

Positive Normal: log(Catch/Number of contributor) = Year + Fishing mode + Season + Waters fished

Keys-EFL H&L 1991 – 2016 (Private, Charter, and Shore Mode):

Binomial: Presence/Absence = Year + Number of contributors + Fishing mode

Positive Normal: log(Catch/Number of contributor) = Year + Fishing mode + Waters fished

Keys-EFL Spear (Private and Charter Mode):

Binomial: Presence/Absence = Year + Number of contributors + Waters fished

Positive Normal: log(Catch/Number of contributor) = Year + Fishing mode + Median avidity + Median hours fished

Keys-EFL H&L/Spear (Private, Charter, and Shore Mode):

Binomial: Presence/Absence = Year + Gear + Fishing mode

Positive Normal: log(Catch/Number of contributor) = Year + Fishing mode + Gear + Waters fished + Median avidity

Abundance Indices: Table 5.8.3 and Figure 5.9.2, Tables A5, 8, 13, 18, A10, 23, 28, and 33 in working paper

Uncertainty and Measures of Precision: Confidence intervals and annual means were estimated by simulating the distribution of the predicted means using 10,000 randomly generated residuals; each residual was a random normal deviate times the standard error for its predicted mean which was then added to the least squared means for the year factor in either log scale (for the positive model) or the logit scale (for the binomial model). Lastly, these estimates were back-transformed and multiplied together to estimate a distribution of the number per contributor and the distribution was described in terms of percentiles and a mean.

Comments on Adequacy for Assessment: For the West Florida Shelf stock, the H&L index for the private fishing mode (1992 – 2024) was deemed suitable and recommended for use in SEDAR 94 by the IWG for several reasons. First, the suitable and recommended fishery independent indices for this stock are only available beginning in 2006. Secondly, excluding the charter mode eliminated potential bias from a developing charter fishery in this region. However,

the H&L index for the private fishing mode shows high uncertainty (CV > .5) in some years - specifically 2001, 2004, 2006, 2012, and 2013 (Table 5.8.3).

All other recreational fishery indices were deemed suitable but not recommended, as adequate fishery-independent data exist that cover comparable temporal, spatial, and size ranges.

5.6 RESEARCH RECOMMENDATIONS

- **Evaluate the Integration of Supplemental SRFS Intercept Data:** The IWG recommends investigating the feasibility and utility of incorporating supplemental SRFS intercept data into MRIP indices of abundance to improve precision.
- **Expand Length Data Collection through REEF/SMILE:** Continue collecting additional length-frequency data via the SMILE project for consideration in future stock assessments.
- **Collect Genetic Data to Assess Stock Mixing:** Obtain genetic samples from broad-scale fishery-independent surveys (e.g., SEAMAP trawl) that encompass both the West Florida Shelf (WFS) and the Keys-East Florida (Keys-EFL) stocks to evaluate mixing rates between the two.
- **Assess Environmental Stressors:** Investigate the impacts of seagrass habitat decline in the Indian River Lagoon and the effects of red tide events on Hogfish population dynamics and distribution.
- **Develop a Juvenile Abundance Survey in the Keys-EFL Region:** Design and implement a fishery-independent survey targeting juvenile Hogfish to generate indices of abundance for the Keys-EFL stock, addressing a current data gap in early life history stages.
- **Examine Migration Patterns:** Study the seasonal and spatial timing of inshore and offshore migrations to better understand life history patterns and inform management strategies.

5.7 LITERATURE CITED

Bodenhofer U., Kothmeier A., Hochreiter S., 2011. APCluster: an R package for affinity Propagation clustering, Bioinformatics, 27(17): 2463-2464. https://doi.org/10.1093/bioinformatics/btr406

Dick E.J., 2004. Beyond 'lognormal versus gamma': discrimination among error distributions for generalized linear models. *Fisheries Research*, 70(2-3):351-366. https://doi.org/10.1016/j.fishres.2004.08.013.

Frey B.J. and Dueck D. 2007. Clustering by passing messages between data points. *Science* 315: 972-976. https://doi: 10.1126/science.1136800

Greenberg D.A., Pattengill-Semmens C.V., and Semmens B.X. 2024. Assessing the value of citizen scientist observations in tracking the abundance of marine fishes. *Conservation Letters* 2024:17:e13009. https://doi.org/10.1111/conl.13009

Lo N.C.H., Jacobson L.D., and Squire J.L. 1992. Indices of relative abundance from fish spotter data based on delta-lognormal models. *Canadian Journal of Fisheries and Aquatic Sciences*. 49: 2515-2526. https://doi.org/10.1139/f92-278

Maunder M.N., and Punt A.E. 2004. Standardizing catch and effort data: a review of recent approaches. *Fisheries Research* 70:141-159. https:// doi:10.1016/j.fishres.2004.08.002

R Core Team. 2025. R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria. <https://www.R-project.org/>.

Shertzer K.W., and Williams E.H, 2008. Fish assemblages and indicator species: reef fishes off the southeastern United States. *Fisheries Bulletin* 106: 257-269.

5.8 TABLES

5.8.1 Indices of abundance considered for inclusion in the assessment for the West Florida Shelf region.

Recommended	Not Recommended
FWRI Seagrass Trawl Survey (1996-2024)	Southeastern U.S. commercial spear fishery (1993-2024)
MRIP Private Mode Hook & Line (1992-2024)	Florida Trip Ticket Spear (1994-2017)
	Florida Trip Ticket Hook and Line (1994-2017)
FWRI-SEAMAP Groundfish Trawl (2010-2023)	MRIP Spear (1992-2024)
Combined Stereo Video Survey (2006-2023)	MRIP Spear and Hook & Line Combined (1991-2024)

5.8.2 Indices of abundance considered for inclusion in the assessment for the Florida Keys/East Florida region.

Recommended	Not Recommended
Combined Stereo Video Survey (1993-2023)	Southeast Reef Fish Survey (2011-2023)
RVC Southeast Florida (2013-2024)	Southeastern U.S. commercial spear fishery (1993-2024)
RVC Florida Keys (1997-2024)	Florida Trip Ticket Spear (1994-2017)
RVC Dry Tortugas (1999-2024)	Florida Trip Ticket Hook and Line (1994-2017)
	MRIP Hook & Line (1992-2016)
	MRIP Spear (1991-2024)
	MRIP Spear and Hook & Line Combined (1991-2024)
	REEF/RVC (1994-2023)
	Southern Indian River Lagoon Seine Index

Table 5.8.3 Sampling effort (N), proportion positive (Prop Pos), relative abundance (Std Index) scaled to a mean of one for each time series and the coefficient of variation on the mean (CV, standard error/mean) of indices deemed "Suitable and Recommended" for SEDAR 94 for the West Florida Shelf.

	SEAMAP Trawl (FI)				Combined Stereo Video Survey (FI)				Seagrass Trawl (FI)			
Year	**N**	**Prop Pos**	**Std Index**	**CV**	**N**	**Prop Pos**	**Std Index**	**CV**	**N**	**Prop Pos**	**Std Index**	**CV**
1992												
1993												
1994												
1995												
1996												
1997												
1998												
1999												
2000												
2001												
2002												
2003												
2004												
2005												
2006					27	0.105	0.8464	0.2055				
2007					24	0.113	1.8874	0.2454				
2008					39	0.200	1.6552	0.1797	98	0.480	2.060	0.129
2009					46	0.180	1.4934	0.1716	100	0.200	0.718	0.245
2010	125	0.240	0.828	0.286	34	0.114	0.7293	0.2453	100	0.170	0.526	0.231
2011	58	0.155	0.423	0.474	63	0.112	0.8610	0.1630	100	0.290	0.888	0.166
2012	121	0.298	0.955	0.264	62	0.116	1.1396	0.1373	100	0.470	2.736	0.113
2013	87	0.184	0.506	0.369	25	0.065	0.8495	0.2178	100	0.040	0.182	0.386
2014	150	0.160	0.376	0.278	37	0.058	0.6009	0.1574	100	0.020	0.047	0.761
2015	146	0.178	0.608	0.253	33	0.056	0.6919	0.1813	100	0.070	0.227	0.368
2016	77	0.143	0.513	0.397	58	0.070	0.7334	0.1336	100	0.170	0.459	0.226
2017	103	0.213	0.714	0.299	78	0.100	0.6645	0.1115	100	0.230	0.629	0.204
2018	111	0.144	0.390	0.313	71	0.095	0.8273	0.1198	100	0.400	2.301	0.126
2019	96	0.250	1.329	0.296	54	0.061	0.7440	0.1550	150	0.140	0.355	0.204
2020	37	0.324	1.488	0.481	59	0.107	1.0802	0.1199	75	0.227	1.028	0.216
2021	69	0.217	0.805	0.389	62	0.083	0.8874	0.1247	150	0.540	3.393	0.081
2022	79	0.228	1.108	0.313	73	0.094	1.0443	0.1180	150	0.080	0.204	0.241
2023	103	0.262	3.043	0.269	65	0.089	1.2643	0.1163	150	0.287	1.028	0.141
2024	110	0.282	1.916	0.262					150	0.073	0.221	0.302

Table 5.8.3 (continued).

Sampling effort (N), proportion positive (Prop Pos), relative abundance (Std Index) scaled to a mean of one for each time series and the coefficient of variation on the mean (CV, standard error/mean) of indices deemed "Suitable and Recommended" for SEDAR 94 for the West Florida Shelf.

	MRIP Private Mode Hook & Line (FD)			
Year	N	Prop Pos	Std Index	CV
1992	23	0.391	0.842	0.428
1993	18	0.444	1.438	0.435
1994	26	0.385	0.769	0.397
1995	26	0.538	1.701	0.316
1996	15	0.6	1.996	0.408
1997	21	0.524	1.571	0.368
1998	11	0.545	1.178	0.482
1999	27	0.333	0.566	0.418
2000	21	0.429	1.07	0.39
2001	37	0.162	0.382	0.556
2002	42	0.19	0.379	0.467
2003	49	0.306	0.869	0.325
2004	18	0.167	0.523	0.859
2005	20	0.35	0.718	0.48
2006	13	0.308	0.615	0.642
2007				
2008	19	0.526	2.034	0.365
2009	24	0.458	0.97	0.361
2010	15	0.733	2.662	0.317
2011	27	0.333	0.978	0.425
2012	24	0.208	0.766	0.618
2013	40	0.175	0.439	0.506
2014	57	0.263	0.788	0.332
2015	57	0.211	0.422	0.378
2016	59	0.271	1.322	0.314
2017	73	0.315	0.658	0.269
2018	46	0.174	0.523	0.469
2019	46	0.283	0.682	0.349
2020	42	0.286	0.599	0.367
2021	31	0.29	0.775	0.426
2022	27	0.37	1.127	0.391
2023	41	0.415	1.276	0.282
2024	44	0.455	1.365	0.268

Table 5.8.4 Sampling effort (N), proportion positive (Prop Pos), relative abundance (Std Index) scaled to a mean of one for each time series and the coefficient of variation on the mean (CV, standard error/mean) of indices deemed "Suitable and Recommended" for SEDAR 94 for the Florida Keys/East Florida region.

	Combined Stereo Video Survey (FI)				RVC Dry Tortugas (FI)			
Year	**N**	**Prop Pos**	**Std Index**	**CV**	**N**	**Prop Pos**	**Std Index**	**CV**
1993	14	0.500	1.895	0.354				
1994	21	0.095	1.474	0.524				
1995	14	0.357	1.587	0.398				
1996	34	0.176	1.032	0.391				
1997	33	0.273	0.951	0.326				
1998								
1999					312	0.462	1.133	0.084
2000					344	0.424	0.834	0.088
2001								
2002	34	0.235	1.571	0.561				
2003								
2004	26	0.154	0.702	0.458	572	0.406	0.855	0.072
2005	58	0.121	0.967	0.368				
2006	57	0.123	0.786	0.363	482	0.359	0.577	0.084
2007	79	0.114	0.650	0.346				
2008	55	0.036	0.354	0.584	653	0.389	0.791	0.07
2009	69	0.058	0.416	0.453				
2010	66	0.106	0.675	0.361	687	0.434	0.834	0.063
2011	75	0.147	1.460	0.255				
2012	79	0.101	0.800	0.316	716	0.535	1.133	0.053
2013								
2014	38	0.158	0.769	0.419	692	0.448	0.813	0.062
2015								
2016	136	0.110	0.721	0.233	511	0.423	0.791	0.075
2017	149	0.094	0.504	0.289				
2018	166	0.127	0.777	0.217	640	0.553	1.112	0.053
2019	175	0.200	0.944	0.165				
2020	145	0.303	1.157	0.149				
2021	147	0.245	1.281	0.157	292	0.562	1.390	0.077
2022	135	0.230	1.252	0.172				
2023	123	0.260	1.276	0.178	299	0.635	1.518	0.07
2024					179	0.615	1.219	0.089

Table 5.8.4 (continued). Sampling effort (N), proportion positive (Prop Pos), relative abundance (Std Index) scaled to a mean of one for each time series and the coefficient of variation on the

mean (CV, standard error/mean) of indices deemed "Suitable and Recommended" for SEDAR 94 for the Florida Keys/East Florida region.

	RVC FL Keys (FI)				RVC SE FL (FI)			
Year	**N**	**Prop Pos**	**Std Index**	**CV**	**N**	**Prop Pos**	**Std Index**	**CV**
1993								
1994								
1995								
1996								
1997	288	0.219	0.201	0.176				
1998	213	0.211	0.201	0.217				
1999	344	0.259	0.331	0.136				
2000	393	0.402	0.639	0.095				
2001	587	0.363	0.710	0.077				
2002	410	0.554	0.876	0.076				
2003	356	0.551	1.030	0.075				
2004	187	0.604	1.148	0.095				
2005	443	0.551	1.018	0.069				
2006	441	0.478	0.888	0.074				
2007	571	0.581	0.983	0.06				
2008	612	0.670	1.527	0.048				
2009	909	0.608	1.089	0.046				
2010	494	0.575	0.864	0.068				
2011	693	0.603	0.935	0.054				
2012	620	0.684	1.148	0.052				
2013					1050	0.293	0.733	0.130
2014	579	0.589	1.432	0.052	565	0.283	0.489	0.155
2015					417	0.245	0.611	0.177
2016	526	0.603	1.681	0.054	462	0.314	0.672	0.155
2017								
2018	600	0.678	1.255	0.05	458	0.402	1.466	0.137
2019								
2020								
2021					283	0.336	0.916	0.172
2022	201	0.562	1.018	0.103	293	0.399	1.099	0.158
2023								
2024	249		2.024	0.074	281	0.470	2.015	0.149

5.9 FIGURES

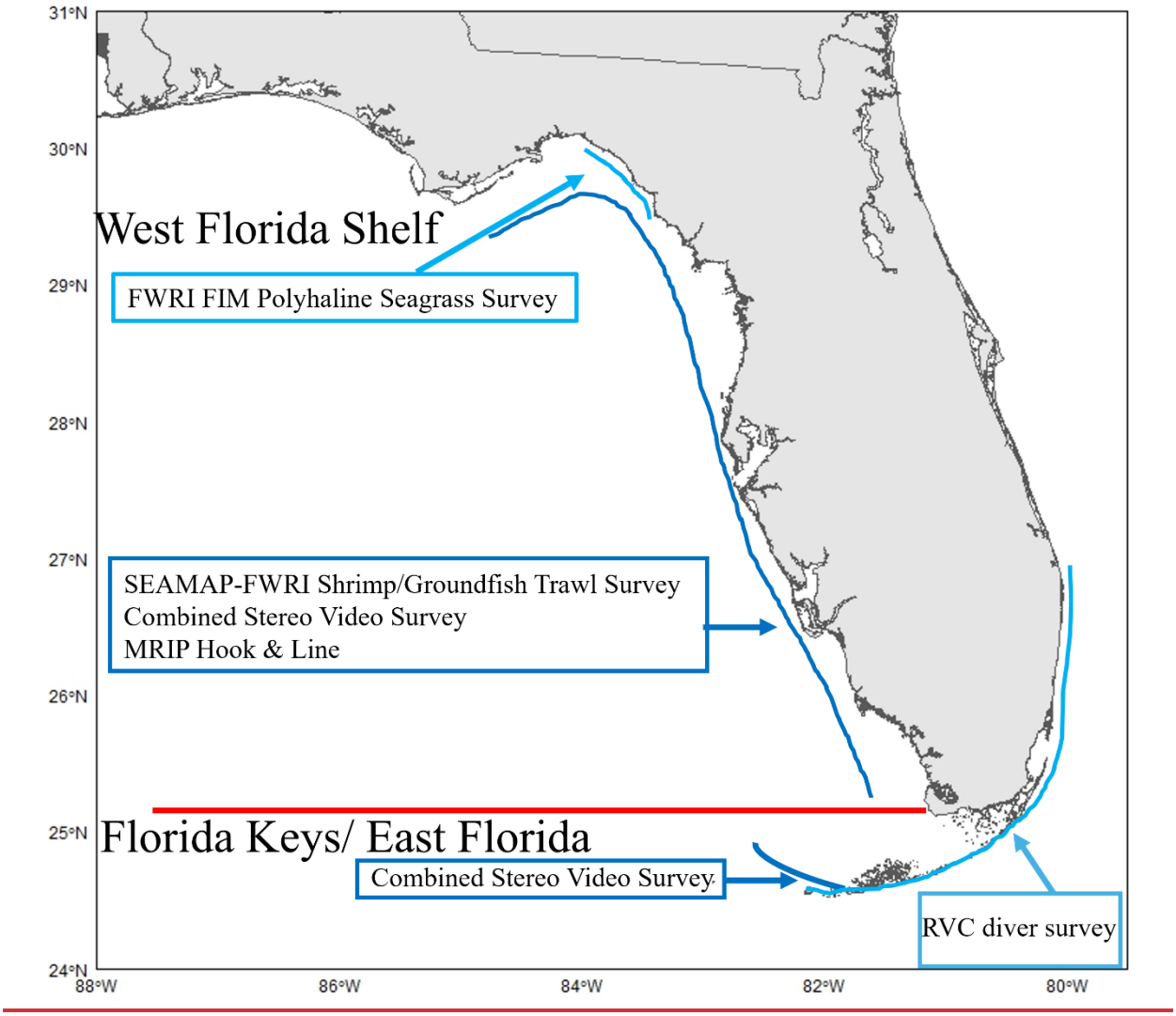


Figure 5.9.1 Relative spatial extent of indices found to be "Suitable and Recommended" for use in SEDAR 94. Red line represents the boundary between the West Florida Shelf and the Florida Keys/ East Florida.

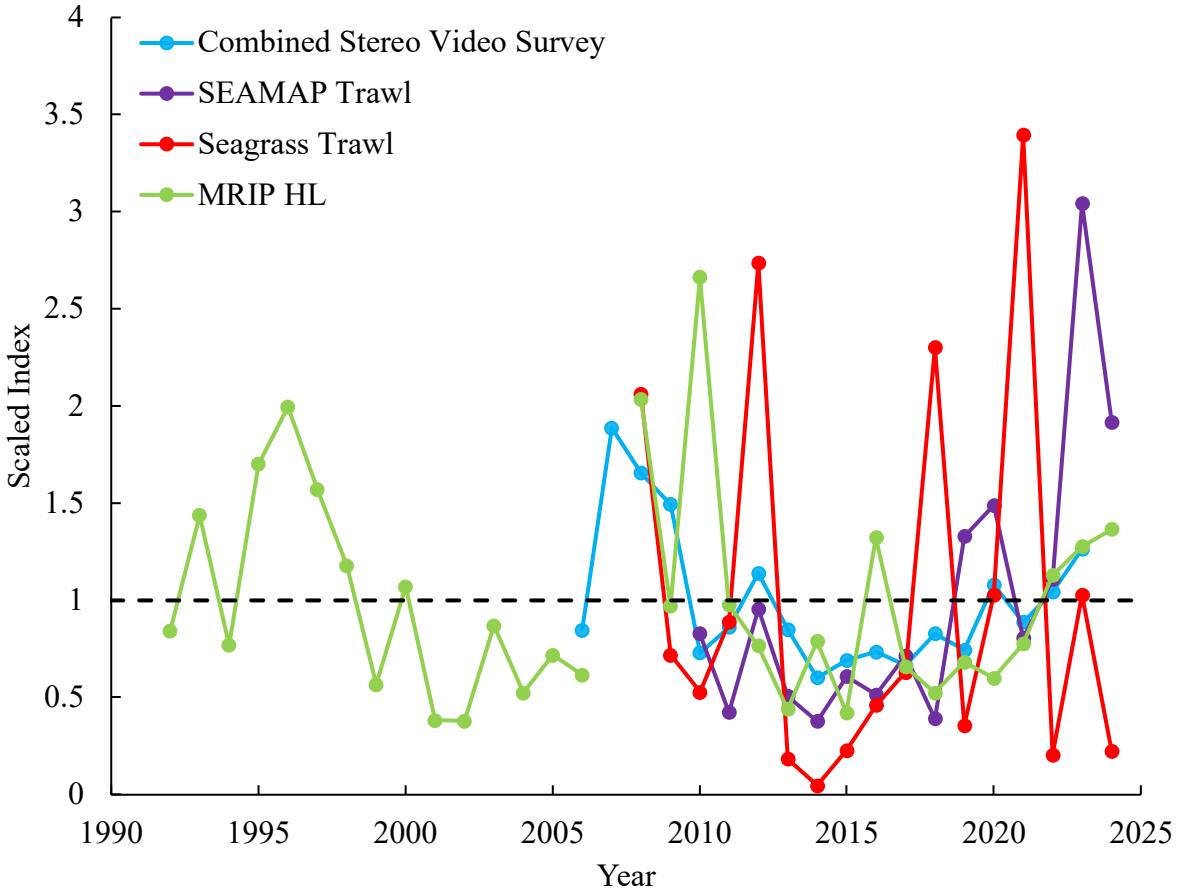


Figure 5.9.2 Relative indices of abundance found to be "Suitable and Recommended" for use in SEDAR 94 in the West Florida Shelf scaled to a mean of one for each time series.

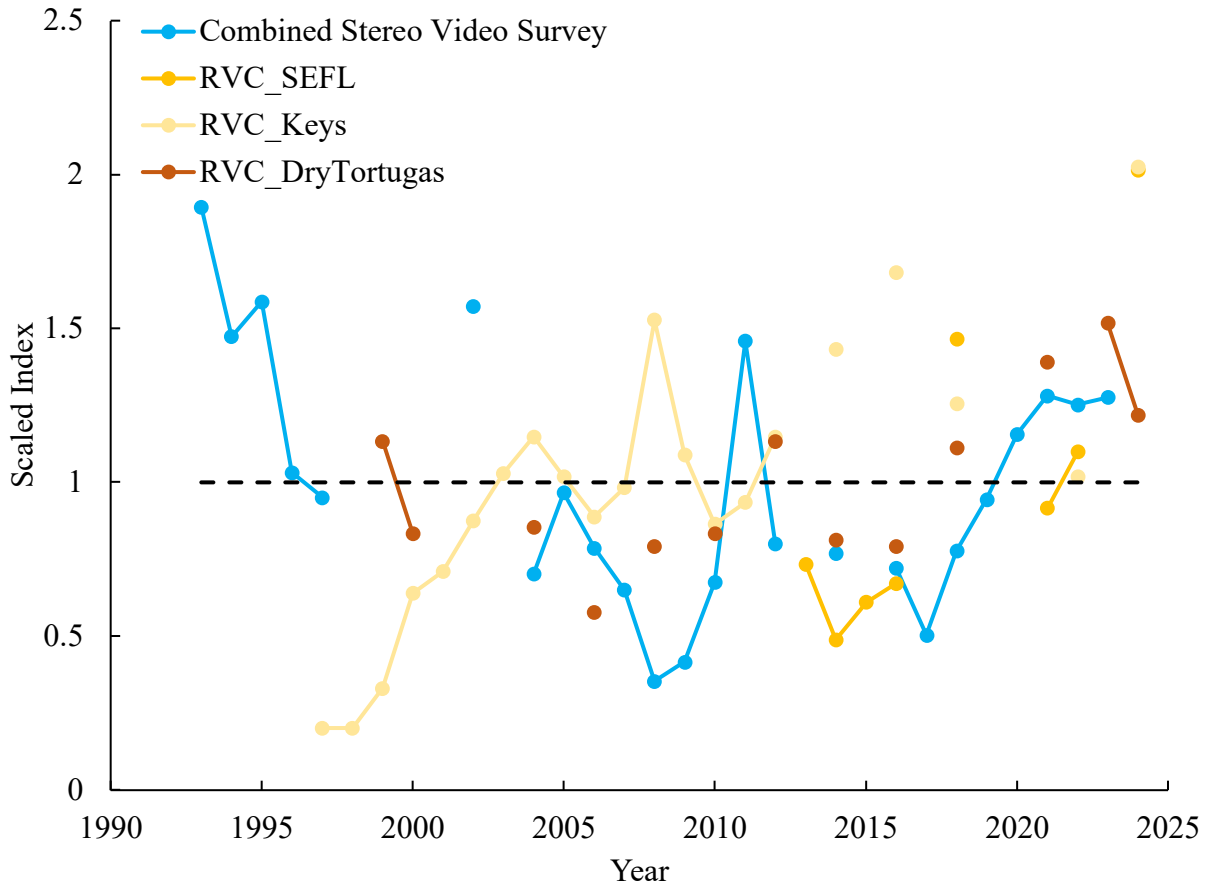


Figure 5.9.3 Relative indices of abundance found to be "Suitable and Recommended" for use in SEDAR 94 in the Florida Keys/East Florida scaled to a mean of one for each time series.

SEDAR

Southeast Data, Assessment, and Review

SEDAR 94

Florida Hogfish

SECTION III: Assessment Report

June 2026

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

This information is distributed solely for the purpose of peer review. It does not represent and should not be construed to represent any agency determination or policy.

Table of Contents

Table of Contents....2
1 Introduction....5
1.1 Workshop Times and Places....5
1.2 Terms of Reference....5
1.3 List of Participants....7
1.4 List of Working Papers and Reference Documents....8
2 Stock Synthesis Model Configurations....8
2.1 Overview....8
2.2 Life History....9
2.3 Fleet and Survey Configuration....10
2.3.1 Commercial....10
2.3.2 Recreational....10
2.3.3 Indices....12
2.3.4 Length Composition Data....13
2.3.5 Conditional Age-at-Length Data....13
2.4 Initial Conditions....14
2.5 Spatio-Temporal Structure....14
2.6 Recruitment Dynamics....15
2.7 Fishing Mortality....15
2.8 Catchability....16
2.9 Selectivity....16
2.9.1 Retention....17
2.9.2 Discards....17
2.10 Maximum Likelihood and Error Structure....18
2.11 Super-Periods and Data Weighting....18
2.12 Model Diagnostics....19
2.12.1 Convergence....19
2.12.2 Goodness of fit....20
2.12.3 Model Consistency....20
2.12.4 Model Validation (Prediction Skill)....21
2.12.5 Sensitivity Runs....21
2.13 Per-recruit Analyses....22
2.14 Uncertainty in Parameters and Derived Quantities....23
2.14.1 MCMC....23

2.14.2 Parametric Bootstrap 24
2.15 Bridge Building 25
3 FL KEYS/EFL Stock Synthesis Model Results 25
3.1 Life History 25
3.2 Landings and Discards 26
3.3 Indices 26
3.4 Length and Age Composition 26
3.4.1 Data Weighting 26
3.4.2 Length Composition 27
3.4.3 Conditional Age-at-Length 28
3.5 Estimated Parameters and Derived Quantities 28
3.5.1 Stock Biomass (Total and Spawning) 29
3.5.2 Recruitment 29
3.5.3 Fishing Mortality 29
3.5.4 Selectivity and Retention 30
3.6 Model Diagnostics 31
3.6.1 Convergence 31
3.6.2 Goodness of fit 31
3.6.3 Model Consistency 32
3.6.4 Model Validation (Prediction Skill) 33
3.6.5 Sensitivity Runs 33
3.7 Per-recruit Analyses 35
3.8 Uncertainty in Parameters and Derived Quantities 35
3.8.1 MCMC Analysis 35
3.8.2 Parametric Bootstrap 35
3.9 Stock Status Determination Criteria 36
3.10 Bridge Building 37
3.11 FL KEYS/EFL Discussion 37
3.12 FL KEYS/EFL Projections 41
3.12.1 Results 42
3.12.2 Discussion 43
3.13 FL KEYS/EFL Tables 45
3.14 FL KEYS/EFL Figures 74
4 WFS Stock Synthesis Model Results 140
4.1 Life History 140

4.2 Landings and Discards 140
4.3 Indices 140
4.4 Length and Age Composition 141
4.4.1 Data Weighting 141
4.4.2 Length Composition 141
4.4.3 Conditional Age-at-Length 142
4.5 Estimated Parameters and Derived Quantities 142
4.5.1 Stock Biomass (Total and Spawning) 143
4.5.2 Recruitment 143
4.5.3 Fishing Mortality 143
4.5.4 Selectivity and Retention 144
4.6 Model Diagnostics 144
4.6.1 Convergence 144
4.6.2 Goodness of fit 145
4.6.3 Model Consistency 145
4.6.4 Model Validation (Prediction Skill) 146
4.6.5 Sensitivity Runs 147
4.7 Per-recruit Analyses 147
4.8 Uncertainty in Parameters and Derived Quantities 148
4.8.1 MCMC Analysis 148
4.8.2 Parametric Bootstrap 148
4.9 Stock Status Determination Criteria 148
4.10 Bridge Building 149
4.11 WFS Discussion 150
4.12 WFS Projections 152
4.12.1 Results 152
4.12.2 Discussion 153
4.13 WFS Tables 154
4.14 WFS Figures 174
5 Literature Cited 234

1 Introduction

A benchmark assessment was conducted for Florida Hogfish which effectively served as two independent stock assessments within Florida waters: the Florida Keys/East Florida stock and the West Florida Shelf stock. Assessment models were constructed within the Stock Synthesis integrated modeling framework in version 3.30.24.1 (Methot and Wetzel 2013). This assessment renewed all available data streams from SEDAR 37 (2014) and the SEDAR 37U (2018) update assessment for the West Florida Shelf, provided and recommended measures of stock status according to each stock's management jurisdiction, and provided projections of spawning stock biomass, recruitment, and retained yield to inform the Acceptable Biological Catch (ABC) and the Annual Catch Limit (ACL) for each stock.

1.1 Workshop Times and Places

SEDAR 94 addressed two stock assessments for Hogfish in Florida waters, the Florida Keys/East Florida stock and the West Florida Shelf stock, and was provided by the State of Florida's Fish and Wildlife Research Institute (FWRI) with assistance from numerous state and federal collaborators. A series of four Assessment Workshop webinars were convened by SEDAR between December 2025 and April 2026.

1.2 Terms of Reference

1) Review any changes in data and data sources following the data workshop and any analyses suggested by the data workshop. Summarize data as used in each assessment model. Provide justification for any deviations from Data Workshop recommendations.
2) Develop population assessment models that are compatible with available data and document input data, model assumptions and configuration, and equations for each model considered.
    a) Fully document and describe the impacts (on population parameters and management benchmarks) of any changes to the model structure, methods, application or fitting procedures made between this assessment and both the prior benchmark (SEDAR 37) and update (SEDAR 37U) assessments.
    b) Provide a continuity model consistent with the prior benchmark (SEDAR 37) and update (SEDAR 37U) assessment configurations, if one exists, updated to include the most recent observations. Alternative approaches to a strict continuity run that distinguish between model, population, and input data influences on findings, may be considered. Provide additional continuity models which update these prior assessment's configurations and terminal years with MRIP-FES landings and discards.
3) Provide estimates of stock population parameters, if feasible:
    a) Include fishing mortality, abundance, biomass, selectivity, stock-recruitment relationship (if applicable), and other parameters as necessary to describe the population.
    b) Include appropriate and representative measures of precision for parameter estimates.
    c) Compare and contrast population parameters and time series estimated in this assessment with values from the previous benchmark (SEDAR 37) and update (SEDAR 37U) assessments, and comment on the impacts of changes in data, assumptions or assessment methods on estimated population conditions.
4) Characterize uncertainty in the assessment and estimated values.
    a) Consider uncertainty in input data, modeling approach, and model configuration.
    b) Consider and include other sources as appropriate for this assessment.
    c) Provide appropriate measures of model performance, reliability, and 'goodness of fit'.
    d) Provide measures of uncertainty for estimated parameters.
5) Provide estimates of yield and productivity.
    a) Include yield-per-recruit, spawner-per-recruit, and stock-recruitment models.
6) Provide estimates of population benchmarks or management criteria consistent with available data, applicable FMPs, proposed FMPs and Amendments, other ongoing or proposed management

programs, and National Standards. Include values for fishing mortality (including assumed discard mortality if appropriate), spawning stock biomass, fishery yield, SPR and recruitment for potential population benchmarks.

a) Evaluate existing or proposed management criteria as specified in the management summary.
b) Review and provide recommendations for proxy values (e.g. MSY) when necessary, and provide appropriate justifications.
c) Compare and contrast reference values (e.g. equilibrium yield at $F_{MSYProxy}$) estimated in this assessment with values from the previous benchmark (SEDAR 37) and update (SEDAR 37U) assessments, and comment on the impacts of changes in data, assumptions or assessment methods on reference point differences.
d) Define recent fishing mortality rates ($F_{Current}$) and recent spawning stock biomass ($SSB_{Current}$) that will be compared to management benchmarks to determine management benchmarks as the geometric mean of the most recent three years and the terminal data year, respectively.

7) Incorporate known applicable environmental covariates into the selected model, and provide justification for why any of those covariates cannot be included at the time of the assessment.
8) Provide declarations of stock status relative to management benchmarks or alternative data poor approaches if necessary.
9) Provide uncertainty distributions of proposed reference points, stock status, and yield.
   a) Provide the probability of overfishing at various harvest or exploitation levels.
   b) Provide a probability density function for biological reference point estimates.
   c) If the stock is overfished, provide the probability of rebuilding within mandated time periods as described in the management summary or applicable federal regulations.
   d) Characterize the differences in fishing mortality, virgin biomass, terminal total biomass, terminal spawning stock biomass, and equilibrium yield at $F_{MSYProxy}$ as a result of updating recreational catch and effort data from MRIP-CHTS to MRIP-FES by comparing SEDAR 37U to a continuity model with MRIP-FES landings and discards and SEDAR 37U configuration and terminal year.
10) Project future stock conditions (biomass, abundance, and exploitation) and develop rebuilding schedules if warranted; include estimated generation time.
   a) Request estimates of retained landings in numbers and biomass from data providers for interim years between the terminal year and first year of the projections, if available, to be used to project future stock conditions. If estimates of retained landings are unavailable, use the average of the previous three years.
   b) Follow SAFMC Catch Level Projections Recommendations for Florida Keys-East Florida Stock.
   c) Recommend levels of recruitment to be used in the projections.
   d) Stock projections (including yields) shall be developed in accordance with the following ($F_{Current}$ is the geometric mean of the most recent three years of data):
      i) If stock is overfished:
         $F=0$, $F_{Current}$, $F=F_{MSY}$, F at 75% of F_{MSY}, F_{OY})
         $F=F_{Rebuild}$ (per Magnuson-Stevens Act)
      ii) If overfishing is occurring:
         $F=F_{Current}$, $F=F_{MSY}$, F at 75% of F_{MSY}, F_{OY}
      iii) If stock is neither overfished nor undergoing overfishing:
         $F=F_{Current}$, $F=F_{MSY}$, F at 75% of F_{MSY}, F_{OY}
      iv) If data limitations preclude classic projections (i.e. A, B, C above), explore alternative models to provide management advice.
      v) If an alternative proxy for F_{MSY} is recommended, provide outputs for both the current and recommended proxies.
11) Provide recommendations for future research and data collection.
   a) Be as specific as practicable in describing sampling design and sampling intensity.
   b) Emphasize items that will improve future assessment capabilities and reliability.
   c) Consider data, monitoring, and assessment needs.

12) Review, evaluate, and report on the status and progress of all research recommendations listed in the last assessment, peer review reports, and SSC report concerning this stock.
13) Complete the Assessment Workshop Report in accordance with project schedule deadlines (Section III of the SEDAR Stock Assessment Report).

1.3 List of Participants

Assessment Team

Chris Swanson ..... USF/FWC
Dustin Addis ..... FWC
Heather Christiansen ..... FWC/FWRI

Assessment Process Participants

Luiz Barbieri ..... GFMC SSC/FWC-FWRI
Genny Nesslage ..... SAFMC SSC/CBL
Steve Saul ..... GFMC SSC/ASU
Steve Turner ..... SAFMC SSC

Assessment Process Webinar Observers

Shanae Allen ..... FWC/FWRI
Jordan Bajema ..... FWC
Alena Figueroa ..... FWC
Jeanette Huber ..... FWC
K W .....
Daniel Luers ..... NOAA
Rich Malinowski ..... NMFS
Robert Muller ..... FWC/FWRI
Halie O'Farrell ..... FWC/FWRI
Ed Walker .....
Sabrine Zemik .....

Staff

Julie Neer ..... SEDAR
Chip Collier ..... SAFMC Staff
Judd Curtis ..... SAFMC Staff
Leonardo Eguia ..... GFMC Staff
Sarah Gardiner ..... GFMC Staff
Lisa Hollensead ..... GFMC Staff
Emily Ott ..... SEDAR
Ryan Rindone ..... GFMC Staff

1.4 List of Working Papers and Reference Documents

Document #	Title	Authors	Date Submitted
Documents Prepared for the Assessment Process			
SEDAR94-AP-01	A Unified Reef Visual Census (RVC) and REEF Citizen Science Index	Brice X. Semmens and Dan A. Greenberg	26 March 2026
SEDAR94-AP-02	Weighted Length Compositions for Recreational FL Keys-EFL Hogfish Landings Using MRIP, Biscayne National Park Creel Survey, and Headboat Data	Shanae D. Allen	15 May 2026

2 Stock Synthesis Model Configurations

2.1 Overview

The base models for the SEDAR 94 Florida Hogfish stock assessment of the Florida Keys/East Florida stock (hereafter, 'KEYS base model') and the West Florida Shelf stock (hereafter, 'WFS base model') were developed in Stock Synthesis (SS) version 3.30.24.1. Stock Synthesis is an age- and size-structured assessment model in the integrated analysis class of models. It has 1) a population sub-model that simulates growth, maturity, fecundity, recruitment, movement, and mortality processes, 2) an observation sub-model which predicts values for the input data, 3) a statistical sub-model which characterizes goodness of fit and obtains best-fitting parameters and their associated variance, and 4) a forecast sub-model which projects various user-determined management quantities (Methot et al. 2026). Further descriptions of SS options, equations, and algorithms can be found in the SS user's manual (Methot et al. 2026), the NOAA Fisheries Toolbox website (http://nft.nefsc.noaa.gov/), and Methot and Wetzel (2013).

The KEYS base model was of moderate complexity and informed by two fishing fleets (including landings, discards, compositional landings-at-length, and compositional discards-at-length where available), three fishery-independent indices of relative abundance (including length compositions), and two fishery-independent CAAL data that were not associated with any fleet or survey. The data sources and their corresponding temporal scale are presented in Figure 3.1. The KEYS base model estimated 165 out of 272 parameters including, but not limited to, growth parameters (asymptotic length [L_{inf}], von Bertalanffy growth coefficient [k], and the reference length for the start of von Bertalanffy growth [L_{min}]), virgin recruitment (*ln(R0)*), *steepness*, variability in recruitment (*sigmaR*), time-varying stock-recruit deviations, fishing mortality rates for each fleet and year that it was operational, and length-based selectivity parameters for fleets, landings, discards, retention and indices with length composition data. Model-derived estimates include maximum sustainable yield (MSY), MSY-proxy reference points (e.g., $F_{30\%SPR}$ and $F_{40\%SPR}$), and a full time series of population abundance-at-age (units: 1,000s of fish) and biomass (female plus male spawning stock biomass, total, and exploitable in metric tons). The 'r4ss' (Taylor et al. 2021) and 'ss3diags' (Carvalho et al. 2021) R software packages were utilized extensively to summarize and plot model outputs and perform diagnostic tests.

The WFS base model was of fair to moderate complexity and informed by three fishing fleets (including landings, discards, compositional landings-at-length, and compositional discards-at-length where available), three fishery-independent indices of relative abundance (including length and age compositions where available), and two fishery-independent CAAL data that were not associated with any fleet or survey. The data sources and their corresponding temporal scale are presented in Figure 4.1. The WFS base model estimated 87 out of 124 parameters including, but not limited to, growth parameters (asymptotic length [L_{inf}], von Bertalanffy growth coefficient [k], and the reference length for the start of von Bertalanffy growth [L_{min}]), virgin recruitment (*ln(R0)*), variability in recruitment (*sigmaR*), time-varying stock-recruit deviations, and length-based selectivity parameters for fleets, landings, discards, retention and indices with length composition data. Model-derived estimates include MSY-proxy reference points (e.g., $F_{30\%SPR}$) and a full time series of population abundance-at-age (units: 1,000s of fish), biomass (female plus male spawning stock biomass, total, and exploitable in metric tons), and fishing mortality rates for each fleet and year that it was operational.

2.2 Life History

Growth was estimated within SS according to the von Bertalanffy growth function where initial values for the asymptotic length (L_{inf}), the von Bertalanffy growth coefficient (k), and the CV as a function of length-at-age were based on the results of the external size-truncated model conducted during the Data Workshop (see Section 2.6.5 in the Data Workshop Report). The L_{max} parameter in SS was specified as equivalent to L_{inf}. The CV parameter was used in SS to describe the variability in length-at-age for the minimum (CV_{young}) and the maximum (CV_{old}) observed ages. Growth was initially configured such that fish grew according to the von Bertalanffy growth model immediately upon 'settlement' at age-0 (A_{min}) beginning at a length of 2 cm (L_{min}), but L_{min} was freely estimated.

The platoons feature within SS was also utilized to help account for "Lee's phenomenon" (Rosa Lee 1912), where the removal of faster growing individuals at a higher rate than slower growing ones leaves behind a population cumulatively comprised of slower growing individuals in the cohorts (McBride and Richardson 2007, Kraak et al. 2019). For the KEYS base model, total recruitment was divided into 5 platoons where the distribution among platoons approximated a normal distribution (0.031, 0.237, 0.464, 0.237, 0.031). In the WFS base model, total recruitment was divided into 3 growth platoons where the distribution among platoons also approximated a normal distribution (0.15, 0.70, 0.15). In both models, the parameter controlling the within/between standard deviation ratio was estimated. As a 'rule of thumb', ratio values below 0.5 were considered to have produced unrealistic distributions of mean size-at-age while ratios above 2.0 indicated no meaningful shift in mean size-at-age (R. Methot, *pers. comm*.).

In the KEYS base model, natural mortality followed the Lorenzen (1996) formulation (see Section 2.7.2 in Data Workshop Report) and the natural mortality-at-age vector was treated as a fixed input. The WFS base model utilized the Lorenzen option within SS where the Hamel and Cope (2022) longevity-based estimate of constant M (0.235 yr^{-1}; see Section 2.7.2 in Data Workshop Report) was treated as a fixed input for the natural mortality parameter across ages 3 – 23. Both models assumed natural mortality-at-age was constant over time.

Both models were configured with two genders to account for the reproductive biology of Hogfish as protogynous hermaphrodites (female at birth, then a portion of the population transitions to male). Thus, it was assumed that the sex-ratio at birth was 100% female. Immature females transitioned to mature females based on fixed stock-specific logistic functions of age (see section 2.8.2 in Data Workshop Report), and mature females transitioned to mature males based on fixed stock-specific cumulative normal distribution functions of length (see section 2.8.3 in Data Workshop Report). Given the

uncertainty of sperm limitation for this species, spawning stock biomass was modeled using the mature biomass of both females and males (Brooks et al. 2008). A fixed length-weight relationship ($w = a*L^b$) was used to convert body length (cm) to body weight (kg) with parameters $a = 2.55e^{-5}$; b = 2.9273 for both stocks as analyses conducted during the Data Workshop revealed no stock-specific differences for this relationship. Fecundity was configured as eggs/kg on body weight ($eggs = a * wt^b$) and parameterized such that the number of eggs was equivalent to spawning biomass by fixing $a = 1$ and $b = 1$ (see Section 2.8.4 in Data Workshop Report).

2.3 Fleet and Survey Configuration

The fleet configurations within each base model were informed by the amount of available length and age composition data, observed differences in sampled lengths and ages, uncertainty in the landings and discards, workgroup recommendations from the Data Workshop, and AW panel discussions.

2.3.1 Commercial

Commercial landings of Florida Hogfish from 1927 – 2024 were obtained from Florida's Marine Fisheries Trip Ticket and NOAA Fisheries' Accumulated Landings System (ALS) and were reviewed by the Data Workshop and recommended for use within each stock's assessment model. Although historical estimates (1927 – 1985) were considered highly uncertain, their lowest estimated precision (CV = 0.25 for 1927 – 1961) was still more precise than most annual recreational landings estimates (CV > 0.3; see Section 4.3 of the Data Workshop Report). Commercial landings were predominantly from spear, hook-and-line, and trap gears (see Section 3.3 of the Data Workshop Report) and are presented in Tables 3.1 – 4 and Figures 3.2 – 3 for years 1950 – 2024 for the Florida Keys/East Florida stock and Tables 4.1 – 4 and Figures 4.2 – 3 for years 1950 – 2024 for the West Florida Shelf stock.

Annual sample sizes for length and CAAL composition data by commercial gear type were also limited and highly variable. Given the relatively small contribution of the commercial sector and the sparse, noisy sampling data, the AW panel determined that, for each stock, aggregating all commercial gears into a single fleet was the most parsimonious modeling approach. This differed from SEDAR 37, which modeled spear, hook-and-line, and trap gears as separate commercial fleets for each stock.

No commercial discards were available for model inclusion in either stock (see Section 3.4 in the Data Workshop Report).

2.3.2 Recreational

Estimates of recreational landings and discards of Hogfish from 1981 – 2024 by anglers using private, rental boats, or charter boats came from the Marine Recreational Information Program (MRIP) and Florida's State Reef Fish Survey (SRFS). The 'Full SRFS' estimates, which were comprised of SRFS (2021 – 2024) and the SRFS ratio-calibrated private mode (1981 – 2020), MRIP charter mode, and MRIP shore mode (see Sections 4.3 and 4.4 in the Data Workshop Report) were reviewed by the Data Workshop and determined for use rather than the MRIP estimates. Estimates from the Southeast Region Headboat Survey (SRHS) were also available and recommended for use by the Data Workshop from 1981 – 2024 for the Florida Keys/East Florida stock and from 1986 – 2024 for the West Florida Shelf stock.

Recreational fishermen predominantly landed Hogfish in both stocks using spear and hook-and-line gears, but estimates were highly uncertain and often above CV thresholds of 30% and 50% (see Section 4.3 of the Data Workshop Report). In the SRHS, fishermen landed and discarded Hogfish using hook-and-line gears only and were often <1% of the SRFS landings and discards estimates. Therefore, in both stocks, the SRHS landings and discards estimates were respectively combined with the SRFS hook-and-line gear

estimates. Recreational landings and discard estimates by gear from the 'Full SRFS' and SRHS timeseries were compiled for each base model and are presented in Tables 3.5 – 6 and Figures 3.4 – 5 for the Florida Keys/East Florida stock and in Tables 4.5 – 6 and Figures 4.4 – 5 for the West Florida Shelf stock.

In the Florida Keys/East Florida stock, annual input sample sizes of recreational length and CAAL composition data by gear and mode were also low (combined across gears and modes: average 65 positive trips per year and 12 fish aged per year). Consequently, the AW panel determined to aggregate the recreational fisheries by gear and mode into a single combined recreational fleet (Tables 3.5 – 6). This differed from that in SEDAR 37 (2014), which despite having also combined the SRHS with the old MRFSS/MRIP hook-and-line estimates, defined two recreational fleets by gear (spear, hook-and-line). Lastly, for the KEYS base model, the landings estimates for 1981 (1.285 million fish) and 1984 (6.644 million fish), which were flagged by the Data Workshop, were each replaced with more 'reasonable' estimates by using the geometric mean of their respective six surrounding years (i.e., 3 years before and 3 years after) to become 295,197 fish in 1981 and 239,962 fish in 1984.

This trend in low data availability was also true for the West Florida Shelf stock where annual input sample sizes of recreational length and CAAL composition data by gear were very low (average 13 positive trips per year and 27 fish aged per year). Initially, the AW panel also wanted to aggregate the recreational fisheries by and gear and mode into a single combined recreational fleet, but determined that since the recreational hook-and-line fishery was continuing to develop and expand and had overtaken the spear fishery in landings in recent years, it should be tracked separately. Therefore, the recreational two-fleet structure by gear (spear, hook-and-line) was retained (Tables 4.5 – 6) as was done in SEDAR 37U (2018).

2.3.2.1 Historical Reconstruction of Recreational Landings

Historical recreational landings were extrapolated back to 1950 using available harvest data (i.e., the full SRFS timeseries plus SRHS landings) and were based on a combination of data related to possible changes in recreational anglers. This extrapolation was done to estimate the potential magnitude of recreational landings that would have occurred leading up to the initiation of the MRIP data in 1981, particularly since license data suggested a peak in recreational effort occurred in the mid-1970s. This data would help provide contrast in information as the fishery developed through time predominantly in the Florida Keys/East Florida region. Contrast in the data is helpful when estimating stock-recruitment parameters within an assessment model, particularly the *steepness* parameter which can be informed if the stock experienced a reduction in biomass and recruitment due to heavier fishing mortality and then recovery if that fishing mortality significantly decreases.

Previous estimates of historic recreational catch have been based on human population from the U.S. Census (Florida spotted seatrout, Murphy et al. 2011) or coastwide estimates of saltwater anglers and days spent saltwater fishing from the National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (FHWAR) (South Atlantic Spanish mackerel, Brennan and Fitzpatrick 2012). The human population method assumes that the number of anglers is proportional to the total coastal population and does not account for periods when recreational fishing expanded faster (or slower) than human population. The FHWAR method applied to Spanish mackerel uses coastwide estimates of saltwater fishing effort and assumes that the rate of expansion in saltwater angling was the same across the entire region. Here, information from the FHWAR survey was combined with historical fishing license data to estimate historical recreational catch in each year from 1950 – 1980.

Historic fishing license data were available in the USFWS National Fishing License Reports from 1958 – 2013; for Florida, no data were available in 1959 and 1960. These reports provide values for the number

of certified paid fishing license holders (participants) in each state, where a license holder is one individual regardless of the number of licenses purchased. The reports do not differentiate between saltwater and freshwater anglers. The National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (FHWAR) provides data about the state in which these activities occurred; number of trips taken; days of participation; and expenditures for food, lodging, transportation, and equipment. The survey was conducted 1991, 1996, 2001, 2006, and 2011 by the Census Bureau for the U.S. Fish and Wildlife Service. An estimate of the percentage of anglers in each state that fish in saltwater is provided in these reports ("%saltwater"). This percentage was extrapolated linearly between years when the survey was not conducted. Prior to 1991, the "%saltwater" was only available nationally and only every five years from 1955 – 1985. These national percentages were used to extrapolate back the statewide estimates. The total number of license holders from the USFWS Historic Fishing License data was then adjusted by the percent estimates from the FHWAR surveys to get the total number of saltwater participants by year and state. Lastly, CPUE was calculated for each year and state by dividing the recreational landings estimates by the total number of saltwater participants. The number of saltwater participants was then multiplied by the average CPUE to estimate historical harvest since 1950. These historical estimates were also available during SEDAR 37 (2014). An update to this method was recently applied to south Atlantic Red Snapper (SEDAR98-DW-08) but showed negligible differences (<=1%) in estimates between the two methods. Thus, the original SEDAR 37 methodology was retained here.

In the Florida Keys/East Florida region, recreational landings estimates from the Full SRFS plus SRHS averaged 97.6% (geometric mean) of the total Florida-wide landings between 1981 – 1985. Therefore, the annual numbers of saltwater angler participants in Florida were multiplied by 0.976097 to estimate the annual numbers of participants for the Florida Keys/East Florida region (Table 3.7). CPUE was calculated only using years 1982, 1983, and 1985 (CPUE = 0.263904) as landings estimates for 1981 and 1984 were flagged by the Data Workshop and, when incorporated, egregiously inflated CPUE values (CPUE >2.6). Thus, historical recreational landings estimates were reconstructed for the Florida Keys/East Florida region for the assessment model and are presented in Table 3.7. A comparison of these reconstructed landings alongside the historic commercial landings estimates (in numbers) for years 1950 – 2024 is provided in Figure 3.6. Commercial landings were generally low relative to recreational landings and averaged 5.75% of total landings in numbers across the entire timeseries. The reconstructed recreational landings provided a ramp-up into higher landings estimated to have occurred during the 1970s at a similar magnitude to those of the 1980s through early-1990s (Figure 3.6).

Historic recreational landings estimates were also reconstructed for the West Florida Shelf. First, the annual number of saltwater angler participants in Florida was multiplied by 0.023903 so that what wasn't apportioned to the Florida Keys/East Florida above went to the West Florida Shelf (i.e., 1 – 0.976097). The CPUE was calculated using years 1981 – 1983 (CPUE = 0.929120; no landings estimates for years 1984 – 1985) which was then multiplied by the number of saltwater angler participants to reconstruct the number of landings (Table 4.7). A comparison of these reconstructed landings alongside the historic commercial landings estimates (in numbers) for years 1950 – 2024 is provided in Figure 4.6. Commercial landings were a little higher, averaging 21.53% of the total landings in numbers across the entire timeseries. The reconstructed recreational landings were not found to add any further contrast to the data but rather portrayed a ramp-up into a landings trend that was already gradually increasing through time thereby extending that trend (Figure 4.6).

2.3.3 Indices

For the KEYS base model, three fishery-independent surveys were modeled: the Reef Visual Census Florida Keys (RVC KEYS), the Reef Visual Census Dry Tortugas (RVC DRTO), and a combined video

survey (combined video; Table 3.8, Figure 3.7). Although the Reef Visual Census Southeast Florida (RVC SEFL) index was submitted for use by the Data Workshop, discussions from the AW panel ultimately led to its removal given frequent duplication with the RVC KEYS index (e.g., overlapping length composition data, 8 years of data with 5 years of overlap) and model parsimony. While there is no individual young-of-year (YOY) survey, the length composition data from the RVC KEYS survey indicates the presence of age-0 fish which have recruited to the reefs and could be used to help inform recruitment within the KEYS base model.

Three fishery-independent surveys were used within the WFS base model: the FWRI FIM polyhaline seagrass survey (seagrass trawl), the SEAMAP-FWRI trawl survey (SEAMAP trawl), and a combined video survey (combined video; Table 4.8, Figure 4.7). The seagrass trawl survey was configured within the WFS base model as an age-0 recruitment index. The fishery-dependent MRIP hook-and-line CPUE, which was submitted for use by the Data Workshop, was ultimately not recommended for inclusion following AW panel discussions and the presence of three fishery-independent indices tracking young-of-year, subadult, and adult life stages.

2.3.4 Length Composition Data

Weighted length compositions for the SEDAR 94 base models were compiled for catch (landings and releases) of Hogfish by fishery and primary gear type. Raw length composition data from fishery-dependent sources may be a biased reflection of the length composition of the catch due to uneven sampling in space and time. Therefore, when calculating landings- and releases-at-length (fish landed or released per length bin in numbers), it is recommended to weight the sampled lengths of landed or released fish at the finest possible scale by the inverse of sampling proportion (Maunder et al. 2020).

Weighted length compositions of the landings and releases are described in detail in SEDAR94-AP-01. In brief, length compositions of landings and releases were catch-weighted according to scales that generally satisfied a minimum level of sampling and captured key differences in sampled lengths. Input sample sizes for length compositions were set equal to the number of trips with at least one measured Hogfish. They were then internally re-weighted using fleet-specific Dirichlet-Multinomial parameters or Francis multipliers to estimate effective sample sizes (for additional details refer below to Section 2.11).

Catch-weighted length compositions of landed and released alive Hogfish are summarized by fleet in Figures 3.8 – 9 for the KEYS base model and in Figure 4.8 for the WFS base model. Length samples were assigned to have occurred mid-year (July) and were binned into 2 cm fork length intervals from 2 – 86 cm (KEYS base model) or 2 – 90 cm (WFS base model).

2.3.5 Conditional Age-at-Length Data

Conditional age-at-length inputs by fleet are presented in Figures 3.10 – 13 for the KEYS base model and Figures 4.9 – 10 for the WFS base model. This input allows the integrated models to use the information from sparse age-length data without assuming that the data was representative of ages across the full range of sizes. Input sample sizes for the number of ages sampled in a given length bin by year were set equal to the number of aged fish and were assigned to have occurred mid-year (July).

Conditional age-at-length data is particularly useful when internally estimating growth and is conditioned on the selectivity associated with the data.

Conditional age-at-length inputs are presented in Figures 3.10 – 13 for the KEYS base model and Figures 4.9 – 10 for the WFS base model and were available from the retained landings of the fishery fleets as well as from the various fishery-independent life history research parsed by gear. Conditional age-at-length data is particularly useful when internally estimating growth. It allows the integrated models to use

the information from sparse age-length data, without assuming that the data was representative of ages across the full range of sizes, and is conditioned on the selectivity associated with the data. For the WFS base model, only the CAAL data from the SEAMAP trawl survey and the fishery-independent spear data collected from various life history research were retained. During the model development process, it was found that inclusion of the sparse commercial and recreational CAAL data resulted in conflict with the length data and prohibited reasonable estimates of L_{inf} (e.g., chasing the upper bound of 130 cm FL). The AW panel was concerned that growth could not be reasonably estimated internally opted to retain only the CAAL data which were considered most informative to growth.

2.4 Initial Conditions

The KEYS base model used 1950 as the starting year and did not assume the stock was at equilibrium because Hogfish removals are known to have occurred in the southeastern U.S. since the late 1930s, primarily in the Florida Keys region. Available estimates of historical commercial and recreational landings were not considered stable over time; instead, they were characterized as a ramp-up to peak catch levels observed during the 1970s through the early-1990s. Although the precision of these historical catch estimates was low, their inclusion allowed for fleet- and year-specific estimation of fishing mortality rates and was considered preferable to assuming unknown fleet-specific equilibrium catch and initial fishing mortality rates. The model also assumed that removals prior to 1950 remained below MSY and that the population had not declined below B_{MSY}.

The start year of the WFS base model was 1986 and the stock was also not assumed to be at equilibrium. As mentioned above, the historic commercial and reconstructed recreational catch suggested a low level of landings which gradually increased through time. The inclusion of this data was explored during the model development process; however, the use of the reconstructed data did not further inform model parameters in a more significant way compared to if the model only had data available from 1986. The trade-off of additional uncertainty for no difference in model results led to the AW panel's decision of starting the model in 1986. Therefore, an *ln(R0)* offset parameter was configured for 1985 which estimated an initial depletion of the stock before the model began in 1986.

2.5 Spatio-Temporal Structure

The SEDAR 94 base models were configured as single area models within their respective stock boundaries as defined by the 25° 9' N latitudinal line off Cape Sable, Florida (see Section 2.3 in Data Workshop Report). The West Florida Shelf encompassed the eastern Gulf waters north of this boundary while the Florida Keys/East Florida stock comprised waters south of this boundary, around the Florida peninsula, and north to the Florida/Georgia border. Fishing fleets were separated by sector (e.g., commercial and recreational), each having a distinct selectivity, with low sample sizes across data components at finer regional spatial scales precluding further spatial separation of fleets within stock boundaries.

Hogfish in the Florida Keys/East Florida stock were modeled from age-0 through age-16 years (maximum age observed in this stock), while Hogfish in the West Florida Shelf stock were modeled from age-0 through age-23 (maximum age observed in this stock). Recruits for both stocks were defined as fish which recruited to the biological population at calendar age-0. Each model was configured with one season (i.e., annual) from January through December where fishing was treated to have occurred throughout the whole season. Hogfish are protracted spawners with a core spawning season in winter months. Therefore, spawning was configured to occur on January 1 and, given a pelagic larval duration of ~34 days (see Section 2.4 in Data Workshop Report), settlement of recruits was configured to occur in February. Surveys, length composition data, and CAAL data were configured to occur mid-year (July 1).

2.6 Recruitment Dynamics

Each SEDAR 94 base model assumed the Beverton-Holt stock-recruitment relationship. In SS, this stock-recruitment function uses three parameters which were simultaneously estimated: 1) *steepness* (the initial slope of the ascending limb), 2) the virgin recruitment estimated in log-space (*ln(R0)*), and 3) the standard deviation of the natural log of recruitment (*sigmaR*). *SigmaR* penalizes deviations from the spawner-recruitment curve (calculated from *ln(R0)* and *steepness*), and it defines the difference between the arithmetic mean spawner-recruitment curve and the expected geometric mean (Methot et al. 2026).

All three stock-recruitment parameters were estimated within the KEYS base model. However, only the *ln(R0)* and *sigmaR* parameters were estimated within the WFS base model. The total landings time series for the West Florida Shelf showed little contrast as it generally increased over time, with the highest removals occurring near the end of the series. Because the data did not provide enough information to estimate the *steepness* parameter, the model consistently converged on a value of 0.99. As a result, *steepness* was fixed at this value, effectively assuming average recruitment rather than estimating a stock-recruitment relationship. This issue was also encountered in SEDAR 37 and SEDAR 37U, where the same approach was adopted.

Simple annual deviations from the stock-recruitment function, which were constrained to sum to zero, were estimated assuming a lognormal error structure. Main recruitment deviations were estimated for years of greater data-richness (1981 – 2021, KEYS; 1986 – 2024, WFS) and corresponded to when the length and age composition data for the fleets began to become available. Recruitment for years 1950 – 1980 in the KEYS base model followed the stock-recruitment curve. No early recruitment deviations were estimated in both models. In SS, expected recruitments need to be bias-adjusted because of its assumed lognormal error structure. The adjustment is accomplished by applying a full-bias correction to the recruitment deviations which have enough data to inform the model about the range of recruitment variability (Methot et al. 2026). Following the recommendation from Methot and Taylor (2011) to use the full bias adjustment on data-rich years, the KEYS base model used full bias adjustment between 1991 – 2022 and the WFS base model used full bias adjustment between 1995 – 2022, after which both models phased out to no bias adjustment through 2024.

Earlier in the KEYS base model development process, main recruitment deviations were configured to extend to the terminal year, 2024, and deviations were not constrained to sum to zero. Estimated recruitment in the last three years (2022 – 2024) was highly elevated, following the index of abundance trends and corresponded to the stock continuing to recover after management intervention beginning in 2017. However, this configuration also produced a retrospective pattern due to the model's inability to predict that recovery trend as the terminal years of the model withdraw. The AW panel felt the increasing trend in recruitment was likely realistic given the data; however, introducing process error by removing the deviations for years 2022 – 2024 (i.e., recruitment followed the stock-recruitment curve instead) still allowed recruitment to increase, but eliminated the retrospective pattern.

2.7 Fishing Mortality

Fishing mortality (F) can be estimated with two approaches in SS: a mid-season harvest rate using Pope's approximation or a season-long fishing mortality rate using the Baranov catch equation (Methot et al. 2026). When estimated as a season-long rate, F can be a parameter for each year and fleet (F_{Par}) or can be a tuned factor using Pope's and Baranov catch equations sequentially (i.e., a hybrid, F_{hybrid}). As a parameter, F_{Par} is influenced most by both types of catch data (retained and discards) and associated standard errors; whereas the tuning of F_{hybrid} is influenced by only the retained catch and can result in the near exact match to the observed retained catch but poorer fits to the discard data.

In the KEYS base model, fishing mortality for the commercial fleet was configured using F_{hybrid} because the standard errors for the landings were generally small (~0.05) and there were no available discard estimates; whereas the recreational fleet was configured using F_{Par} because discards were available and the standard errors associated with the landings were often >0.4. While the same was true for the West Florida Shelf data, the WFS base model did not show significant improvement to model fit of the indices, length compositions, or CAAL data when configured with F_{Par}. Therefore, rather than unnecessarily add annual fleet-specific fishing mortality parameters to the model (i.e., overparameterize), all three fleets were configured using F_{hybrid}.

For tracking and reporting purposes, both base models utilized the annual exploitation rate (biomass), calculated as the ratio of the total annual catch in biomass to the age-1+ biomass at the beginning of the year, to characterize the fishing mortality rates of Hogfish. This was chosen to account for the differing spear and hook-and-line selectivities, to track both female and male portions of the population (not just one or the other), and to be consistent and comparable with both SEDAR 37 (2014) and SEDAR 37U (2018) assessments.

2.8 Catchability

For each of the three respective fishery-independent surveys within each SEDAR 94 base model, constant catchability was assumed. In the SEDAR 37 FLK/EFL base model, time varying catchability was applied to an earlier-starting RVC KEYS index to account for a change in survey design, and which resulted in a doubling of estimated survey catchability. For the SEDAR 94 KEYS base model, the RVC KEYS index started in 1999 and thereby circumvented the need to estimate changes in survey catchability.

2.9 Selectivity

Selectivity patterns describe the probability of capture-at-length or -age by a given fishery or gear. Selectivity can be used to model different gear types, targeting, and fish availability according to the spatial utilization of fish and/or fishery. When configuring length-based selectivity, SS will also estimate a derived age-based selectivity.

The KEYS base model was configured using length-based selectivity for all fleets and indices where selectivity for the commercial fleet and retention for the recreational fleet followed major changes in size limits and bag/trip limits in the south Atlantic regulation of Hogfish in the Florida Keys/East Florida. Selectivity of both the commercial and recreational fleets were configured using the six-parameter double normal function to best accommodate each fleet's differences in gear's selectivity patterns. Five of the six parameters were freely estimated and the fixed parameter (p5 – initial selectivity at start bin) was configured such as to extend the logistic decay of small fish selectivity down to the start bin. Without any estimated discards, commercial selectivity was configured to change following major changes in South Atlantic regulations of Hogfish. Time-varying selectivity was applied for years 1950 – 1994 (no size or bag limit regulations), 1995 – 2017 (minimum size limit of 12" fork length), and 2018 – 2024 (minimum size limit of 16" fork length and 25lb ww bag limit per boat/day).

Both RVC indices (Florida Keys and Dry Tortugas) were configured with dome-shaped selectivity using the six-parameter double normal function based on the survey area, length composition data, as well as the survey design being constrained to depths less than 30 m. For both indices, five of the six parameters were freely estimated where p5 (initial selectivity at start bin) was fixed as above. Selectivity for both indices was also held constant over time.

Selectivity for the combined video survey in the KEYS base model was configured using a single-logistic function (flat-topped) based on the gear (stereo-imaging cameras), survey area and design where sampled

depths occurred greater than 30 m, and length composition data. Both parameters were freely estimated and held constant over time.

The WFS base model was configured using length-based selectivity for all fleets and indices except for the FWRI FIM polyhaline seagrass survey which was specified as an age-0 recruitment index (i.e., selectivity = 1 only on age-0 fish). All three fishing fleets were configured using the six-parameter double normal function for flexibility and were based on fishermen input on where the fisheries largely operate and their respective observed composition data. Selectivity of all three fishing fleets varied through time following eastern Gulf regulatory changes in minimum size limits of Hogfish for years 1986 – 1999 (no size or bag limit regulations), 2000 – 2017 (minimum size limit of 12" fork length), and 2018 – 2024 (minimum size limit of 14" fork length). For the commercial fleet, 5 of the 6 parameters were freely estimated and allowed for selection of larger and older fish through the final length bin. However, for both recreational fleets, the length composition data were heavily domed and showed very little selectivity of fish into the larger length bins. Following model parsimony, only 4 of the 6 parameters were estimated where p5 and p6 (final selectivity at last bin) was also fixed to decay the large fish selectivity down to the final bin.

The SEAMAP-FWRI trawl survey in the WFS was configured with dome-shaped selectivity using the six-parameter double normal function and based on gear design (i.e., a trawl), survey area where Hogfish were primarily collected, and the length composition data. Five of six parameters were freely estimated and held constant through time.

The combined video survey in the WFS was configured using a single-logistic function (flat-topped) based on the gear (stereo-imaging cameras), survey area, sampling depths, and length composition data. Both parameters were freely estimated and held constant over time.

2.9.1 Retention

Size regulations for Hogfish are in the form of a minimum size limit; therefore, retention was modeled as an asymptotic function of size using a four-parameter logistic function.

In the KEYS base model, time varying asymptotic retention was applied to the recreational fleet to account for changes in size and bag limits. The first three retention parameters were freely estimated but varied for years 1950 – 1994 (no size or bag limit regulations), 1995 – 2017 (minimum size limit of 12" fork length and bag limit of 5 fish/person), and 2018 – 2024 (minimum size limit of 16" fork length and bag limit of 1 fish/person). The fourth parameter (male offset) was not applicable and was fixed at zero.

For the WFS base model, asymptotic retention was applied only to the recreational hook-and-line fleet where the first three retention parameters were freely estimated and the first two varied for years 1986 – 1999 (no size or bag limit regulations), 2000 – 2017 (minimum size limit of 12" fork length), and 2018 – 2024 (minimum size limit of 14" fork length) to account for changes in size limits. The fourth parameter (male offset) was not applicable and was fixed at zero. Discard estimates were unavailable for the commercial fleet and were insufficient (i.e., only two observations) for the recreational spear fleet (i.e., only two years of highly uncertain observations); therefore, retention was not modeled separately.

2.9.2 Discards

Live and dead discards were calculated and fit for the recreational fleet within the KEYS base model and for the recreational hook-and-line fleet within the WFS base model. Live discards were estimated by applying the converse of the retention function to the total catch, while dead discards were the result of assumed discard mortality rates (Methot and Wetzel 2013). The recreational discard mortality rate was treated as a fixed input (41.4 %, see section 4.7 in the Data Workshop Report) for each base model.

Discard mortality rates are a logistic function of size such that mortality may decline from 1.0 to an asymptotic level as fish get larger. However, the discard mortality rate was treated as constant across size by setting both the ascending slope (p1) and descending slope (p2) parameters to 0.1 and the parameter producing the discard mortality rate (p3) to the specified value (i.e., 0.414). Discard mortality rates were also assumed to be constant through time.

2.10 Maximum Likelihood and Error Structure

A maximum likelihood approach is used in SS to evaluate the overall goodness of fit to each data source (i.e., landings, discards, indices, length compositions, and CAAL). Datasets contained an assumed error distribution (e.g. lognormal) and an associated likelihood determined by the difference between observed and predicted values and the variance of the error distribution. The total likelihood is the sum of the individual components' likelihoods. The global best fit to all the data was determined using a nonlinear iterative search algorithm to minimize the total negative loglikelihood across the multidimensional parameter space.

The error structure for landings, discards, and indices was assumed to be lognormal, except where noted. For most data sources, the variance of the observations was available only as a coefficient of variation (CV). In SS, if lognormal error structures were required, CVs were converted to a standard error (SE) in log-space using $SE = \sqrt{ln(1 + CV^2)}$. Within the landings data, commercial landings contained little uncertainty (see Section 3.3 of the Data Workshop Report) because the programs which collect those data consider it a census (assumed to be complete or nearly so) rather than a survey (which is from a sample). Limitations of the SRHS design prevented variance estimates from being developed for the headboat landings and discard estimates, and while proxy CV values were available for this assessment, the CVs for the SRFS estimates were used since they were combined into one recreational fleet. Uncertainty in the index observations was estimated through the standardization techniques used therein to determine final observed index CV values (see Section 5.4 of the Data Workshop Report).

Multinomial distributions were assumed for the length composition data of the landings, discards, and indices as well as the CAAL data of the landings and fishery-independent datasets, which have variances estimated by the input sample sizes. The variance of the multinomial distribution is a function of true probability and sample size; thus, an increase in sample size represents lower variance and vice versa. The effective sample size is meant to represent the number of independent and random samples each year to determine the length or age composition. The assumption of independent sampling is typically violated because fish caught in the same tow or set tend to be more similar to each other in length or age than are fish from different catches, and this can extend to fish caught by the same vessel. In addition, the assumption of random sampling can be violated (e.g. by sampling vessels non-randomly or by under-sampling nighttime trips or fishing areas).

The variance associated with each data source can be highly influential, especially when there are conflicts among data sources. Because true effective sample sizes are unknown, input sample sizes were initially set equal to the number of trips with at least one measured Hogfish for length composition data to avoid over-weighting observations of lengths in the likelihoods. The input sample sizes for CAAL data were set to the number of Hogfish sampled because there are fewer fish aged at a given length bin.

2.11 Super-Periods and Data Weighting

In both SEDAR 94 base models, the length composition data for the respective commercial and recreational fleets were characterized by low annual sample sizes, often well below 30 or 50, which produced very coarse and angular distributions for selectivity functions to fit. To help reduce noise and

increase input sample sizes, the super-period approach within SS was utilized which allowed the data to be representative blend across a set of time steps and cause the model to create an expected value for this observation using the same set of time steps (Methot et al. 2026). For the respective fishery fleets within each base model, the super-periods followed when the data became available and when the regulatory time blocks occurred to align with the changes in selectivity and/or retention. In the KEYS base model, super-periods were not applied to the size composition data of either RVC index, but a single super-period was applied across the whole timeseries for the combined video survey due to similar annual sample size issues. In the WFS base model, no super-periods were applied to the SEAMAP survey or the combined video survey composition data.

In the KEYS base model, the Dirichlet-Multinomial distribution, which estimates a parameter (*theta*, θ) that internally scales the input sample size for composition data, was implemented on all length composition data (Thorson et al. 2017; Methot et al. 2026). All *theta* parameters were also given a normal prior N(0, 1.813) as recommended by Ian Taylor (Methot et al. 2026). For the CAAL data (i.e., commercial landings, recreational landings, fishery-independent spear, and fishery-independent trawl), theta parameters were generally estimated greater than 4 and nearly 5 (i.e., they were associated with 99 – 100% weight with little information in the likelihood about the parameter value) and the theta ratios ($\theta/(1+\theta)$) were close to 1.0, indicating that the model was attempting to tune the input sample sizes as high as possible (Methot et al. 2026). Since the CAAL input sample sizes were based on the number of fish aged within each length bin, manually changing them to a higher input sample size seemed unachievable apart from aggregating them into larger age-at-length bins. Therefore, the CAAL data were left unweighted.

For the WFS base model, Francis weighting was applied to the length composition data as well as to the CAAL data (TA1.8 in Francis 2011). Francis (2011) and Punt (2017) developed re-weighting procedures to adjust the effective sample sizes of length and age data iteratively until the multipliers reached a stable value. Multipliers are calculated so that variability of model inputs is consistent with the model fits to mean length or mean age (Francis 2011). Iterations of the WFS base model were sequentially conducted until the decrease in total likelihood of the model resulted in a difference of two units or less and subjective intervention by the analyst was minimized.

Both Francis and Dirichlet-multinomial weighting methods were explored within each respective base model and final weighting methods were chosen based on individual model performance, diagnostics, and AW panel discussions.

2.12 Model Diagnostics

Model diagnostics of the SEDAR 96 base models were performed in R using the 'r4ss' and 'ss3diags' (github.com/JABBAmodel/ss3diags) packages and largely followed the recommendations put forth in the Carvalho et al. (2021) "cookbook" for integrated stock assessment models. While each diagnostic is briefly summarized below, further descriptions can be found in Carvalho et al. (2021) and references therein.

2.12.1 Convergence

Convergence of the base model was initially assessed by determining that there were no parameters estimated at a bound, the final gradient was 0.0001 or less, and that the Hessian matrix was positive definite.

2.12.1.1 Correlation Analysis

High correlation among parameters was assessed as it can lead to poor model stability along with flat likelihood response surfaces. While some parameters will always be correlated due to their structural nature (e.g., growth and stock-recruitment parameters), many highly correlated parameters may warrant reconsideration of modeling assumptions and parameterization. Therefore, correlation among parameters was examined and any correlations with an absolute value greater than 0.7 were reported. Parameters correlated due to their structural nature were estimated in different phases of the base model to reduce their direct influence on one another.

2.12.1.2 Jitter Analysis

Once individual model convergence was established, a jitter analysis varied the parameter's starting values to gauge whether the base model had converged on a global solution instead of a local minimum. For this analysis, initial values were jittered by 20% and 100 iterations were performed.

2.12.2 Goodness of fit

Fits and patterns in residuals were assessed in a variety of ways to identify potential model misspecification. First, model fits to landings, discards, indices, length compositions, and CAAL data were evaluated via visual inspection of residuals. Overall residual patterns for each model component (indices, length compositions, and CAAL) were identified through joint residual plots (Winker et al. 2018; Carvalho et al. 2021). These plots include a Loess smoother to detect auto-correlation of residual patterns and data conflicts, as well as indicate outliers that were beyond the 3-sigma limit. Then, a non-parametric runs test (Wald and Wolfowitz 1940) was performed on the indices, length compositions, and CAAL data to test for randomness and the presence of temporal autocorrelation in residuals. Combined root mean square error (RMSE) values were also calculated for the indices and length composition data to evaluate goodness-of-fit. Generally, undesirably high RMSEs exceed 30%.

2.12.3 Model Consistency

2.12.3.1 Likelihood Profiles

Consistency within the base model was evaluated by identifying how the sources of information influence various model estimates. This was done first through likelihood component profiles on two important stock-recruitment parameters where applicable: the virgin recruitment parameter, *ln(R0)*, and the *steepness* parameter. The *ln(R0)* parameter, largely regarded as an ideal global scaling parameter, was sequentially fixed to plausible values ranging in log-space from 7.0 – 9.0 by 0.1 (KEYS base model) or from 6.5 – 8.5 by 0.1 (WFS base model) and the change in total and data-component likelihoods were examined. In the KEYS base model, the *steepness* parameter was fixed to values ranging from 0.3 – 0.99 by 0.05. Ideally, the plotted relationship between negative marginal likelihood values and the range of parameter values yields a well-defined minimum that aligns with that estimated by the base model. If a given parameter is not well estimated, the profile plot may show conflicting signals across data sources and/or a flat marginal likelihood surface. This indicates that multiple parameter values are equally likely given the data. In such instances, the parameter may not be influential in the model, or the model shows instability and model assumptions may need to be reconsidered.

2.12.3.2 Age-structured Production Models

An age-structured production model (ASPM) and an ASPM with estimated recruitment deviations (ASPMdev) were also developed in SS to investigate which processes were influencing the shape of the production function and whether composition data were influencing the variability in recruitment. For the ASPM, this was completed first by fixing all parameters to those values estimated by the base model, except for the *ln(R0)* parameter and the initial fishing mortality parameters. Next, the likelihood

components (i.e., lambdas) for the length composition and CAAL data were set to zero along with the recruitment deviations for both the early and main periods, such that only the catch and indices of abundance were fit by the model. For the ASPMdev, the recruitment deviations of the ASPM were configured back to the values in the base model and the bias-correction factor was re-adjusted following Methot and Taylor (2011). Trends in both spawning stock biomass and fishing mortality were compared between the base model, the ASPM, and the ASPMdev.

2.12.3.3 Retrospective Analysis

Each base model was subjected to a retrospective analysis which removed six successive years of data from the terminal year of the model (i.e., years 2018 – 2024) corresponding to the most recent regulatory time blocks beginning in 2018. Iteratively removing data associated with the model's terminal year elucidates the effect of the final year on model results. If results of this analysis show a retrospective bias (consistent patterns of increasing or decreasing model estimates and related derived quantities with each retrospective peel), it can be an indication of model misspecification of temporal dynamics. It is preferable for estimates associated with each retrospective peel to be randomly distributed around the base model results. Model performance was evaluated through visual inspection of retrospective patterns and the Mohn's Rho (ρ) metric (Mohn 1999, Hurtado-Ferro et al. 2015). Here, the 'rule of thumb' ρ values (-0.15 to 0.20) as proposed by Hurtado-Ferro et al. (2015) for longer-lived species were used to characterize retrospective bias.

2.12.4 Model Validation (Prediction Skill)

Having established model consistency and structural stability, the predictive skill of the base model was evaluated to check whether the model's predictive capacity is consistent with the future reality. This was done in two ways. First, a retrospective forecast was performed by adding model-based hindcasts to each of the seven-year peels of the retrospective analysis. Then, a forecast bias, which is an average relative error corresponding to the retrospective bias (i.e., Mohn's Rho (ρ) metric), was computed to gauge model performance and consistency when adding data.

The second method was through the hindcast cross-validation approach (Kell et al. 2021), which compares observations to their predicted future values, and was applied to both the indices and length composition data. Predictive skill was evaluated based on the mean absolute scaled error (MASE), which scales the mean absolute error of the forecasted value to the mean absolute error of the naïve in-sampled value and indicates whether the average model forecasts are better or worse than a random walk. For example, MASE scores >1 indicate average model forecasts are worse than a random walk (i.e., no predictive skill). However, a MASE score of 0.5 would indicate that the model forecasts twice as accurately as a naïve baseline prediction, thereby containing predictive skill.

2.12.5 Sensitivity Runs

2.12.5.1 Florida Keys/East Florida: Start Year

During the model development process, a preliminary base model for the KEYS was constructed to explore the start year of 1986. This configuration followed the SEDAR 37 base model as well as discussions at the Data Workshop concerning when catch or effort data start becoming more available with less uncertainty (e.g., see Sections 3.7 and 4.9.2 in the Data Workshop Report). In addition to a start year sensitivity, this model was unable to adequately estimate any stock-recruitment relationship (h = 0.99), indicating that it contained insufficient contrast in the data (e.g., the stock experienced a reduction in SSB and recruitment due to periods of heavier fishing followed by periods of less intense fishing pressure where the SSB and recruitment were able to begin recovering again). However, profiling the *steepness* parameter for this model revealed an improved model fit if *steepness* was <0.99. When

including the historical catch data, the model was able to estimate a *steepness* value, which ultimately led AW panel discussions to determine this configuration would become the new base model. Therefore, this preliminary model was retained as a sensitivity to these differing assumptions.

2.12.5.2 Florida Keys/East Florida and West Florida Shelf: Discard Mortality

In accordance with Data Workshop (see Data Workshop Report Section 4.7), model runs examining sensitivity to discard mortality rates for the fishing fleets were recommended. Since discards from the commercial fleets in both base models and the recreational spear fleet in the WFS base model were unavailable and/or assumed negligible, sensitivity runs were conducted only for the recreational fleet (KEYS base model) or the recreational hook-and-line fleet (WFS base model). This was completed by configuring the fixed parameter inputs in the discard mortality equation to produce the respective discard mortality rates for each scenario. For the recreational fleet, the upper bound sensitivity was set at 59% while the lower bound was set at 23.8%.

2.12.5.3 Florida Keys/East Florida and West Florida Shelf: Natural Mortality

Sensitivity runs exploring alternative assumptions on natural mortality were conducted based on recommendations from the Data Workshop (see Section 2.7.4 in the Data Workshop Report). While several were explored during the model development process, only three per stock will be presented here. All scenarios continued to assume natural mortality was inversely related to length.

For the KEYS base model, the first sensitivity explored the assumption of using the longevity-based estimator from Hamel and Cope (2022), where $M = 5.4/t_{max}$ (as was performed for the WFS base model) and fixed as the reference value for age-3 fish. For the Florida Keys/East Florida stock, the maximum age observed has been 16 years, thus $M = 0.338$ yr^{-1}. The second scenario sought to explore further recommendations of Maunder et al. (2023) and Hamel and Cope (2022) by internally estimating natural mortality within the KEYS base model and using the standard deviation = 0.31 (in log-space) as a prior. Lastly, the third scenario continued to internally estimate natural mortality, but removed the standard deviation prior in effort to understand where the model would internally absorb mortality if given free reign. This was done to help provide potential insight into how the model felt natural mortality was needed to occur in order to better fit the data.

The first sensitivity run for the WFS base model utilized the mortality-at-weight formulation of Lorenzen (1996) as a fixed input (as was performed for the KEYS base model) and explored the effects of reducing the base model's natural mortality-at-age. A second sensitivity run applied the longevity-based estimator from Hamel and Cope (2022; i.e., $M = 0.235$ yr^{-1}) as the reference age for age-3 fish; this configuration similarly reduced natural mortality at younger ages but was found to have increased it across older ages when compared to the prior Lorenzen (1996) method. The third sensitivity run reported here also followed as in the KEYS base model where internal estimation of natural mortality was explored across ages 3 – 23 without the use of the standard deviation prior in log-space. The use of the standard deviation prior was explored but will not be reported here as the freely estimated sensitivity run resulted in a comparatively better fit to the data.

2.13 Per-recruit Analyses

The expected results of a yield-per-recruit (YPR) analysis are to obtain targets of fishing mortality and age at first capture in effort to evaluate regulations regarding gear types (e.g. hook/mesh sizes and minimum sizes), fishing seasons, or fishing effort (e.g. harvest strategies; Haddon 2001). Overall, the assumed goal is to identify the maximum yield from the fishery and then to adjust that target based on risk aversion and uncertainty. Inherent in YPR analyses is the inconsideration of whether the target fishing effort is sustainable, and it assumes that the fishery has reached an equilibrium with the fishing

mortality it exerts. It also assumes characteristics of natural mortality, growth, and recruitment are constant with stock size (Haddon 2001).

2.14 Uncertainty in Parameters and Derived Quantities

A total of 165 out of 272 parameters were estimated within the KEYS base model for Hogfish in the Florida Keys/East Florida. Of the 272 total parameters, 24 were used to describe life history components (6 estimated), 5 were related to the stock-recruitment relationship (3 estimated), 41 estimated annual recruitment deviations, 150 described annual fleet-specific fishing mortality rates for years 1950 – 2024 (75 estimated), 3 were related to index catchabilities, 5 estimated the Dirichlet-Multinomial theta parameters for length composition data, and 44 described selectivity, retention and discard mortality for the 2 fleets and 3 indices (35 estimated).

Within the WFS base model, a total of 87 out of 124 parameters were estimated. Of the 87 total parameters, 26 were used to describe life history components (5 estimated), 6 were related to the stock-recruitment relationship (3 estimated), 40 estimated annual recruitment deviations, 3 were related to index catchabilities, and 50 described selectivity, retention and discard mortality for the 3 fleets and 3 indices (39 estimated).

Parameter input for SS includes an initial starting value, the range of values a parameter could take (min/max), an associated standard deviation, the prior type and standard deviation (where applicable), and the phase which the parameter will be estimated (positive value) or fixed (negative value). Both base models also used the soft bounds option which moves parameters away from the bounds with a weak penalty (Methot et al. 2026).

Derived quantities include annual numbers- and biomass-at-age, spawning stock biomass, fishing mortality rates-at-age, and internally calculated reference points (e.g., F_{MSY}, $F_{30\%SPR}$, SSB_{MSY}, $SSB_{F30\%SPR}$). Also, recent fishing mortality rates ($F_{Current}$) and recent spawning stock biomass ($SSB_{Current}$) as the geometric mean of the most recent three years were compared to management benchmarks to determine stock status.

Approximate uncertainty estimates for estimated and derived quantities were calculated after model fitting based on the asymptotic standard errors from the covariance matrix determined by inverting the Hessian matrix (i.e., the matrix of second derivatives was used to determine the level of curvature in the parameter phase space and to calculate parameter correlations; Methot and Wetzel 2013). Asymptotic standard errors provided a minimum estimate of uncertainty in parameter values.

2.14.1 MCMC

Monte Carlo Markov Chain (MCMC) analyses provided posterior distributions of model parameters and selected derived quantities. MCMC allows probabilistic reporting of the uncertainty associated with the estimated values. Estimates of population values in the terminal year of the stock assessment are often the most uncertain. Assuming the MCMC posterior distributions provide reliable estimates of model uncertainty, the probability that the estimated terminal year value is above or below the overfished/overfishing reference points can be calculated. In this way, a level of risk associated with failing to reach the reference points can be quantitatively specified. Posterior distributions of current spawning stock biomass ($SSB_{Current}$) and fishing mortality rates ($F_{Current}$) as the geometric mean of the most recent three years (2022 – 2024) were compared to associated reference points (i.e., MSST, MFMT).

Convergence of single chains was assessed by Geweke's diagnostic to determine whether the mean of the first 10% of the chain was not significantly different from the last 50% of the chain, while convergence of

the combined chains was assessed using Gelman and Rubin's (1992) potential reduction scale factor implemented in the 'coda' package (Plummer et al. 2006) in R.

2.14.1.1 Florida Keys/East Florida

Two configurations of the KEYS base model precluded a conventional approach to the MCMC analysis: 1) the need for constraining the recruitment deviations to sum to zero, and 2) the use of F as an annual fleet-specific estimable parameter (i.e., F_{Par}). In MCMC, recruitment deviations cannot sum to zero as the constraint prevents the algorithm from exploring the space efficiently, leading to illogical patterns in the posteriors and slow convergence; conversely, F as a freely estimable parameter allows too much space for the algorithm to explore and also leads to poor mixing and slow convergence. To explore this issue, an MCMC 'proxy' model was developed which took the KEYS base model and removed the sum to zero constraint on the recruitment deviations and allowed deviations to continue through 2024 (ending main recruitment deviations in 2021 led to a negatively summed total deviation, which was resolved by extending to 2024). Next, the expected recreational landings estimated by the KEYS base model, which accounted for the observation error in the catch as well as the discards, was used as the data input for recreational landings in the MCMC 'proxy' model and the F_{hybrid} configuration was utilized to produce an exact fit to that catch. Since the F_{hybrid} configuration was already being utilized for the commercial fleet, it precluded the need to apply this approach in the MCMC 'proxy' model, and the commercial catch was left unchanged. During the model development process, the results between the KEYS base model and this MCMC 'proxy' model were found to be similar and differences were driven predominantly by changes to the recruitment deviation configuration. While unconventional, the goal of this alternative ensemble approach was to help provide further measures of potential uncertainty within the KEYS base model.

In total, eight MCMC chains were produced based on the MCMC 'proxy' model. For each chain, a total of 2,000,000 iterations were performed but only one out of every 500 iterations were saved, resulting in 4,000 potential iterations used to generate estimates of uncertainty in fishing mortality and spawning stock biomass. Visual inspection of trace plots to adjust appropriate levels of burn-in and thinning as well as to address any autocorrelation in the iterations led to a burn-in of 800 with further thinning of every 8, resulting in 400 samples per chain.

2.14.1.2 West Florida Shelf

Eight MCMC chains were produced from the WFS base model. In each chain, 1,000,000 iterations were performed with every 500 iterations saved, resulting in 2,000 potential iterations used to generate posterior distributions. Visual inspection of trace plots to adjust appropriate levels of burn-in and thinning as well as to address any autocorrelation in the iterations led to a burn-in of 500, resulting in 1,500 samples per chain.

2.14.2 Parametric Bootstrap

Parametric bootstrap resampling methods were used to analyze the uncertainty associated with the data and to detect possible model misspecification. One thousand bootstrapped datasets were produced by randomly drawing datasets according to assumed error distributions centered on fitted values. By fitting the model to each of the bootstrapped datasets, base model parameter estimates and derived quantities were compared to the distribution of parameter estimates and derived quantities from the bootstraps. Large discrepancies between the base model estimates and the median of the distribution produced by bootstrap analysis may indicate model misspecification of error distributions, data conflicts, or considerable autocorrelation within datasets (Methot and Wetzel 2013).

2.15 Bridge Building

The second TOR (2a) specifies the development of continuity models consistent with the prior benchmark assessment's configuration. Unfortunately, as is frequent with models developed over a decade ago, a strict continuity model was largely unreproducible due to significant changes occurring with several data streams. For example, the recreational landings and discard data estimates were no longer based on the older MRFSS and MRIP ad-hoc survey combination method, there were no commercial discard estimates available here, the combined video survey design is not the same from 2012, and all fishery-dependent indices developed during SEDAR 37 (2014) were not recommended for use or utilized in either the KEYS or WFS base models.

Thus, a bridge building exercise was performed for each stock which compared the estimates of spawning stock biomass, fishing mortality rates, and recruitment from 1) the SEDAR 37 base model, 2) a SEDAR 37 base model re-formed using the original data put into the respective SEDAR 94 configuration, and 3) the SEDAR 94 KEYS or WFS base model. Notable changes to the SEDAR 37 FLK/EFL base model to bring it into the SEDAR 94 KEYS base model configuration include: adding the regulatory time blocks starting in 1995, condensing the three commercial fleets and their respective length and age composition data into one commercial fleet, condensing the two recreational fleets and their respective length and age composition data into one fleet, removing the fishery-dependent indices, correct a misspecified input to the hermaphroditism function, match super-period application to the length composition data, match application of Dirichlet-multinomial weighting, estimate growth, and apply the platoon function. Similarly, bringing the SEDAR 37U WFS base model into the SEDAR 94 WFS base model configuration included: adding the regulatory time blocks starting in 2000, condensing the three commercial fleets and their respective length and age composition data into one commercial fleet, removing the fishery-dependent indices, correct a misspecified input to the hermaphroditism function, match super-period application to the length composition data, match application of Francis weighting, estimate growth, and apply the platoon function.

This TOR (2b) also requested development of additional models which replaced the MRFSS/MRIP recreational landings plus dead discards in the SEDAR 37 base models with the Full SRFS landings plus dead discards timeseries. In the SEDAR 37 base model, discards were not modeled separately; rather, dead discards were incorporated into the landings by applying a discard mortality rate of 100% for spear and 10% for hook-and-line gears. While the TOR actually specified using the MRIP-FES timeseries, the AW panel resolved that since the Full SRFS timeseries was recommended for use over the MRIP-FES by the Data Workshop panel and the TORs were written well beforehand, the Full SRFS timeseries should be used to satisfy this TOR.

3 FL KEYS/EFL Stock Synthesis Model Results

3.1 Life History

The KEYS base model internally estimated growth where asymptotic length (L_{inf}) was estimated at 51.2 cm FL and the growth coefficient (k) was estimated at 0.177. Using the platoons feature within SS, this corresponded to the 3rd platoon (of the 5 total platoons) which was apportioned 46.4% of annual recruitment. The estimated mean length-at-age was found similar to the results of the external growth model developed during the Data Workshop (Figure 3.14; see Section 2.3.5 in the Data Workshop Report) and the additional platoons allowed fish to grow faster (i.e., larger) and slower (i.e., smaller). For example, in the fourth platoon, where 23.7% of annual recruitment was apportioned, mean fish size was as large as 63.1 cm FL; but in the second platoon, also receiving 23.7% of recruitment, mean fish size was

as large as 33.9 cm FL. These faster growing fish became vulnerable to the fisheries sooner whereas the slower growing fish encountered the fisheries much less, helping to mimic the "Lee phenomenon" hypothesized to be occurring in this stock. Furthermore, the platoon within/between standard deviation ratio parameter was estimated at 0.73, suggesting a shift to lower mean size-at-age has been occurring for this population.

3.2 Landings and Discards

Fits to the landings data for the commercial and recreational fleets are presented in Figures 3.15 – 16. The fits to the commercial landings were nearly exact (total negative log-likelihood = 3.500e-05) while the recreational landings were allowed more flexibility given their higher observation error (total negative log-likelihood = 17.053). The KEYS base model generally fit the observed recreational landings well except in 1988, which expected much higher landings, and in years 2008, 2012, and 2015, which expected lower landings. Figures 3.17 – 18 compare model estimated landings across fleets in biomass and numbers of fish, respectively.

Fits to the recreational discard data were well (total negative log-likelihood = -1.544) as most estimates were close to the observed values and within the 95% confidence intervals (Figure 3.19) except for year 2009 which estimated higher numbers of fish discarded.

3.3 Indices

The KEYS base model fits to the three fishery-independent indices (RVC Florida Keys, RVC Dry Tortugas, and combined video) are presented in Figures 3.20 – 22. Model fits to the indices were overall well (total negative log-likelihood = 7.023) and seemed to follow a similar common trend.

Model fits to the RVC Florida Keys index were fair (RMSE = 0.2527), but misfit in certain years contributed the most to the model's overall total negative log-likelihood for the index component. The observed trend started very low and gradually increased through time until the series high in 2024. But the model expected higher abundances in those first two years before becoming more aligned through 2018. Fits to years 2022 and 2024 were an average between the two as the model balanced fitting the other two indices (Figure 3.20).

Fits to the RVC Dry Tortugas index were closest (RMSE = 0.1646) and the observed trend was similar to the RVC Florida Keys index. The fitted values followed the observed stable but variable trend through the 2000s and then increased from 2018 – 2024 (Figure 3.21).

Lastly, model fits to the combined video index were the worst of the three (RMSE = 0.3804), but this index also contained the greatest amount of observed error. The fitted values generally followed the observed trend which began as an initial high in 1993 and gradually decreased though 1997, became stable but variable through 2017, then began gradually increasing again (Figure 3.22).

3.4 Length and Age Composition

3.4.1 Data Weighting

Weighting of the length composition data using the Dirichlet-multinomial distribution resulted in $ln(\theta)$ parameters < 5 with most close to 0 (commercial landings: $\theta = 2.093$, recreational discards: $\theta = 0.987$, recreational landings: $\theta = -0.764$, combined video: $\theta = 0.442$, RVC indices: $\theta = -0.347$; Table 3.9). Thus, theta ratios were all below 1.0 (commercial landings: 0.890, recreational discards: 0.728, recreational landings: 0.318, combined video: 0.609, RVC indices: 0.414). Fits to all three indices also improved (via RMSE) when compared to an unweighted model. The RVC Dry Tortugas index decreased from RMSE =

0.201 to 0.165, the RVC Florida Keys decreased from RMSE = 0.276 to 0.253, and the combined video decreased from RMSE = 0.400 to 0.380.

3.4.2 Length Composition

The KEYS base model fits to the length composition data along with the Pearson residuals associated with the landings, discards, and indices are presented in Figures 3.23 – 27. The quality of the fit varied among fleets and indices and fits aggregated across time were reasonable (total negative log-likelihood = 582.548). The model's predicted distributions were able to match the observed overall distributions but partially underestimated the peak for the recreational discards (Figure 3.23).

The retained length composition data for the commercial fleet were weighted annually by the commercial landings and were aggregated into three super-periods: 1989 – 1994 (n_input = 48), 1995 – 2017 (n_input = 457), and 2018 – 2023 (n_input = 24); no length data were available for year 2024. Fits to these data largely agreed with the observed distributions (Figures 3.24a and 3.27a), matched the changes in minimum size limits, and smoothed through jagged-looking length bins in earlier and later periods characterized by low input sample sizes. For both the 1989 and 2018 super-periods, under-sampling in years 1991 and 2021 influenced atypically larger proportions of fish calculated for the largest length bins (Figure 3.24a). The commercial fleet's length composition data also reflected larger individuals were more regularly targeted when compared to the recreational fishery, especially during the second super-period (1995 – 2017; Figure 3.24a – b).

The recreational retained length composition data were weighted annually by the recreational landings, were characterized by comparatively larger sample sizes, and were aggregated into five super-periods: 1981 – 1985 (n_input = 230), 1986 – 1994 (n_input = 555), 1995 – 2004 (n_input = 749), 2005 – 2017 (n_input = 1,247), and 2018 – 2024 (n_input = 119; Figures 3.24b and 3.27a). The first two super-periods (1981 – 1994) characterize the first time block (no size limits) and were split to accommodate alternative models developed during the AW process which started in 1986. While there is no minimum size limit during this time, length composition data show similar patters to the second time block containing a 12" FL (30.5 cm) minimum size limit. The third and fourth super-periods (1995 – 2017; second time block) were split to align with the recreational discards which became available in 2005 (Figure 3.24c). The fifth super-period (2018 – 2024) reflected a shift in mode to the new 16" FL (40.6 cm), however smaller fish were still shown to be retained (Figure 3.24b). Fits to the recreational discard length composition data were split into two super-periods: 2005 – 2017 and 2018 – 2024. Distributions show discards are predominantly individuals smaller than the respective minimum size limits; while there were some fish above the minimum size limit discarded from 2005 – 2017, there were no fish discarded above 16" FL (40.6 cm) in the 2018 - 2024 time block when the daily bag limit reduced to 1 fish/person (Figure 3.24c).

The observed length distributions for both RVC indices utilized 5 cm bin widths to resolve the digit bias observed in 2 cm bin widths where model fits to the overall distributions appeared well (Figure 3.23). Annual fits to the RVC Florida Keys length compositions were reasonable (Figures 3.25 and 3.27b; total n_input = 5,194); modal lengths were generally around 20 cm FL, but annual variability led to some years being underestimated at the mode with overestimation at adjacent sizes or vice-versa. While Hogfish in the Florida Keys were observed by this survey up to the 85 cm FL bin, individuals were predominantly less than 40 cm FL (Figure 3.25). Fits to the annual observed length compositions for the RVC Dry Tortugas index were also fair but exhibited comparatively more annual variability and noise across length bins (Figures 3.26 and 3.27c; total n_input = 2,974). Fish were generally larger in the Dry Tortugas, with modal lengths around 35 – 40 cm FL and more frequently observed individuals up to the largest length bin compared to the RVC Florida Keys survey.

The observed length composition data of the combined video survey were generally more uniform in distribution, rather than having a stronger dome-shape as seen in the other length compositions (Figure 3.23). Annual sample sizes for this survey were very low (commonly less than 20) leading to noisy compositions; without any changes in catchability or regulatory time blocks to consider for this index, a single super-period was applied for years 2002 – 2024 (n_input = 184). Models fits to these aggregated data became reasonable and were able to smooth through the coarse and irregular length bins (Figures 3.23 and 3.27a).

3.4.3 Conditional Age-at-Length

The KEYS base model fits to the CAAL data associated with the landings as well as fishery-independent spear and trawl data are presented in Figures 3.28 – 32. The quality of the fit varied among data sources and fits to their aggregated mean ages were generally acceptable (total negative log-likelihood = 618.568; Figure 3.28). Ages sampled from the fleets were infrequent and the average number of ages available annually per length bin was 2 – 3; therefore, to reduce noise and help the model's internal estimation of growth, years where only one or two age-at-length observations were available were removed.

The fits to the annual mean ages for the commercial fleet followed the trends of the observations generally well and mean age occurred between ages 4 – 7 (Figure 3.28). The model did not fit year 2015 by expecting a slightly lower mean age and year 2016 had the greatest uncertainty due to single observations for each age-at-length bin. No ages were sampled from 2017 – 2024 (except for one otolith sampled in 2022 which was removed). The annual fits to the observed ages were reasonable and the model was able to track the observed ages across length bins (Figure 3.29). Between 1998 – 2011, sampled ages-at-length contained larger individuals (~28 – 54 cm FL) predominantly collected from the spear gear but were more length-truncated (~30 – 40 cm FL) across 2012 – 2015 from additional hook-and-line and trap gear samples.

Model fits to the annual mean ages for the recreational landings were largely within the bounds of uncertainty with mean age stable but variable around age 5 (Figure 3.28). Annual fits to the observed ages-at-length were adequate; the combined age data were comprised of both spear and hook-and-line gears, were more consistently sampled across years compared to the commercial fishery, and were normally within 30 – 50 cm FL (Figure 3.30). Ages-at-length above 50 cm FL were more commonly sampled from the spear gear.

The fishery-independent CAAL data were constructed from the life-history research of McBride and Richardson (2007), Faletti and Stallings (2021), Towne et al. (2021), and from unpublished FWRI research (see Section 2.6 in Data Workshop Report). The data were parsed by gear into two fleets: a spear fleet and a trawl fleet, and they were not linked to any other fleet or index. Their main purpose of inclusion was to inform the internal estimation of growth. The fits to the annual mean ages for the fishery-independent spear fleet were suitable and followed the observed trends, largely between ages 3 – 6 (Figure 3.28). Annual fits to the observed ages-at-length were well and were considered the most informative data source for the internal estimation of growth, encompassing annually the widest range of ages-at-length (~6 – 62 cm FL; Figure 3.31). Contrastly, the fishery-independent trawl fleet were predominantly smaller individuals (<30 cm FL) and were helpful with informing growth of the younger individuals. Fits to the annual mean ages were well with observations variable around ages 1 – 3 (Figure 3.28); fits to the annual observed ages-at-length were also consistent (Figure 3.32).

3.5 Estimated Parameters and Derived Quantities

The SEDAR 94 KEYS base model estimated most parameters reasonably well (i.e., |CV| < 1; Table 3.10). Of the 165 active parameters, 37 exhibited poor estimation (i.e., |CV| > 1); including 26 recruitment

deviations, 2 years estimating the annual recreational fishing mortality rates, and 9 parameters describing selectivity (mostly commonly the top logit and/or end logit parameters). No parameters were estimated near bounds.

3.5.1 Stock Biomass (Total and Spawning)

The predicted total biomass and spawning stock (mature female plus male) biomass are summarized in Table 3.11 and Figures 3.33 – 34. Both trends in biomasses gradually decreased through time from 1950 until about the year 2000, then became stable but variable through 2017, then began increasing again through 2024 (Figures 3.33 – 34).

The unfished spawning stock biomass (SSB_0) was estimated at 5,462.14 mt (Table 3.11, Figure 3.34a) where the estimated female spawning biomass was 1,391 mt and the male biomass as 4,071 mt (Figure 3.34b). In 1986, the depletion ratio (SSB/ SSB_0) was 0.446 and decreased to an average 0.223 from 1995 – 2017; it was lowest from 2006 – 2010 (avg. ratio = 0.189) but since 2018 has increased in trend from 0.246 to 0.382 in 2024 (Table 3.11). Temporal trends in spawning biomass appeared to be influenced predominantly by changes in male spawning biomass, whereas female spawning biomass showed greater stability through time (Figure 3.34b), consistent with the historical tendency of males being targeted more heavily than females.

3.5.2 Recruitment

The relationship between spawning biomass and age-0 fish as parameterized by the Beverton-Holt stock-recruitment model is presented in Figure 3.35. The *steepness* parameter was estimated at 0.472, the *sigmaR* parameter was estimated at 0.449, and the *ln(R0)* parameter was estimated at 8.000 (Table 3.10), which equates to 2,981,882 age-0 Hogfish.

The estimated annual recruitment of age-0 Hogfish to the biological population in the Florida Keys/East Florida is summarized in Table 3.11 and Figure 3.36a-b. From 1950 – 1980, age-0 recruitment followed the stock-recruitment curve, declining gradually as the population declined through time (Figure 3.36a). Recruitment was stable but variable from 1981 – 1992 (avg. 2.257 million fish), diminished considerably from 1993 – 1998 (avg. 0.942 million fish), then began gradually increasing in trend again with variation through 2024 to 2.052 million fish (Figure 3.36a). Recent notably high years of recruitment were estimated to be in 2007 (2.523 million fish), 2012 (2.486 million fish), 2013 (2.032 million fish), and 2015 (2.830 million fish). Higher recruitment may also likely have occurred for years 2022 – 2024 based on the trend in both RVC indices as well as additional models developed during this process which estimated annual deviations in recruitment through 2024 (e.g., see the MCMC 'proxy' model description above in Section 2.13.1). Uncertainty in the estimated recruitment was highest during the 1980s when only catch and sparse fishery length composition data were available.

Annual deviations of estimated recruitment from the stock-recruitment curve were configured from 1981 – 2021 and followed the annual trend of the estimated recruitment above (Figure 3.36b). Values deviated around the stock-recruitment curve, except between 1993 and 1998 where they were negatively deviated, and from 2016 – 2021 where they were slightly but continually positively deviated (Figure 3.36b). The estimated (and applied) recruitment bias adjustment ramp as recommended by Methot and Taylor (2011) is shown in Figure 3.37.

3.5.3 Fishing Mortality

The annual exploitation fishing mortality rates on Florida Keys/East Florida Hogfish are presented in Table 3.12 and Figure 3.38. Exploitation rates generally followed the trend in catch; between 1981 and 1994 exploitation averaged 0.102 yr^{-1} with a high in 1988 (0.217 yr^{-1}). From 1995 – 2017, exploitation

rates were variable with notable highs in 2005 (F = 0.262 yr^{-1}), 2009 (F = 0.216 yr^{-1}), and 2015 (F = 0.179 yr^{-1}; Table 3.12, Figure 3.38). After new regulations (SAFMC Snapper Grouper Amendment 37) were implemented near the end of 2017, exploitation averaged 0.022 yr^{-1} for years 2018 – 2024.

Fleet-specific fishing mortality rates (i.e., instantaneous apical rates representing the fishing mortality level on the most vulnerable age class) are also provided in Table 3.12 and Figure 3.39. Apical fishing mortality rates were considerably higher for the recreational fleet and, like the exploitation rates above, followed the trend in annual catch. In contrast, commercial fishing mortality rates were very low but were highest between 1986 – 2005 (Table 3.12, Figure 3.39).

3.5.4 Selectivity and Retention

Selectivity for all fleets and indices was estimated using length-based selectivity functions which the KEYS base model used to further derive age-based selectivity (Figures 3.40 – 44). Fishing fleet-specific length-based selectivity and/or retention patterns, as well as assumed discard mortality rates, are illustrated in Figures 3.40 – 41.

Selectivity of Hogfish for the commercial fleet was time-varying to follow changes in minimum size regulations; without discard estimates (which must be assumed negligible) or discard length composition data, selectivity here functions as retention. Selectivity was dome-shaped generally between 27 – 41 cm FL from 1950 – 1994, 29 – 41 cm FL from 1995 – 2017, and 39 – 53 cm FL from 2018 – 2024; an asymptote of 60% was reached in all three time blocks (Figure 3.40). In the first two time blocks, fish became vulnerable beginning at age-2 before becoming more fully selected by ages 5 and 6; age-derived selectivity of fish in the 2018 – 2024 time block was more gradual due to the increase in minimum size, beginning around age-3 and continuing to age-16 (Figure 3.43).

Dome-shaped selectivity of Hogfish by the recreational fleet was generally between 23 – 54 cm FL, reaching an asymptote of 9% by 55 cm FL (Figure 3.41). Age-derived selectivity was primarily across ages 2+ with fuller selectivity occurring between ages 4 – 6 (Figure 3.44). Retention was time-varying and fish were fully retained by 9 cm FL from 1950 – 1994 (Figure 3.41a), 33 cm FL from 1995 – 2017 (Figure 3.41b), and 55 cm from 2018 – 2024 (Figure 3.41c). Note that where retention was estimated to occur well below 23 cm FL from 1950 – 1994, it meant fish vulnerability still followed the estimated selectivity curve and that, given the absence of minimum size limits, whatever negligible number of fish were encountered were retained. Furthermore, this time period contained no discard length composition data; thus, discards-at-length from 1950 – 1994 followed selectivity and the additive inverse of retention. From 1995 – 2017, Hogfish were discarded largely between 21 – 33 cm FL (Figure 3.41b), whereas fish from 2018 – 2024 were discarded in greater proportion across a wider range from 21 – 51 cm FL due to the increased minimum size limit and reduction in daily bag limit (Figure 3.41c).

The selectivity (vulnerability to observations by divers) of Hogfish by the RVC Florida Keys index was dome-shaped, occurring mostly between 11 – 53 cm FL and reached an asymptote of 12% by 55 cm FL (Figure 3.42). Juvenile fish started to become vulnerable at about 9 cm and individuals became fully selected between 21 – 29 cm FL (Figure 3.42). Age-derived selectivity occurred across all ages with fish becoming more fully selected at ages 2 – 3 (Figure 3.44). In the RVC Dry Tortugas index, selectivity was dome-shaped and primarily occurred on larger individuals between 29 – 87 cm FL (Figure 3.42). As a result, age-derived selectivity appeared more flat-topped by gradually increasing from age 1 to the maximum age (Figure 3.44). Fish observed by the combined video index, which operated near and north of the Dry Tortugas but sampled deeper waters, began to be selected around 11 cm FL and became fully selected by 41 cm FL (Figure 3.42). Age-derived selectivity of this index started at age-1 and became more fully selected by ages 10+ (Figure 3.44).

3.6 Model Diagnostics

3.6.1 Convergence

The SEDAR 94 KEYS base model converged with a total objective function of 2314.27. The model contained no parameters on the bounds, had a small final gradient <0.0001, and had a positive definite Hessian matrix. Highly correlated parameters were inspected, but all were found to be structurally correlated and therefore left as-is estimated in their different model phases.

The results of the jitter analysis found that no jittered runs contained a total likelihood lower than the base model, suggesting that the base model had converged on a global solution (Figure 3.45). From the 100 jittered runs, 70% had a low gradient (<0.0001) but the maximum gradient was 0.3174.

3.6.2 Goodness of fit

The joint residual plots for the indices (Figure 3.46a), mean length composition data (Figure 3.46b), the conditional age-at-length data (Figure 3.46c), and the mean general size composition data (Figure 3.46d) indicated reasonable fits to the data as combined RMSE values were 0.302, 0.023, 0.316, and 0.105 respectively. As illustrated by the loess-smoother and size of the boxplots, residual variability of the indices was more positively biased at the beginning of the timeseries due to the more poorly fit combined video index (RMSE = 0.38). When the RVC indices became available in 1999, the overall trend centered around zero through 2009 then became more negatively deviated until reaching near zero again in the terminal years (Figure 3.46a). Due to the application of super-periods, the frequency of mean length residuals was only during the start of those periods; residuals and interquartile ranges of these data were small and consistent across time, indicating general agreement with the fisheries and index data (Figure 3.46b). In the conditional age-at-length data, residuals were more negatively biased in the beginning and end of the timeseries as influenced by the poorer-fitting fishery-independent trawl ages (RMSE = 0.657) and, to a lesser extent, the recreational ages (RMSE = 0.234; Figure 3.46c). Lastly, the fits to the mean size data for the RVC indices were well and mostly centered around zero across the timeseries (Figure 3.46d).

The residual series of all three indices passed the runs test, indicating residuals were sufficiently random and without significant autocorrelation (Figure 3.47). The RVC Florida Keys index had a residual in 1999 larger than three standard deviations and this misfit in the KEYS base model was likely balancing with the trends of the other two indices that suggested abundance in prior years was more elevated. It's unclear if this low relative abundance reflects more localized depletion in the Florida Keys or reflects the survey design change in the sampling of available habitat. Earlier index values available during the Data Workshop (i.e., 1997 – 1998) also indicated low abundances; but rather than estimate time-varying catchability (as was done with this index in SEDAR 37 [2014]), the AW panel determined to further curtail the index to 1999 to account for the change in survey.

Only the recreational length composition data had sufficient observations for the runs test and passed (Figure 3.48a). The other length composition data had too few observations due to the application of the super-periods. For the RVC size composition data, both indices failed due to each having two years of residuals greater than three standard deviations with some possible temporal autocorrelation (Figure 3.48b). The KEYS base model estimated for each RVC index a more consistent mean size across time, however, the data showed greater annual variability in mean sizes causing some misfit as described above in Section 3.3.2. While the fits to the annual distributions would not change, these residual patterns may likely be improved if Francis data weighting was utilized since the changes to effective sample sizes would extend the confidence intervals for these annual mean lengths. The conditional age-at-length residuals for the commercial landings and both fishery independent fleets passed the runs test (Figure

3.49). The fishery independent spear ages had one residual greater than three standard deviations and, as noted above, the fishery independent trawl data showed large residuals. The residuals for the recreational landings failed the runs test and showed some positive temporal autocorrelation from 2009 – 2016 as well as a residual in 2004 greater than three standard deviations (Figure 3.49).

3.6.3 Model Consistency

3.6.3.1 Likelihood Profiles

The profile likelihood on the *ln(R0)* parameter revealed that the parameter was largely influenced by the recruitment and RVC size data components but conflicted with the index data component (Figure 3.50). The profile minimum agreed with the KEYS base model estimate of 8.0, but also indicated a parameter estimate between ~7.8 – 8.2 would not produce a significantly worse fit to the data (i.e., change in log-likelihood <2 units). Agreement from the RVC size data component was primarily influenced by the RVC Dry Tortugas size data while the RVC Florida Keys size data preferred an *ln(R0)* estimate greater than 8.3. The length, discard, and conditional age-at-length data were largely non-informative to the *ln(R0)* parameter but showed some indication that the estimate should be >7.2 and <8.4.

Similarly, the profile of the *steepness* parameter indicated influence from the recruitment component, but conflict with the index component. The profile minimum agreed with the KEYS base model estimate of 0.472 but showed a parameter estimate between 0.4 – 0.6 would not produce a significantly worse fit to the data (Figure 3.51). The recruitment component favored a *steepness* estimate between 0.35 – 0.5 while the index component suggested a much weaker stock-recruitment relationship (*steepness* >0.75). The remaining length, size, discard, and conditional age-at-length data components were largely non-informative but indicated the parameter estimate should be >0.35.

3.6.3.2 Age-structured Production Models

The results from the ASPM indicate that for most of the timeseries there is enough information in both the catch and index data for the production function to largely drive the stock dynamics and for the model to be adequately informed about scale (Figures 3.52 – 53). The ASPM also greatly benefited from the F as a parameter configuration (process error) which allowed the model to access the observational error of the catch in order to compensate for the lack of recruitment deviations. In other words, rather than being able to adjust how many recruits will be needed to fit the upcoming data (bottom-up), the ASPM was able to tune fishing mortality to adjust the numbers in the population and fit the data (top-down). This resulted in the ASPM artificially estimating a significantly high exploitation rate in 1984 in order to reduce the spawning biomass low enough so that estimated recruitment (based on the stock-recruitment curve) would be low enough to fit the data through the mid-1990s (Figure 3.52a-c). After year 2000 when all three indices were available, the ASPM had a close enough estimate of absolute scale in which to adequately fit the indices (Figure 3.53b-d) and continued to follow the population trends of the KEYS base model.

The estimate of *ln(R0)* by all three models generally overlapped in distribution (Figure 3.53a) and corroborated the results of the *ln(R0)* profile. The ASPM with recruitment deviations (ASPMdev) estimated a slightly smaller population scale with larger exploitation rates but followed the same trend as the KEYS base model (and to a lesser extent the ASPM), indicating the inclusion of length and age composition data in the KEYS base model is still informative to estimates of population scale (Figure 3.52a-b). The trend in age-0 recruitment and recruitment deviations of the ASPMdev was also very similar to the KEYS base model, suggesting the model needed that process error in order to better fit the trends in the indices (Figure 3.52c-d). Indeed, without the influence of the composition data, fits to all three indices by the ASPMdev were improved.

Fits to the RVC Dry Tortugas index ($RMSE_{ASPMdev}$ = 0.109; $RMSE_{ASPM}$ = 0.202; Figure 3.53c; Table 3.13) were the best, followed by the RVC Florida Keys index ($RMSE_{ASPMdev}$ = 0.205; $RMSE_{ASPM}$ = 0.310; Figure 3.53a; Table 3.13). The combined video survey was the worse fitting of the three indices ($RMSE_{ASPMdev}$ = 0.352; $RMSE_{ASPM}$ = 0.493; Figure 3.53d; Table 3.13) with the ASPM largely underestimating the first 5 years of the survey.

3.6.3.3 Retrospective Analysis

The retrospective analysis showed a slight pattern in estimates of spawning stock biomass and exploitation after removing successive terminal years. Spawning stock biomass tended to decrease in trend while exploitation tended to increase in trend; thus, estimates of the population became more favorable with the addition of each successive year of data (Figure 3.54a-b). All runs were within the 95% confidence interval of the KEYS base model, converged, and contained no parameters on the bounds. Furthermore, the calculated values for Mohn's rho for SSB (ρ_M = -0.112; Table 3.14) and exploitation (ρ_M = 0.112; Table 3.14) were within the "acceptable" range for longer-lived species according to Hurtado-Ferro et al. (2015).

As mentioned earlier in Section 2.6, the KEYS base model's inclusion of process error in the form of recruitment deviations ending in 2021 and the sum-to-zero constraint eliminated the stronger retrospective pattern observed in earlier models. Also mentioned earlier in section 2.13.1 was the use of an MCMC 'proxy' model to aid in estimates of uncertainty in model parameters and derived quantities. Since this model had to remove the sum-to-zero constraint and extend recruitment deviations through 2024, we report a retrospective pattern could still be seen in that model. The calculated Mohn's rho value for SSB was -0.222 and 0.230 for exploitation; hence, we continued to treat this model as supplementary in providing further measures of uncertainty rather than a replacement to the KEYS base model.

3.6.4 Model Validation (Prediction Skill)

Retrospective forecasting showed that the one year forward projections were largely consistent with the overall estimated trend in the reference model and were similar in trend to the results of the retrospective analysis (Figure 3.54a-b). All retrospective forecasts fell within the 95% confidence interval of the KEYS base model. The forecast rho value for spawning stock biomass increased slightly to ρ_F = -0.099 and exploitation decreased to ρ_F = -0.095 (Table 3.14), suggesting model stability as well as consistency when successive data became available.

A hindcast with cross-validation of the terminal seven years of data was performed to gauge predictive capacity of the KEYS base model. From the indices, eleven total observations were available, and a joint MASE score of 0.657 indicated the KEYS base model predicted these indices almost twice as accurately as a naïve forecast (Table 3.15). All three indices scored similar MASE values; the combined video survey was lowest (MASE = 0.63, Table 3.15), followed by the RVC Dry Tortugas index (MASE = 0.67, Table 3.15), and the Florida Keys index (MASE = 0.69, Table 3.15). Only the RVC Dry Tortugas mean size data indicated predictive capacity (MASE = 0.597, Table 3.15) while the number of super-period observations for commercial, recreational, and combined video mean length data precluded computing of prediction residuals. The MASE values for the conditional age-at-length (CAAL) data demonstrated low mean absolute errors and all CAAL data sources were better predicted by the KEYS base model than a naïve baseline prediction (joint MASE = 0.167; Table 3.15).

3.6.5 Sensitivity Runs

3.6.5.1 Start Year

The results from the sensitivity model using 1986 as a start year exhibited substantial consistency with the KEYS base model (Figure 3.55a – f). Estimates of exploitation (Figure 3.55a), spawning stock biomass

(Figure 3.55b), and recruitment (Figure 3.55e), were all on average <10% difference from the KEYS base model estimates. However, the differences between the two models came down to estimated differences in stock productivity and subsequent SPR-based reference points for biomass.

Since the data in the 'StYr_1986' model were insufficient to estimate a stock-recruitment relationship, *steepness* was fixed at 0.99. This meant that, although estimates of SSB and recruitment were similar between the two models, recruitment would be centered around the same average at lower stock sizes as it would be at larger and unfished stock sizes (Figure 3.55f). This difference becomes significant primarily when considering reference points for the stock. For example, the estimates of exploitation at 30% and 40% SPR were largely consistent between the two models (KEYS base model = 0.190 and 0.128, 'StYr_1986' model = 0.186 and 0.133, respectively). However, the $SSB_{F40\%SPR}$ value estimated by the 'StYr_1986' model was 1,321.570 mt (compared to 912 mt by the KEYS base model) and the $SSB_{F30\%SPR}$ value was 989.077 mt (compared to 154.312 mt by the KEYS base model). Furthermore, the $SSB_{F30\%SPR}$ value estimated by the KEYS base model was in close proximity to equilibrium yield values nearing zero (see below Section 3.7) and contained high uncertainty (CV = 2.54). MSY-based reference points were also not possible for the 'StYr_1986' model given the absence of a stock-recruitment relationship.

Interestingly, profiling the *steepness* parameter in the 'StYr_1986' model indicated a significantly better model fit to the data (via total log-likelihood) when set well below 0.99 (Figure 3.55g) and was influenced most by both the recruitment component and the RVC size composition component.

3.6.5.2 Discard Mortality

The KEYS base model was rather insensitive to changes in discard mortality estimates. Higher (59%) discard mortality rates corresponded to higher exploitation rates, and vice-versa, but produced on average a 5% difference in annual exploitation from the KEYS base model (Figure 3.56a). Increases in exploitation corresponded to decreases in spawning stock biomass which overall only exhibited an average 2% change (Figure 3.56b). Age-0 recruitment was nearly unchanged with <1% average difference (Figure 3.56c).

3.6.5.3 Natural Mortality

The differing assumptions on natural mortality primarily resulted in mortality-at-age values which were higher than those input to the KEYS base model, especially at the youngest ages (Figure 3.57a). In the KEYS base model, age-3 fish experienced $M = 0.279$ yr^{-1} based on the Lorenzen (1996) mortality-at-weight equation (see Section 2.7 in the Data Workshop Report). The three sensitivity runs, 'HamelCope_age3', 'est_HamelCope_age3', and 'est_HamelCope_age3_noprior' resulted in age-3 M values of 0.338 yr^{-1}, 0.435 yr^{-1}, and 0.312 yr^{-1}, respectively. Estimates of exploitation rate (Figure 3.57b) and spawning stock biomass (Figure 3.57c) were consistent and were within the uncertainty provided by the KEYS base model. However, a scalar pattern that emerged was that as M increased across scenarios, so did estimates of age-0 recruitment (Figure 3.57d). This makes sense because the greatest increases to *M-at-age* occurred on age-0 individuals; therefore, the model needed to generate more age-0 fish to ensure enough adult fish were available in the population.

From a likelihood perspective, both the 'HamelCope_age3' and 'est_HamelCope_age3_noprior' scenarios fit the data similarly to the KEYS base model (i.e., within 2 LL units) and produced comparable estimates of life history and stock-recruitment parameters. For example, estimated (L_{inf}) values were 54.0 and 52.5 cm FL, respectively, while *steepness* estimates were 0.44 and 0.46. These results were particularly informative because when the model was allowed to freely estimate natural mortality internally without a prior (i.e., 'est_HamelCope_age3_noprior'), the outputs closely aligned with those of the KEYS base model.

Surprisingly, when *M* was estimated internally using the standard deviation prior in log-space, it resulted in a significantly higher *M* and poorer model fits to the data (via LL). In response, the model adjusted several life history and stock-recruitment parameters to compensate for the elevated mortality. Virgin recruitment (R_0) and annual recruitment, on average, was nearly four times greater than the KEYS base model and L_{inf} increased to 64.2 cm FL. With this larger asymptotic length, the model consistently underestimated mean lengths for fish ages 1–11 as the growth coefficient (*k*) was reduced to 53% (*k* = 0.095) the value estimated by the KEYS base model.

3.7 Per-recruit Analyses

The yield-per-recruit (YPR), spawner-per-recruit (SSB/R), static spawning potential ratio (SPR), and total equilibrium yield analyses were computed as a function of the instantaneous exploitation rate on Florida Keys/East Florida Hogfish and are presented in Table 3.16 and Figures 3.58 – 59a. Presented with these values is also their relation to various MSY- and SPR-based reference points. The SPR values by year were calculated and are presented in Figure 3.59b. The retained yield at F_{MSY} for Florida Keys/East Florida Hogfish was estimated to be 94.552 mt (208,451 lbs.; Figure 3.58d) while the total yield (retained yield plus dead discards) at F_{MSY} was 165.068 mt (363,913 lbs.; Figure 3.58c). The retained yield associated with $F_{40\%SPR}$ was estimated at 71.100 mt (156,749 lbs.; Figure 3.58d) but at $F_{30\%SPR}$ was estimated to be 17.249 mt (38,027 lbs.; Figure 3.58d) with high uncertainty (CV = 2.54).

3.8 Uncertainty in Parameters and Derived Quantities

3.8.1 MCMC Analysis

Of the eight chains produced, only six were found to have converged based on Geweke's diagnostic; thus, a total of 2,400 iterations remained. The six chains were combined, and convergence was evaluated using trace plots (Figure 3.60) and the Gelman and Rubin's (1992) potential scale reduction factor (PSRF) for selected model parameters (*ln(R0)*, SSB_0, and *steepness*) and derived quantities (exploitation in 2024, SSB in 2024, F_{MSY}, SSB at F_{MSY}, and the retained yield at F_{MSY}). PSRF values for all selected parameters and stock status criteria were close to 1 and since none of the PSRF upper confidence intervals exceeded the 'rule of thumb' value of 1.1, it was concluded that the MCMC converged (Table 3.17).

Posterior distributions from the MCMC 'proxy' model were produced for stock-recruitment parameters (Figure 3.61) as well as the derived quantities of $F_{current}$ (Figure 3.62a), F_{MSY} (Figure 3.62b), the retained yield associated with F_{MSY} (Figure 3.62c), $SSB_{current}$ (Figure 3.62d), SSB at F_{MSY} (Figure 3.62e), 75% of the SSB at F_{MSY} (Figure 3.62f), $F_{40\%SPR}$ (Figure 3.63a), and SSB at $F_{40\%SPR}$ (Figure63b). Estimated values of the KEYS base model were generally found to fall within the interquartile ranges of these posterior distributions (Figures 3.61 – 63) which further evidenced the MLE values were not "captured in a strange neighborhood". Given the high uncertainty of 30% SPR-based reference points estimated by the KEYS base model, posterior distributions were not attempted.

3.8.2 Parametric Bootstrap

Results of the bootstrap analysis indicated that the model exhibited a measure of instability when fitting to the randomly generated data sets. From the 1,000 bootstrapped data sets, 669 runs had a gradient >0.0001 yet the maximum gradient observed was still relatively low at 0.707. A total of 746 runs had at least one parameter on the bounds. However, distributions of selected parameter estimates and derived quantities were largely consistent with those observed in the posterior distributions from the MCMC 'proxy' model and the KEYS base model estimates generally fell within the interquartile ranges (Figure 3.64).

3.9 Stock Status Determination Criteria

A summary of the Florida Keys/East Florida Hogfish stock status determination criteria and their values as presented in the TORs and according to the SAFMC from the SEDAR 94 KEYS base model is presented in Table 3.18. Stock status of Florida Keys/East Florida Hogfish was considered in SEDAR 37 (2014) according to both MSY and MSY_{proxy} based reference points (e.g., SPR 30%) and *steepness* was estimated to be 0.83 using a full beta prior (h = 0.748, sd = 0.146) based on Shertzer and Conn (2002). Subsequently, the SAFMC Snapper Grouper Amendment 37 set MSY to $F_{30\%SPR}$. The KEYS base model also estimated the *steepness* parameter with the assumption of a stock-recruitment relationship and we continue by presenting both MSY- and SPR-based reference points for consideration (Figures 3.65 – 66). However, while SPR-based reference points are characterized here, it should be noted that due to the lower value of the *steepness* parameter estimated by the KEYS base model (h = 0.47), most 30% SPR reference points were estimated with high uncertainty (i.e., CV >2).

The Maximum Fishing Mortality Threshold (MFMT) for Florida Keys/East Florida Hogfish is currently defined as $F_{30\%SPR}$ and overfishing is occurring if the recent average of fishing mortality rates ($F_{current}$) exceeds the MFMT. $F_{current}$ is calculated as the geometric mean of exploitation rates for 2022 – 2024. Based on this, the MFMT was estimated by the KEYS base model to be 0.190 yr^{-1}, $F_{current}$ was estimated to be 0.020 yr^{-1}, and F_{2024} was estimated to be 0.016 yr^{-1} (Figure 3.66a). The F_{MSY} was estimated to be 0.077 yr^{-1} (Figure 3.65a) and $F_{40\%SPR}$ was estimated to be 0.128 yr^{-1} (Figure 3.66a). Using either of these reference points, the Florida Keys/East Florida Hogfish stock was not found to be experiencing overfishing ($F_{current}/F_{30\%SPR}$ = 0.105; $F_{current}/F_{MSY}$ = 0.258; $F_{current}/F_{40\%SPR}$ = 0.156).

The minimum stock size threshold (MSST) for Florida Keys/East Florida Hogfish is currently defined as 75 percent of the spawning stock biomass associated with $F_{30\%SPR}$ (i.e., 0.75* $SSB_{F30\%SPR}$). The stock is overfished if the recent average spawning stock biomass ($SSB_{current}$) is less than MSST. The $SSB_{current}$ is calculated as the geometric mean of the spawning stock biomass for 2022 – 2024 and was estimated to be 1,964.579 mt (2,204.623 lbs.) with SSB_{2024} estimated to be 2,084.69 mt (4,595,955 lbs.). The $SSB_{F30\%SPR}$ was estimated by the KEYS base model with high uncertainty (CV = 2.54) at 154.312 mt (340,200 lbs.) and MSST was therefore defined as 115.734 mt (255,150 lbs.; Figure 3.66b). The SSB_{MSY} was estimated at 1,952.400 mt (4,304,305 lbs.; Figure 3.65b) and the $SSB_{F40\%SPR}$ was estimated at 912.573 mt (2,011,879 lbs.; Figure 3.66b). Based on these results, the Florida Keys/East Florida Hogfish stock was not found to be overfished ($SSB_{current}/SSB_{F30\%SPR}$ = 16.975; $SSB_{current}/SSB_{MSY}$ = 1.342; $SSB_{current}/SSB_{F40\%SPR}$ = 2.870).

From the posterior distributions of the MCMC 'proxy' model, the median value for F_{MSY} was estimated to be 0.099 yr^{-1} (Figure 3.62b), $F_{current}$ was estimated to be 0.019 yr^{-1} (Figure 3.62a), SSB_{MSY} was estimated to be 1,650.74 mt (3,639,259 lbs.; Figure 3.62e), $MSST_{MSY}$ was 1,238.055 mt (2,729,444 lbs.; Figure 3.62f), and $SSB_{current}$ was estimated to be 2,084.086 mt (4,594,623 lbs.; Figure 3.62d). Median values of $F_{40\%SPR}$ and $SSB_{F40\%SPR}$ were 0.133 yr^{-1} (Figure 3.63a) and 1,124.165 mt (2,478,360 lbs.; Figure 3.63b), respectively. The MCMC distribution of the retained yield at F_{MSY} had a median value of 97.388 mt (214,704 lbs.; Figure 3.62c). Additional posterior distributions of the MSY-based F_{ratio} ($F_{current}/F_{MSY}$) and SSB_{ratio} ($SSB_{current}/MSST_{MSY}$) are presented in Figure 3.67 where median values were 0.193 and 1.685, respectively. The estimates for these reference points as derived by the KEYS base model were just outside the interquartile ranges of these posterior distributions; however, the uncertainty indicated a more favorable stock condition, namely that the F_{ratio} was lower (Figure 3.67a) and the SSB_{ratio} was higher (Figure 3.67b). The distribution of the F_{ratio} was entirely below one, indicating a high probability that overfishing is not occurring while 99% of the distribution for the SSB_{ratio} was above one, indicating a high probability that the stock is not overfished.

3.10 Bridge Building

The SEDAR 37 base model characterized a stock that was heavily depleted in the start year and remained depleted through the terminal year. This was very different in comparison to the SEDAR 94 KEYS base model which estimated around double or more the spawning stock size for most overlapping years and the bridge building model which estimated more of a middle ground between the two (Figure 3.68a). Typically, this display of model behavior in SS would be identified with some temporal or configuration misspecification and addressed. Unfortunately, however, at the time of the SEDAR 37 assessment the diagnostic capabilities of SS were not as developed as we have available today and misspecifications were missed in that model development process. For example, by applying the 'cookbook' diagnostics to the SEDAR 37 base model, the ASPM model immediately crashed the population without access to the composition data or recruitment deviations while the ASPMdev model was near exact to the base model; this suggests the base model sustained the population almost entirely on the process error of recruitment deviations. Corresponding to the trend in SSB, estimates of exploitation rate in the SEDAR 37 base model were higher than reported here but tended to follow the same trend. Exploitation rates from the bridge building model were closer in scale to the KEYS base model and typically fell within the 95% confidence intervals (Figure 3.68b). Age-0 recruitment of the bridge building model was more often similar to the KEYS base model while the SEDAR 37 base model was closer in magnitude to the lower 95% confidence interval (Figure 3.68c).

However, stock-recruitment dynamics were quite different between all three models (Figure 3.68d) due to differences in available data and configuration. For example, s*teepness* was estimated in both the KEYS base model and the SEDAR 37 base model, but at very different values (S94: $h = 0.472$; S37: $h = 0.829$). In SEDAR 37, the *steepness* parameter was not configured for use in the initial equilibrium recruitment which meant any decline in SSB between SSB_0 and the start year did not correspond with any decline in recruitment (i.e., $h = 0.99$). Depletion in the 1986 start year was significant (~90%) and since the SSB_0 estimate was similar to the KEYS base model estimate, the absence of any reduction in recruitment was influential to the *steepness* parameter and resulted in a comparatively higher value. The KEYS base model also had access to the historic catch data which greatly informed the *steepness* parameter. In contrast, the bridge building model, without the historic catch data or a prior, had a difficult time estimating *steepness* and needed to be fixed at 0.99. This resulted in similar SSB and recruitment magnitudes (Figure 3.68a,c) but also higher recruitment estimates during the 1990s when stock size was much lower.

Lastly, a continuity model which aimed at exploring the impact of updating the recreational landings timeseries from the old MRFSS/MRIP to the SRFS back-calculated historical timeseries within the SEDAR 37 base model was developed (i.e., "SEDAR 37 SRFS"). For each gear, spear (Figure 3.69a) and hook-and-line (Figure 3.69b), the differences in catch magnitude between the two survey methods were minimal and higher SRFS estimates became more consistent starting in 2004 (Figure 3.69c). This was not too surprising as the SRFS estimates for these years (1986 – 2012) behave more like a scalar reduction to the MRIP estimates. Consequently, differences in model estimated population dynamics were minimal as trends in spawning stock biomass (Figure 3.70a), recruitment (Figure 3.70b), and exploitation rate (Figure 3.70c) were often within the uncertainty estimated by the SEDAR 37 base model in the first half of the timeseries before becoming higher through 2012.

3.11 FL KEYS/EFL Discussion

The SEDAR 94 Florida Keys/East Florida Benchmark Assessment incorporated fourteen years of new data since the previous assessment (SEDAR 37; terminal year = 2012); changes to the data took place in nearly every component and all historical data were procured and recompiled following SEDAR Data

Best Practices as closely as possible. This assessment utilized stock-specific characterizations of life history data, reanalyzed older reproduction data according to recent recommendations (Lowerre-Barbieri et al. 2022), and applied recent methods to estimate natural mortality (Hamel and Cope 2022; Lorenzen 2022). It made use of revised estimates of recreational landings and discards (via SRFS and SRFS-calibrated data for the Florida private mode and MRIP-FES data for charter and shore modes), incorporated historic commercial landings and reconstructed recreational landings, and revised recreational discard mortality rates based on recent data collections. Lastly, this assessment incorporated additional fishery-independent age-at-length data and updated original fishery-independent surveys but removed several fishery-dependent CPUE timeseries.

Data used in the KEYS base model were often characterized by high uncertainty and limited availability, necessitating several configuration changes to maintain model parsimony. One of the most important changes involved the treatment of fishing fleets. Recreational landings, discards, and composition data separated by spear and hook-and-line gears were highly uncertain, with annual CVs frequently exceeding 0.5 and sample sizes often being low. To address these limitations, the gears were combined into a single recreational fleet, resulting in modest improvements in the precision of landings and discard estimates. However, annual CVs still commonly exceeded 0.3 – 0.5, and length-composition data remained noisy, requiring the use of super-periods to increase effective sample sizes. Similar challenges existed for the commercial fishery. Although commercial landings estimates were relatively precise, annual sample sizes for composition data were low, discard estimates were unavailable, and commercial landings represented only a small proportion of total landings (on average, less than 5%). As a result, commercial gears were also aggregated into a single fleet, and super-periods were applied to the length-composition data. These data limitations underscore the importance of improving more targeted and consistent biological sampling in both the recreational and commercial fisheries to reduce uncertainty in model estimates and strengthen future Hogfish stock assessments.

By configuring recreational fishing mortality as an annual parameter within the KEYS base model, uncertainty in the recreational landings and discard data could be better accommodated. The model generally reproduced the observed trend and magnitude of recreational landings, although it estimated higher landings in 1988 and lower landings in 2008, 2012, and 2015. These deviations were linked to the model's interpretation of population dynamics. Specifically, the model estimated a decline in female numbers-at-age during the late 1990s and early 2000s, a signal that was likely informed by the co-occurring period of low recreational landings. To generate this reduction in females, the model first estimated a decline in mean male numbers-at-age beginning in 1988, which reduced reproductive output. Because sex transition in the model is governed by the cumulative hermaphroditism function, the initial decline in males subsequently propagated through the population and contributed to further reductions in female numbers, which in turn led to continued reductions in mean male numbers-at-age through approximately 2009. As spawning biomass declined, the model was unable to produce enough fish to support the unusually high recreational landings estimates observed in several later years. Consequently, the model favored lower landings estimates in those years to remain consistent with the broader population dynamics implied by the full dataset. The configuration of recreational fishing mortality to annual parameters was supported by a runs test of the recreational landing's residuals from 1981 – 2024, which indicated the residuals were sufficiently random and lacked significant temporal autocorrelation ($p = 0.36$). Additional support came from a sensitivity analysis conducted during the model development process in which recreational landings were fit exactly (i.e., F_{hybrid}). Although that configuration improved agreement with the recreational landings data, it produced poorer fits to other data sources, particularly the abundance indices, discards, and length composition data. Together, these results suggest that

allowing the model flexibility to deviate from the input recreational landings estimates resulted in a more internally consistent fit across all available datasets.

Historically, the recreational private mode catch time series has been the largest contributor to recreational landings and discards for the Florida Keys/East Florida Hogfish stock. In recent stock assessments, incorporation of Florida's SRFS data effectively acted as a scalar reduction to the pre-2021 private mode catch series, resulting in reductions to estimates of spawning stock biomass and productivity when comparing to models utilizing the MRIP-FES calibration. This pattern was observed in the SEDAR 79 (2024) Mutton Snapper benchmark assessment and the SEDAR 96 (2024) Yellowtail Snapper operational assessment. For Hogfish, however, the ad-hoc calibrated MRFSS-MRIP estimates used in SEDAR 37 were already similar in magnitude to the "Full SRFS" estimates evaluated here and the MRIP-FES calibration estimates were never used in a Florida Keys/East Florida Hogfish assessment. As a result, incorporating SRFS produced only minor changes in estimated stock size and exploitation rates, as demonstrated by the "SEDAR 37 SRFS" continuity model. In contrast, results from the "S37data_S94config" continuity model indicated that the larger difference in biomass estimates between the KEYS base model and the SEDAR 37 base model were driven primarily by the configuration changes implemented for SEDAR 94. These findings suggest that model structural and configuration changes, rather than the adoption of SRFS catch estimates, were the primary source of the observed differences in estimated biomass.

In SEDAR 37, all three Hogfish stocks in the southeastern U.S. were assumed to be exhibit the same life history characteristics where knowledge on growth, mortality, reproduction, and hermaphroditism was predominantly informed by West Florida Shelf data. Thus, a key modification to the KEYS base model in the current assessment was the incorporation of stock-specific life-history information for the Florida Keys/East Florida stock. Central to this effort was the availability and inclusion of fishery-independent CAAL data from multiple life-history studies, which allowed growth to be estimated directly within the assessment model. Although some of these data were available during SEDAR 37 (e.g., the McBride dataset), they were not incorporated as direct model inputs. Without these fishery-independent data, the SEDAR 37 model could not reliably estimate growth, as reported therein by a sensitivity run which estimated an asymptotic length of 42.6 cm FL. In contrast, growth parameter estimates from the KEYS base model were consistent with those from the external growth model developed during the Data Workshop and the estimated platoon parameter (0.73) indicated evidence of age truncation and Lee's phenomenon within the Florida Keys/East Florida stock (McBride and Richardson 2007). Estimates of mean length-at-age for platoon 4 (63.1 cm FL at age 16) and platoon 5 (77.8 cm FL at age 16) were further supported by observations of larger Hogfish within the commercial length composition data (i.e., commercial TIP data from northeast Florida that were not aged) and anecdotally by fish observed but not measured during dives in the Dry Tortugas (D. Morley, *pers. comm.*). Similarly, mean length-at-age estimates for platoons 3 and 4 were consistent with growth parameter estimates reported by Drake (2021) for Hogfish sampled in Puerto Rico and the U.S. Virgin Islands (L_{inf} = 62.4 cm FL), where habitat conditions are more comparable to the Florida Keys reef tract than to those of the West Florida Shelf or northeast Florida regions (see also section 2.9.4 of the Data Workshop report for comparative discussion on the growth estimates from Cuba). Lastly, incorporating stock-specific hermaphroditism transition rates allowed the KEYS base model to better represent the earlier female-to-male transition observed in the Florida Keys/East Florida stock. Overall, this assessment has benefited substantially from the incorporation of targeted life-history research and the use of stock-specific biological information.

The development and application of the MCMC "proxy" model in this assessment was an uncommon approach but may provide a useful pathway for future Stock Synthesis assessments that benefit from the

flexibility of the F as parameter configuration. This may be particularly valuable when catch data contain considerable observation error and there is a desire to characterize uncertainty beyond model-based standard errors or self-testing bootstrap analyses. Stock Synthesis models configured with the F_{hybrid} approach typically fit landings almost exactly, effectively ignoring observation error and assuming that catches are known without uncertainty. In the southeastern U.S., this assumption is often reasonable for commercial fisheries because monitoring programs function more like a census than a statistical survey and observation error is low (CV = 0.05). However, as demonstrated in this assessment, recreational landings estimates from private, shore, and charter modes are survey-based and can contain considerable uncertainty that should be accounted for within the assessment framework. Estimating F as a parameter allows uncertainty in landings to be integrated with other data sources, enabling the model to estimate catches that differ slightly from the survey estimates while remaining within the bounds of the reported observation error. The MCMC "proxy" model therefore retained the same underlying assumption of a "known" catch used in other F_{hybrid} configurations but treated the KEYS base model's expected catch values as the reference truth rather than the original survey estimates (e.g., SRFS or MRIP). But when including annual fleet-specific F values in an MCMC routine, it greatly expands the parameter space and often causes simulants to explore regions far from the MLE estimates. The MCMC "proxy" model therefore provided a practical configuration workaround for the KEYS base model, capturing uncertainty in parameters and derived quantities while relying on the landings estimates generated by the KEYS base model.

The results of the model diagnostics suggest the SEDAR 94 KEYS base model may be suitable for use in the management of Florida Keys/East Florida Hogfish. The KEYS base model demonstrated adequate fits to the various data components while the jitter analysis and low gradient (<0.0001) lent support that the KEYS base model converged to a global solution. The KEYS base model also exhibited model consistency as the removal of successive years of data back to the 2018 (first model year of new regulations) showed no discernable retrospective patterns in estimates of exploitation rates and spawning stock biomass. The results of the *ln(R0)* profiling, as well as the ASPM and ASPMdev, suggested that the estimates of absolute abundance and trend were consistent and primarily influenced by both the catch information and the variability in recruitment. Retrospective forecasting and the hindcast cross-validation techniques also suggested the KEYS base model exhibited more predictive skill than a random-walk for several data sources.

The MSY-based reference values for Florida Keys/East Florida Hogfish as estimated by the SEDAR 94 KEYS base model moderately supported the historical stock status paradigm of the prior assessments by indicating that the stock experienced intermittent overfishing over a 36-year period and remained overfished for 22 years. Exploitation rates oscillated above and below the candidate F_{MSY} largely between 1981 – 2017; from 1950 – 1980 and from 2017 – 2024 they were estimated below F_{MSY}. The estimated spawning stock biomass dropped below the candidate SSB_{MSY} target in 1993 but rose above it again in the terminal year 2024; the stock was below the candidate $MSST_{MSY}$ from 1996 – 2018. Using these reference point values, the current stock would not be undergoing overfishing ($F_{current}/F_{MSY} = 0.258$), nor would it be considered overfished ($SSB_{current}/MSST_{MSY} = 1.342$). However, estimates of stock condition based on SPR reference values by the KEYS base model differed substantially from this historical perspective. Using the candidate $F_{40\%SPR}$ proxy, exploitation rates were mainly below $F_{40\%SPR}$ with only eight years above it. The spawning stock biomass has remained above both a candidate $SSB_{F40\%SPR}$ target (reaching it in 2006) and $MSST_{F40\%SPR}$ for the duration of the timeseries. From these reference point values, the current stock would also be considered not overfished ($SSB_{current}/MSST_{F40\%SPR} = 2.870$), nor undergoing overfishing ($F_{current}/F_{40\%SPR} = 0.156$). For either of these candidate reference values, the uncertainty in derived quantities was well captured by both the MCMC and bootstrapping analyses with

distributions inclining towards even more favorable stock conditions. In addition, the Florida Keys/East Florida Hogfish stock has shown signs of recovery since 2018, both in observed measures (e.g., RVC indices) and in model-based estimates, likely due in part to the regulatory changes implemented in late 2017.

The SAFMC Snapper Grouper Amendment 37 defines MSY as $F_{30\%SPR}$ and the MSST as 75% of $SSB_{F30\%SPR}$. Under these reference values, the SEDAR 94 KEYS base model indicates that the current Florida Keys/East Florida Hogfish stock is also neither overfished ($SSB_{current}$/MSST > 1.0) nor undergoing overfishing ($F_{current}$/MFMT < 1.0). However, these reference values provide the least protection for the stock as the stock would need to undergo considerable decline to trigger any management intervention moving forward. Current biomass was estimated to be nearly 17 times the MSST, with no evidence of an overfished condition since 1950. The assessment identified only a few years of overfishing having occurred – 1988, 2005, and 2009. The per-recruit analysis conducted in this assessment indicated that $F_{30\%SPR}$ maximizes yield-per-recruit, but it led to very low long-term yields and was estimated to be highly uncertain. Furthermore, projection analyses suggested yields at this exploitation rate were not sustainable. By comparison, F_{MSY} reduced yield-per-recruit by 32% but increased equilibrium total yield by 486% (74,902 to 363,913 lbs.), while $F_{40\%SPR}$ yielded a 13% reduction in yield-per-recruit but a 387% increase in total yield (to 289,974 lbs.). Overall, F_{MSY} (0.077 yr^{-1}) was more conservative than $F_{40\%SPR}$ (0.128 yr^{-1}) but produced higher equilibrium yields, supporting consideration of alternative candidate reference points to $F_{30\%SPR}$ for this stock.

The disparity in $F_{30\%SPR}$ values between the SEDAR 37 FLK/EFL base model and the SEDAR 94 KEYS base model was primarily driven by differences in model configuration, life-history assumptions, and estimates of stock productivity. Notably, the *steepness* parameter was estimated at $h = 0.83$ in the SEDAR 37 FLK/EFL base model, compared with $h = 0.47$ in the current assessment. As demonstrated by the per-recruit analysis, these differences in stock-recruitment dynamics resulted in substantially different $F_{30\%SPR}$ estimates and corresponding positions on the equilibrium yield curve. Additional insight was provided by the "S37data_S94config" continuity model. Using $F_{30\%SPR}$ reference points and the geometric mean $F_{current}$ (2010 – 2012), this model suggested that applying configuration changes similar to those used in the current assessment to the SEDAR 37 FLK/EFL base model could have produced a more favorable terminal stock condition (e.g., $SSB_{ratio} = 1.24$ and $F_{ratio} = 0.70$). Consequently, the stock may have been perceived as being in better condition than indicated by the original assessment. Furthermore, evidence of undiagnosed model misspecification in the SEDAR 37 FLK/EFL base model, as indicated by the ASPM diagnostic described in Section 3.10, adds uncertainty regarding the validity of that model's conclusions. Taken together, the differences in model assumptions, configuration, and apparent misspecification led to substantially different perceptions of stock status and highlight the uncertainty associated with the SEDAR 37 FLK/EFL base model. These findings suggest that the contrasting stock status outcomes between the two assessments were driven more by differences in assessment methodology and underlying assumptions than by changes in the underlying population dynamics themselves.

3.12 FL KEYS/EFL Projections

Short- and long-term deterministic projections were conducted to estimate Florida Keys/East Florida Hogfish spawning stock biomass and yield under a range of harvest scenarios. These were performed under several assumed conditions: growth, and stock-recruitment parameters were kept constant (at values estimated by the SEDAR 94 KEYS base model) while relative apical F, selectivity, and discarding and retention associated with the terminal three years (2022 – 2024) would remain the same into the future. The average relative apical F values from 2022 – 2024 as estimated by the base model were used to determine the fleet allocations in the projection scenarios. These were 1.43% for the commercial fleet

and 98.57% for the recreational fleet. The method to project the assessment results was developed in the R statistical computing environment by SEFSC assessment scientists (https://github.com/SEFSC/SFD-AllocationForecasting).

Although the Florida Keys/East Florida Hogfish stock is currently managed using the $F_{30\%SPR}$ proxy reference point, projections from the KEYS base model (as well as the per-recruit analysis in Section 3.6) suggested this F value (0.189 yr^{-1}) was of much higher risk. In long-term equilibrium projections using the stock-recruitment curve, $F_{30\%SPR}$ held constant depleted the population to <20% within the first 7 years (by 2032) and was <5% in the terminal 10 years of the projections. By assuming recruitment to be constant at the whole timeseries average (1950 – 2024), the population declined until being 21% depleted in the final 10 years of the projections; however, results from the KEYS base model indicate it is unlikely recruitment could be sustained at that average given the degree of depletion. Furthermore, estimates of exploitation rate by the KEYS base model only exceeded this value in 3 years (1988, 2005, and 2009). Therefore, we discuss projections using the F_{MSY} and $F_{40\%SPR}$ proxy reference values but tabulate the $F_{30\%SPR}$ proxy reference value scenarios in Tables 3.19 – 20 to satisfy the TOR.

First, long-term deterministic projections were conducted to determine the equilibrium fishing mortality rate that achieves F_{MSY} or 40%SPR ($F_{40\%SPR}$), as well as the associated spawning stock biomass (SSB_{MSY} or $SSB_{40\%SPR}$), by using an iterative process to set exploitation rates each year that ensures 1) MSY or the MSY_{proxy} (i.e. SPR 40%) is achieved at equilibrium, and 2) annual relative apical fishing mortality between fleets is maintained at the average of the base model's terminal three years (2022 – 2024). This iterative process to achieve equilibrium F_{MSY} or $F_{40\%SPR}$ is different than the Newton-Raphson method utilized by the base model, thus results will be near-exact rather than identical to base model reference point values (Methot et al. 2026). Projections were for 100 years (2025 – 2124) where recruitment either followed the Beverton-Holt stock-recruitment relationship, as parameterized by the KEYS base model, or was held constant at the long-term (1950 – 2024) average; equilibrium was assumed to have been obtained in the final 10 years of the projection (i.e., 2115 – 2124) as recommended by Van Beveren et al. (2021). Please note, however, that due to the configuration of the KEYS base model where main recruitment deviations ended in 2021, projected recruitment within all scenarios *not* relying on the stock-recruitment curve began in 2022. This was a limitation imposed by the structural framework of SS and could not be changed.

Next, short-term deterministic projections, which used a similar iterative process as the long-term projections, were conducted under a range of harvest scenarios and assumed age-0 recruitment remained constant at the recent 5-year average (2020 – 2024) estimated by the KEYS base model (Schueller et al. 2022; Van Beveren et al. 2021). Per the TORs, short-term projections explored the effects of holding fishing mortality rates constant at the equilibrium F_{MSY} or $F_{40\%SPR}$ (as determined via the long-term projection above), at 75% of that equilibrium F_{MSY} or $F_{40\%SPR}$, and at $F_{current}$ (from section 3.8) in order to produce annual yield values. While only the first 5 years of the short-term projection are recommended for use, reported projections were extended until 2034.

3.12.1 Results

The projection results for the constant F scenarios including the associated fishing mortality rates, retained landings (in pounds and numbers), spawning stock biomass (mt), and age-0 recruitment (in numbers) as estimated for assessment years (1950 – 2024) and forecast years (2025 – 2044) are presented in Figures 3.71 – 78 and Tables 3.21 – 25. The equilibrium fishing mortality rate that achieved 40% SPR ($F_{40\%SPR}$) in the long-term projections was 0.129 yr^{-1} (Figure 3.71, Table 3.21) and was near exact to the KEYS base model estimate (0.128 yr^{-1}). Likewise, the equilibrium F_{MSY} in the long-term projection was 0.073 yr^{-1} (Figure 3.75, Table 3.24) compared to 0.077 yr^{-1} by the KEYS base model.

Retained landings from the long-term constant $F_{40\%SPR}$ projection scenario initially increased to values similar to yields prior to 2018, then quickly declined through the 5-yr projection period from 395,330 lbs. in 2025 to 315,678 lbs. in 2029 (Table 3.21, Figure 3.72). Spawning stock biomass declined in response to the higher exploitation rates but became similar to recent years since 2020 (Table 3.21, Figure 3.73); when following the stock-recruitment curve, SSB declined further until becoming more like the mid-2000s years (Table 3.21, Figure 3.73) as recruitment continued to decline through the projection period (Table 3.21, Figure 3.74).

Resulting trends from the short-term $F_{40\%SPR}$ scenario presented as a middle ground between the two long-term projection scenarios given the differing assumptions on recruitment (Table 3.22, Figures 3.71 – 74). $F_{40\%SPR}$ is higher than most exploitation rates estimated throughout the model timeseries and was nearly six-and-a-half times higher than recent exploitation rates ($F_{40\%SPR}/F_{current} = 6.43$). When exploitation rates were held at 75% $F_{40\%SPR}$ (0.097 yr^{-1}; Table 3.22, Figure 3.71), they were a little higher than the whole timeseries (1950 – 2024) average of 0.065 yr^{-1} and were nearly five times higher than recent exploitation rates (75% $F_{40\%SPR}/F_{current} = 4.82$). In the short-term $F_{40\%SPR}$ scenario, retained landings were 387,977 lbs. (114,417 fish) in 2025 and 295,513 lbs. (88,248 fish) in 2029 (Table 3.22, Figure 3.72). In the 75% $F_{40\%SPR}$ scenario, retained landings were 290,920 lbs. (85,881 fish) in 2025 and 254,188 lbs. (74,818 fish) in 2029 (Table 3.22, Figure 3.72). In both scenarios, projected SSB immediately declined (Table 3.22, Figure 3.73) but stabilized near recent year values due to the assumptions on recruitment (Table 3.22, Figure 3.74).

Results from both the long- and short-term constant F_{MSY} projection scenarios were comparatively more stable across time. The exploitation rate at F_{MSY} was nearly four times greater than the current exploitation rate ($F_{MSY}/F_{current} = 3.88$) and 75% F_{MSY} (0.054 yr^{-1}; Table 3.25, Figure 3.75) was nearly three times greater (75% $F_{MSY}/F_{current} = 2.91$). Unlike the $F_{30\%SPR}$ or $F_{40\%SPR}$ scenarios, whose initial spike in retained landings led to immediate declines in SSB and subsequent further declines in yield, the retained landings from the long- and short-term constant F_{MSY} scenarios (Tables 3.24 – 25, Figure 3.76) shaped more steady projections of the SSB (Tables 3.24 – 25, Figure 3.77) given the constant recruitment (Tables 3.24 – 25, Figure 3.78). Retained landings from the short-term constant F_{MSY} scenario were 217,900 lbs. (64,372 fish) in 2025 and 207,928 lbs. (60,588 fish) in 2029 (Table 3.25, Figure 3.76). In the 75% F_{MSY} scenario, retained landings were 163,401 lbs. (48,298 fish) in 2025 and 169,282 lbs. (48,986 fish) in 2029 (Table 3.25, Figure 3.76). Since recruitment in the short-term is held constant at values lower than the long-term or stock-recruit curve estimate (Table 3.25, Figure 3.78), SSB under the constant F_{MSY} scenario declined slightly; however, SSB under the constant 75% F_{MSY} scenario was steadier with a slight increase over time (Table 3.25, Figure 3.77).

Short-term projections for the $F_{current}$ scenario estimated comparatively lower F values (i.e., 0.020 yr^{-1}; Table 3.23, Figure 3.71) and resulted in retained landings increasing to 59,990 lbs. (17,750 fish) in 2025 and 71,199 lbs. (20,355 fish) in 2029 (Table 3.23, Figure 3.72). Projected SSB continued to increase to values estimated similar to the 1980s, reaching 2,517.76 metric tons in 2029 (Table 3.23, Figure 3.73).

3.12.2 Discussion

The various constant F scenarios reflect progressing degrees of risk and management. As for many projection exercises, there were numerous caveats to the methods, including unchanging fleet selectivity and fleet allocations, growth, natural mortality, stock-recruitment parameters, other fixed quantities in the base model, process error in recruitment for the terminal three years, and assumptions of recruitment in future years. Projection results should, therefore, be interpreted carefully.

The estimates of retained yield from the first five years of the short-term $F_{30\%SPR}$ projection decreased from 570,132 to 339,973 lbs. and were similar in magnitude to the average retained landings across earlier parts of the timeseries (e.g., 1950 – 1994: avg. 365,791 lbs.; 1986 – 1994: avg. 562,018 lbs.) when the stock was experiencing its fastest decline. This scenario, and the 75% $F_{30\%SPR}$ scenario, present the highest risk given the greater landings and the underlying assumption that recruitment will not diminish with a depleting stock size, which occurred in the long-term equilibrium scenario when recruitment followed the stock-recruitment curve.

In the short-term constant $F_{40\%SPR}$ and 75% $F_{40\%SPR}$ scenarios, the estimated retained yield from the first five years were similar to the average yield from 1995 – 2017 (287,855 lbs.). During this period, spawning biomass remained above $SSB_{F40\%SPR}$ and followed a more stable but variable trend, while exploitation rates fluctuated between levels that approached or exceeded $F_{40\%SPR}$. Furthermore, as the population's biomass began to increase again in 2018, projections under the constant $F_{40\%SPR}$ scenario suggest that, depending on recruitment assumptions, this increasing trend may be overturned.

The results from the short-term F_{MSY} projections were slightly more conservative than $F_{40\%SPR}$ and indicated a level of harvest that either would not significantly decrease the population from where it has recovered or allow much further recovery, thereby acting as an in-between of more recent (2018+) and prior (1995 – 2017) average yields.

The most conservative constant F scenario representing the least amount of risk was $F_{current}$ and was the only constant F projection where the SSB continued to recover (increase) though time. Results under this scenario represent a status-quo where projected yields were like the average landings from 2018 – 2024 (52,415 lbs.) with both SSB and exploitation rates projected to continue well within any MSY or SPR-based thresholds.

3.13 FL KEYS/EFL Tables

Table 3.1. Historic commercial landings (metric tons) and annual CVs of Florida Keys/East Florida Hogfish by gear for years 1950 – 1985.

	Landings (mt)				
Year	Spear	Hook-and-line	Trap	Combined	CV
1950	0.000	6.305	0.000	6.305	0.25
1951	0.000	11.340	0.000	11.793	0.25
1952	0.000	12.292	0.000	12.292	0.25
1953	0.000	11.294	0.000	11.294	0.25
1954	0.000	12.338	0.000	12.338	0.25
1955	0.000	11.022	0.000	11.068	0.25
1956	0.000	9.163	0.000	9.163	0.25
1957	0.000	4.128	0.000	4.128	0.25
1958	0.000	2.087	0.000	2.087	0.25
1959	0.000	2.449	0.000	2.449	0.25
1960	0.000	1.678	0.000	1.678	0.25
1961	0.454	0.726	0.000	0.726	0.25
1962	0.000	1.225	0.000	1.225	0.2
1963	0.000	3.629	0.000	3.629	0.2
1964	0.000	6.123	0.000	6.123	0.2
1965	0.045	3.719	0.000	3.719	0.2
1966	0.000	4.808	0.000	4.808	0.2
1967	0.000	5.534	0.000	5.534	0.2
1968	0.000	5.488	0.000	5.488	0.2
1969	0.000	3.946	0.000	3.946	0.2
1970	0.000	4.853	0.000	4.853	0.2
1971	0.000	4.264	0.000	4.264	0.2
1972	0.000	4.672	0.000	4.672	0.2
1973	0.000	3.266	0.000	3.266	0.2
1974	0.000	3.447	0.000	3.447	0.2
1975	0.000	3.447	0.000	3.447	0.2
1976	0.000	1.860	0.000	1.860	0.2
1977	0.000	5.162	0.000	5.162	0.2
1978	0.000	1.025	0.000	1.025	0.1
1979	0.000	0.918	0.000	0.918	0.1
1980	0.000	8.917	0.000	8.917	0.1
1981	0.000	8.187	0.000	8.187	0.1
1982	0.000	1.028	0.000	1.028	0.1
1983	0.000	2.097	0.000	2.097	0.1
1984	0.000	1.051	0.000	1.051	0.1
1985	0.000	2.013	0.000	2.013	0.1

Table 3.2. Historic commercial landings (numbers) and annual CVs of Florida Keys/East Florida Hogfish by gear for years 1950 – 1985.

	Landings (numbers)				
Year	Spear	Hook-and-line	Trap	Combined	CV
1950	0	4,894	0	4,894	0.25
1951	352	8,803	0	9,155	0.25
1952	0	9,542	0	9,542	0.25
1953	0	8,768	0	8,768	0.25
1954	0	9,577	0	9,577	0.25
1955	35	8,556	0	8,592	0.25
1956	0	7,113	0	7,113	0.25
1957	0	3,204	0	3,204	0.25
1958	0	1,620	0	1,620	0.25
1959	0	1,901	0	1,901	0.25
1960	0	1,303	0	1,303	0.25
1961	0	563	0	563	0.25
1962	0	951	0	951	0.2
1963	0	2,817	0	2,817	0.2
1964	0	4,754	0	4,754	0.2
1965	0	2,887	0	2,887	0.2
1966	0	3,732	0	3,732	0.2
1967	0	4,296	0	4,296	0.2
1968	0	4,261	0	4,261	0.2
1969	0	3,063	0	3,063	0.2
1970	0	3,768	0	3,768	0.2
1971	0	3,310	0	3,310	0.2
1972	0	3,627	0	3,627	0.2
1973	0	2,535	0	2,535	0.2
1974	0	2,676	0	2,676	0.2
1975	0	2,676	0	2,676	0.2
1976	0	1,444	0	1,444	0.2
1977	0	4,007	0	4,007	0.2
1978	0	796	0	796	0.1
1979	0	713	0	713	0.1
1980	0	6,922	0	6,922	0.1
1981	0	6,356	0	6,356	0.1
1982	0	798	0	798	0.1
1983	0	1,628	0	1,628	0.1
1984	0	816	0	816	0.1
1985	0	1,562	0	1,562	0.1

Table 3.3. Commercial landings (metric tons) and annual CVs of Florida Keys/East Florida Hogfish by gear for years 1986 – 2024.

	Landings (mt)				
Year	Spear	Hook-and-line	Trap	Combined	CV
1986		21.740		21.740	0.05
1987		29.068		29.068	0.05
1988		29.238		29.238	0.05
1989		35.769		35.769	0.05
1990		34.682		34.682	0.05
1991	6.859	11.537	13.412	31.808	0.05
1992	11.284	21.296	9.599	42.180	0.05
1993	11.272	22.035	9.730	43.037	0.05
1994	10.632	14.830	3.123	28.585	0.05
1995	8.042	10.800	2.887	21.729	0.05
1996	7.909	9.224	2.677	19.809	0.05
1997	6.954	10.664	3.834	21.452	0.05
1998	7.065	5.283	3.340	15.688	0.05
1999	4.374	4.151	7.153	15.678	0.05
2000	5.292	3.680	5.088	14.060	0.05
2001	5.481	4.261	1.030	10.772	0.05
2002	5.878	4.135	0.857	10.870	0.05
2003	3.888	6.730	1.219	11.837	0.05
2004	5.617	6.185	1.091	12.892	0.05
2005	3.987	3.056	0.606	7.650	0.05
2006	3.722	1.865	0.858	6.444	0.05
2007	3.387	2.603	0.596	6.586	0.05
2008	3.398	1.965	0.634	5.997	0.05
2009	3.336	2.412	0.750	6.498	0.05
2010	2.441	2.423	0.451	5.315	0.05
2011	2.854	2.257	0.578	5.689	0.05
2012	3.732	1.738	0.969	6.438	0.05
2013	4.936	2.012	0.828	7.775	0.05
2014	6.046	2.340	1.391	9.777	0.05
2015	6.442	2.042	1.525	10.008	0.05
2016	5.311	1.812	0.880	8.003	0.05
2017	3.659	0.852	0.314	4.825	0.05
2018	1.610	0.374	0.077	2.060	0.05
2019	0.814	0.124	0.119	1.057	0.05
2020	1.190	0.107	0.043	1.341	0.05
2021	1.348	0.151	0.035	1.534	0.05
2022	1.188	0.159	0.037	1.383	0.05
2023	1.032	0.061	0.043	1.137	0.05
2024	1.007	0.087	0.025	1.118	0.05

Table 3.4. Commercial landings (numbers) and annual CVs of Florida Keys/East Florida Hogfish by gear for years 1986 – 2024.

Landings (numbers)

Year	Spear	Hook-and-line	Trap	Combined	CV
1986	0	16,876	0	16,876	0.05
1987	0	22,565	0	22,565	0.05
1988	0	22,696	0	22,696	0.05
1989	0	27,767	0	27,767	0.05
1990	0	26,923	0	26,923	0.05
1991	5,324	8,956	10,411	24,692	0.05
1992	8,760	16,532	7,452	32,743	0.05
1993	8,751	17,106	7,553	33,409	0.05
1994	8,253	11,512	2,425	22,190	0.05
1995	6,243	8,383	2,241	16,867	0.05
1996	6,139	7,160	2,078	15,377	0.05
1997	5,398	8,279	2,976	16,653	0.05
1998	5,485	4,101	2,592	12,178	0.05
1999	3,396	3,222	5,553	12,170	0.05
2000	4,108	2,857	3,950	10,914	0.05
2001	4,255	3,308	800	8,362	0.05
2002	4,563	3,210	666	8,438	0.05
2003	3,018	5,224	946	9,189	0.05
2004	4,360	4,801	847	10,008	0.05
2005	3,095	2,373	471	5,939	0.05
2006	2,889	1,447	666	5,003	0.05
2007	2,629	2,021	463	5,113	0.05
2008	2,638	1,526	492	4,655	0.05
2009	2,590	1,872	582	5,044	0.05
2010	1,895	1,881	350	4,126	0.05
2011	2,215	1,752	448	4,416	0.05
2012	2,897	1,349	752	4,998	0.05
2013	3,832	1,562	642	6,036	0.05
2014	4,693	1,817	1,080	7,589	0.05
2015	5,000	1,585	1,183	7,769	0.05
2016	4,123	1,407	683	6,213	0.05
2017	1,910	445	164	2,519	0.05
2018	840	195	40	1,076	0.05
2019	425	65	62	552	0.05
2020	621	56	23	700	0.05
2021	704	79	18	801	0.05
2022	620	83	19	722	0.05
2023	539	32	23	594	0.05
2024	526	45	13	584	0.05

Table 3.5. Recreational landings (numbers) of Florida Keys/East Florida Hogfish by gear for years 1981 – 2024 and annual CVs. The 'Full SRFS' estimates are comprised of 'SRFS & SRFS-calibrated Private' mode, MRIP charter mode, and MRIP shore mode landings estimates. 'SRFS & SRFS-calibrated Private' estimates are comprised of SRFS private mode (2021 – 2024) and SRFS ratio-calibrated MRIP private mode (1981 – 2020). The 'Full SRFS Combined' is comprised of the 'Full SRFS' estimates plus the SRHS estimates.

Landings (thousands)

Year	Full SRFS Spear	CV	Full SRFS HL	CV	SRHS HL	CV	Full SRFS Combined	CV
1981	1,261.618	0.64	22.688	0.62	1.063	0.05	1,285.369	0.77
1982	49.56	0.58	-	-	0.105	0.05	106.740	0.76
1983	182.971	0.80	10.475	0.93	0.314	0.05	193.760	0.77
1984	374.61	0.65	6,269.688	1.04	0.567	0.05	6,644.906	1.01
1985	-	-	176.795	0.97	0.273	0.05	177.068	1.07
1986	95.631	0.74	44.713	0.64	0.589	0.05	140.933	0.62
1987	175.257	0.52	115.874	0.41	0.562	0.05	287.793	0.50
1988	2.391	1.07	66.048	0.81	0.512	0.05	207.630	0.60
1989	61.153	0.96	107.177	0.55	0.392	0.05	168.651	0.58
1990	151.498	0.67	94.21	0.66	0.226	0.05	245.934	0.56
1991	28.131	0.87	59.774	0.80	0.239	0.05	88.144	0.79
1992	126.627	0.49	80.219	0.61	0.383	0.05	244.231	0.50
1993	89.084	0.54	182.23	0.50	0.251	0.05	271.565	0.52
1994	131.068	0.51	66.587	0.49	0.188	0.05	197.843	0.54
1995	64.259	0.64	93.467	0.53	0.414	0.05	158.139	0.63
1996	47.283	0.55	61.529	0.56	0.23	0.05	109.042	0.54
1997	38.643	0.65	27.429	0.50	0.226	0.05	66.140	0.59
1998	31.882	0.54	15.534	0.51	0.236	0.05	47.623	0.61
1999	78.313	0.54	20.54	0.50	0.207	0.05	99.008	0.71
2000	23.817	0.67	12.236	0.69	0.166	0.05	36.220	0.82
2001	21.254	0.51	48.929	0.56	0.2	0.05	70.384	0.79
2002	57.898	0.56	23.566	0.55	0.152	0.05	81.615	0.81
2003	87.332	0.50	48.728	0.62	0.146	0.05	136.206	0.58
2004	62.844	0.52	105.71	0.70	0.467	0.05	169.022	0.69
2005	138.33	0.74	25.447	0.51	0.543	0.05	164.319	0.77
2006	77.115	0.61	50.908	0.48	0.608	0.05	128.631	0.57
2007	115.967	0.48	63.299	0.61	0.336	0.05	179.602	0.52
2008	330.684	0.64	27.319	0.59	0.203	0.05	358.206	0.65
2009	150.09	0.53	95.188	0.76	0.134	0.05	245.412	0.56
2010	163.503	0.68	28.789	0.89	0.071	0.05	192.364	0.74
2011	46.612	0.59	36.482	0.71	0.095	0.05	83.188	0.68
2012	343.894	0.79	42.228	0.58	0.106	0.05	386.226	0.79
2013	76.11	0.46	62.8	0.57	0.124	0.05	139.034	0.53
2014	235.219	0.48	49.699	0.41	0.181	0.05	285.100	0.51
2015	389.797	0.62	122.587	0.27	0.283	0.05	512.667	0.49
2016	176.357	0.44	62.756	0.45	0.167	0.05	239.280	0.48
2017	61.083	0.53	17.219	0.56	0.078	0.05	78.379	0.57
2018	17.155	0.80	1.345	0.90	0.012	0.05	18.512	0.74
2019	-	-	5.689	1.07	0	0.05	5.689	0.39
2020	0.01	1.00	8.975	0.66	0.015	0.05	9.000	0.82
2021	27.456	0.23	5.756	0.54	0.007	0.05	37.713	0.25
2022	6.861	0.28	13.481	0.59	0.006	0.05	18.421	0.28
2023	11.236	0.24	3.976	0.50	0.043	0.05	10.158	0.29
2024	8.971	0.30	4.325	0.48	0.012	0.05	13.308	0.28

Table 3.6. Recreational discards (numbers) of Florida Keys/East Florida Hogfish by gear for years 1981 – 2024 and annual CVs. The 'Full SRFS' estimates are comprised of 'SRFS & SRFS-calibrated Private' mode, MRIP charter mode, and MRIP shore mode landings estimates. 'SRFS & SRFS-calibrated Private' estimates are comprised of SRFS private mode (2021 – 2024) and SRFS ratio-calibrated MRIP private mode (1981 – 2020). The 'Full SRFS Combined' is comprised of the 'Full SRFS' estimates plus the SRHS estimates.

Discards (thousands)

Year	Full SRFS Spear	CV	Full SRFS HL	CV	SRHS HL	CV	Full SRFS Combined	CV
1981	-	-	-	-	-	-	-	-
1982	-	-	-	-	-	-	-	-
1983	-	-	-	-	-	-	-	-
1984	-	-	-	-	-	-	-	-
1985	-	-	-	-	-	-	-	-
1986	-	-	-	-	-	-	-	-
1987	-	-	2.714	1.09	-	-	2.714	1.09
1988	-	-	228.086	1.09	-	-	230.511	1.08
1989	-	-	5.37	1.09	-	-	5.370	1.09
1990	1.677	1.09	14.419	0.86	-	-	16.095	0.80
1991	-	-	-	-	-	-	-	-
1992	2.996	1.09	14.775	0.71	-	-	34.489	0.62
1993	-	-	5.31	1.09	-	-	5.310	1.09
1994	-	-	21.894	0.76	-	-	21.894	0.78
1995	2.072	1.09	66.178	0.70	-	-	68.249	0.70
1996	2.062	1.09	23.835	0.64	-	-	25.897	0.79
1997	-	-	11.35	0.67	-	-	11.350	0.67
1998	-	-	30.742	0.54	-	-	30.723	0.62
1999	0.643	1.09	31.21	0.49	-	-	31.863	0.53
2000	1.363	1.09	12.994	0.72	-	-	14.357	0.91
2001	-	-	9.715	0.92	-	-	9.715	1.08
2002	3.148	0.97	-	-	-	-	3.148	1.09
2003	-	-	25.348	0.60	-	-	25.348	0.74
2004	0.466	1.09	70.534	0.83	0.023	0.5	71.023	0.84
2005	-	-	147.51	0.80	0.099	0.5	147.609	0.80
2006	2.132	1.09	33.235	0.84	0.178	0.5	35.545	0.81
2007	7.263	1.09	48.359	0.85	0.115	0.5	55.737	0.82
2008	-	-	35.794	0.62	0.175	0.5	35.969	0.63
2009	-	-	10.026	1.08	0.073	0.5	10.099	1.08
2010	-	-	8.871	0.81	0.039	0.5	8.910	0.76
2011	-	-	3.643	0.77	0.032	0.5	3.675	1.06
2012	-	-	51.392	0.80	0.086	0.5	51.478	0.82
2013	2.483	1.09	51.632	0.52	0.11	0.5	54.225	0.55
2014	4.141	0.84	87.451	0.36	0.109	0.5	91.701	0.42
2015	-	-	60.743	0.55	0.155	0.5	60.898	0.69
2016	1.953	1.09	35.694	0.69	0.112	0.5	37.759	0.72
2017	-	-	55.895	0.86	0.149	0.5	56.044	0.88
2018	-	-	42.916	0.57	0.118	0.5	43.034	0.70
2019	-	-	43.62	0.76	0.066	0.5	43.686	0.78
2020	-	-	43.522	0.62	0.099	0.5	43.621	0.68
2021	6.089	0.78	69.36	0.29	0.258	0.5	80.429	0.29
2022	-	-	67.396	0.36	0.132	0.5	75.619	0.38
2023	0.165	0.90	95.582	0.31	0.213	0.5	122.053	0.40
2024	0.928	1.26	44.626	0.32	0.13	0.5	45.971	0.35

Table 3.7. Historical reconstruction of recreational landings (Full SRFS Combined) of Florida Keys/East Florida Hogfish from 1950 – 1980. The estimated number of saltwater angler participants in Florida was multiplied by the ratio 0.976097 to obtain the estimated number of participants within the Florida Keys/East Florida region. The number of participants was then multiplied by the average catch/number of participants from years 1982, 1983, and 1985 (CPUE = 0.263904) to reconstruct the number of landings.

	Number of Saltwater Anglers		Reconstructed Landings (numbers)
Year	Florida	Florida Keys/East Florida	Florida Keys/East Florida
1950	265,900	259,544	68,495
1951	274,187	267,633	70,629
1952	282,475	275,723	72,764
1953	290,762	283,812	74,899
1954	299,049	291,901	77,034
1955	307,337	299,990	79,169
1956	315,624	308,080	81,303
1957	323,911	316,169	83,438
1958	332,199	324,258	85,573
1959	365,676	356,935	94,197
1960	374,577	365,623	96,489
1961	414,720	404,807	106,830
1962	391,199	381,848	100,771
1963	399,699	390,145	102,961
1964	418,956	408,941	107,921
1965	442,416	431,840	113,964
1966	453,819	442,972	116,902
1967	493,510	481,714	127,126
1968	496,090	484,232	127,791
1969	521,289	508,828	134,282
1970	562,752	549,301	144,963
1971	705,592	688,726	181,758
1972	731,204	713,726	188,355
1973	772,865	754,391	199,087
1974	834,392	814,448	214,936
1975	870,670	849,858	224,281
1976	821,995	802,346	211,742
1977	739,438	721,764	190,476
1978	667,847	651,884	172,035
1979	716,261	699,140	184,506
1980	588,882	574,806	151,694

Table 3.8. Indices of relative biomass or abundance values and associated CVs for Florida Keys/East Florida Hogfish from years 1993 – 2024.

	RVC Florida Keys		RVC Dry Tortugas		Combined Video	
Year	Index	CV	Index	CV	Index	CV
1993	-	-	-	-	1.852	0.34
1994	-	-	-	-	1.441	0.49
1995	-	-	-	-	1.552	0.38
1996	-	-	-	-	1.009	0.38
1997	-	-	-	-	0.930	0.32
1998	-	-	-	-	-	-
1999	0.300	0.13	1.133	0.08	-	-
2000	0.592	0.09	0.834	0.09	-	-
2001	0.652	0.08	-	-	-	-
2002	0.806	0.08	-	-	1.536	0.52
2003	0.948	0.08	-	-	0.686	0.44
2004	1.063	0.09	0.855	0.07	0.945	0.36
2005	0.938	0.07	-	-	0.768	0.35
2006	0.815	0.07	0.577	0.08	0.635	0.34
2007	0.907	0.06	-	-	0.346	0.54
2008	1.402	0.05	0.791	0.07	0.407	0.43
2009	1.004	0.05	-	-	0.660	0.35
2010	0.797	0.07	0.834	0.06	1.427	0.25
2011	0.865	0.06	-	-	0.782	0.31
2012	1.059	0.05	1.133	0.05	0.752	0.40
2013	-	-	-	-	0.705	0.23
2014	1.324	0.05	0.813	0.06	0.492	0.28
2015	-	-	-	-	0.760	0.21
2016	1.543	0.05	0.791	0.07	0.923	0.16
2017	-	-	-	-	1.214	0.15
2018	1.158	0.05	1.112	0.05	1.262	0.16
2019	-	-	-	-	1.175	0.17
2020	-	-	-	-	1.648	0.16
2021	-	-	1.390	0.08	1.094	0.19
2022	0.943	0.10	-	-	1.536	0.52
2023	-	-	1.518	0.07	0.686	0.44
2024	1.882	0.07	1.219	0.09	0.945	0.36

Table 3.9. Dirichlet-multinomial weights applied to length and size composition data of the SEDAR 94 KEYS base model. Theta ratios are calculated as theta/(1+theta).

Data Type	Fleet/Index	*ln(theta)*	*theta*	*theta ratio*
Length Composition	Commercial landings	2.093	8.11	0.89
	Recreational discards	0.987	2.68	0.73
	Recreational landings	-0.764	0.47	0.32
	Combined video index	0.442	1.56	0.61
Size Composition	RVC Florida Keys and RVC Dry Tortugas indices	-0.347	0.71	0.41

Table 3.10. List of Stock Synthesis parameters for the SEDAR 94 KEYS base model. The list includes expected parameter values (Value), lower (Min) and upper (Max) bounds of the parameters, associated standard deviation (Std Dev) and coefficients of variation (CV), prior type (Prior), prior standard deviation (Prior Std Dev), and the phase (Phase) of estimation. Parameters designated as fixed were held at their initial values and have no associated range or SE.

	Parameter Label	Value	Min	Max	Std Dev	CV	Prior	Prior Std Dev	Phase
1	L_at_Amin_Fem_GP_1	6.649	2	20	0.754	0.113			3
2	L_at_Amax_Fem_GP_1	51.170	30	80	3.391	0.066			3
3	VonBert_K_Fem_GP_1	0.177	0.05	0.4	0.024	0.138			4
4	CV_young_Fem_GP_1	0.479	0.05	0.9	0.051	0.107			7
5	CV_old_Fem_GP_1	0.367	0.05	0.9	0.045	0.122			7
6	Wtlen_1_Fem_GP_1	2.55E-05	-3	3					Fixed
7	Wtlen_2_Fem_GP_1	2.927	-3	4					Fixed
8	Mat50%_Fem_GP_1	2.080	1	4					Fixed
9	Mat_slope_Fem_GP_1	-3.034	-4	-0.1					Fixed
10	Eggs_scalar_Fem_GP_1	1.000	-3	3					Fixed
11	Eggs_exp_wt_Fem_GP_1	1.000	-3	3					Fixed
12	L_at_Amin_Mal_GP_1	0.000	-1	1					Fixed
13	L_at_Amax_Mal_GP_1	0.000	-1	1					Fixed
14	VonBert_K_Mal_GP_1	0.000	-1	1					Fixed
15	CV_young_Mal_GP_1	0.000	-1	1					Fixed
16	CV_old_Mal_GP_1	0.000	-1	1					Fixed
17	Wtlen_1_Mal_GP_1	2.55E-05	-3	3					Fixed
18	Wtlen_2_Mal_GP_1	2.927	-3	4					Fixed
19	Herm_Infl_age	6.080	1	11					Fixed
20	Herm_stdev	2.330	1	5					Fixed
21	Herm_asymptote	0.999	0.01	1					Fixed
22	CohortGrowDev	1.000	0	1					Fixed
23	Platoon_SD_Ratio	0.730	0.1	3	0.253	0.346			1
24	FracFemale_GP_1	1.000	0	1					Fixed
25	SR_LN(R0)	8.000	6	14	0.150	0.019			1
26	SR_BH_steep	0.472	0.2	0.99	0.049	0.103			2
27	SR_sigmaR	0.449	0.1	2	0.101	0.226			7
28	SR_regime	0.000	-5	5					Fixed
29	SR_autocorr	0.000	0	0					Fixed
30	Main_RecrDev_1981	-0.012	-4	4	0.404	33.109			3
31	Main_RecrDev_1982	-0.042	-4	4	0.400	9.532			3
32	Main_RecrDev_1983	-0.088	-4	4	0.396	4.503			3
33	Main_RecrDev_1984	-0.083	-4	4	0.398	4.807			3
34	Main_RecrDev_1985	0.234	-4	4	0.391	1.676			3
35	Main_RecrDev_1986	-0.037	-4	4	0.374	10.120			3
36	Main_RecrDev_1987	0.222	-4	4	0.341	1.537			3
37	Main_RecrDev_1988	0.168	-4	4	0.315	1.873			3
38	Main_RecrDev_1989	0.016	-4	4	0.300	18.933			3
39	Main_RecrDev_1990	0.349	-4	4	0.230	0.659			3
40	Main_RecrDev_1991	-0.045	-4	4	0.226	5.040			3
41	Main_RecrDev_1992	0.112	-4	4	0.183	1.636			3
42	Main_RecrDev_1993	-0.595	-4	4	0.221	0.372			3
43	Main_RecrDev_1994	-0.159	-4	4	0.174	1.092			3
44	Main_RecrDev_1995	-0.644	-4	4	0.206	0.320			3
45	Main_RecrDev_1996	-0.757	-4	4	0.211	0.279			3
46	Main_RecrDev_1997	-0.320	-4	4	0.174	0.545			3
47	Main_RecrDev_1998	-1.010	-4	4	0.264	0.261			3
48	Main_RecrDev_1999	0.091	-4	4	0.162	1.767			3
49	Main_RecrDev_2000	-0.334	-4	4	0.247	0.740			3
50	Main_RecrDev_2001	-0.177	-4	4	0.242	1.363			3
51	Main_RecrDev_2002	0.238	-4	4	0.211	0.888			3
52	Main_RecrDev_2003	0.151	-4	4	0.232	1.534			3
53	Main_RecrDev_2004	0.163	-4	4	0.210	1.286			3
54	Main_RecrDev_2005	-0.147	-4	4	0.243	1.659			3
55	Main_RecrDev_2006	0.189	-4	4	0.193	1.025			3
56	Main_RecrDev_2007	0.722	-4	4	0.132	0.183			3
57	Main_RecrDev_2008	-0.053	-4	4	0.176	3.346			3
58	Main_RecrDev_2009	0.286	-4	4	0.139	0.485			3
59	Main_RecrDev_2010	-0.334	-4	4	0.194	0.581			3
60	Main_RecrDev_2011	0.029	-4	4	0.151	5.192			3

61	Main_RecrDev_2012	0.547	-4	4	0.107	0.196	3
62	Main_RecrDev_2013	0.335	-4	4	0.116	0.345	3
63	Main_RecrDev_2014	-0.203	-4	4	0.158	0.780	3
64	Main_RecrDev_2015	0.659	-4	4	0.125	0.190	3
65	Main_RecrDev_2016	0.166	-4	4	0.201	1.212	3
66	Main_RecrDev_2017	0.032	-4	4	0.207	6.477	3
67	Main_RecrDev_2018	0.129	-4	4	0.208	1.609	3
68	Main_RecrDev_2019	0.010	-4	4	0.234	22.484	3
69	Main_RecrDev_2020	0.081	-4	4	0.234	2.891	3
70	Main_RecrDev_2021	0.109	-4	4	0.229	2.098	3
71	F_fleet_1_YR_1950_s_1	0.010					_
72	F_fleet_1_YR_1951_s_1	0.010					_
73	F_fleet_1_YR_1952_s_1	0.010					_
74	F_fleet_1_YR_1953_s_1	0.010					_
75	F_fleet_1_YR_1954_s_1	0.010					_
76	F_fleet_1_YR_1955_s_1	0.010					_
77	F_fleet_1_YR_1956_s_1	0.010					_
78	F_fleet_1_YR_1957_s_1	0.010					_
79	F_fleet_1_YR_1958_s_1	0.010					_
80	F_fleet_1_YR_1959_s_1	0.010					_
81	F_fleet_1_YR_1960_s_1	0.010					_
82	F_fleet_1_YR_1961_s_1	0.010					_
83	F_fleet_1_YR_1962_s_1	0.010					_
84	F_fleet_1_YR_1963_s_1	0.010					_
85	F_fleet_1_YR_1964_s_1	0.010					_
86	F_fleet_1_YR_1965_s_1	0.010					_
87	F_fleet_1_YR_1966_s_1	0.010					_
88	F_fleet_1_YR_1967_s_1	0.010					_
89	F_fleet_1_YR_1968_s_1	0.010					_
90	F_fleet_1_YR_1969_s_1	0.010					_
91	F_fleet_1_YR_1970_s_1	0.010					_
92	F_fleet_1_YR_1971_s_1	0.010					_
93	F_fleet_1_YR_1972_s_1	0.010					_
94	F_fleet_1_YR_1973_s_1	0.010					_
95	F_fleet_1_YR_1974_s_1	0.010					_
96	F_fleet_1_YR_1975_s_1	0.010					_
97	F_fleet_1_YR_1976_s_1	0.010					_
98	F_fleet_1_YR_1977_s_1	0.010					_
99	F_fleet_1_YR_1978_s_1	0.010					_
100	F_fleet_1_YR_1979_s_1	0.010					_
101	F_fleet_1_YR_1980_s_1	0.010					_
102	F_fleet_1_YR_1981_s_1	0.010					_
103	F_fleet_1_YR_1982_s_1	0.010					_
104	F_fleet_1_YR_1983_s_1	0.010					_
105	F_fleet_1_YR_1984_s_1	0.010					_
106	F_fleet_1_YR_1985_s_1	0.010					_
107	F_fleet_1_YR_1986_s_1	0.010					_
108	F_fleet_1_YR_1987_s_1	0.010					_
109	F_fleet_1_YR_1988_s_1	0.010					_
110	F_fleet_1_YR_1989_s_1	0.010					_
111	F_fleet_1_YR_1990_s_1	0.010					_
112	F_fleet_1_YR_1991_s_1	0.010					_
113	F_fleet_1_YR_1992_s_1	0.010					_
114	F_fleet_1_YR_1993_s_1	0.010					_
115	F_fleet_1_YR_1994_s_1	0.010					_
116	F_fleet_1_YR_1995_s_1	0.010					_
117	F_fleet_1_YR_1996_s_1	0.010					_
118	F_fleet_1_YR_1997_s_1	0.010					_
119	F_fleet_1_YR_1998_s_1	0.010					_
120	F_fleet_1_YR_1999_s_1	0.010					_
121	F_fleet_1_YR_2000_s_1	0.010					_
122	F_fleet_1_YR_2001_s_1	0.010					_
123	F_fleet_1_YR_2002_s_1	0.010					_
124	F_fleet_1_YR_2003_s_1	0.010					_
125	F_fleet_1_YR_2004_s_1	0.010					_
126	F_fleet_1_YR_2005_s_1	0.010					_
127	F_fleet_1_YR_2006_s_1	0.010					_
128	F_fleet_1_YR_2007_s_1	0.010					_
129	F_fleet_1_YR_2008_s_1	0.010					_
130	F_fleet_1_YR_2009_s_1	0.010					_

131	F_fleet_1_YR_2010_s_1	0.010					_
132	F_fleet_1_YR_2011_s_1	0.010					_
133	F_fleet_1_YR_2012_s_1	0.010					_
134	F_fleet_1_YR_2013_s_1	0.010					_
135	F_fleet_1_YR_2014_s_1	0.010					_
136	F_fleet_1_YR_2015_s_1	0.010					_
137	F_fleet_1_YR_2016_s_1	0.010					_
138	F_fleet_1_YR_2017_s_1	0.010					_
139	F_fleet_1_YR_2018_s_1	0.010					_
140	F_fleet_1_YR_2019_s_1	0.010					_
141	F_fleet_1_YR_2020_s_1	0.010					_
142	F_fleet_1_YR_2021_s_1	0.010					_
143	F_fleet_1_YR_2022_s_1	0.010					_
144	F_fleet_1_YR_2023_s_1	0.010					_
145	F_fleet_1_YR_2024_s_1	0.010					_
146	F_fleet_2_YR_1950_s_1	0.039	0	3	0.023	0.579	2
147	F_fleet_2_YR_1951_s_1	0.041	0	3	0.024	0.580	2
148	F_fleet_2_YR_1952_s_1	0.043	0	3	0.025	0.581	2
149	F_fleet_2_YR_1953_s_1	0.045	0	3	0.026	0.582	2
150	F_fleet_2_YR_1954_s_1	0.047	0	3	0.027	0.582	2
151	F_fleet_2_YR_1955_s_1	0.049	0	3	0.028	0.583	2
152	F_fleet_2_YR_1956_s_1	0.050	0	3	0.029	0.584	2
153	F_fleet_2_YR_1957_s_1	0.052	0	3	0.031	0.584	2
154	F_fleet_2_YR_1958_s_1	0.054	0	3	0.032	0.585	2
155	F_fleet_2_YR_1959_s_1	0.060	0	3	0.035	0.585	2
156	F_fleet_2_YR_1960_s_1	0.062	0	3	0.036	0.586	2
157	F_fleet_2_YR_1961_s_1	0.070	0	3	0.041	0.587	2
158	F_fleet_2_YR_1962_s_1	0.066	0	3	0.039	0.587	2
159	F_fleet_2_YR_1963_s_1	0.068	0	3	0.040	0.588	2
160	F_fleet_2_YR_1964_s_1	0.073	0	3	0.043	0.588	2
161	F_fleet_2_YR_1965_s_1	0.077	0	3	0.046	0.589	2
162	F_fleet_2_YR_1966_s_1	0.080	0	3	0.047	0.590	2
163	F_fleet_2_YR_1967_s_1	0.089	0	3	0.052	0.591	2
164	F_fleet_2_YR_1968_s_1	0.090	0	3	0.053	0.592	2
165	F_fleet_2_YR_1969_s_1	0.096	0	3	0.057	0.593	2
166	F_fleet_2_YR_1970_s_1	0.106	0	3	0.063	0.594	2
167	F_fleet_2_YR_1971_s_1	0.136	0	3	0.082	0.598	2
168	F_fleet_2_YR_1972_s_1	0.145	0	3	0.087	0.600	2
169	F_fleet_2_YR_1973_s_1	0.158	0	3	0.095	0.603	2
170	F_fleet_2_YR_1974_s_1	0.177	0	3	0.107	0.605	2
171	F_fleet_2_YR_1975_s_1	0.191	0	3	0.116	0.608	2
172	F_fleet_2_YR_1976_s_1	0.185	0	3	0.112	0.608	2
173	F_fleet_2_YR_1977_s_1	0.169	0	3	0.102	0.606	2
174	F_fleet_2_YR_1978_s_1	0.154	0	3	0.093	0.605	2
175	F_fleet_2_YR_1979_s_1	0.168	0	3	0.102	0.606	2
176	F_fleet_2_YR_1980_s_1	0.138	0	3	0.084	0.603	2
177	F_fleet_2_YR_1981_s_1	0.320	0	3	0.265	0.827	2
178	F_fleet_2_YR_1982_s_1	0.105	0	3	0.082	0.785	2
179	F_fleet_2_YR_1983_s_1	0.201	0	3	0.163	0.809	2
180	F_fleet_2_YR_1984_s_1	0.307	0	3	0.316	1.027	2
181	F_fleet_2_YR_1985_s_1	0.254	0	3	0.272	1.068	2
182	F_fleet_2_YR_1986_s_1	0.162	0	3	0.103	0.638	2
183	F_fleet_2_YR_1987_s_1	0.203	0	3	0.098	0.481	2
184	F_fleet_2_YR_1988_s_1	0.672	0	3	0.347	0.516	2
185	F_fleet_2_YR_1989_s_1	0.166	0	3	0.089	0.538	2
186	F_fleet_2_YR_1990_s_1	0.299	0	3	0.141	0.472	2
187	F_fleet_2_YR_1991_s_1	0.107	0	3	0.085	0.794	2
188	F_fleet_2_YR_1992_s_1	0.418	0	3	0.161	0.386	2
189	F_fleet_2_YR_1993_s_1	0.284	0	3	0.141	0.497	2
190	F_fleet_2_YR_1994_s_1	0.408	0	3	0.190	0.466	2
191	F_fleet_2_YR_1995_s_1	0.416	0	3	0.195	0.468	2
192	F_fleet_2_YR_1996_s_1	0.213	0	3	0.099	0.464	2
193	F_fleet_2_YR_1997_s_1	0.112	0	3	0.052	0.465	2
194	F_fleet_2_YR_1998_s_1	0.168	0	3	0.073	0.434	2
195	F_fleet_2_YR_1999_s_1	0.371	0	3	0.174	0.468	2
196	F_fleet_2_YR_2000_s_1	0.124	0	3	0.072	0.579	2
197	F_fleet_2_YR_2001_s_1	0.121	0	3	0.071	0.590	2
198	F_fleet_2_YR_2002_s_1	0.072	0	3	0.045	0.631	2
199	F_fleet_2_YR_2003_s_1	0.214	0	3	0.089	0.417	2
200	F_fleet_2_YR_2004_s_1	0.362	0	3	0.157	0.433	2

201	F_fleet_2_YR_2005_s_1	0.834	0	3	0.254	0.304			2
202	F_fleet_2_YR_2006_s_1	0.244	0	3	0.101	0.414			2
203	F_fleet_2_YR_2007_s_1	0.230	0	3	0.083	0.363			2
204	F_fleet_2_YR_2008_s_1	0.223	0	3	0.093	0.414			2
205	F_fleet_2_YR_2009_s_1	0.594	0	3	0.198	0.333			2
206	F_fleet_2_YR_2010_s_1	0.097	0	3	0.055	0.570			2
207	F_fleet_2_YR_2011_s_1	0.053	0	3	0.029	0.539			2
208	F_fleet_2_YR_2012_s_1	0.177	0	3	0.074	0.420			2
209	F_fleet_2_YR_2013_s_1	0.269	0	3	0.094	0.349			2
210	F_fleet_2_YR_2014_s_1	0.407	0	3	0.121	0.297			2
211	F_fleet_2_YR_2015_s_1	0.491	0	3	0.142	0.290			2
212	F_fleet_2_YR_2016_s_1	0.345	0	3	0.131	0.378			2
213	F_fleet_2_YR_2017_s_1	0.254	0	3	0.127	0.499			2
214	F_fleet_2_YR_2018_s_1	0.093	0	3	0.051	0.546			2
215	F_fleet_2_YR_2019_s_1	0.041	0	3	0.017	0.415			2
216	F_fleet_2_YR_2020_s_1	0.059	0	3	0.031	0.522			2
217	F_fleet_2_YR_2021_s_1	0.158	0	3	0.047	0.294			2
218	F_fleet_2_YR_2022_s_1	0.107	0	3	0.039	0.363			2
219	F_fleet_2_YR_2023_s_1	0.077	0	3	0.024	0.315			2
220	F_fleet_2_YR_2024_s_1	0.063	0	3	0.018	0.295			2
221	LnQ_base_RVC_KEYS(3)	-7.207	-18	5					Fixed
222	LnQ_base_RVC_DRTO(4)	-6.377	-18	5					Fixed
223	LnQ_base_COMB_VIDEO(5)	-6.928	-18	5					Fixed
224	Size_DblN_peak_COM(1)	29.896	15	60	2.796	0.094			3
225	Size_DblN_top_logit_COM(1)	-9.531	-15	15	74.964	7.865			4
226	Size_DblN_ascend_se_COM(1)	3.161	0.01	15	0.879	0.278			5
227	Size_DblN_descend_se_COM(1)	3.046	0.01	5	0.711	0.233			5
228	Size_DblN_start_logit_COM(1)	-999.000	-15	15					Fixed
229	Size_DblN_end_logit_COM(1)	0.387	-15	15	0.415	1.073			3
230	Size_DblN_peak_REC(2)	32.770	15	50	0.607	0.019			3
231	Size_DblN_top_logit_REC(2)	-12.290	-15	15	46.133	3.754			4
232	Size_DblN_ascend_se_REC(2)	3.812	0.1	15	0.146	0.038			5
233	Size_DblN_descend_se_REC(2)	4.601	0.1	15	0.229	0.050			5
234	Size_DblN_start_logit_REC(2)	-999.000	-15	7					Fixed
235	Size_DblN_end_logit_REC(2)	-2.351	-15	15	0.329	0.140			3
236	Retain_L_infl_REC(2)	6.443	4	50	50.294	7.806			3
237	Retain_L_width_REC(2)	0.683	0.01	10	12.928	18.920			4
238	Retain_L_asymptote_logit_REC(2)	2.723	-15	15	0.356	0.131			5
239	Retain_L_maleoffset_REC(2)	0.000	-1	1					Fixed
240	DiscMort_L_infl_REC(2)	0.100	0	1					Fixed
241	DiscMort_L_width_REC(2)	0.100	0	1					Fixed
242	DiscMort_L_level_old_REC(2)	0.414	0.01	1					Fixed
243	DiscMort_L_male_offset_REC(2)	0.000	-1	2					Fixed
244	Size_DblN_peak_RVC_KEYS(3)	22.080	5	50	0.673	0.030			3
245	Size_DblN_top_logit_RVC_KEYS(3)	-2.735	-15	15	0.589	0.215			4
246	Size_DblN_ascend_se_RVC_KEYS(3)	3.796	0.1	15	0.130	0.034			3
247	Size_DblN_descend_se_RVC_KEYS(3)	4.924	0.1	15	0.363	0.074			5
248	Size_DblN_start_logit_RVC_KEYS(3)	-999.000	-15	15					Fixed
249	Size_DblN_end_logit_RVC_KEYS(3)	-2.014	-15	15	0.337	0.167			3
250	Size_DblN_peak_RVC_DRTO(4)	55.507	30	70	3.188	0.057			3
251	Size_DblN_top_logit_RVC_DRTO(4)	-2.166	-15	15	2.980	1.376			4
252	Size_DblN_ascend_se_RVC_DRTO(4)	6.188	0.1	15	0.116	0.019			3
253	Size_DblN_descend_se_RVC_DRTO(4)	6.900	0.1	15	5.596	0.811			5
254	Size_DblN_start_logit_RVC_DRTO(4)	-999.000	-5	5					Fixed
255	Size_DblN_end_logit_RVC_DRTO(4)	-0.979	-15	15	1.661	1.696			3
256	Size_inflection_COMB_VIDEO(5)	27.744	15	40	3.062	0.110			3
257	Size_95%width_COMB_VIDEO(5)	11.501	0.1	15	2.864	0.249			4
258	ln(DM_theta)_Len_P1	2.093	-5	20	0.807	0.385	0	1.813	2
259	ln(DM_theta)_Len_P2	0.987	-5	20	0.895	0.907	0	1.813	2
260	ln(DM_theta)_Len_P3	-0.764	-5	20	0.195	0.255	0	1.813	2
261	ln(DM_theta)_Len_P4	0.442	-5	20	0.613	1.387	0	1.813	2
262	ln(DM_theta)_Sz_P5	-0.347	-5	20	0.141	0.406	0	1.813	2
263	Size_DblN_peak_COM(1)_BLK1repl_1995	31.034	15	60	0.437	0.014			3
264	Size_DblN_peak_COM(1)_BLK1repl_2018	41.809	15	60	1.193	0.029			3
265	Size_DblN_ascend_se_COM(1)_BLK1repl_1995	1.883	0.01	15	0.286	0.152			5
266	Size_DblN_ascend_se_COM(1)_BLK1repl_2018	1.473	0.01	6	0.777	0.528			5
267	Retain_L_infl_REC(2)_BLK1repl_1995	28.543	6	50	0.317	0.011			3
268	Retain_L_infl_REC(2)_BLK1repl_2018	42.700	6	50	2.200	0.052			3
269	Retain_L_width_REC(2)_BLK1repl_1995	1.332	0.1	10	0.200	0.150			4
270	Retain_L_width_REC(2)_BLK1repl_2018	5.030	0.1	10	1.342	0.267			4

271	Retain_L_asymptote_logit_REC(2)_BLK1repl_1995	3.081	-15	15	0.560	0.182	5
272	Retain_L_asymptote_logit_REC(2)_BLK1repl_2018	9.293	-15	15	77.497	8.339	5

Table 3.11. Predicted total biomass (metric tons, pounds), spawning stock biomass (SSB; metric tons, pounds), age 1+ abundance (1000s of fish), age-0 recruits (1000s of fish), and depletion (SSB/SSB0) for Florida Keys/East Florida Hogfish. Virgin is the estimated unfished condition while Initial is the estimated initial conditions of the stock before the model start year.

Year	Biomass (mt)	Biomass (lbs.)	SSB (mt)	SSB (lbs.)	Age 1+ Abundance (000s)	Age-0 Recruits (000s)	B/B0	SSB/SSB0
Virgin	5,768	12,716,770	5,462	12,041,957	6,588	2,982	1.000	1.000
Initial	5,768	12,716,770	5,462	12,041,957	6,588	2,982	1.000	1.000
1950	5,768	12,716,770	5,462	12,041,957	6,588	2,982	1.000	1.000
1951	5,685	12,532,288	5,380	11,860,561	6,522	2,969	0.985	0.985
1952	5,596	12,336,870	5,292	11,667,216	6,457	2,955	0.970	0.969
1953	5,508	12,142,841	5,206	11,476,229	6,396	2,941	0.955	0.953
1954	5,423	11,956,506	5,122	11,293,113	6,338	2,928	0.940	0.938
1955	5,341	11,774,625	5,041	11,114,517	6,282	2,914	0.926	0.923
1956	5,263	11,602,686	4,965	10,945,753	6,229	2,901	0.912	0.909
1957	5,190	11,441,727	4,893	10,787,924	6,180	2,888	0.900	0.896
1958	5,125	11,297,963	4,829	10,647,049	6,136	2,877	0.888	0.884
1959	5,064	11,164,209	4,770	10,516,072	6,094	2,866	0.878	0.873
1960	4,998	11,018,770	4,705	10,373,587	6,047	2,854	0.866	0.861
1961	4,935	10,879,394	4,643	10,236,945	6,002	2,842	0.856	0.850
1962	4,865	10,726,437	4,575	10,087,163	5,951	2,829	0.843	0.838
1963	4,807	10,597,180	4,518	9,960,529	5,910	2,817	0.833	0.827
1964	4,748	10,467,107	4,460	9,833,366	5,867	2,806	0.823	0.817
1965	4,685	10,328,966	4,399	9,698,201	5,822	2,793	0.812	0.805
1966	4,622	10,190,207	4,337	9,562,440	5,775	2,780	0.801	0.794
1967	4,559	10,050,786	4,276	9,426,084	5,728	2,767	0.790	0.783
1968	4,488	9,893,553	4,206	9,272,356	5,674	2,752	0.778	0.770
1969	4,420	9,743,727	4,139	9,125,881	5,623	2,737	0.766	0.758
1970	4,350	9,590,241	4,071	8,976,055	5,570	2,722	0.754	0.745
1971	4,272	9,417,486	3,995	8,807,335	5,510	2,704	0.741	0.731
1972	4,157	9,163,955	3,883	8,559,602	5,418	2,677	0.721	0.711
1973	4,039	8,903,898	3,767	8,305,320	5,324	2,649	0.700	0.690
1974	3,916	8,632,575	3,647	8,040,898	5,225	2,618	0.679	0.668
1975	3,781	8,334,752	3,516	7,750,924	5,116	2,582	0.655	0.644
1976	3,641	8,028,023	3,380	7,452,528	5,001	2,544	0.631	0.619
1977	3,525	7,771,118	3,267	7,203,362	4,905	2,510	0.611	0.598
1978	3,436	7,574,268	3,181	7,013,456	4,831	2,484	0.596	0.582
1979	3,376	7,443,357	3,124	6,888,013	4,781	2,466	0.585	0.572
1980	3,307	7,290,797	3,058	6,741,163	4,720	2,444	0.573	0.560
1981	3,269	7,207,485	3,022	6,662,105	4,689	2,383	0.567	0.553
1982	3,040	6,702,009	2,802	6,177,286	4,460	2,226	0.527	0.513
1983	3,054	6,733,843	2,822	6,222,173	4,414	2,119	0.530	0.517
1984	2,963	6,531,239	2,744	6,049,110	4,239	2,091	0.514	0.502
1985	2,778	6,124,816	2,561	5,646,237	4,015	2,765	0.482	0.469
1986	2,675	5,896,858	2,438	5,374,583	4,286	2,050	0.464	0.446

Table 3.11 continued. Predicted total biomass (metric tons, pounds), spawning stock biomass (SSB; metric tons, pounds), age 1+ abundance (1000s of fish), age-0 recruits (1000s of fish), and depletion (SSB/SSB0) for Florida Keys/East Florida Hogfish. Virgin is the estimated unfished condition while Initial is the estimated initial conditions of the stock before the model start year.

Year	Biomass (mt)	Biomass (lbs.)	SSB (mt)	SSB (lbs.)	Age 1+ Abundance (000s)	Age-0 Recruits (000s)	B/B0	SSB/SSB0
1987	2,655	5,852,347	2,412	5,317,440	4,097	2,624	0.460	0.442
1988	2,606	5,744,299	2,368	5,220,172	4,278	2,451	0.452	0.433
1989	2,198	4,846,797	1,964	4,328,953	3,938	1,906	0.381	0.359
1990	2,212	4,876,537	1,987	4,380,519	3,755	2,659	0.383	0.364
1991	2,135	4,707,156	1,913	4,217,575	3,981	1,747	0.370	0.350
1992	2,201	4,853,344	1,982	4,369,672	3,733	2,069	0.382	0.363
1993	2,006	4,421,635	1,824	4,022,003	3,545	975	0.348	0.334
1994	1,893	4,174,210	1,743	3,841,621	2,885	1,470	0.328	0.319
1995	1,702	3,753,282	1,582	3,487,250	2,694	857	0.295	0.290
1996	1,531	3,375,564	1,422	3,134,092	2,241	720	0.265	0.260
1997	1,461	3,221,130	1,375	3,031,224	1,963	1,092	0.253	0.252
1998	1,431	3,155,256	1,343	2,961,778	2,026	540	0.248	0.246
1999	1,378	3,037,176	1,287	2,838,209	1,721	1,582	0.239	0.236
2000	1,255	2,765,787	1,149	2,533,927	2,045	962	0.217	0.210
2001	1,254	2,764,861	1,131	2,493,274	1,958	1,113	0.217	0.207
2002	1,272	2,803,993	1,156	2,549,624	2,006	1,711	0.220	0.212
2003	1,332	2,936,227	1,189	2,620,745	2,394	1,596	0.231	0.218
2004	1,348	2,970,971	1,184	2,611,133	2,519	1,612	0.234	0.217
2005	1,308	2,883,183	1,152	2,539,946	2,558	1,162	0.227	0.211
2006	1,102	2,429,384	967	2,131,500	2,168	1,445	0.191	0.177
2007	1,146	2,526,938	1,001	2,206,761	2,287	2,523	0.199	0.183
2008	1,218	2,684,613	1,031	2,272,988	2,973	1,186	0.211	0.189
2009	1,293	2,849,938	1,109	2,445,919	2,648	1,747	0.224	0.203
2010	1,197	2,638,051	1,053	2,321,490	2,637	908	0.207	0.193
2011	1,295	2,855,956	1,160	2,558,178	2,349	1,391	0.225	0.212
2012	1,416	3,121,635	1,281	2,824,166	2,483	2,486	0.245	0.235
2013	1,493	3,290,995	1,301	2,869,206	3,124	2,032	0.259	0.238
2014	1,530	3,372,367	1,319	2,908,118	3,220	1,196	0.265	0.241
2015	1,494	3,293,420	1,316	2,902,342	2,758	2,830	0.259	0.241
2016	1,437	3,167,888	1,241	2,734,901	3,364	1,665	0.249	0.227
2017	1,459	3,217,559	1,249	2,754,500	3,129	1,463	0.253	0.229
2018	1,511	3,331,185	1,346	2,967,620	2,936	1,689	0.262	0.246
2019	1,654	3,646,049	1,492	3,289,760	3,054	1,595	0.287	0.273
2020	1,809	3,989,000	1,641	3,616,728	3,104	1,807	0.314	0.300
2021	1,952	4,304,107	1,776	3,914,903	3,264	1,956	0.338	0.325
2022	2,045	4,508,299	1,855	4,088,583	3,418	1,931	0.355	0.340
2023	2,159	4,760,067	1,961	4,323,772	3,528	1,989	0.374	0.359
2024	2,286	5,039,547	2,085	4,595,955	3,657	2,052	0.396	0.382

Table 3.12. Annual exploitation rates on Florida Keys/East Florida Hogfish combined across all fleets as well as annual estimates of instantaneous apical fishing mortality rates by fleet. Apical fishing mortality rates represent the instantaneous fishing mortality level on the most vulnerable age class for each fleet.

Year	Exploitation (Biomass)	Commercial	Recreational	Year	Exploitation (Biomass)	Commercial	Recreational
1950	0.0132	0.0018	0.0393	1988	0.2168	0.0206	0.6724
1951	0.0146	0.0033	0.0412	1989	0.0722	0.0275	0.1658
1952	0.0154	0.0037	0.0431	1990	0.1185	0.0269	0.2991
1953	0.0158	0.0034	0.0449	1991	0.0537	0.0246	0.1072
1954	0.0167	0.0038	0.0468	1992	0.1642	0.0334	0.4182
1955	0.0171	0.0034	0.0486	1993	0.1210	0.0365	0.2842
1956	0.0173	0.0029	0.0504	1994	0.1546	0.0262	0.4079
1957	0.0170	0.0013	0.0522	1995	0.1445	0.0235	0.4163
1958	0.0172	0.0007	0.0540	1996	0.0826	0.0229	0.2134
1959	0.0192	0.0008	0.0601	1997	0.0519	0.0256	0.1123
1960	0.0197	0.0006	0.0622	1998	0.0650	0.0193	0.1685
1961	0.0219	0.0002	0.0697	1999	0.1247	0.0208	0.3710
1962	0.0210	0.0004	0.0664	2000	0.0497	0.0200	0.1241
1963	0.0222	0.0013	0.0685	2001	0.0477	0.0152	0.1205
1964	0.0241	0.0021	0.0725	2002	0.0328	0.0150	0.0717
1965	0.0252	0.0013	0.0775	2003	0.0800	0.0161	0.2143
1966	0.0264	0.0017	0.0804	2004	0.1291	0.0177	0.3622
1967	0.0292	0.0020	0.0887	2005	0.2620	0.0117	0.8339
1968	0.0298	0.0020	0.0903	2006	0.0908	0.0106	0.2439
1969	0.0314	0.0015	0.0963	2007	0.0885	0.0105	0.2298
1970	0.0346	0.0019	0.1057	2008	0.0861	0.0090	0.2233
1971	0.0440	0.0017	0.1363	2009	0.2162	0.0096	0.5936
1972	0.0469	0.0019	0.1454	2010	0.0422	0.0078	0.0971
1973	0.0506	0.0014	0.1582	2011	0.0257	0.0075	0.0530
1974	0.0564	0.0015	0.1765	2012	0.0716	0.0080	0.1766
1975	0.0609	0.0015	0.1906	2013	0.1008	0.0095	0.2687
1976	0.0590	0.0009	0.1846	2014	0.1491	0.0119	0.4073
1977	0.0554	0.0025	0.1687	2015	0.1793	0.0126	0.4913
1978	0.0501	0.0005	0.1536	2016	0.1270	0.0104	0.3451
1979	0.0549	0.0005	0.1679	2017	0.0984	0.0060	0.2543
1980	0.0483	0.0045	0.1385	2018	0.0255	0.0033	0.0928
1981	0.1043	0.0043	0.3199	2019	0.0113	0.0015	0.0409
1982	0.0351	0.0006	0.1049	2020	0.0158	0.0016	0.0587
1983	0.0670	0.0012	0.2013	2021	0.0399	0.0017	0.1582
1984	0.0991	0.0006	0.3073	2022	0.0268	0.0015	0.1071
1985	0.0825	0.0012	0.2542	2023	0.0192	0.0011	0.0772
1986	0.0612	0.0137	0.1617	2024	0.0155	0.0011	0.0626
1987	0.0790	0.0185	0.2031				

Table 3.13. Index root mean square error (RMSE) values from the SEDAR 94 KEYS base model (Base), the age-structured production model (ASPM), and the ASPM with estimated recruitment deviations (ASPMdev).

Index	Base	ASPM	ASPMdev
RVC Florida Keys	0.2527	0.3100	0.2055
RVC Dry Tortugas	0.1646	0.2016	0.1085
Combined Video	0.3804	0.4934	0.3524

Table 3.14. Mohn's rho (ρ_M) and forecast Mohn's rho (ρ_F) values calculated from the retrospective and retrospective forecasting analyses, respectively, on estimates of spawning stock biomass (SSB) and exploitation fishing mortality rates (F) from the SEDAR 94 KEYS base model. Analyses were performed across 6 successive years of removal from the terminal year 2024.

Quantity	Year Peel	Mohn's Rho (ρ_M)	Forecast Mohn's Rho (ρ_F)
SSB	2023	-0.059	-0.065
SSB	2022	-0.011	-0.027
SSB	2021	-0.072	-0.048
SSB	2020	-0.143	-0.106
SSB	2019	-0.186	-0.161
SSB	2018	-0.198	-0.188
SSB	Combined	-0.112	-0.099
F	2023	0.065	0.106
F	2022	0.069	-0.392
F	2021	0.040	-0.196
F	2020	0.123	0.278
F	2019	0.096	-0.119
F	2018	0.280	-0.247
F	Combined	0.112	-0.095

Table 3.15. Hindcast cross-validation summary statistics for the KEYS base model. N = number of observations to compute each statistic. MASE = mean absolute scaled error, with values < 1 (in green) indicative of superior prediction skill over a naïve baseline forecast (random walk) and values > 1 (in red) indicative of poor prediction skill. Model MAE = mean absolute error of model prediction residuals. Naïve MAE = mean absolute error of naïve predictions

Model Component	Data Source	MASE	Model MAE	Naïve MAE	N
Index of Abundance	RVC_KEYS	0.693	0.311	0.448	2
	RVC_DRTO	0.672	0.119	0.177	3
	COMB_VIDEO	0.628	0.139	0.221	6
	joint	0.657	0.165	0.250	11
Conditional Age-at-Length	REC	0.305	0.091	0.298	3
	FI_LHR_SP	0.142	0.019	0.134	1
	FI_LHR_TW	0.040	0.038	0.944	1
	joint	0.167	0.066	0.395	5
Size Composition	RVC_KEYS	1.984	0.120	0.060	2
	RVC_DRTO	0.597	0.038	0.064	3
	joint	1.132	0.071	0.063	5

Table 3.16. The yield-per-recruit (YPR), spawner-per-recruit (SSB/R), static spawning potential ratio (SPR), and total equilibrium yield in metric tons computed over a range of exploitation rates on Florida Keys/East Florida Hogfish.

Exploitation	YPR	SSB/R	SPR	Total Yield (mt)
0.000	0.000	1.831	1.000	0.123
0.005	0.009	1.743	0.951	26.680
0.010	0.018	1.661	0.907	50.138
0.015	0.025	1.584	0.865	70.771
0.020	0.032	1.512	0.825	88.819
0.025	0.039	1.445	0.789	104.498
0.031	0.045	1.382	0.755	117.999
0.036	0.051	1.323	0.722	129.495
0.041	0.056	1.268	0.692	139.138
0.047	0.061	1.216	0.664	147.067
0.052	0.066	1.167	0.637	153.407
0.058	0.070	1.122	0.612	158.270
0.064	0.074	1.078	0.589	161.759
0.069	0.078	1.037	0.566	163.968
0.075	0.082	0.999	0.545	164.980
0.081	0.085	0.962	0.525	164.874
0.087	0.088	0.928	0.506	163.721
0.093	0.091	0.895	0.489	161.585
0.099	0.094	0.864	0.472	158.528
0.105	0.097	0.835	0.456	154.604
0.111	0.099	0.807	0.441	149.863
0.117	0.101	0.781	0.426	144.354
0.123	0.104	0.756	0.412	138.121
0.129	0.106	0.732	0.399	131.203
0.135	0.108	0.709	0.387	123.639
0.141	0.110	0.687	0.375	115.465
0.147	0.111	0.667	0.364	106.712
0.153	0.113	0.647	0.353	97.412
0.160	0.114	0.628	0.343	87.595
0.166	0.116	0.611	0.333	77.286
0.172	0.117	0.593	0.324	66.512
0.178	0.119	0.577	0.315	55.296
0.185	0.120	0.562	0.307	43.662
0.191	0.121	0.547	0.298	31.630
0.197	0.122	0.532	0.291	19.221
0.204	0.123	0.519	0.283	6.453
0.210	0.125		0.276	

Table 3.17. Gelman and Rubin's (1992) potential scale reduction factor (PSRF) values from the combined six MCMC chains for selected model parameters (*ln(R0)* and *steepness*) and derived quantities (SSB_0, SSB in 2024, F exploitation in 2024, $F_{40\%SPR}$, F_{MSY}, SSB at F_{MSY}, and the retained yield at F_{MSY}) of the SEDAR 94 KEYS base model.

PSRF	PSRF Upper CI	Parameter or Derived Quantity
1.00	1.01	*ln(R0)*
1.00	1.01	*steepness*
1.00	1.01	SSB_0
1.00	1.00	SSB_{2024}
1.00	1.00	F_{2024}
1.03	1.06	$F_{40\%SPR}$
1.02	1.03	F_{MSY}
1.00	1.01	SSB_{MSY}
1.01	1.01	Retained yield at F_{MSY}

Table 3.18. The stock status determination criteria for Florida Keys/East Florida Hogfish according to the South Atlantic Fishery Management Council (SAFMC). All MSY or SPR proxy values of 30%SPR and 40%SPR were derived from the SEDAR 94 KEYS base model.

South Atlantic and Gulf of Mexico Fishery Management Councils

Criteria	Definition	MSY	30% SPR	40% SPR
MSY	The retained yield at F_{MSY} or $F_{SPRproxy}$	94.552 mt (208,451 lbs.)	17.249 mt (38,027 lbs.)	71.100 mt (156,709 lbs.)
$F_{MSY\ or\ proxy}$	The fishing mortality rate associated with MSY or SPR proxy	0.077 yr^{-1}	0.190 yr^{-1}	0.128 yr^{-1}
MFMT (Maximum Fishing Mortality Threshold)	$F_{MSY\ or\ SPR\ proxy}$	0.077 yr^{-1}	0.190 yr^{-1}	0.128 yr^{-1}
$F_{current}$ (recent average fishing mortality rate)	The geometric mean of F exploitation for 2022 – 2024		0.020 yr^{-1}	
$SSB_{MSY\ or\ SPRproxy}$	The estimated spawning stock biomass associated with F_{MSY} or $F_{SPRproxy}$	1,952.4 mt (4,304,305 lbs.)	154.312 mt (340,300 lbs.)	912.573 mt (2,011,879 lbs.)
MSST (Minimum Stock Size Threshold)	$0.75*SSB_{MSY\ or\ SPRproxy}$	1,464.3 mt (3,228,229 lbs.)	115.734 mt (255,150 lbs.)	684.43 mt (1,508,909 lbs.)
$SSB_{current}$ (recent average of SSB)	The geometric mean of SSB for 2022 – 2024		1,964.579 mt (4,331,156 lbs.)	

Table 3.19**.** Projection results when exploitation rates = $F_{30\%SPR}$ (0.190) for Florida Keys/East Florida Hogfish. Equilibrium projections assume predicted recruitment follows either the spawner-recruit curve (S-R) or the long-term average from 1950 – 2024 (2.145 million fish). Recruitment (Recruits) is in thousands of age-0 fish, F is the exploitation rate, SSB is in metric tons (female plus male SSB), Retained Yield is in pounds (whole weight), and Retained Num is in numbers of fish.

	$F_{30\%SPR}$ Equilibrium Long-Term Projections (S-R)					**$F_{30\%SPR}$ Equilibrium Long-Term Projections**				
Year	**Age-0 Recruits**	**F**	**SSB**	**Retained Yield**	**Retained Num**	**Age-0 Recruits**	**F**	**SSB**	**Retained Yield**	**Retained Num**
2025	2,095.40	0.190	2,155.98	570,691	168,223	2,145.97	0.191	2,185.38	580,881	172,753
2026	1,952.30	0.190	1,875.40	497,337	146,197	2,145.97	0.191	1,916.61	510,476	151,453
2027	1,822.94	0.190	1,652.00	433,813	129,071	2,145.97	0.191	1,696.18	447,544	134,281
2028	1,714.14	0.190	1,482.80	383,751	116,153	2,145.97	0.191	1,529.40	398,698	121,997
2029	1,620.17	0.190	1,348.56	344,973	106,122	2,145.97	0.191	1,407.67	363,882	113,866
2030	1,537.71	0.190	1,238.86	314,323	98,017	2,145.97	0.191	1,320.37	339,911	108,658
2031	1,464.66	0.190	1,147.39	289,426	91,271	2,145.97	0.191	1,258.52	323,561	105,358
2032	1,398.92	0.190	1,069.30	268,588	85,490	2,145.97	0.191	1,214.62	312,262	103,220
2033	1,339.71	0.190	1,002.13	250,929	80,478	2,145.97	0.191	1,184.14	304,507	101,837
2034	1,286.12	0.190	943.77	235,761	76,087	2,145.97	0.191	1,163.39	299,210	100,945

Table 3.20. Projection results when exploitation rates = $F_{30\%SPR}$ (0.190) and 75% $F_{30\%SPR}$ (0.142) for Florida Keys/East Florida Hogfish. Short-term projections assume predicted age-0 recruitment is equal to the average from 2022 to 2024 (1.926 million). Recruitment (Recruits) is in thousands of age-0 fish, F is the exploitation rate, SSB is in metric tons (female plus male SSB), Retained Yield is in pounds (whole weight), and Retained Num is in numbers of fish.

	$F_{30\%SPR}$ Short-Term Projections					**0.75 * $F_{30\%SPR}$ Short-Term Projections**				
Year	**Age-0 Recruits**	**F**	**SSB**	**Retained Yield**	**Retained Num**	**Age-0 Recruits**	**F**	**SSB**	**Retained Yield**	**Retained Num**
2025	1,926.50	0.190	2,155.77	570,132	167,826	1,926.50	0.142	2,155.77	427,532	126,030
2026	1,926.50	0.190	1,869.46	494,613	144,732	1,926.50	0.142	1,978.62	393,651	115,229
2027	1,926.50	0.190	1,635.39	427,970	126,381	1,926.50	0.142	1,821.10	361,314	106,084
2028	1,926.50	0.190	1,457.90	376,586	113,371	1,926.50	0.142	1,690.87	333,212	98,817
2029	1,926.50	0.190	1,327.66	339,998	104,783	1,926.50	0.142	1,587.27	310,172	93,232
2030	1,926.50	0.190	1,233.56	314,744	99,271	1,926.50	0.142	1,507.44	292,090	89,053
2031	1,926.50	0.190	1,166.21	297,431	95,761	1,926.50	0.142	1,447.68	278,162	85,948
2032	1,926.50	0.190	1,117.87	285,407	93,477	1,926.50	0.142	1,403.57	267,813	83,724
2033	1,926.50	0.190	1,083.77	277,093	91,990	1,926.50	0.141	1,372.19	260,447	82,200
2034	1,926.50	0.190	1,060.06	271,359	91,021	1,926.50	0.141	1,350.48	255,349	81,193

Table 3.21. Projection results when exploitation rates = $F_{40\%SPR}$ (0.129) for Florida Keys/East Florida Hogfish. Equilibrium projections assume predicted recruitment follows either the spawner-recruit curve (S-R) or the long-term average from 1950 – 2024 (2.145 million fish). Recruitment (Recruits) is in thousands of age-0 fish, F is the exploitation rate, SSB is in metric tons (female plus male SSB), Retained Yield is in pounds (whole weight), and Retained Num is in numbers of fish.

	$F_{40\%SPR}$ Equilibrium Long-Term Projections (S-R)					**$F_{40\%SPR}$ Equilibrium Long-Term Projections**				
Year	**Age-0 Recruits**	**F**	**SSB**	**Retained Yield**	**Retained Num**	**Age-0 Recruits**	**F**	**SSB**	**Retained Yield**	**Retained Num**
2025	2,095.40	0.129	2,155.98	388,356	114,684	2,145.97	0.130	2,185.38	395,330	117,777
2026	2,026.02	0.129	2,015.12	363,898	106,997	2,145.97	0.130	2,059.46	373,607	110,836
2027	1,962.11	0.129	1,893.44	340,320	100,535	2,145.97	0.130	1,944.46	351,083	104,475
2028	1,907.09	0.129	1,794.33	320,020	95,315	2,145.97	0.130	1,848.36	331,348	99,374
2029	1,858.12	0.129	1,710.20	303,064	91,019	2,145.97	0.130	1,771.09	315,678	95,612
2030	1,814.10	0.129	1,637.66	288,840	87,386	2,145.97	0.130	1,710.44	303,796	92,943
2031	1,774.46	0.129	1,574.65	276,752	84,259	2,145.97	0.130	1,663.73	294,951	91,083
2032	1,738.09	0.129	1,518.71	266,203	81,491	2,145.97	0.130	1,627.52	288,264	89,752
2033	1,705.01	0.129	1,469.29	257,001	79,038	2,145.97	0.130	1,600.22	283,304	88,809
2034	1,674.85	0.129	1,425.40	248,919	76,849	2,145.97	0.130	1,579.99	279,639	88,140

Table 3.22. Projection results when exploitation rates = $F_{40\%SPR}$ (0.129) and 75% $F_{30\%SPR}$ (0.097) for Florida Keys/East Florida Hogfish. Short-term projections assume predicted age-0 recruitment is equal to the average from 2020 to 2024 (1.926 million). Recruitment (Recruits) is in thousands of age-0 fish, F is the exploitation rate, SSB is in metric tons (female plus male SSB), Retained Yield is in pounds (whole weight), and Retained Num is in numbers of fish.

	$F_{40\%SPR}$ Short-Term Projections					**0.75 * $F_{40\%SPR}$ Short-Term Projections**				
Year	**Age-0 Recruits**	**F**	**SSB**	**Retained Yield**	**Retained Num**	**Age-0 Recruits**	**F**	**SSB**	**Retained Yield**	**Retained Num**
2025	1,926.50	0.129	2,155.77	387,977	114,417	1,926.50	0.097	2,155.77	290,920	85,881
2026	1,926.50	0.129	2,008.97	361,975	105,975	1,926.50	0.097	2,083.63	282,153	82,639
2027	1,926.50	0.129	1,875.57	335,863	98,479	1,926.50	0.097	2,011.21	272,361	79,612
2028	1,926.50	0.129	1,763.71	313,326	92,573	1,926.50	0.097	1,945.21	262,819	76,996
2029	1,926.50	0.129	1,673.19	295,513	88,248	1,926.50	0.097	1,887.62	254,188	74,818
2030	1,926.50	0.129	1,601.54	281,984	85,181	1,926.50	0.097	1,839.18	246,758	73,048
2031	1,926.50	0.129	1,545.76	271,867	83,037	1,926.50	0.097	1,799.77	240,519	71,627
2032	1,926.50	0.129	1,502.12	264,205	81,501	1,926.50	0.097	1,767.69	236,111	70,717
2033	1,926.50	0.129	1,468.76	258,484	80,410	1,926.50	0.097	1,742.11	232,258	69,913
2034	1,926.50	0.129	1,443.60	254,228	79,632	1,926.50	0.097	1,722.37	229,227	69,295

Table 3.23. Projection results when exploitation rates = $F_{current}$ (0.020) for Florida Keys/East Florida Hogfish. Short-term projections assume predicted age-0 recruitment is equal to the average from 2020 to 2024 (1.926 million). Recruitment (Recruits) is in thousands of age-0 fish, F is the exploitation rate, SSB is in metric tons (female plus male SSB), Retained Yield is in pounds (whole weight), and Retained Num is in numbers of fish.

$F_{current}$ Short-Term Projections

Year	Age-0 Recruits	F	SSB	Retained Yield	Retained Num
2025	1,926.50	0.020	2,155.77	59,990	17,750
2026	1,926.50	0.020	2,262.18	63,201	18,531
2027	1,926.50	0.020	2,358.30	66,169	19,226
2028	1,926.50	0.020	2,443.60	68,845	19,834
2029	1,926.50	0.020	2,517.76	71,199	20,355
2030	1,926.50	0.020	2,581.60	73,242	20,796
2031	1,926.50	0.020	2,636.39	75,004	21,170
2032	1,926.50	0.020	2,681.80	76,471	21,477
2033	1,926.50	0.020	2,720.02	77,714	21,734
2034	1,926.50	0.020	2,752.18	78,762	21,948

Table 3.24. Projection results when exploitation rates = F_{MSY} (0.073) for Florida Keys/East Florida Hogfish. Equilibrium projections assume predicted recruitment follows either the spawner-recruit curve (S-R) or the long-term average from 1950 – 2024 (2.145 million fish). Recruitment (Recruits) is in thousands of age-0 fish, F is the exploitation rate, SSB is in metric tons (female plus male SSB), Retained Yield is in pounds (whole weight), and Retained Num is in numbers of fish.

	F_{MSY} Equilibrium Long-Term Projections (S-R)					**F_{MSY} Equilibrium Long-Term Projections**				
Year	**Age-0 Recruits**	**F**	**SSB**	**Retained Yield**	**Retained Num**	**Age-0 Recruits**	**F**	**SSB**	**Retained Yield**	**Retained Num**
2025	2,095.40	0.073	2,155.98	218,112	64,521	2,145.97	0.073	2,185.38	222,050	66,262
2026	2,090.78	0.073	2,146.29	217,779	64,067	2,145.97	0.073	2,193.60	223,641	66,363
2027	2,086.26	0.073	2,136.87	216,692	63,675	2,145.97	0.073	2,194.87	223,564	66,123
2028	2,083.28	0.073	2,130.67	215,583	63,402	2,145.97	0.073	2,193.32	222,748	65,783
2029	2,080.71	0.073	2,125.35	214,639	63,209	2,145.97	0.073	2,190.30	221,783	65,472
2030	2,078.45	0.073	2,120.68	213,883	63,066	2,145.97	0.073	2,186.84	220,926	65,230
2031	2,076.60	0.073	2,116.85	213,294	62,964	2,145.97	0.073	2,183.70	220,251	65,065
2032	2,074.61	0.073	2,112.75	212,729	62,863	2,145.97	0.073	2,180.06	219,635	64,931
2033	2,072.90	0.073	2,109.24	212,265	62,778	2,145.97	0.073	2,176.98	219,162	64,837
2034	2,071.48	0.073	2,106.32	211,893	62,707	2,145.97	0.073	2,174.55	218,815	64,775

Table 3.25. Projection results when exploitation rates = F_{MSY} (0.073) and 75% F_{MSY} (0.054) for Florida Keys/East Florida Hogfish. Short-term projections assume predicted age-0 recruitment is equal to the average from 2020 to 2024 (1.926 million). Recruitment (Recruits) is in thousands of age-0 fish, F is the exploitation rate, SSB is in metric tons (female plus male SSB), Retained Yield is in pounds (whole weight), and Retained Num is in numbers of fish.

	F_{MSY} Short-Term Projections					**0.75 * F_{MSY} Short-Term Projections**				
Year	**Age-0 Recruits**	**F**	**SSB**	**Retained Yield**	**Retained Num**	**Age-0 Recruits**	**F**	**SSB**	**Retained Yield**	**Retained Num**
2025	1,926.50	0.073	2,155.77	217,900	64,372	1,926.50	0.054	2,155.77	163,401	48,298
2026	1,926.50	0.073	2,139.95	216,661	63,479	1,926.50	0.054	2,182.07	166,019	48,654
2027	1,926.50	0.073	2,117.77	213,933	62,404	1,926.50	0.054	2,198.84	167,707	48,850
2028	1,926.50	0.073	2,094.41	210,819	61,406	1,926.50	0.054	2,209.31	168,732	48,950
2029	1,926.50	0.073	2,071.79	207,928	60,588	1,926.50	0.054	2,215.04	169,282	48,986
2030	1,926.50	0.073	2,051.14	205,480	59,958	1,926.50	0.054	2,217.67	169,532	48,983
2031	1,926.50	0.073	2,033.16	203,499	59,495	1,926.50	0.054	2,218.60	169,613	48,968
2032	1,926.50	0.073	2,016.90	201,820	59,133	1,926.50	0.054	2,217.49	169,510	48,927
2033	1,926.50	0.073	2,003.19	200,482	58,862	1,926.50	0.054	2,215.90	169,363	48,884
2034	1,926.50	0.073	1,991.89	199,432	58,663	1,926.50	0.054	2,214.27	169,212	48,846

3.14 FL KEYS/EFL Figures

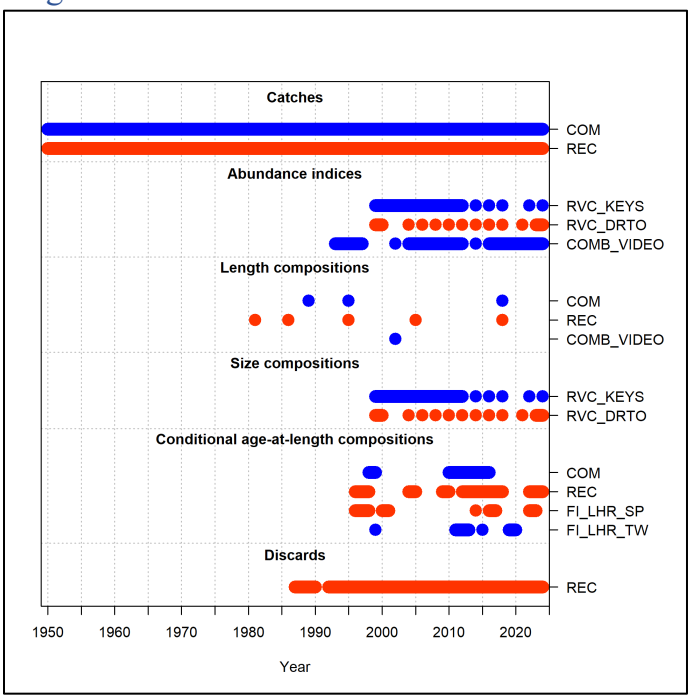


Figure 3.1. Data sources used in the Florida Keys/East Florida Hogfish Stock Synthesis assessment model (KEYS base model).

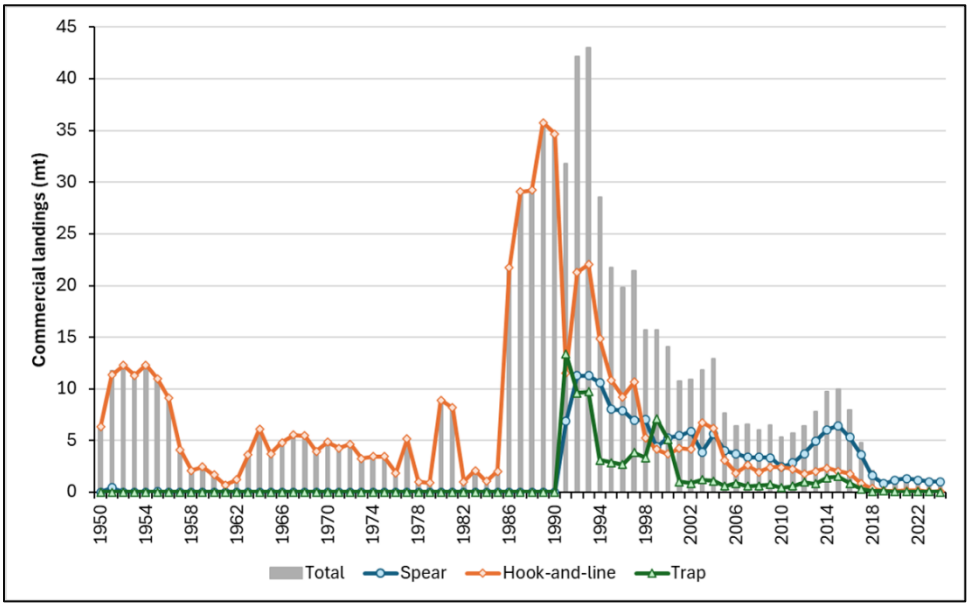


Figure 3.2. Commercial landings (metric tons) of Florida Keys/East Florida Hogfish by gear for years 1950 – 2024.

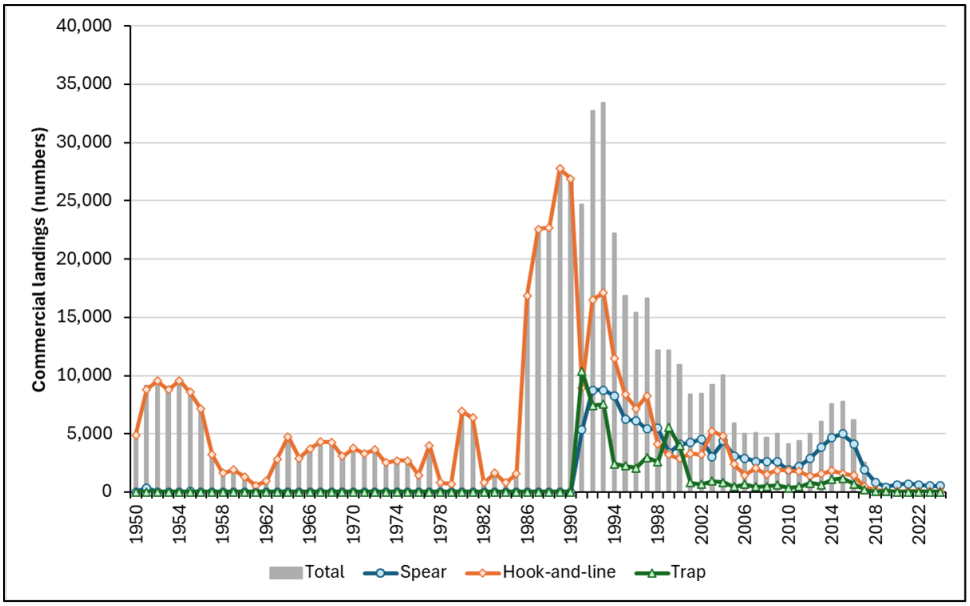


Figure 3.3. Commercial landings (numbers) of Florida Keys/East Florida Hogfish by gear for years 1950 – 2024.

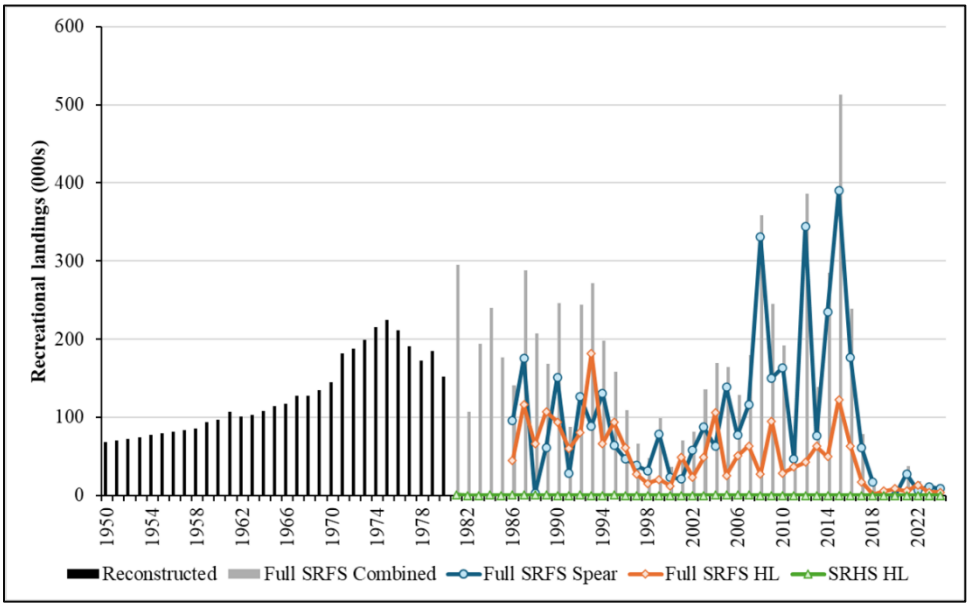


Figure 3.4. Recreational landings (numbers) of Florida Keys/East Florida Hogfish for years 1950 – 2024. The reconstructed historic landings are from 1950 – 1980 (black bars). The 'Full SRFS' estimates are from 1981 – 2024 (grey bars) and are comprised of 'SRFS & SRFS-calibrated Private' mode, MRIP charter mode, and MRIP shore mode landings estimates. 'SRFS & SRFS-calibrated Private' estimates are comprised of SRFS private mode (2021 – 2024) and SRFS ratio-calibrated MRIP private mode (1981 – 2020). The 'Full SRFS Combined' is comprised of the 'Full SRFS' estimates plus the SRHS estimates where the flagged estimates for 1981 and 1984 were replaced with the geometric mean of their six respective surrounding years. Landings by gear are presented beginning in 1986.

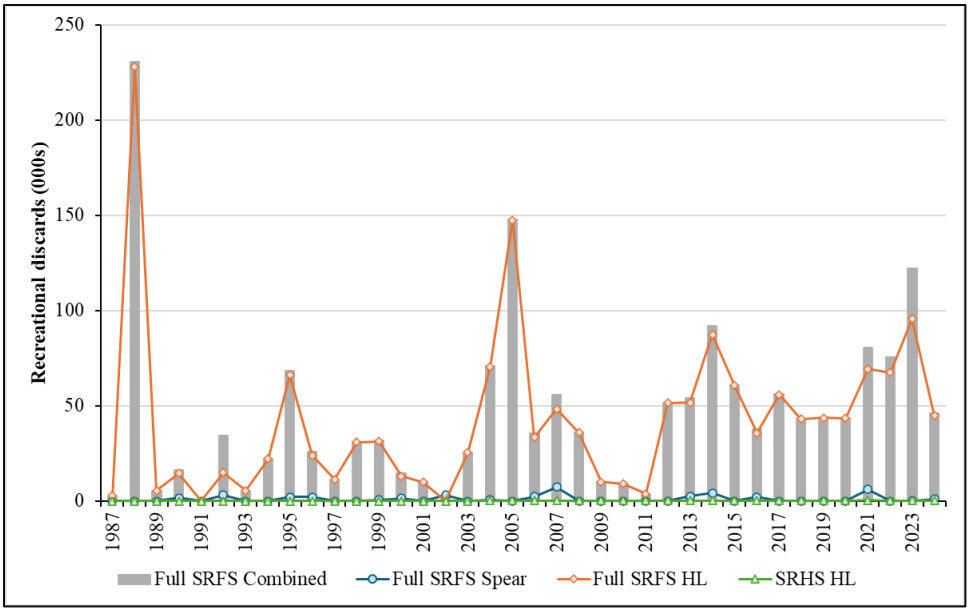


Figure 3.5. Recreational discards (numbers) of Florida Keys/East Florida Hogfish by gear for years 1987 – 2024. The 'Full SRFS' estimates are comprised of 'SRFS & SRFS-calibrated Private' mode, MRIP charter mode, and MRIP shore mode landings estimates. 'SRFS & SRFS-calibrated Private' estimates are comprised of SRFS private mode (2021 – 2024) and SRFS ratio-calibrated MRIP private mode (1981 – 2020). The 'Full SRFS Combined' is comprised of the 'Full SRFS' estimates plus the SRHS estimates.

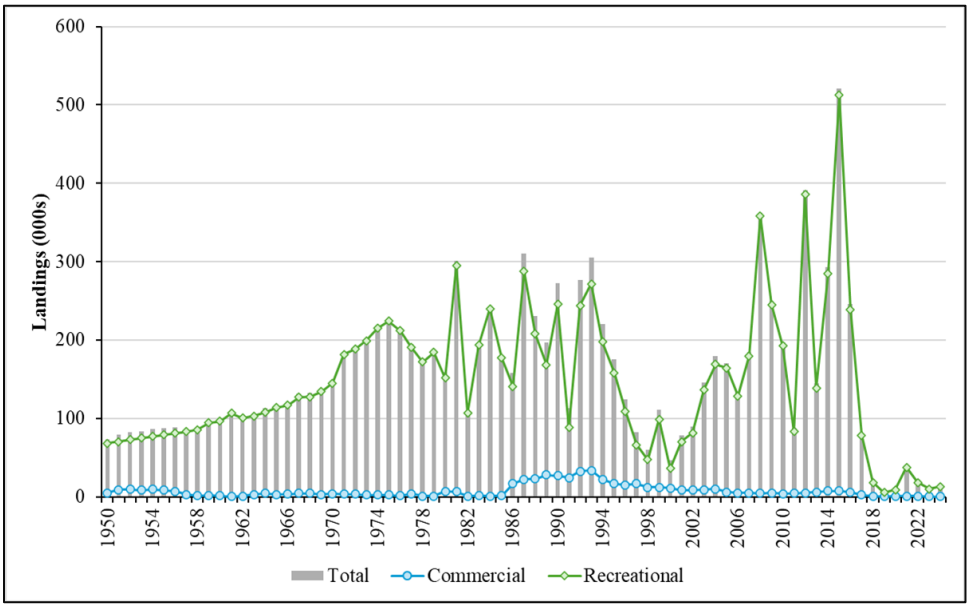


Figure 3.6. A comparison of the commercial landings (numbers; blue dots) with the recreational landings (numbers; green diamonds) of Florida Keys/East Florida Hogfish from 1950 – 2024.

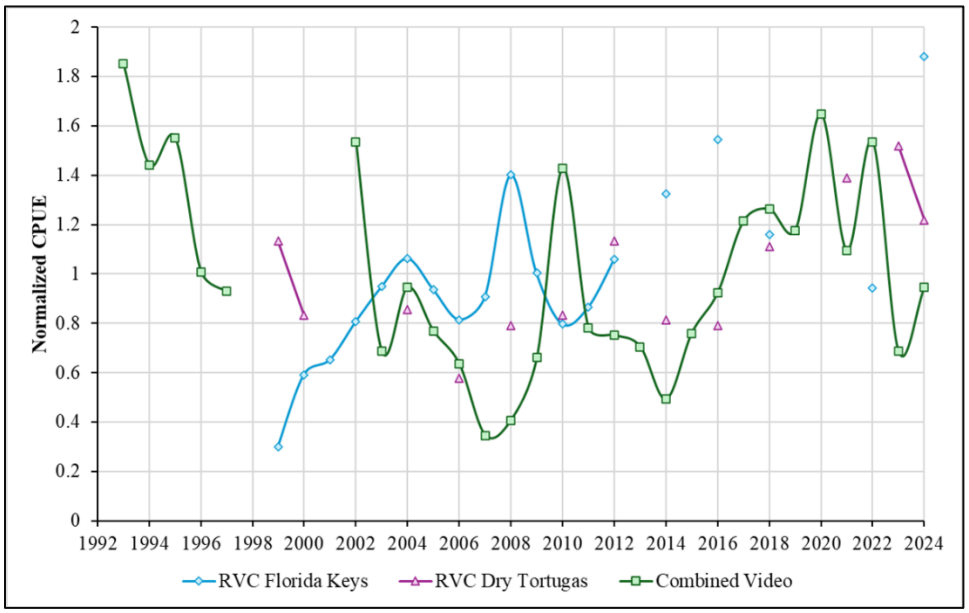


Figure 3.7. Normalized indices of relative abundance for Florida Keys/East Florida Hogfish from 1993 – 2024 from the Reef Fish Visual Census (RVC) and combined video surveys. The RVC Florida Keys was from 1999 – 2012, 2014, 2016, 2018, 2022, and 2024 while the RVC Dry Tortugas was from 1999 – 2000, biennially from 2004 – 2018, 2021, 2023, and 2024. The combined video was from 1993 – 1997 then 2002 – 2024.

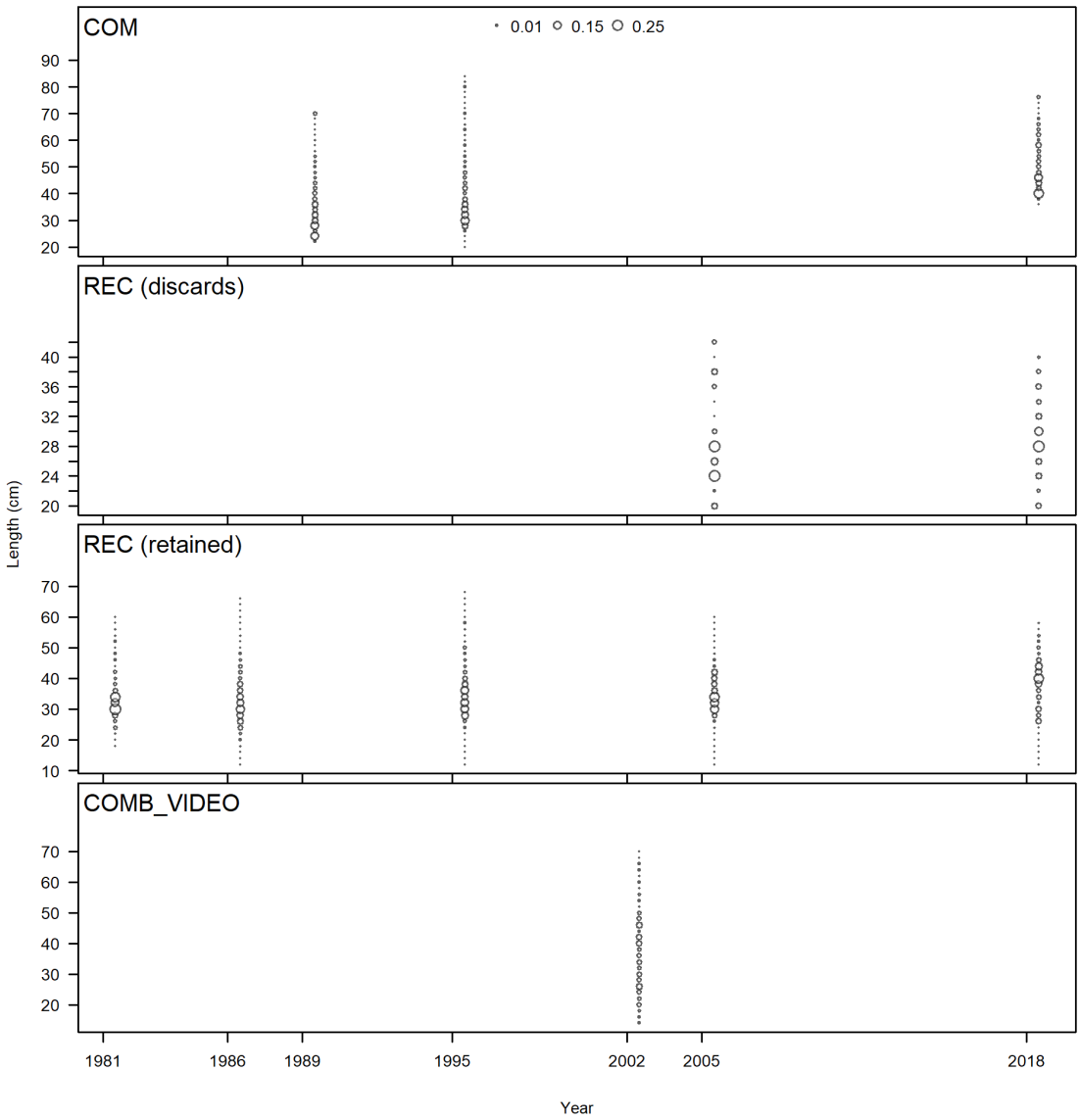


Figure 3.8. Catch-weighted length compositions (2 cm FL bins) of Florida Keys/East Florida Hogfish landings (retained) and discards by fishery for years 1981 – 2024. Commercial = COM, Full SRFS plus SRHS = REC, and combined video Index = COMB_VIDEO.

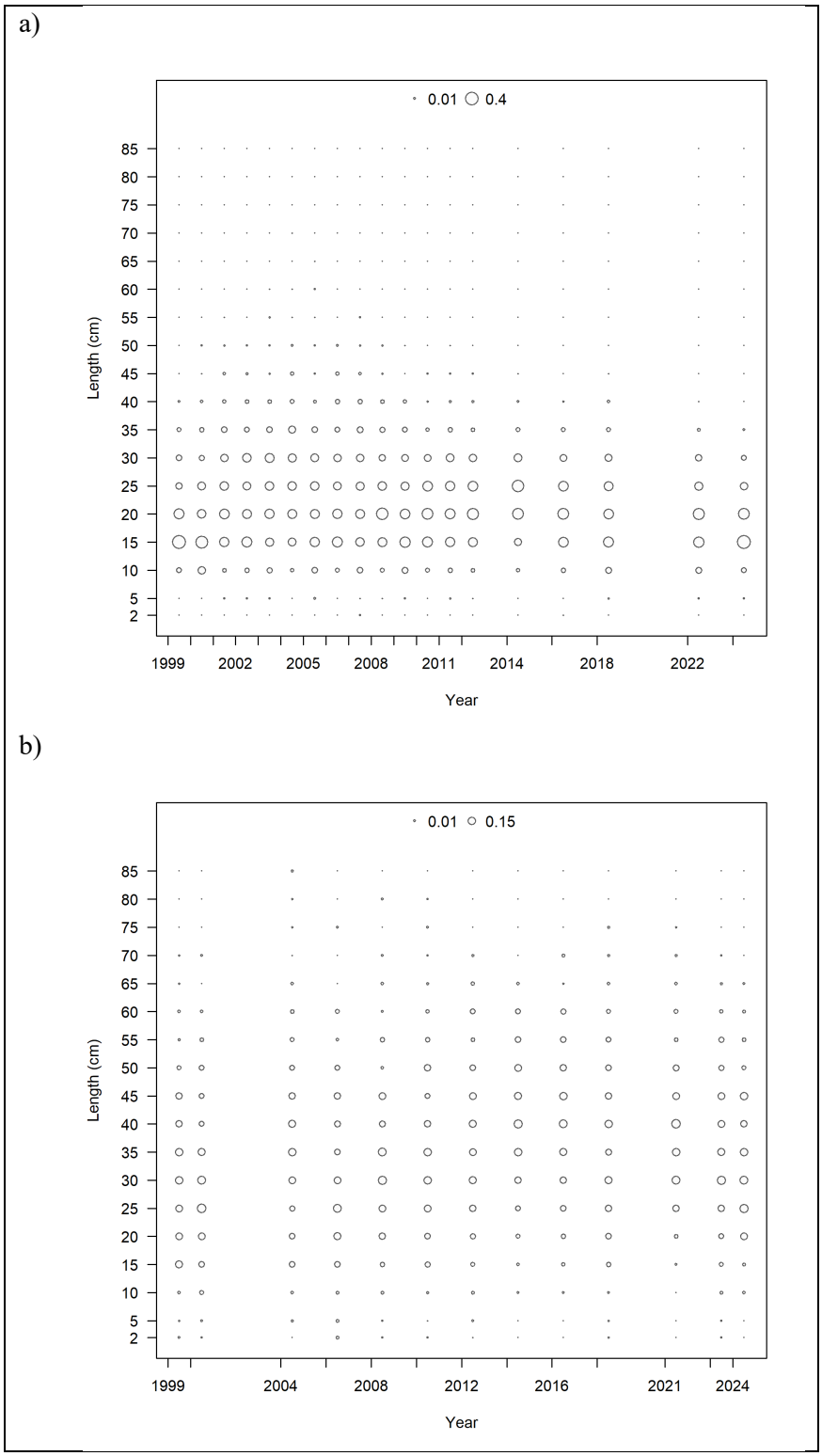


Figure 3.9. Generalized size compositions (5 cm FL bins) of Florida Keys/East Florida Hogfish from a) the RVC Florida Keys index and b) the RVC Dry Tortugas index for years 1999 – 2024.

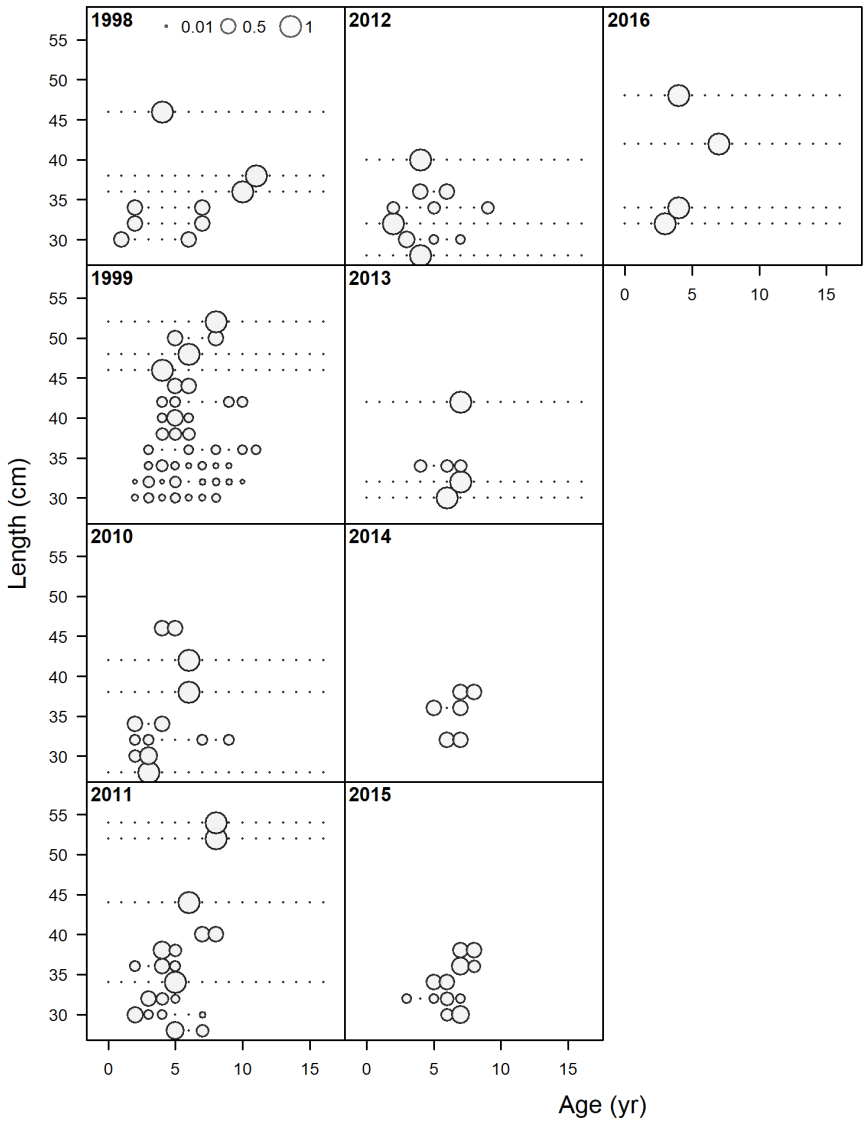


Figure 3.10. Observed conditional age-at-length in 2 cm FL bins of Florida Keys/East Florida Hogfish for the commercial fleet during years 1998 – 2016.

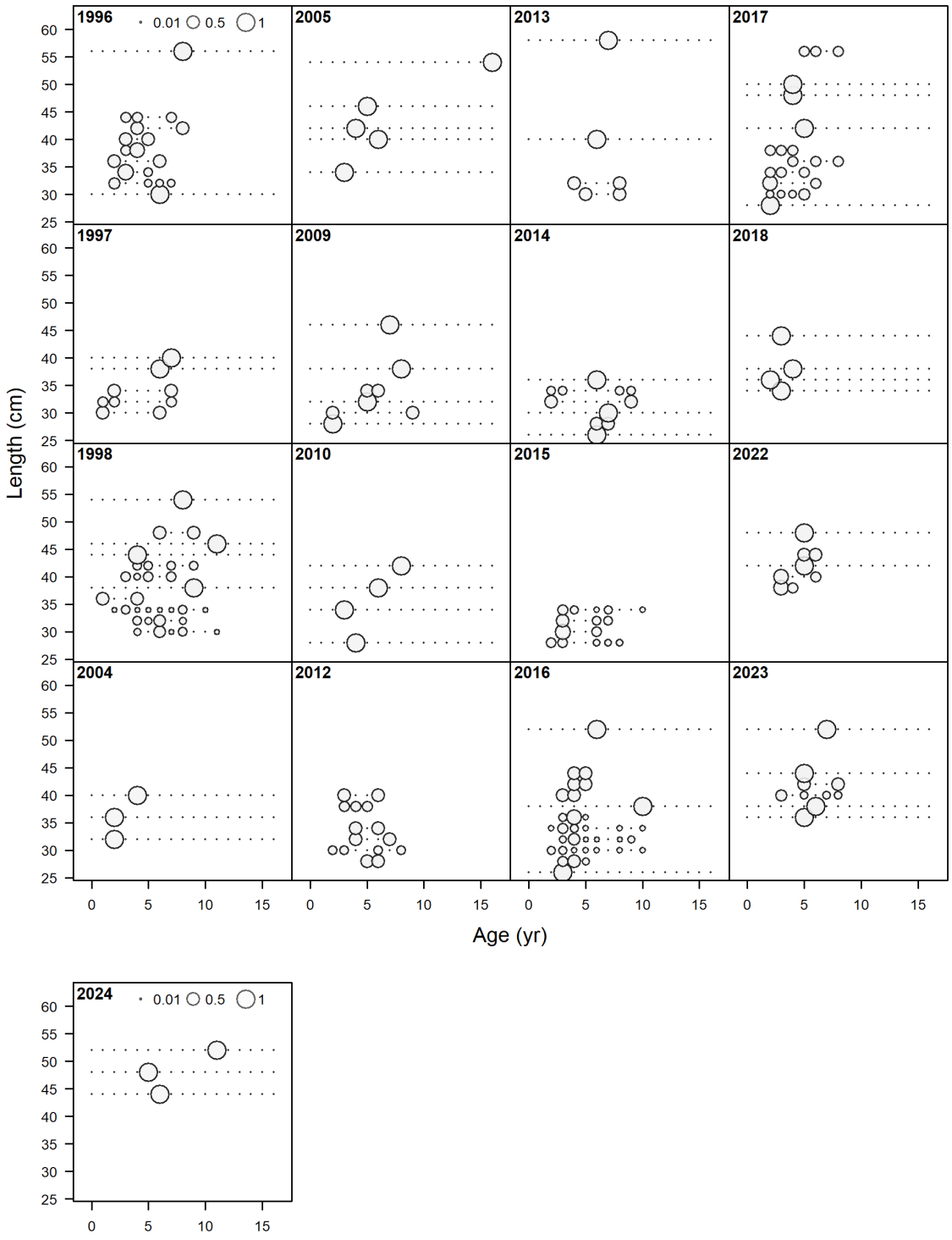


Figure 3.11. Observed conditional age-at-length in 2 cm FL bins of Florida Keys/East Florida Hogfish for the recreational fleet during years 1996 – 2024.

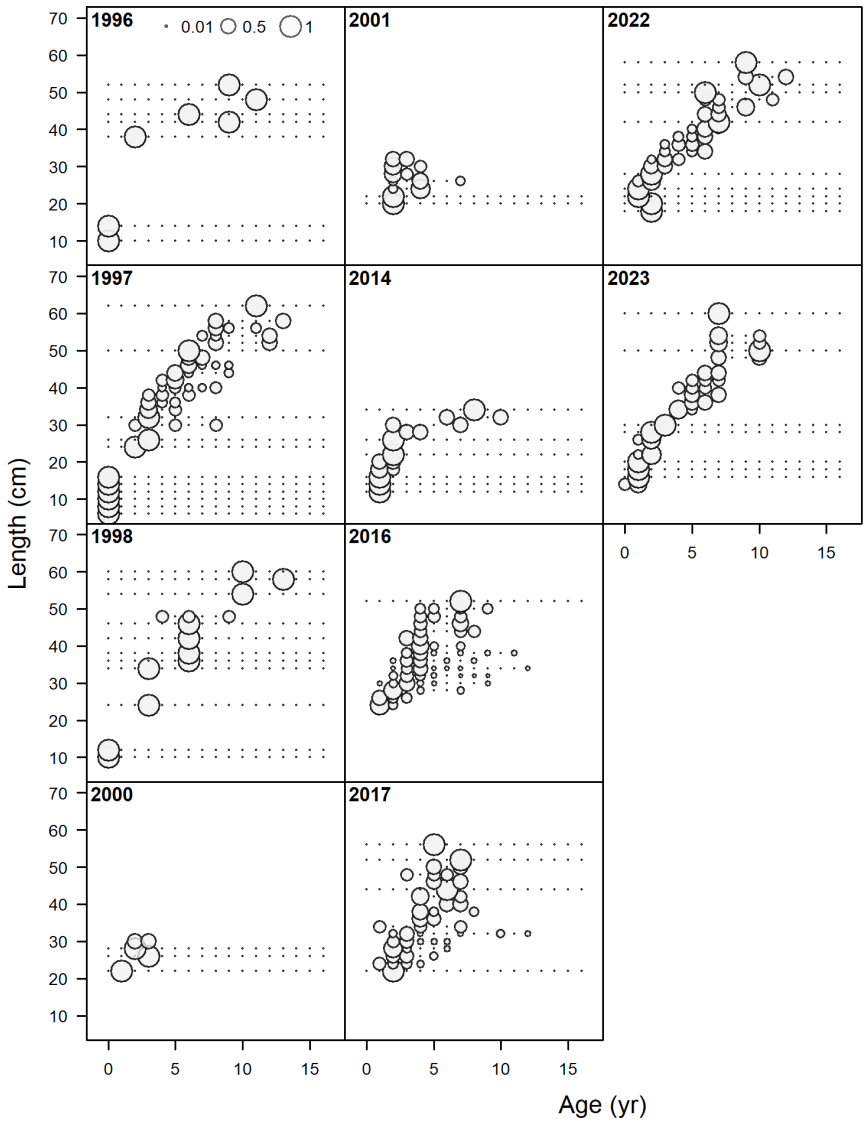


Figure 3.12. Observed conditional age-at-length in 2 cm FL bins of Florida Keys/East Florida Hogfish collected by the spear gear from fishery-independent data sources during years 1996 – 2023.

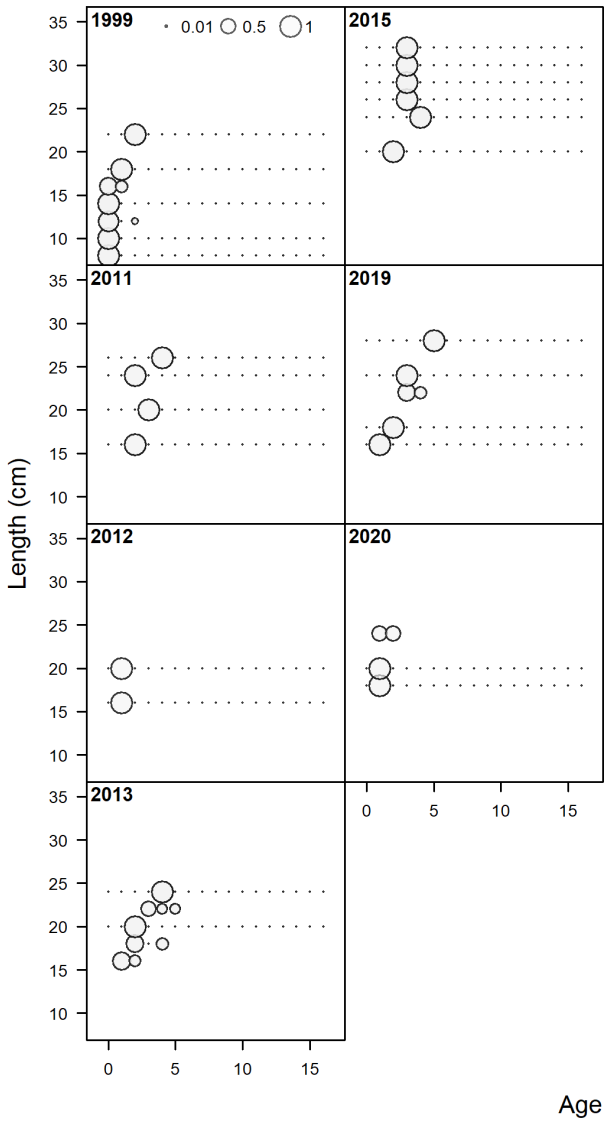


Figure 3.13. Observed conditional age-at-length in 2 cm FL bins of Florida Keys/East Florida Hogfish collected by the trawl gear from fishery-independent data sources during years 1999 – 2020.

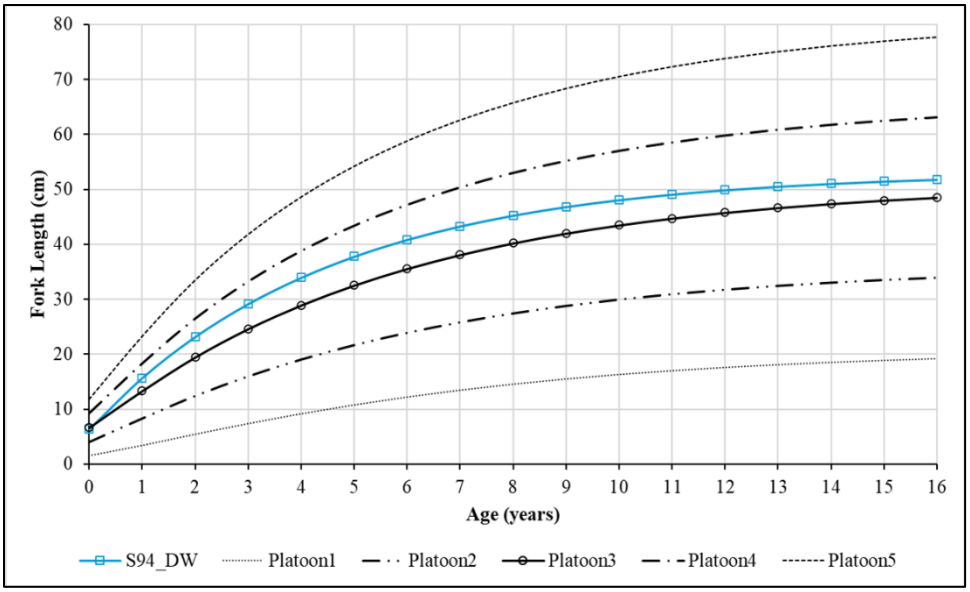


Figure 3.14. Mean size-at-age across 5 platoons for Florida Keys/East Florida Hogfish as estimated by the SEDAR 94 KEYS base model. Distribution of recruitment among platoons approximated a normal distribution (0.031, 0.237, 0.464, 0.237, 0.031) and the 3rd platoon (black circles) followed the L_{inf} (51.2 cm FL) and k (0.177) parameters estimated by the SEDAR 94 KEYS base model. A comparison with the external growth model developed during the Data Workshop is shown by the blue squares.

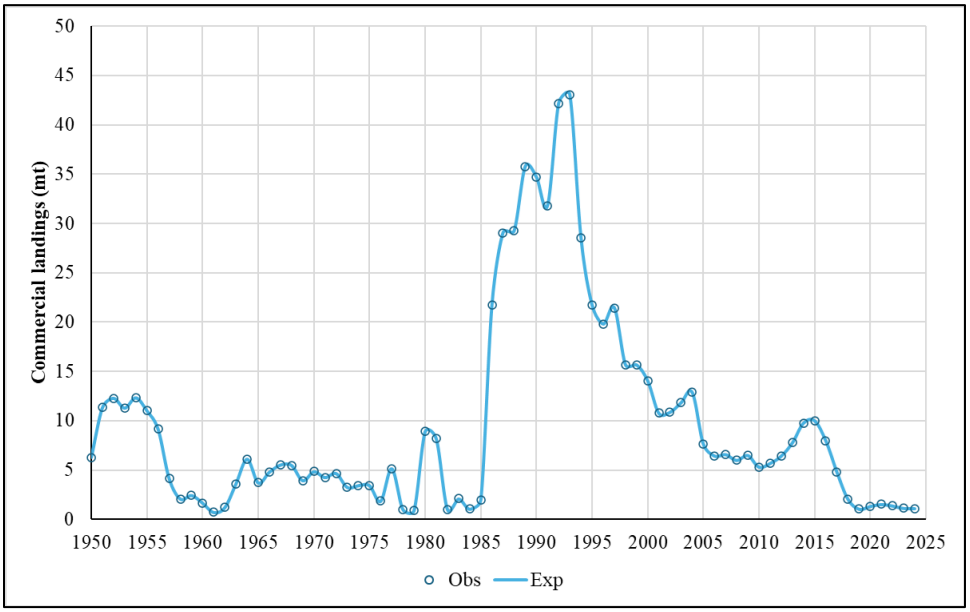


Figure 3.15. Florida Keys/East Florida Hogfish observed (dots) and expected (solid line) landings by the commercial fleet (in metric tons) from the SEDAR 94 KEYS base model.

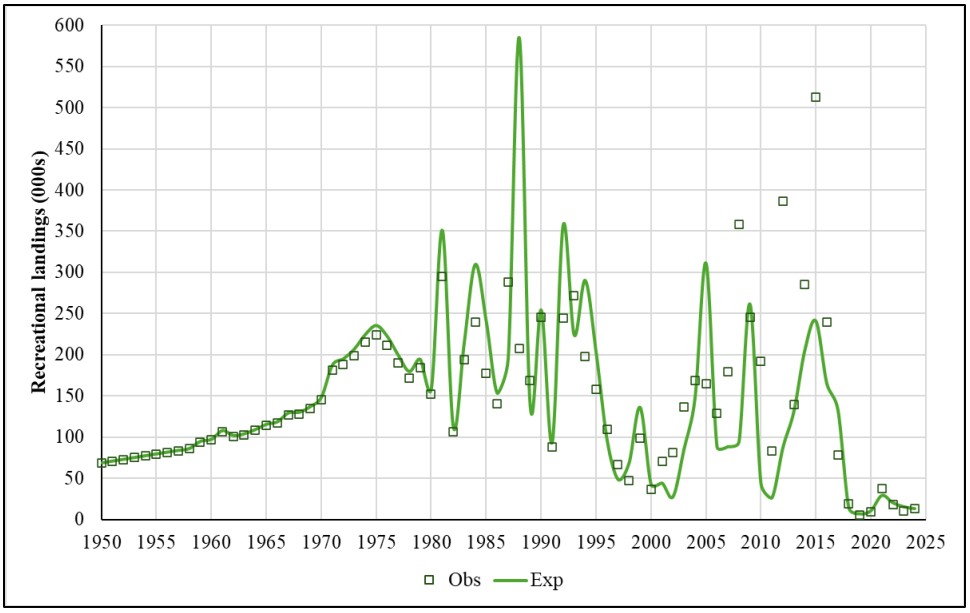


Figure 3.16. Florida Keys/East Florida Hogfish observed (squares) and expected (solid line) landings by the recreational fleet (in thousands of fish) from the SEDAR 94 KEYS base model.

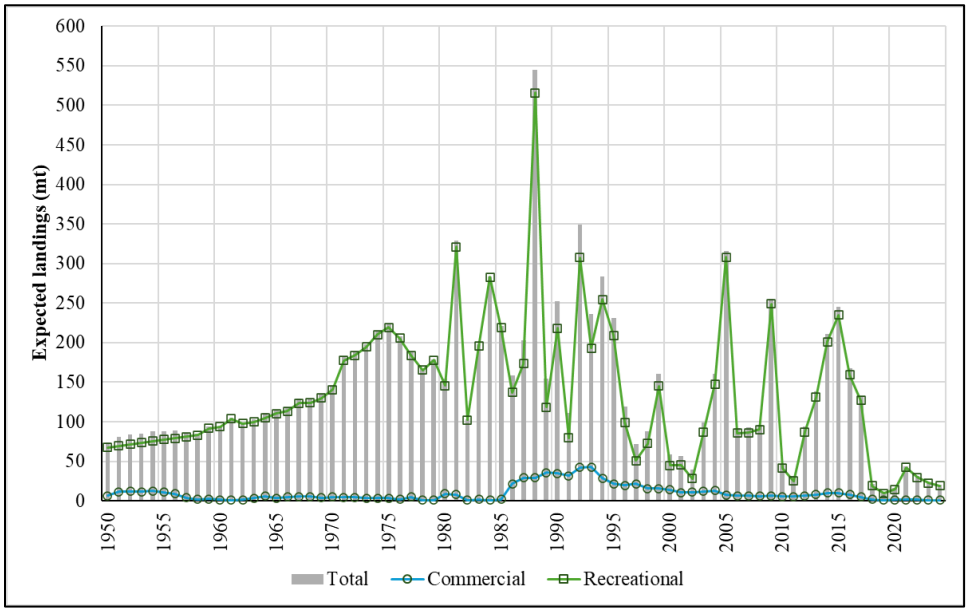


Figure 3.17. Expected landings of Florida Keys/East Florida Hogfish by fleet (in metric tons) as estimated from the SEDAR 94 KEYS base model.

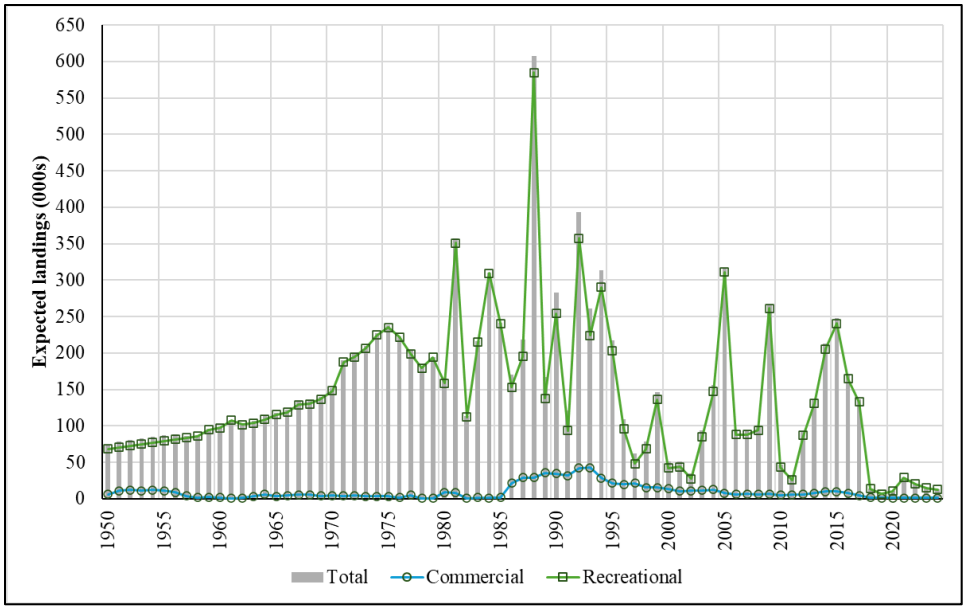


Figure 3.18. Expected landings of Florida Keys/East Florida Hogfish by fleet (in thousands of fish) as estimated from the SEDAR 94 KEYS base model.

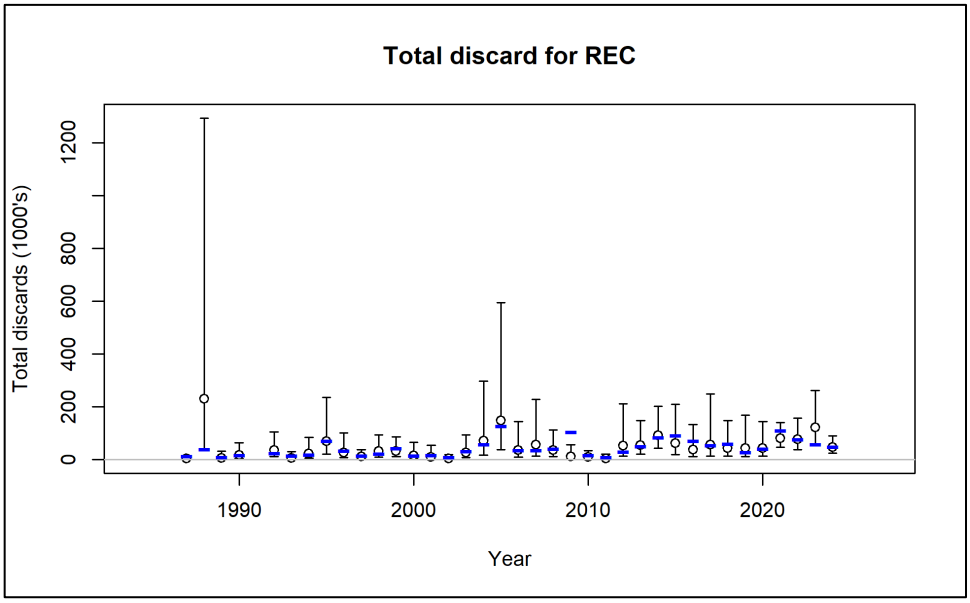


Figure 3.19. Florida Keys/East Florida Hogfish observed (dots with 95% confidence intervals) and expected (blue dashes) discards (i.e., before applying the discard mortality rate for each fleet) by the recreational fleet (in thousands of fish) from the SEDAR 94 KEYS base model.

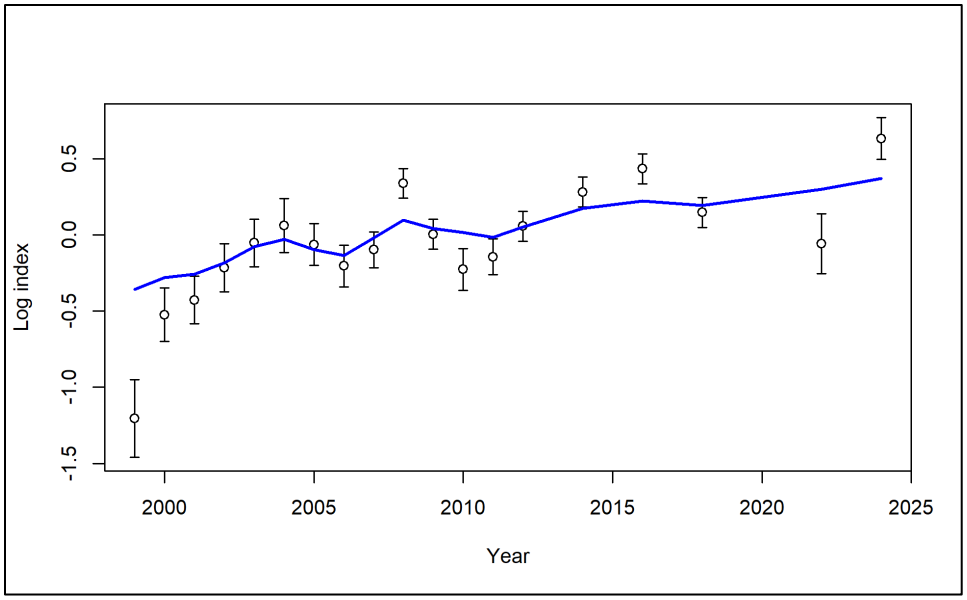


Figure 3.20. The Florida Keys/East Florida Hogfish observed (dots with 95% confidence intervals) and predicted (blue line) RVC Florida Keys index of relative abundance (log-transformed) from the SEDAR 94 KEYS base model.

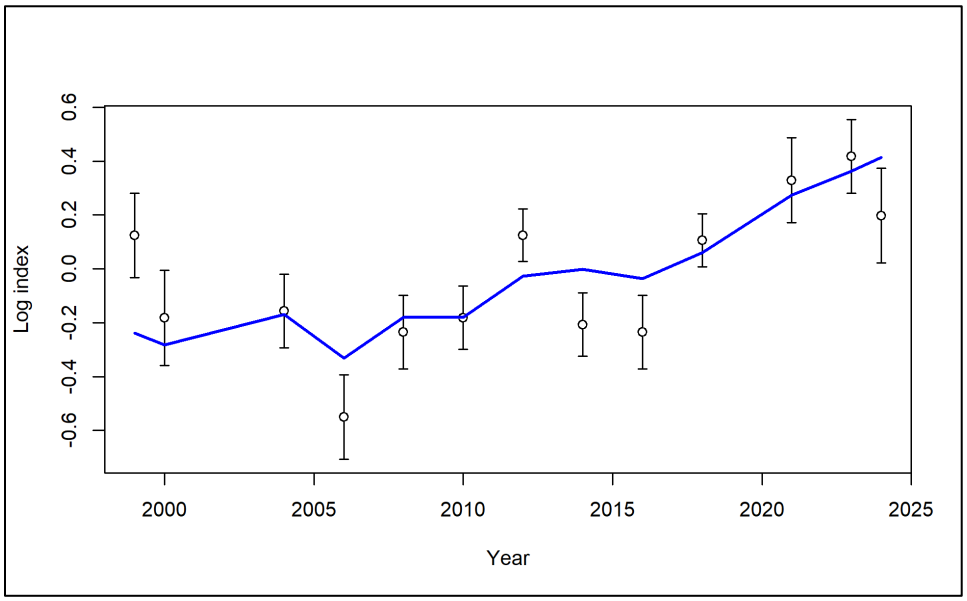


Figure 3.21. The Florida Keys/East Florida Hogfish observed (dots with 95% confidence intervals) and predicted (blue line) RVC Dry Tortugas index of relative abundance (log-transformed) from the SEDAR 94 KEYS base model.

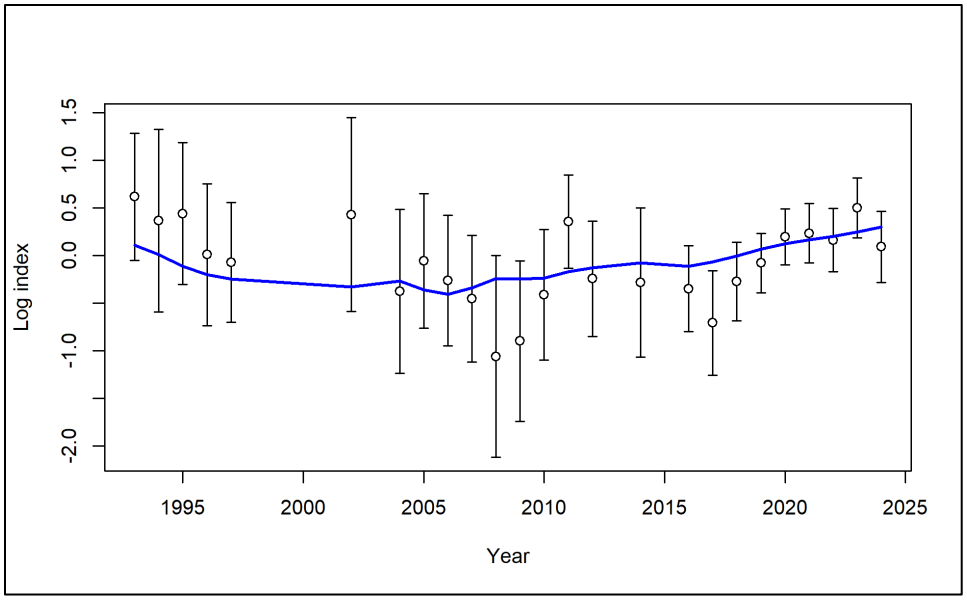


Figure 3.22. The Florida Keys/East Florida Hogfish observed (dots with 95% confidence intervals) and predicted (blue line) combined video index of relative abundance (log-transformed) from the SEDAR 94 KEYS base model.

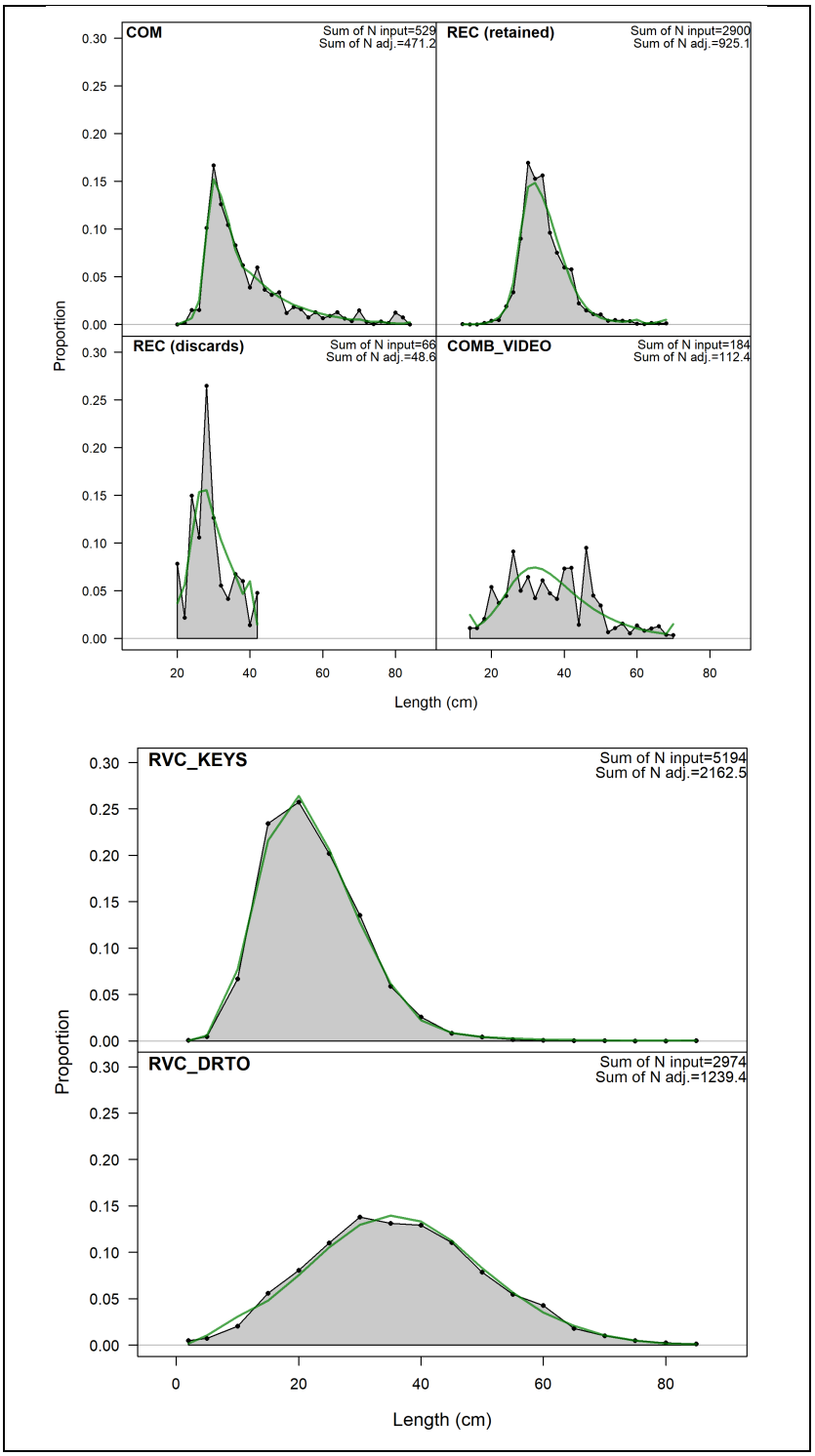


Figure 3.23. Model fits to the length composition of retained and discarded catch within a given fleet or survey aggregated across years for Florida Keys/East Florida Hogfish. Green lines represent predicted length compositions, while grey shaded regions represent observed length compositions. In the upper right hand corners, 'N input.' is the input sample size while 'N adj.' is the effective sample size calculated using the Dirichlet-Multinomial data-weighting adjustment.

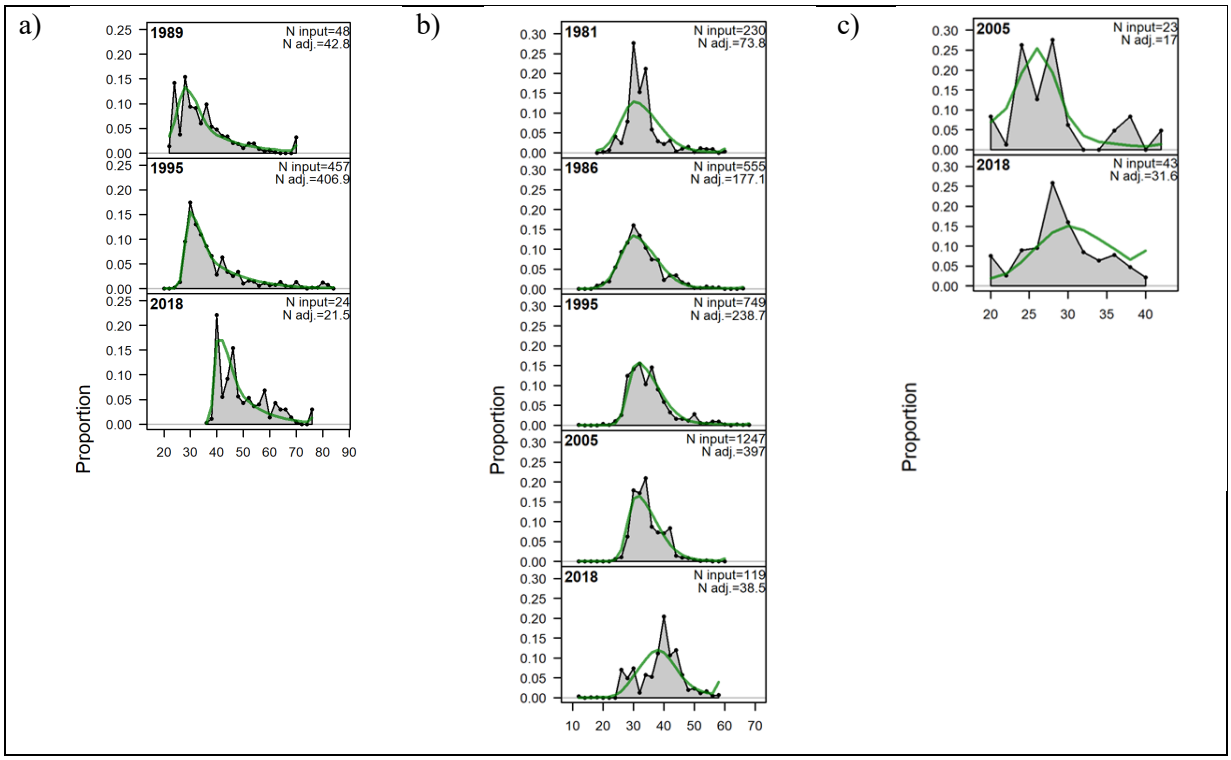


Figure 3.24. Model fits to the length composition of a) retained catch by the commercial fleet, b) retained catch by the recreational fleet, and c) discards for the recreational fleet by super-period for Florida Keys/East Florida Hogfish. Green lines represent predicted length compositions, while grey shaded regions represent observed length compositions. In the upper right hand corners, 'N input.' is the input sample size while 'N adj.' is the effective sample size calculated using the Dirichlet-Multinomial data-weighting adjustment. Data are in 2 cm fork length bins.

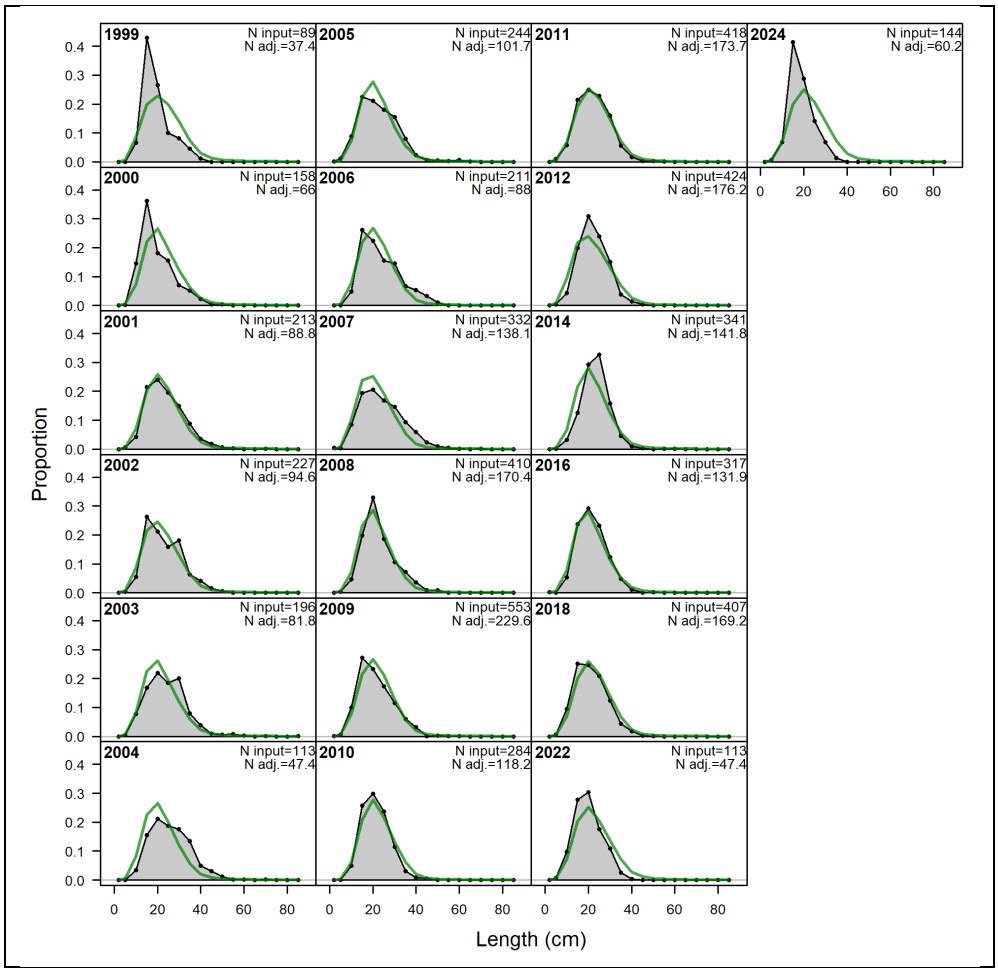


Figure 3.25. Model fits to the length composition data by the RVC Florida Keys index for Florida Keys/East Florida Hogfish. Green lines represent predicted length compositions, while grey shaded regions represent observed length compositions. In the upper right hand corners, 'N input.' is the input sample size while 'N adj.' is the effective sample size calculated using the Dirichlet-Multinomial data-weighting adjustment. Data are in 5 cm fork length bins.

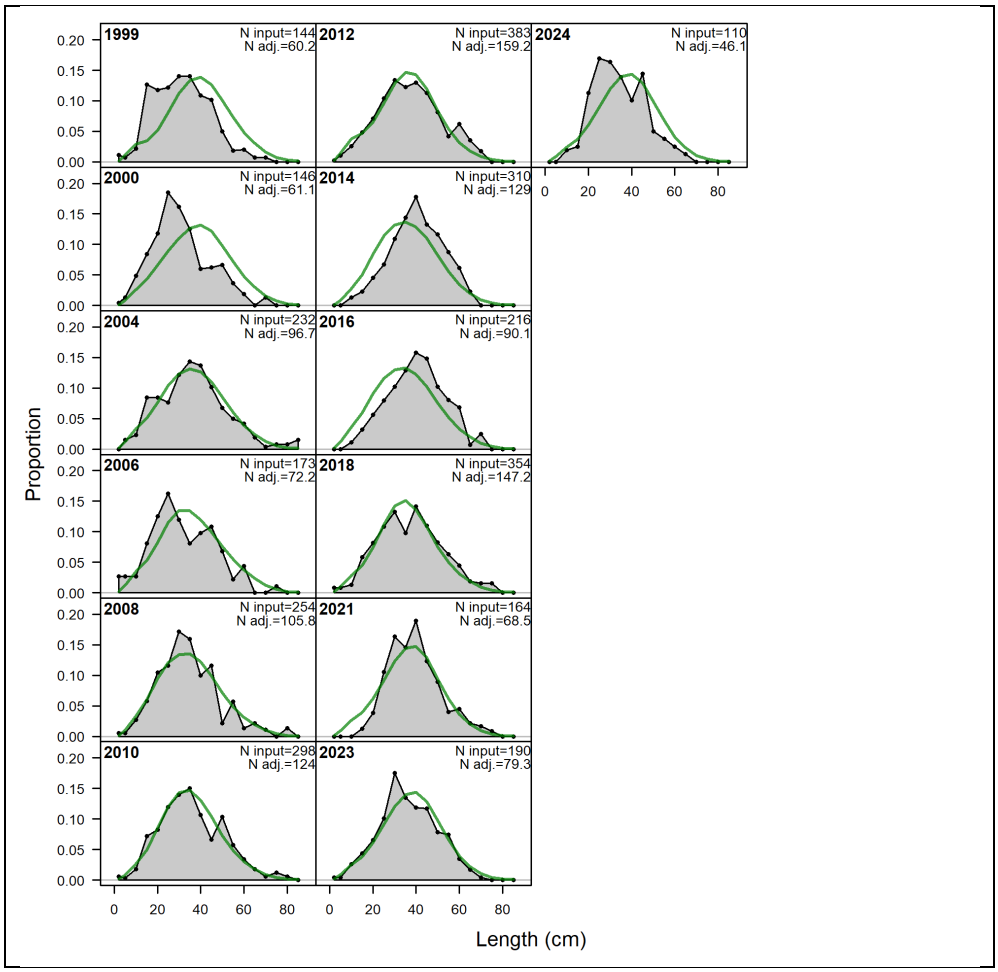


Figure 3.26. Model fits to the length composition data by the RVC Dry Tortugas index Florida Keys/East Florida Hogfish. Green lines represent predicted length compositions, while grey shaded regions represent observed length compositions. In the upper right hand corners, 'N input.' is the input sample size while 'N adj.' is the effective sample size calculated using the Dirichlet-Multinomial data-weighting adjustment. Data are in 5 cm fork length bins.

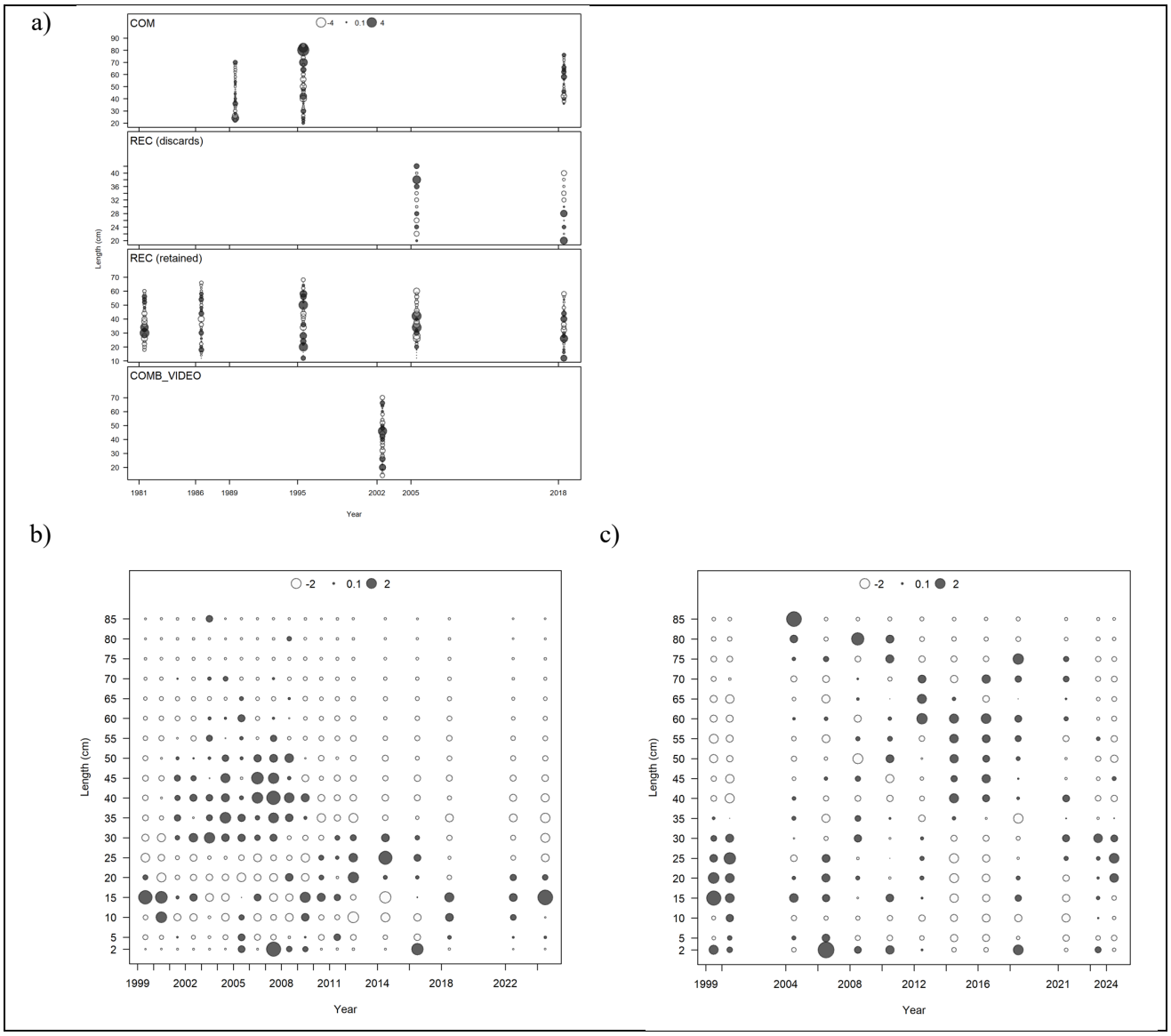


Figure 3.27. Pearson residuals for length composition data for a) the commercial and recreational fleets as well as the combined video index by super-period, b) the RVC Florida Keys index by year, and c) the RVC Dry Tortugas index by year for Florida Keys/East Florida Hogfish. Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected).

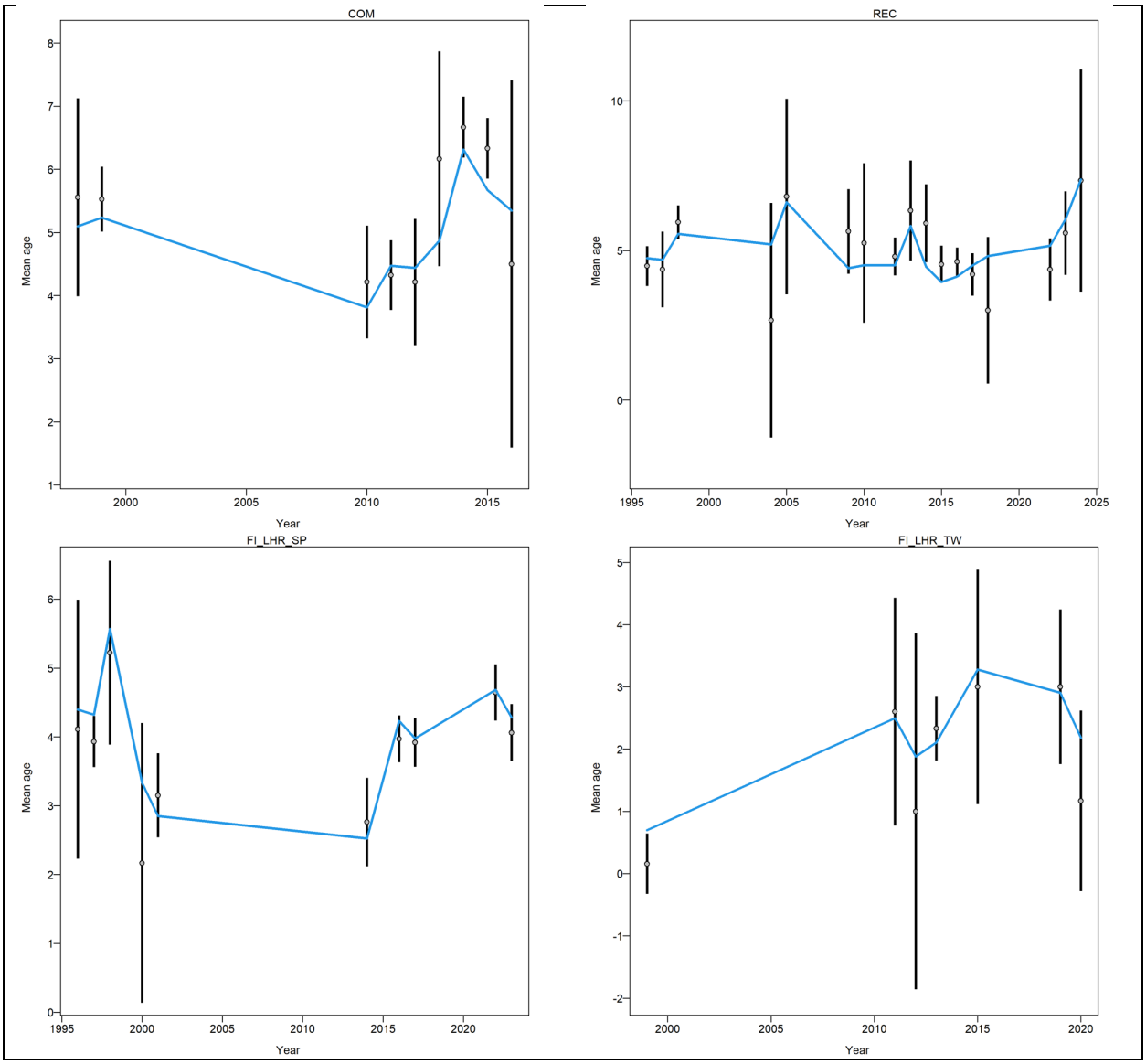


Figure 3.28. Mean ages of Florida Keys/East Florida Hogfish from conditional age-at-length data (commercial retained catch, recreational retained catch, fishery-independent spear, and fishery-independent trawl) aggregated across length bins. Observed values are dots with 95% confidence intervals and predicted values are the blue lines).

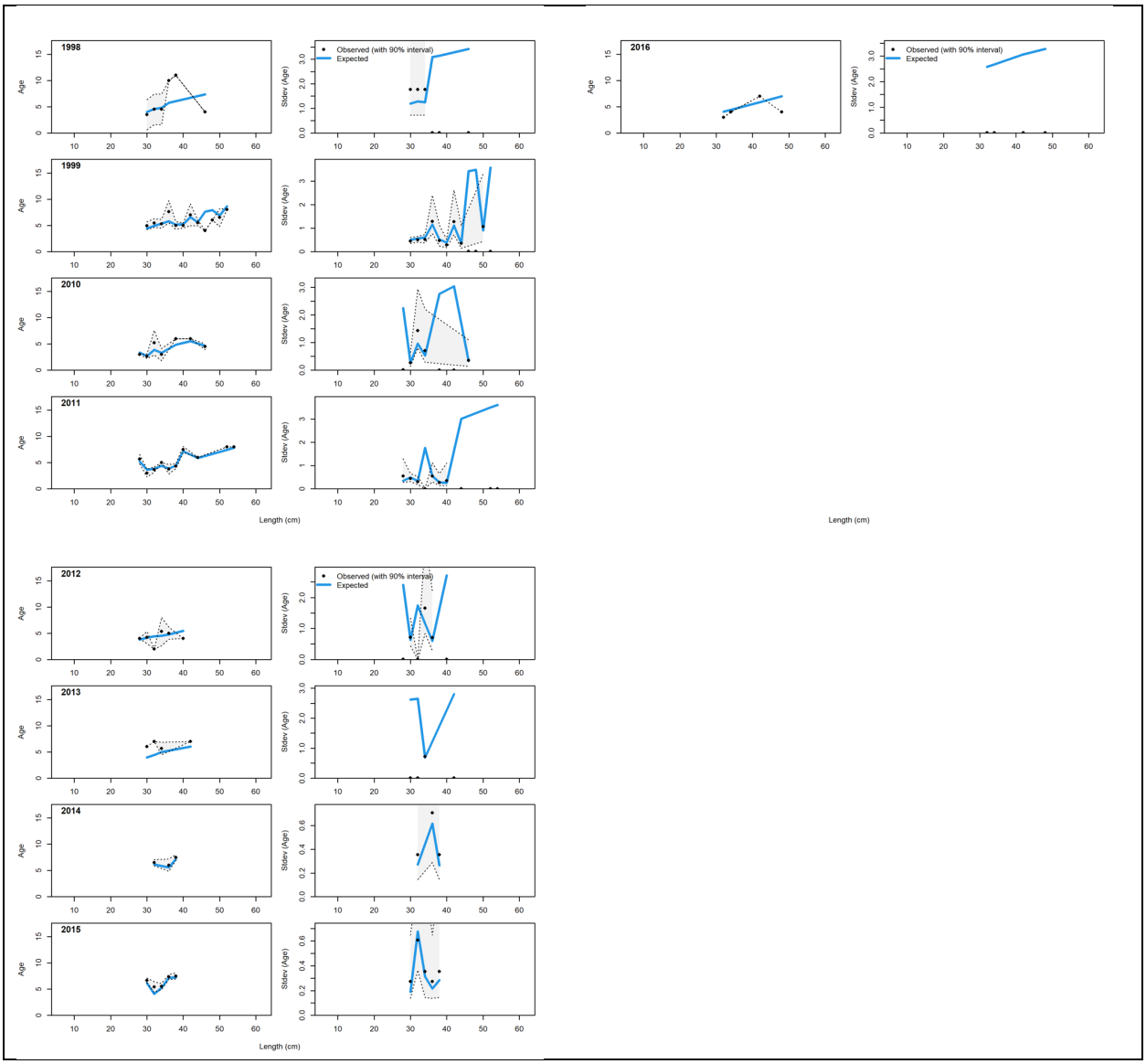


Figure 3.29. Model fits to the annual conditional age-at-length data from retained catch by the commercial fleet for Florida Keys/East Florida Hogfish. In the left plots, the blue lines represent predicted mean age-at-length by size class while the black dots and grey shaded regions represent the observed mean age-at-length by size class with 90% confidence intervals. In the right plots, the blue lines represent predicted standard error of mean age-at-length by size class while the black dots and grey shaded regions represent the observed standard error of mean age-at-length by size class with 90% confidence intervals.

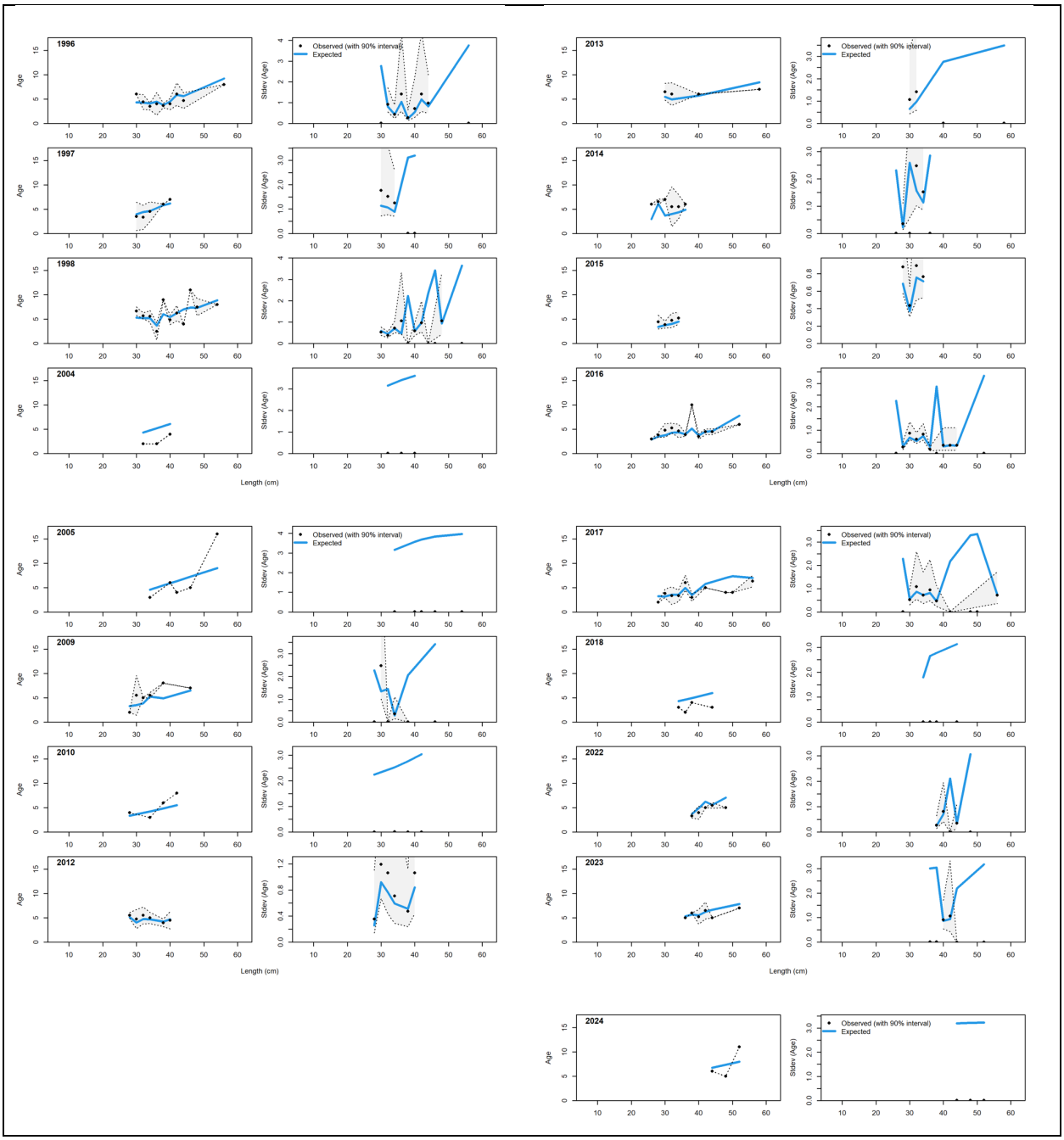


Figure 3.30. Model fits to the annual conditional age-at-length data from retained catch by the recreational fleet for Florida Keys/East Florida Hogfish. In the left plots, the blue lines represent predicted mean age-at-length by size class while the black dots and grey shaded regions represent the observed mean age-at-length by size class with 90% confidence intervals. In the right plots, the blue lines represent predicted standard error of mean age-at-length by size class while the black dots and grey shaded regions represent the observed standard error of mean age-at-length by size class with 90% confidence intervals.

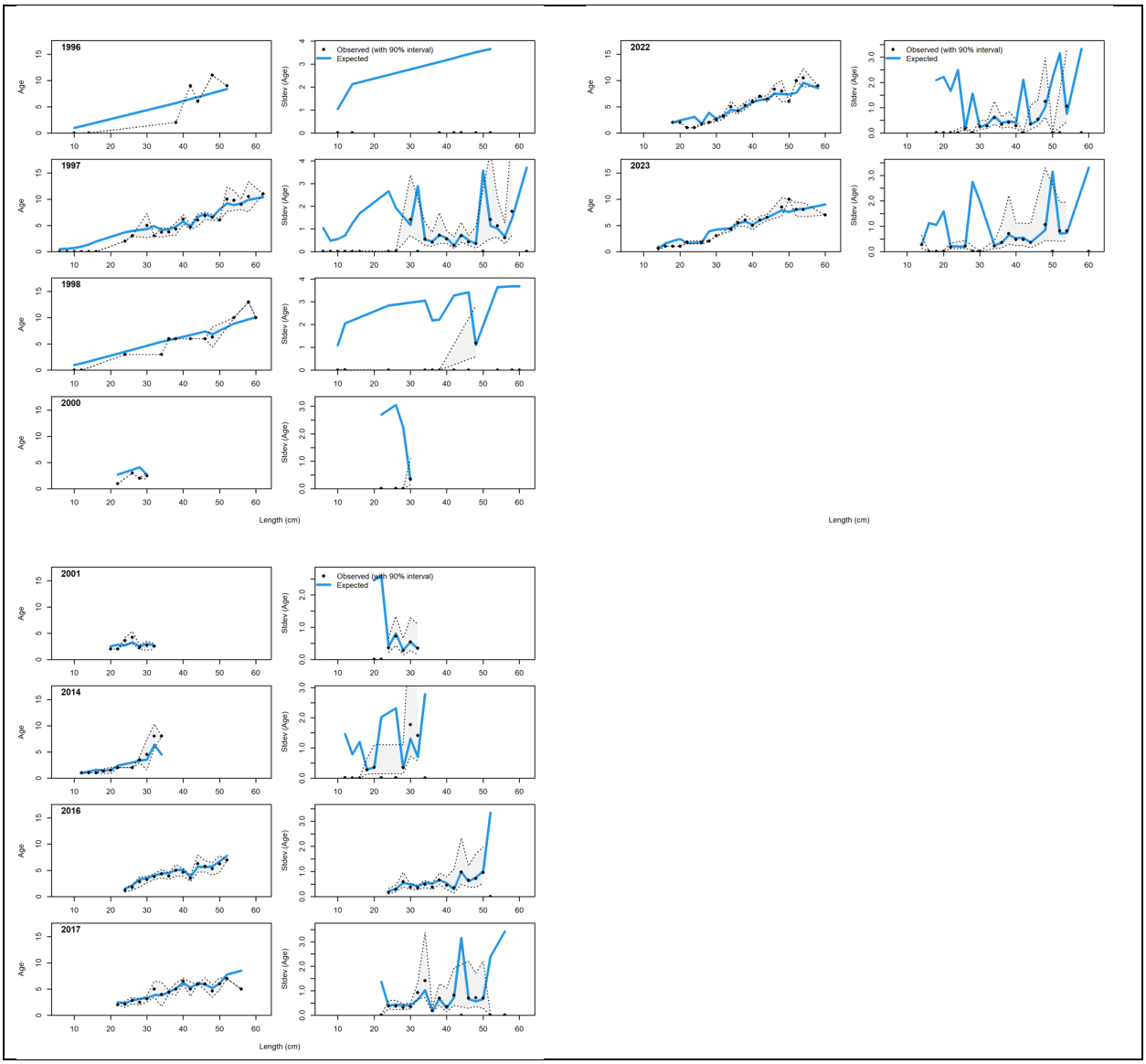


Figure 3.31. Model fits to the annual conditional age-at-length data from fishery-independent spear data sources for Florida Keys/East Florida Hogfish. In the left plots, the blue lines represent predicted mean age-at-length by size class while the black dots and grey shaded regions represent the observed mean age-at-length by size class with 90% confidence intervals. In the right plots, the blue lines represent predicted standard error of mean age-at-length by size class while the black dots and grey shaded regions represent the observed standard error of mean age-at-length by size class with 90% confidence intervals.

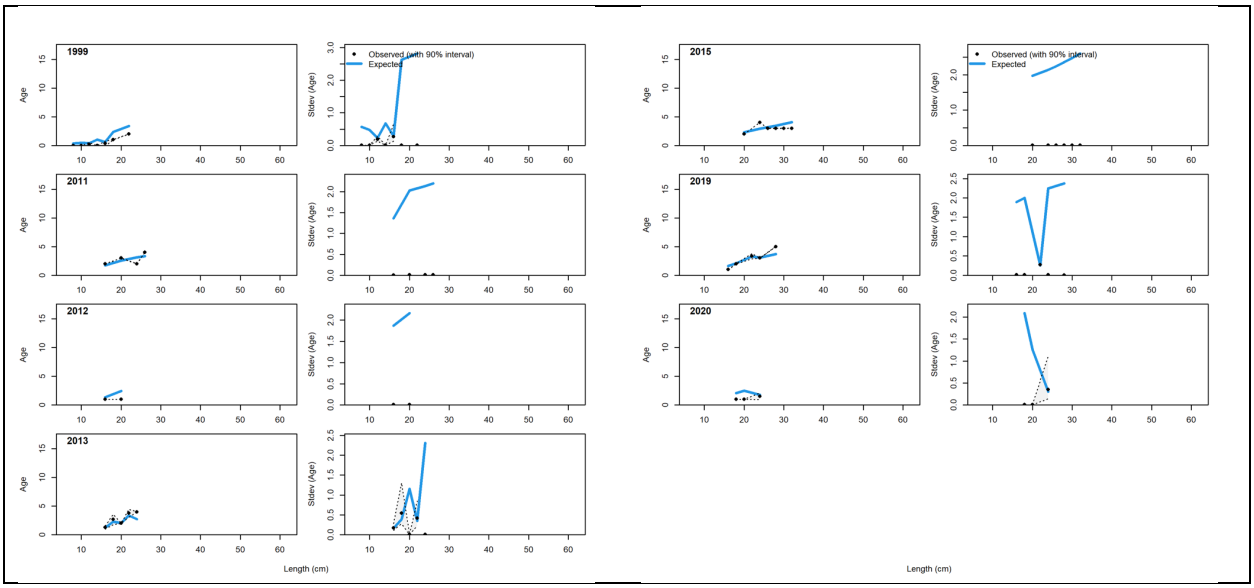


Figure 3.32. Model fits to the annual conditional age-at-length data from fishery-independent trawl data sources for Florida Keys/East Florida Hogfish. In the left plots, the blue lines represent predicted mean age-at-length by size class while the black dots and grey shaded regions represent the observed mean age-at-length by size class with 90% confidence intervals. In the right plots, the blue lines represent predicted standard error of mean age-at-length by size class while the black dots and grey shaded regions represent the observed standard error of mean age-at-length by size class with 90% confidence intervals.

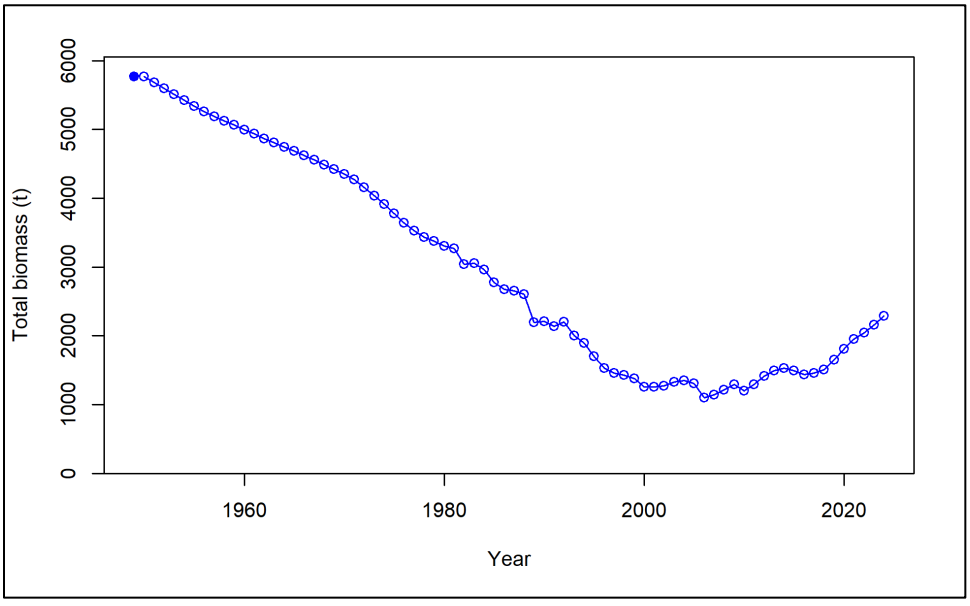


Figure 3.33. Estimates of total biomass (in metric tons) of Florida Keys/East Florida Hogfish (open circles) from 1950 – 2024. The solid blue circle is the estimated unfished total biomass.

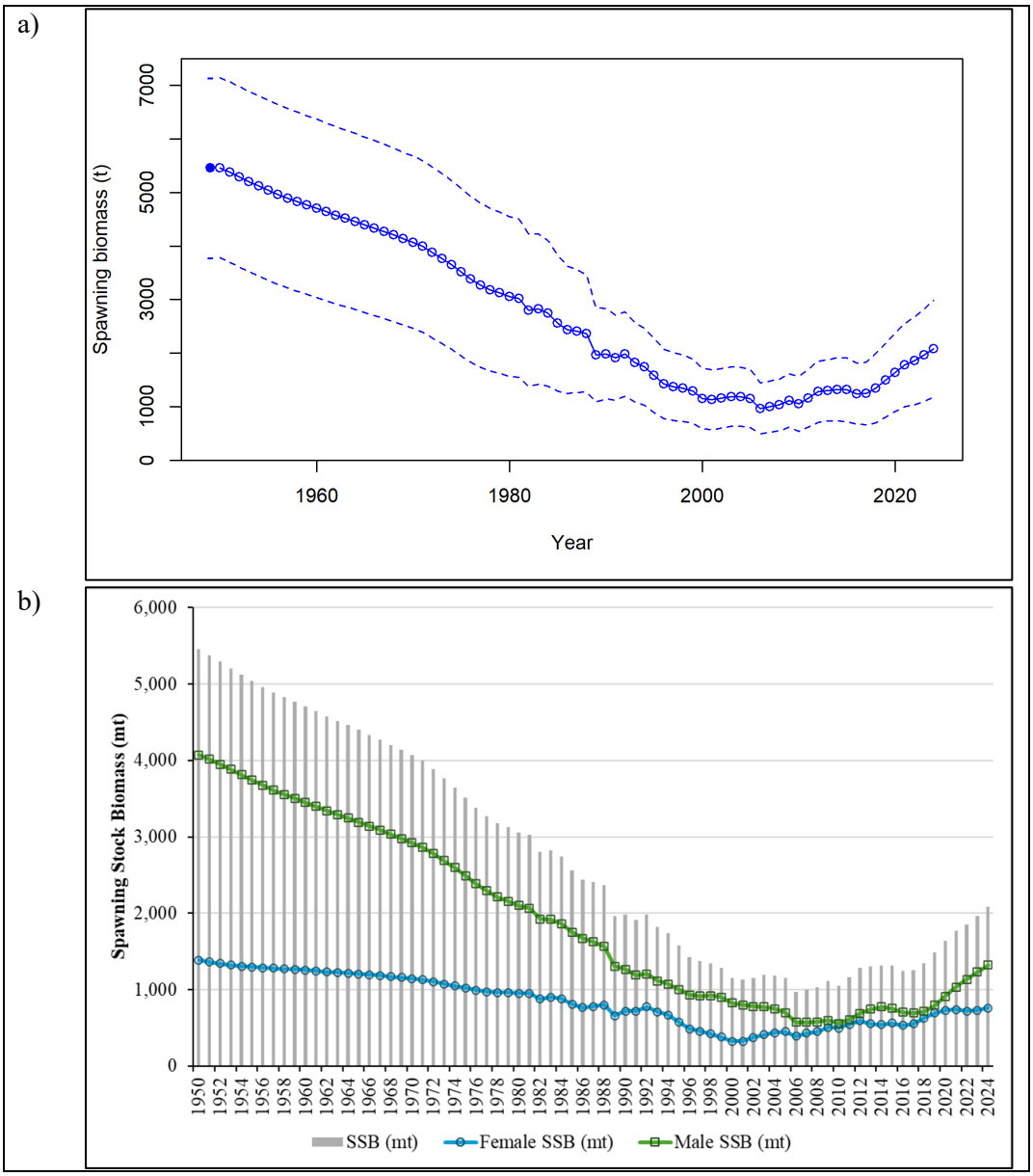


Figure 3.34. Estimates of mature female and male spawning stock biomass a) combined (in metric tons, open circles) with approximate 95% confidence intervals (dashed lines) where the solid blue circle is the estimated unfished spawning stock biomass, and b) separated by sex (female = blue circles, male = green squares, combined = grey bars) for Florida Keys/East Florida Hogfish from 1950 – 2024.

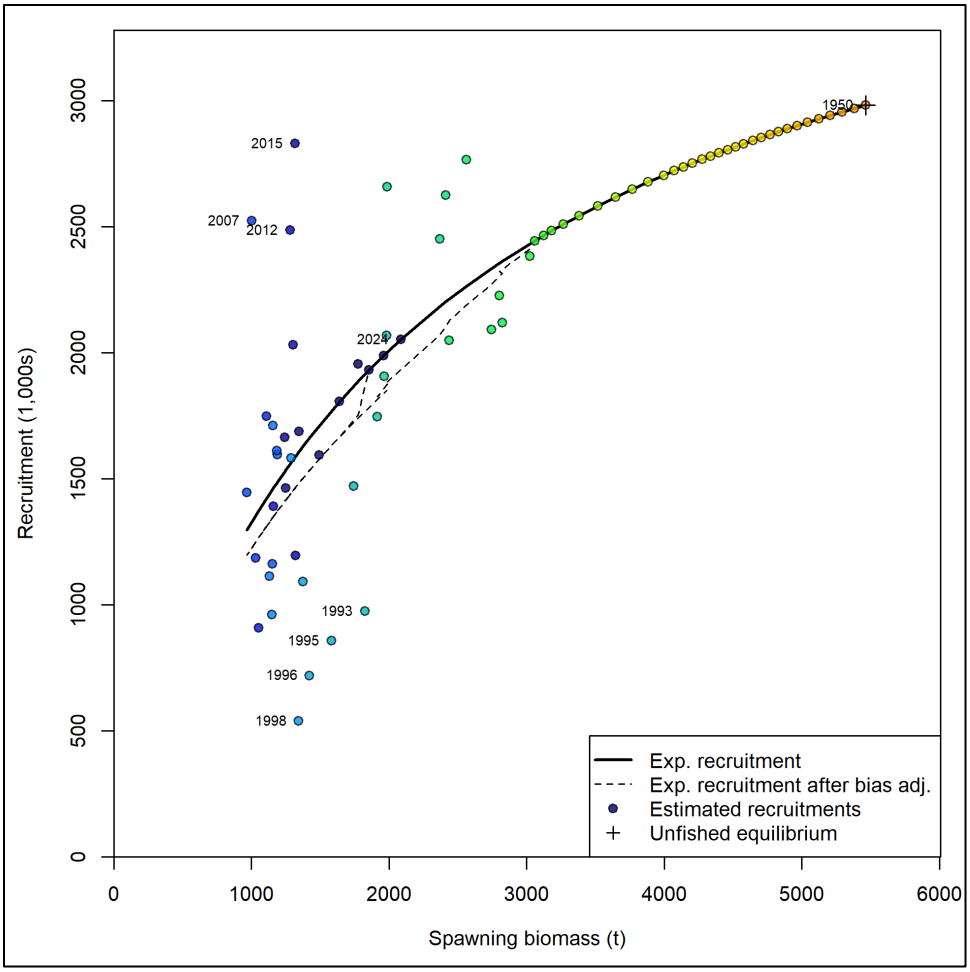


Figure 3.35. Expected stock-recruitment relationship for Florida Keys/East Florida Hogfish. Steepness was estimated at 0.472 and sigmaR was estimated at 0.449. Plotted are expected annual recruitments from the SEDAR 94 KEYS base model (circles), expected recruitment from the stock-recruitment relationship (black line), and bias adjusted recruitment from the stock-recruit relationship (dashed line). Point colors indicate year, with warmer colors indicating earlier years and cooler colors showing later years.

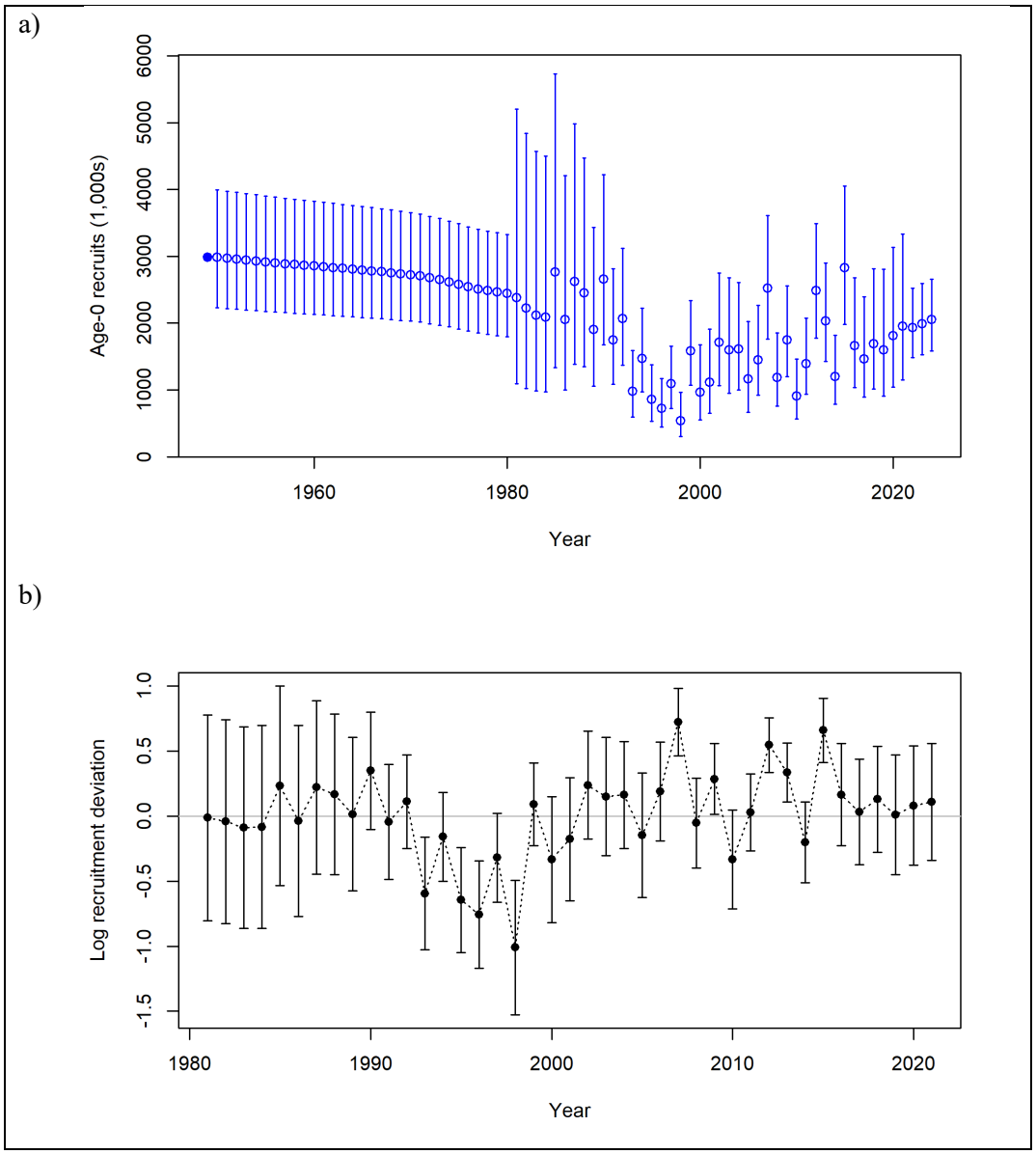


Figure 3.36. Estimated recruitment for Florida Keys/East Florida Hogfish. a) Annual estimated age-0 recruitment (open circles) with 95% confidence intervals (lines) as well as estimated initial equilibrium recruitment (blue dot). b) Log-scaled main recruitment deviations (dots) with 95% confidence intervals (lines) from 1981 – 2021. Recruitment for years 1950 – 1980 and 2022 – 2024 was estimated following the expected stock-recruitment curve.

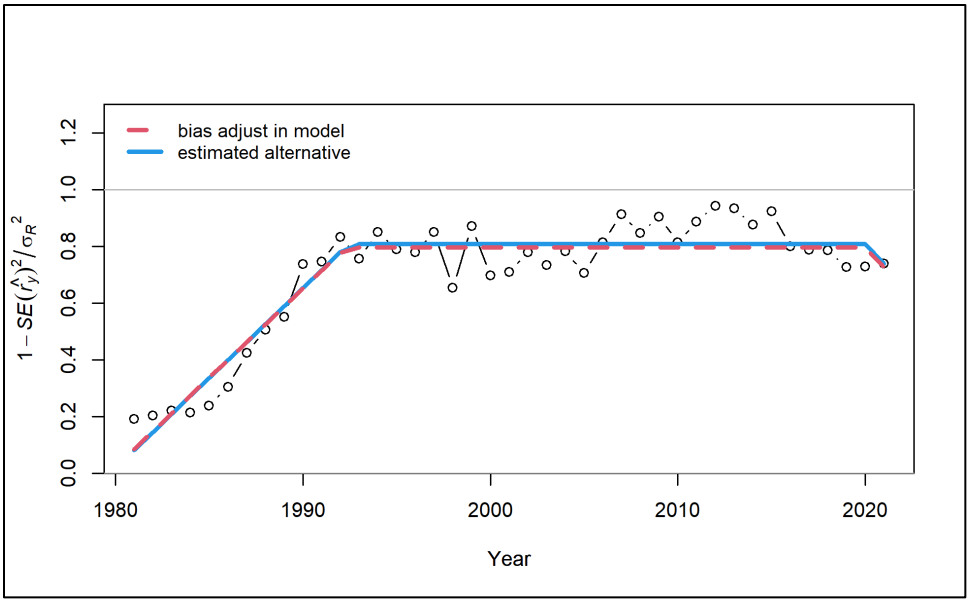


Figure 3.37. Points are transformed variances. Red line shows current settings for bias adjustment specified for the SEDAR 94 KEYS base model, which coincides with the least squares estimate of alternative bias adjustment relationship for recruitment deviations (dashed red line). For more information, see Methot and Taylor (2011).

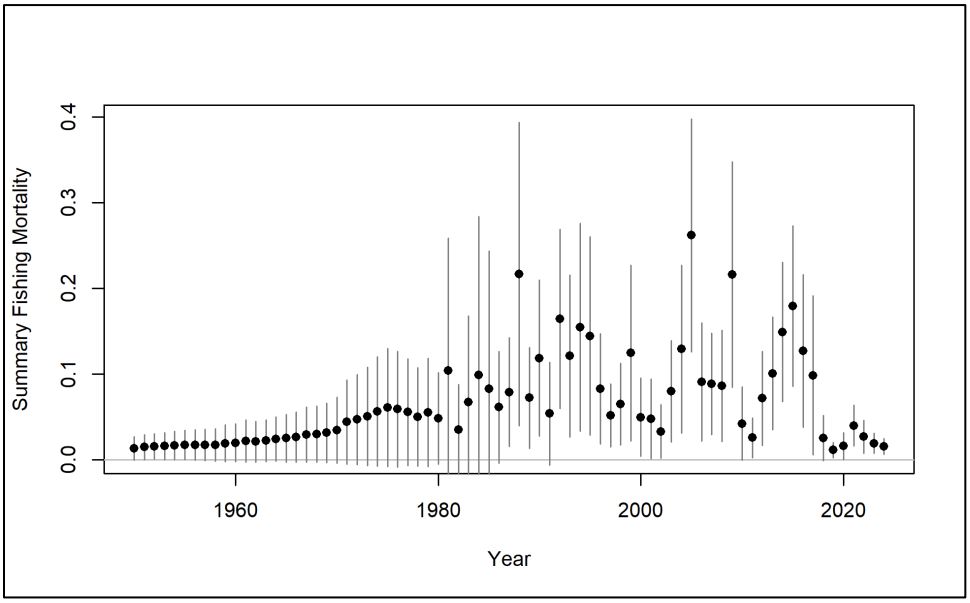


Figure 3.38. Annual exploitation fishing mortality rates, calculated as the ratio of the total annual catch in biomass to the age-1+ biomass at the beginning of the year, for Florida Keys/East Florida Hogfish with 95% confidence intervals from the SEDAR 94 KEYS base model.

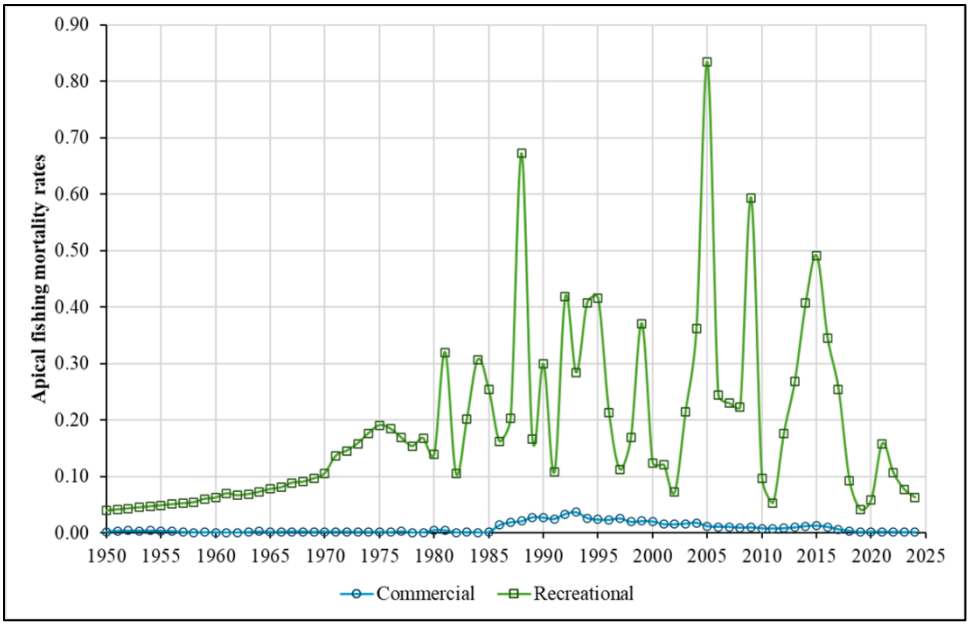


Figure 3.39. Annual fleet-specific instantaneous apical fishing mortality rates for Florida Keys/East Florida Hogfish from the SEDAR 94 KEYS base model. This represents the instantaneous fishing mortality level on the most vulnerable (i.e., selectivity = 1) age class for each fleet.

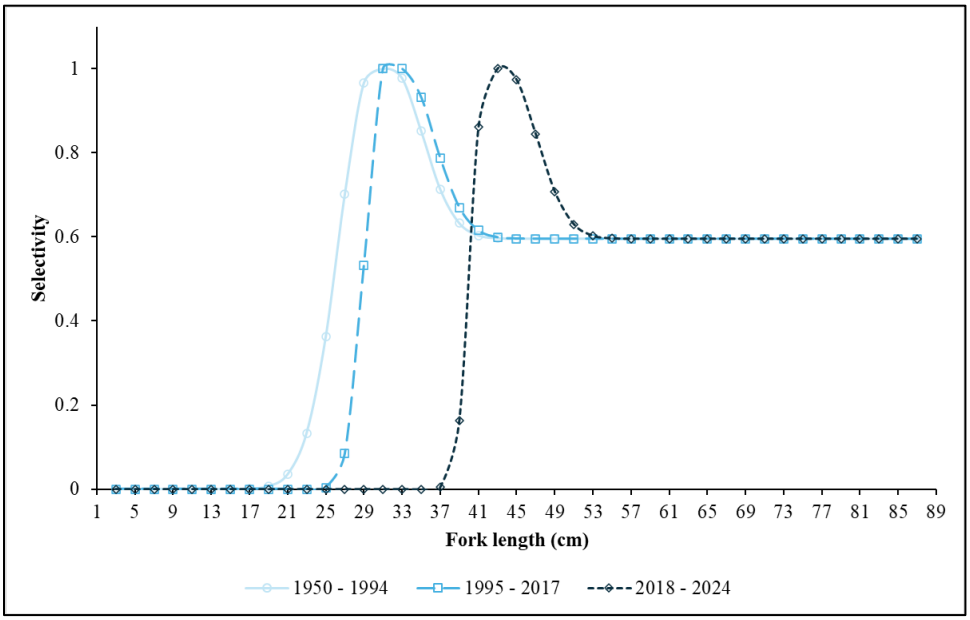


Figure 3.40. Length-based selectivity of the commercial fleet by time block for Florida Keys/East Florida Hogfish from the SEDAR 94 KEYS base model.

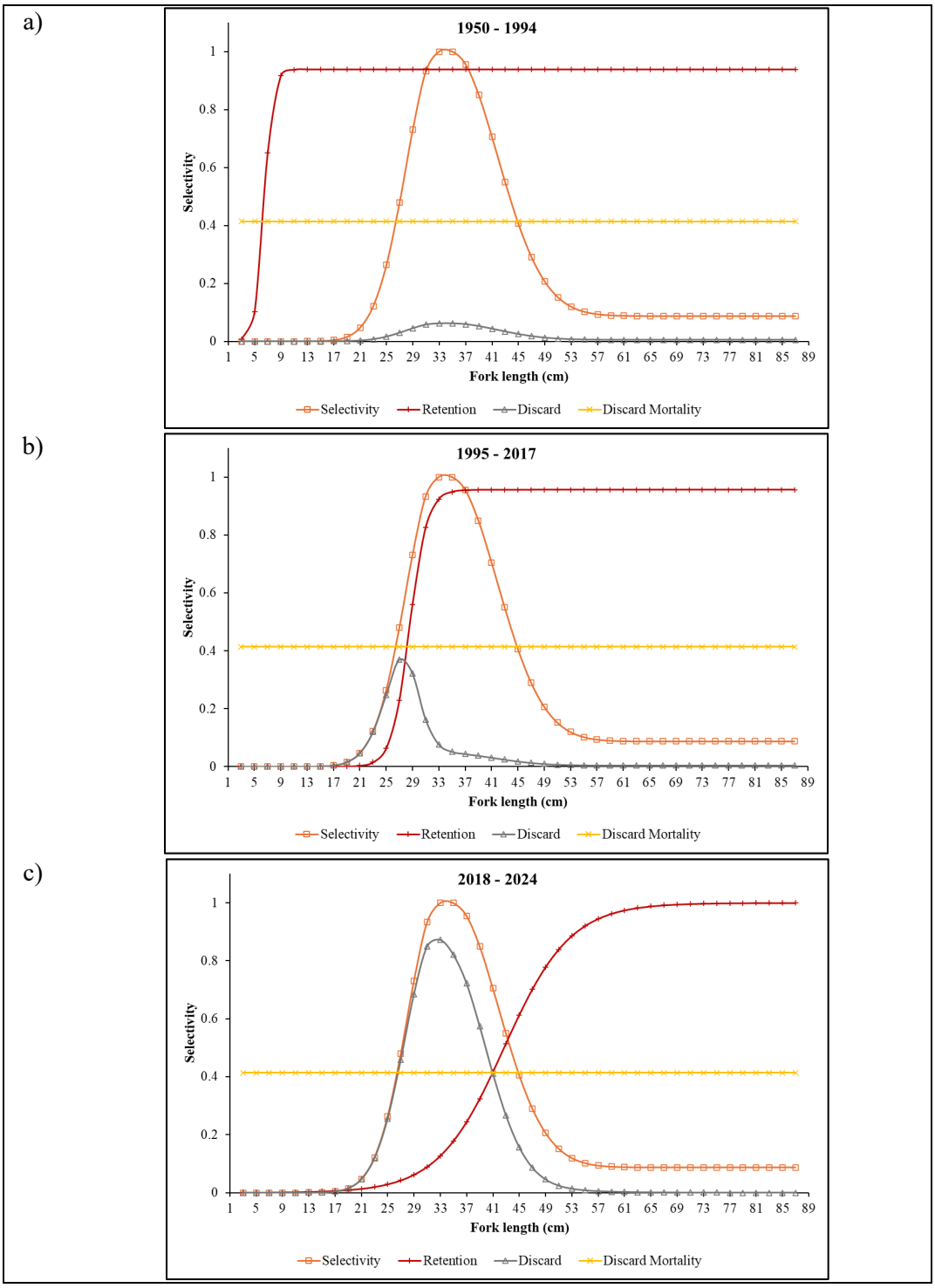


Figure 3.41. Length-based selectivity, retention, discard, and discard mortality (41.4%) patterns of the recreational fleet by time block a) 1950 – 1994, b) 1995 – 2017, and c) 2018 – 2024 for Florida Keys/East Florida Hogfish from the SEDAR 94 KEYS base model.

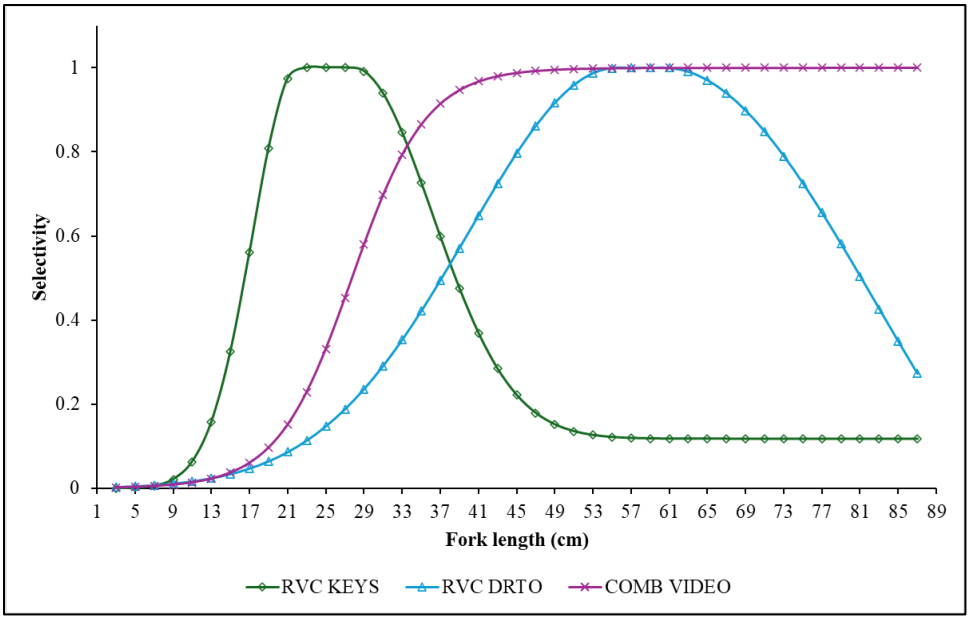


Figure 3.42. Length-based selectivity of the RVC Florida Keys index (green diamonds), RVC Dry Tortugas index (blue triangles), and combined video index (purple x's) for Florida Keys/East Florida Hogfish from the SEDAR 94 KEYS base model.

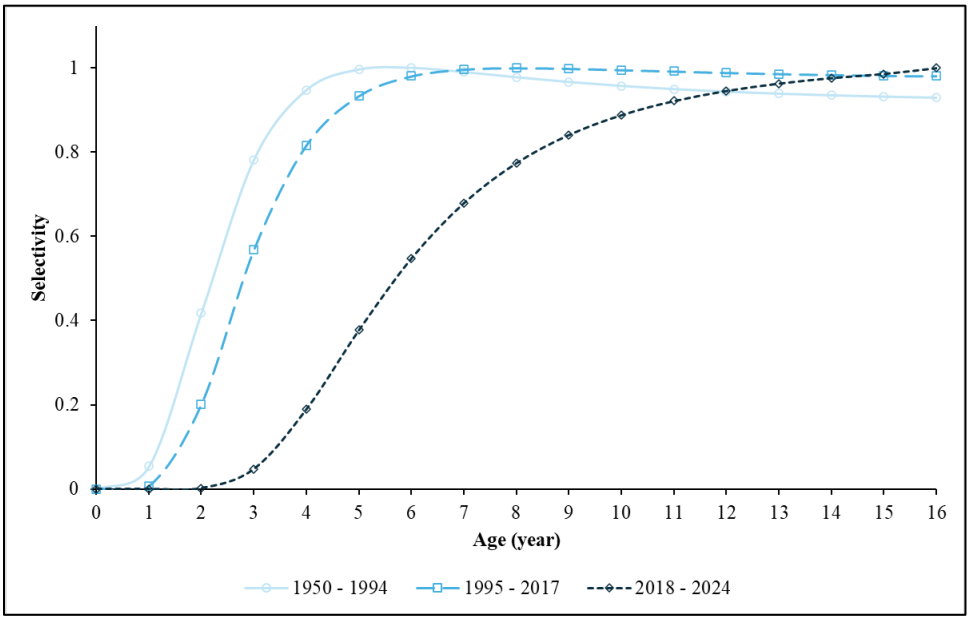


Figure 3.43. Age-derived selectivity of the commercial fleet by time block for Florida Keys/East Florida Hogfish from the SEDAR 94 KEYS base model.

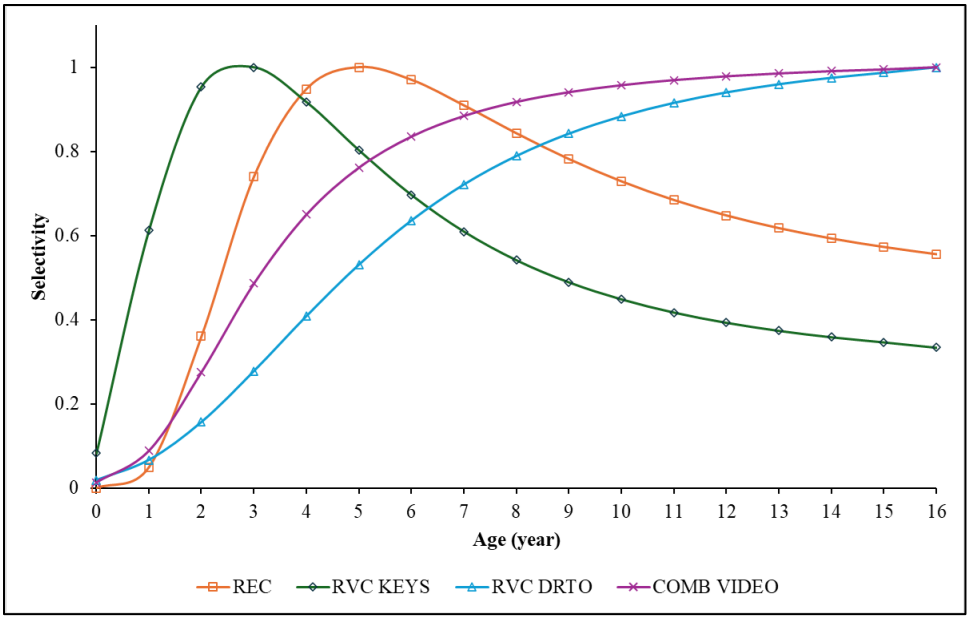


Figure 3.44. Age-derived selectivity of the recreational fleet (orange square), RVC Florida Keys index (green diamonds), RVC Dry Tortugas index (blue triangles), and combined video index (purple x's) for Florida Keys/East Florida Hogfish from the SEDAR 94 KEYS base model.

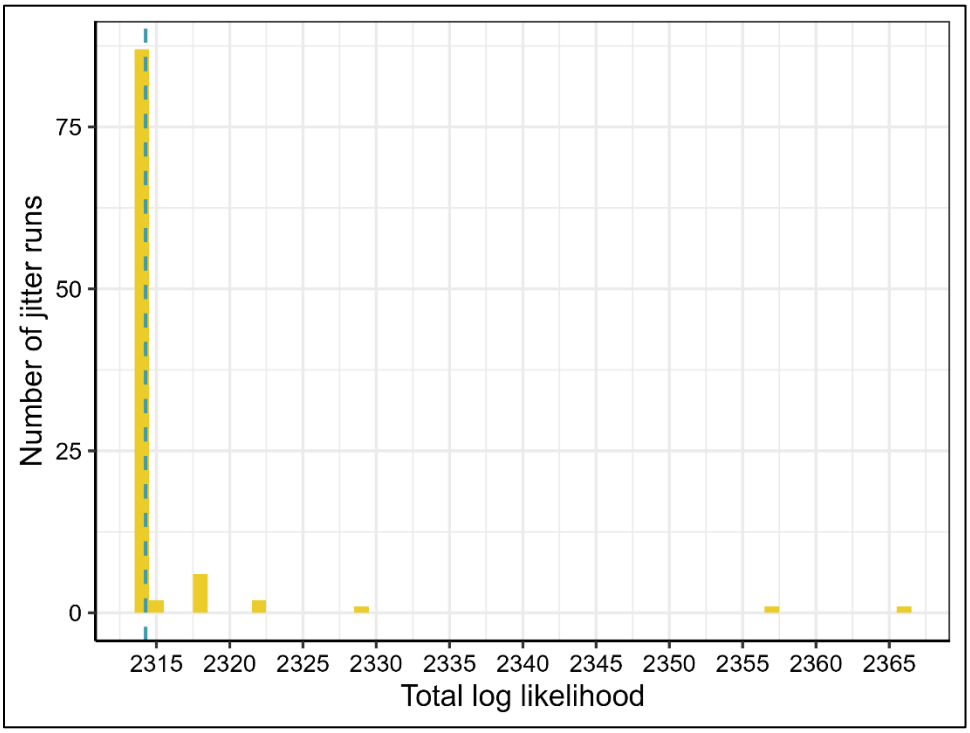


Figure 3.45. Total log-likelihood values of model runs performed by the jitter analysis (yellow bars) and the SEDAR 94 KEYS base model (blue dashed line).

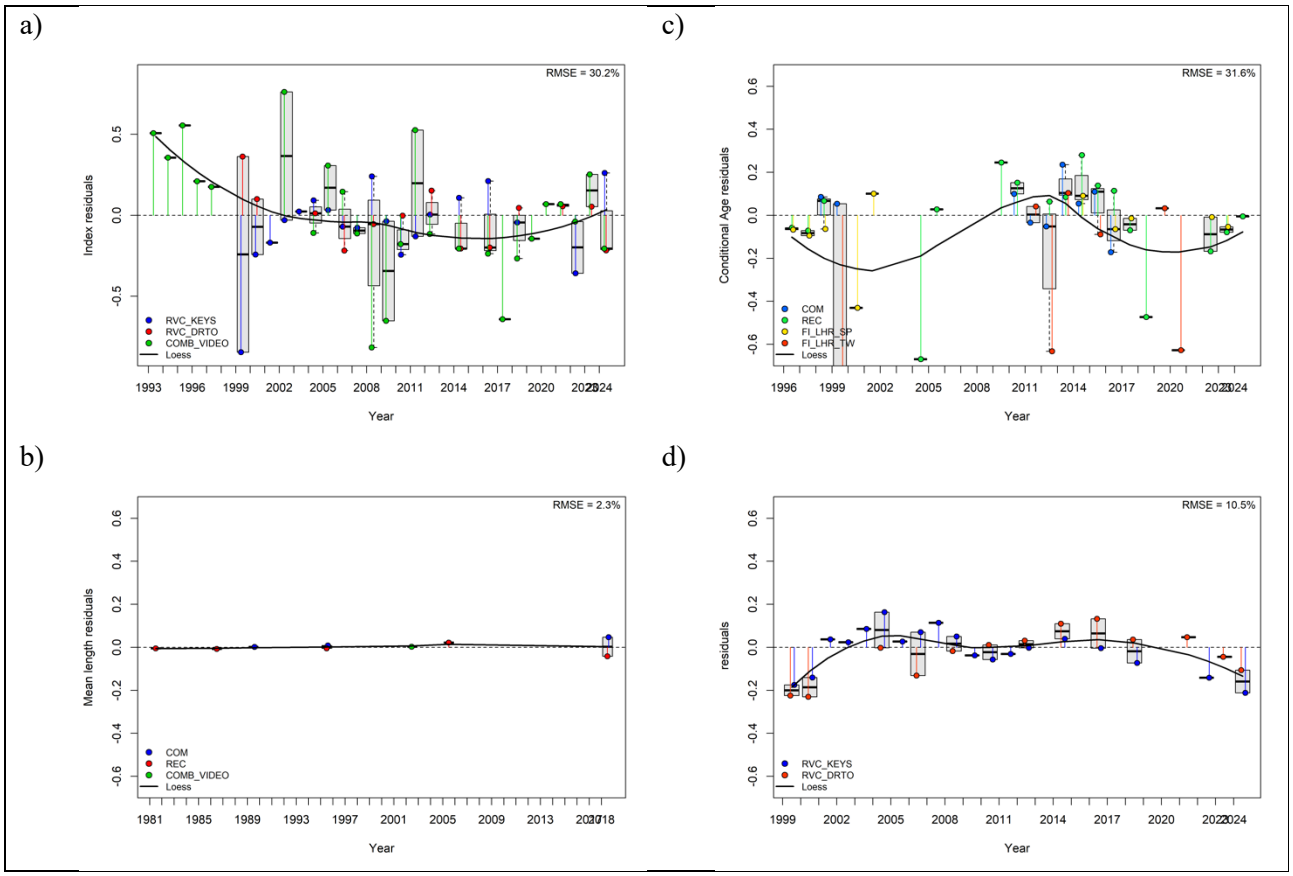


Figure 3.46. Joint residual plots for a) the indices of abundance, b) the annual mean length estimates, and c) the annual conditional age-at-length estimates, and d) the annual mean general size composition (i.e., RVC lengths) of available fleets and indices from the SEDAR 94 KEYS base model. Vertical lines with points show the residuals, boxplots show residual medians and quantiles, and solid black lines are a loess smoother. Root-mean squared errors (RMSE) are included in the upper right-hand corner of each plot.

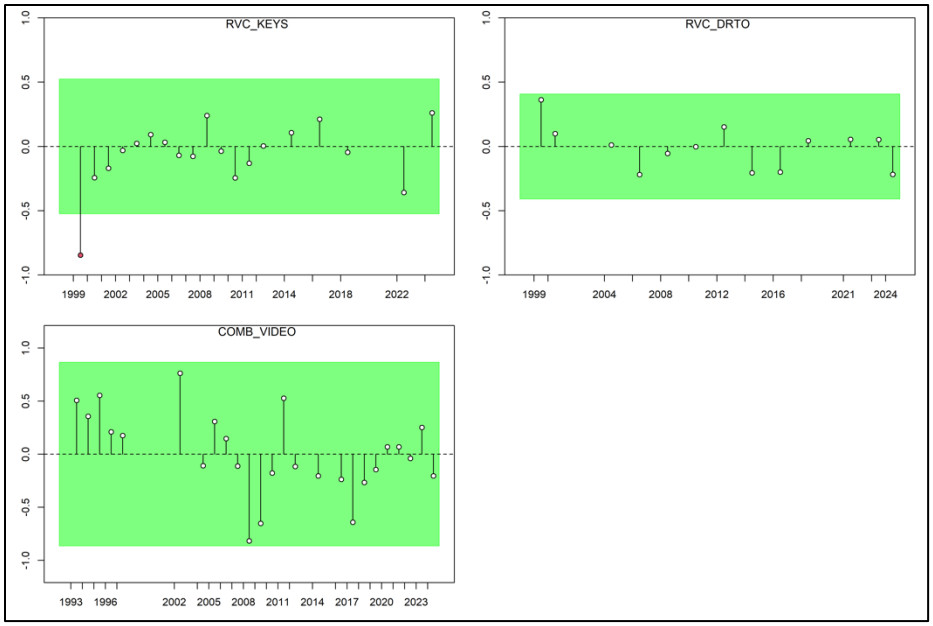


Figure 3.47. Runs tests results for the indices of abundance from the SEDAR 94 KEYS base model. Green shading indicates no evidence ($p \geq 0.05$) and red shading evidence ($p < 0.05$) to reject the hypothesis of a randomly distributed time-series of residuals, respectively. Shaded regions span three residual standard deviations to either side from zero and red points outside of the shading indicate a violation of that 'three-sigma limit'.

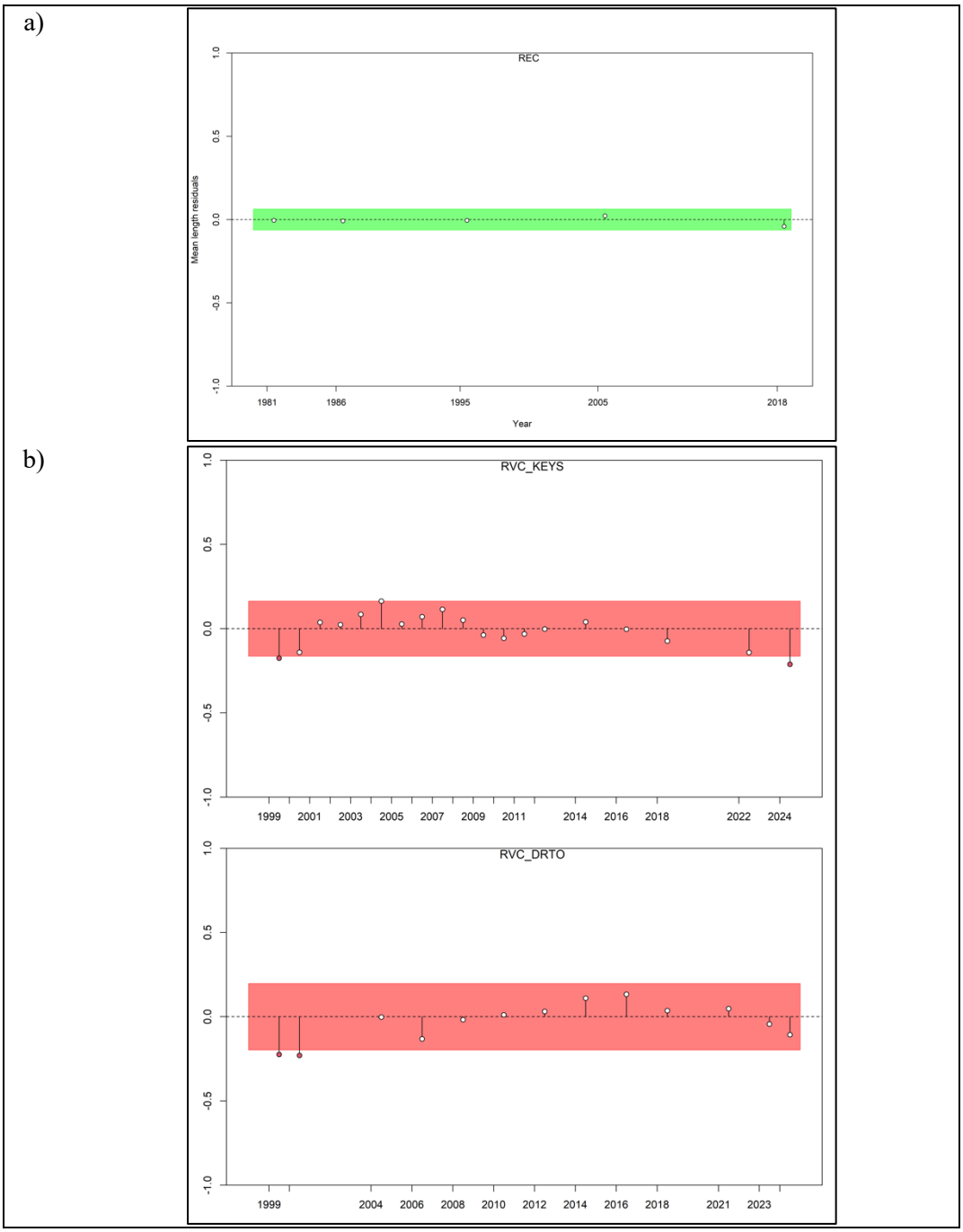


Figure 3.48. Runs tests results for a) the annual mean length estimates of the recreational fleet and b) the annual mean general size composition (i.e., RVC lengths) from the SEDAR 94 KEYS base model. Green shading indicates no evidence ($p \geq 0.05$) and red shading evidence ($p < 0.05$) to reject the hypothesis of a randomly distributed time-series of residuals, respectively. Shaded regions span three residual standard deviations to either side from zero and red points outside of the shading indicate a violation of that 'three-sigma limit'.

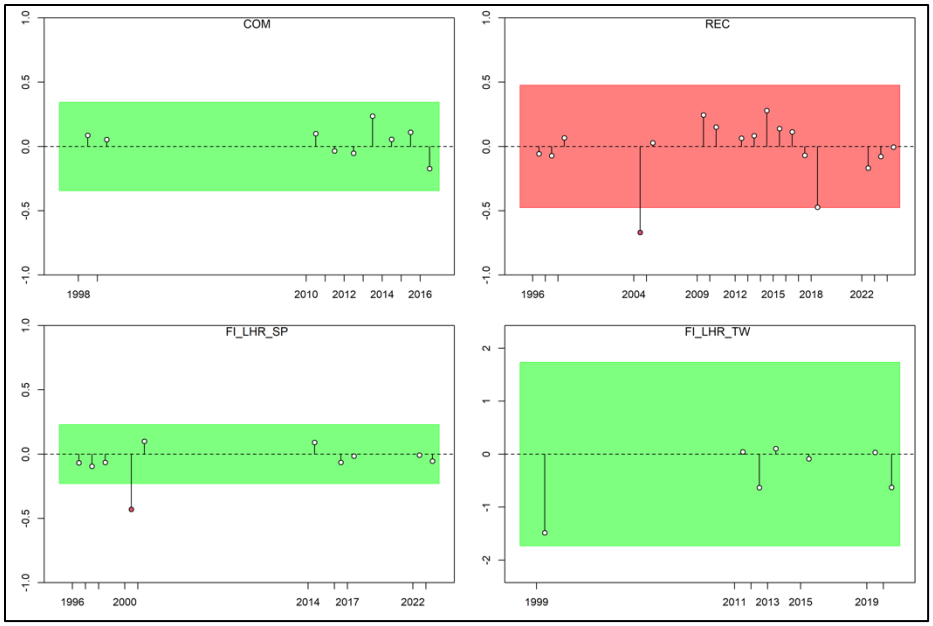


Figure 3.49. Runs tests results for the conditional age-at-length estimates from the SEDAR 94 KEYS base model. Green shading indicates no evidence ($p \geq 0.05$) and red shading evidence ($p < 0.05$) to reject the hypothesis of a randomly distributed time-series of residuals, respectively. Shaded regions span three residual standard deviations to either side from zero and red points outside of the shading indicate a violation of that 'three-sigma limit'.

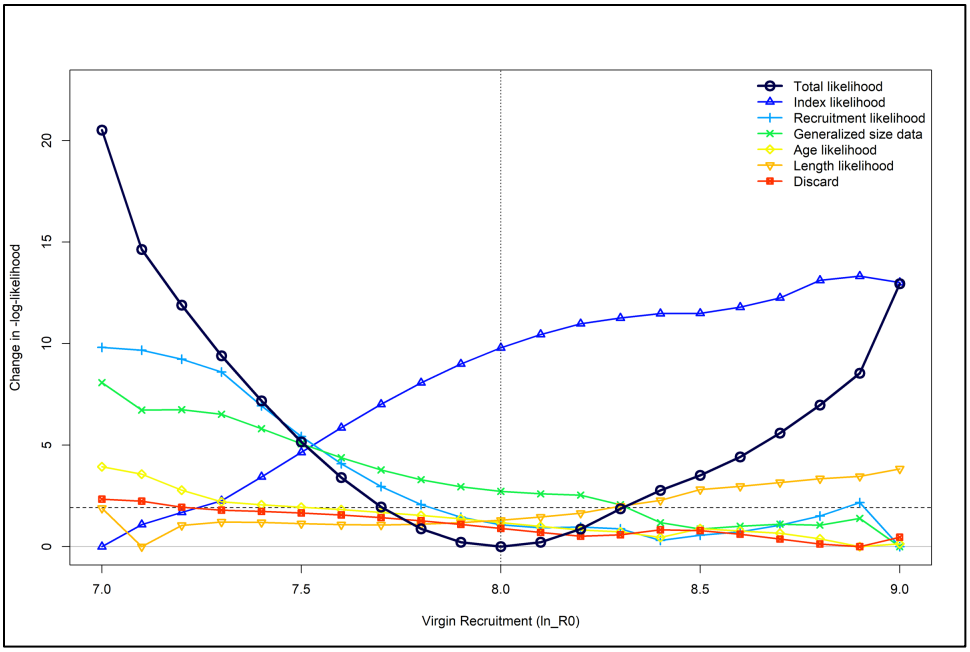


Figure 3.50. Log-likelihood profiles of the unfished (i.e., virgin) recruitment (*ln(R0)*) parameter for various data components in the SEDAR 94 KEYS base model. The horizontal dashed line indicates a 2 unit difference in log-likelihood while the vertical dotted line is the estimate from the SEDAR 94 KEYS base model.

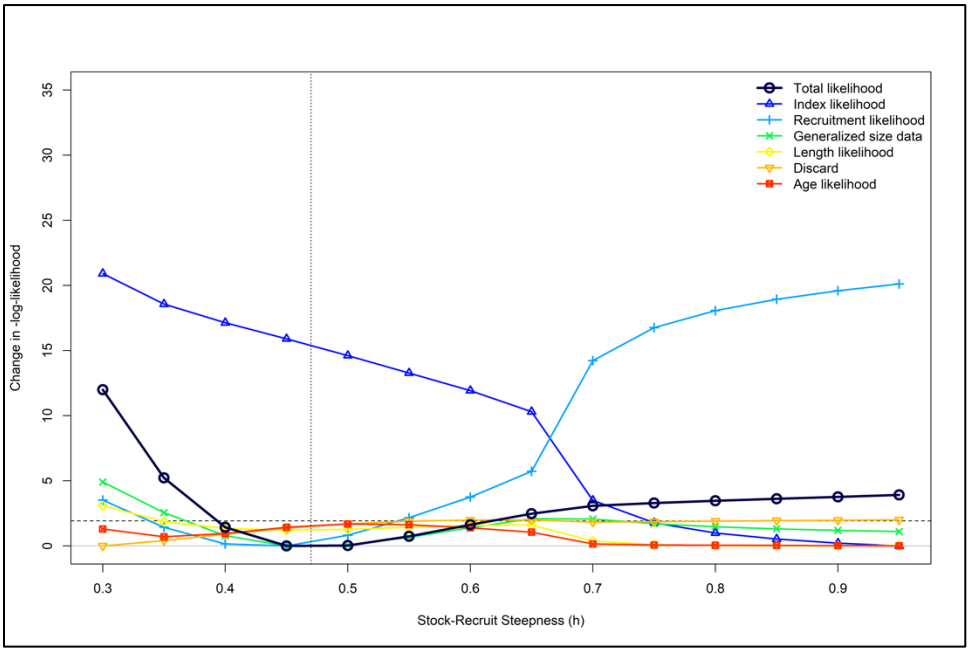


Figure 3.51. Log-likelihood profiles of the *steepness (h)* parameter for various data components in the SEDAR 94 KEYS base model. The horizontal dashed line indicates a 2 unit difference in log-likelihood while the vertical dotted line is the estimate from the SEDAR 94 KEYS base model.

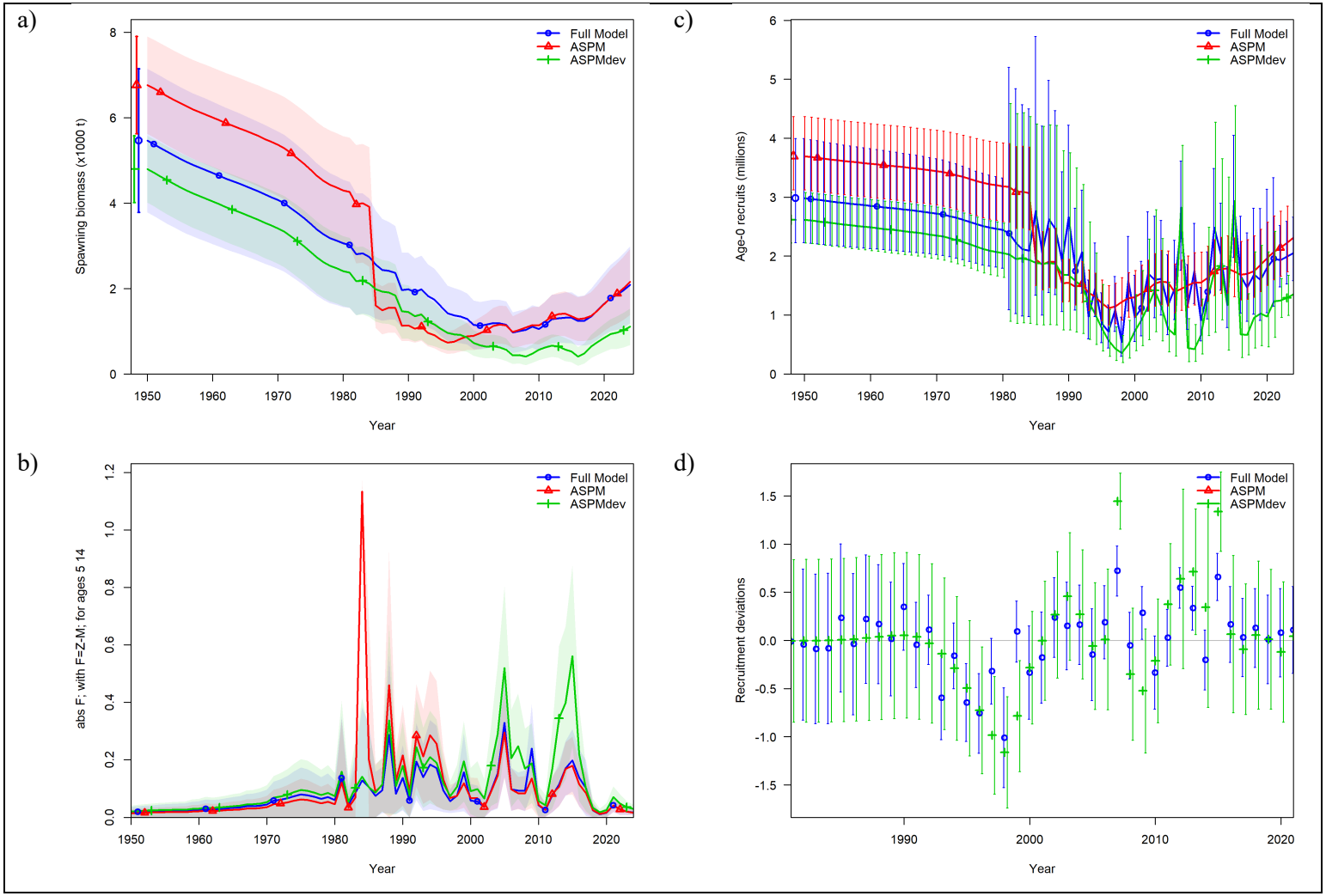


Figure 3.52. Results comparison between the SEDAR 94 KEYS base model (Full Model), the deterministic Age-Structured-Production Model (ASPM), and the ASPM with recruitment deviations (ASPMdev) showing a) spawning stock biomass, b) exploitation rates, c) estimates of age-0 recruitment, and d) estimates of recruitment deviations.

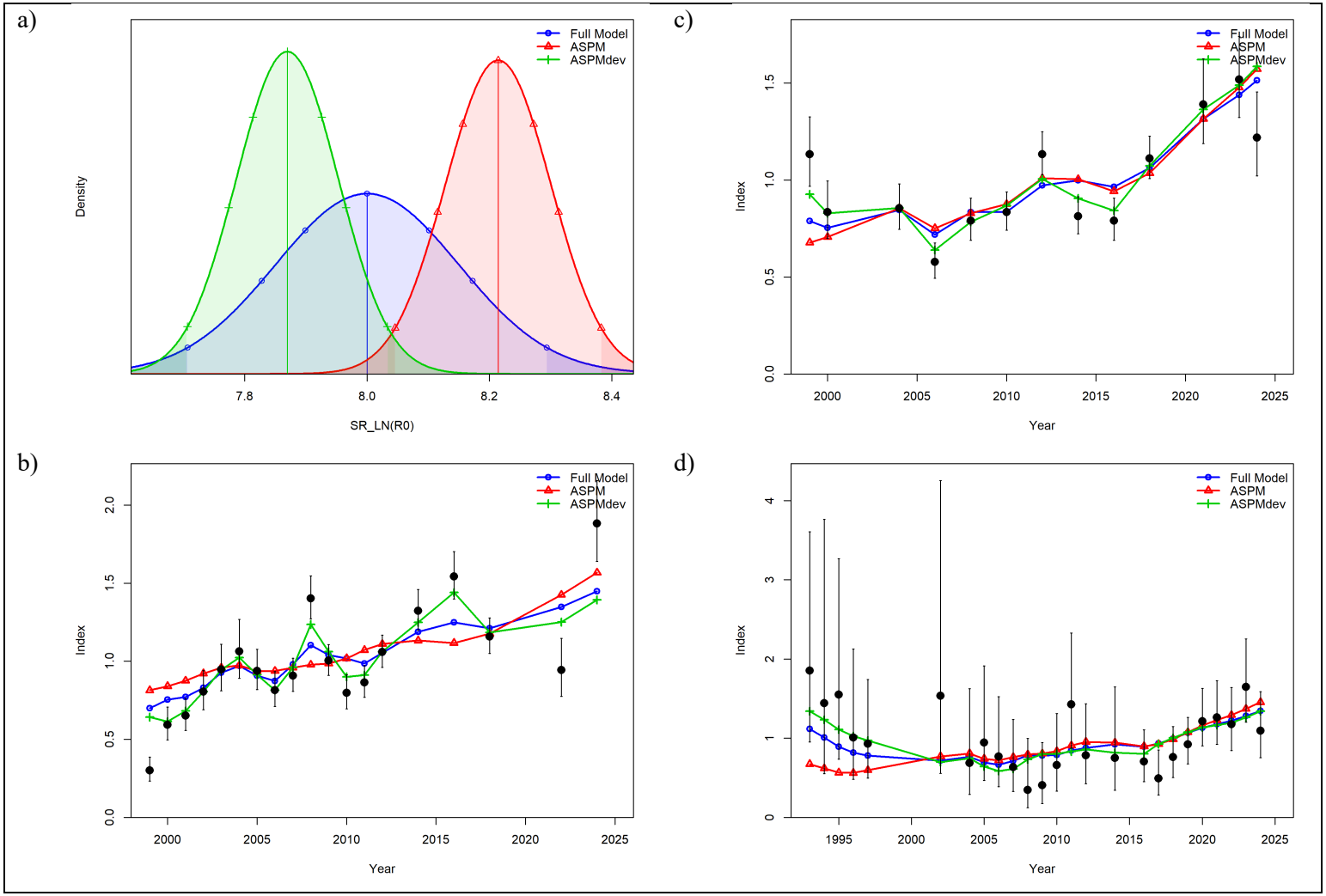


Figure 3.53. Results comparison between the SEDAR 94 KEYS base model (Full Model), the deterministic Age-Structured-Production Model (ASPM), and the ASPM with recruitment deviations (ASPMdev) showing a) estimates of the virgin recruitment parameter in log-space *ln(R0)*, b) observed and predicted values for the RVC Florida Keys index, c) observed and predicted values for the RVC Dry Tortugas index., and d) observed and predicted values for the combined video index.

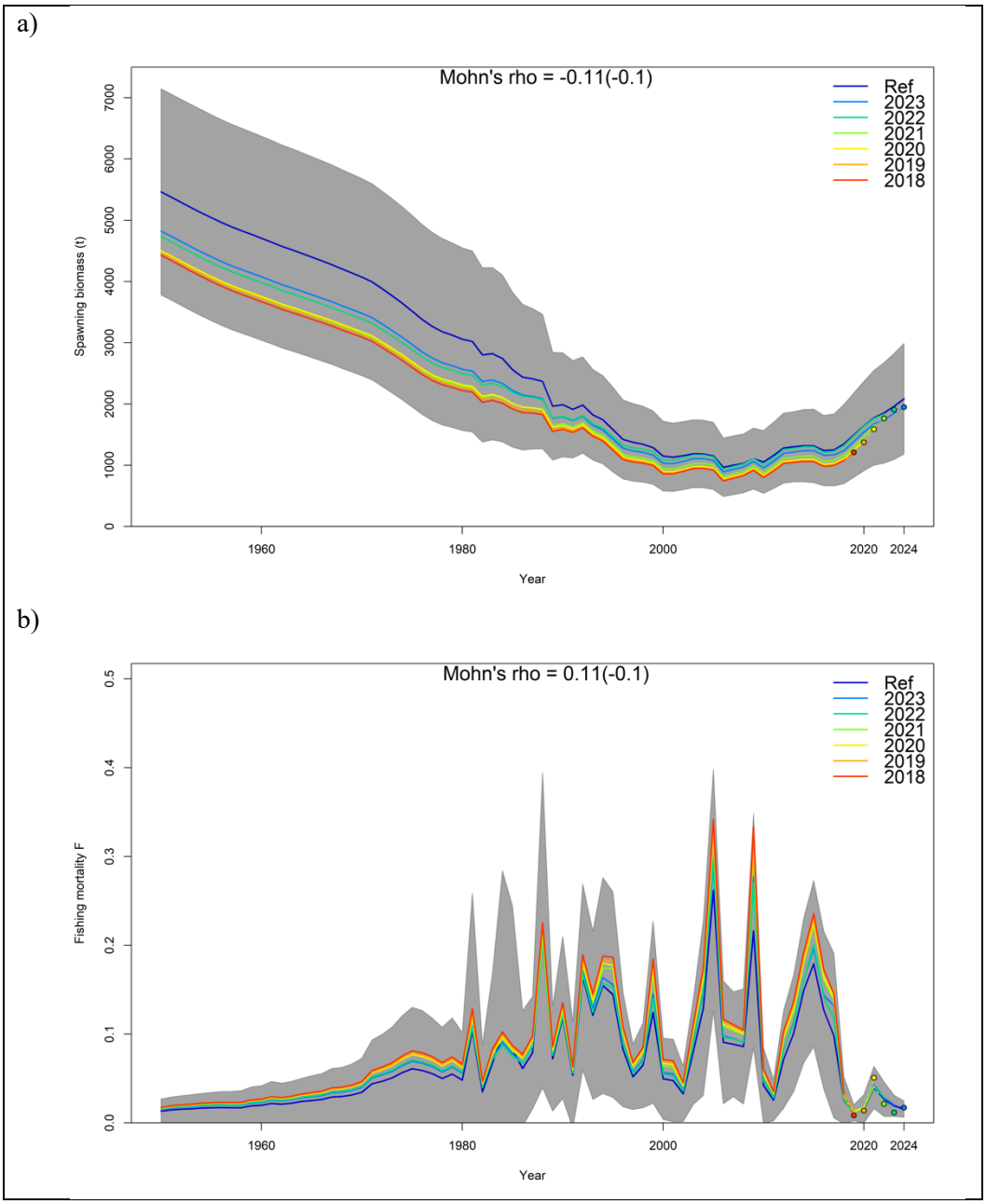


Figure 3.54. Retrospective forecast results of a) spawning stock biomass and b) exploitation rates conducted by re-fitting the SEDAR 94 KEYS base model (Ref) after sequentially removing seven years of observations. The Mohn's rho (ρ_M) statistic and corresponding forecast rho (ρ_F) values (in parenthesis) are provided at the top of each panel. One-year-ahead projections denoted by color-coded dashed lines with terminal points are shown for each peel. Grey shaded areas are the 95 % confidence intervals from the SEDAR 94 KEYS base model.

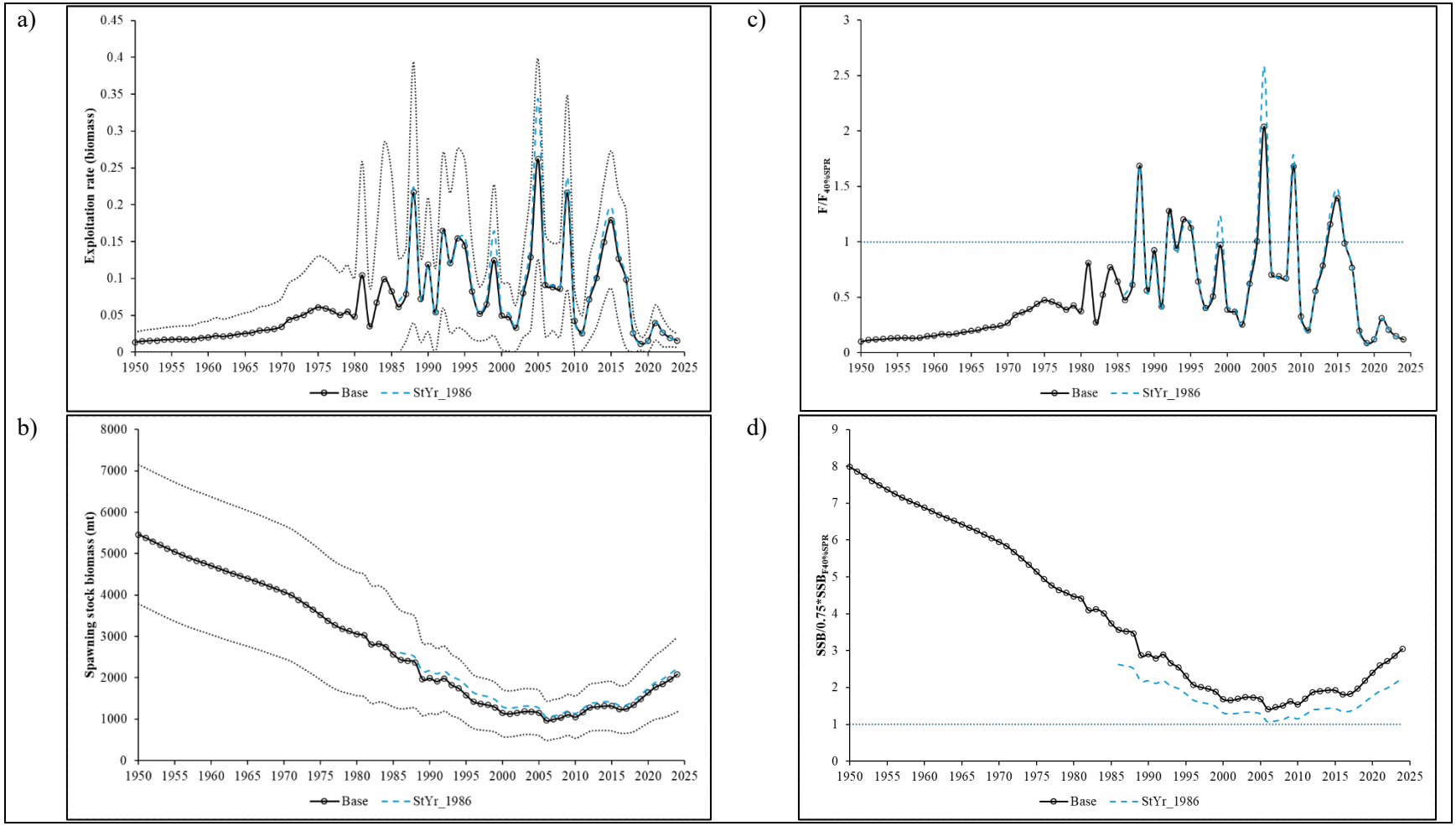


Figure 3.55. The a) exploitation rate, b) spawning stock biomass, c) $F/F_{40\%SPR}$ ratio, and d) $SSB/0.75*SSB_{F40\%SPR}$ ratio from the KEYS base model compared to a sensitivity run with 1986 as the start year and *steepness* = 0.99 for Florida Keys/East Florida Hogfish.

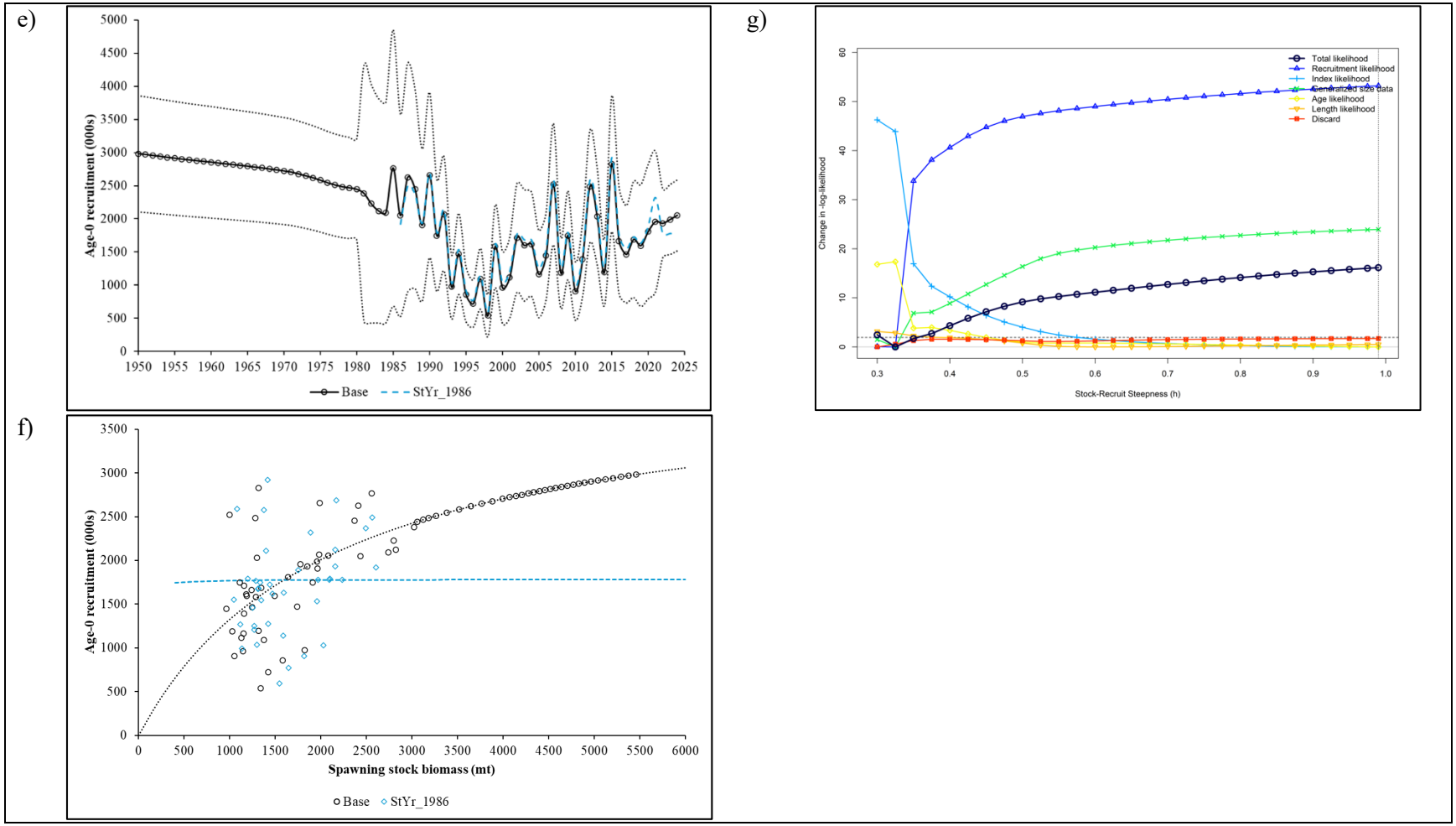


Figure 3.55 *cont*. The e) age-0 recruitment and f) stock-recruitment relationship from the KEYS base model compared to a sensitivity run with 1986 as the start year and *steepness* = 0.99 for Florida Keys/East Florida Hogfish. Panel (g) shows the *steepness* parameter profile of the sensitivity model with 1986 as the start year and *steepness* = 0.99.

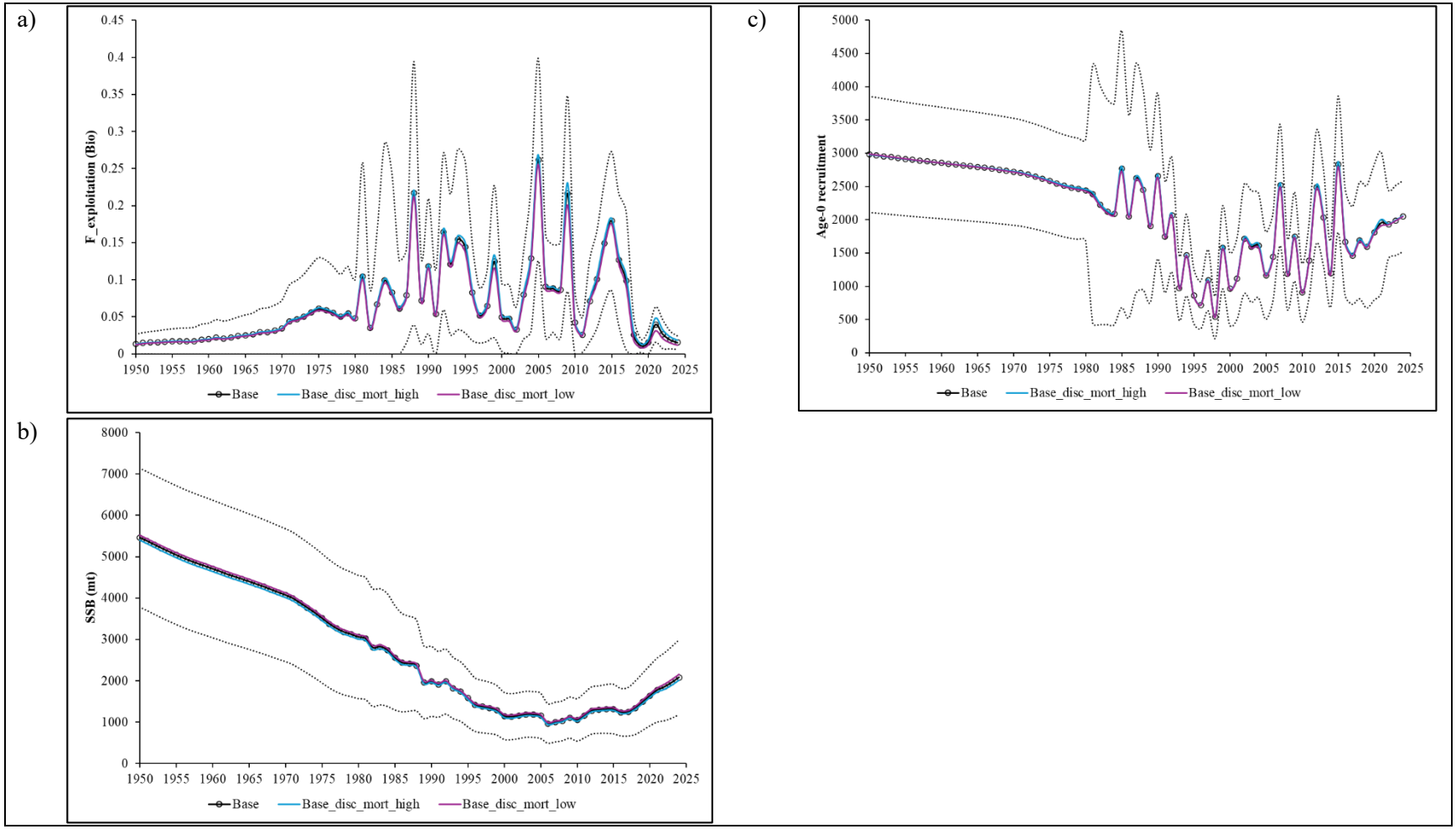


Figure 3.56. The a) exploitation rate, b) spawning stock biomass, and c) age-0 recruitment from the KEYS base model compared to sensitivity runs exploring high (59%) and low (23.8%) discard mortality rates for Florida Keys/East Florida Hogfish.

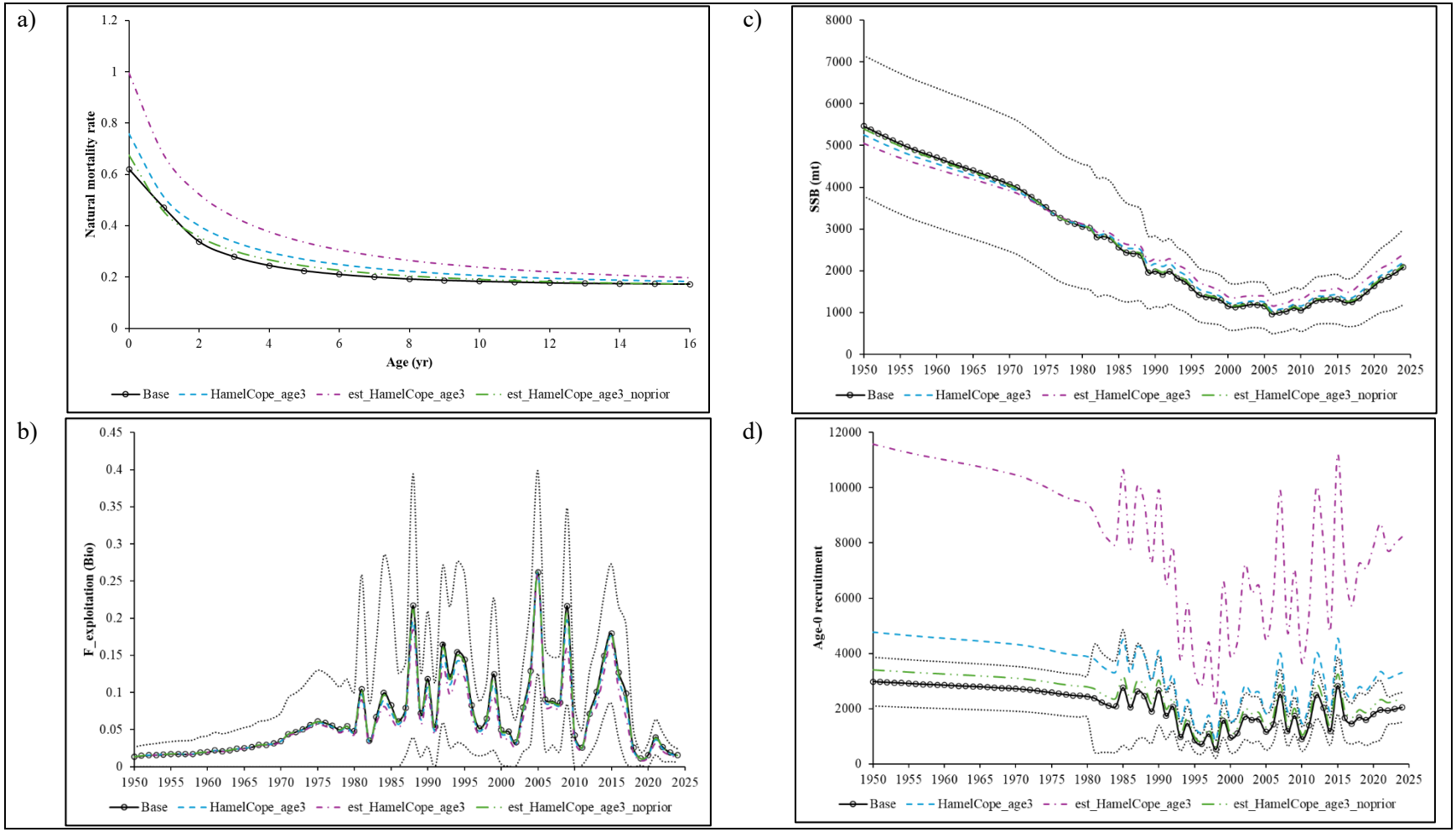


Figure 3.57. The a) natural mortality rate, b) exploitation rate, c) spawning stock biomass, and d) age-0 recruitment from the KEYS base model compared to sensitivity runs exploring assumptions on natural mortality for Florida Keys/East Florida Hogfish. 'HamelCope_age3' uses the Hamel and Cope (2022) longevity-based estimate (M=0.338 yr^{-1}) for age-3 fish, 'est_HamelCope_age3' estimates M using the standard deviation (0.31) prior in log-space, and 'est_HamelCope_age3_noprior' removes the standard deviation prior to freely estimate.

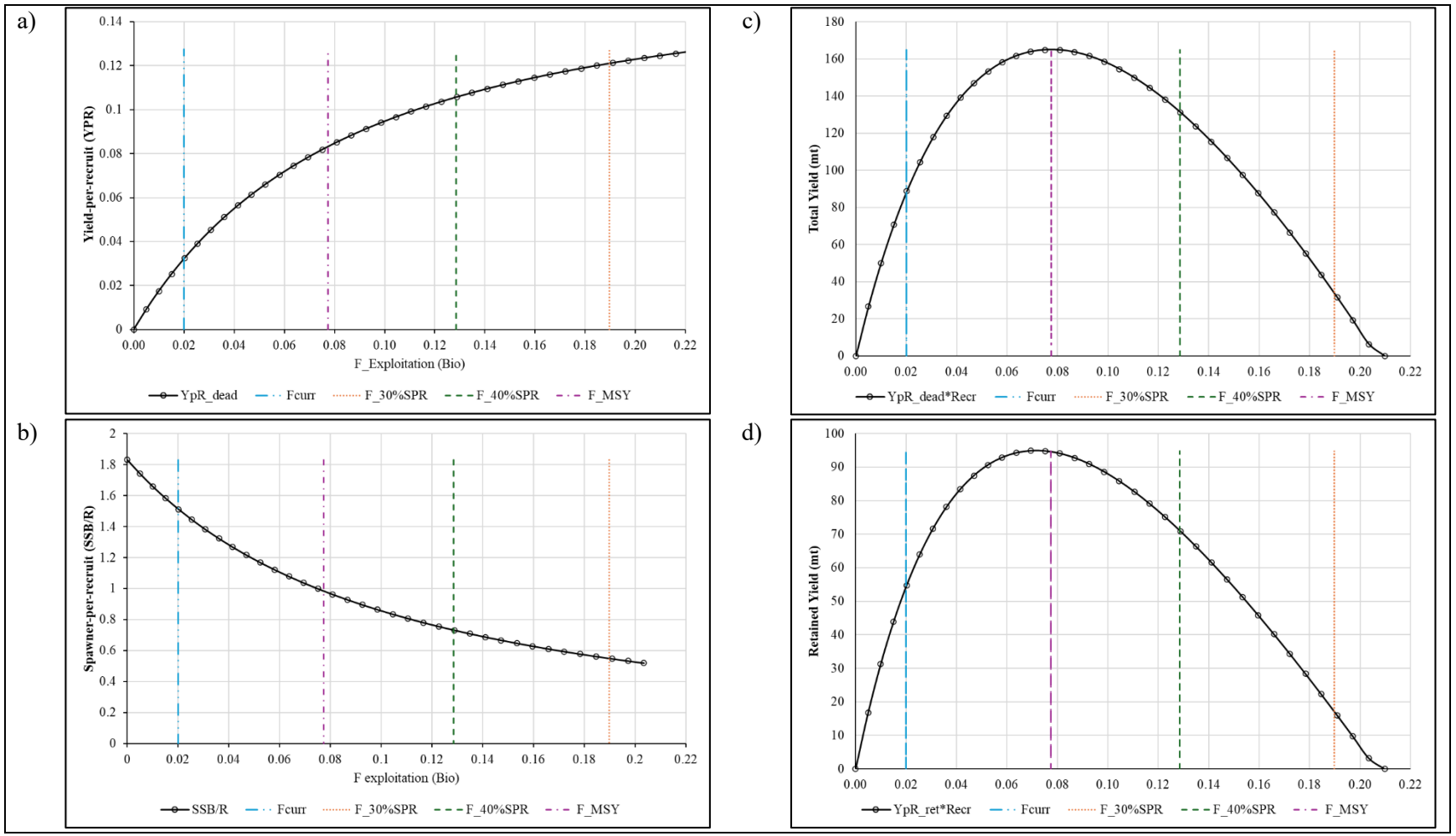


Figure 3.58. The a) yield-per-recruit, b) spawner-per-recruit, c) total equilibrium yield, and d) retained equilibrium yield computed as a function of the instantaneous exploitation rate on Florida Keys/East Florida Hogfish.

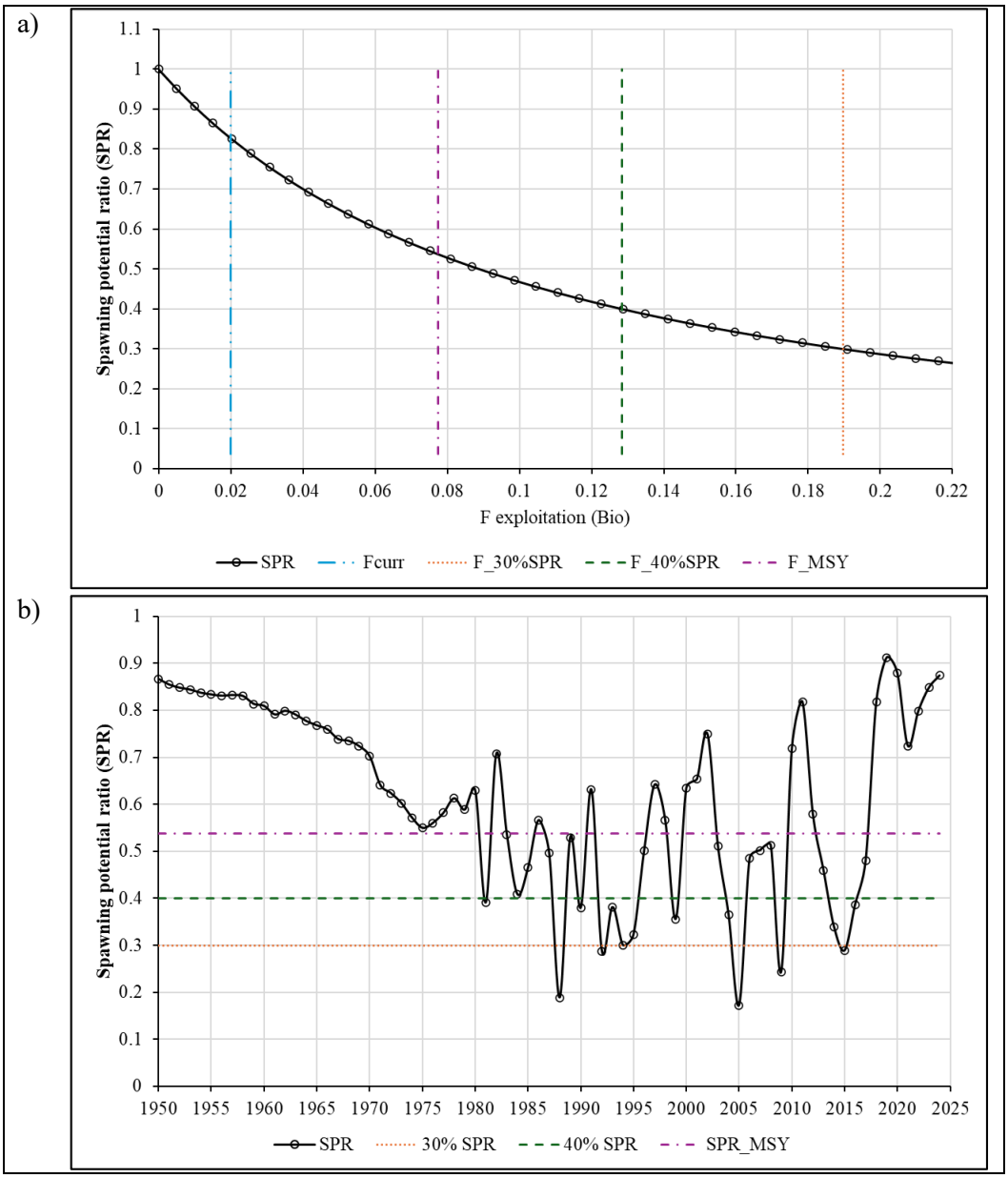


Figure 3.59. The a) static spawning potential ratio (SPR) computed as a function of the instantaneous exploitation rate, and b) static spawning potential ratio (SPR) by year for Florida Keys/East Florida Hogfish.



Figure 3.60. Combined trace plots of the six MCMC chains for selected parameters and derived quantities from the MCMC 'proxy' model based on the SEDAR 94 KEYS base model.

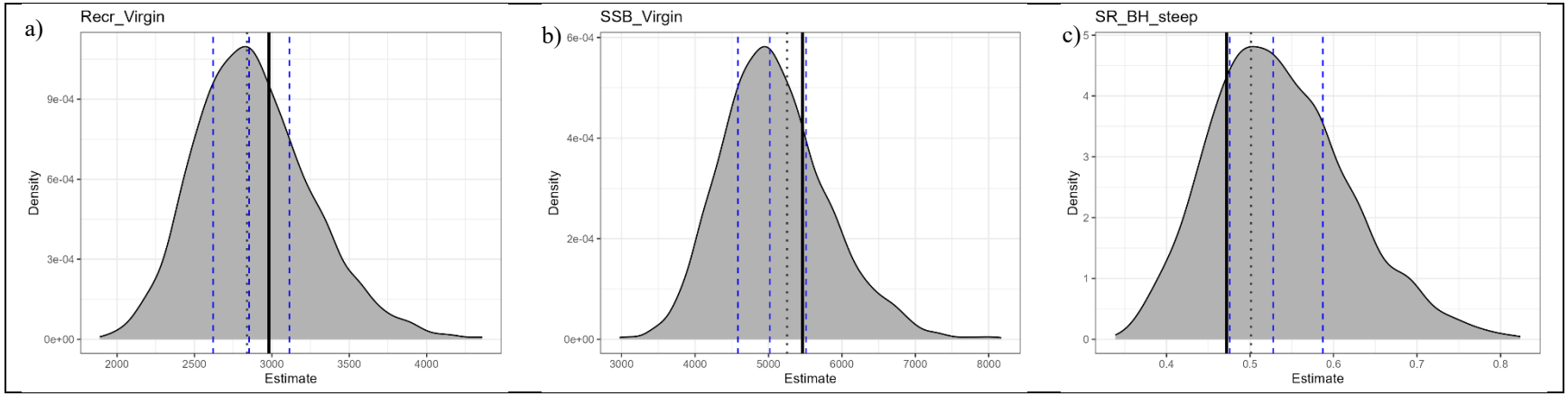


Figure 3.61. The posterior distributions for a) R_0 (i.e., virgin recruitment), b) SSB_0 (i.e., virgin spawning stock biomass), and c) steepness from the combined six-chain MCMC of the MCMC 'proxy' model based on the SEDAR 94 KEYS base model. The blue dashed lines indicate the median and interquartile range, the black dotted line is the estimate from the MCMC 'proxy' model, and the solid black line is the estimate from the SEDAR 94 KEYS base model.

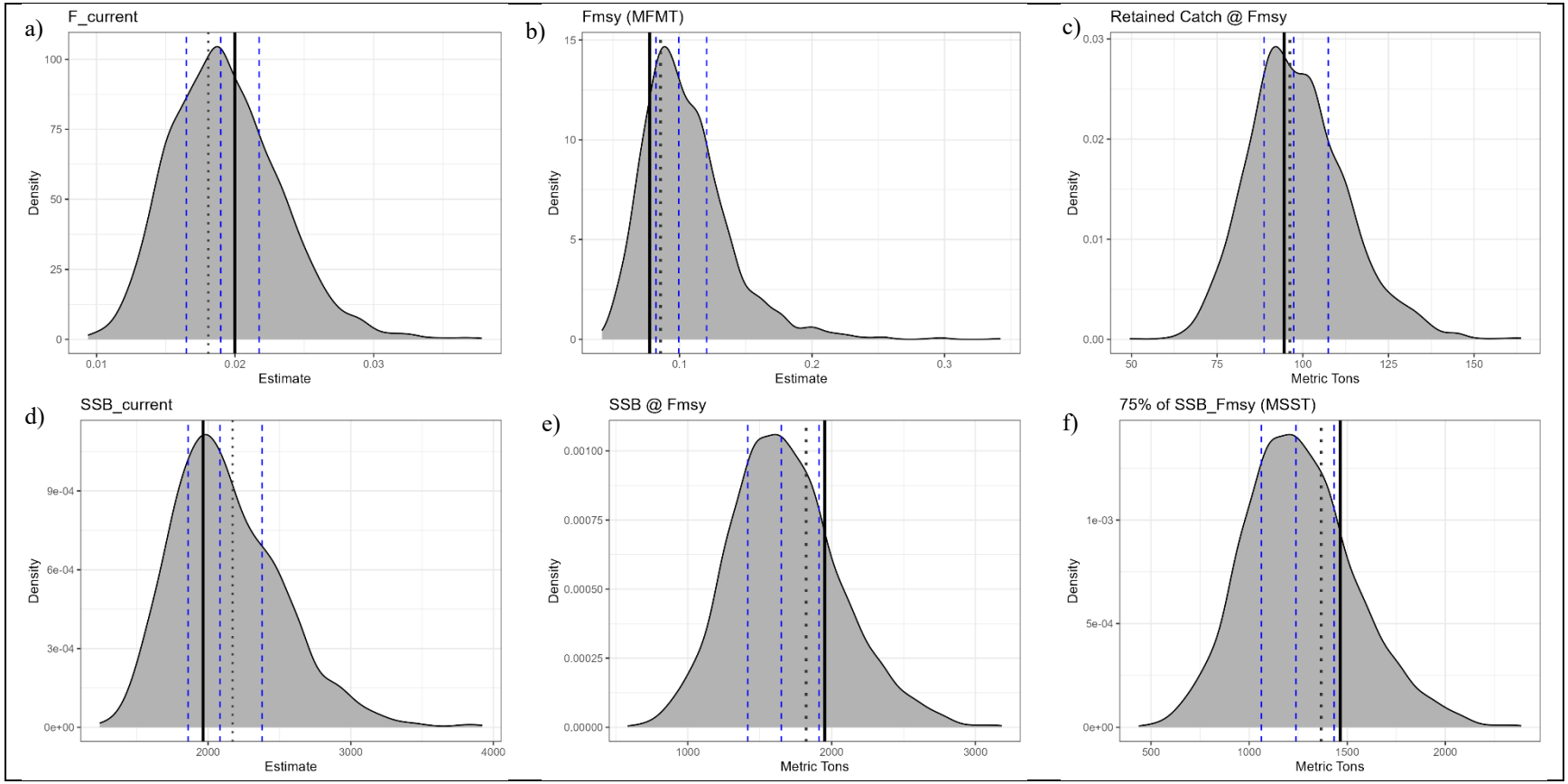


Figure 3.62. The posterior distributions for a) $F_{current}$ (i.e., geometric mean of F for years 2022 – 2024), b) F_{MSY} (i.e., MFMT), and c) the retained yield associated with F_{MSY}, d) $SSB_{current}$ (i.e., geometric mean of SSB for years 2022 – 2024), e) SSB at F_{MSY}, and f) 75% of SSB at F_{MSY} (i.e., MSST) from the combined six-chain MCMC of the MCMC 'proxy' model based on the SEDAR 94 KEYS base model. The blue dashed lines indicate the median and interquartile range, the black dotted line is the estimate from the MCMC 'proxy' model, and the solid black line is the estimate from the SEDAR 94 KEYS base model.

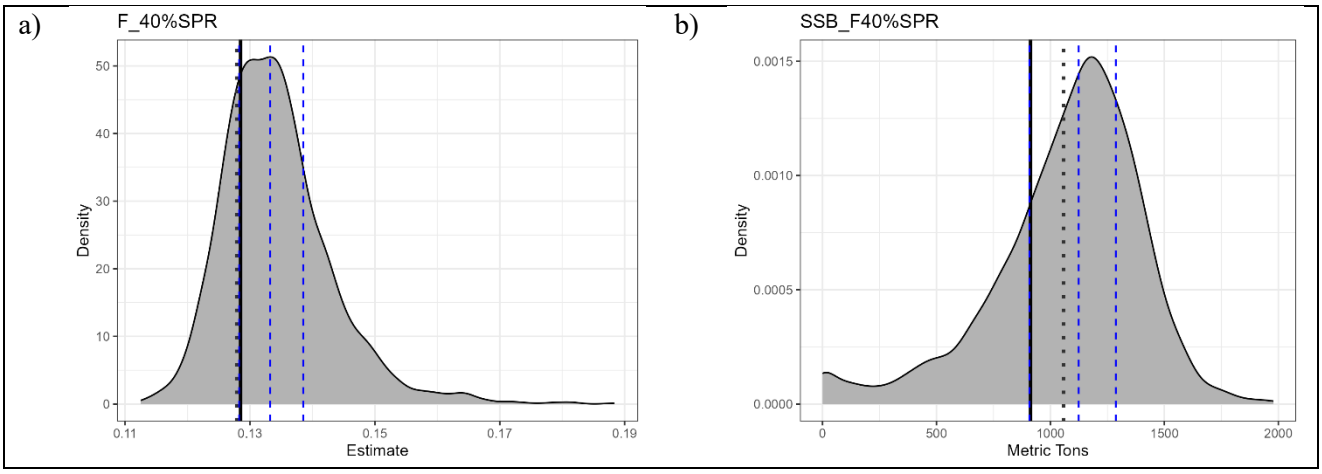


Figure 3.63. The posterior distribution for a) $F_{40\%SPR}$ and b) SSB at $F_{40\%SPR}$ values from the combined six-chain MCMC of the MCMC 'proxy' model based on the SEDAR 94 KEYS base model. The blue dashed lines indicate the median and interquartile range, the black dotted line is the estimate from the MCMC 'proxy' model, and the solid black line is the estimate from the SEDAR 94 KEYS base model.

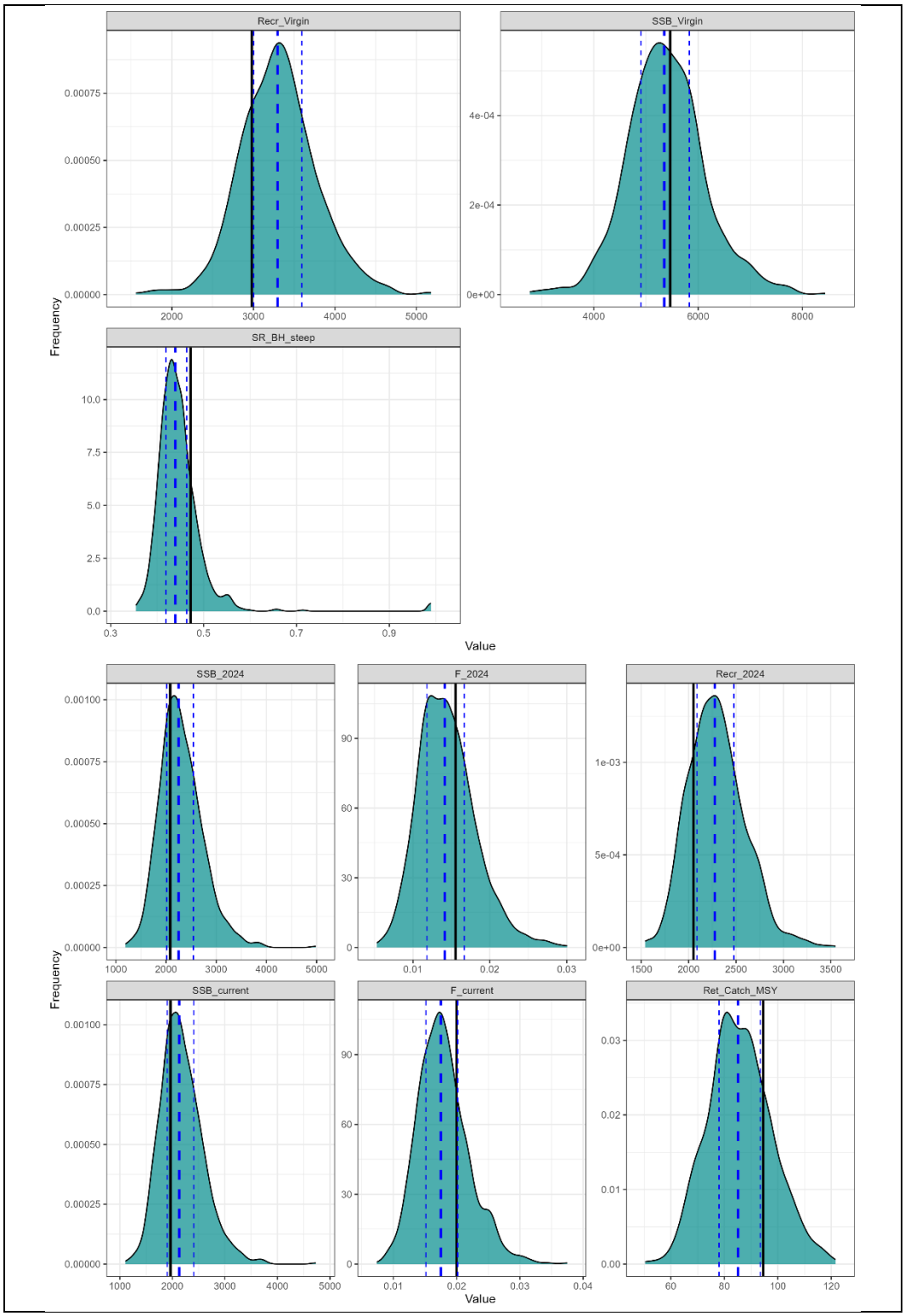


Figure 3.64. Distributions of selected parameter estimates and derived quantities from parametric bootstrapping the SEDAR 94 KEYS base model.

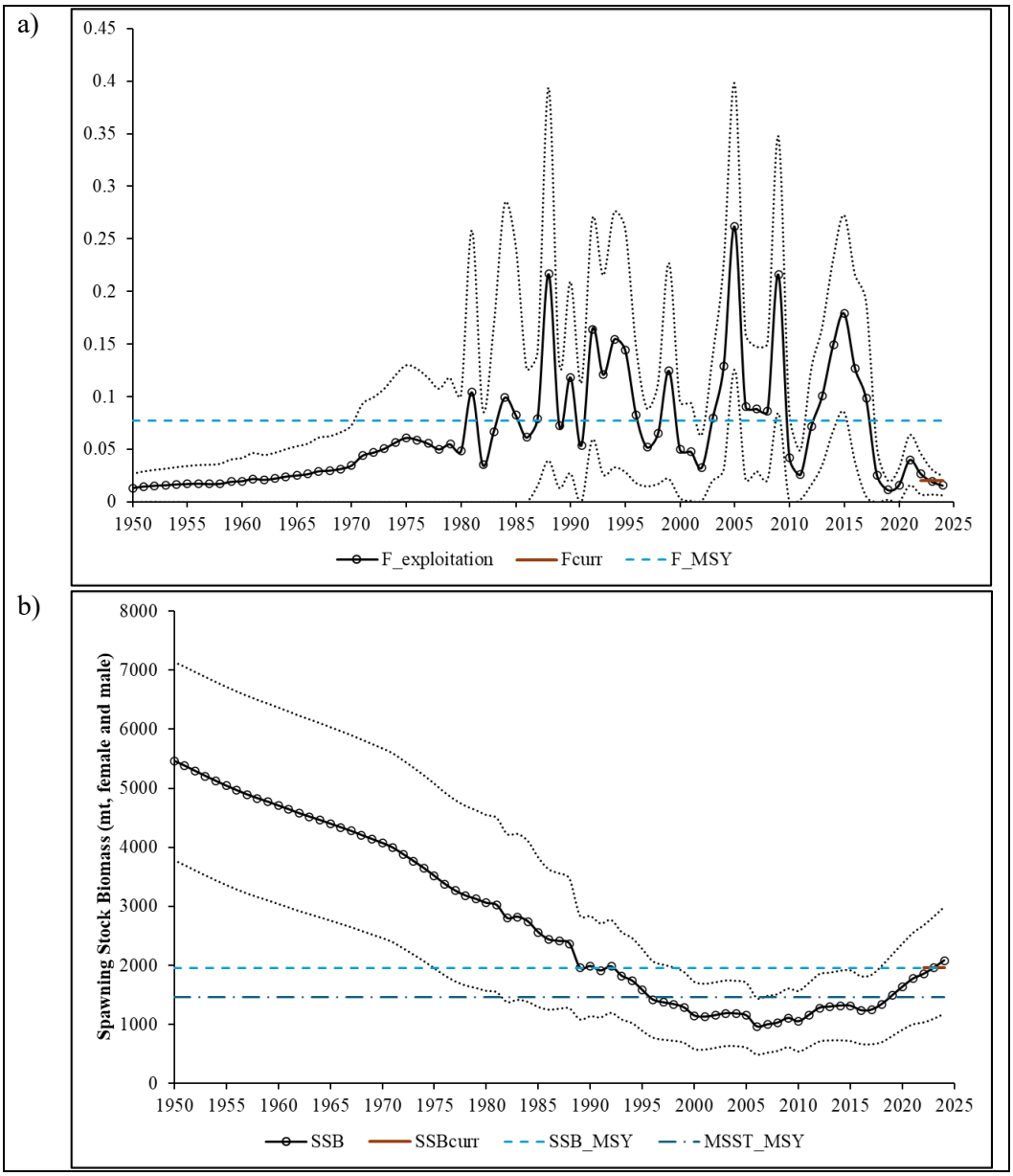


Figure 3.65. Annual estimates of a) exploitation relative to F_{MSY} and the geometric mean of exploitation in the last three years ($F_{current}$), and b) spawning stock biomass (SSB) relative to MSST (75% SSB_{MSY}), SSB_{MSY}, and the geometric mean of SSB in the last three years ($SSB_{current}$) by the SEDAR 94 KEYS base model. Dotted lines represent 95% confidence intervals.

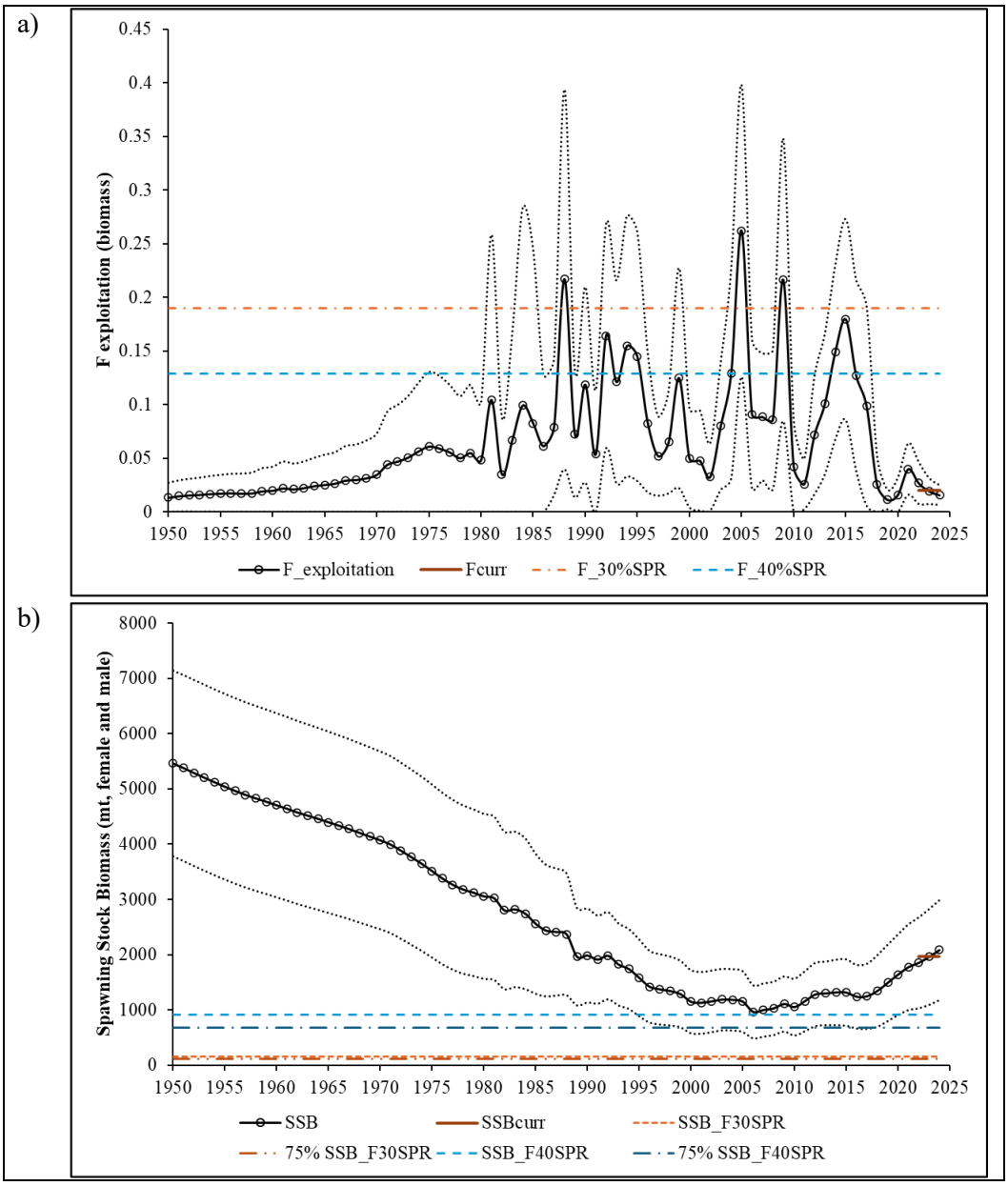


Figure 3.66. Annual estimates of a) exploitation relative to $F_{30\%SPR}$, $F_{40\%SPR}$, and the geometric mean of exploitation in the last three years ($F_{current}$), and b) spawning stock biomass (SSB) relative to 75% $SSB_{F40\%SPR}$, $SSB_{F40\%SPR}$, and the geometric mean of SSB in the last three years ($SSB_{current}$) by the SEDAR 94 KEYS base model. Dotted lines represent 95% confidence intervals.

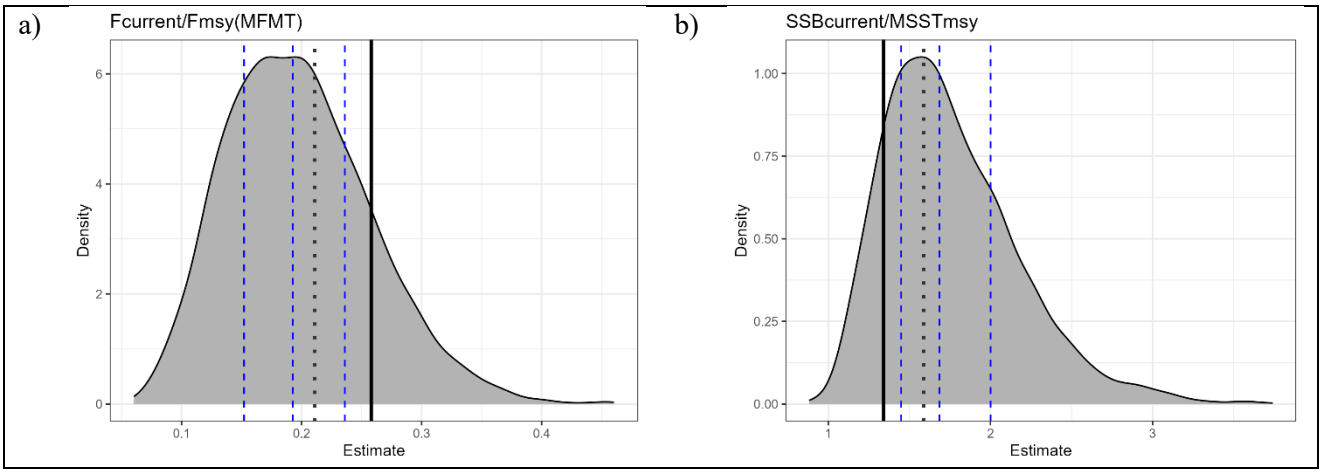


Figure 3.67. The posterior distribution for the F ratio ($F_{current}/F_{MSY}$) and SSB ratio ($SSB_{current}/MSST_{MSY}$) values from the combined six-chain MCMC of the MCMC 'proxy' model based on the SEDAR 94 KEYS base model. The blue dashed lines indicate the median and interquartile range, the black dotted line is the estimate from the MCMC 'proxy' model, and the solid black line is the estimate from the SEDAR 94 KEYS base model.

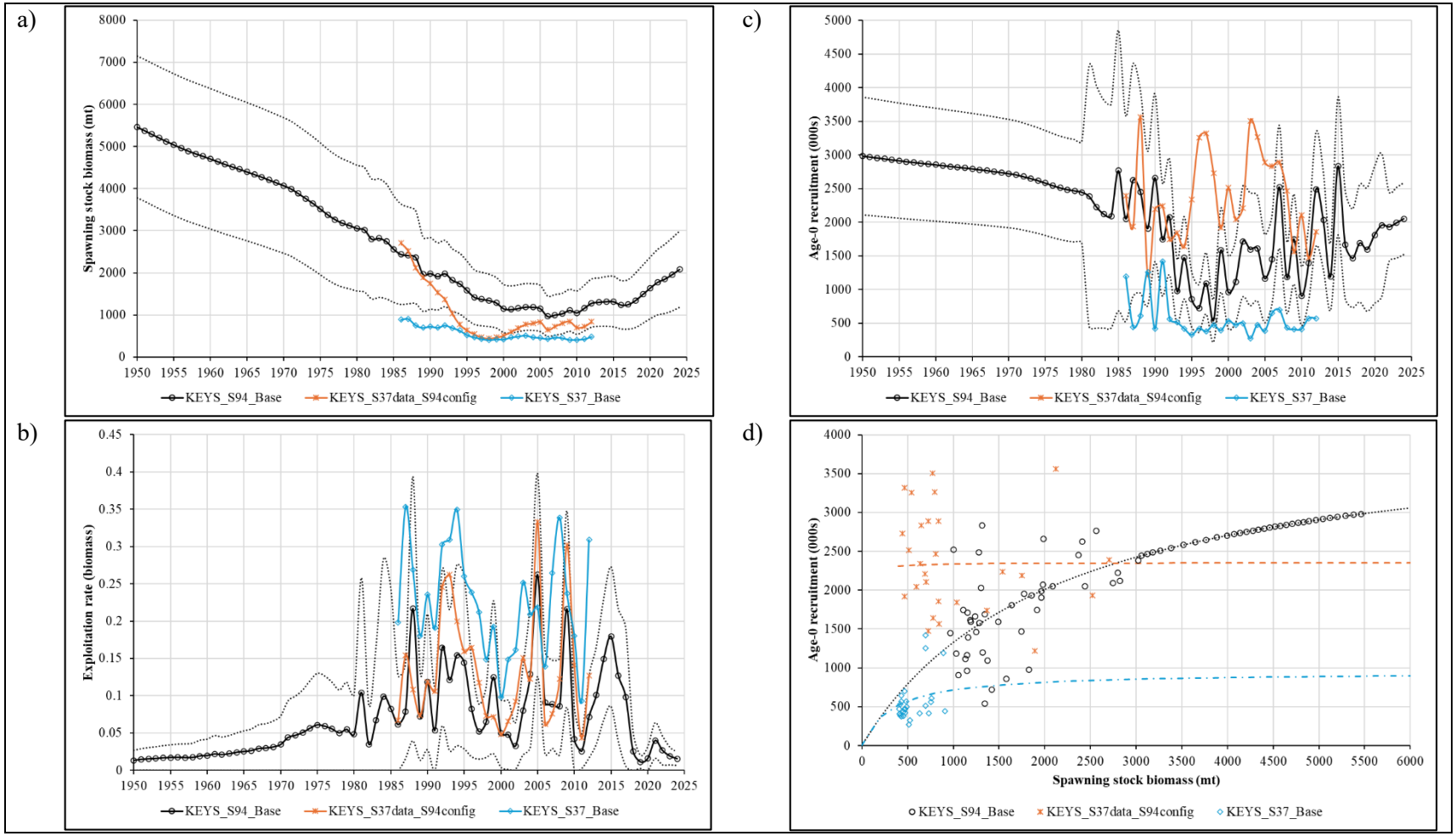


Figure 3.68. A comparison of the results between the SEDAR 94 KEYS base model (KEYS_S94_Base), the bridge building model (KEYS_S37data_S94config), and the SEDAR 37 base model (KEYS_S37_Base) for a) spawning stock biomass, b) exploitation rates, c) age-0 recruitment, and d) the estimated stock-recruitment relationship.

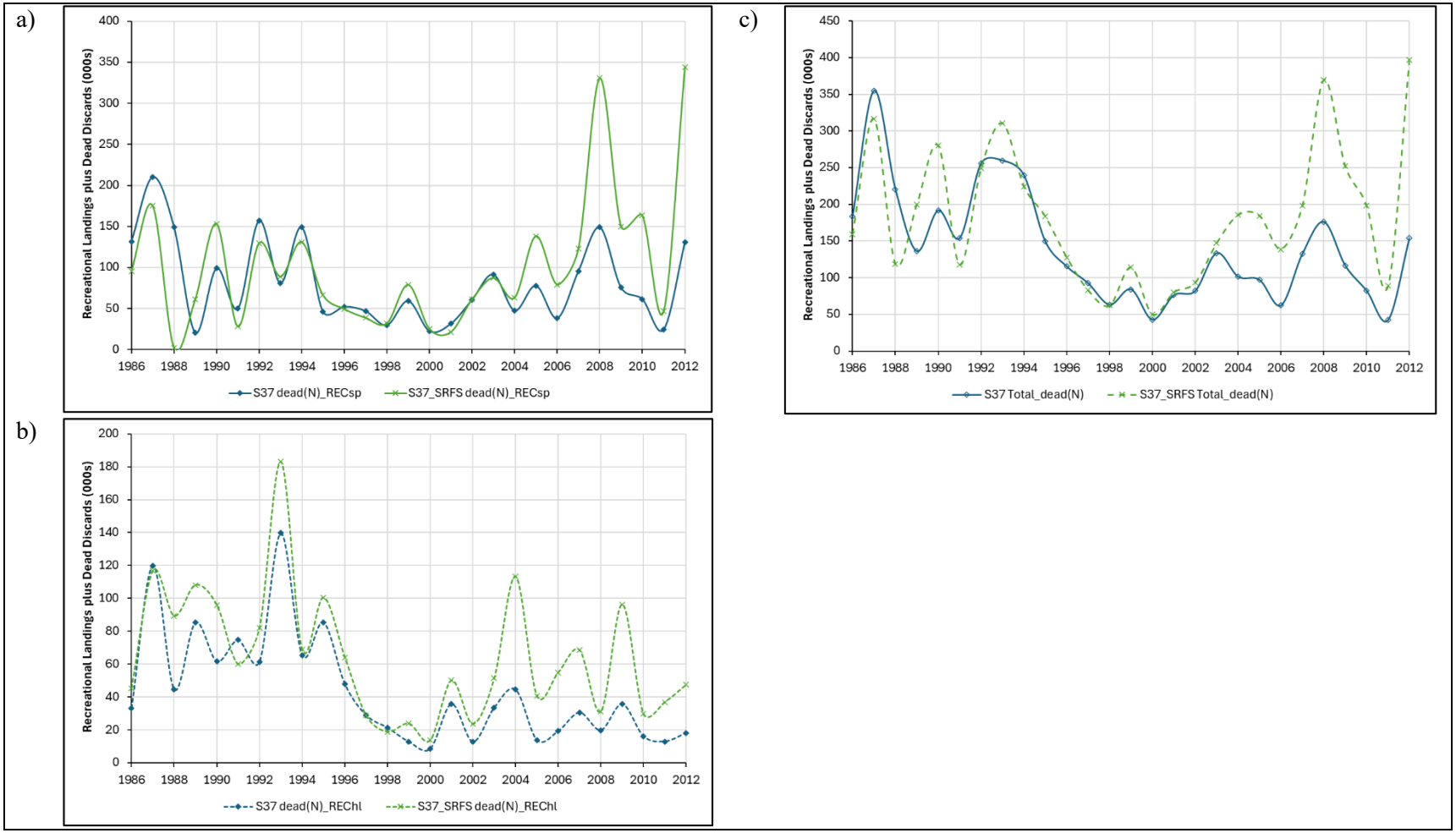


Figure 3.69. A comparison of the input recreational landings plus dead discards in numbers (dead[N]) between the SEDAR 37 base model (S37) and the SEDAR 37 base model containing the 'Full SRFS' (S37_SRFS) catch timeseries a) for the spear gear, b) for the hook-and-line gears, and c) when gears were combined as configured for the S94 KEYS base model.

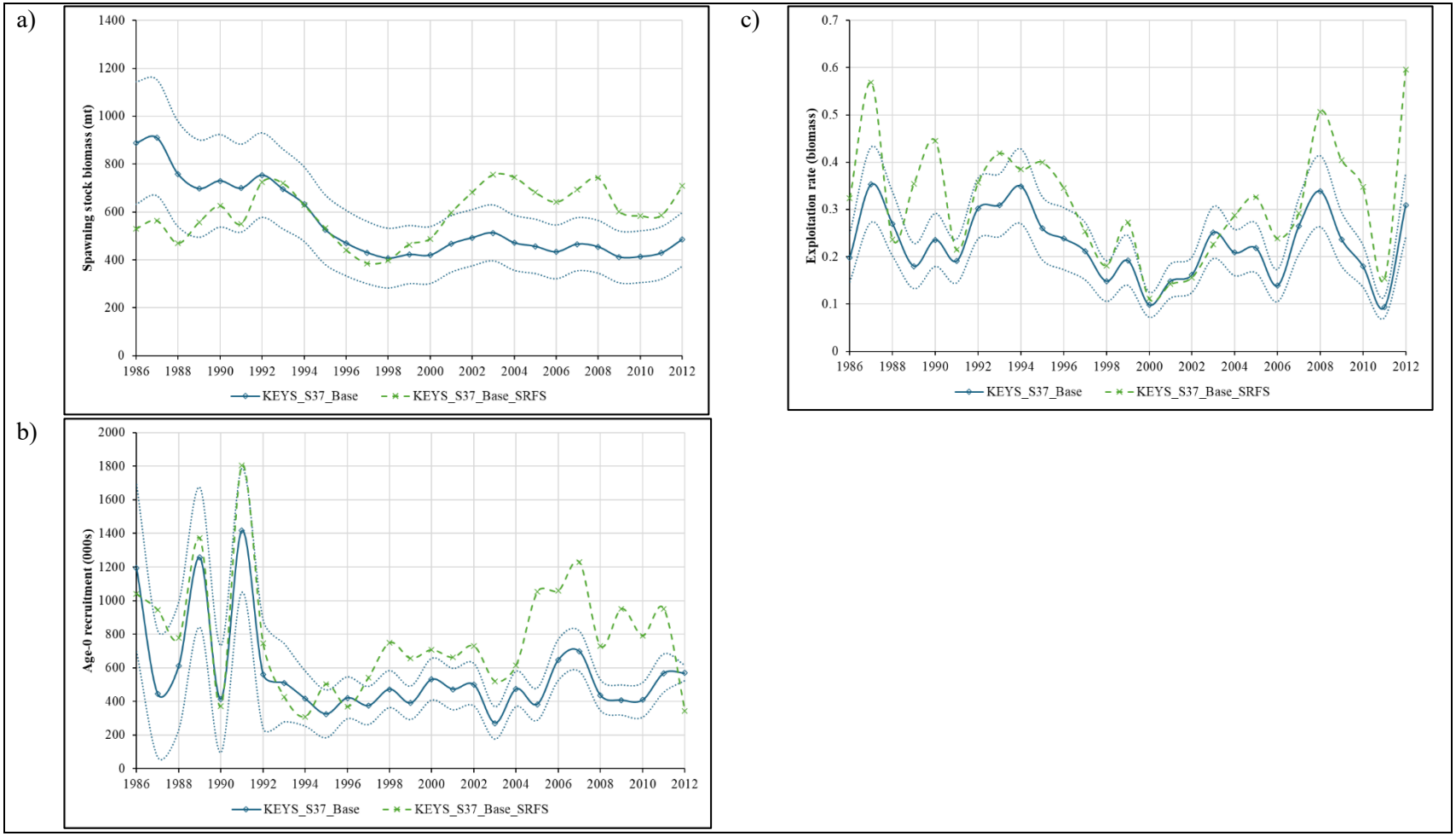


Figure 3.70. A comparison of the results between the SEDAR 37 base model (S37) and the SEDAR 37 base model containing the 'Full SRFS' catch timeseries (S37_SRFS) for a) spawning stock biomass, b) age-0 recruitment, and c) exploitation rates.

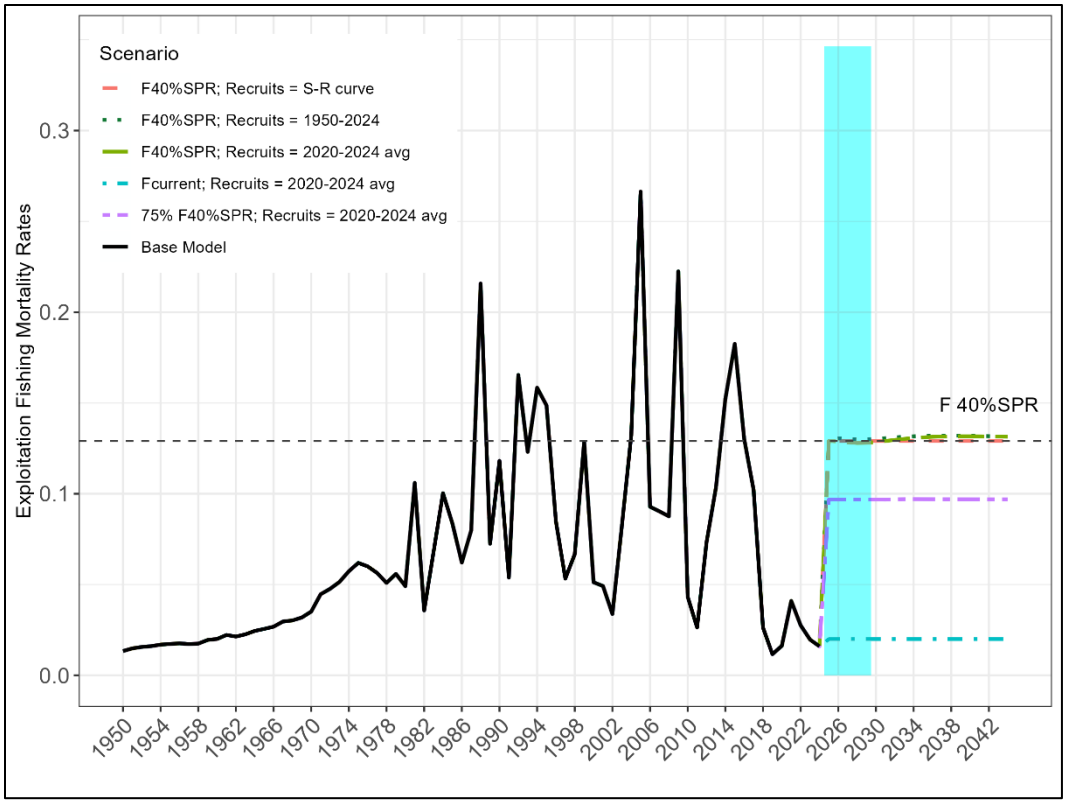


Figure 3.71. Exploitation rates based on projections under long-term equilibrium $F_{40\%SPR}$ using the stock-recruitment curve (red dashed line), long-term equilibrium $F_{40\%SPR}$ using average recruitment from the whole timeseries (dark green dotted line), short-term $F_{40\%SPR}$ (mustard dashed line), $F_{current}$ (teal dot-dashed line), 75% of short-term $F_{40\%SPR}$ (purple short-dash-long-dashed line), and as estimated by the SEDAR 94 KEYS base model (black solid line). The cyan region highlights the first five years of the projection (2025 – 2030).

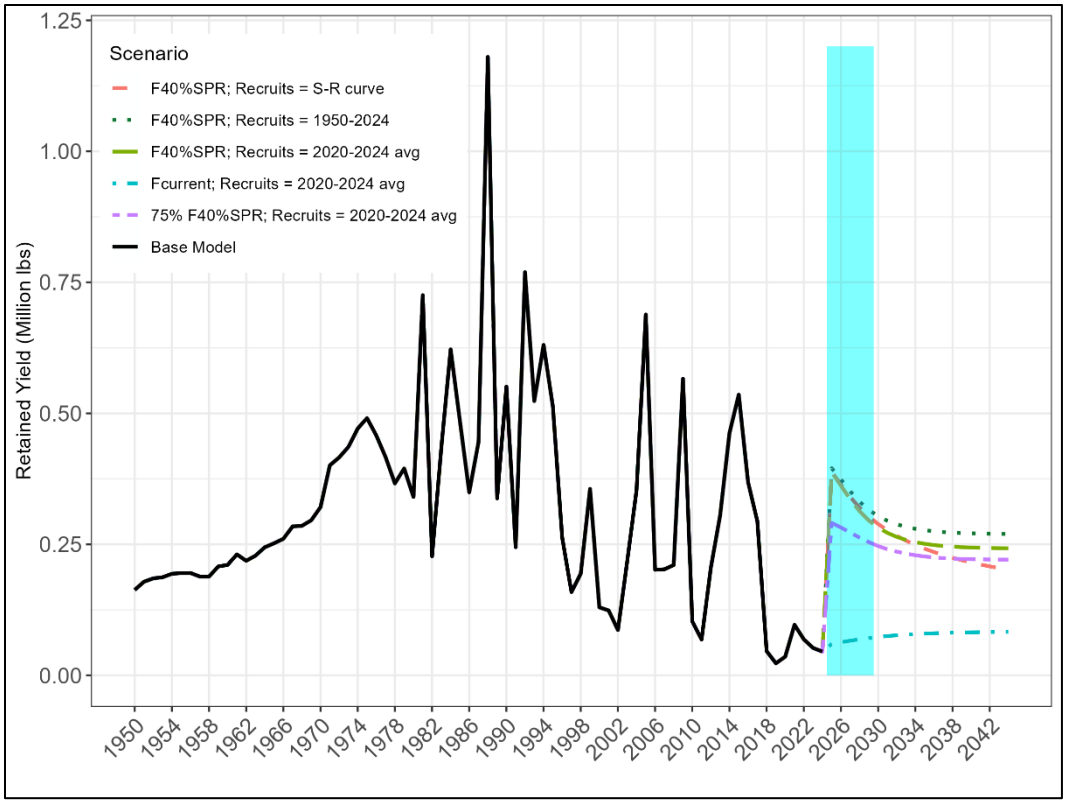


Figure 3.72. Retained yield (million pounds) based on projections under long-term equilibrium $F_{40\%SPR}$ using the stock-recruitment curve (red dashed line), long-term equilibrium $F_{40\%SPR}$ using average recruitment from the whole timeseries (dark green dotted line), short-term $F_{40\%SPR}$ (mustard dashed line), $F_{current}$ (teal dot-dashed line), 75% of short-term $F_{40\%SPR}$ (purple short-dash-long-dashed line), and as estimated by the SEDAR 94 KEYS base model (black solid line). The cyan region highlights the first five years of the projection (2025 – 2030).

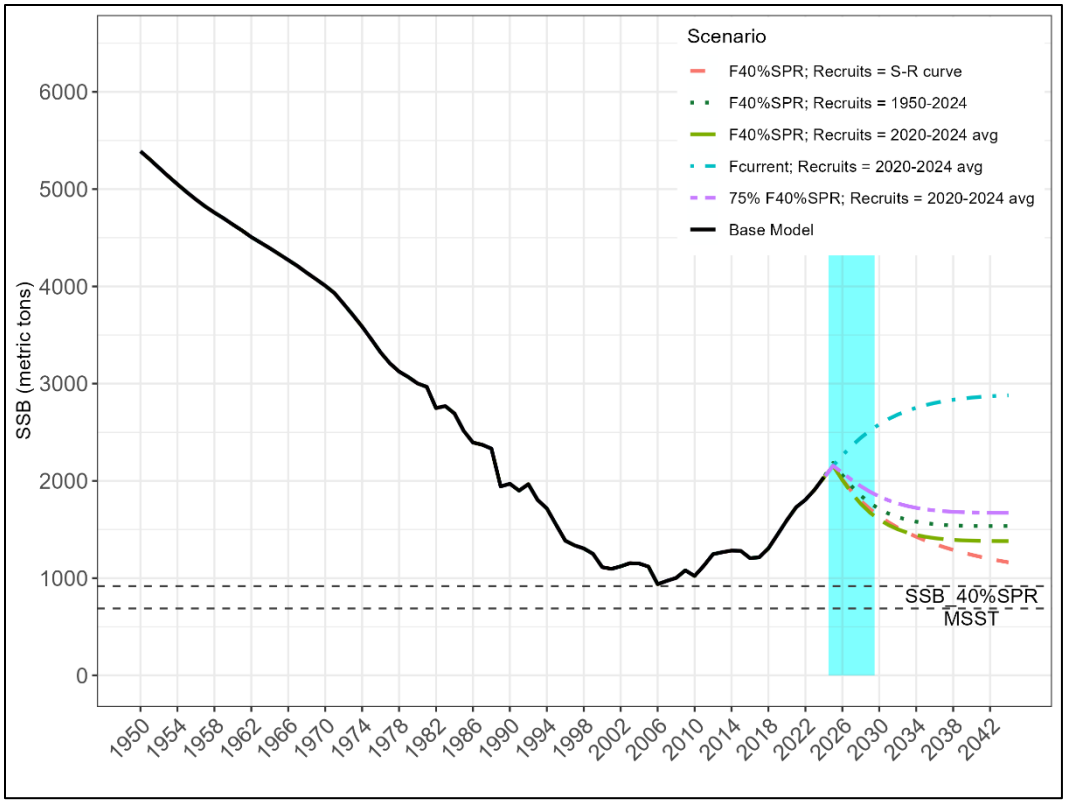


Figure 3.73. Spawning stock biomass (metric tons) based on projections under long-term equilibrium $F_{40\%SPR}$ using the stock-recruitment curve (red dashed line), long-term equilibrium $F_{40\%SPR}$ using average recruitment from the whole timeseries (dark green dotted line), short-term $F_{40\%SPR}$ (mustard dashed line), $F_{current}$ (teal dot-dashed line), 75% of short-term $F_{40\%SPR}$ (purple short-dash-long-dashed line), and as estimated by the SEDAR 94 KEYS base model (black solid line). The cyan region highlights the first five years of the projection (2025 – 2030).

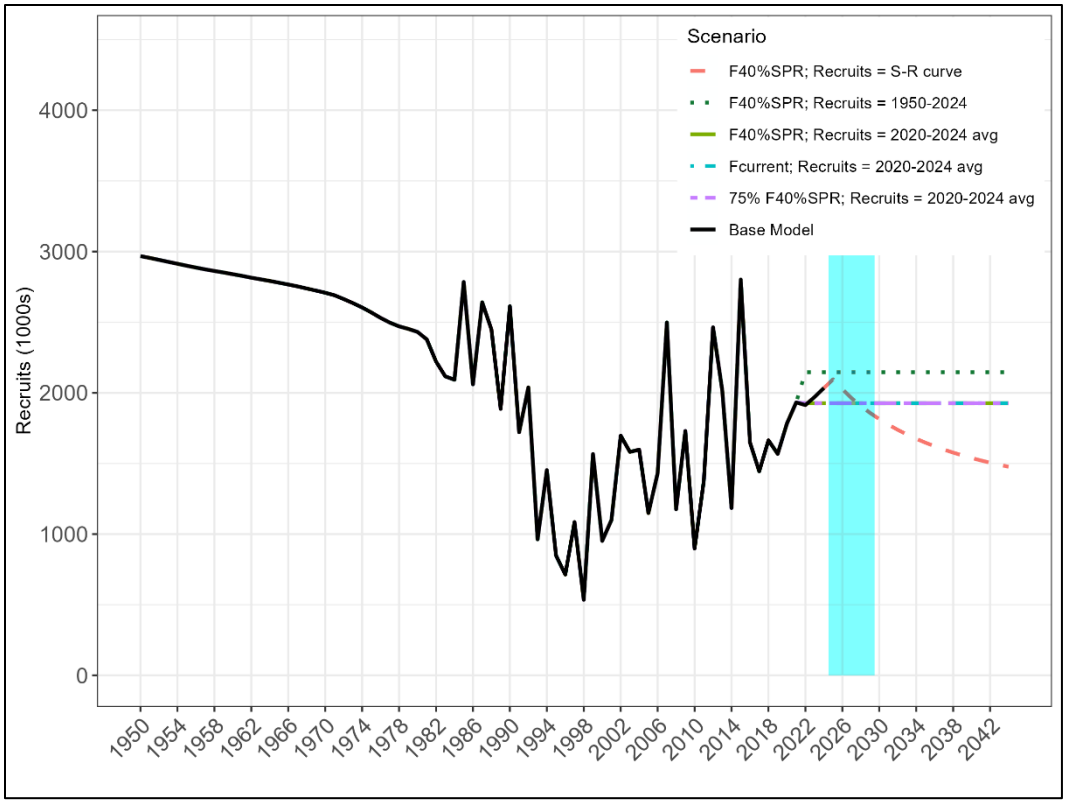


Figure 3.74. Age-0 recruits (in thousands) based on projections under long-term equilibrium $F_{40\%SPR}$ using the stock-recruitment curve (red dashed line), long-term equilibrium $F_{40\%SPR}$ using average recruitment from the whole timeseries (dark green dotted line), short-term $F_{40\%SPR}$ (mustard dashed line), $F_{current}$ (teal dot-dashed line), 75% of short-term $F_{40\%SPR}$ (purple short-dash-long-dashed line), and as estimated by the SEDAR 94 KEYS base model (black solid line). The cyan region highlights the first five years of the projection (2025 – 2030).

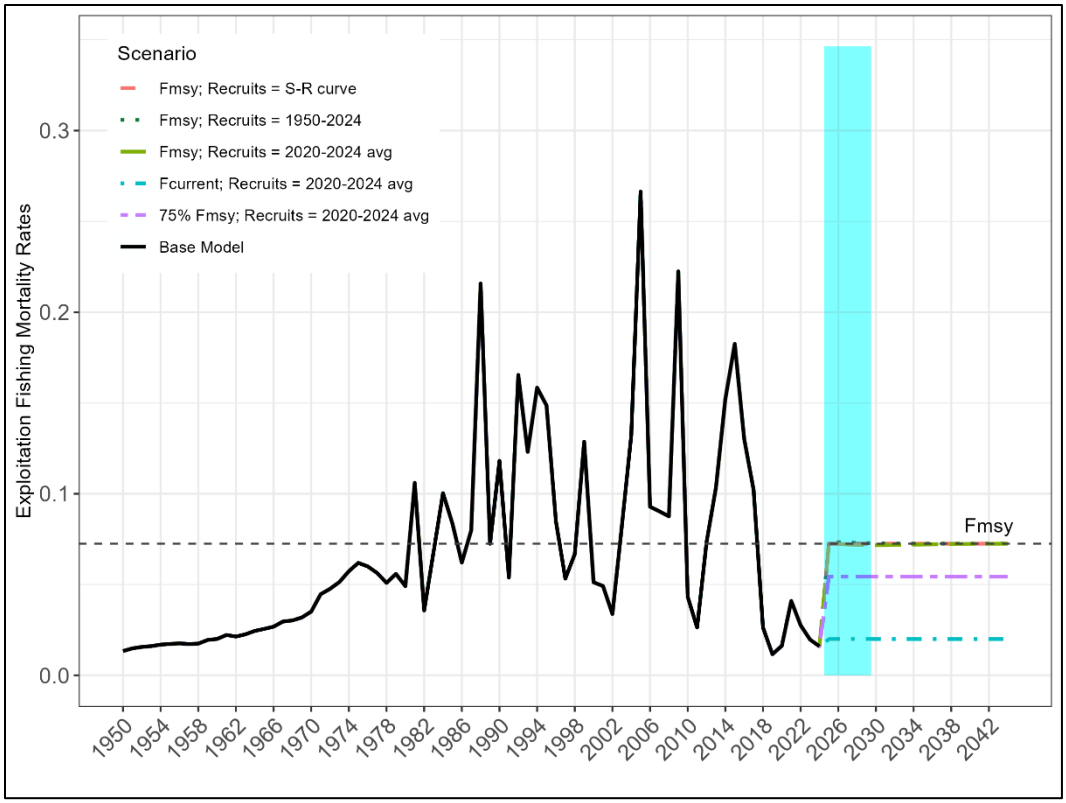


Figure 3.75. Exploitation rates based on projections under long-term equilibrium F_{MSY} using the stock-recruitment curve (red dashed line), long-term equilibrium F_{MSY} using average recruitment from the whole timeseries (dark green dotted line), short-term F_{MSY} (mustard dashed line), $F_{current}$ (teal dot-dashed line), 75% of short-term F_{MSY} (purple short-dash-long-dashed line), and as estimated by the SEDAR 94 KEYS base model (black solid line). The cyan region highlights the first five years of the projection (2025 – 2030).

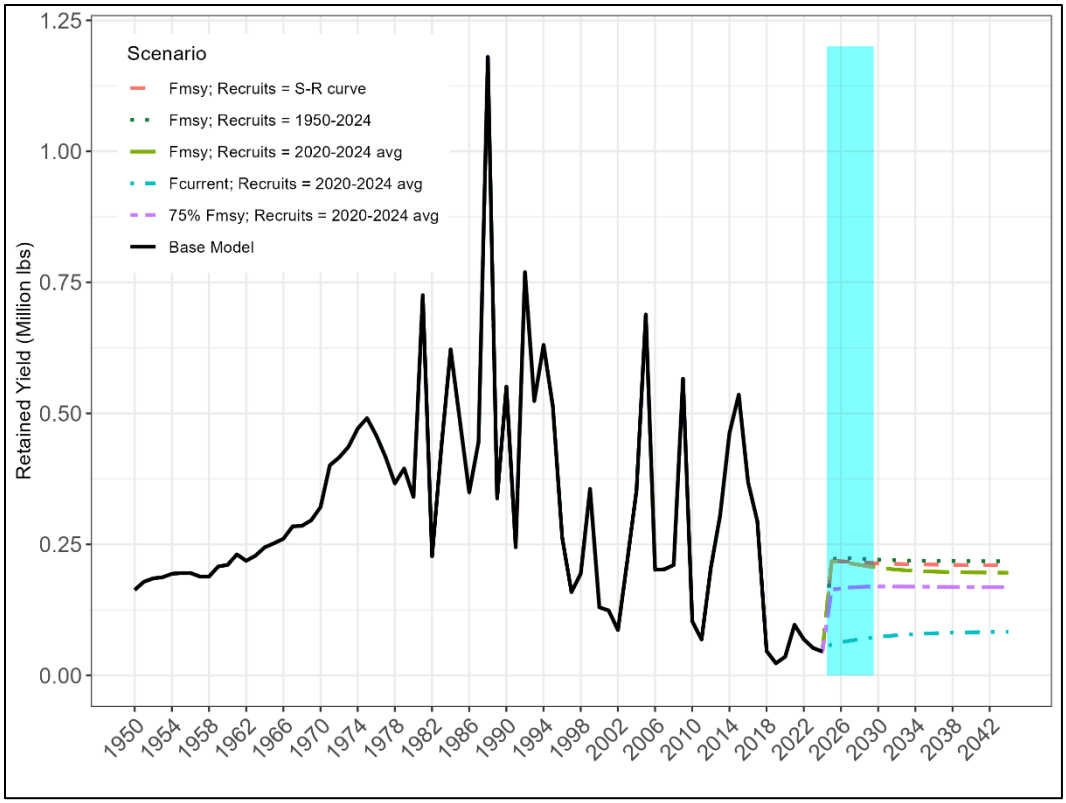


Figure 3.76. Retained yield (million pounds) based on projections under long-term equilibrium F_{MSY} using the stock-recruitment curve (red dashed line), long-term equilibrium F_{MSY} using average recruitment from the whole timeseries (dark green dotted line), short-term F_{MSY} (mustard dashed line), $F_{current}$ (teal dot-dashed line), 75% of short-term F_{MSY} (purple short-dash-long-dashed line), and as estimated by the SEDAR 94 KEYS base model (black solid line). The cyan region highlights the first five years of the projection (2025 – 2030).

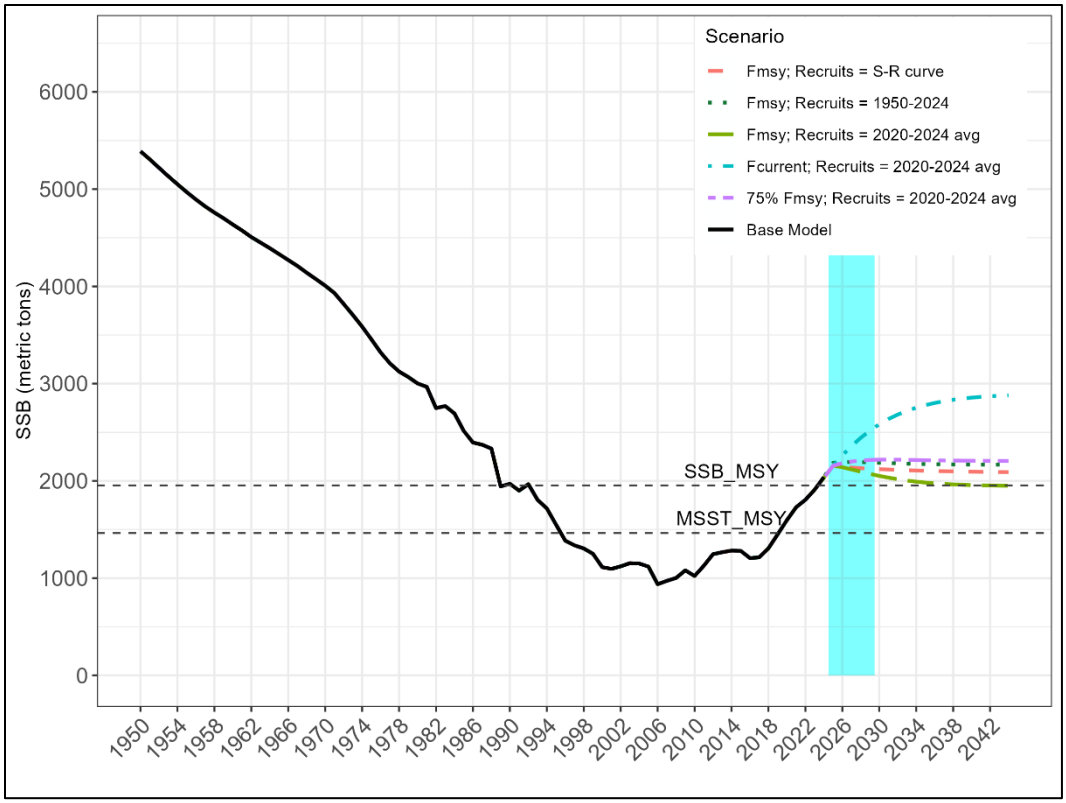


Figure 3.77. Spawning stock biomass (metric tons) based on projections under long-term equilibrium F_{MSY} using the stock-recruitment curve (red dashed line), long-term equilibrium F_{MSY} using average recruitment from the whole timeseries (dark green dotted line), short-term F_{MSY} (mustard dashed line), $F_{current}$ (teal dot-dashed line), 75% of short-term F_{MSY} (purple short-dash-long-dashed line), and as estimated by the SEDAR 94 KEYS base model (black solid line). The cyan region highlights the first five years of the projection (2025 – 2030).

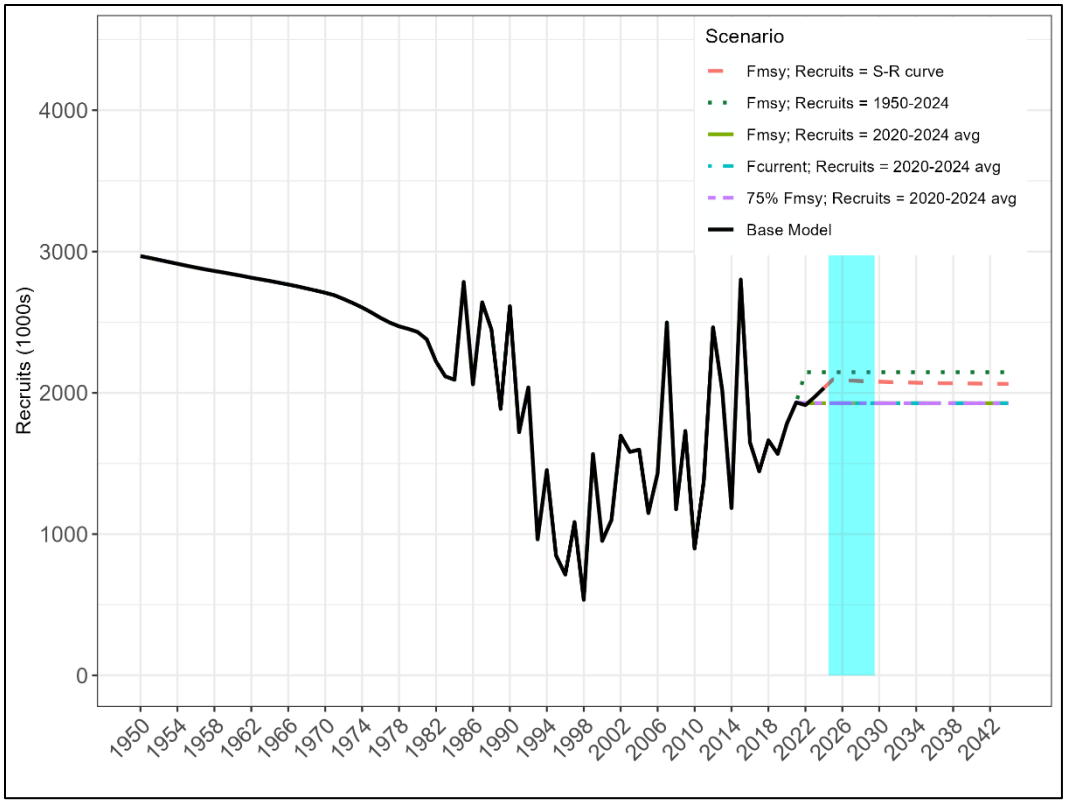


Figure 3.78. Age-0 recruits (in thousands) based on projections under long-term equilibrium F_{MSY} using the stock-recruitment curve (red dashed line), long-term equilibrium F_{MSY} using average recruitment from the whole timeseries (dark green dotted line), short-term F_{MSY} (mustard dashed line), $F_{current}$ (teal dot-dashed line), 75% of short-term F_{MSY} (purple short-dash-long-dashed line), and as estimated by the SEDAR 94 KEYS base model (black solid line). The cyan region highlights the first five years of the projection (2025 – 2030).

4 WFS Stock Synthesis Model Results

4.1 Life History

The WFS base model internally estimated growth where asymptotic length (L_{inf}) was estimated at 89.6 cm FL and the growth coefficient (k) was estimated at 0.083. Using the platoons feature within SS, this corresponded to the 2nd platoon (of the 3 total platoons) which was apportioned 70% of annual recruitment. The estimated mean length-at-age was found similar to the results of the external growth model developed during the Data Workshop (Figure 4.11; see Section 2.3.5 in the Data Workshop Report) and the additional platoons allowed fish to grow faster (i.e., larger) and slower (i.e., smaller). In the first platoon, where 15% of annual recruitment was apportioned, mean fish size at maximum age was as small as 64.7 cm FL; but in the third platoon, also receiving 15% of recruitment, mean fish size was as large as 90.2 cm FL at maximum age. These faster growing fish became vulnerable to the fisheries sooner whereas the slower growing fish encountered the fisheries much less, helping to mimic the "Lee phenomenon" hypothesized to be occurring in this stock. Additionally, the platoon within/between standard deviation ratio parameter was estimated at 0.85, suggesting a shift to lower mean size-at-age has been occurring for this population.

4.2 Landings and Discards

Fits to the landings data for the commercial, recreational hook-and-line, and recreational spear fleets are presented in Figures 4.12 – 14 and were nearly exact (total negative log-likelihood = $4.03134e^{-10}$). Figures 3.15 – 16 compare model estimated landings across fleets in biomass and numbers of fish, respectively.

Fits to the discard data were reasonable (total negative log-likelihood = 19.0468) as most estimates were close to the observed values, were within the 95% confidence intervals, and followed the increasing trend during the latter portion of the timeseries (Figure 4.17).

4.3 Indices

The WFS base model fits to the three fishery-independent indices (seagrass trawl, SEAMAP trawl, and combined video) are presented in Figures 4.18 – 20. Overall model fits to the indices were well estimated (total negative log-likelihood = -8.45446) and exhibited more stable but variable trends across time.

Model fits to the seagrass trawl index were the worst of the three indices (RMSE = 0.6722). The expected trend followed the observed trend but was more relatively stable through time; the model expected lower recruitment in 2012 and higher recruitment during 2013 – 2015 and 2019 (Figure 4.18). As an age-0 recruitment index, this is directly tied to the expected trend in recruitment deviations and fits were thought to have improved if the sum-to-zero constraint was removed; however, when explored during the model development process, this was not found to occur. Changing the index configuration to one with length-based selectivity and added length composition data to investigate potential misspecification, which also would have added more parameters to the model, was not explored due to time and resources.

The fits to the SEAMAP trawl index were largely within the observed error, but overestimated years 2013, 2014, and 2018 and underestimated years 2023 – 2024 (Figure 4.19, RMSE = 0.5280). The expected values tended to be staggered from the seagrass trawl (recruitment) index. For example, higher recruitment in 2012, 2018, and 2021 led to higher expected abundances in 2013, 2019, and 2022. More below average recruitment in 2022 and 2024 may have influenced the complete underestimation of abundance for 2023 – 2024.

The combined video index was fit the best (RMSE = 0.2221), which was expected given the low input values of observed error, and greatly influenced the population's predicted trend in biomass. The fitted values followed the observed trend with poorest fit occurring in outlying years 2010 and 2014 and a slight increasing trend was predicted from 2017 to 2024 (Figure 4.20).

4.4 Length and Age Composition

4.4.1 Data Weighting

Iterative reweighting of length composition data as well as CAAL data was performed according to the Francis composition weighting method TA1.8 (Francis 2011). Francis weights were calculated iteratively until they stabilized to the values presented in Table 4.9, which occurred on the 3rd iteration. All composition data were weighted across fleets and partitions by multiplying the corresponding Francis weights with the input sample sizes to produce the adjusted ('N. adj.') input sample sizes as reported in Figure 4.21. Applying the Francis weights resulted in large reductions to the unweighted base model's objective function. While this mostly occurred in the length composition and CAAL data's likelihood components, improvements to index likelihood components were particularly observed in the seagrass trawl index (Δ negative log-likelihood -8.597 units), and to lesser extents in the combined video index (Δ negative log-likelihood -0.468 units), and SEAMAP trawl index (Δ negative log-likelihood -0.241 units).

4.4.2 Length Composition

The base model fits to the length composition data along with the Pearson residuals associated with the landings, discards, and indices are presented in Figures 4.21 – 25. The quality of the fit varied among fleets and indices and fits aggregated across time were reasonable (total negative log-likelihood = 421.624; Figure 4.21). The model's predicted distributions were able to match the observed overall distributions, smoothing through the noise, and slightly overestimated the peak for the recreational spear.

The length composition data for the commercial fleet were weighted annually by the commercial landings and were aggregated into three super-periods: 1991 – 1999 (N.adj. = 29.5), 2000 – 2017 (N.adj. = 96.9), and 2018 – 2024 (N.adj. = 29.5); no length data were available for year 2004. Fits to these data largely agreed with the observed distributions (Figure 4.22a and 4.25), matched the changes in minimum size limits, and smoothed through jagged-looking length bins. The first super-period has large peaks throughout the length distribution leading to underestimates in the number of smaller and larger fish. The distribution was more concentrated between 28 – 44 cm FL in the second super-period which led to a slight overestimation of the smallest fish and an underestimation of the larger fish. For the most recent super-period the distribution was further concentrated between 32 – 42 cm FL and the peak was slightly underestimated. All super-period distributions reflected a consistent retention of larger individuals through time.

The recreational hook-and-line retained length composition data were weighted annually by the recreational hook-and-line landings, were characterized by comparatively larger sample sizes, and were aggregated into four super-periods: 1986 – 1999 (N.adj. = 210.3), 2000 – 2004 (N.adj. = 103.9), 2005 – 2017 (N.adj. = 423.1), and 2018 – 2024 (N.adj. = 536.9). The length distributions in all four super-periods fit well but exhibited a truncation at larger sizes through time alongside the shift in minimum size limits (Figures 4.22b and 4.25). The first super-period characterized the first time block (no size limits) where length composition data indicated some retention of larger individuals and fits to the data were slightly underestimated at the peak. The second and third super-periods (2000 – 2017; second time block) were split to align with the recreational hook-and-line discards which became available in 2005 (Figure 4.22c) and reflected the shift to a 12" FL (30.5 cm) minimum size limit. Distributions in these super-periods were largely concentrated below 46 cm FL. The third super-period (2018 – 2024) reflected a shift in mode

to the new 14" FL (35.6 cm), however smaller fish were still shown to be retained (Figure 4.22b) and the distribution was more concentrated below 44 cm FL. The recreational hook-and-line discard length compositions in the first super-period were characterized by very low annual sample sizes and no data for years 2006 – 2008, 2010 – 2012, and 2014. Fits to the available data overestimated the number of fish between 22 – 26 cm FL and underestimated the peak at 28 cm FL (Figures 4.22c and 4.25). In the second super-period, annual samples sizes increased and fits to the length compositions were fairly well and were aligned below the 14" FL (35.6 cm) minimum size limit (Figures 4.22c and 4.25).

The recreational spear length composition data were weighted annually by the recreational spear landings, contained generally larger sample sizes than the recreational hook-and-line, and were aggregated into three super-periods: 1986 – 1999 (N.adj. = 192.8), 2000 – 2017 (N.adj. = 422.5), and 2018 – 2024 (N.adj. = 66.4). As observed in the recreational hook-and-line composition data, the length distributions in all three super-periods fit well but indicated truncation at larger sizes through time alongside the shift in minimum size limits (Figures 4.22d and 4.25). The recreational spear fishery was more prominent during the first two super-periods and reflected that in the annual sample sizes; in the third super-period, annual sample sizes diminished and fits to the data underestimated the peak at 36 cm FL (Figure 4.22d).

Model fits were reasonable for the length composition data of the SEAMAP trawl index, but peaks were underestimated for most years (Figures 4.23 and 4.25) and observations were noisy. The mid-size (20 – 30 cm FL) fish were underestimated in the early part of the time series (2011 – 2018), while the smallest sizes (<20 cm FL) were underestimated in the beginning and end of the time series (2010 and 2019 – 2024).

For the length composition data of the combined video index, model fits were reasonable for most years. Low sample sizes led to sharp peaks, noise, and underestimation from 2007 – 2016 (Figures 4.24 and 4.25).

4.4.3 Conditional Age-at-Length

The WFS base model fits to the CAAL data associated with the SEAMAP trawl and fishery-independent spear data are presented in Figures 4.26 – 28. The fit among data sources and to their aggregated mean ages appeared well (total negative log-likelihood = 477.089; Figure 4.26).

The fits to the annual mean ages for the SEAMAP trawl followed the trends of the observations generally well and the mean age between years 2019 – 2023 were observed to decrease by ~1 year (Figure 4.26a). This signal in combination with the seagrass trawl index likely informed the high expected recruitment for years 2018 and 2021 by the WFS base model. The annual fits to the observed ages were reasonable and the WFS base model was able to track the observed ages across length bins (Figure 4.27).

The fishery-independent spear CAAL data were constructed from the life-history research of McBride and Richardson (2007), Collins and McBride (2008, 2011, 2015), and Faletti and Stallings (2021; see Section 2.6 in Data Workshop Report). The trend of the observed mean ages was stable but variable across time with the observed mean age being younger in 1999 and 2017 and older in 1996 and 2005 (Figure 4.26b). The annual fits to the observed ages were well and the WFS base model was able to track the observed ages across length bins, which was important as this was intended to be the primary data source informing the internal estimation of growth within the WFS base model (Figure 4.27).

4.5 Estimated Parameters and Derived Quantities

The SEDAR 94 WFS base model estimated most parameters reasonably well (i.e., |CV| < 1; Table 4.10). Of the 124 active parameters, 5 exhibited poor estimation (i.e., |CV| > 1); including 4 recruitment

deviations and 1 parameter describing selectivity (i.e., descending se from the commercial fleet). No parameters were estimated near bounds.

4.5.1 Stock Biomass (Total and Spawning)

The predicted total biomass and spawning stock (mature female plus male) biomass are summarized in Table 4.11 and Figures 4.29 – 30. The total biomass generally decreased in trend through 1999, then increased through 2010, before decreasing until 2021 and increasing again in the final years (Table 4.11 and Figure 4.29). The predicted spawning stock biomass largely followed the same trends (Table 4.11, Figure 4.30a).

The unfished spawning stock biomass (SSB_0) was estimated at 1,740 mt (Table 4.11) where the estimated female spawning biomass was 610 mt and the male biomass as 1,130 mt (Figure 4.30b). In 1986, the depletion ratio (SSB/SSB_0) was 0.927 which reflected AW panel discussions that the stock at this point in time had not yet experienced intense fishing pressures like the Florida Keys/East Florida stock. Depletion decreased to an average 0.555 between 1996 – 1999, increased to an average 0.867 between 2008 – 2012, and since 2018 averaged 0.570 (Table 4.11). The changes in biomass appear to be driven more by changes in the female spawning biomass which could be due to greater targeting by the fisheries; as the females decline, the males eventually decline too due to the staggering from the hermaphroditism function, and vice-versa (Figure 4.30b).

4.5.2 Recruitment

The relationship between spawning output and age-0 fish as parameterized by the Beverton-Holt stock-recruitment model is presented in Figure 4.31. The *ln(R0)* parameter was estimated at 7.651, which equates to 2.103 million age-0 Hogfish, the *steepness* parameter was fixed at 0.99, and the *sigmaR* parameter was estimated at 0.726 (Table 4.10).

The estimated annual recruitment of age-0 Hogfish to the biological population is summarized in Table 4.11 and Figure 4.32a-b. The WFS base model estimated age-0 recruitment as a stable but variable trend (Figure 4.32a) with notable highs in 1999 (7.222 million fish), 2006 (7.127 million fish), and 2021 (6.834 million fish). Estimated recruitment was below average in 2022 and 2024 (Figure 4.32b) and averaged 1.181 million fish from 2022 – 2024.

Annual deviations of estimated recruitment from the stock-recruitment curve followed the annual trend of the estimated recruitment above (Figure 4.32b) and the expected seagrass trawl index (Figure 4.18). The estimated (and applied) recruitment bias adjustment ramp as recommended by Methot and Taylor (2011) is shown in Figure 4.33.

4.5.3 Fishing Mortality

The annual exploitation fishing mortality rates on West Florida Shelf Hogfish are presented in Table 4.12 and Figure 4.34. Exploitation rates generally followed the trend in catch and were variable from 1986 – 2007 (avg. 0.037 yr^{-1}), then increased and remained variable until 2024 (avg. 0.072 yr^{-1}). Notable highs occurred in 2016 (0.149 yr^{-1}) and 2023 (0.110 yr^{-1}). After the new regulations were implemented near the end of 2017, exploitation averaged 0.0650 yr^{-1} for years 2018 – 2024.

Fleet-specific fishing mortality rates (i.e., instantaneous apical rates representing the fishing mortality level on the most vulnerable age class) are also provided in Table 4.12 and Figure 4.35. Apical fishing mortality rates by fleet were highest for both recreational hook-and-line and spear fleets and generally followed their respective trends in annual catch. Apical fishing mortality rates were stable but variable from 1986 – 2006, increased to the timeseries high in 2016, then decreased again through 2024 (Table 4.12, Figure 4.35). Similarly, the apical fishing mortality rates by the recreational hook-and-line fleet

fluctuated over time through 2012, then they increased through 2024 to a magnitude similar to the timeseries high from the recreational spear fleet (Table 4.12, Figure 4.35). The combined Commercial fleet had the lowest amount of fishing mortality rates and has generally declined in trend from 2016 – 2024 (Table 4.12, Figure 4.35).

4.5.4 Selectivity and Retention

Selectivity for all fleets and indices was estimated using length-based selectivity functions which the WFS base model used to further derive age-based selectivity (Figures 4.36 – 43). Fleet-specific length-based selectivity and retention patterns, as well as assumed discard mortality rates, are illustrated in Figures 4.36 – 38.

Selectivity of Hogfish for the commercial fleet was time-varying to follow changes in minimum size regulations; without discard estimates (which must be assumed negligible) or discard length composition data, selectivity here functions as retention. Selectivity was dome-shaped generally between 39 – 63 cm FL from 1986 – 1999, 30 – 45 cm FL from 2000 – 2017, and 33 – 45 cm FL from 2018 – 2024; an asymptote of 40% was reached in all three time blocks (Figure 4.36). In the first time block, fish became vulnerable beginning at age-2 before becoming more fully selected by ages 9 and 10; age-derived selectivity of fish in the second and third time blocks (2000 – 2024) was much younger, still beginning around age-2 but becoming fully selected at ages 5 and 6 (Figure 4.40).

Dome-shaped selectivity of Hogfish by the recreational hook-and-line fleet was generally between 23 – 53 cm FL and was effectively zero above 60 cm FL (Figure 4.37). Age-derived selectivity began around age-2 and fish were fully selected at ages 4 and 5 (Figure 4.41). Retention was time-varying and followed the minimum size limits through time where fish were fully retained by 37 cm FL from 1986 – 1999 (Figure 4.37a), by 33 cm FL from 2000 – 2017 (Figure 4.37b), and by 39 cm FL from 2018 – 2024 (Figure 4.37c). From 1986 – 1999, there were no discard length composition data; therefore, discards-at-length followed selectivity and the additive inverse of retention. From 2000 – 2017, discards of Hogfish were low and largely between 23 – 33 cm FL (Figure 4.37b); however, from 2018 – 2024 discards increased substantially with the ongoing development of the hook-and-line fishery and became in greater proportion from 23 – 37 cm FL (Figure 4.37c).

Selectivity of Hogfish for the recreational spear fleet was also time-varying to follow changes in minimum size regulations and functioned as retention like the commercial fleet. Selectivity was dome-shaped between 25 – 53 cm FL from 1986 – 1999, 29 – 53 cm FL from 2000 – 2017, and 33 – 53 cm FL from 2018 – 2024 (Figure 4.38). Age-derived selectivity of fish was consistent across all three time blocks beginning about age-2 and were fully selected at ages 5 and 6 (Figure 4.42).

Selectivity of Hogfish by the SEAMAP trawl index was dome-shaped between 13 – 41 cm FL before becoming reaching an asymptote of 5% (Figure 4.39). This corresponded to an age-derived selectivity primarily between ages 1 – 8 before reaching an asymptote of 7%. Fish observed by the combined video index were 50% selected by 21 cm FL and became fully selected by 29 cm FL (Figure 4.39). Age-derived selectivity of this index started at age-1 and became more fully selected by ages 5+ (Figure 4.43).

4.6 Model Diagnostics

4.6.1 Convergence

The SEDAR 94 WFS base model converged with a total objective function of 916.605. The model contained no parameters on the bounds, had a small final gradient <0.0001, and had a positive definite Hessian matrix. Highly correlated parameters were inspected, but all were found to be structurally correlated and therefore left as-is estimated in their different model phases.

The results of the jitter analysis (100 iterations, 20% jitter) found that no jittered runs contained a total likelihood lower than the base model, suggesting that the base model had converged on a global solution (Figure 4.44). From the 100 jittered runs, 37 runs (37%) had at least one parameter bound warning and 41 runs (41%) had a gradient >0.0001.

4.6.2 Goodness of fit

The joint residual plots for the indices (Figure 4.45a), mean length composition data (Figure 4.45b), and the conditional age-at-length data (Figure 4.45c) indicated varying fits to the data as combined RMSE values were 0.501, 0.125, and 0.094 respectively. As illustrated by the loess-smoother and size of the boxplots, residual variability of the indices had a slight positive bias at the beginning of the timeseries by the combined video and seagrass trawl indices. However, when the SEAMAP trawl index became available in 2010, the trend becomes negatively biased until 2019 when it stabilizes (Figure 4.45a). Residuals and interquartile ranges of the mean length data were stable in early years from the fisheries, then showed interquartile variability in later years from index data becoming available (Figure 4.45b). Residuals of the CAAL data from the SEAMAP trawl index and fishery-independent spear data were relatively consistent throughout the timeseries and mostly centered around zero (Figure 4.45c).

The residual series of all three indices and conditional age-at-length data passed the runs test, indicating residuals were sufficiently random and without significant autocorrelation (Figures 4.46 – 47). Results of the runs test for the mean length residuals for the recreational hook-and-line fleet and the SEAMAP trawl index passed the runs test (Figure 4.48). The mean length residuals of the combined video index exhibited non-random variation with sequential patterns of positive and negative values and three residuals larger than three standard deviations in years 2007, 2008, and 2010 (Figure 4.48). The commercial and recreational spear mean length residuals had too few observations due to the application of the super-periods and were unavailable for this analysis.

4.6.3 Model Consistency

4.6.3.1 Likelihood Profiles

The profile likelihood on the *ln(R0)* parameter revealed that the parameter is largely influenced by the length, CAAL, and to a lesser degree the index data components (Figure 4.49). The profile minimum primarily agreed with the WFS base model estimate of 7.651 and further indicated a parameter estimate between ~7.3 – 8.1 would not produce a significantly worse fit to the data (i.e., change in log-likelihood <2 units). Agreement with the CAAL data component was primarily influenced by the fishery-independent spear ages while agreement with the length data component was primarily driven by the combined video survey that informed a lower *ln(R0)* value. The index data component favored a higher *ln(R0)* value >7.9 and was influenced mainly by the combined video survey. The recruitment component was completely non-informative to the *ln(R0)* parameter and showed no indication of what range the value should be estimated.

4.6.3.2 Age-structured Production Models

The ASPM results indicated that the catch and index data were not particularly informative for informing the production function (Figures 4.50 – 4.51). Compared with the WFS base model, the ASPM estimated both population size and average recruitment to be approximately half as large (Figures 4.50a,c–d, and 4.51a). This smaller estimated population size translated into substantially higher exploitation rates, which were, on average, more than 3.5 times greater than those estimated by the WFS base model (Figure 4.50b). In addition, the relationship between the indices and the landings was weak, further inhibiting a strong signal to the production function. For example, average landings during 2007 onward were approximately double those observed during 1986 – 2006. However, all three indices were collected after

this period (with the exception of the combined video survey, which began in 2006 but actually doubled in relative abundance between 2006 and 2007) and therefore could not adequately capture the populations response over that time period. Furthermore, all three indices were relatively stable over time and the ASPM fit as flat lines through them (Figures 4.51b–d); as removals continued to increase, the indices did not reflect a corresponding decline in abundance (in fact, the SEAMAP trawl index increased during 2023 – 2024).

When the recruitment deviations were included (i.e., in the ASPMdev), the model estimated a significantly larger population magnitude; but, the uncertainty associated with estimates of spawning biomass (Figure 4.50a), recruitment (Figure 4.50c), and virgin recruitment (Figure4.51a) were greatly enlarged and the average CV across the each timeseries was nearly 1.5. Since the population was estimated to be larger but the catches were unchanged, the estimated exploitation rates were significantly lower (Figure 4.50b). Model fit to all indices improved relative to the WFS base model (Table 4.13, Figure 4.51b-d). The ASPMdev produced trends similar to those of the WFS base model, indicating that process error, represented by variability in age-0 recruitment (Figure 4.50d), was necessary to adequately fit the observed relative abundance indices. However, the considerable uncertainty associated with the ASPMdev estimates further indicated that composition data were needed to reliably estimate population scale.

4.6.3.3 Retrospective Analysis

The retrospective analysis showed a slight pattern in estimates of spawning stock biomass and exploitation rates after removing successive terminal years. Spawning stock biomass tended to decrease in trend while exploitation tended to increase in trend; thus, estimates of the population became more favorable with the addition of each successive year of data (Figure 4.52a-b). All runs converged and no parameters were found on the bounds. The calculated values for Mohn's rho for SSB ($\rho_m = -0.15$; Table 4.14) and F ($\rho_m = 0.19$; Table 4.14) were at or near the bounds of values considered "acceptable" for long-lived species (Hurtado-Ferro et al. 2015). The negative value for SSB indicates a tendency for slight underestimation of biomass in terminal years, while the positive value for F suggests a corresponding tendency to overestimate fishing mortality.

4.6.4 Model Validation (Prediction Skill)

Retrospective forecasting showed that the one year forward projections were largely consistent with the overall estimated trend in the reference base model (Figure 4.52a-b). All retrospective forecasts fell within the 95% confidence interval of the WFS base model. The forecast rho values for spawning stock biomass was the same ($\rho_F = -0.15$) and the forecast rho values for fishing mortality slightly decreased to $\rho_F = 0.18$ (Table 4.14), suggesting model stability as well as consistency when subsequent data became available.

A hindcast with cross-validation of the terminal seven years of data was performed to gauge predictive capacity of the WFS base model (Figures 4.53 – 54, Table 4.15). The seagrass trawl index, the SEAMAP trawl survey, and the combined video survey had MASE scores <1 which suggested the WFS base model contained reasonable prediction skill for these when compared to a naïve forecast (Figure 4.53). The seagrass trawl survey contained the lowest MASE score = 0.56, indicating the ability to predict is closer to twice as accurately as a naïve baseline prediction. The model exhibited predictive capacity (MASE<1) for the mean length data of the SEAMAP trawl survey and the combined video survey (Figure 4.54) and all predicted mean length values across fleets were within the predicted confidence intervals. The model exhibited predictive capacity (MASE<1) for the conditional age-at-length data available from the SEAMAP trawl survey (MASE = 0.34).

4.6.5 Sensitivity Runs

4.6.5.1 Natural mortality

Natural mortality sensitivity runs produced substantial differences in estimated population dynamics and derived quantities relative to the WFS base model (Figure 4.55). Both the 'Lorenzen_1996' and 'HamelCope_age3' mortality functions resulted in a lower mortality-at-age where M averaged 0.142yr^{-1} and 0.162yr^{-1} across ages 3 – 23, respectively (Figure 4.55a). Both scenarios also resulted in much lower age-0 recruitment estimates (Figure 4.55b). Interestingly, they resulted in different life history dynamics and subsequent population estimates. The 'Lorenzen_1996' scenario estimated a larger asymptotic length (L_{inf} = 114.7 cm FL) with similar spawning stock biomass (Figure 4.55c) and exploitation rate (Figure 4.55d) estimates as the WFS base model. But the 'HamelCope_age3' scenario estimated a much smaller asymptotic length (L_{inf} = 54.2 cm FL), resulting in a smaller spawning stock biomass (Figure 4.55c) near the lower confidence limit of the WFS base model and a correspondingly higher exploitation rate (Figure 4.55d). In both scenarios, the model likelihood was significantly greater than the WFS base model, indicating a worsened fit to the data.

In contrast, the 'est_HamelCope_age3_23_noprior' model estimated higher mortality-at-age compared to the WFS base model (Figure 4.55a) and indicated that, when given the flexibility, the model wanted an even greater average mortality across ages 3 – 23 (M = 0.286 yr^{-1}). The greater mortality on age-0 individuals resulted in much higher recruitment estimates (Figure 4.55b) with estimates of spawning stock biomass near the upper confidence limits of the WFS base model (Figure 4.55c) and exploitation rates near the lower confidence limits of the WFS base model (Figure 4.55d). Furthermore, L_{inf} was similarly estimated at 86.5 cm FL and the model's fit to the data was similar to the WFS base model (i.e., within 2 LL units). However, estimating natural mortality added more uncertainty to the model and resulted in annual CVs >0.7 for most estimates of spawning stock biomass, recruitment, and exploitation rates. This was somewhat encouraging because it indicated that the mortality-at-age and life history dynamics configured within the WFS base model were reasonable and the estimated uncertainty was satisfactorily captured.

4.6.5.2 Discard mortality

Discard mortality sensitivity runs showed that assumptions had minimal influence on model outputs (Figure 4.56). The high (59%) and low (23%) discard mortality sensitivity runs produced spawning stock biomass (Figure 4.56a), exploitation rate (Figure 4.56b), and recruitment (Figure 4.56c) estimates that closely tracked the WFS base model (41.1%) throughout the time series. Minor differences were observed in recent exploitation rate and recruitment estimates, but stock-scale trends and biomass dynamics were largely insensitive to changes in discard mortality rate.

4.7 Per-recruit Analyses

The yield-per-recruit (YPR), spawner-per-recruit (SSB/R), static spawning potential ratio (SPR), and total equilibrium yield analyses were computed as a function of the instantaneous exploitation rate on West Florida Shelf Hogfish and are presented in Table 4.16 and Figure 4.57. Presented with these values is also their relation to various SPR-based reference points. The retained yield at $F_{30\%SPR}$ for West Florida Shelf Hogfish was estimated to be 101.489 mt (223,744 lbs.; Figure 4.57d) while the total yield (retained yield plus dead discards) at $F_{30\%SPR}$ was 128.282 mt (282,593 lbs.; Figure 4.57c). The retained yield associated with $F_{40\%SPR}$ was estimated at 84.86 mt (187,085 lbs.; Figure 4.57d) while the total yield at $F_{40\%SPR}$ was estimated to be 104.9 mt (231,264 lbs.; Figure 4.57c).

4.8 Uncertainty in Parameters and Derived Quantities

4.8.1 MCMC Analysis

Of the eight chains produced, only six were found to have converged based on Geweke's diagnostic; thus, a total of 9,000 iterations remained. Convergence was evaluated using trace plots (Figure 4.59) and the Gelman and Rubin's (1992) potential scale reduction factor (PSRF values from the combined six MCMC chains for selected model parameters and derived quantities (*ln(R0),* SSB_0, SSB in 2024, F in 2024, $F_{30\%SPR}$, SSB at $F_{30\%SPR}$) of the SEDAR 94 WFS base model. MCMC convergence was generally acceptable based on PSRF diagnostics. PSRF values for all selected parameters and stock status criteria were close to 1 and since none of the PSRF upper confidence intervals exceeded the 'rule of thumb' value of 1.1, it was concluded that the MCMC converged (Table 4.17).

Posterior distributions were produced for stock-recruitment parameters (Figure 4.60) as well as the derived quantities of $F_{current}$ (Figure 4.61a), $F_{30\%SPR}$ (Figure 4.61b), the retained yield associated with $F_{30\%SPR}$ (Figure 4.61c), $SSB_{current}$ (Figure 4.61d), SSB at $F_{30\%SPR}$ (Figure 4.61e), and 50% of the SSB at $F_{30\%SPR}$ (Figure 4.61f). Results of the WFS base model were found to fall within the interquartile range of the posterior distributions for all considered criteria (Figures 4.60 – 61).

4.8.2 Parametric Bootstrap

Results of the bootstrap analysis indicated that the model exhibited a measure of instability when fitting to the randomly generated data sets. From the 500 bootstrapped data sets, few (2%, n = 10) had a gradient >0.0001 and 34% (n = 168) had at least one parameter on the bounds. The WFS base model estimates fell within the interquartile ranges (Figures 4.62 – 63).

4.9 Stock Status Determination Criteria

A summary of the West Florida Shelf stock status determination criteria and their values as presented in the TORs and according to the Gulf Council from the SEDAR 94 WFS base model is presented in Table 4.18. Stock status of Hogfish on the West Florida Shelf has been determined in past and current assessments according to the MSY_{proxy} reference point of 30% SPR.

The Maximum Fishing Mortality Threshold (MFMT) for Hogfish is currently defined as $F_{30\%SPR}$ and overfishing is occurring if the recent average of fishing mortality rates ($F_{current}$) exceeds the MFMT. $F_{current}$ is calculated as the geometric mean of Hogfish fishing mortality rates for 2022 – 2024. The MFMT was estimated by the WFS base model to be 0.229 yr^{-1}, $F_{current}$ was estimated to be 0.072 yr^{-1}, and F_{2024} was estimated to be 0.074 yr^{-1} (Figure 4.64). Based on the results of the WFS base model, the WFS Hogfish stock is not experiencing overfishing ($F_{current}$/MFMT = 0.314).

The minimum stock size threshold (MSST) for Hogfish is defined as 50 percent of the spawning stock biomass associated with $F_{30\%SPR}$ (0.50* $SSB_{F30\%SPR}$). The stock is overfished if the recent average spawning stock biomass ($SSB_{current}$) is less than MSST. The $SSB_{current}$ is calculated as the geometric mean of the spawning stock biomass for 2022 – 2024. The $SSB_{F30\%SPR}$ was estimated by the WFS base model to be 518.9 mt (1,143,979 lbs.) with MSST therefore defined as 259.45 mt (571,989 lbs.). The $SSB_{current}$ was estimated to be 1,086.51 mt (2,395,343 lbs.) and SSB_{2024} was estimated to be 1,106.69 mt (2,439,834 lbs.; Figure 4.65). Based on the results of the WFS base model, the WFS Hogfish stock continues to not be overfished ($SSB_{current}$/MSST = 4.188).

Posterior distributions were produced by the MCMC analysis for the stock status determination criteria and benchmark reference points of $F_{current}$, $F_{30\%SPR}$ (MFMT), the retained yield associated with $F_{30\%SPR}$, $SSB_{current}$, $SSB_{F30\%SPR}$, and 50% of SSB at $F_{30\%SPR}$ (MSST) (Figure 4.61). Based on the median values of the posterior distributions, MFMT was estimated to be 0.230 yr^{-1}, $F_{current}$ was estimated to be 0.065 yr^{-1},

$SSB_{F30\%SPR}$ was estimated to be 562.931 mt (1,240,991 lbs.), MSST was 281.466 mt (620,495 lbs.), and $SSB_{current}$ was estimated to be 1206.057 mt (2,646,367 lbs.). Additional posterior distributions of the F_{ratio} ($F_{current}$/MFMT) and SSB_{ratio} ($SSB_{current}$/MSST) are presented in Figure 4.66 where median value of the F_{ratio} = 0.282 and the median value of the SSB_{ratio} = 4.285. The estimates for these reference points as derived by the WFS base model were near the median values and within the interquartile ranges of these posterior distributions. The distribution of the F_{ratio} was entirely below one, indicating a high probability that overfishing is not occurring, and the distribution for the SSB_{ratio} was entirely above one, indicating a high probability that the stock is not overfished. The MCMC distribution of the retained yield at $F_{30\%SPR}$ (Figure 4.61c) had a median value of 110.475 mt (243,556 lbs.).

4.10 Bridge Building

As part of the TORs for SEDAR 94, a continuity model consistent with the prior update assessment (SEDAR 37U) configuration updated to include the most recent observations, is to be provided. A strict continuity model was determined to be largely unreproducible due to considerable differences in model structure between SEDAR 37U and the current assessment (fleets and surveys), large changes to data streams (e.g. MRFSS to MRIP to SRFS), and survey design changes (e.g. combined video survey). An alternative approach to a strict continuity run was explored by updating the existing SEDAR 37U assessment model to the SEDAR 94 configuration. Important configuration changes to SEDAR 37U include: updating the Stock Synthesis model version (3.24 to 3.30.34), combining three commercial fleets into a single, general commercial fleet, the addition of a regulatory time block in 2000, removal of all fishery dependent indices, changes in selectivity patterns for all fleets/surveys to double normal except for the combined video survey (logistic), applying Francis reweighting to length composition, the addition of three growth platoons, adopting the life history configuration (natural mortality, fixed growth, maturity, hermaphroditism) from SEDAR 94, fixing steepness at 0.99, estimating *sigmaR*, not estimating early recruitment deviations, limiting the estimation of initial F's to the recreational spear fleet, and adding super periods to the fishery fleet length composition data.

The results of the continuity run were then compared with the SEDAR 37U base model and the SEDAR 94 WFS base model. Annual estimates of spawning stock biomass in the continuity run were scaled much lower than estimates from SEDAR 37U and SEDAR 94, however the trends were very similar but dampened (Figure 4.67). Spawning stock biomass estimates from SEDAR 37U were on the same magnitude and trend as the SEDAR 94 WFS base model estimates, apart from differing initial conditions and differing trajectories around the timeframe the combined video survey was implemented within SEDAR 94 (Figure 4.67a). With the lower biomass estimates, annual exploitation rate estimates in the continuity run were scaled higher than those of SEDAR 37U and the SEDAR 94WFS base model, which comparatively showed similar estimates between them (Figure 4.67b). The estimated $F_{30\%SPR}$ reference point from the SEDAR 94 WFS base model (0.229 yr^{-1}) was slightly lower than in the continuity run (0.240 yr^{-1}) which was higher than the SEDAR 37U model estimate (0.096 yr^{-1}). The estimated $SSB_{F30\%SPR}$ reference point from the SEDAR 94 WFS base model (518.9 mt) was also higher than in the continuity run (282.173 mt) but lower than the SEDAR 37U model estimate (747.4 mt). Annual recruitment estimates were higher and more variable in the SEDAR 94 WFS base model compared to the continuity run and the SEDAR 37U model which were similar in magnitude (Figure 4.67c-d). The estimated SSB_0 from the SEDAR 94 WFS base model was 1,740 mt and the R_0 estimate was 2.103 million fish, both of which were greater than the estimated SSB_0 of 946 mt and R_0 of 0.853 million fish in the continuity run. Within the SEDAR 37U model, SSB_0 was higher (2,748 mt) and R_0 was lower at 0.463 million fish.

Lastly, a continuity model which aimed at exploring the impact of updating the recreational landings timeseries from the old MRFSS/MRIP to the SRFS back-calculated historical timeseries within the SEDAR 37 base model was developed (i.e., "SEDAR 37 SRFS"). For each gear, spear (Figure 4.68a) and hook-and-line (Figure 4.68b), the differences in catch magnitude and trend between the two survey methods were minimal and largely followed the same trend. This was not too surprising as the SRFS estimates for these years (1986 – 2012) behaved more like a scalar reduction to the MRIP estimates. When the gears were combined, the trend in landings followed the more predominant spear gear (Figure 4.68c). Consequently, differences in model estimated population dynamics were minimal as trends in spawning stock biomass (Figure 4.69a), recruitment (Figure 4.69b), and exploitation rate (Figure 4.69c) were often within the uncertainty estimated by the SEDAR 37U base model.

4.11 WFS Discussion

This report provides a stock assessment for Hogfish across the West Florida Shelf that was conducted in SS Version 3.30.24, which is an update from SEDAR 37U (2018) which was conducted in SS Version 3.24F. Compared to SEDAR 37 and its update, this assessment utilized seven years of new data, including revised recreational catch information, updated fishery-independent indices, expanded composition datasets, and a modified fleet structure. The combined video survey underwent a design change in 2020 and the video surveys now have unified survey design (2020 – 2024). The baitfish trawl survey ended in 2017 and was not provided during the Data Workshop, therefore these data were not included in the assessment. It was also determined during the Data Workshop that the fishery-dependent indices were not recommended for inclusion in SEDAR 94. Despite these changes, the WFS base model demonstrated generally acceptable statistical performance, converging on a global solution with no parameters estimated at bounds, a positive-definite Hessian matrix, reasonable predictive skill, and only minor retrospective tendencies.

Several diagnostics highlighted important sources of uncertainty in the assessment. Results from likelihood profile and age-structured production model (ASPM) analyses indicated that stock dynamics and population scale were not strongly informed by a traditional production relationship. Instead, the model relied heavily on length-composition and conditional age-at-length (CAAL) data to estimate population scale and recruitment variability. The ASPM analyses further demonstrated that catch and index data alone were insufficient to adequately characterize abundance dynamics. Although catches generally increased over the time series, the abundance indices did not exhibit corresponding declines or other clear responses. Consequently, the available data provided limited evidence regarding how the population has responded to removals. This lack of a clear relationship between increasing catches and abundance indices contributes substantial uncertainty to the assessment and raises questions about whether the West Florida Shelf Hogfish population has yet exhibited a measurable response to current levels of fishing mortality.

Additional uncertainty arose from unresolved spatial dynamics that could not be adequately incorporated into the WFS base model. Hogfish on the West Florida Shelf exhibit substantial spatial variability in distribution, density, habitat use, life-history characteristics (e.g., growth, maturity, and hermaphroditism), and exploitation patterns. However, available data lacked the spatial resolution, precision, and consistency needed to support a spatially explicit assessment framework. Recreational harvest of Hogfish has historically been concentrated in nearshore waters (<30 m) of the West Florida Shelf, as indicated by fishery composition data and corroborated by fishermen during the Data Workshop. As recreational effort—particularly hook-and-line fishing—continues to expand into deeper offshore areas where larger and older Hogfish are prevalent, the population-level response remains uncertain.

Consequently, the assumption of a single-area model may obscure important spatial heterogeneity in population dynamics, productivity, and fishery impacts.

Notable confounding among growth, natural mortality, and population abundance was observed during the model development process. Incorporating fishery-independent spear CAAL data improved the WFS base model's ability to estimate growth internally. In contrast, incorporating CAAL data from the fishery fleets, particularly from recreational hook-and-line fisheries, introduced conflicts among these population processes. Because natural mortality was fixed and population scale was constrained by composition data, the model primarily adjusted growth to accommodate discrepancies in the data. This often led to biologically implausible growth estimates, indicating inconsistency among the available data sources and model assumptions. These became decision points by the panel on why only the SEAMAP trawl and fishery-independent spear CAAL data were retained within the WFS base model as primary information sources to growth. Changing model configuration of these fishery CAAL data to landings-weighted age composition data may have helped alleviate these conflicts, however, time and resources precluded this exploration.

The time series of catch and index data provided limited information to the stock-recruitment dynamics; therefore, the WFS base model struggled to estimate any *steepness* parameter value other than 0.99. Without a corresponding response from the indices to the increasing number of removals (or vice-versa), the model only increased the variability of that average recruitment to accommodate the increased number of removals. The inclusion of the reconstructed recreational catch data during the model development process was also found uninformative to the *steepness* parameter as it only provided a further ramp-up into a catch trend that was already increasing over time. Its inclusion, therefore, added only further uncertainty to the model. An uninformed stock-recruitment relationship was also exhibited by the SEDAR 37 and 37U assessment models, lending further support to this stemming from the data rather than the model configuration. Thus, strong uncertainty surrounding stock productivity of Hogfish on the West Florida Shelf and associated management benchmarks remain.

Under the reference points defined in Gulf Council Reef Fish Amendment 43, where MSY is represented by $F_{30\%SPR}$ and MSST by 50% $SSB_{F30\%SPR}$, the SEDAR 94 WFS base model indicates that the Hogfish stock is neither overfished ($SSB_{current}/MSST > 1.0$) nor undergoing overfishing ($F_{current}/MFMT < 1.0$). Current SSB is estimated at 4.19 times the MSST, and the stock has not been estimated to have been overfished at any point since the model start year of 1986. However, uncertainty around biomass estimates remains, as the lower confidence limits for SSB fluctuated above and below the target $SSB_{F30\%SPR}$ level across the timeseries. Similarly, current exploitation rates are estimated at 31.4% of MFMT. Although no historical overfishing has been estimated, the upper confidence limit for exploitation in 2016 exceeded the MFMT. Applying a more conservative candidate reference point of 40%SPR does not change the overall stock status determination. Under this scenario, current SSB is estimated at 3.13 times the MSST-equivalent level ($SSB_{current}/SSB_{F40\%SPR}$), while the current exploitation rate is estimated at 50.2% of $F_{40\%SPR}$. Because a stock-recruitment relationship could not be reliably estimated, candidate MSY-based reference points could not be derived.

Overall, the SEDAR 94 WFS base model provides a statistically stable and biologically reasonable representation of the stock given the quality of available information. However, uncertainty associated with productivity, composition-driven scaling, and unresolved spatial structure remains important. Future improvements in age and CAAL data and spatially resolved monitoring would likely improve assessment performance and reduce key uncertainties.

4.12 WFS Projections

Short- and long-term deterministic projections were conducted to estimate WFS Hogfish spawning stock biomass and yield under a range of harvest scenarios. These were performed under several assumed conditions: growth, and stock-recruitment parameters were kept constant (at values estimated by the SEDAR 94 base model) while fleet allocations, selectivity, and retention associated with the terminal three years (2022 – 2024) would remain the same into the future. The method to project the assessment results was developed in the R statistical computing environment by SEFSC assessment scientists (https://github.com/SEFSC/SFD-AllocationForecasting).

First, long-term deterministic projections were conducted to determine the equilibrium fishing mortality rate that achieves 30%SPR ($F_{30\%SPR}$), as well as the associated spawning stock biomass ($SSB_{30\%SPR}$), by using an iterative process to set fishing mortality rates each year that ensures 1) the MSY_{proxy} (i.e. SPR 30%) is achieved at equilibrium, and 2) annual relative apical fishing mortality between fleets is maintained at the average of the base model's terminal three years (2022 – 2024). This iterative process to achieve equilibrium $F_{30\%SPR}$ is different than the Newton-Raphson method utilized by the base model, thus results will be near-exact rather than identical to base model reference point values (Methot et al. 2026). Projections were for 100 years (2025 – 2124) where recruitment was held constant at the long-term (1986 – 2024) average and that equilibrium was assumed to have been obtained in the final 10 years of the projection (i.e., 2115 – 2124), as recommended by Van Beveren et al. (2021).

Next, short-term deterministic projections, which used a similar iterative process as the long-term projections, were conducted under a range of harvest scenarios and assumed age-0 recruitment remained constant at the recent average (2020 – 2024) estimated by the base model (Schueller et al. 2022; Van Beveren et al. 2021). The first set of short-term projections explored the effects of holding fishing mortality rates constant. The equilibrium $F_{30\%SPR}$ (as determined via the long-term projection above) was applied to produce annual yield values (i.e., the overfishing limit or OFL). Additionally, a constant fishing mortality rate scenario utilizing the $F_{current}$ was conducted.

4.12.1 Results

The projection results for the constant F scenarios including the associated fishing mortality rates, retained landings (in pounds and numbers), spawning stock biomass (mt), and age-0 recruitment (in numbers) as estimated for assessment years (1986 – 2024) and forecast years (2025 – 2044) are presented in Figures 4.70 – 74 and Tables 4.19 – 20. The equilibrium fishing mortality rate that achieved 30% SPR ($F_{30\%SPR}$) in the long-term projections was 0.229 yr^{-1} and was near exact to the base model estimate (0.229 yr^{-1}). Comparable magnitudes and similar to fishing mortality rates estimated earlier in the base model timeseries; however, they are much higher than recent fishing mortality rates ($F_{current}$ = 0.072 yr^{-1}). Retained landings from the long-term constant $F_{30\%SPR}$ projection scenario initially increased to values greater than historical yields, then quickly declined through the 5-yr projection period from 474,501 lbs. (180,733 fish) in 2025 to 228,955 lbs. (98,588 fish) in 2029 (Table 4.19, Figures 4.72 – 73). Spawning stock biomass immediately declined as well (Table 4.19, Figure 4.74) to lowest historic estimates as recruitment followed the stock-recruitment curve (Table 4.19, Figure 4.71).

In the short-term $F_{30\%SPR}$ scenario, retained landings were 474,495 lbs. (180,731 fish) in 2025 and 263,080 lbs. (106,444 fish) in 2029 (Table 4.19, Figures 4.72 – 73). The projected SSB immediately declined and stabilized after 5 years (Table 4.19, Figure 4.74). Short-term projections for the $F_{current}$ scenario estimated much lower F values (i.e., 0.072 yr^{-1}; Table 4.20, Figure 4.70) and resulted in retained landings decreasing to 149,434 lbs. (56,932 fish) in 2025 and 141,303 lbs. (54,238 fish) in 2029 (Table 4.20, Figures 4.72 – 73). Projected SSB remained near recent estimates and was at 1,040 metric tons in 2029

(Table 4.20, Figure 4.74) given the average recruitment assumption (Table 4.20, Figure 4.71). In the 75% $F_{30\%SPR}$ scenario, retained landings were 356,321 lbs. (135,733 fish) in 2025 and 237,315 lbs. (94,204 fish) in 2029 (Table 4.20, Figures 4.72 – 73).

4.12.2 Discussion

As for many projection exercises, there were numerous caveats to the methods, including assumptions of recruitment in future years, unchanging fleet selectivity and fleet allocations, growth, natural mortality, stock-recruitment parameters, and other fixed quantities in the WFS base model. Projection results should, therefore, be interpreted carefully. For example, using a constant mean recruitment in the projections assumes there is no variability in recruitment. This may be reasonable for short-term projections where SSB may be unlikely to decrease rapidly in response to decreases in recruitment, but would be inappropriate for long-term or equilibrium projections.

Historically, the stock has not shown an overfished status nor undergone overfishing according to the WFS base model. The results of the $F_{current}$ scenario appeared more consistent with historic yields, with projected retained yield being more conservative than under the $F_{30\%SPR}$ and 75% $F_{30\%SPR}$ runs. The projected SSB under the $F_{current}$ scenario, appears to decline slightly in the short term and then increases gradually in the long term. The other projection scenarios ($F_{30\%SPR}$, 75% $F_{30\%SPR}$) show more dramatic rising retention yields along with declines in SSB within the short term to achieve the goal of the projection. Nevertheless, of the constant F scenarios provided here and as requested by the TORs, the $F_{current}$ scenario is the most conservative followed by 75% $F_{30\%SPR}$.

4.13 WFS Tables

Table 4.1. Historic commercial landings (metric tons) and annual CVs of West Florida Shelf Hogfish by gear for years 1950 – 1985.

	Landings (mt)				
Year	Spear	Hook-and-line	Trap	Combined	CV
1950	0.000	1.588	0.000	1.588	0.25
1951	0.000	3.765	0.000	3.765	0.25
1952	0.000	7.031	0.000	7.031	0.25
1953	0.000	4.400	0.000	4.400	0.25
1954	0.000	2.177	0.000	2.177	0.25
1955	0.000	3.266	0.000	3.266	0.25
1956	0.000	5.851	0.000	5.851	0.25
1957	0.000	13.880	0.000	13.880	0.25
1958	0.000	8.981	0.000	8.981	0.25
1959	0.000	6.260	0.000	6.260	0.25
1960	0.000	8.029	0.000	8.029	0.25
1961	0.000	16.012	0.000	16.012	0.25
1962	0.000	6.396	0.000	6.396	0.20
1963	0.000	5.851	0.000	5.851	0.20
1964	0.000	4.763	0.000	4.763	0.20
1965	0.000	4.082	0.000	4.082	0.20
1966	0.000	5.443	0.000	5.443	0.20
1967	0.000	2.722	0.000	2.722	0.20
1968	0.000	7.983	0.000	7.983	0.20
1969	0.000	4.899	0.000	4.899	0.20
1970	0.000	6.804	0.000	6.804	0.20
1971	0.000	6.078	0.000	6.078	0.20
1972	0.000	5.625	0.000	5.625	0.20
1973	0.000	2.540	0.000	2.540	0.20
1974	0.000	3.992	0.000	3.992	0.20
1975	0.000	6.214	0.000	6.214	0.20
1976	0.000	5.080	0.000	5.080	0.20
1977	0.000	14.901	0.000	14.901	0.20
1978	0.000	16.997	0.000	16.997	0.10
1979	0.000	21.815	0.000	21.815	0.10
1980	0.000	21.160	0.000	21.160	0.10
1981	0.000	20.166	0.000	20.166	0.10
1982	0.000	13.572	0.000	13.572	0.10
1983	0.000	14.698	0.000	14.698	0.10
1984	0.000	16.712	0.000	16.712	0.10
1985	0.000	19.302	0.000	19.302	0.10

Table 4.2. Historic commercial landings (numbers) and annual CVs of West Florida Shelf Hogfish by gear for years 1950 – 1985.

	Landings (numbers)				
Year	Spear	Hook-and-line	Trap	Combined	CV
1950	0	899	0	899	0.25
1951	0	2,131	0	2,131	0.25
1952	0	3,980	0	3,980	0.25
1953	0	2,491	0	2,491	0.25
1954	0	1,233	0	1,233	0.25
1955	0	1,849	0	1,849	0.25
1956	0	3,313	0	3,313	0.25
1957	0	7,858	0	7,858	0.25
1958	0	5,085	0	5,085	0.25
1959	0	3,544	0	3,544	0.25
1960	0	4,545	0	4,545	0.25
1961	0	9,065	0	9,065	0.25
1962	0	3,621	0	3,621	0.2
1963	0	3,313	0	3,313	0.2
1964	0	2,696	0	2,696	0.2
1965	0	2,311	0	2,311	0.2
1966	0	3,082	0	3,082	0.2
1967	0	1,541	0	1,541	0.2
1968	0	4,520	0	4,520	0.2
1969	0	2,773	0	2,773	0.2
1970	0	3,852	0	3,852	0.2
1971	0	3,441	0	3,441	0.2
1972	0	3,184	0	3,184	0.2
1973	0	1,438	0	1,438	0.2
1974	0	2,260	0	2,260	0.2
1975	0	3,518	0	3,518	0.2
1976	0	2,876	0	2,876	0.2
1977	0	8,437	0	8,437	0.2
1978	0	9,623	0	9,623	0.1
1979	0	12,351	0	12,351	0.1
1980	0	11,980	0	11,980	0.1
1981	0	11,417	0	11,417	0.1
1982	0	7,684	0	7,684	0.1
1983	0	8,321	0	8,321	0.1
1984	0	9,461	0	9,461	0.1
1985	0	10,928	0	10,928	0.1

Table 4.3. Commercial landings (metric tons) and annual CVs of West Florida Shelf Hogfish by gear for years 1986 – 2024.

	Landings (mt)				
Year	Spear	Hook-and-line	Trap	Combined	CV
1986	0.000	3.009	0.000	3.009	0.05
1987	0.000	4.353	0.000	4.353	0.05
1988	0.000	5.267	0.000	5.267	0.05
1989	0.000	14.203	0.000	14.203	0.05
1990	2.044	15.638	0.528	18.210	0.05
1991	1.938	14.831	0.501	17.269	0.05
1992	3.433	7.510	1.319	12.263	0.05
1993	4.075	10.398	4.761	19.234	0.05
1994	4.634	7.109	2.293	14.036	0.05
1995	2.937	4.113	0.783	7.832	0.05
1996	3.813	2.831	1.084	7.728	0.05
1997	4.101	2.751	1.821	8.673	0.05
1998	3.184	1.289	1.445	5.918	0.05
1999	2.232	2.140	1.569	5.942	0.05
2000	3.530	4.015	0.840	8.384	0.05
2001	5.659	3.121	1.271	10.051	0.05
2002	7.990	2.348	1.630	11.969	0.05
2003	7.351	2.609	0.604	10.563	0.05
2004	8.088	0.970	0.354	9.412	0.05
2005	5.993	1.226	0.011	7.229	0.05
2006	5.415	0.543	0.001	5.959	0.05
2007	6.226	0.785	0.001	7.011	0.05
2008	9.221	0.952	0.000	10.173	0.05
2009	12.436	1.283	0.000	13.719	0.05
2010	12.700	2.430	0.065	15.195	0.05
2011	17.385	2.508	0.009	19.902	0.05
2012	16.864	1.767	0.000	18.630	0.05
2013	8.619	1.148	0.039	9.807	0.05
2014	14.976	0.670	0.070	15.716	0.05
2015	10.440	1.712	0.019	12.171	0.05
2016	11.204	1.644	0.192	13.040	0.05
2017	6.967	0.343	0.170	7.480	0.05
2018	4.547	0.221	0.070	4.838	0.05
2019	4.321	0.397	0.034	4.752	0.05
2020	3.707	0.149	0.018	3.874	0.05
2021	4.744	0.201	0.000	4.945	0.05
2022	3.953	0.030	0.004	3.987	0.05
2023	3.739	0.210	0.003	3.952	0.05
2024	3.061	0.266	0.000	3.327	0.05

Table 4.4. Commercial landings (numbers) and annual CVs of West Florida Shelf Hogfish by gear for years 1986 – 2024.

Landings (numbers)

Year	Spear	Hook-and-line	Trap	Combined	CV
1986	0	1,704	0	1,704	0.05
1987	0	2,465	0	2,465	0.05
1988	0	2,982	0	2,982	0.05
1989	0	8,041	0	8,041	0.05
1990	1,157	8,854	299	10,310	0.05
1991	1,097	8,397	284	9,777	0.05
1992	1,944	4,252	747	6,943	0.05
1993	2,307	5,887	2,695	10,889	0.05
1994	2,624	4,025	1,298	7,946	0.05
1995	1,663	2,329	443	4,434	0.05
1996	2,159	1,603	614	4,375	0.05
1997	2,322	1,558	1,031	4,910	0.05
1998	1,803	730	818	3,351	0.05
1999	1,264	1,212	888	3,364	0.05
2000	1,999	2,273	475	4,747	0.05
2001	3,204	1,767	719	5,690	0.05
2002	4,524	1,329	923	6,776	0.05
2003	4,162	1,477	342	5,981	0.05
2004	4,579	549	201	5,329	0.05
2005	3,393	694	6	4,093	0.05
2006	3,066	307	0	3,374	0.05
2007	3,525	444	0	3,969	0.05
2008	5,220	539	0	5,760	0.05
2009	7,041	727	0	7,767	0.05
2010	7,190	1,376	37	8,603	0.05
2011	9,843	1,420	5	11,268	0.05
2012	9,547	1,000	0	10,548	0.05
2013	4,880	650	22	5,552	0.05
2014	8,479	380	40	8,898	0.05
2015	5,911	969	11	6,891	0.05
2016	6,343	930	109	7,383	0.05
2017	5,011	247	122	5,380	0.05
2018	3,270	159	50	3,480	0.05
2019	3,108	286	24	3,418	0.05
2020	2,667	107	13	2,786	0.05
2021	3,412	145	0	3,557	0.05
2022	2,843	21	3	2,868	0.05
2023	2,690	151	2	2,843	0.05
2024	2,202	191	0	2,393	0.05

Table 4.5. Recreational landings (numbers) of West Florida Shelf Hogfish by gear for years 1981 – 2024 and annual CVs. The 'Full SRFS' estimates are comprised of 'SRFS & SRFS-calibrated Private' mode, MRIP charter mode, and MRIP shore mode landings estimates. 'SRFS & SRFS-calibrated Private' estimates are comprised of SRFS private mode (2021 – 2024) and SRFS ratio-calibrated MRIP private mode (1981 – 2020). The 'Full SRFS Combined' is comprised of the 'Full SRFS' estimates plus the SRHS estimates.

Landings (thousands)

Year	Full SRFS Spear	CV	Full SRFS HL	CV	SRHS HL	CV	Full SRFS Combined	CV
1981	20.604	0.82	5.868	1.03	-	-	26.472	0.70
1982	6.002	0.71	-	-	-	-	6.002	0.71
1983	9.067	0.77	-	-	-	-	9.067	0.77
1984	-	-	-	-	-	-	-	-
1985	-	-	-	-	-	-	-	-
1986	23.356	0.71	2.422	1.00	0.117	0.05	25.213	0.66
1987	46.376	0.60	1.366	1.03	0.034	0.05	46.065	0.60
1988	8.216	0.55	1.467	1.03	0.187	0.05	27.229	0.41
1989	45.383	0.60	6.878	1.03	0.041	0.05	50.838	0.57
1990	12.833	0.87	14.102	1.03	0.147	0.05	27.081	0.70
1991	65.255	0.51	-	-	0.094	0.05	67.592	0.51
1992	20.351	0.82	7.446	0.49	0.213	0.05	35.906	0.56
1993	35.225	0.49	6.577	0.56	0.167	0.05	41.969	0.44
1994	15.482	0.51	9.242	0.51	0.654	0.05	25.379	0.41
1995	29.364	0.53	15.682	0.51	0.465	0.05	47.802	0.41
1996	9.644	0.51	5.077	0.59	0.013	0.05	14.734	0.43
1997	23.000	0.44	11.721	0.60	0.007	0.05	34.728	0.37
1998	27.914	0.42	14.008	0.48	0.025	0.05	37.662	0.36
1999	39.848	0.36	5.115	0.46	0.040	0.05	44.776	0.34
2000	10.043	0.69	12.749	0.47	0.066	0.05	22.859	0.44
2001	30.948	0.52	16.345	0.56	0.057	0.05	47.351	0.41
2002	12.837	0.72	8.948	0.60	0.061	0.05	21.846	0.51
2003	25.289	0.42	29.925	0.48	0.080	0.05	55.295	0.37
2004	42.874	0.54	0.772	0.82	0.053	0.05	43.699	0.53
2005	21.050	0.71	5.304	0.61	0.123	0.05	26.477	0.60
2006	17.784	0.56	10.299	1.02	0.041	0.05	28.124	0.54
2007	27.078	0.53	7.878	0.52	0.076	0.05	35.032	0.44
2008	82.396	0.41	17.076	0.48	0.061	0.05	99.533	0.36
2009	42.329	0.40	11.959	0.48	0.125	0.05	54.413	0.36
2010	94.188	0.42	17.569	0.56	0.430	0.05	112.187	0.39
2011	34.618	0.40	15.892	0.58	2.945	0.05	53.454	0.36
2012	68.411	0.41	12.090	0.63	4.137	0.05	84.638	0.39
2013	89.371	0.53	20.967	0.93	1.975	0.05	112.312	0.49
2014	29.422	0.35	29.323	0.49	2.030	0.05	60.775	0.34
2015	35.510	0.55	14.137	0.48	1.272	0.05	50.919	0.44
2016	103.807	0.48	36.993	0.46	2.553	0.05	143.353	0.39
2017	31.308	0.44	24.370	0.42	2.155	0.05	57.833	0.35
2018	19.476	0.52	15.937	0.31	1.405	0.05	36.817	0.33
2019	14.327	0.41	17.771	0.37	1.645	0.05	33.743	0.33
2020	15.351	0.62	19.041	0.36	1.622	0.05	36.014	0.37
2021	4.786	0.40	28.598	0.23	2.331	0.05	39.391	0.19
2022	13.759	0.53	18.279	0.28	2.168	0.05	36.391	0.26
2023	18.477	0.32	65.229	0.30	2.730	0.05	110.206	0.13
2024	12.064	0.30	43.949	0.21	2.121	0.05	56.686	0.12

Table 4.6. Recreational discards (numbers) of West Florida Shelf Hogfish by gear for years 1981 – 2024 and annual CVs. The 'Full SRFS' estimates are comprised of 'SRFS & SRFS-calibrated Private' mode, MRIP charter mode, and MRIP shore mode landings estimates. 'SRFS & SRFS-calibrated Private' estimates are comprised of SRFS private mode (2021 – 2024) and SRFS ratio-calibrated MRIP private mode (1981 – 2020). The 'Full SRFS Combined' is comprised of the 'Full SRFS' estimates plus the SRHS estimates.

Discards (thousands)

Year	Full SRFS Spear	CV	Full SRFS HL	CV	SRHS HL	CV	Full SRFS Combined	CV
1981	-	-	-	-	-	-	-	-
1982	-	-	-	-	-	-	-	-
1983	-	-	-	-	-	-	-	-
1984	-	-	-	-	-	-	-	-
1985	-	-	-	-	-	-	-	-
1986	-	-	-	-	-	-	-	-
1987	-	-	3.528	1.06	-	-	3.528	1.06
1988	-	-	-	-	-	-	-	-
1989	-	-	1.794	1.06	-	-	1.794	1.06
1990	-	-	-	-	-	-	-	-
1991	-	-	-	-	-	-	-	-
1992	-	-	2.337	1.06	-	-	2.337	1.06
1993	-	-	-	-	-	-	-	-
1994	-	-	-	-	-	-	-	-
1995	-	-	3.758	0.77	-	-	3.758	0.77
1996	-	-	9.260	0.74	-	-	9.260	0.74
1997	-	-	0.392	1.06	-	-	0.392	1.06
1998	-	-	10.981	0.68	-	-	6.686	0.71
1999	-	-	5.012	0.93	-	-	5.012	0.93
2000	-	-	0.895	1.06	-	-	0.895	1.06
2001	-	-	-	-	-	-	-	-
2002	-	-	0.363	1.06	-	-	0.363	1.06
2003	-	-	0.498	1.06	-	-	0.498	1.06
2004	-	-	0.805	1.06	0.003	0.50	0.808	1.06
2005	-	-	2.939	0.79	0.099	0.50	3.038	0.79
2006	-	-	1.901	0.89	0.093	0.50	1.994	0.89
2007	-	-	0.549	1.00	0.012	0.50	0.561	1.00
2008	-	-	8.127	0.68	0.005	0.50	8.132	0.68
2009	-	-	4.420	0.59	0.006	0.50	4.426	0.59
2010	-	-	6.771	0.72	0.022	0.50	6.793	0.72
2011	-	-	0.781	1.06	0.402	0.50	1.183	1.06
2012	-	-	-	-	0.522	0.50	-	-
2013	2.072	0.83	1.587	0.90	0.126	0.50	3.785	0.66
2014	-	-	7.857	0.79	0.128	0.50	7.985	0.79
2015	-	-	0.970	0.63	0.282	0.50	1.252	0.63
2016	-	-	12.875	0.70	0.487	0.50	13.362	0.71
2017	-	-	21.632	0.51	0.777	0.50	22.409	0.51
2018	-	-	25.932	0.41	1.857	0.50	27.789	0.41
2019	-	-	25.941	0.55	2.621	0.50	28.562	0.55
2020	-	-	25.727	0.37	2.393	0.50	28.120	0.38
2021	0.673	1.51	49.466	0.23	4.001	0.50	57.565	0.22
2022	-	-	36.934	0.33	3.587	0.50	40.530	0.33
2023	-	-	112.544	0.35	3.786	0.50	146.228	0.28
2024	-	-	52.939	0.23	2.452	0.50	56.550	0.23

Table 4.7. Historical reconstruction of recreational landings (Full SRFS Combined) of West Florida Shelf Hogfish from 1950 – 1980. The estimated number of saltwater angler participants in Florida was multiplied by the ratio 0.023903 to obtain the estimated number of participants within the West Florida Shelf region. The number of participants was then multiplied by the average catch/number of participants from years 1981 – 1985 (CPUE = 0.929120) to reconstruct the number of landings.

	Number of Saltwater Anglers		Reconstructed Landings (numbers)
Year	Florida	West Florida Shelf	West Florida Shelf
1950	265,900	6,356	5,905
1951	274,187	6,554	6,089
1952	282,475	6,752	6,273
1953	290,762	6,950	6,457
1954	299,049	7,148	6,642
1955	307,337	7,346	6,826
1956	315,624	7,544	7,010
1957	323,911	7,742	7,194
1958	332,199	7,941	7,378
1959	365,676	8,741	8,121
1960	374,577	8,954	8,319
1961	414,720	9,913	9,210
1962	391,199	9,351	8,688
1963	399,699	9,554	8,877
1964	418,956	10,014	9,304
1965	442,416	10,575	9,825
1966	453,819	10,848	10,079
1967	493,510	11,796	10,960
1968	496,090	11,858	11,018
1969	521,289	12,460	11,577
1970	562,752	13,451	12,498
1971	705,592	16,866	15,670
1972	731,204	17,478	16,239
1973	772,865	18,474	17,164
1974	834,392	19,944	18,531
1975	870,670	20,812	19,336
1976	821,995	19,648	18,255
1977	739,438	17,675	16,422
1978	667,847	15,964	14,832
1979	716,261	17,121	15,907
1980	588,882	14,076	13,078

Table 4.8. Indices of relative biomass or abundance values and associated CVs for West Florida Shelf Hogfish from years 2006 – 2024.

	Seagrass Trawl		SEAMAP Trawl		Combined Video	
Year	Index	CV	Index	CV	Index	CV
2006	-	-	-	-	1.111	0.20
2007	-	-	-	-	1.989	0.25
2008	2.060	0.13	-	-	1.860	0.20
2009	0.718	0.24	-	-	1.699	0.19
2010	0.526	0.23	0.828	0.28	0.733	0.24
2011	0.888	0.16	0.423	0.45	0.809	0.14
2012	2.736	0.11	0.955	0.26	1.120	0.14
2013	0.182	0.37	0.506	0.36	0.822	0.22
2014	0.047	0.68	0.376	0.27	0.617	0.16
2015	0.227	0.36	0.608	0.25	0.703	0.18
2016	0.459	0.22	0.513	0.38	0.75	0.14
2017	0.629	0.20	0.714	0.29	0.678	0.11
2018	2.301	0.13	0.39	0.31	0.811	0.12
2019	0.355	0.20	1.329	0.29	0.743	0.15
2020	1.028	0.21	1.488	0.46	0.893	0.12
2021	3.393	0.08	0.805	0.38	0.723	0.12
2022	0.204	0.24	1.108	0.31	0.947	0.11
2023	1.028	0.14	3.043	0.26	0.999	0.11
2024	0.221	0.30	1.916	0.26	0.992	0.11

Table 4.9. Francis weights applied to length and conditional age-at-length data of the SEDAR 94 WFS base model.

Data Type	Fleet/Index	SEDAR 94 WFS Base Francis Weights
Length Composition	Commercial	0.687077
	Recreational Hook & Line	2.47439
	Recreational Spear	1.27651
	SEAMAP Trawl	0.811778
	Combined Video	0.240563
Conditional Age-at-length	SEAMAP Trawl	0.726728
	FI_LHR_SP	0.690107

Table 4.10. List of Stock Synthesis parameters for the SEDAR 94 WFS base model. The list includes expected parameter values (Value), lower (Min) and upper (Max) bounds of the parameters, associated standard deviation (Std Dev) and coefficients of variation (CV), prior type (Prior), and the phase (Phase) of estimation. Parameters designated as fixed were held at their initial values and have no associated range or SE.

Parameter Label	Value	Min	Max	Std Dev	CV	Prior	Phase
NatM_Lorenzen_averageFem_GP_1	0.235	0.01	1				Fixed
L_at_Amin_Fem_GP_1	7.617	2	20	0.618	0.081		3
L_at_Amax_Fem_GP_1	89.580	20	130	7.610	0.085		3
VonBert_K_Fem_GP_1	0.083	0.01	0.9	0.013	0.150		4
CV_young_Fem_GP_1	0.526	0.05	0.9	0.068	0.130		7
CV_old_Fem_GP_1	0.163	0.05	0.9	0.046	0.280		7
Wtlen_1_Fem_GP_1	0.000	-3	3				Fixed
Wtlen_2_Fem_GP_1	2.927	-3	4				Fixed
Mat50%_Fem_GP_1	1.090	1	4				Fixed
Mat_slope_Fem_GP_1	-5.450	-6	-0.1				Fixed
Eggs_scalar_Fem_GP_1	1.000	-3	3				Fixed
Eggs_exp_wt_Fem_GP_1	1.000	-3	3				Fixed
NatM_Lorenzen_averageMal_GP_1	0.000	-1	1				Fixed
L_at_Amin_Mal_GP_1	0.000	-1	1				Fixed
L_at_Amax_Mal_GP_1	0.000	-1	1				Fixed
VonBert_K_Mal_GP_1	0.000	-1	1				Fixed
CV_young_Mal_GP_1	0.000	-1	1				Fixed
CV_old_Mal_GP_1	0.000	-1	1				Fixed
Wtlen_1_Mal_GP_1	0.000	-3	3				Fixed
Wtlen_2_Mal_GP_1	2.927	-3	4				Fixed
Herm_Infl_age	8.410	1	11				Fixed
Herm_stdev	4.180	1	5				Fixed
Herm_asymptote	0.999	0.01	1				Fixed
CohortGrowDev	1.000	0	1				Fixed
Platoon_SD_Ratio	0.853	0.1	3	0.317	0.372		1
FracFemale_GP_1	1.000	0	1				Fixed
SR_LN(R0)	7.651	2	20	0.212	0.028		1
SR_BH_steep	0.990	0.3	0.99				Fixed
SR_sigmaR	0.726	0.1	2	0.092	0.127		7
SR_regime	0.000	-5	5				Fixed
SR_autocorr	0.000	0	0				Fixed
SR_regime_BLK2repl_1985	-0.076	-5	5	0.155	-2.048		3
Main_RecrDev_1986	0.651	-4	4	0.313	0.480		3
Main_RecrDev_1987	-0.502	-4	4	0.444	-0.885		3
Main_RecrDev_1988	-0.203	-4	4	0.360	-1.769		3
Main_RecrDev_1989	0.433	-4	4	0.244	0.564		3
Main_RecrDev_1990	-0.159	-4	4	0.291	-1.827		3
Main_RecrDev_1991	-0.578	-4	4	0.304	-0.526		3
Main_RecrDev_1992	-0.344	-4	4	0.250	-0.727		3
Main_RecrDev_1993	-1.146	-4	4	0.297	-0.259		3
Main_RecrDev_1994	-0.566	-4	4	0.235	-0.415		3
Main_RecrDev_1995	-0.593	-4	4	0.236	-0.398		3
Main_RecrDev_1996	0.653	-4	4	0.168	0.256		3
Main_RecrDev_1997	0.000	-4	4	0.226	1220.707		3
Main_RecrDev_1998	-0.862	-4	4	0.360	-0.418		3
Main_RecrDev_1999	1.479	-4	4	0.142	0.096		3
Main_RecrDev_2000	0.107	-4	4	0.224	2.092		3
Main_RecrDev_2001	-0.197	-4	4	0.236	-1.196		3
Main_RecrDev_2002	0.240	-4	4	0.191	0.797		3
Main_RecrDev_2003	-0.703	-4	4	0.273	-0.389		3
Main_RecrDev_2004	-0.150	-4	4	0.215	-1.433		3
Main_RecrDev_2005	1.018	-4	4	0.176	0.173		3
Main_RecrDev_2006	1.464	-4	4	0.179	0.122		3
Main_RecrDev_2007	0.314	-4	4	0.297	0.944		3
Main_RecrDev_2008	0.807	-4	4	0.123	0.152		3
Main_RecrDev_2009	-0.363	-4	4	0.179	-0.493		3
Main_RecrDev_2010	-0.530	-4	4	0.178	-0.336		3
Main_RecrDev_2011	0.362	-4	4	0.131	0.361		3
Main_RecrDev_2012	0.819	-4	4	0.101	0.124		3
Main_RecrDev_2013	-0.579	-4	4	0.195	-0.338		3

Main_RecrDev_2014	-0.801	-4	4	0.264	-0.329		3
Main_RecrDev_2015	0.061	-4	4	0.186	3.036		3
Main_RecrDev_2016	-0.304	-4	4	0.175	-0.577		3
Main_RecrDev_2017	-0.141	-4	4	0.168	-1.192		3
Main_RecrDev_2018	0.820	-4	4	0.116	0.141		3
Main_RecrDev_2019	-0.234	-4	4	0.173	-0.741		3
Main_RecrDev_2020	0.126	-4	4	0.170	1.351		3
Main_RecrDev_2021	1.423	-4	4	0.093	0.065		3
Main_RecrDev_2022	-1.201	-4	4	0.230	-0.192		3
Main_RecrDev_2023	0.383	-4	4	0.145	0.379		3
Main_RecrDev_2024	-1.004	-4	4	0.291	-0.290		3
LnQ_base_SEAGRASS_TW(4)	-7.627	-18	5				Fixed
LnQ_base_SEAMAP_TW(5)	-6.816	-18	5				Fixed
LnQ_base_COMB_VIDEO(6)	-6.908	-18	5				Fixed
Size_DblN_peak_COM(1)	55.213	15	70	1.530	0.028		3
Size_DblN_top_logit_COM(1)	-2.927	-15	15	0.806	-0.275		4
Size_DblN_ascend_se_COM(1)	5.645	0.01	15	0.177	0.031		3
Size_DblN_descend_se_COM(1)	1.248	0.01	15	1.320	1.057	Sym_Beta	5
Size_DblN_start_logit_COM(1)	-999.000	-15	15				Fixed
Size_DblN_end_logit_COM(1)	-0.398	-15	15	0.408	-1.027		3
Size_DblN_peak_REC_HL(2)	38.900	15	70	1.513	0.039		3
Size_DblN_top_logit_REC_HL(2)	-12.511	-15	15	43.508	-3.477		4
Size_DblN_ascend_se_REC_HL(2)	5.189	0.01	15	0.253	0.049		5
Size_DblN_descend_se_REC_HL(2)	4.391	0.01	15	0.111	0.025		5
Size_DblN_start_logit_REC_HL(2)	-999.000	-15	15				Fixed
Size_DblN_end_logit_REC_HL(2)	-999.000	-15	15				Fixed
Retain_L_infl_REC_HL(2)	27.128	10	50	0.856	0.032		3
Retain_L_width_REC_HL(2)	1.955	0.01	15	0.486	0.249		4
Retain_L_asymptote_logit_REC_HL(2)	5.490	-15	15	0.811	0.148		5
Retain_L_maleoffset_REC_HL(2)	0.000	-1	1				Fixed
DiscMort_L_infl_REC_HL(2)	0.100	0	1				Fixed
DiscMort_L_width_REC_HL(2)	0.100	0	1				Fixed
DiscMort_L_level_old_REC_HL(2)	0.414	0	1				Fixed
DiscMort_L_male_offset_REC_HL(2)	0.000	-1	2				Fixed
Size_DblN_peak_REC_SP(3)	36.665	15	70	1.312	0.036		3
Size_DblN_top_logit_REC_SP(3)	-3.154	-15	15	0.731	-0.232		4
Size_DblN_ascend_se_REC_SP(3)	4.227	0.01	15	0.208	0.049		3
Size_DblN_descend_se_REC_SP(3)	4.084	0.01	15	0.244	0.060		5
Size_DblN_start_logit_REC_SP(3)	-999.000	-15	15				Fixed
Size_DblN_end_logit_REC_SP(3)	-999.000	-15	15				Fixed
Size_DblN_peak_SEAMAP_TW(5)	23.229	10	50	1.011	0.044		3
Size_DblN_top_logit_SEAMAP_TW(5)	-10.809	-15	15	62.201	-5.754		4
Size_DblN_ascend_se_SEAMAP_TW(5)	3.783	0.01	15	0.216	0.057		3
Size_DblN_descend_se_SEAMAP_TW(5)	4.324	0.01	15	0.394	0.091		5
Size_DblN_start_logit_SEAMAP_TW(5)	-999.000	-15	15				Fixed
Size_DblN_end_logit_SEAMAP_TW(5)	-2.931	-15	15	0.698	-0.238		3
Size_inflection_COMB_VIDEO(6)	21.156	15	40	0.855	0.040		3
Size_95%width_COMB_VIDEO(6)	5.152	0.01	15	0.988	0.192		4
Size_DblN_peak_COM(1)_BLK1repl_2000	35.594	15	70	1.948	0.055		3
Size_DblN_peak_COM(1)_BLK1repl_2018	36.286	15	70	1.816	0.050		3
Size_DblN_ascend_se_COM(1)_BLK1repl_2000	2.867	0.01	15	0.648	0.226		5
Size_DblN_ascend_se_COM(1)_BLK1repl_2018	1.883	0.01	15	1.115	0.592	Sym_Beta	5
Size_DblN_peak_REC_HL(2)_BLK1repl_2000	36.193	15	70	0.640	0.018		3
Size_DblN_peak_REC_HL(2)_BLK1repl_2018	33.036	15	70	0.504	0.015		3
Size_DblN_ascend_se_REC_HL(2)_BLK1repl_2000	3.981	0.01	15	0.124	0.031		5
Size_DblN_ascend_se_REC_HL(2)_BLK1repl_2018	3.335	0.01	15	0.114	0.034		5
Retain_L_infl_REC_HL(2)_BLK1repl_2000	29.077	10	50	0.231	0.008		3
Retain_L_infl_REC_HL(2)_BLK1repl_2018	34.649	10	50	0.144	0.004		3
Retain_L_width_REC_HL(2)_BLK1repl_2000	1.166	0.01	10	0.166	0.143		4
Retain_L_width_REC_HL(2)_BLK1repl_2018	1.089	0.01	10	0.080	0.073		4
Size_DblN_peak_REC_SP(3)_BLK1repl_2000	36.506	15	70	1.083	0.030		3
Size_DblN_peak_REC_SP(3)_BLK1repl_2018	35.682	15	70	0.979	0.027		3
Size_DblN_ascend_se_REC_SP(3)_BLK1repl_2000	3.493	0.01	15	0.242	0.069		5
Size_DblN_ascend_se_REC_SP(3)_BLK1repl_2018	1.581	0.01	15	0.603	0.382		5

Table 4.11. Predicted total biomass (metric tons, pounds), spawning stock biomass (SSB; metric tons, pounds), age 1+ abundance (1000s of fish), age-0 recruits (1000s of fish), and depletion (SSB/SSB_0) for West Florida Shelf Hogfish. Virgin is the estimated unfished condition while Initial is the estimated initial conditions of the stock before the model start year.

Year	Biomass (mt)	Biomass (lbs.)	SSB (mt)	SSB (lbs.)	Age-1+ Abundance (000s)	Age-0 Recruits (000s)	B/B_0	SSB/SSB_0
Virgin	1,814	3,998,502	1,740	3,835,933	2,188	2,103	1.000	1.000
Initial	1,682	3,707,073	1,613	3,556,365	2,028	1,950	0.927	0.927
1986	1,703	3,754,230	1,613	3,556,365	2,028	3,318	0.939	0.927
1987	1,678	3,699,842	1,598	3,522,789	2,559	1,042	0.925	0.918
1988	1,622	3,575,567	1,579	3,481,275	1,887	1,398	0.894	0.908
1989	1,612	3,553,962	1,544	3,403,805	1,735	2,627	0.889	0.887
1990	1,541	3,398,073	1,468	3,236,629	2,101	1,445	0.850	0.844
1991	1,482	3,268,088	1,439	3,172,827	1,807	946	0.817	0.827
1992	1,379	3,039,271	1,341	2,957,457	1,435	1,189	0.760	0.771
1993	1,303	2,872,204	1,272	2,803,178	1,360	530	0.718	0.731
1994	1,200	2,645,569	1,175	2,589,947	1,024	942	0.662	0.675
1995	1,118	2,465,518	1,086	2,394,044	1,019	912	0.617	0.624
1996	1,054	2,324,003	987	2,175,883	968	3,165	0.581	0.567
1997	1,045	2,303,522	958	2,112,793	1,866	1,647	0.576	0.551
1998	1,014	2,234,870	970	2,139,452	1,686	696	0.559	0.558
1999	1,076	2,371,402	949	2,092,072	1,236	7,222	0.593	0.545
2000	1,139	2,512,145	973	2,144,278	3,650	1,833	0.628	0.559
2001	1,212	2,672,532	1,154	2,543,848	2,699	1,353	0.668	0.663
2002	1,249	2,754,213	1,190	2,623,721	2,098	2,095	0.689	0.684
2003	1,271	2,802,208	1,218	2,684,856	2,115	816	0.701	0.700
2004	1,239	2,730,579	1,200	2,645,900	1,562	1,418	0.683	0.690
2005	1,250	2,756,109	1,152	2,538,645	1,525	4,559	0.689	0.662
2006	1,363	3,004,438	1,164	2,565,674	2,764	7,127	0.751	0.669
2007	1,478	3,258,697	1,305	2,877,407	4,420	2,258	0.815	0.750
2008	1,602	3,531,056	1,499	3,303,715	3,334	3,696	0.883	0.861
2009	1,621	3,573,296	1,532	3,376,468	3,400	1,147	0.894	0.880
2010	1,628	3,588,508	1,589	3,504,204	2,426	971	0.897	0.914
2011	1,549	3,414,299	1,493	3,290,950	1,818	2,369	0.854	0.858
2012	1,533	3,378,738	1,429	3,149,325	2,074	3,740	0.845	0.821
2013	1,452	3,200,164	1,365	3,009,067	2,695	925	0.800	0.784
2014	1,327	2,925,071	1,296	2,858,095	1,841	740	0.732	0.745
2015	1,261	2,779,787	1,219	2,687,567	1,384	1,752	0.695	0.701
2016	1,199	2,642,527	1,146	2,526,255	1,547	1,216	0.661	0.659
2017	1,021	2,249,972	974	2,148,268	1,308	1,430	0.563	0.560
2018	994	2,190,339	907	2,000,448	1,322	3,737	0.548	0.522
2019	988	2,178,445	896	1,975,075	2,264	1,303	0.545	0.515
2020	996	2,195,198	940	2,073,426	1,757	1,867	0.549	0.541
2021	1,082	2,385,732	939	2,070,641	1,763	6,834	0.597	0.540
2022	1,141	2,516,114	1,002	2,209,781	3,766	496	0.629	0.576
2023	1,206	2,658,422	1,156	2,549,139	2,227	2,432	0.665	0.665
2024	1,163	2,563,866	1,107	2,439,834	2,245	614	0.641	0.636

Table 4.12. Annual exploitation rates on West Florida Shelf Hogfish combined across all fleets as well as annual estimates of instantaneous apical fishing mortality rates by fleet. Apical fishing mortality rates represent the instantaneous fishing mortality level on the most vulnerable age class for each fleet.

Year	Exploitation (Biomass)	Commercial	Recreational Hook-and-line	Recreational Spear
1986	0.0176	0.0038	0.0068	0.0605
1987	0.0306	0.0057	0.0037	0.1190
1988	0.0094	0.0070	0.0043	0.0205
1989	0.0430	0.0191	0.0189	0.1207
1990	0.0310	0.0255	0.0420	0.0366
1991	0.0554	0.0255	0.0003	0.1924
1992	0.0302	0.0191	0.0249	0.0646
1993	0.0486	0.0314	0.0246	0.1257
1994	0.0351	0.0245	0.0415	0.0641
1995	0.0522	0.0149	0.0810	0.1451
1996	0.0234	0.0161	0.0290	0.0535
1997	0.0418	0.0195	0.0627	0.1155
1998	0.0444	0.0141	0.0607	0.1137
1999	0.0494	0.0143	0.0205	0.1499
2000	0.0290	0.0205	0.0577	0.0441
2001	0.0479	0.0209	0.0508	0.0956
2002	0.0285	0.0218	0.0239	0.0338
2003	0.0563	0.0189	0.0842	0.0694
2004	0.0483	0.0174	0.0026	0.1322
2005	0.0320	0.0140	0.0201	0.0751
2006	0.0300	0.0119	0.0410	0.0678
2007	0.0299	0.0130	0.0249	0.0831
2008	0.0715	0.0160	0.0393	0.1881
2009	0.0441	0.0196	0.0251	0.0869
2010	0.0850	0.0212	0.0386	0.1983
2011	0.0530	0.0291	0.0472	0.0842
2012	0.0792	0.0299	0.0508	0.2058
2013	0.0946	0.0175	0.0835	0.3138
2014	0.0617	0.0289	0.1108	0.1020
2015	0.0554	0.0229	0.0571	0.1287
2016	0.1488	0.0281	0.1882	0.4779
2017	0.0717	0.0187	0.1536	0.1761
2018	0.0585	0.0135	0.2075	0.1584
2019	0.0538	0.0138	0.2280	0.1153
2020	0.0553	0.0108	0.1955	0.1010
2021	0.0579	0.0130	0.2563	0.0275
2022	0.0459	0.0102	0.1603	0.0745
2023	0.1101	0.0091	0.4198	0.0797
2024	0.0738	0.0072	0.2650	0.0481

Table 4.13. Index root mean square error (RMSE) values from the SEDAR 94 WFS base model (Base), the age-structured production model (ASPM), and the ASPM with estimated recruitment deviations (ASPMdev).

Fleet/Survey	Base	ASPM	ASPMdev
Seagrass Trawl Survey	0.672	1.407	0.450
SEAMAP Trawl Survey	0.528	0.587	0.527
Combined Video Survey	0.222	0.259	0.232

Table 4.14. Mohn's rho (ρ_M) and forecast Mohn's rho (ρ_F) values calculated from the retrospective and retrospective forecasting analyses, respectively, on estimates of spawning stock biomass (SSB) and fishing mortality rates (F) from the SEDAR 94 WFS base model. Analyses were performed across 6 successive years of removal from the terminal year 2024.

Quantity	Year Peel	Mohn's Rho (ρ_M)	Forecast Mohn's Rho (ρ_F)
SSB	2023	-0.019	-0.026
SSB	2022	-0.044	-0.055
SSB	2021	-0.071	-0.070
SSB	2020	-0.233	-0.220
SSB	2019	-0.357	-0.332
SSB	2018	-0.204	-0.190
SSB	Combined	-0.155	-0.149
F	2023	0.024	0.033
F	2022	0.050	0.056
F	2021	0.072	0.074
F	2020	0.266	0.241
F	2019	0.475	0.463
F	2018	0.233	0.198
F	Combined	0.187	0.177

Table 4.15. Hindcast cross-validation summary statistics for the SEDAR 94 WFS Base Model. N = number of observations to compute each statistic. MASE = mean absolute scaled error, with values < 1 (in green) indicative of superior prediction skill over a naïve baseline forecast (random walk) and values > 1 (in red) indicative of poor prediction skill. Model MAE = mean absolute error of model prediction residuals. Naïve MAE = mean absolute error of naïve predictions.

Model Component	Data Source	MASE	Model MAE	Naïve MAE	N
Index of Abundance	Seagrass Trawl	0.56	0.94	1.68	6
	SEAMAP Trawl	0.94	0.59	0.62	6
	Combined Video	0.85	0.12	0.14	6
	Joint	0.67	0.55	0.81	18
Length Composition	SEAMAP Trawl	0.79	0.08	0.10	6
	Combined Video	0.71	0.06	0.09	6
	Joint	0.75	0.07	0.09	12
Conditional Age-at-Length	SEAMAP Trawl	0.34	0.10	0.28	6
	Joint	0.34	0.10	0.28	6

Table 4.16. The yield-per-recruit (YPR), spawner-per-recruit (SSB/R), static spawning potential ratio (SPR), and total equilibrium yield in metric tons computed over a range of exploitation rates on West Florida Shelf Hogfish.

Exploitation	YPR	SSB/R	SPR	Total Yield (mt)
0.000	0.000	0.827	1.000	0.027
0.018	0.013	0.688	0.832	26.753
0.039	0.023	0.580	0.701	48.660
0.062	0.032	0.494	0.598	66.791
0.088	0.039	0.427	0.516	81.940
0.115	0.045	0.373	0.451	94.718
0.145	0.050	0.329	0.398	105.596
0.175	0.055	0.294	0.356	114.940
0.206	0.059	0.266	0.321	123.038
0.238	0.062	0.242	0.293	130.114
0.269	0.065	0.223	0.269	136.347
0.301	0.068	0.207	0.250	141.881
0.331	0.070	0.193	0.233	146.829
0.361	0.073	0.182	0.219	151.283
0.390	0.075	0.172	0.208	155.319
0.418	0.076	0.163	0.197	158.997
0.445	0.078	0.156	0.188	162.366
0.471	0.080	0.150	0.181	165.470
0.496	0.081	0.144	0.174	168.341
0.520	0.082	0.139	0.168	171.008
0.543	0.084	0.134	0.162	173.495
0.566	0.085	0.130	0.158	175.823
0.587	0.086	0.127	0.153	178.009
0.608	0.087	0.124	0.149	180.067
0.628	0.088	0.121	0.146	182.011
0.647	0.089	0.118	0.142	183.851
0.666	0.090	0.115	0.139	185.597
0.684	0.090	0.113	0.137	187.257
0.701	0.091	0.111	0.134	188.839
0.718	0.092	0.109	0.131	190.348
0.735	0.093	0.107	0.129	191.791
0.751	0.093	0.105	0.127	193.173
0.767	0.094	0.103	0.125	194.499
0.782	0.095	0.102	0.123	195.771
0.797	0.095	0.100	0.121	196.995
0.811	0.096	0.099	0.120	198.172
0.826	0.097	0.098	0.118	199.308
0.840	0.097	0.096	0.116	200.403
0.853	0.098	0.095	0.115	201.460
0.867	0.098	0.094	0.114	202.482

Table 4.17. Gelman and Rubin's (1992) potential scale reduction factor (PSRF) values from the combined four MCMC chains for selected model parameter (*ln(R0)*) and derived quantities (SSB_0, SSB in 2024, F in 2024, $F_{30\%SPR}$, SSB at $F_{30\%SPR}$, and the retained yield at $F_{30\%SPR}$) of the SEDAR 94 WFS base model.

PSRF	PSRF Upper CI	Parameter or Derived Quantity
1.04	1.06	*ln(R0)*
1.04	1.06	SSB_0
1.05	1.07	SSB_{2024}
1.00	1.01	F_{2024}
1.01	1.04	$F_{30\%SPR}$
1.04	1.06	$SSB_{F30\%SPR}$
1.05	1.06	Retained yield at $F_{30\%SPR}$

Table 4.18. The stock status determination criteria for the WFS Hogfish stock according to the Gulf of Mexico Fishery Management Council (GMFMC). Values were derived from the SEDAR 94 WFS base model using the MSY_{proxy} of 30%SPR or 40%SPR.

Gulf of Mexico Fishery Management Council			
Criteria	Definition	40% SPR	30% SPR
MSY	The retained yield at F_{MSY} (or proxy, $F_{30\%SPR}$)	85.098 mt (187,608 lbs.)	101.489 mt (223,745 lbs.)
$F_{MSY\ or\ proxy}$	The fishing mortality rate associated with MSY (or proxy, 30% SPR)	0.143 yr^{-1}	0.229 yr^{-1}
MFMT (Maximum Fishing Mortality Threshold)	$F_{MSY\ or\ 30\%\ SPR}$	0.143 yr^{-1}	0.229 yr^{-1}
$F_{current}$ (recent average fishing mortality rate)	The geometric mean of F for 2022 – 2024	0.072 yr^{-1}	0.072 yr^{-1}
$SSB_{MSY\ or\ proxy}$	The estimated spawning stock biomass associated with F_{MSY} or $F_{30\%SPR}$	693.335 mt (1,528,542 lbs.)	518.900 mt (1,143,979 lbs.)
MSST (Minimum Stock Size Threshold)	$0.50*SSB_{MSY\ or\ F30\%SPR}$	346.668 mt (764,271 lbs.)	259.450 mt (571,989 lbs.)
$SSB_{current}$ (recent average of SSB)	The geometric mean of SSB for 2022 – 2024	1,086.509 mt (2,395,342 lbs.)	1,086,509 mt (2,395,342 lbs.)
OY (Optimum Yield)	75% of OFL	63.824 mt (140,708 lbs.)	76.117 mt (167,809 lbs.)

Table 4.19**.** Projection results when exploitation fishing mortality rates = $F_{30\%SPR}$ for WFS Hogfish. Equilibrium projections assume predicted recruitment follows the spawner-recruit curve. Short-term projections assume predicted age-0 recruitment is equal to the average from 2020 to 2024 (2.45 million). Recruitment (Recruits) is in millions of age-0 fish, F is fishing mortality rate, SSB is in metric tons (female SSB), Retained Yield is in pounds (whole weight), and Retained Num is in numbers of fish.

	$F_{30\%SPR}$ Long-Term Projections					**$F_{30\%SPR}$ Short-Term Projections**				
Year	**Age-0 Recruits**	**F**	**SSB**	**Retained Yield**	**Retained Num**	**Age-0 Recruits**	**F**	**SSB**	**Retained Yield**	**Retained Num**
2025	2,148.99	0.229	1,098.320	474,501	180,733	2,448.48	0.229	1,098.320	474,495	180,731
2026	2,148.99	0.229	879.571	391,917	146,774	2,448.48	0.229	883.079	394,511	147,869
2027	2,148.99	0.229	730.788	313,153	119,436	2,448.48	0.229	746.092	318,423	122,269
2028	2,148.99	0.229	637.676	265,442	104,935	2,448.48	0.229	667.239	277,113	110,467
2029	2,148.99	0.229	589.817	244,981	98,588	2,448.48	0.229	632.402	263,080	106,444
2030	2,148.99	0.229	565.137	236,158	95,548	2,448.48	0.229	617.618	258,978	105,059
2031	2,148.99	0.229	551.677	232,121	93,977	2,448.48	0.229	611.254	258,190	104,625
2032	2,148.99	0.229	543.855	230,198	93,104	2,448.48	0.229	608.374	258,447	104,521
2033	2,148.99	0.229	539.213	229,322	92,612	2,448.48	0.229	607.102	259,004	104,540
2034	2,148.99	0.229	536.386	228,955	92,326	2,448.48	0.229	606.531	259,561	104,591

Table 4.20. Projection results when exploitation fishing mortality rates = $F_{current}$ and 75% $F_{30\%SPR}$ for WFS Hogfish. Equilibrium projections assume predicted recruitment follows the spawner-recruit curve. Short-term projections assume predicted age-0 recruitment is equal to the average from 2020 to 2024 (2.45 million). Recruitment (Recruits) is in millions of age-0 fish, F is fishing mortality rate, SSB is in metric tons (female SSB), Retained Yield is in pounds (whole weight), and Retained Num is in numbers of fish.

	$F_{current}$ Short-Term Projections					**75% $F_{30\%SPR}$ Short-Term Projections**				
Year	**Age 0 Recruits**	**F**	**SSB**	**Retained Yield**	**Retained Num**	**Age 0 Recruits**	**F**	**SSB**	**Retained Yield**	**Retained Num**
2025	2,448.48	0.072	1,098.320	149,434	56,932	2,448.48	0.172	1,098.320	356,321	135,733
2026	2,448.48	0.072	1,049.180	148,782	55,441	2,448.48	0.172	943.152	317,531	118,738
2027	2,448.48	0.072	1,037.880	144,058	53,833	2,448.48	0.172	844.351	274,487	104,221
2028	2,448.48	0.072	1,034.770	141,132	53,641	2,448.48	0.172	781.040	247,796	96,958
2029	2,448.48	0.072	1,040.260	141,303	54,238	2,448.48	0.172	749.438	237,315	94,204
2030	2,448.48	0.072	1,050.700	142,908	54,996	2,448.48	0.172	734.913	233,816	93,146
2031	2,448.48	0.072	1,063.030	144,887	55,733	2,448.48	0.172	728.430	232,904	92,762
2032	2,448.48	0.072	1,075.120	146,781	56,388	2,448.48	0.172	725.537	232,910	92,646
2033	2,448.48	0.072	1,086.240	148,466	56,960	2,448.48	0.172	724.428	233,252	92,650
2034	2,448.48	0.072	1,096.040	149,905	57,448	2,448.48	0.172	724.160	233,671	92,701

4.14 WFS Figures

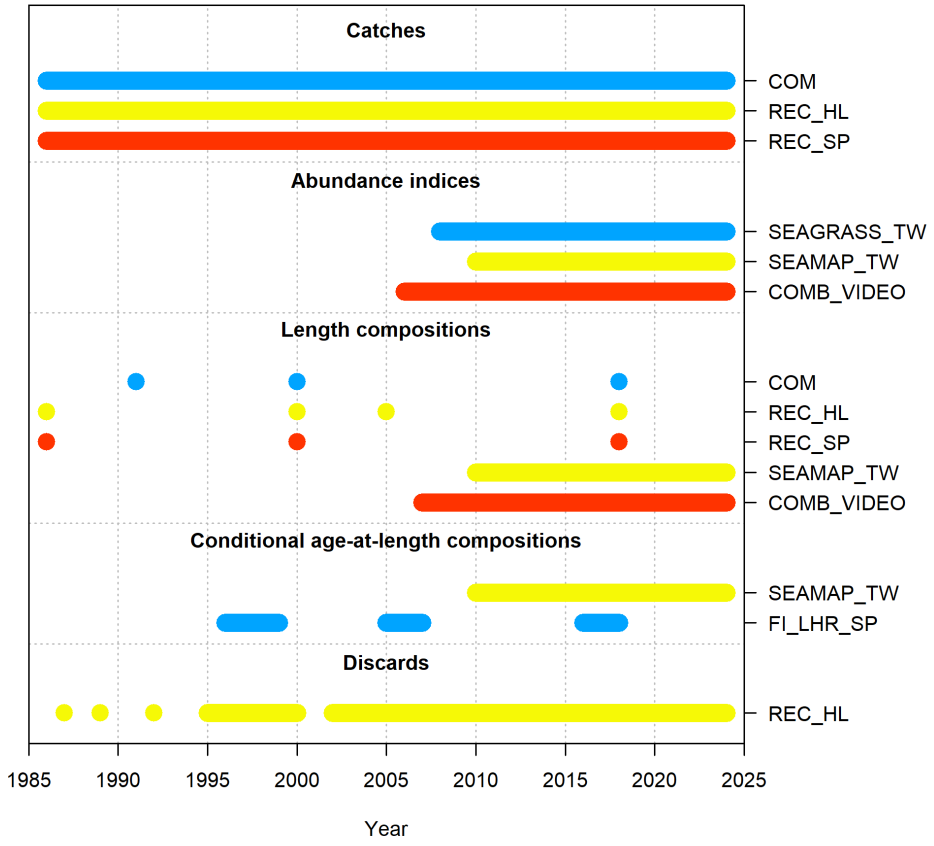


Figure 4.1. Data sources used in the West Florida Shelf Hogfish Stock Synthesis assessment model (WFS base model).

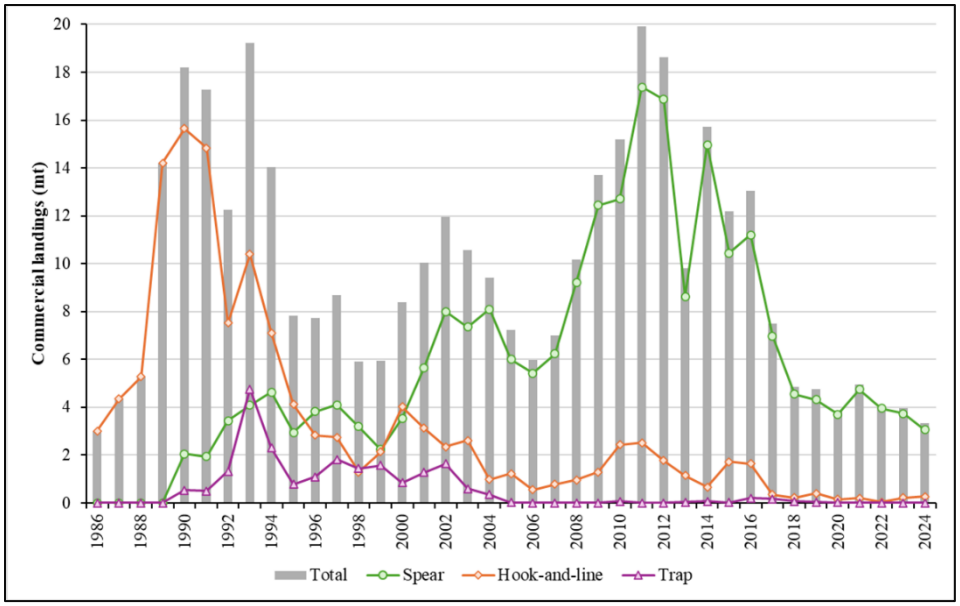


Figure 4.2. Commercial landings (metric tons) of West Florida Shelf Hogfish by gear for years 1986 – 2024.

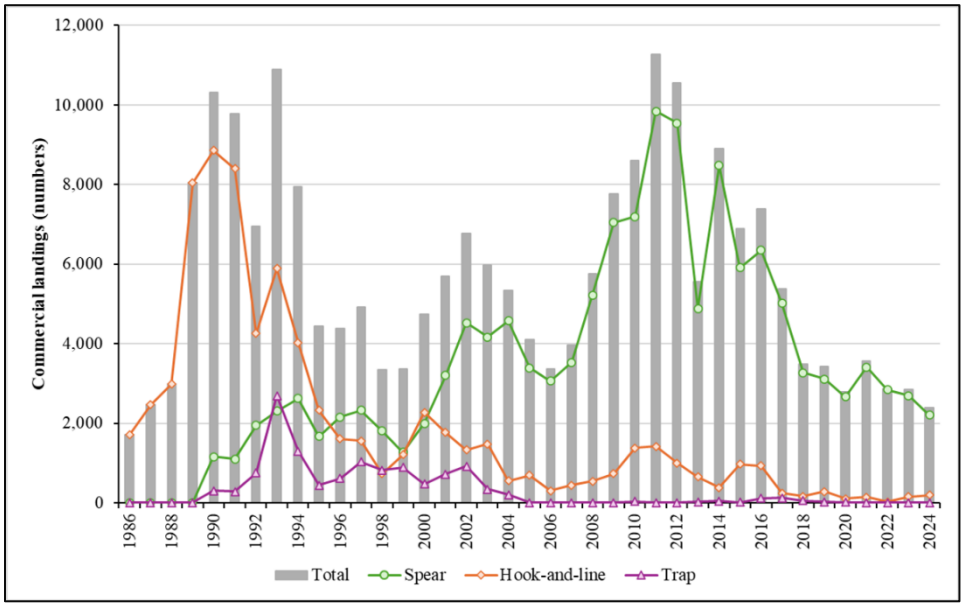


Figure 4.3. Commercial landings (numbers) of West Florida Shelf Hogfish by gear for years 1986 – 2024.

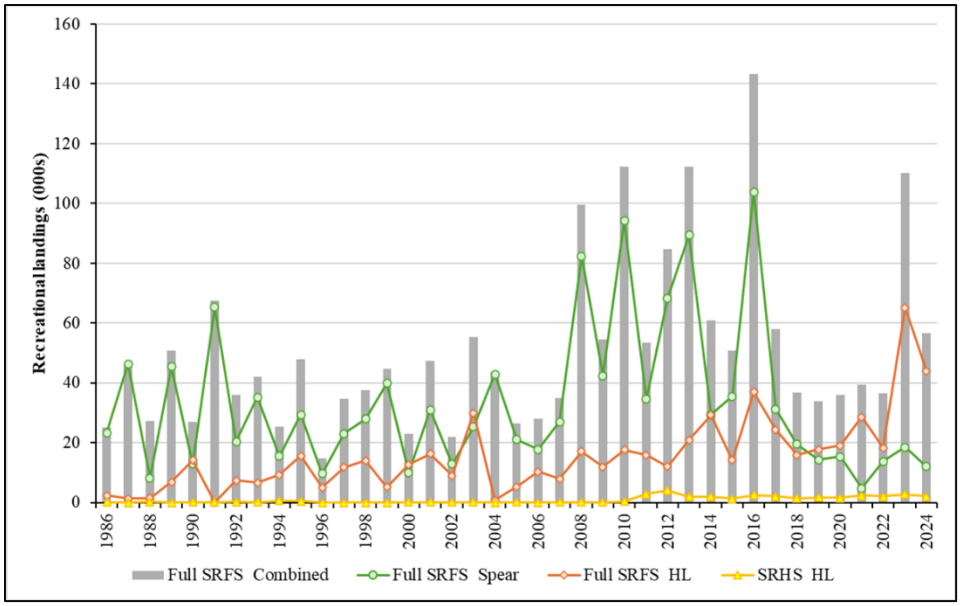


Figure 4.4. Recreational landings (numbers) of West Florida Shelf Hogfish by gear for years 1986 – 2024. The 'Full SRFS' estimates are from 1986 – 2024 (grey bars) and are comprised of 'SRFS & SRFS-calibrated Private' mode, MRIP charter mode, and MRIP shore mode landings estimates. 'SRFS & SRFS-calibrated Private' estimates are comprised of SRFS private mode (2021 – 2024) and SRFS ratio-calibrated MRIP private mode (1981 – 2020). The 'Full SRFS Combined' is comprised of the 'Full SRFS' estimates plus the SRHS estimates.

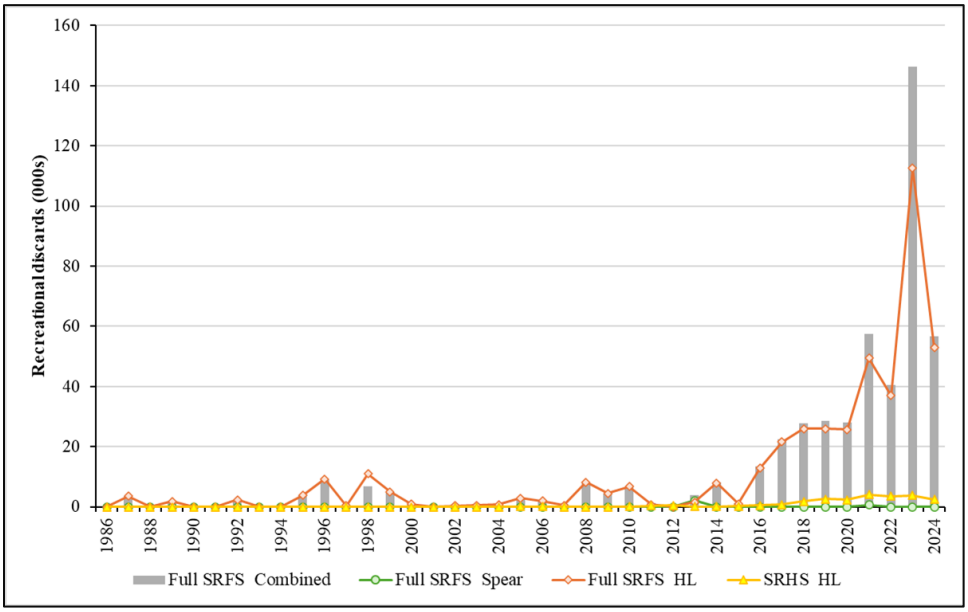


Figure 4.5. Recreational discards (numbers) of West Florida Shelf Hogfish by gear for years 1987 – 2024. The 'Full SRFS' estimates are comprised of 'SRFS & SRFS-calibrated Private' mode, MRIP charter mode, and MRIP shore mode landings estimates. 'SRFS & SRFS-calibrated Private' estimates are comprised of SRFS private mode (2021 – 2024) and SRFS ratio-calibrated MRIP private mode (1981 – 2020). The 'Full SRFS Combined' is comprised of the 'Full SRFS' estimates plus the SRHS estimates.

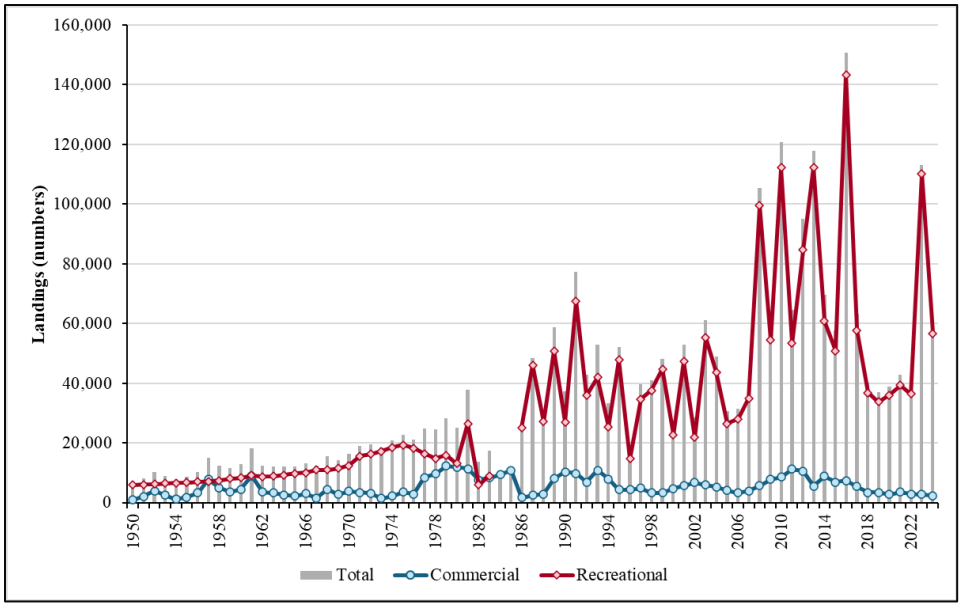


Figure 4.6. A comparison of the historic commercial (numbers; blue dots) and recreational (numbers; red diamonds) landings estimates of West Florida Shelf Hogfish from 1950 – 2024.

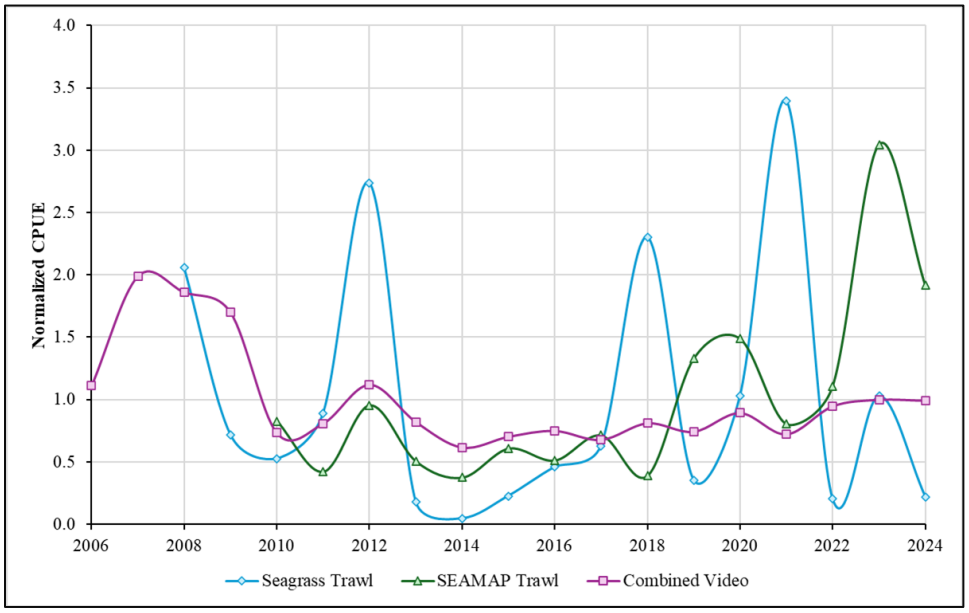


Figure 4.7. Normalized indices of relative abundance for West Florida Shelf Hogfish from 2006 – 2024 from the seagrass trawl, SEAMAP trawl, and combined video surveys.

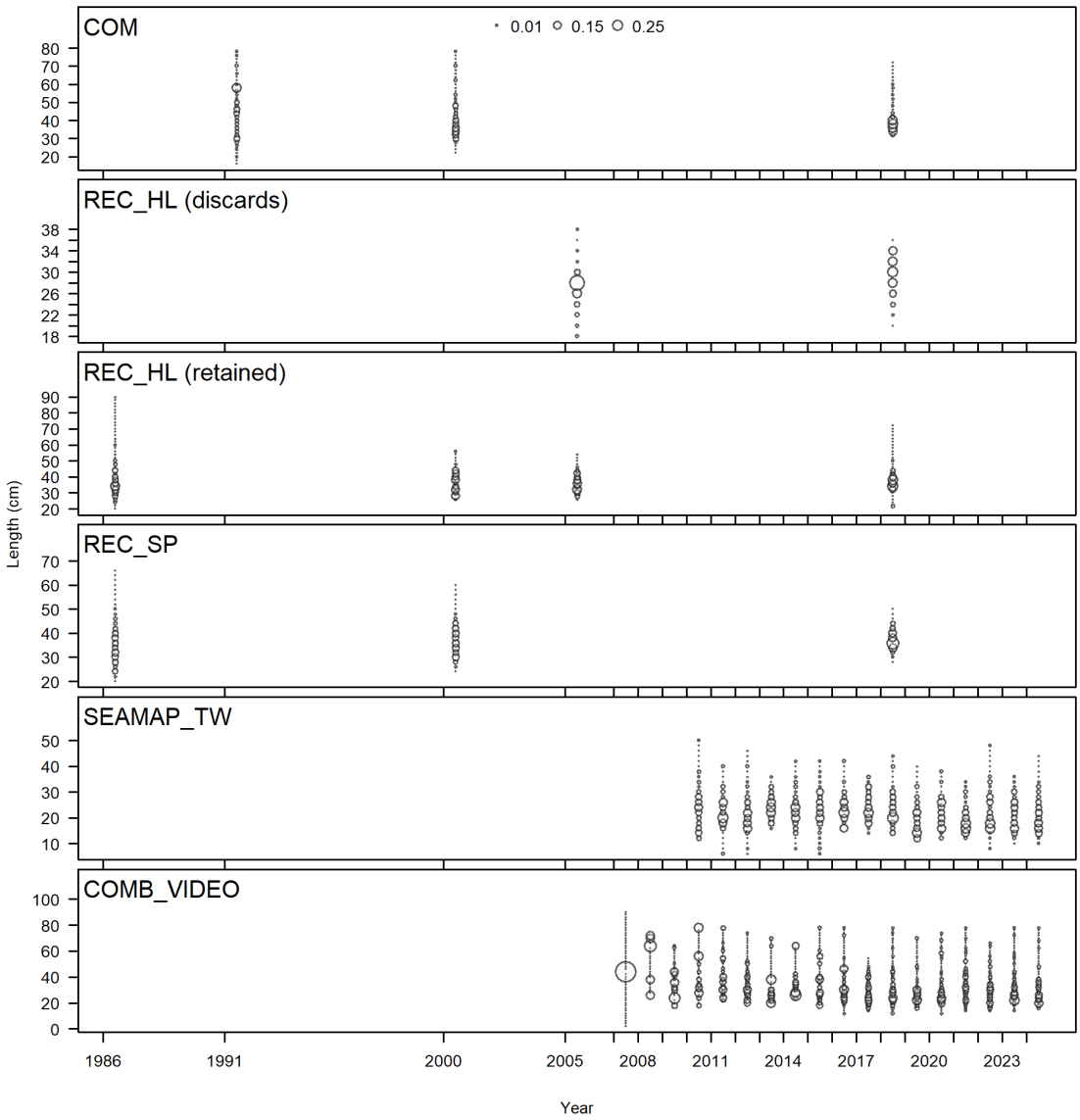


Figure 4.8. Catch-weighted length compositions (2 cm FL bins) of West Florida Shelf Hogfish landings (retained) and discards by fishery for years 1986 – 2024. Commercial = COM, Full SRFS hook-and-line plus SRHS hook-and-line = REC_HL, Full SRFS Spear = REC_SP, SEAMAP trawl survey = SEAMAP_TW, and combined video survey = COMB_VIDEO.

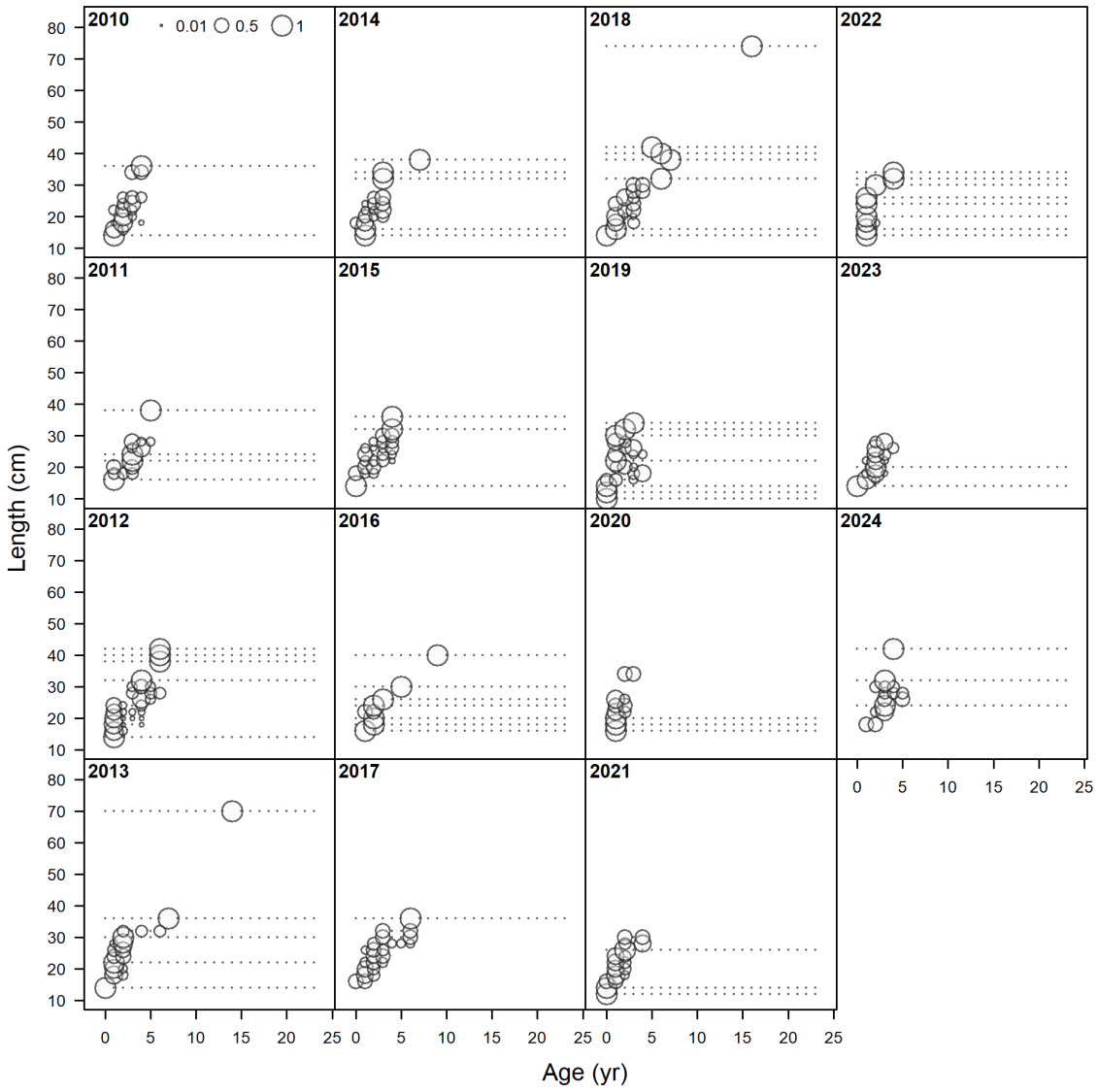


Figure 4.9. Observed conditional age-at-length in 2 cm FL bins of West Florida Shelf Hogfish for the SEAMAP trawl survey during years 2010 – 2024.

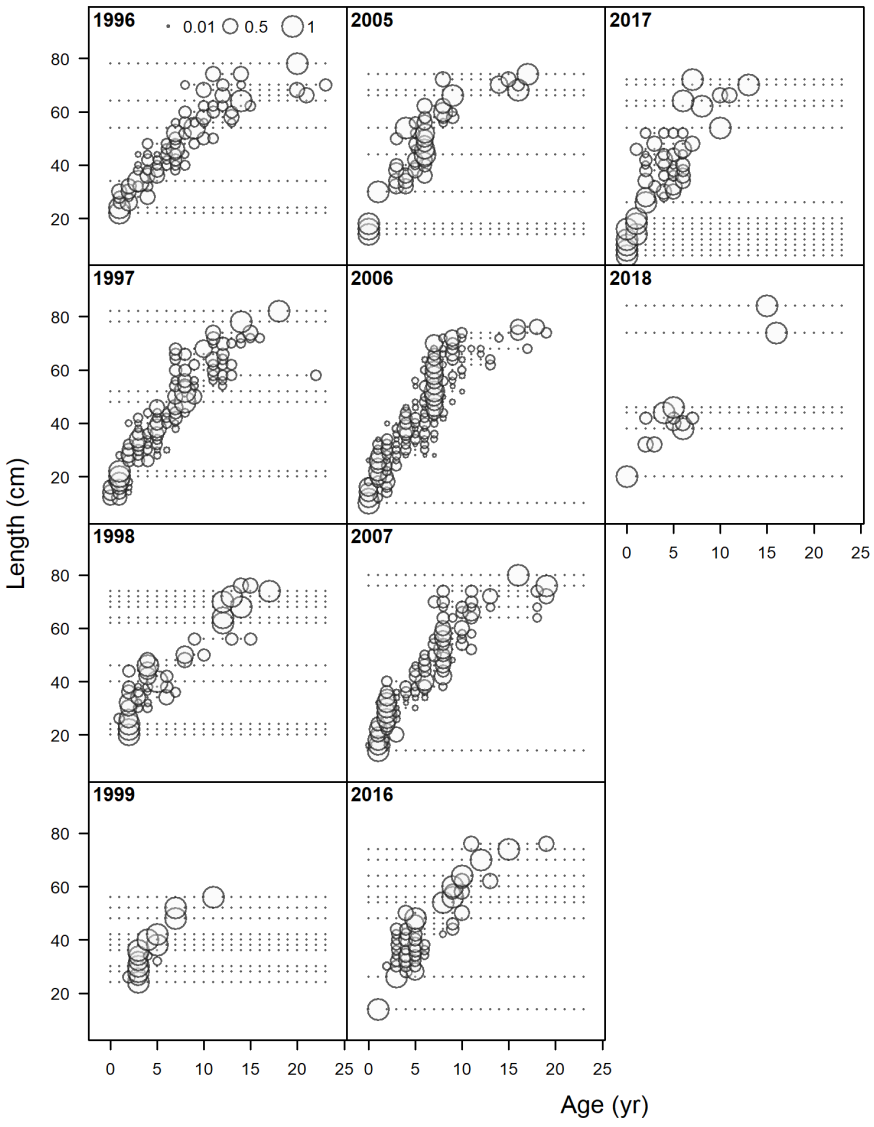


Figure 4.10. Observed conditional age-at-length in 2 cm FL bins of West Florida Shelf Hogfish collected by the spear gear from fishery-independent data sources during years 1996 – 2018.

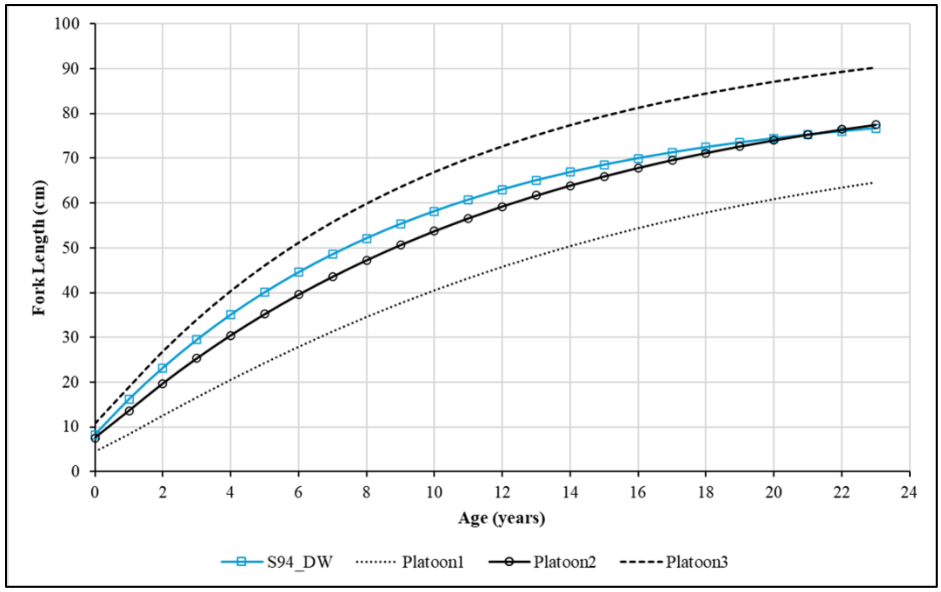


Figure 4.11. Mean size-at-age across 3 platoons for West Florida Shelf Hogfish as estimated by the SEDAR 94 WFS base model. Distribution of recruitment among platoons approximated a normal distribution (0.150, 0.700, 0.150) and the 2nd platoon (black circles) followed the L_{inf} (89.6 cm FL) and k (0.083) parameters estimated by the SEDAR 94 WFS base model. A comparison with the external growth model developed during the Data Workshop (S94_DW) is shown by the blue squares.

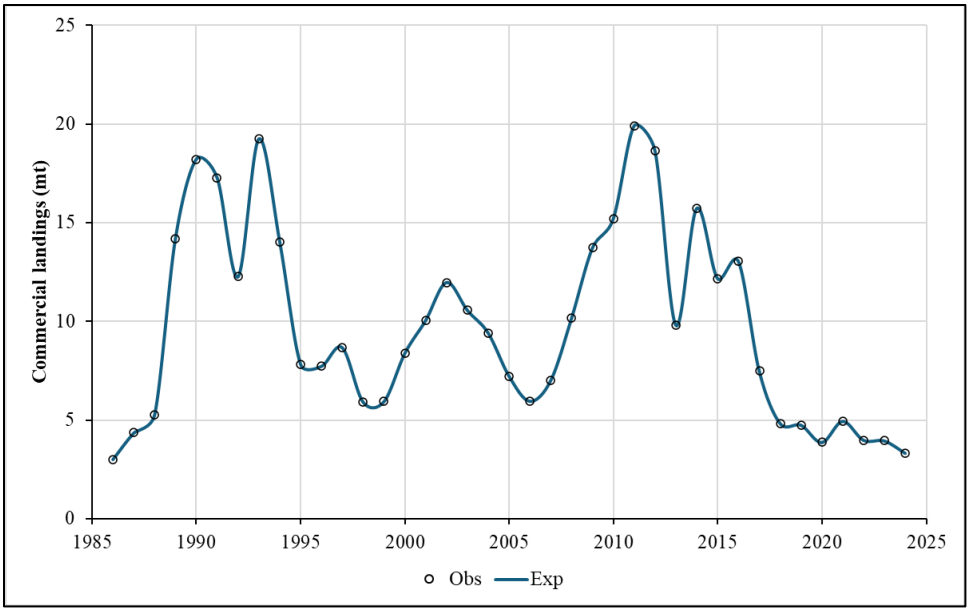


Figure 4.12. West Florida Shelf Hogfish observed (dots) and expected (solid line) landings by the commercial fleet (in metric tons) from the SEDAR 94 WFS base model.

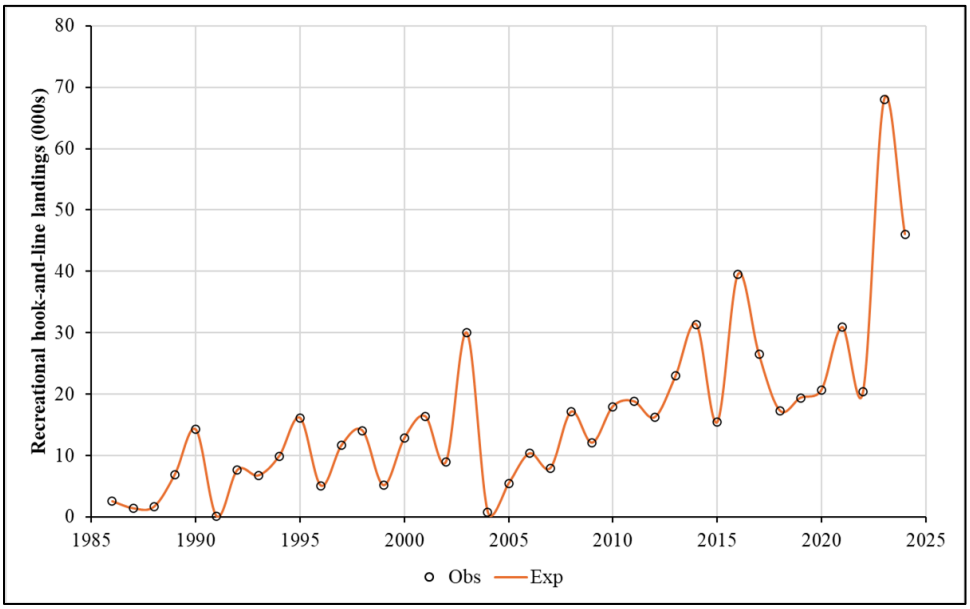


Figure 4.13. West Florida Shelf Hogfish observed (dots) and expected (solid line) landings by the recreational hook-and-line fleet (in thousands of fish) from the SEDAR 94 WFS base model.

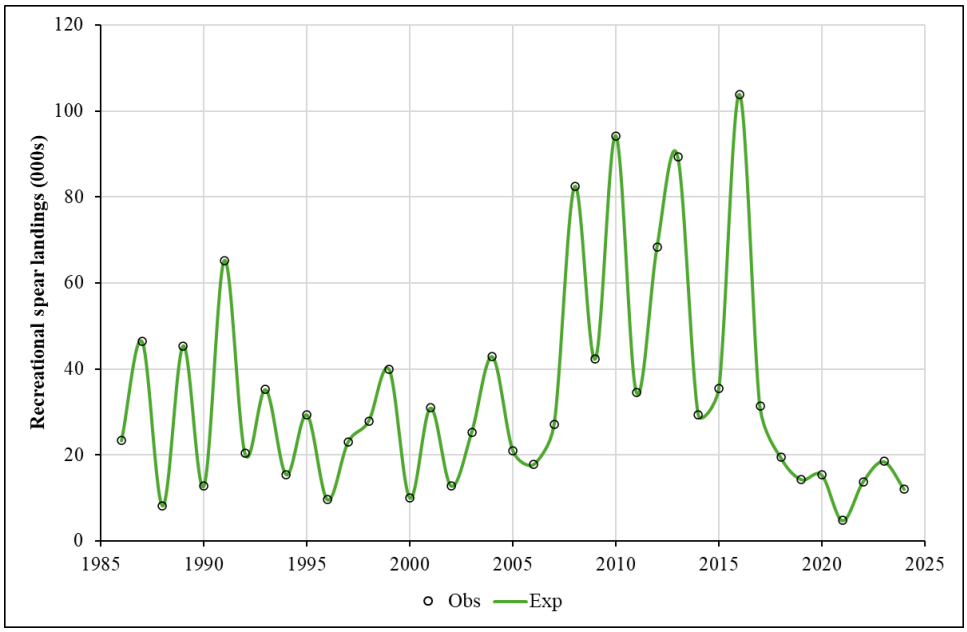


Figure 4.14. West Florida Shelf Hogfish observed (dots) and expected (solid line) landings by the recreational spear fleet (in thousands of fish) from the SEDAR 94 WFS base model.

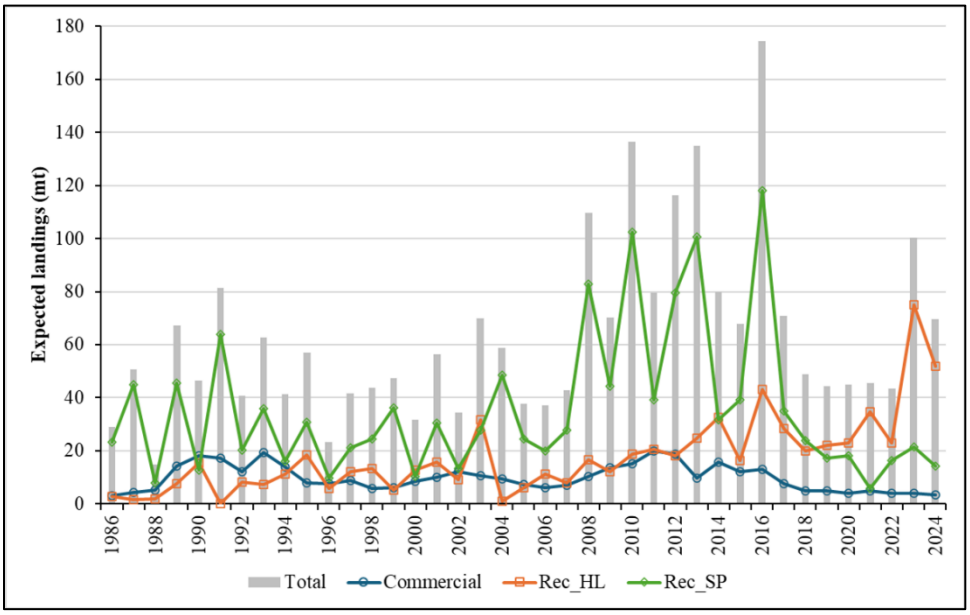


Figure 4.15. Expected landings of West Florida Shelf Hogfish by fleet (in metric tons) as estimated from the SEDAR 94 WFS base model.

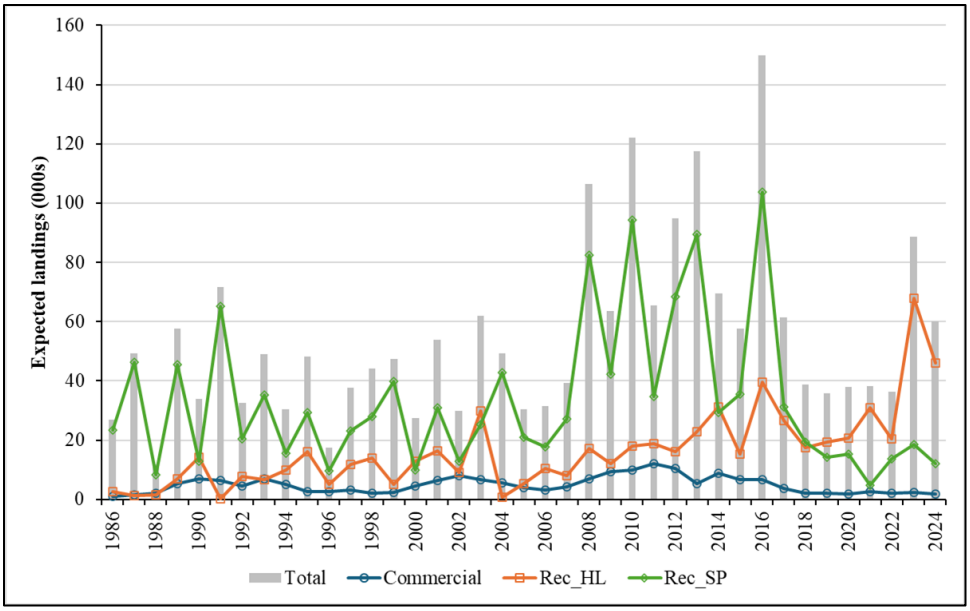


Figure 4.16. Expected landings of West Florida Shelf Hogfish by fleet (in thousands of fish) as estimated from the SEDAR 94 WFS base model.

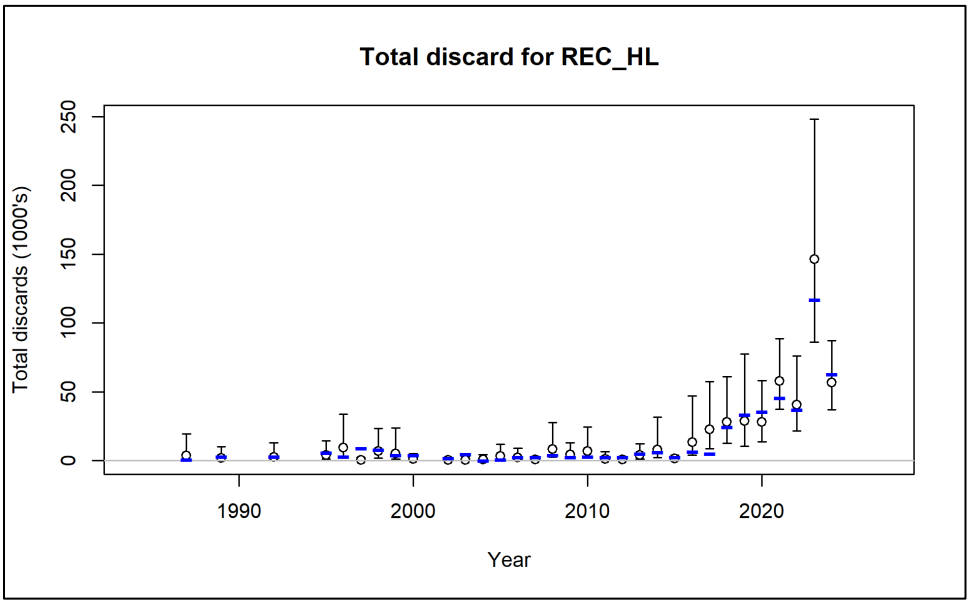


Figure 4.17. West Florida Shelf Hogfish observed (dots with 95% confidence intervals) and expected (blue dashes) discards (i.e., before applying the discard mortality rate for each fleet) by the recreational hook-and-line fleet (in thousands of fish) from the SEDAR 94 WFS base model.

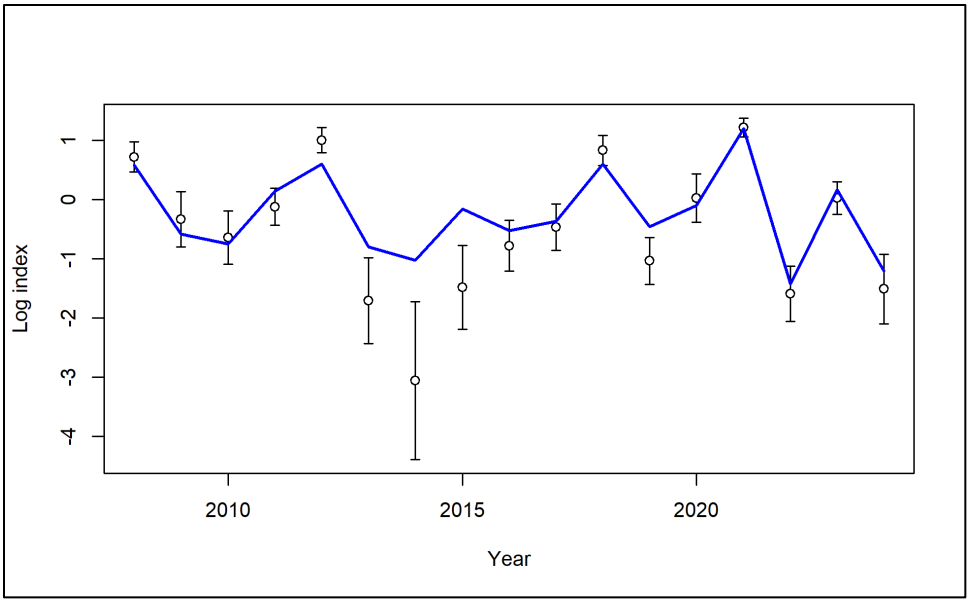


Figure 4.18. The WFS Hogfish observed (dots with 95% confidence intervals) and predicted (blue line) seagrass trawl index of relative abundance (log-transformed) for SEDAR 94.

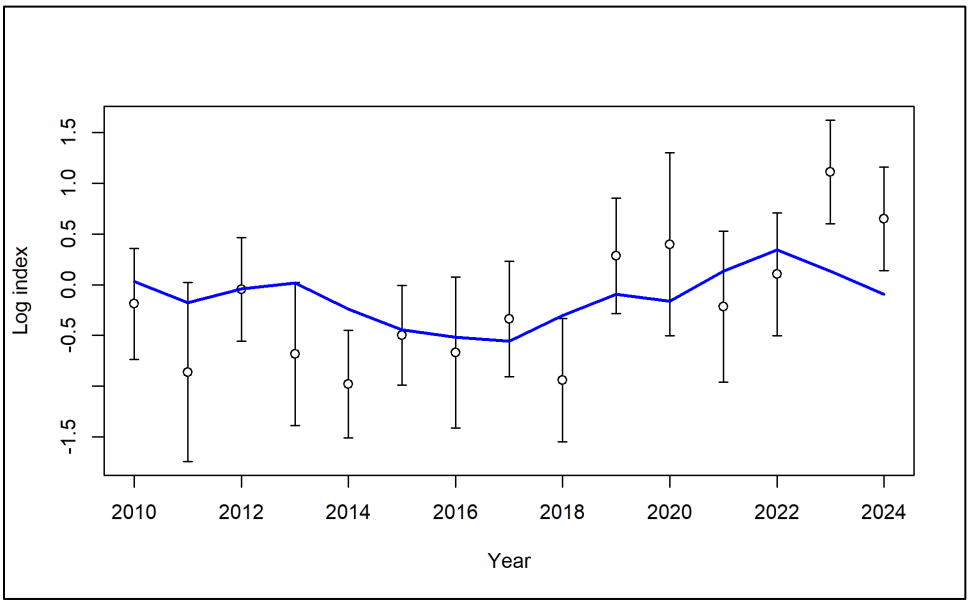


Figure 4.19. The WFS Hogfish observed (dots with 95% confidence intervals) and predicted (blue line) SEAMAP index of relative abundance (log-transformed) for SEDAR 94.

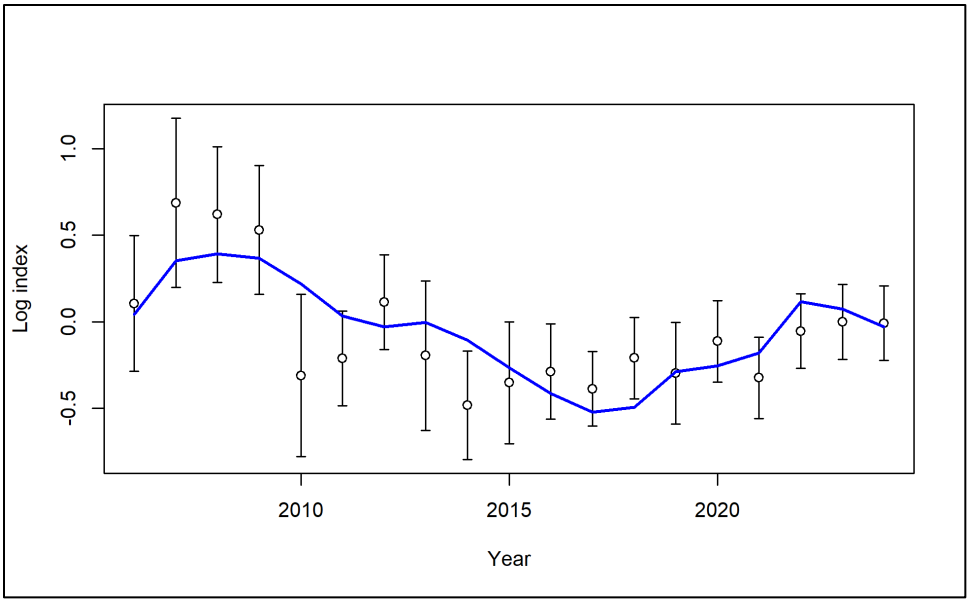


Figure 4.20. The West Florida Shelf Hogfish observed (dots with 95% confidence intervals) and predicted (blue line) combined video index of relative abundance (log-transformed) from the SEDAR 94 WFS base model.

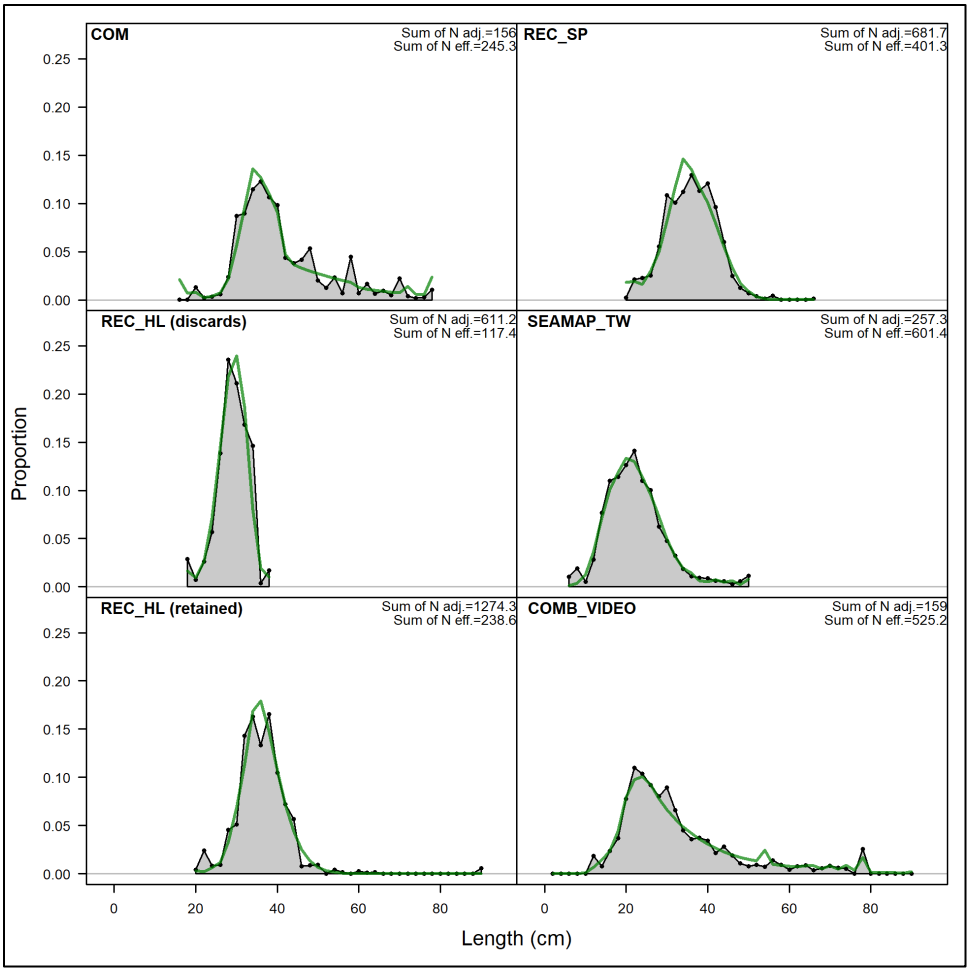


Figure 4.21. Model fits to the length composition of retained and discarded catch aggregated across years within a given fleet or survey for West Florida Shelf Hogfish. Green lines represent predicted length compositions, while grey shaded regions represent observed length compositions. In the upper right hand corners, 'N adj.' is the input sample size after applying the Francis data-weighting adjustment while 'N eff.' is the calculated effective sample size used in the McAllister-Ianelli tuning method.

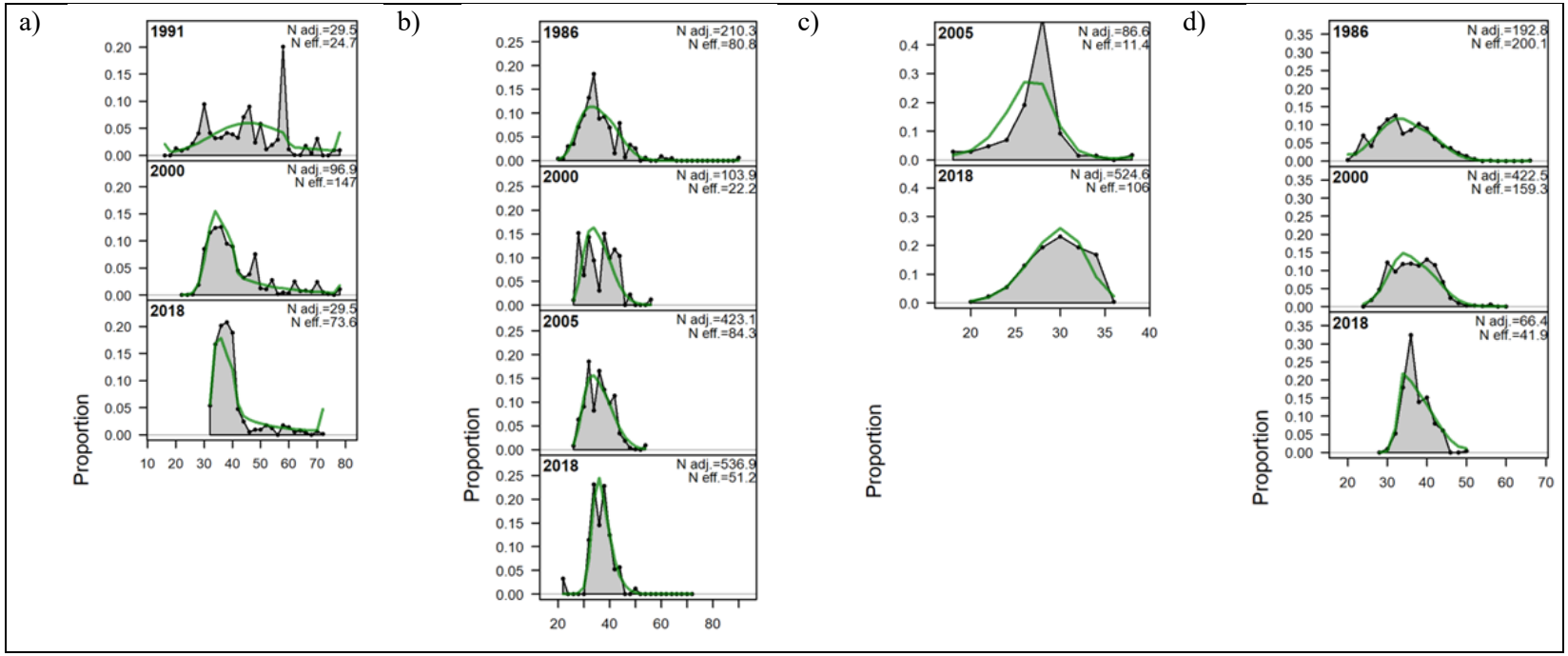


Figure 4.22. Model fits to the length composition of a) retained catch by the commercial fleet, b) retained catch by the recreational hook-and-line fleet, and c) discards for the recreational hook-and-line fleet, and d) retained catch by the recreational spear fleet by super-period for West Florida Shelf Hogfish. Green lines represent predicted length compositions, while grey shaded regions represent observed length compositions. In the upper right hand corners, 'N adj.' is the input sample size after applying the Francis data-weighting adjustment while 'N eff.' is the calculated effective sample size used in the McAllister-Ianelli tuning method. Data are in 2 cm fork length bins.

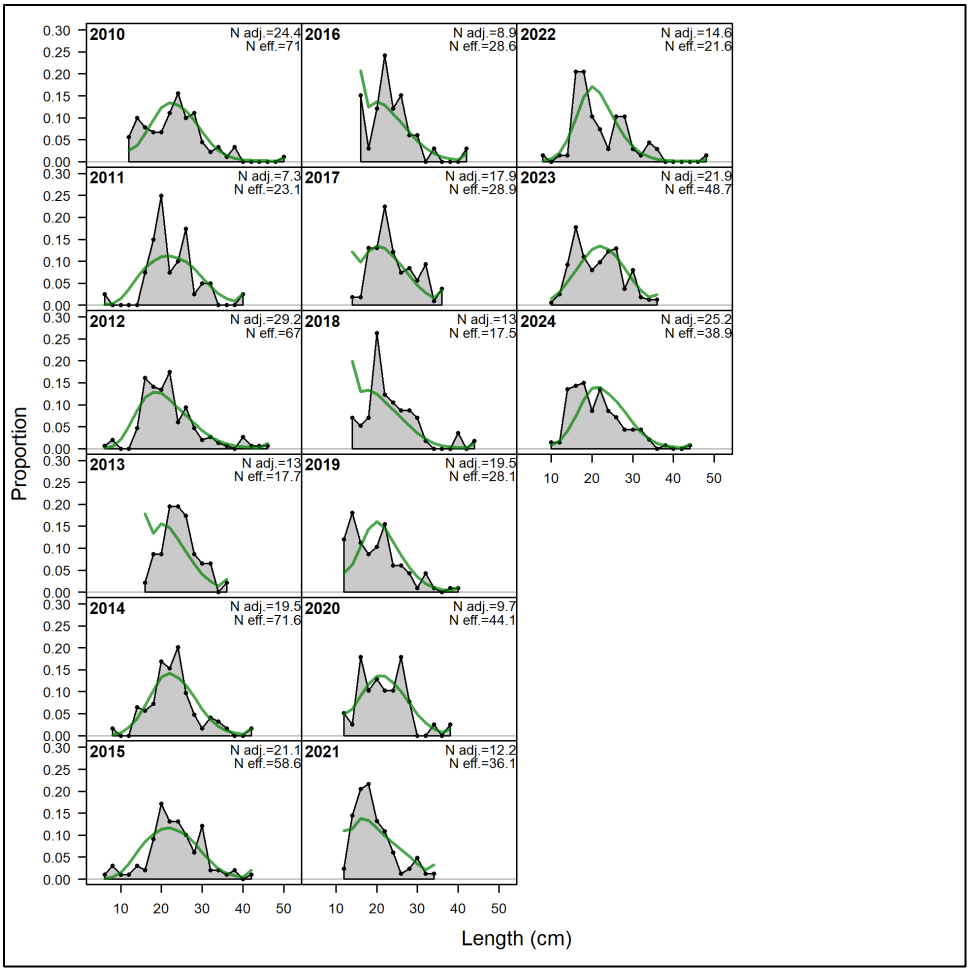


Figure 4.23. Model fits to the length composition data for the SEAMAP trawl index for West Florida Shelf Hogfish. Green lines represent predicted length compositions, while grey shaded regions represent observed length compositions. In the upper right hand corners, 'N adj.' is the input sample size after applying the Francis data-weighting adjustment while ‘N eff.’ is the calculated effective sample size used in the McAllister-Ianelli tuning method. Data are in 2 cm fork length bins.

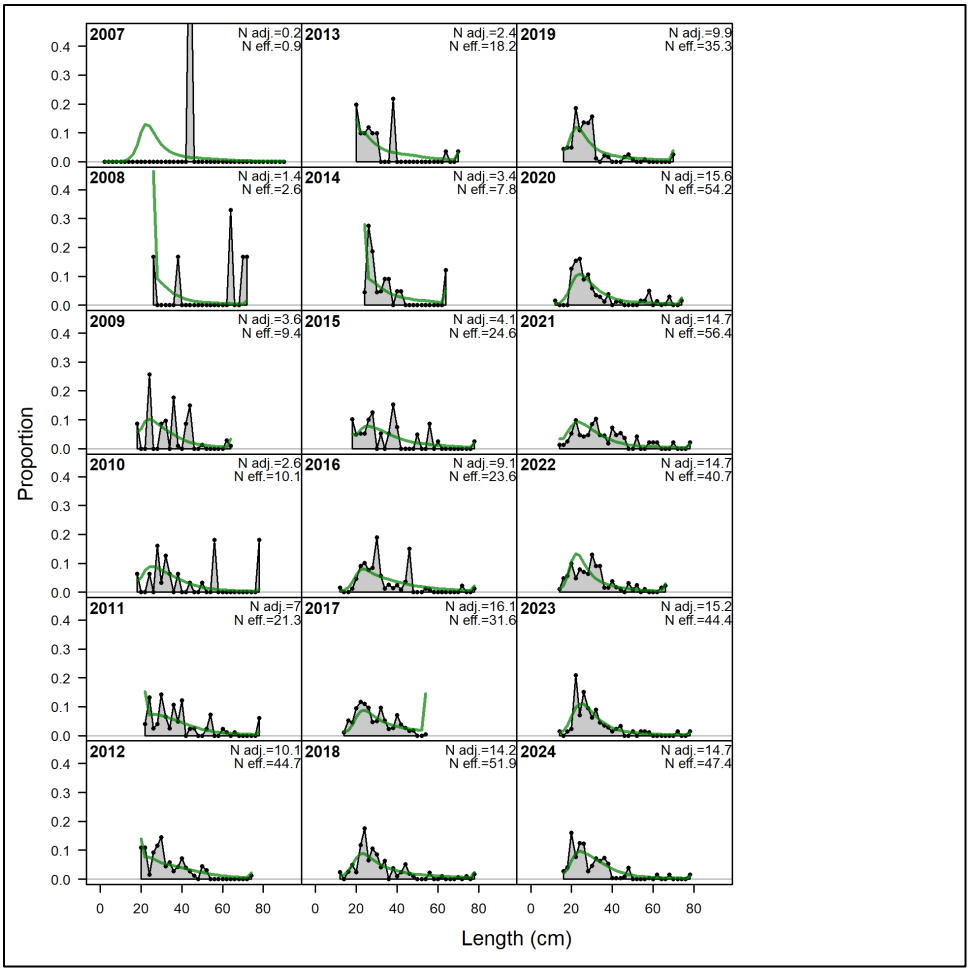


Figure 4.24. Model fits to the length composition data for the combined video index for West Florida Shelf Hogfish. Green lines represent predicted length compositions, while grey shaded regions represent observed length compositions. In the upper right hand corners, 'N adj.' is the input sample size after applying the Francis data-weighting adjustment while 'N eff.' is the calculated effective sample size used in the McAllister-Ianelli tuning method. Data are in 2 cm fork length bins.

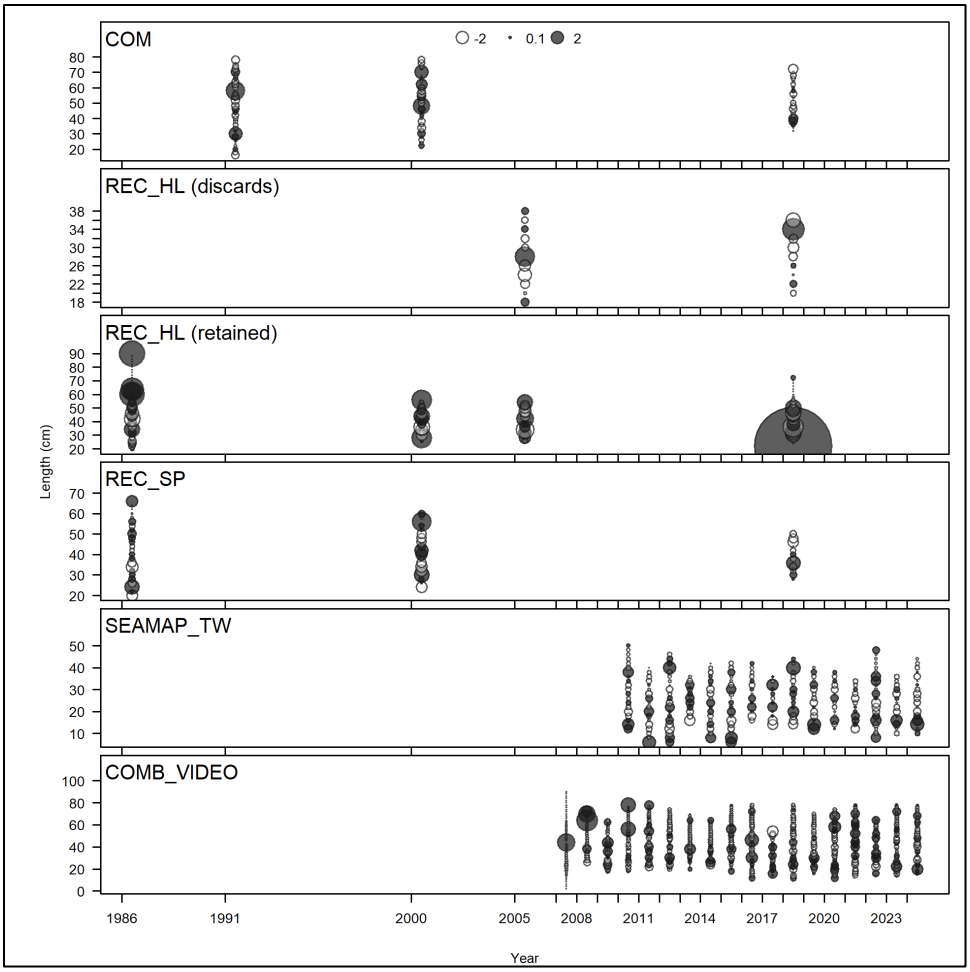


Figure 4.25. Pearson residuals for length composition data by year compared across a given fleet or survey for West Florida Shelf Hogfish. Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected).

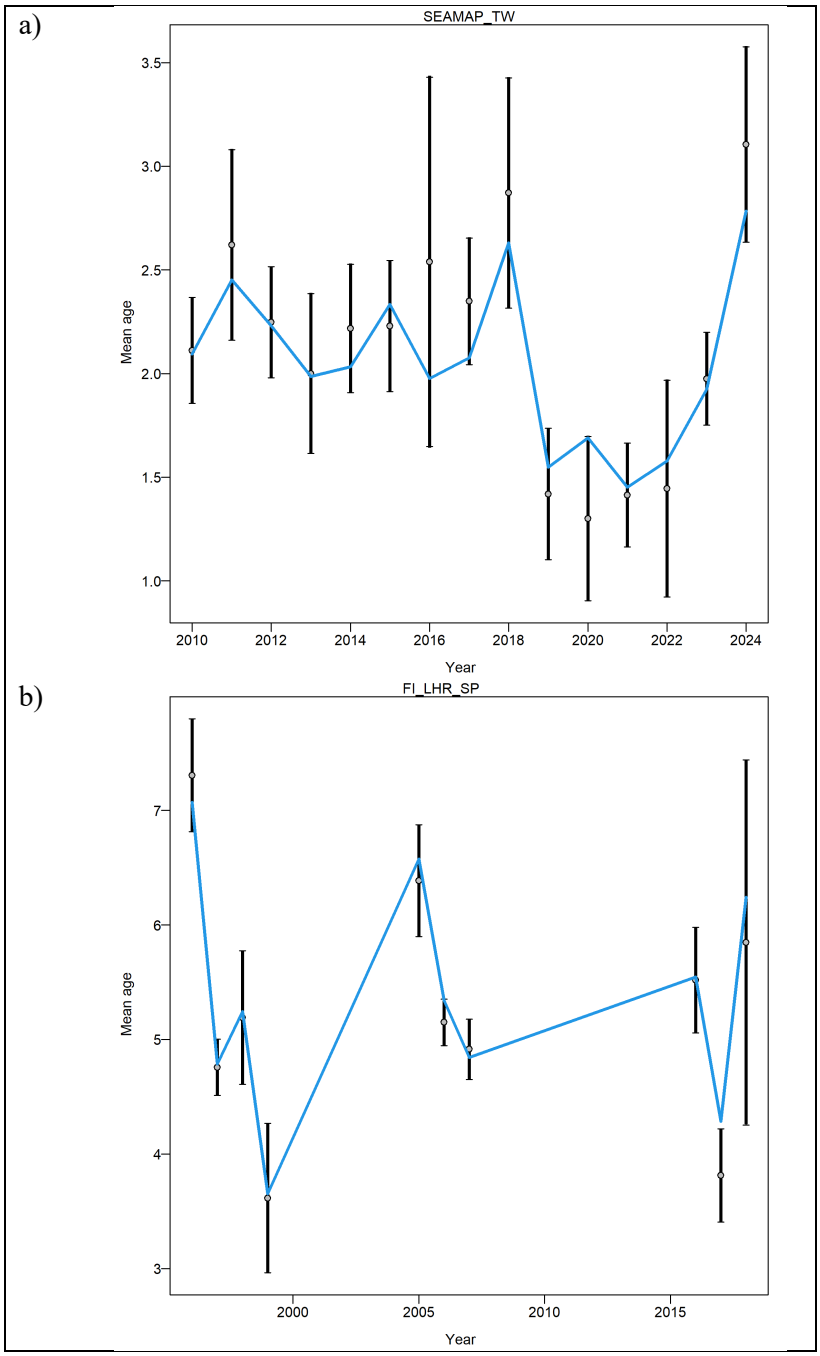


Figure 4.26. Mean ages of West Florida Shelf Hogfish conditional age-at-length data collected by a) the SEAMAP trawl survey (SEAMAP_TW) and b) fishery-independent research using the spear gear (FI_LHR_SP) aggregated across length bins. Observed values are dots with 95% confidence intervals and predicted values are the blue lines.

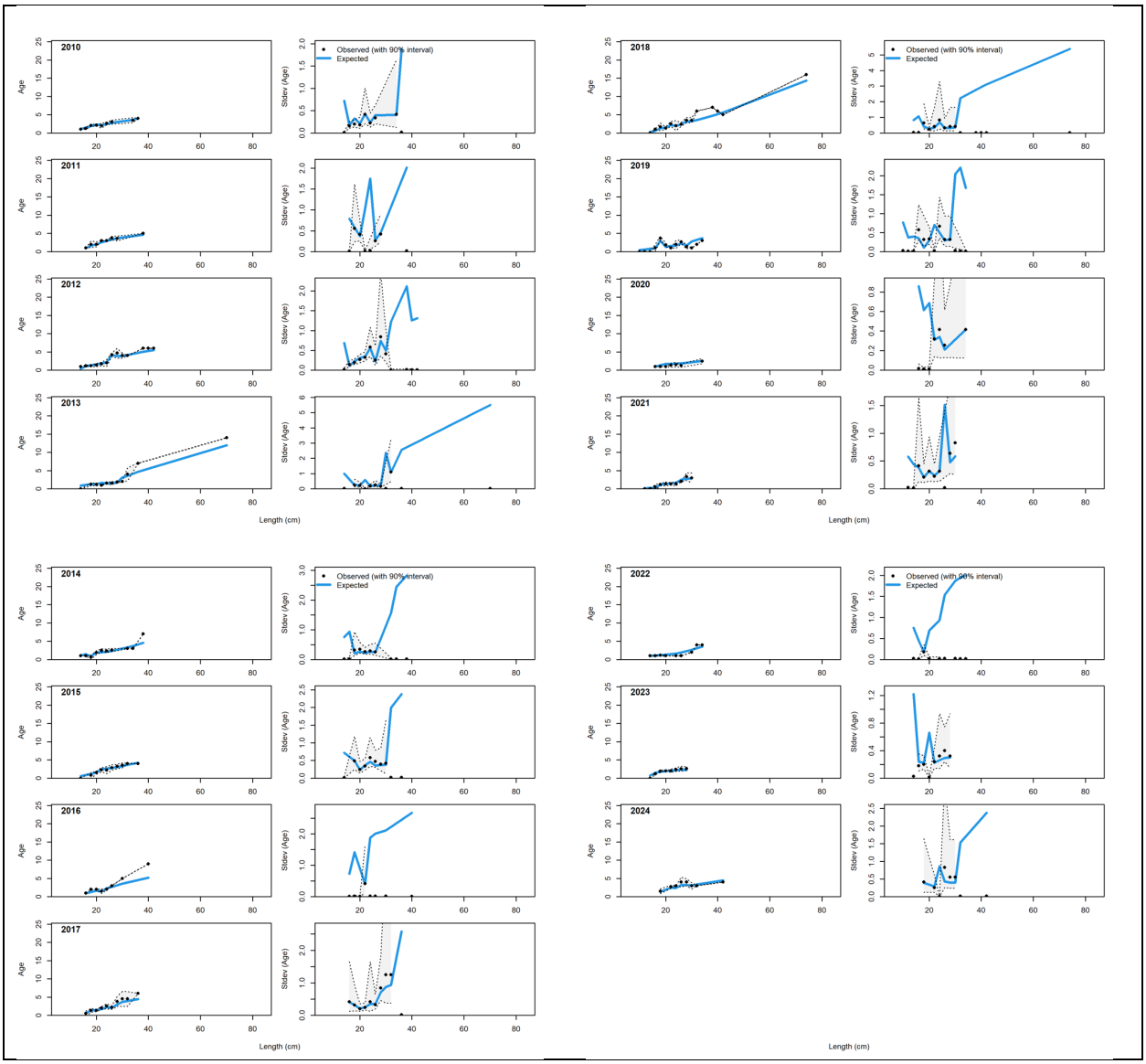


Figure 4.27. Model fits to the annual conditional age-at-length data by the SEAMAP trawl survey for West Florida Shelf Hogfish. In the left plots, the blue lines represent predicted mean age-at-length by size class while the black dots and grey shaded regions represent the observed mean age-at-length by size class with 90% confidence intervals. In the right plots, the blue lines represent predicted standard error of mean age-at-length by size class while the black dots and grey shaded regions represent the observed standard error of mean age-at-length by size class with 90% confidence intervals.

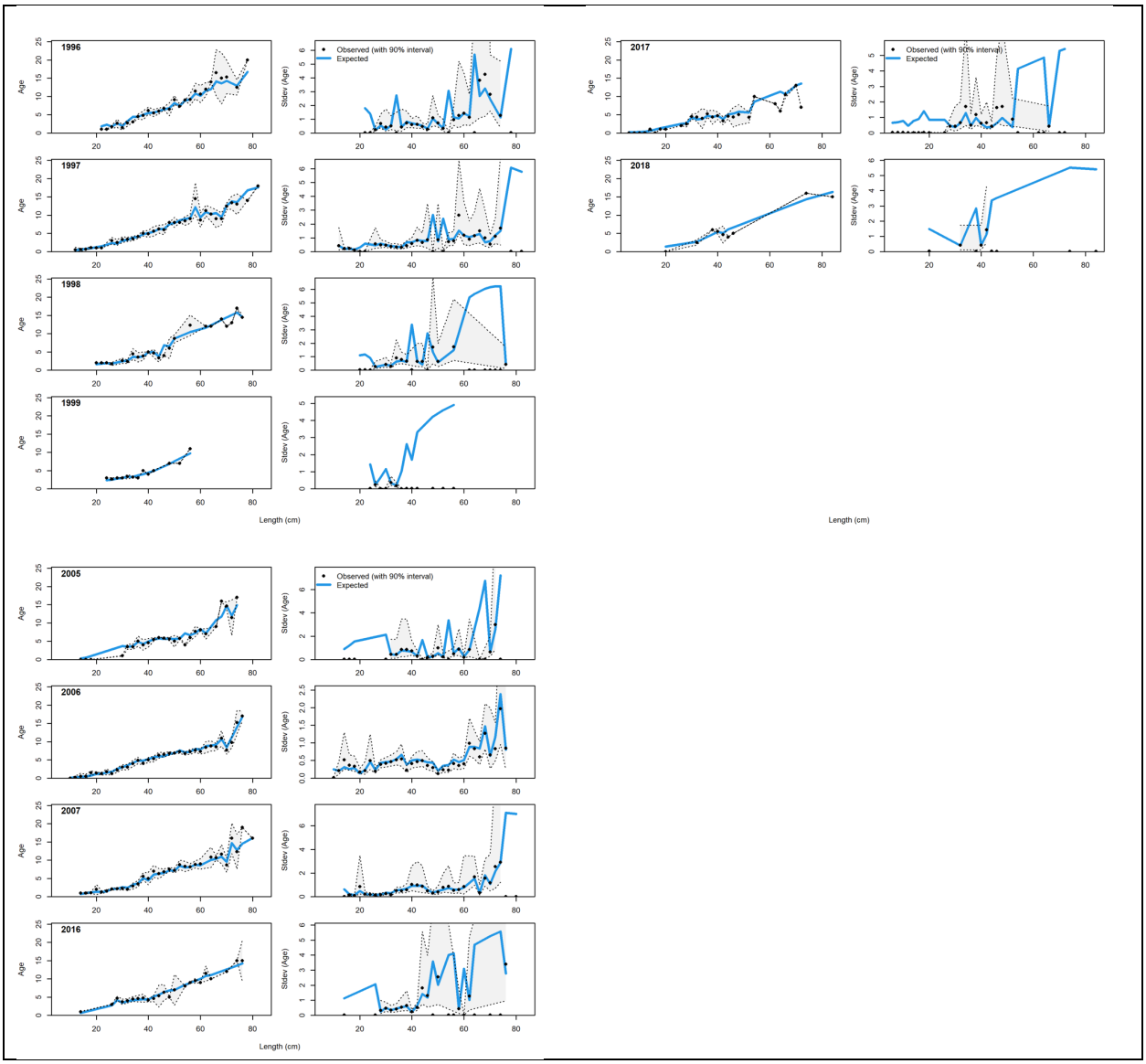


Figure 4.28. Model fits to the annual conditional age-at-length data from fishery-independent research collected using the spear gear for West Florida Shelf Hogfish. In the left plots, the blue lines represent predicted mean age-at-length by size class while the black dots and grey shaded regions represent the observed mean age-at-length by size class with 90% confidence intervals. In the right plots, the blue lines represent predicted standard error of mean age-at-length by size class while the black dots and grey shaded regions represent the observed standard error of mean age-at-length by size class with 90% confidence intervals.

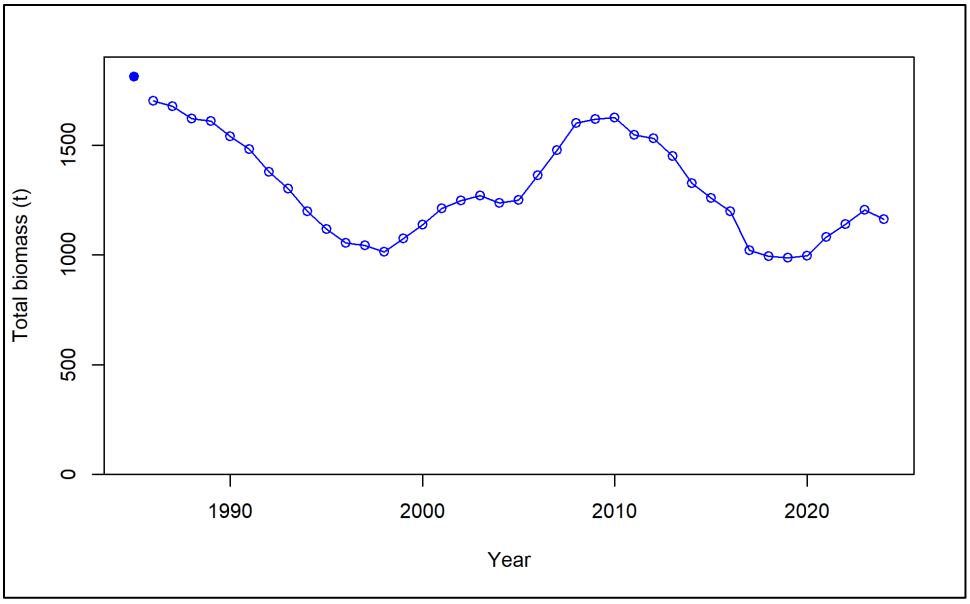


Figure 4.29. Estimates of total biomass (in metric tons) of West Florida Shelf Hogfish (open circles) from 1986 – 2024. The solid blue dot is the estimated unfished total biomass.

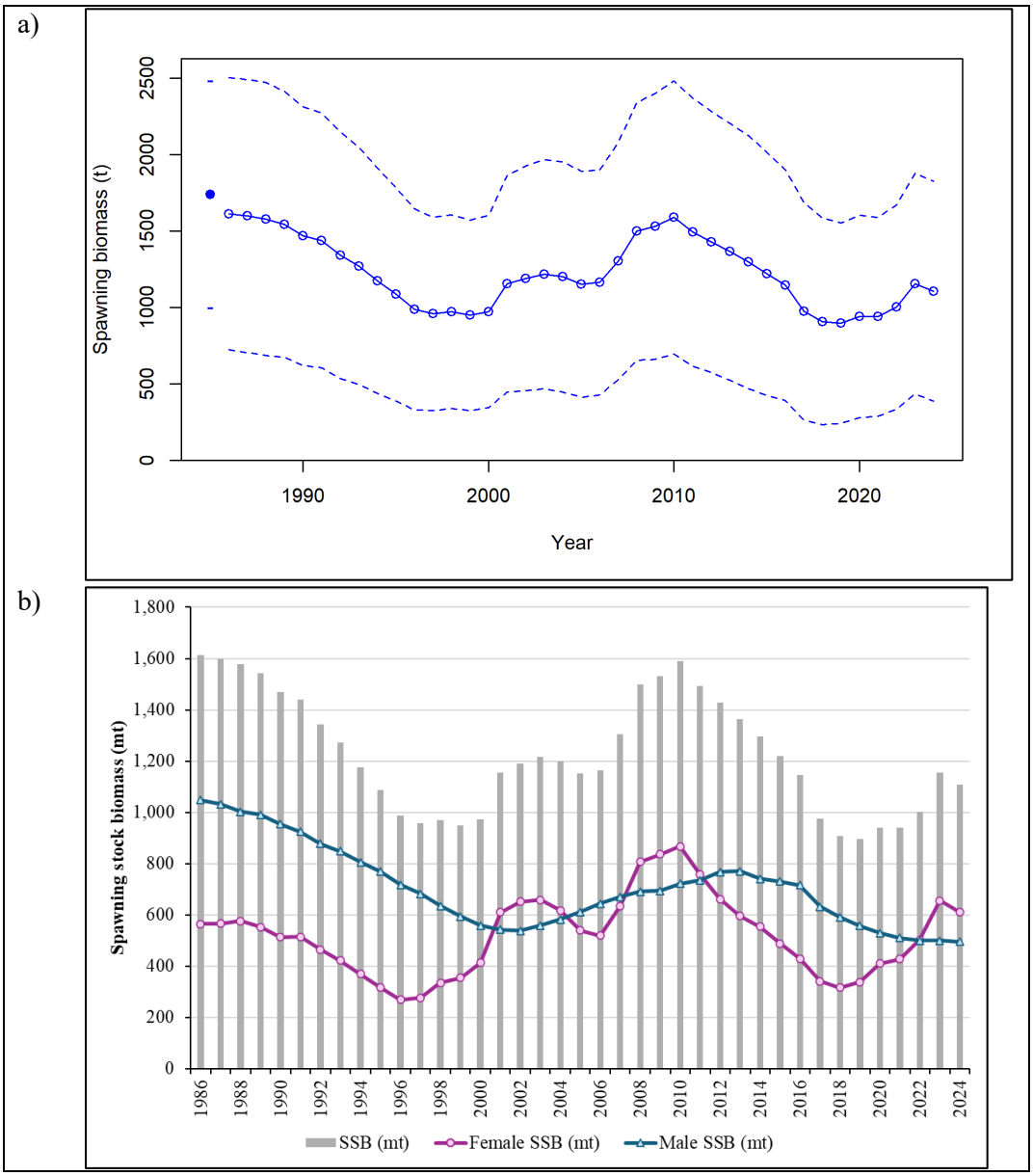


Figure 4.30. Estimates of mature female and male spawning stock biomass a) combined (in metric tons, open circles) with approximate 95% confidence intervals (dashed lines) where the solid blue circle is the estimated unfished spawning stock biomass, and b) separated by sex (female = purple circles, male = blue triangles, combined = grey bars) for West Florida Shelf Hogfish from 1986 – 2024.

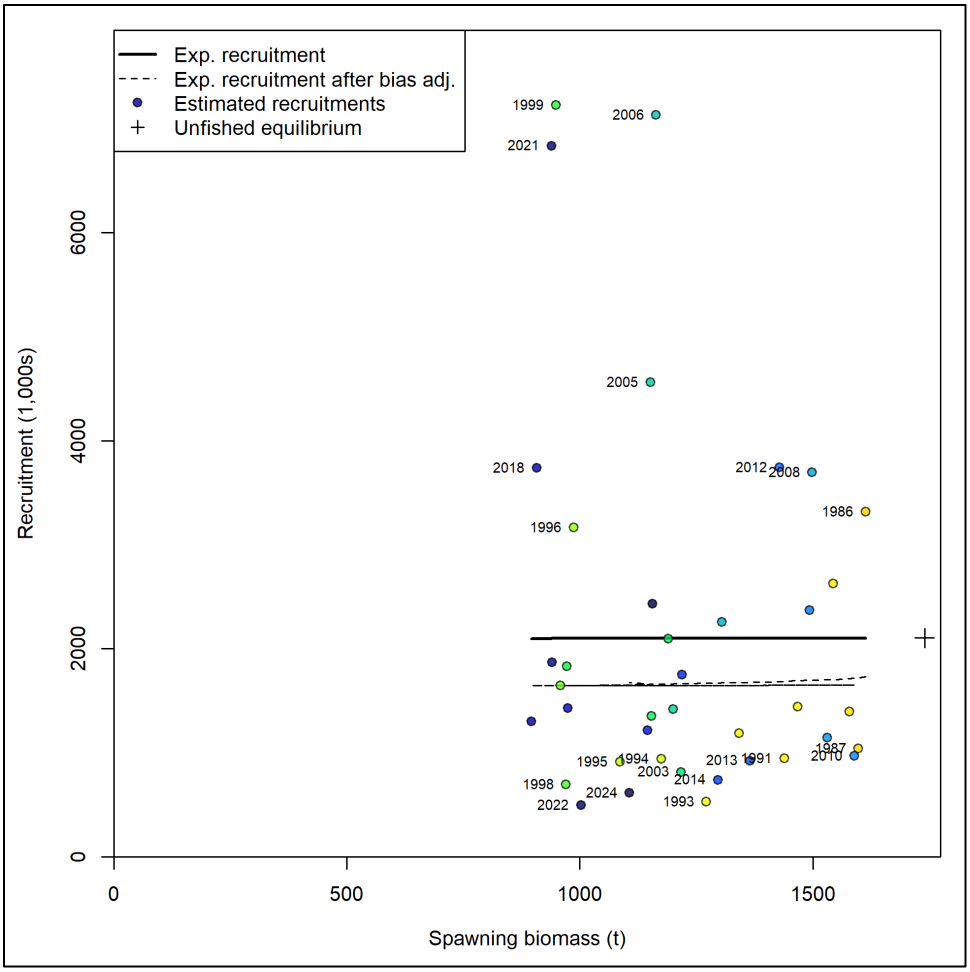


Figure 4.31. Expected stock-recruitment relationship for West Florida Shelf Hogfish. Steepness was fixed at 0.99, thereby representing average recruitment across time, and sigmaR was estimated at 0.726. Plotted are expected annual recruitments from the SEDAR 94 WFS base model (circles), expected recruitment from the stock-recruitment relationship (black line), and bias adjusted recruitment from the stock-recruit relationship (dashed line). Point colors indicate year, with warmer colors indicating earlier years and cooler colors showing later years.

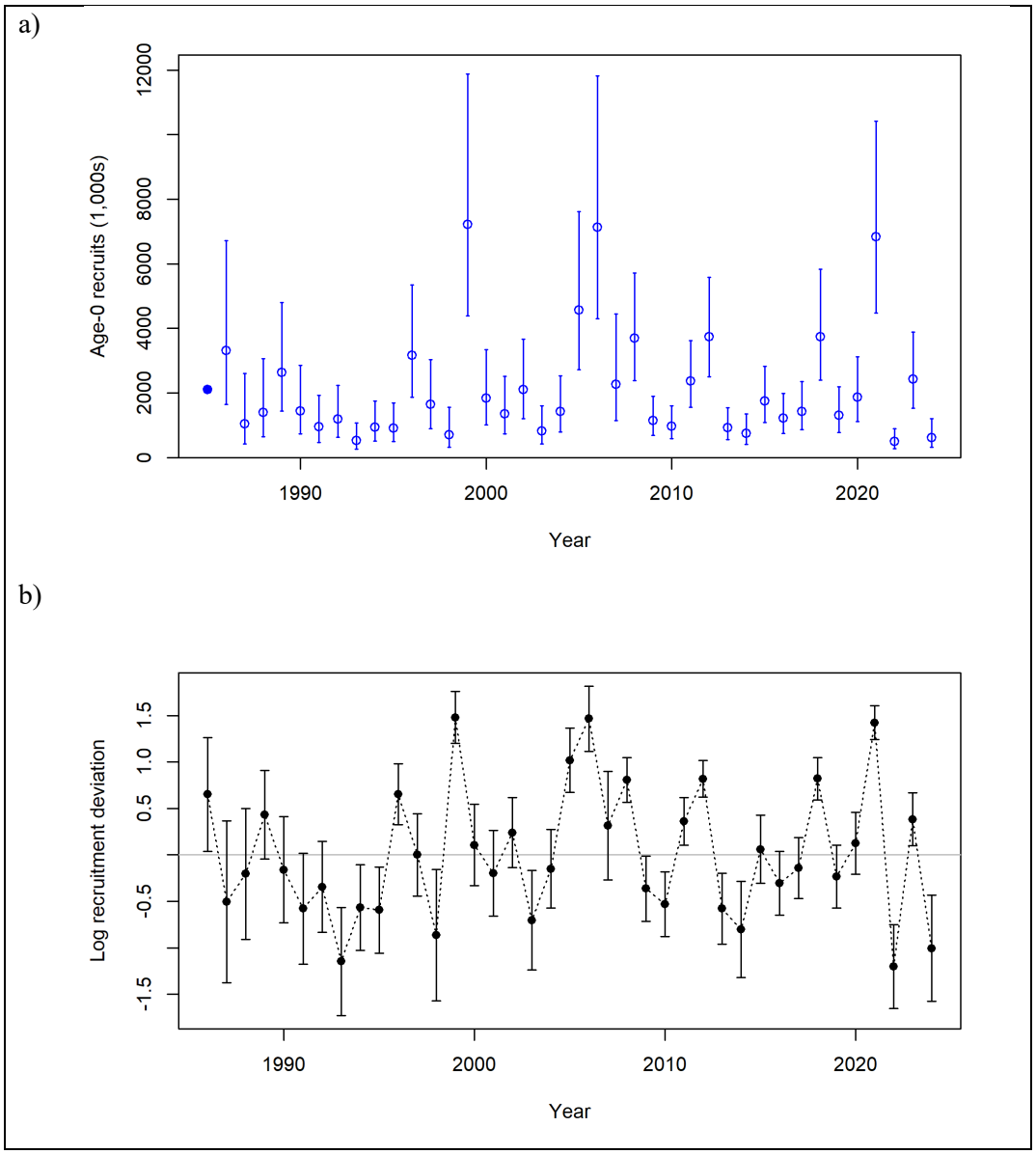


Figure 4.32. Estimated recruitment for West Florida Shelf Hogfish. a) Annual estimated age-0 recruitment (open circles) with 95% confidence intervals (lines) as well as estimated initial equilibrium recruitment (blue dot). b) Log-scaled main recruitment deviations (dots) with 95% confidence intervals (lines) from 1981 – 2021.

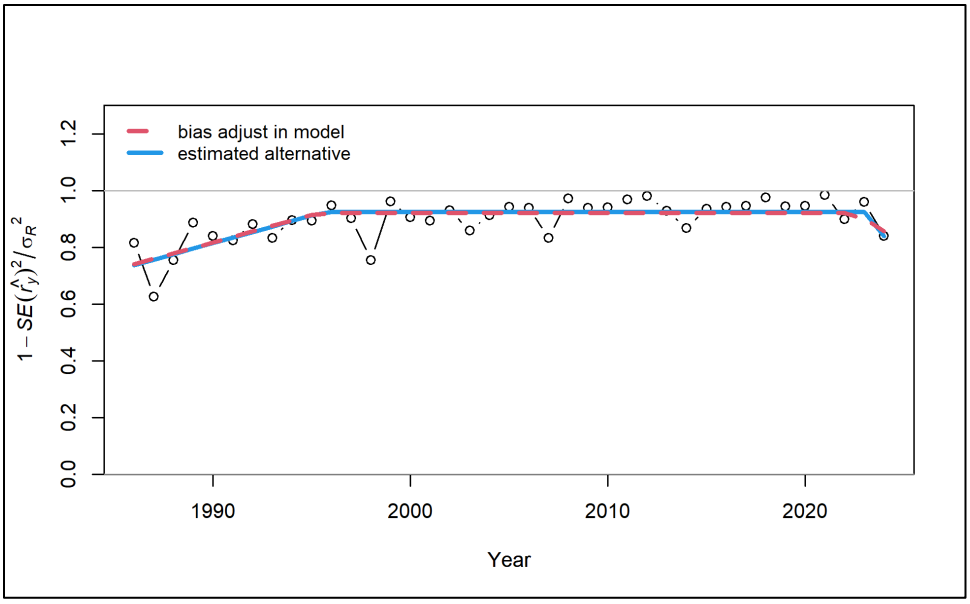


Figure 4.33. Points are transformed variances. Red line shows current settings for bias adjustment specified for the SEDAR 94 WFS base model, which coincides with the least squares estimate of alternative bias adjustment relationship for recruitment deviations (dashed red line). For more information, see Methot and Taylor (2011).

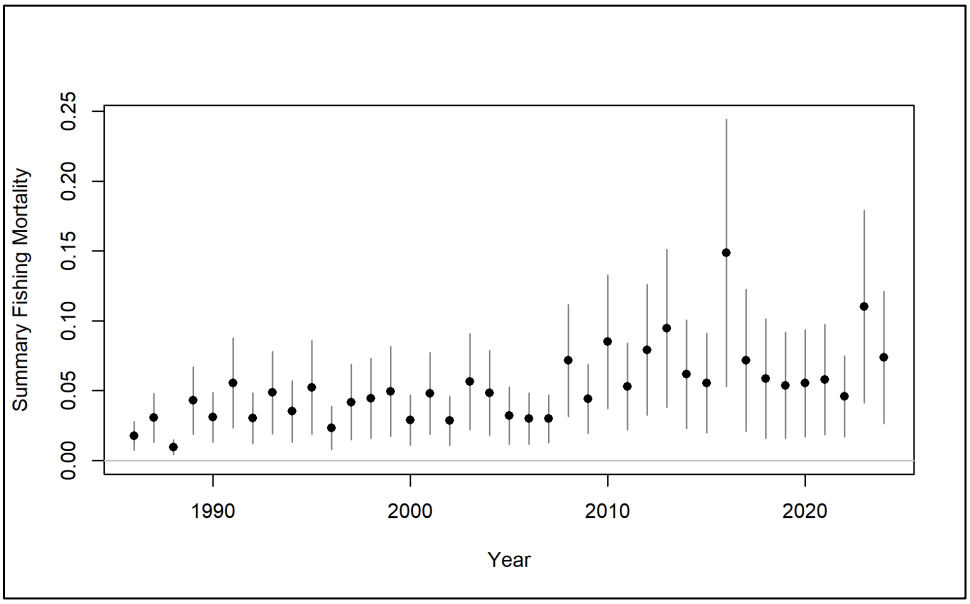


Figure 4.34. Annual exploitation fishing mortality rates, calculated as the ratio of the total annual catch in biomass to the age-1+ biomass at the beginning of the year, for West Florida Shelf Hogfish with 95% confidence intervals from the SEDAR 94 WFS base model.

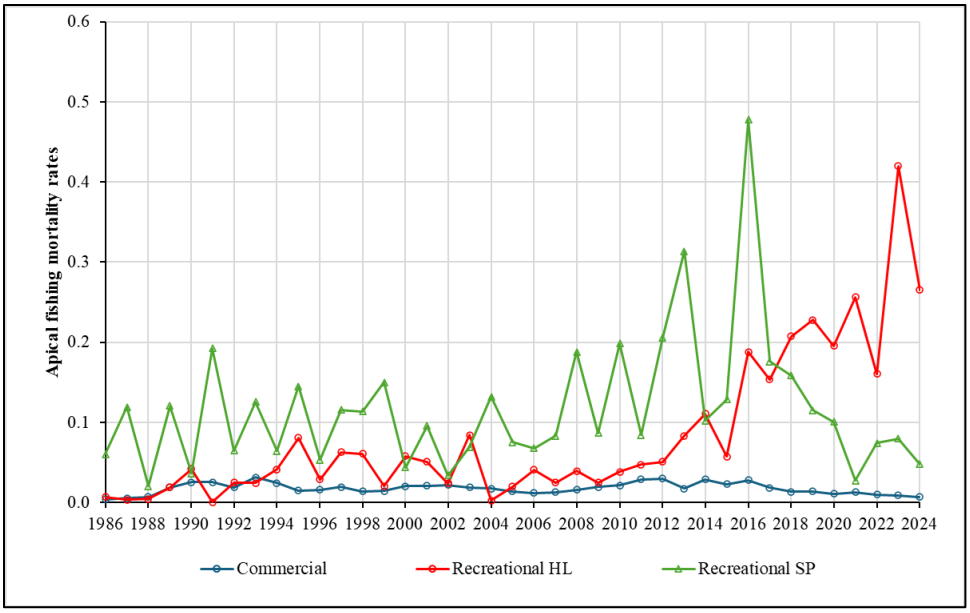


Figure 4.35. Annual fleet-specific instantaneous apical fishing mortality rates for West Florida Shelf Hogfish from the SEDAR 94 WFS base model. This represents the instantaneous fishing mortality level on the most vulnerable (i.e., selectivity = 1) age class for each fleet.

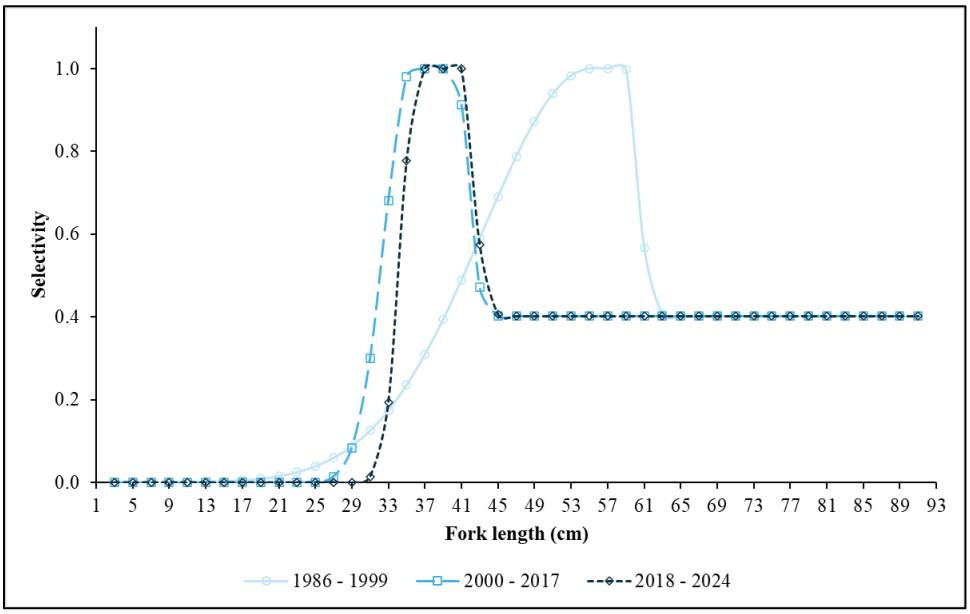


Figure 4.36. Length-based selectivity of the commercial fleet by time block for West Florida Shelf Hogfish from the SEDAR 94 WFS base model.

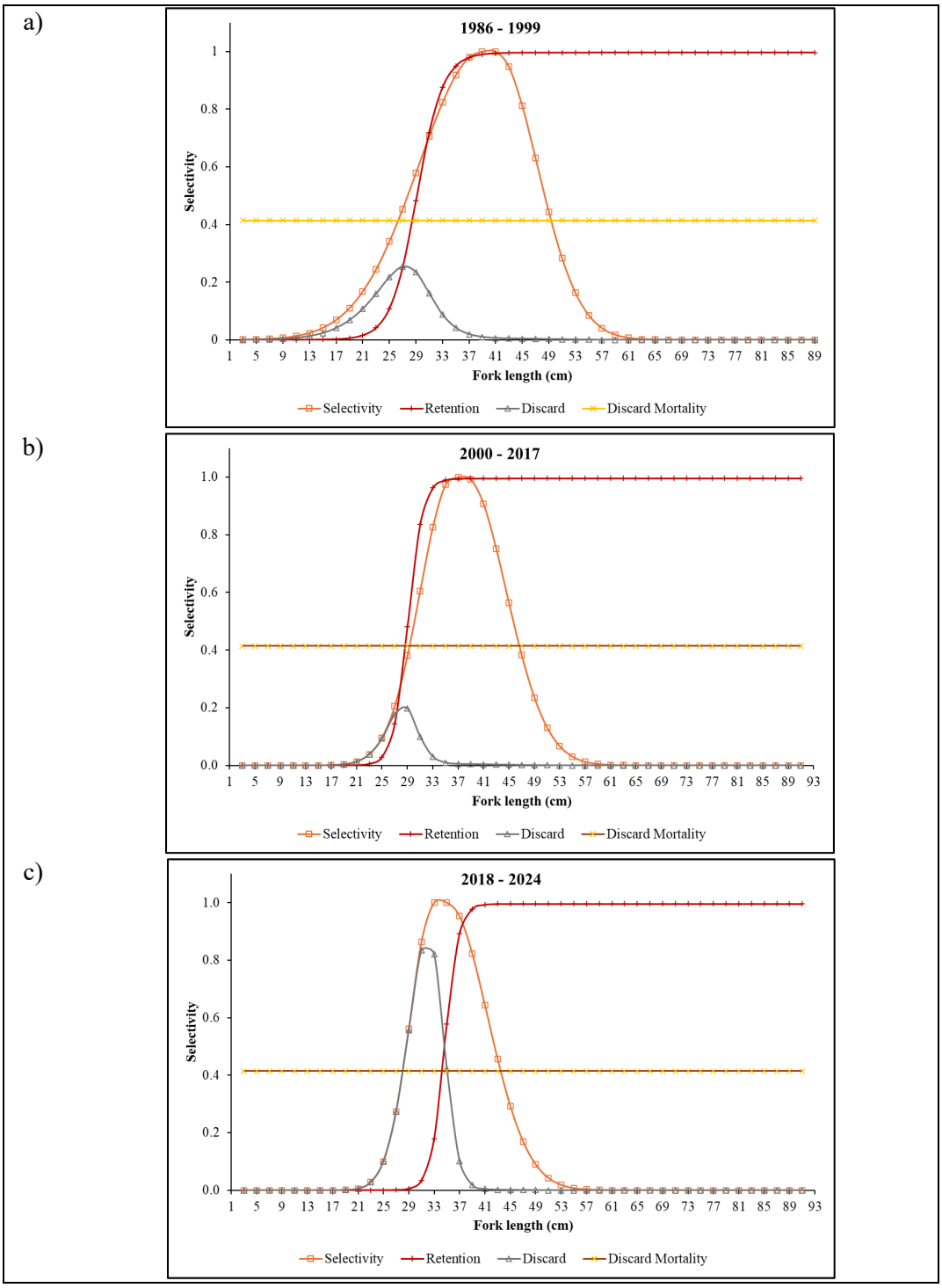


Figure 4.37. Length-based selectivity, retention, discard, and discard mortality (41.4%) patterns of the recreational hook-and-line fleet by time block a) 1986 – 1999, b) 2000 – 2017, and c) 2018 – 2024 for West Florida Shelf Hogfish from the SEDAR 94 WFS base model.

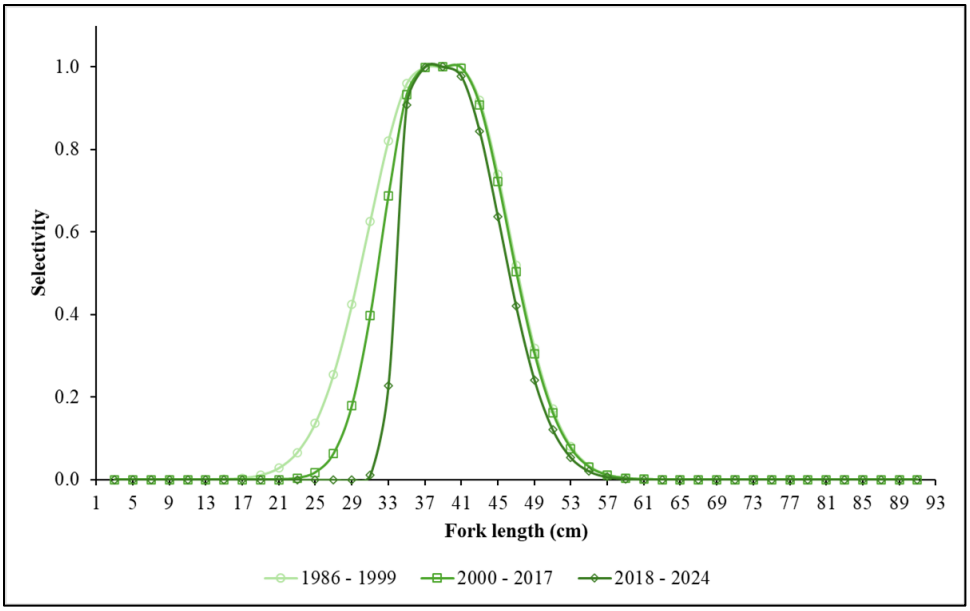


Figure 4.38. Length-based selectivity of the recreational spear fleet by time block for West Florida Shelf Hogfish from the SEDAR 94 WFS base model.

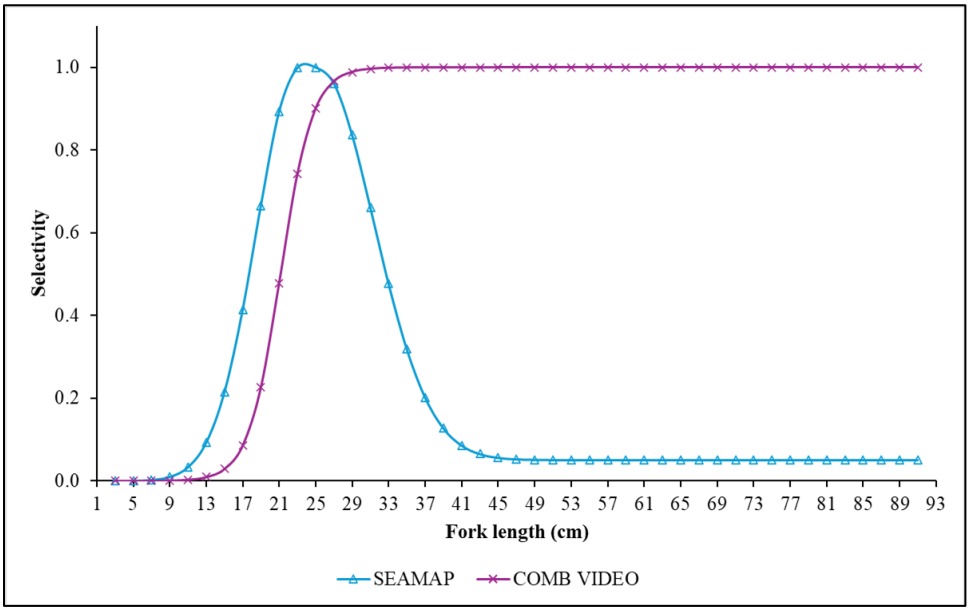


Figure 4.39. Length-based selectivity of the SEAMAP trawl index (blue triangles) and combined video index (purple x's) for West Florida Shelf Hogfish from the SEDAR 94 WFS base model.

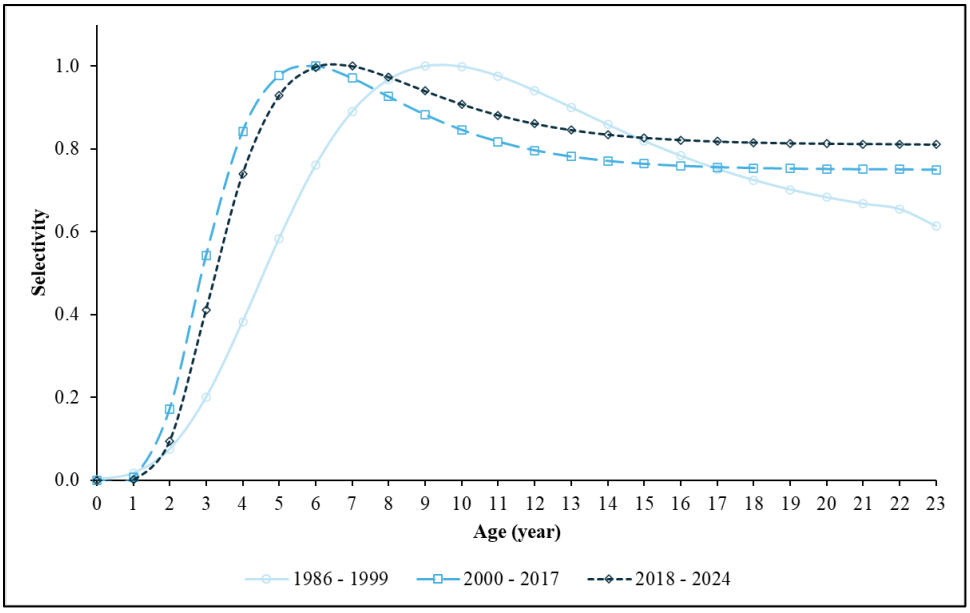


Figure 4.40. Age-derived selectivity of the commercial fleet by time block for West Florida Shelf Hogfish from the SEDAR 94 WFS base model.

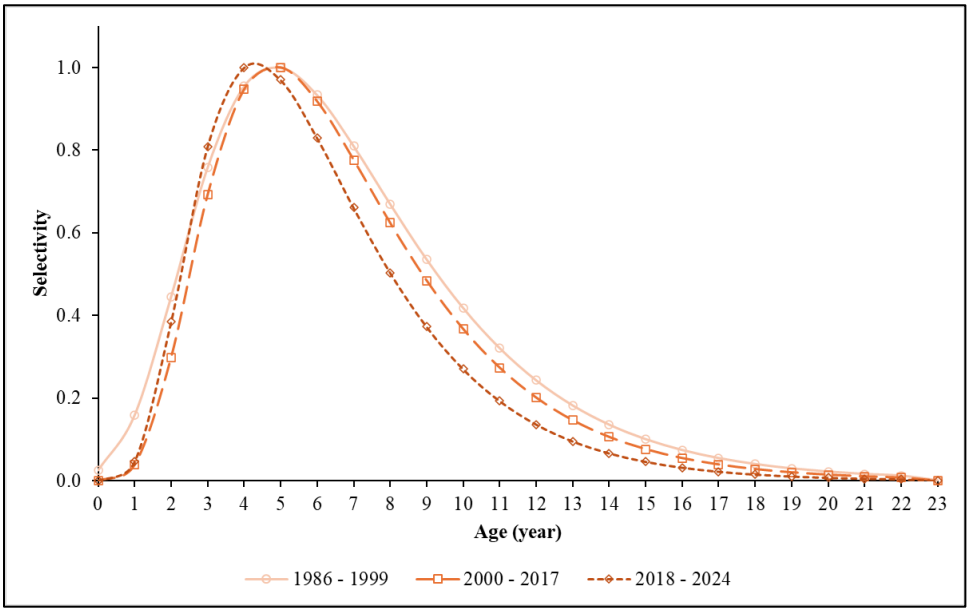


Figure 4.41. Age-derived selectivity of the recreational hook-and-line fleet by time block for West Florida Shelf Hogfish from the SEDAR 94 WFS base model.

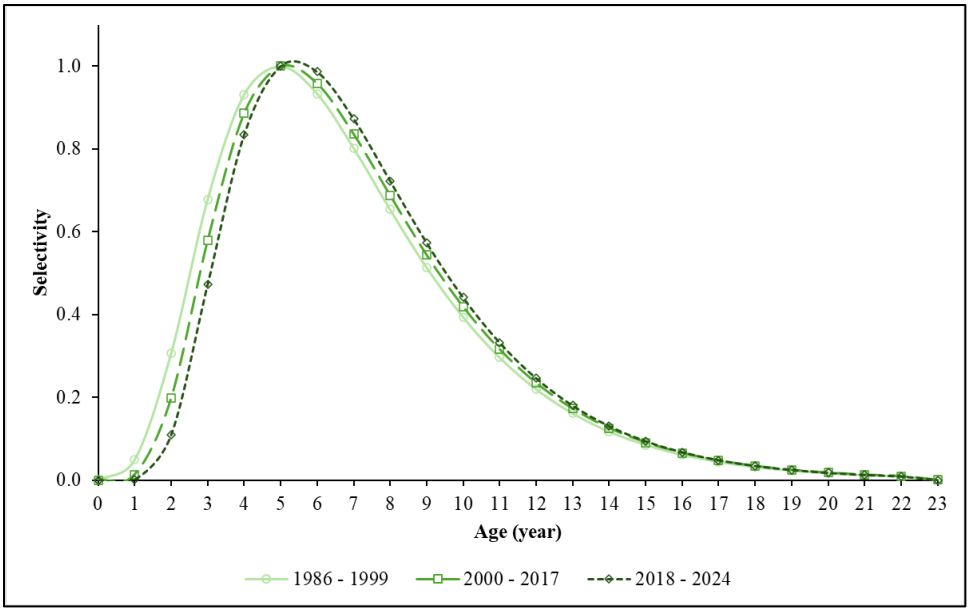


Figure 4.42. Age-derived selectivity of the recreational spear fleet by time block for West Florida Shelf Hogfish from the SEDAR 94 WFS base model.

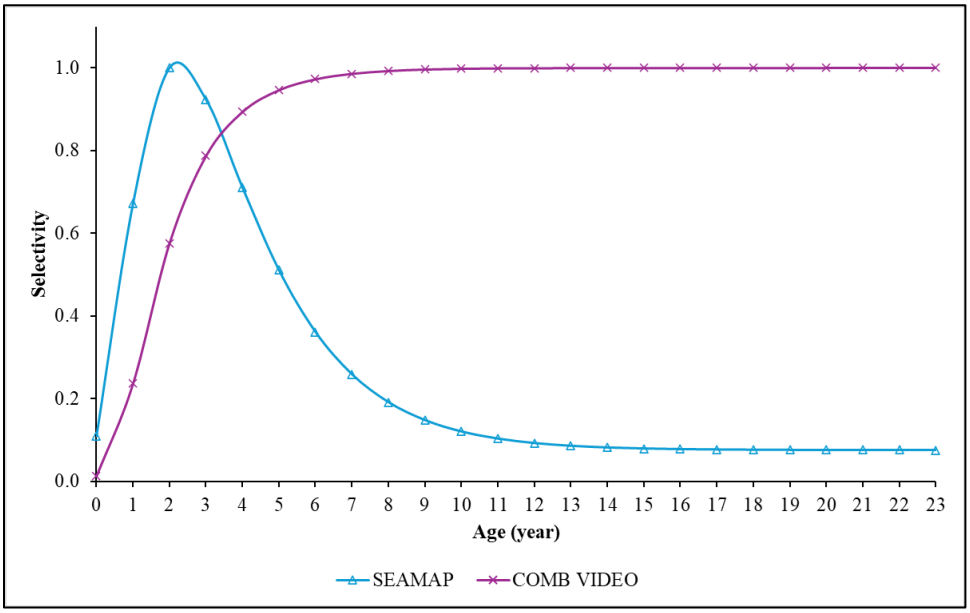


Figure 4.43. Age-derived selectivity of the SEAMAP trawl index (blue triangles) and combined video index (purple x's) for West Florida Shelf Hogfish from the SEDAR 94 WFS base model.

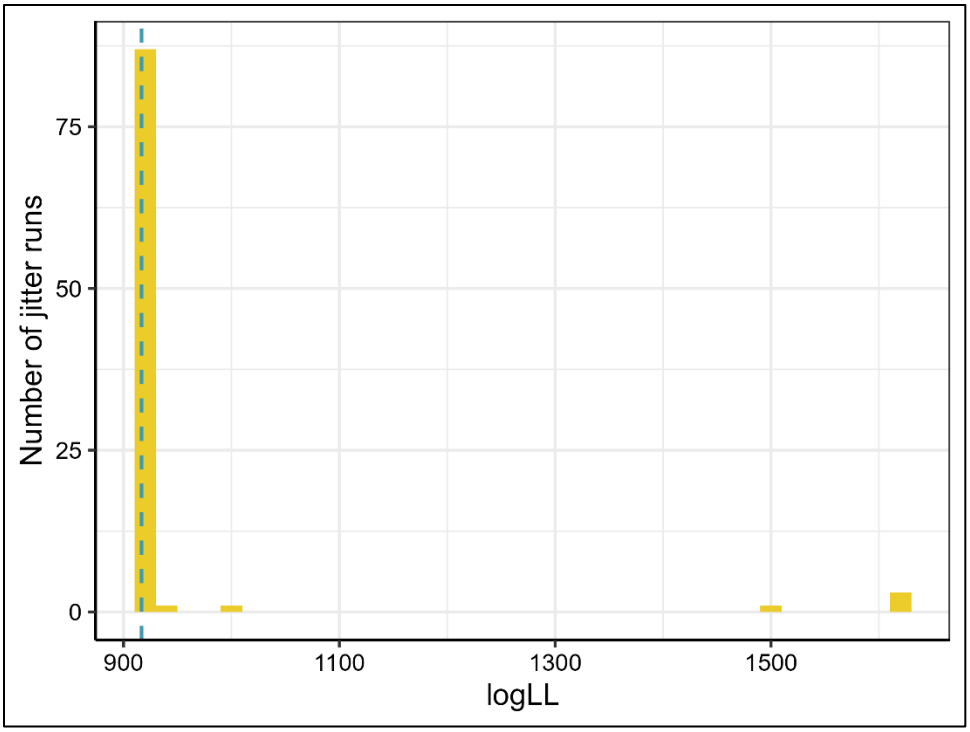


Figure 4.44. Total log-likelihood values of model runs performed by the jitter analysis (yellow bars) and the SEDAR 94 WFS base model (blue dashed line).

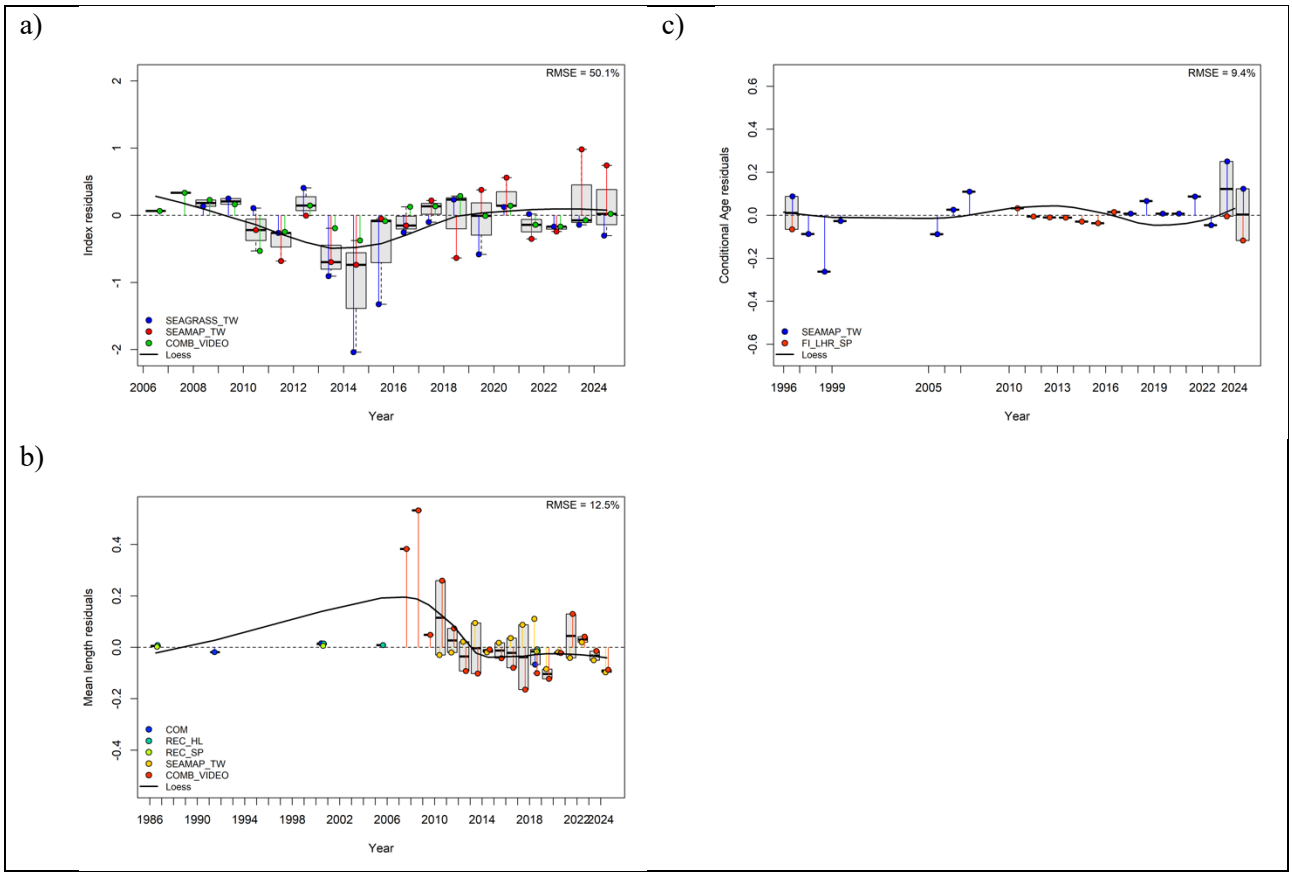


Figure 4.45. Joint residual plots for a) the indices of abundance, b) the annual mean length estimates, and c) the annual conditional age-at-length estimates of available fleets and indices from the SEDAR 94 WFS base model. Vertical lines with points show the residuals, boxplots show residual medians and quantiles, and solid black lines are a loess smoother. Root-mean squared errors (RMSE) are included in the upper right-hand corner of each plot.

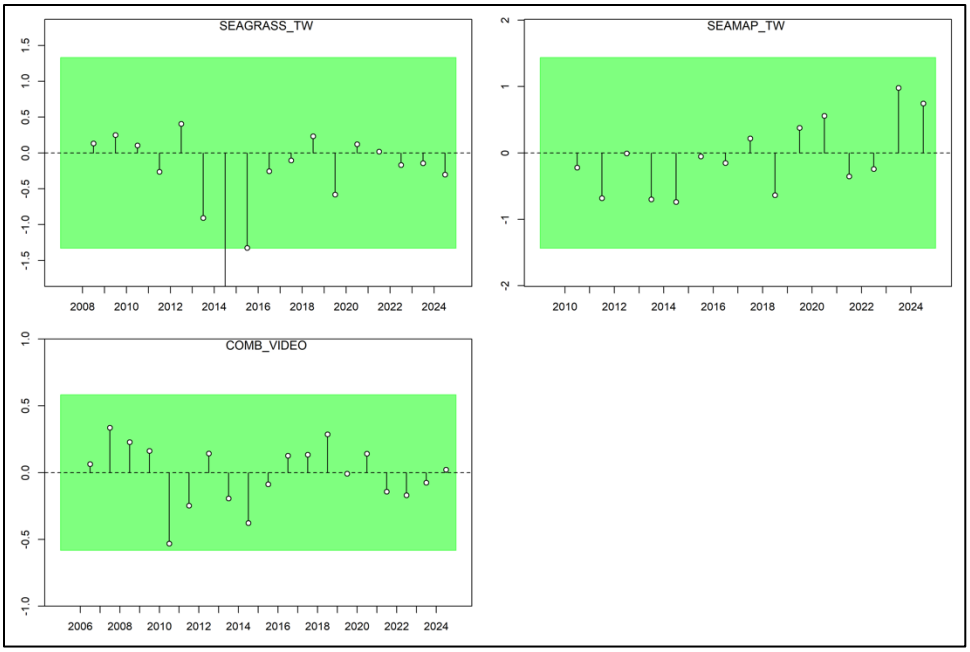


Figure 4.46. Runs tests results for the indices of abundance from the SEDAR 94 WFS base model. Green shading indicates no evidence ($p \geq 0.05$) and red shading evidence ($p < 0.05$) to reject the hypothesis of a randomly distributed time-series of residuals, respectively. Shaded regions span three residual standard deviations to either side from zero and red points outside of the shading indicate a violation of that 'three-sigma limit'.

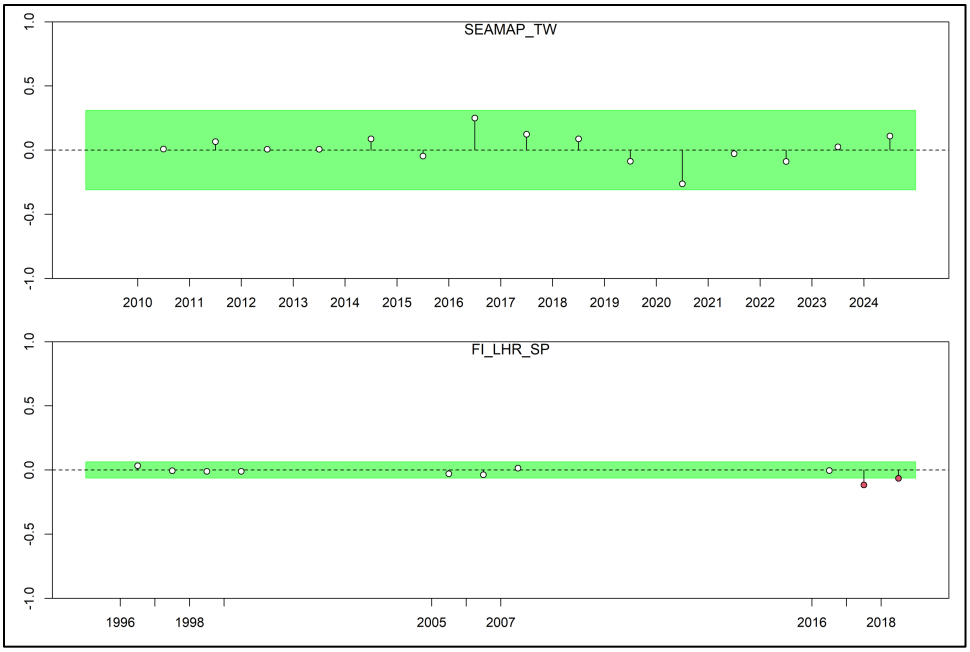


Figure 4.47. Runs tests results for the conditional age-at-length estimates (b) from the SEDAR 94 WFS base model. Green shading indicates no evidence ($p \geq 0.05$) and red shading evidence ($p < 0.05$) to reject the hypothesis of a randomly distributed time-series of residuals, respectively. Shaded regions span three residual standard deviations to either side from zero and red points outside of the shading indicate a violation of that 'three-sigma limit'.

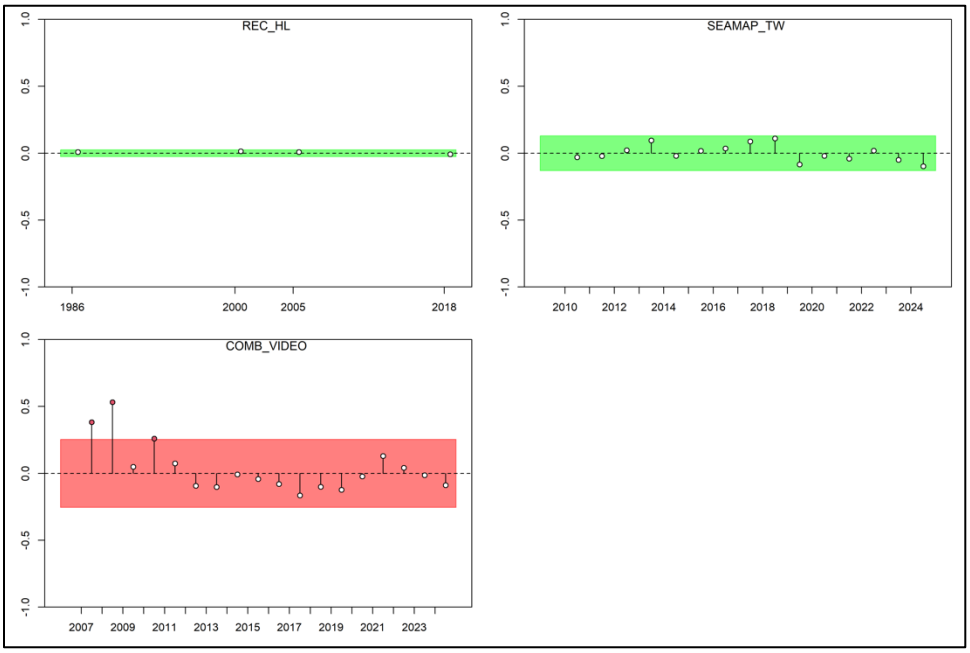


Figure 4.48. Runs tests results for the annual mean length estimates from the SEDAR 96 WFS base model. Green shading indicates no evidence ($p \geq 0.05$) and red shading evidence ($p < 0.05$) to reject the hypothesis of a randomly distributed time-series of residuals, respectively. Shaded regions span three residual standard deviations to either side from zero and red points outside of the shading indicate a violation of that 'three-sigma limit'.

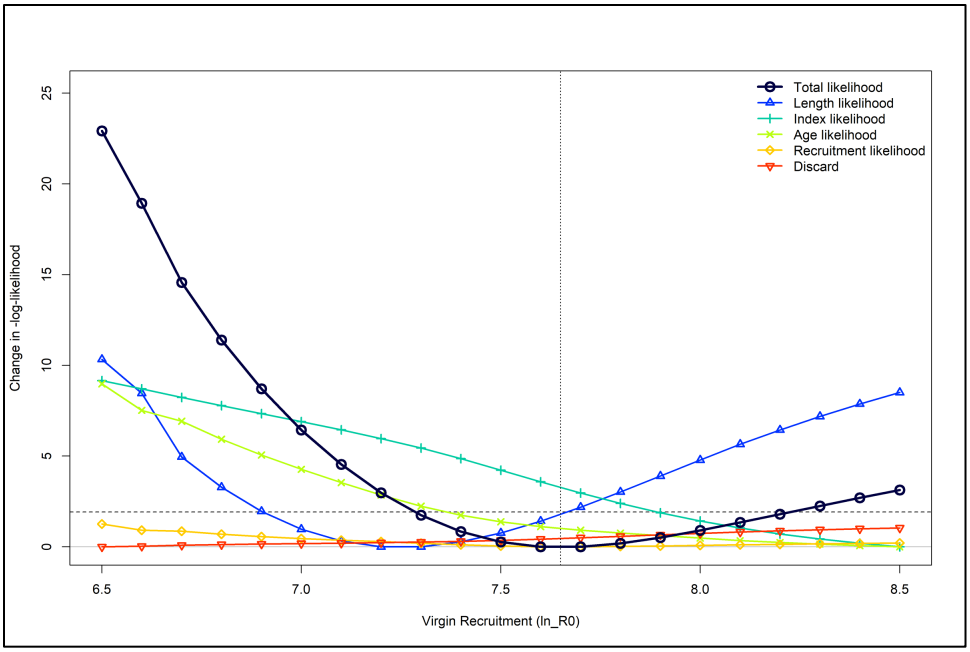


Figure 4.49. Log-likelihood profiles of the unfished (i.e., virgin) recruitment (*ln(R0)*) parameter for various data components in the SEDAR 94 WFS base model.

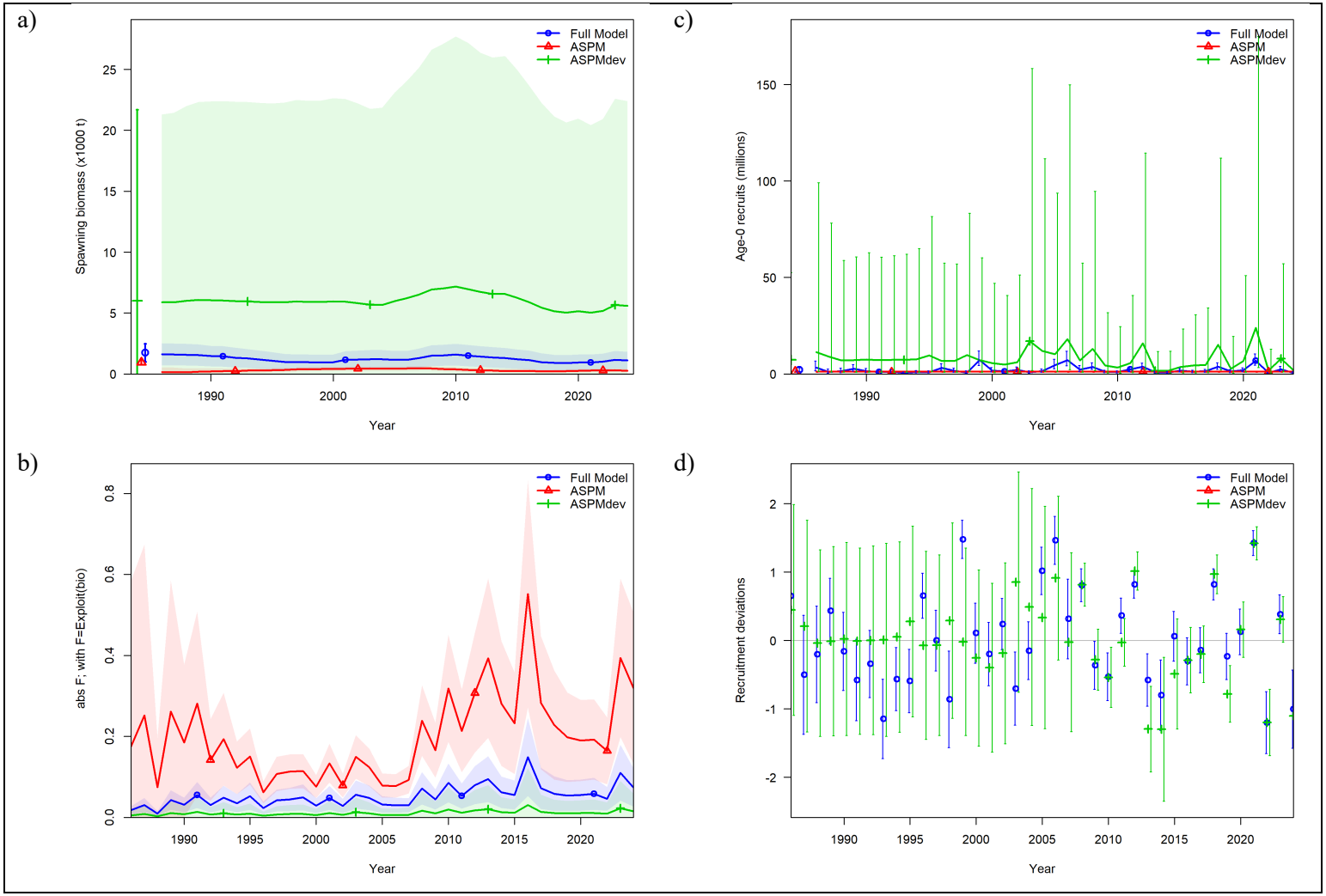


Figure 4.50. Results comparison between the SEDAR 94 WFS base model (Full Model), the deterministic Age-Structured-Production Model (ASPM), and the ASPM with recruitment deviations (ASPMdev) showing a) spawning stock biomass, b) exploitation rates, c) estimates of age-0 recruitment, and d) estimates of recruitment deviations.

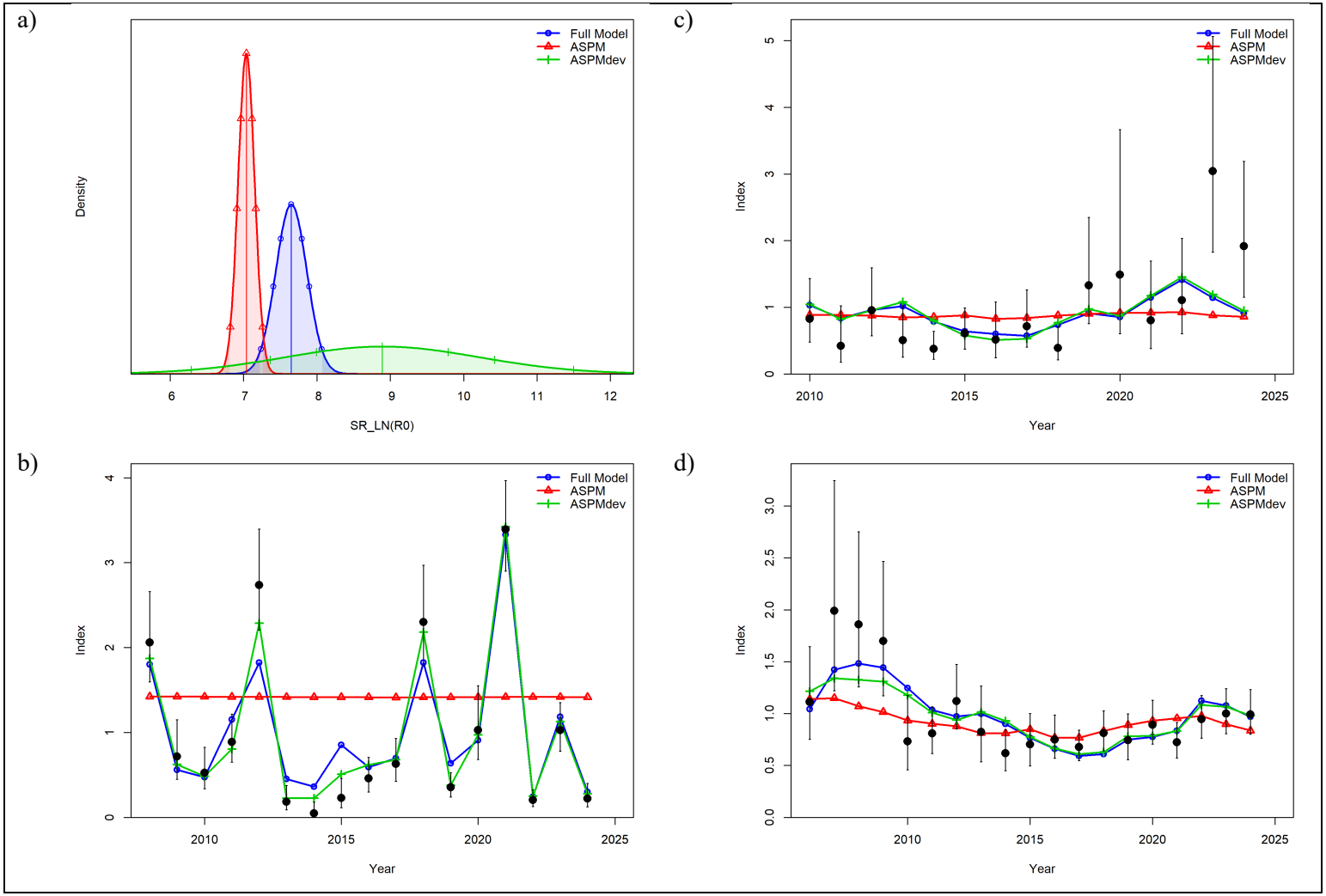


Figure 4.51. Results comparison between the SEDAR 94 WFS base model (Full Model), the deterministic Age-Structured-Production Model (ASPM), and the ASPM with recruitment deviations (ASPMdev) showing a) estimates of the virgin recruitment parameter in log-space *ln(R0)*, b) observed and predicted values for the seagrass trawl index, c) observed and predicted values for the SEAMAP trawl index, and d) observed and predicted values for the combined video index.

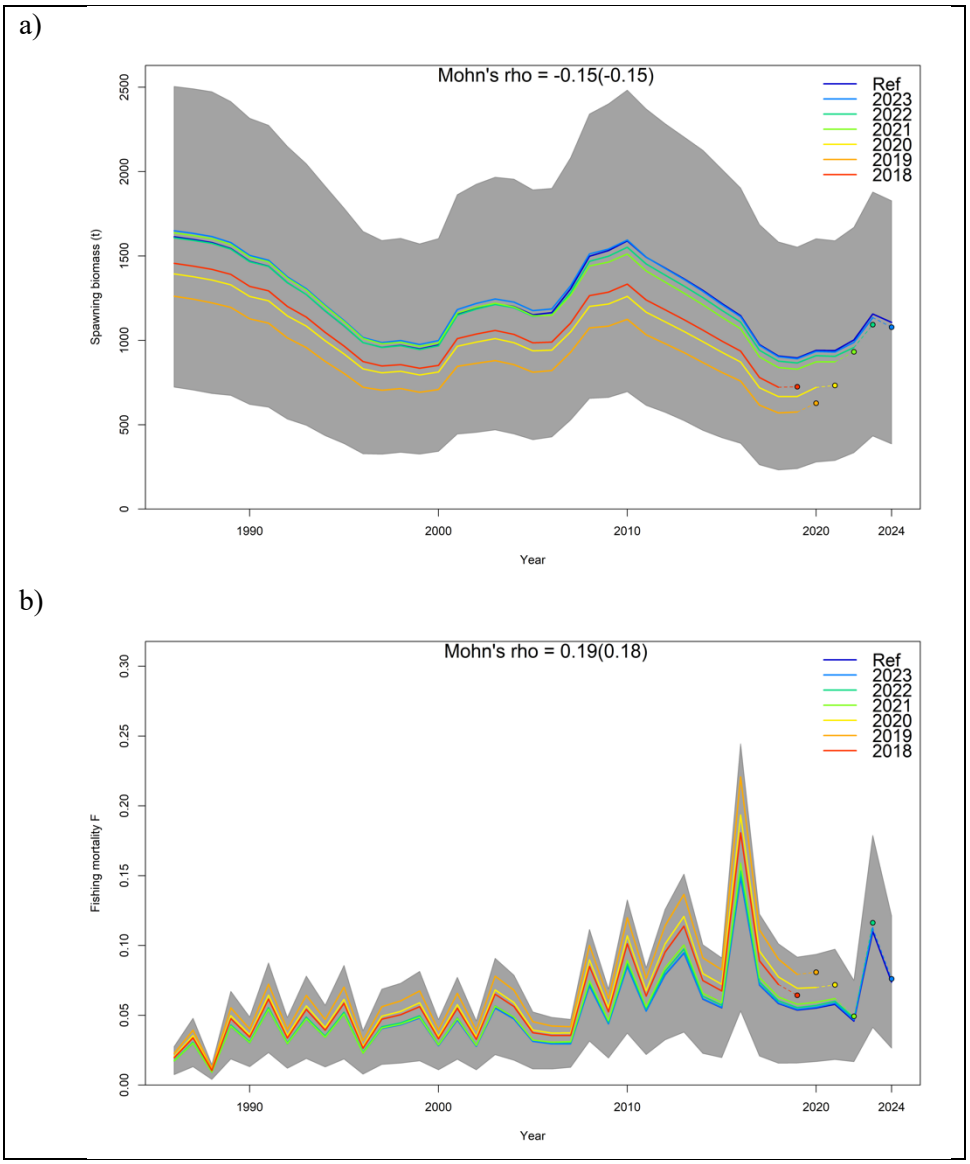


Figure 4.52. Retrospective forecast results of a) spawning stock biomass and b) exploitation rates conducted by re-fitting the SEDAR 94 WFS base model (Ref) after sequentially removing six years of observations. The Mohn's rho (ρ_M) statistic and corresponding forecast rho (ρ_F) values (in parenthesis) are provided at the top of each panel. One-year-ahead projections denoted by color-coded dashed lines with terminal points are shown for each peel. Grey shaded areas are the 95% confidence intervals from the SEDAR 94 WFS base model.

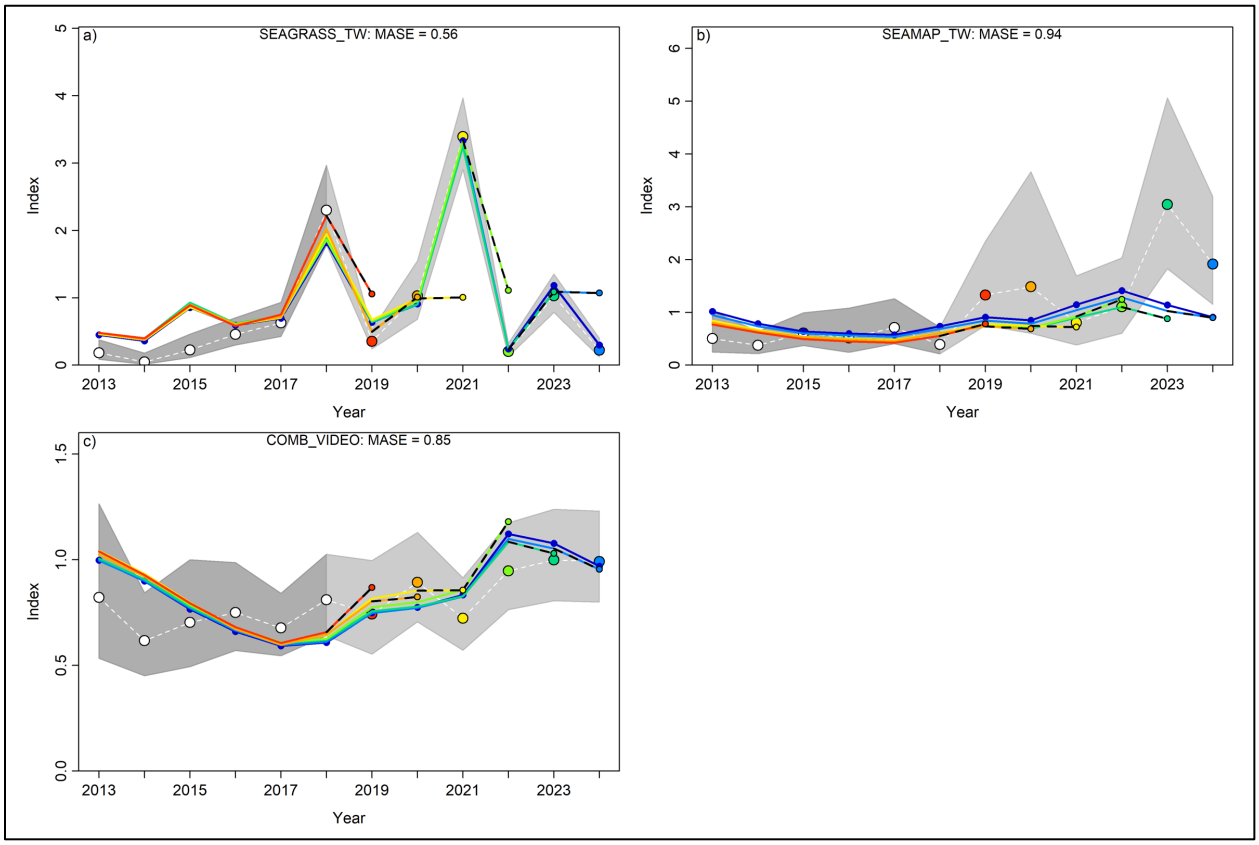


Figure 4.53. Hindcasting cross-validation results for the a) seagrass trawl index, b) SEAMAP trawl survey, and c) combined video survey from the SEDAR 94 WFS base model showing observed (large white points connected with dashed line), fitted (solid lines), and one-year ahead forecast values (small terminal points). The color-coded solid circles are the observations used for cross-validation and the light-gray shaded area is the associated 95 % confidence intervals. The mean absolute scaled error (MASE) scores for each index are provided at the top of each panel.

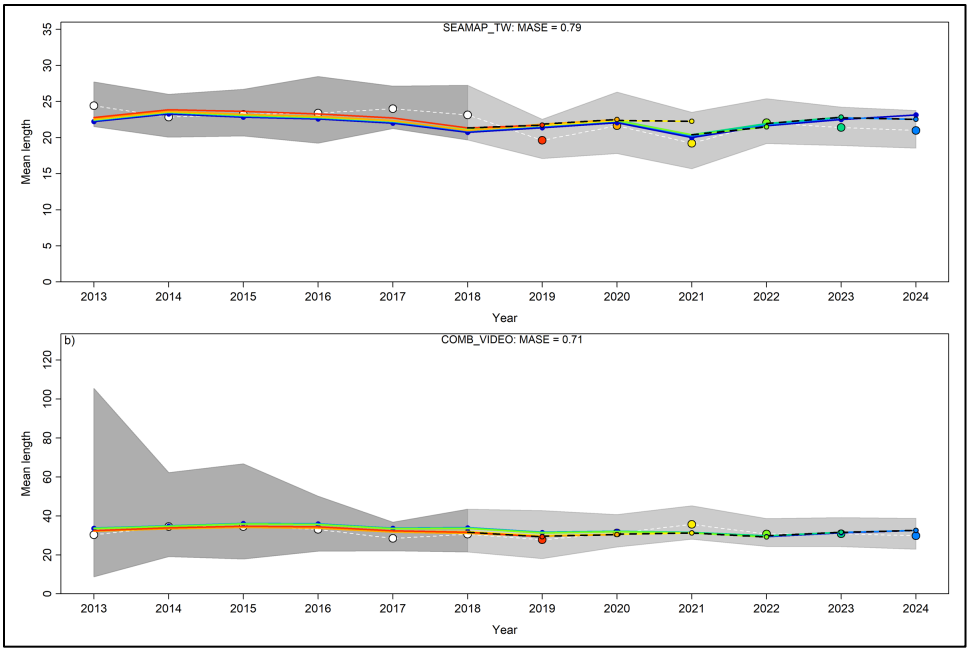


Figure 4.54. Hindcasting cross-validation results for a) SEAMAP trawl survey and b) combined video survey annual mean length estimates from the SEDAR 94 WFS base model showing observed (large white points connected with dashed line), fitted (solid lines), and one-year ahead forecast values (small terminal points). The color-coded solid circles are the observations used for cross-validation and the light-gray shaded area is the associated 95 % confidence intervals. The mean absolute scaled error (MASE) scores for each length composition series are provided at the top of each panel.

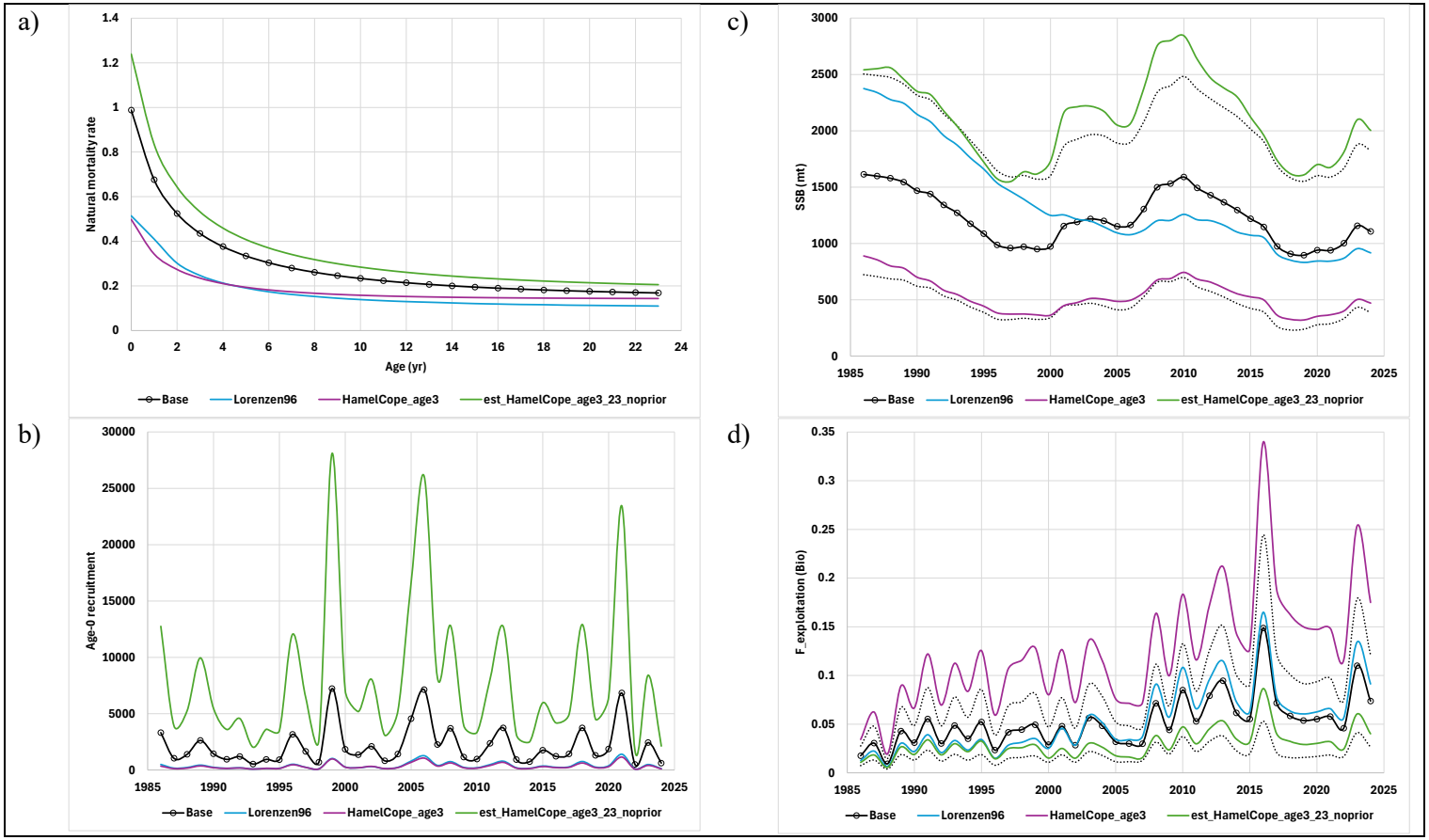


Figure 4.55. Comparison of natural mortality sensitivity runs for estimated M, age-0 recruitment, spawning stock biomass (SSB), and fishing mortality (F) for the WFS base model. Sensitivity runs included Lorenzen (1996) mortality-at-weight, Hamel and Cope (2022) age-3 specified M, and Hamel and Cope (2022) age-3 estimated M without a prior constraint.

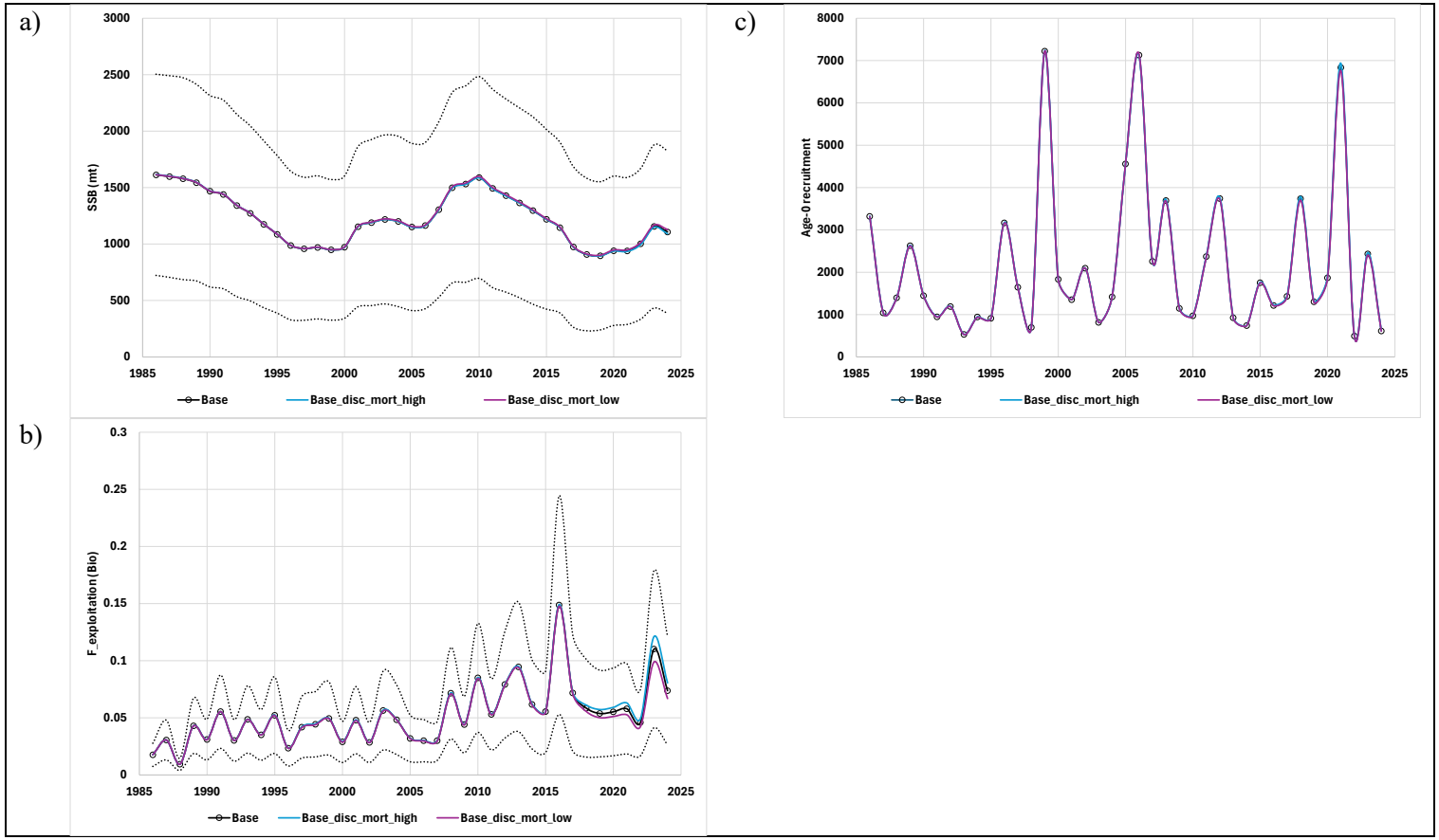


Figure 4.56. Comparison of model outputs from discard mortality sensitivity runs, including age-0 recruitment, spawning stock biomass (SSB), and fishing mortality (F), for the WFS base model and alternative high and low discard mortality scenarios applied to the recreational hook and line fleet.

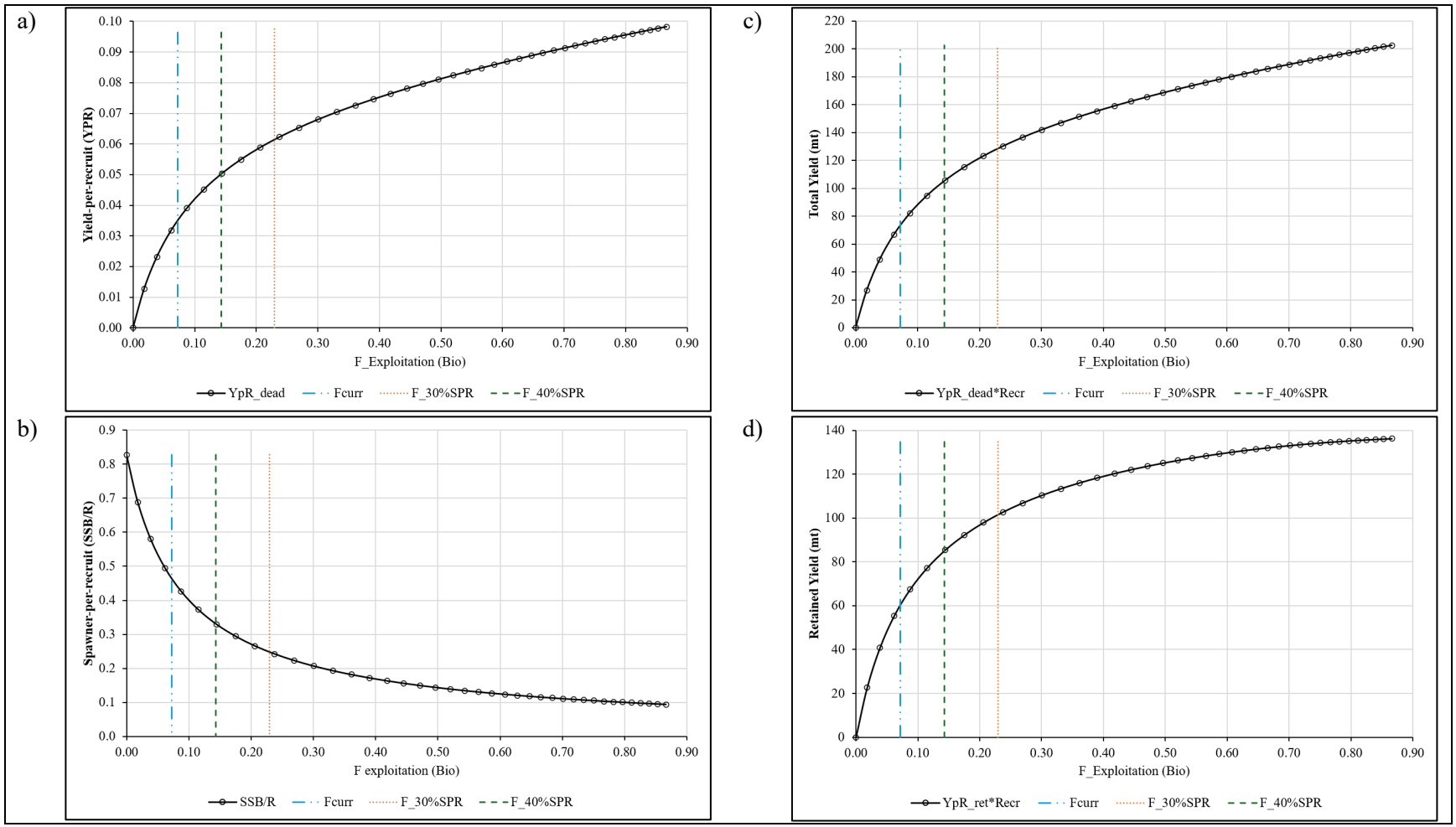


Figure 4.57. The a) yield-per-recruit, b) spawner-per-recruit, c) total equilibrium yield, and d) retained equilibrium yield computed as a function of the instantaneous exploitation rate on West Florida Shelf Hogfish.

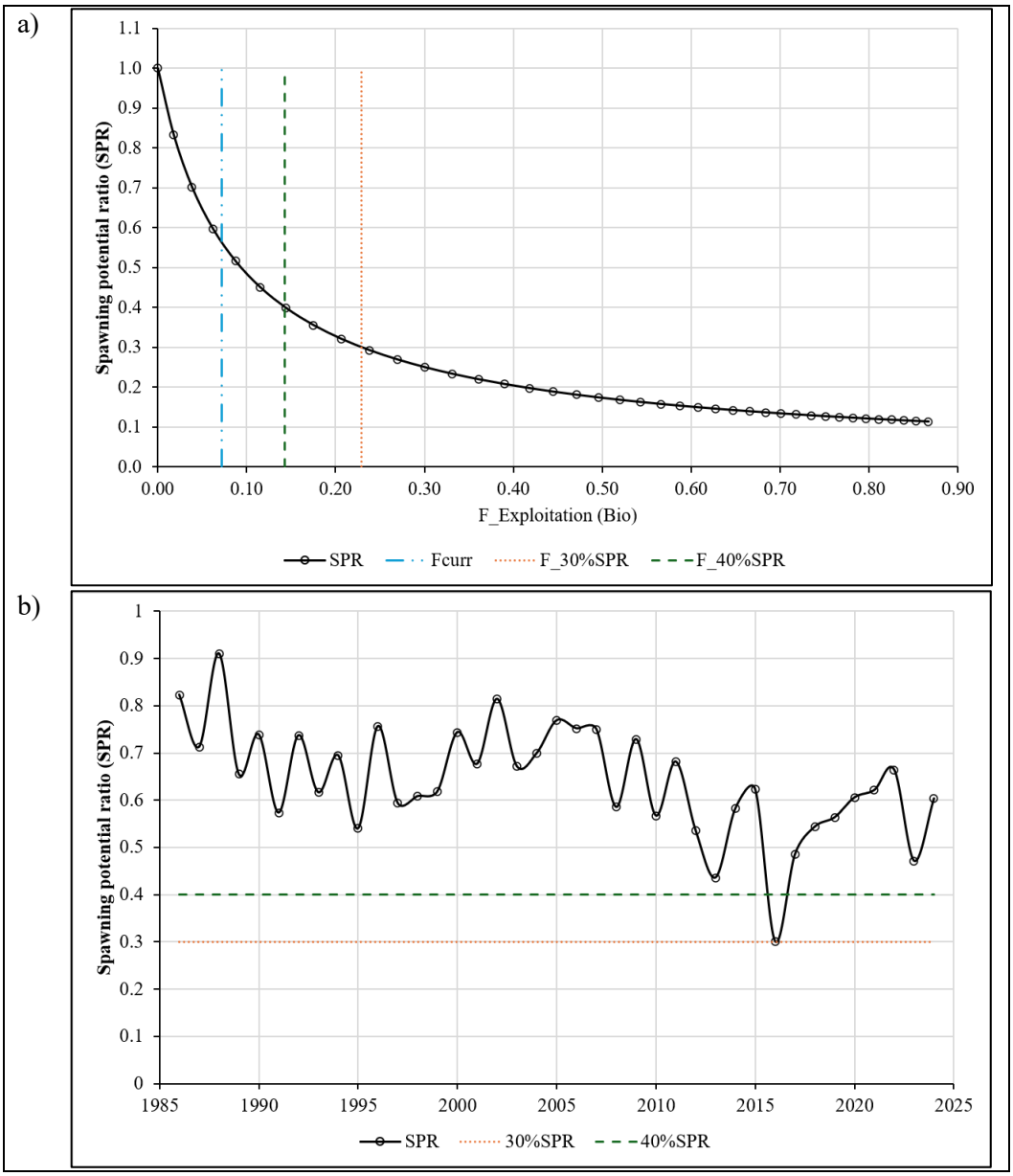
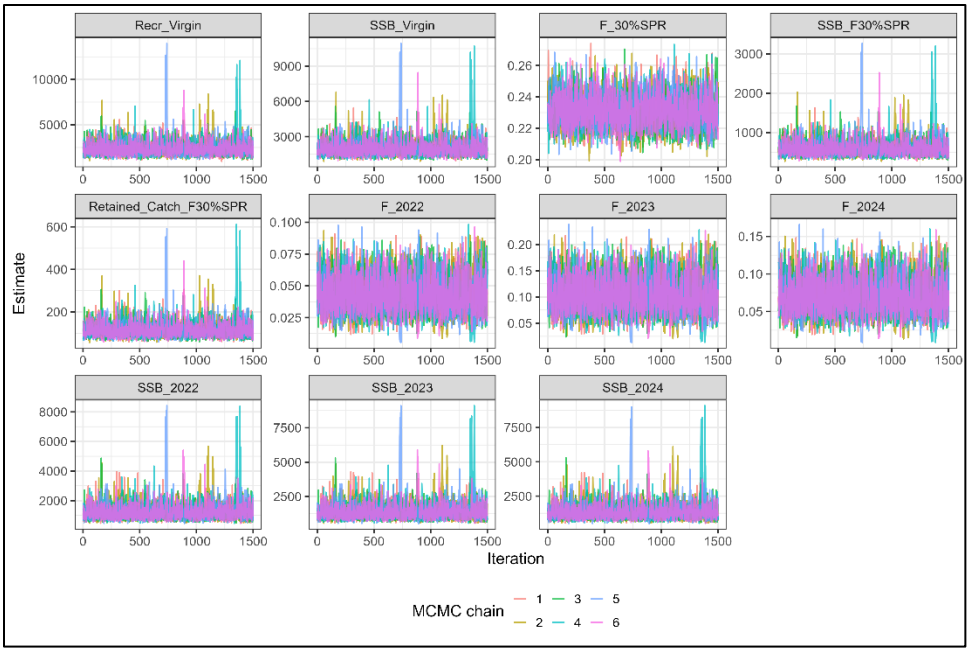


Figure 4.58. The a) static spawning potential ratio (SPR) computed as a function of the instantaneous exploitation rate, and b) static spawning potential ratio (SPR) by year for West Florida Shelf Hogfish.



c)

Figure 4.59. Combined trace plots of the six MCMC chains for selected parameters and derived quantities from the SEDAR 94 WFS base model.

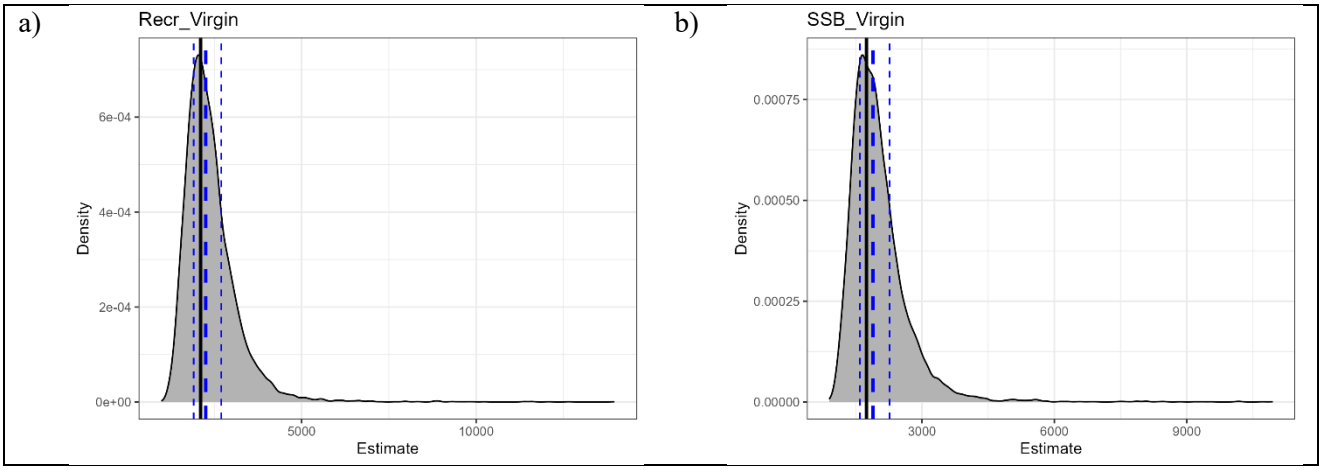


Figure 4.60. The posterior distributions for a) R_0 (i.e., virgin recruitment) and b) SSB_0 (i.e., virgin spawning stock biomass) the combined four-chain MCMC. The blue dashed lines indicate the median and interquartile ra0nge while the solid black line is the estimate from the SEDAR 94 WFS base model.

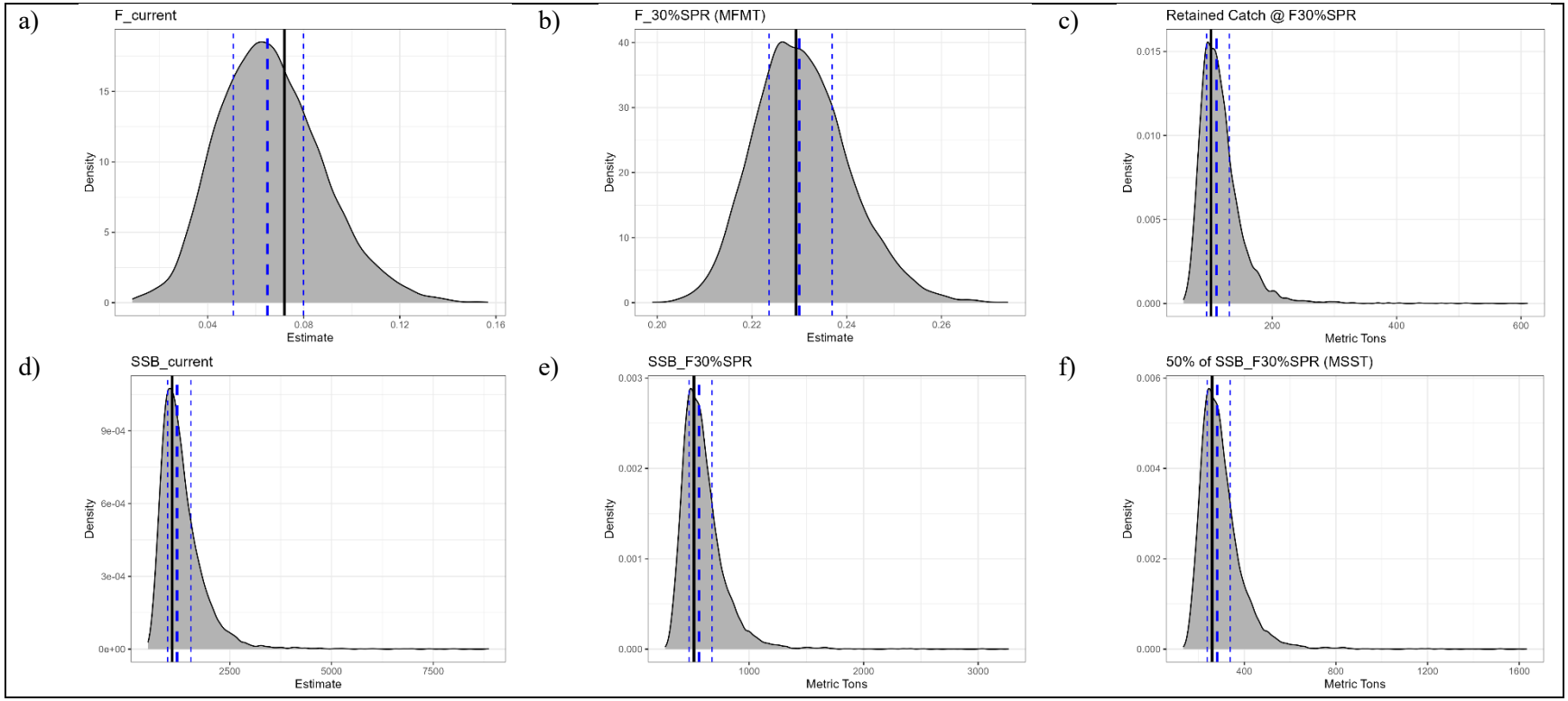


Figure 4.61. The posterior distributions for a) $F_{current}$ (i.e., geometric mean of F for years 2022 – 2024), b) $F_{30\%SPR}$ (i.e., MFMT), and c) the retained yield associated with $F_{30\%SPR}$, d) $SSB_{current}$ (i.e., geometric mean of SSB for years 2022 – 2024), e) SSB at $F_{30\%SPR}$, and f) 50% of SSB at $F_{30\%SPR}$ (i.e., MSST) from the combined six-chain MCMC. The blue dashed lines indicate the median and interquartile range while the solid black line is the estimate from the SEDAR 94 WFS base model.

c)

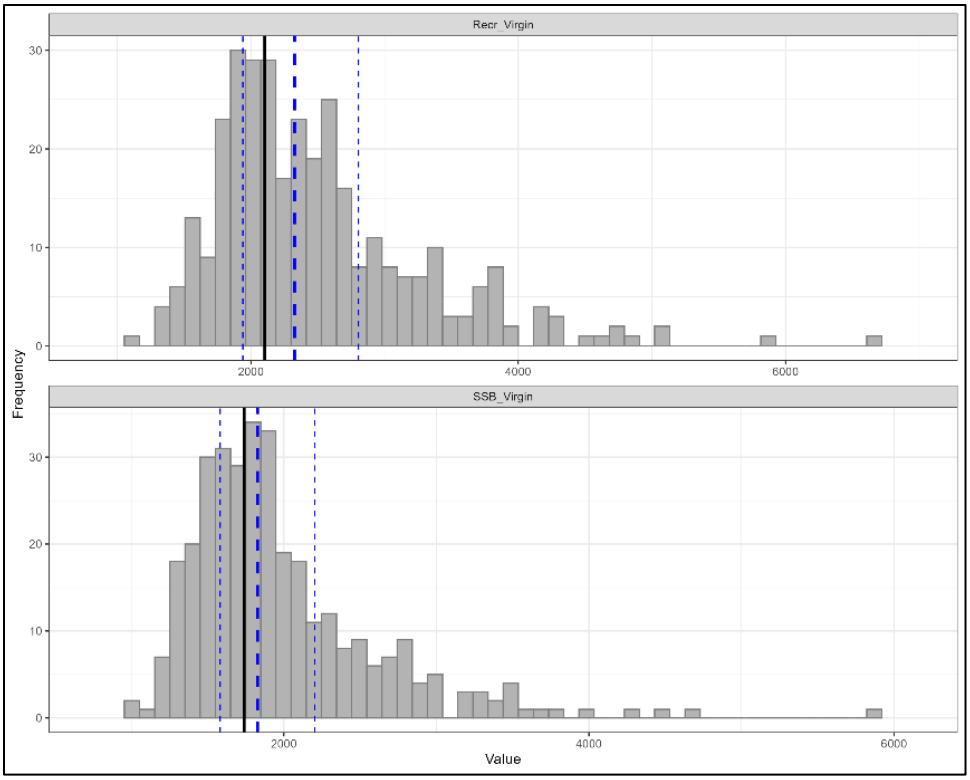


Figure 4.62. Distributions for R_0 (i.e., virgin recruitment) and SSB_0 (i.e., virgin spawning stock biomass) from parametric bootstrapping the SEDAR 94 base model. The blue dashed lines indicate the median and interquartile range while the solid black line is the estimate from the SEDAR 94 WFS base model.

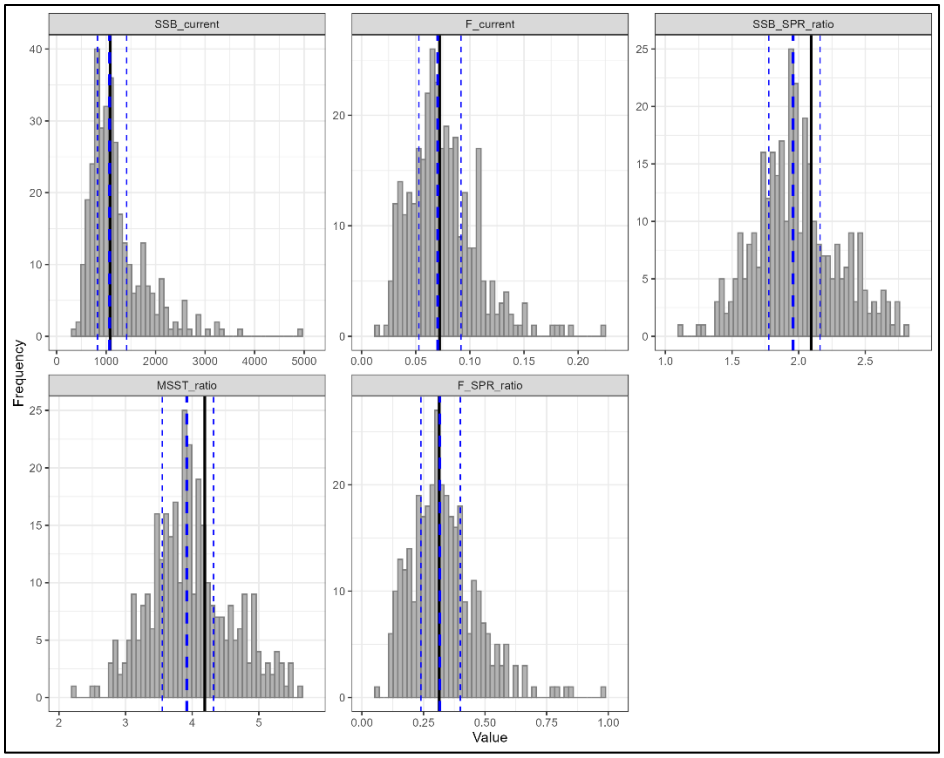


Figure 4.63. Distributions of selected parameter estimates and derived quantities from parametric bootstrapping the SEDAR 94 base model. The blue dashed lines indicate the median and interquartile range while the solid black line is the estimate from the SEDAR 94 WFS base model.

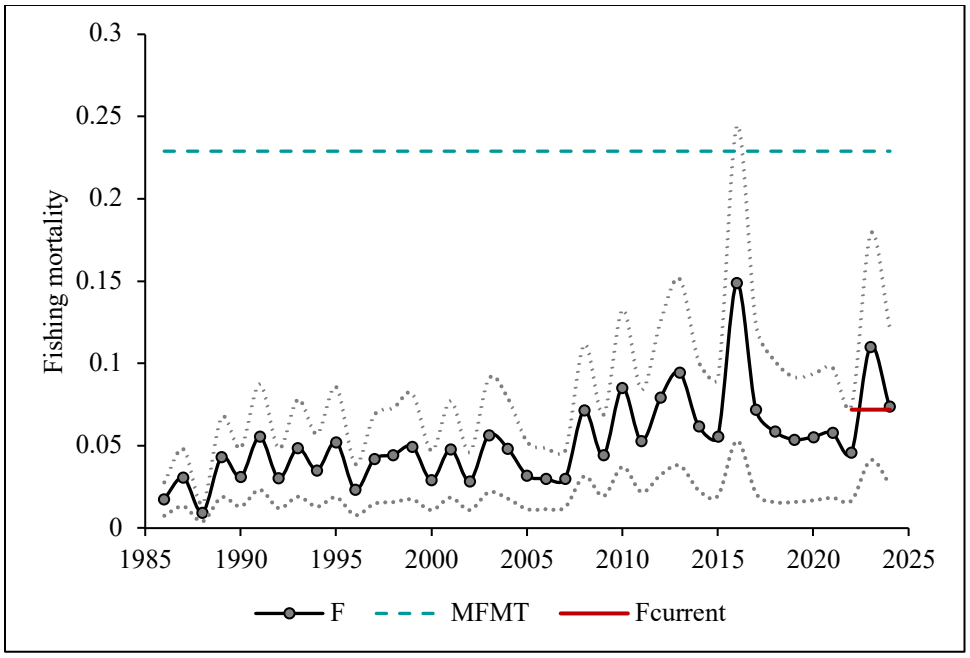


Figure 4.64. Annual estimates of fishing mortality relative to MFMT (i.e., $F_{30\%SPR}$) and the geometric mean of fishing mortality in the last three years ($F_{current}$) from the SEDAR 94 WFS base model. Dotted lines represent 95% confidence intervals.

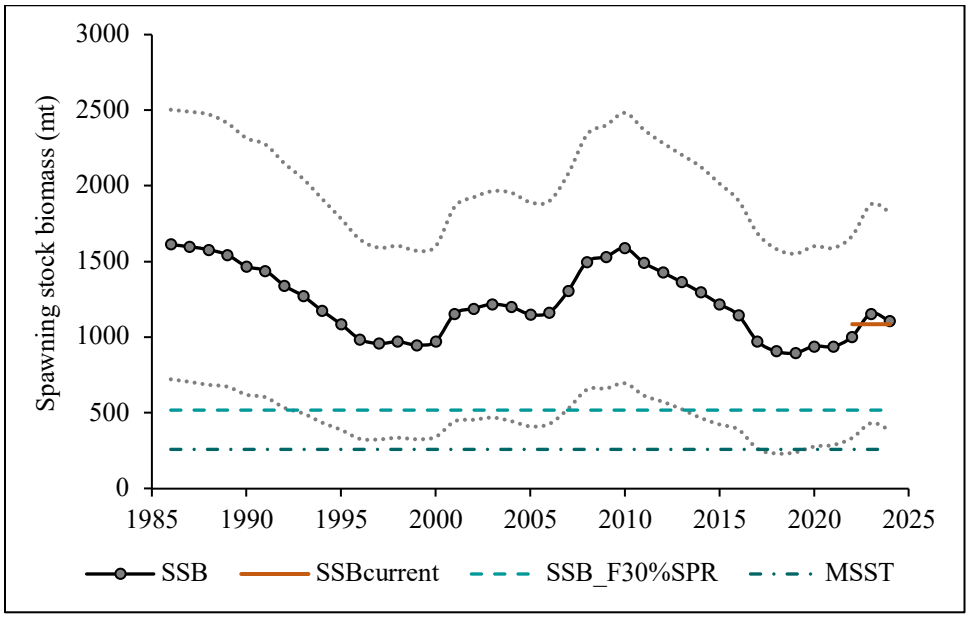


Figure 4.65. Annual estimates of spawning stock biomass (SSB) relative to MSST (i.e., 50% $SSB_{F30\%SPR}$), $SSB_{F30\%SPR}$, and the geometric mean of SSB in the last three years ($SSB_{current}$) from the SEDAR 94 WFS base model. Dotted lines represent 95% confidence intervals.

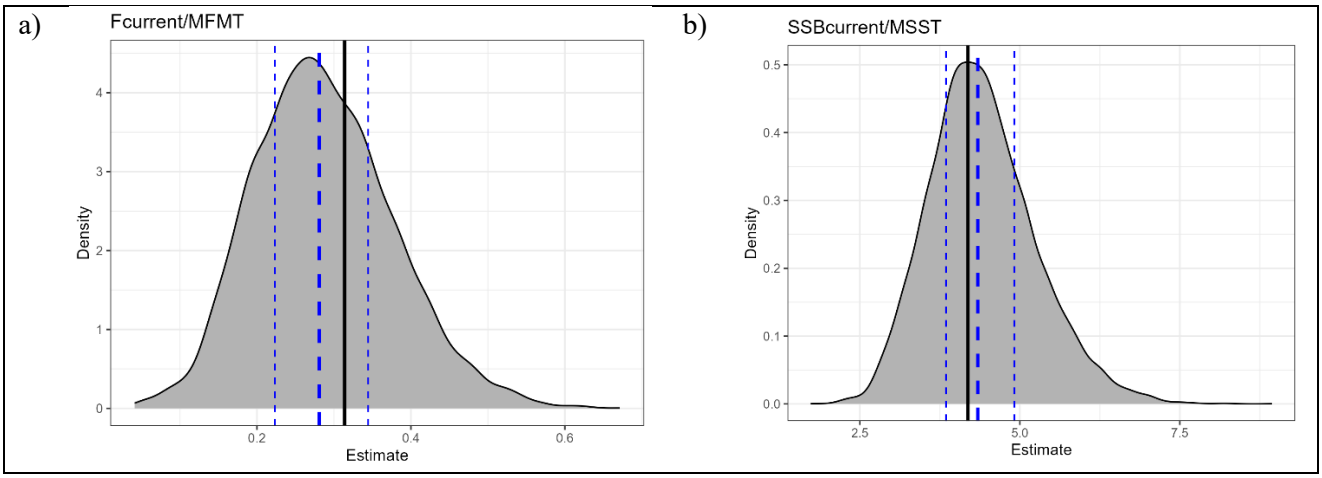


Figure 4.66. The posterior distribution for the F ratio ($F_{current}$/MFMT) and SSB ratio ($SSB_{current}$/MSST) values from the combined six-chain MCMC. The blue dashed lines indicate the median and interquartile range while the solid black line is the estimate from the SEDAR 94 WFS base model.

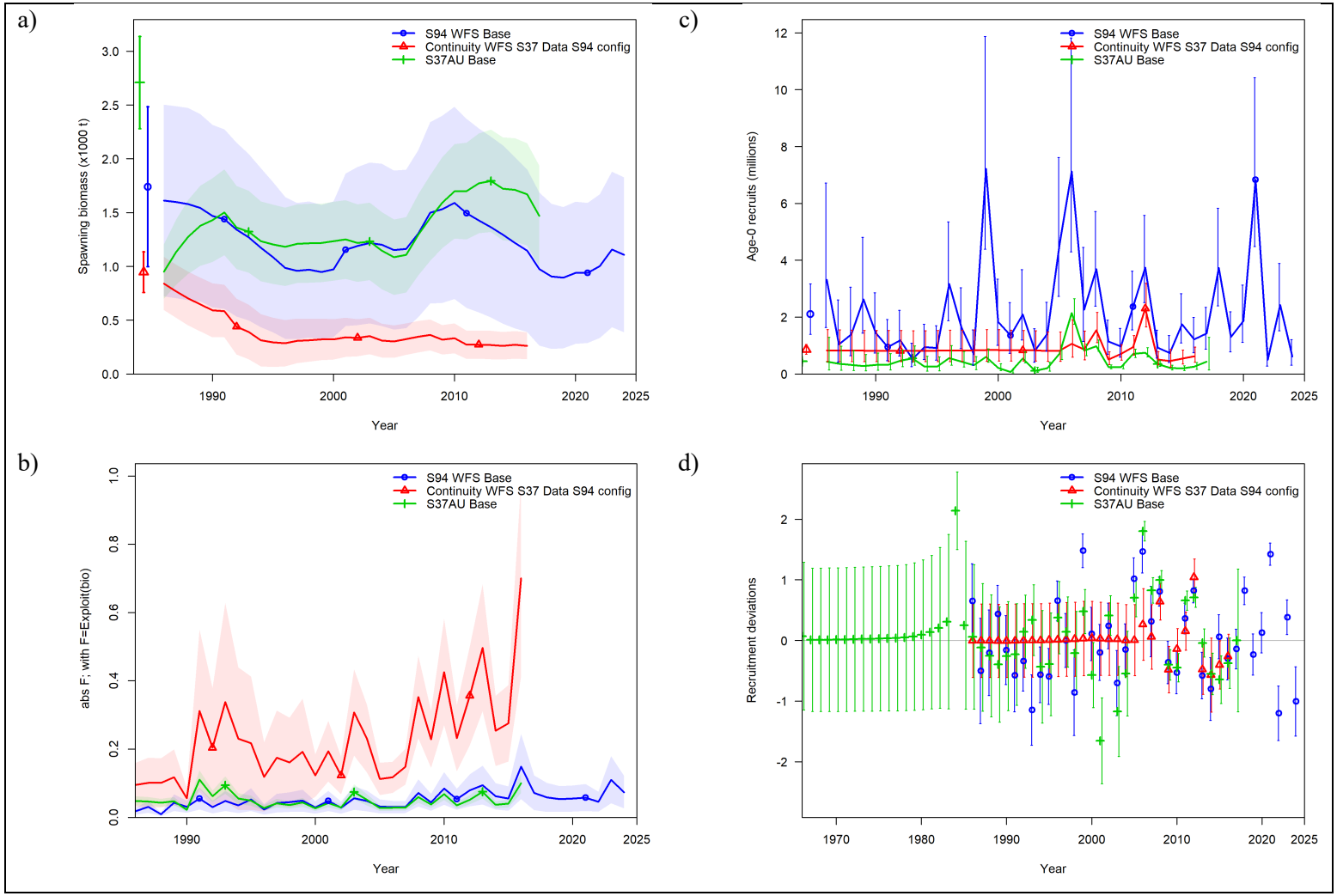


Figure 4.67. A comparison of the results between the SEDAR 37 Update base model ("S37U Base"), the SEDAR 94 WFS Base model ("S94 WFS Base") and the Continuity run using data from S37U with the model configuration of S94 ("Continuity WFS S37 Data S94 config") for a) spawning stock biomass, b) fishing mortality, c) age-0 recruits, and d) recruitment deviations.

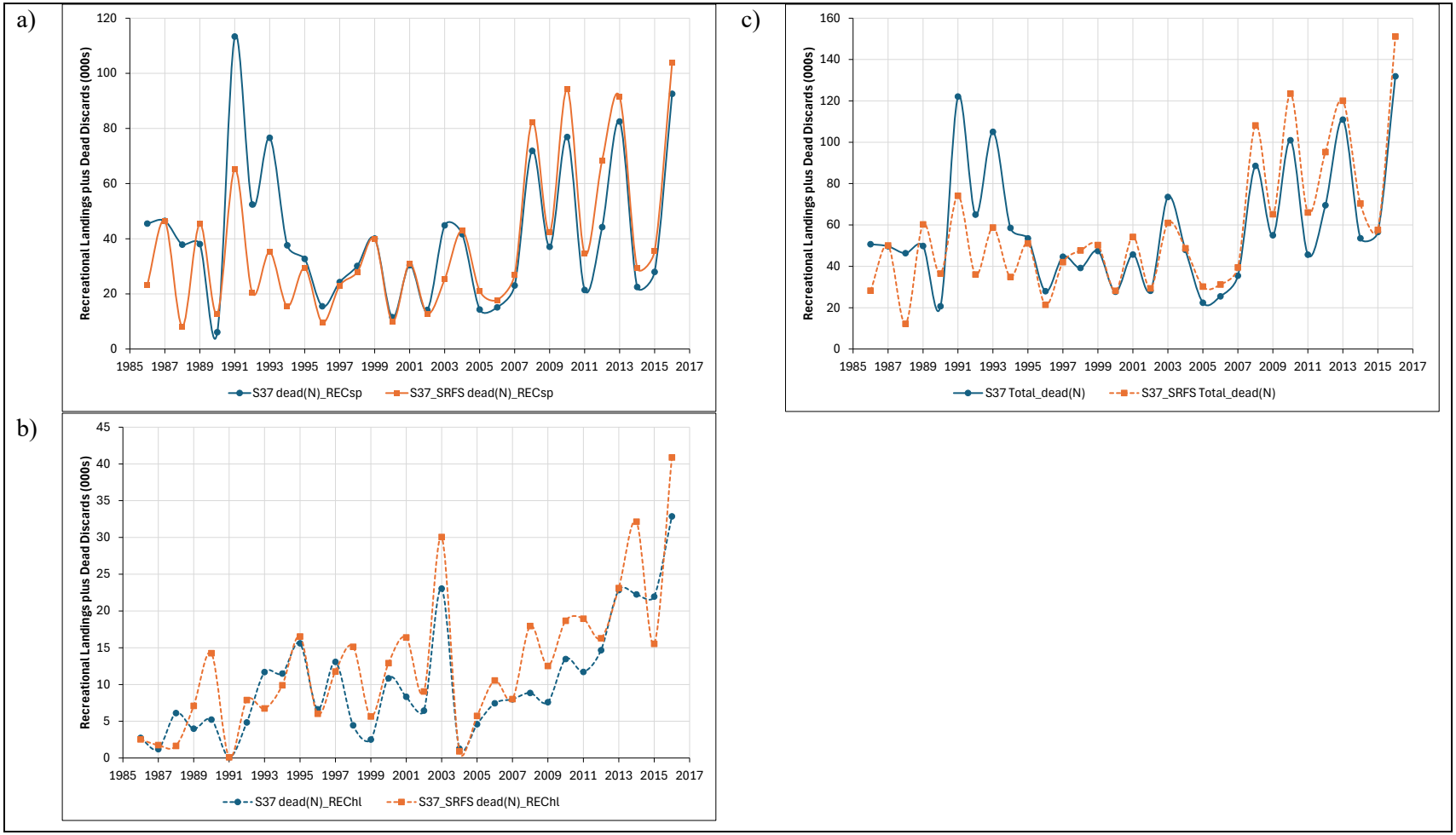


Figure 4.68. A comparison of the input recreational landings plus dead discards in numbers (dead[N]) between the SEDAR 37 WFS base model (S37) and the SEDAR 37 WFS base model containing the 'Full SRFS' (S37_SRFS) catch timeseries a) for the spear gear, b) for the hook-and-line gears, and c) when gears were combined as configured for the S94 WFS base model.

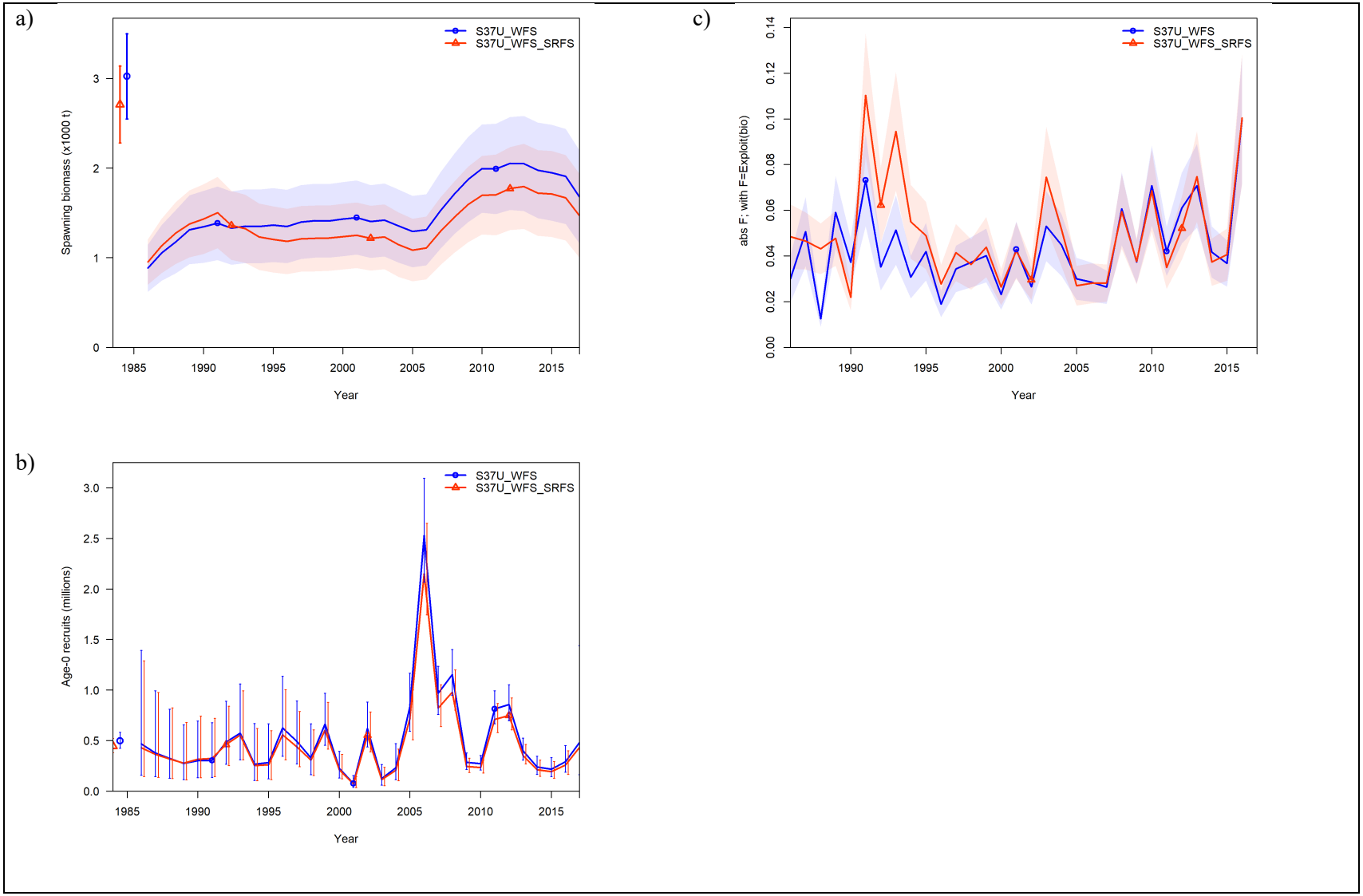


Figure 4.69. A comparison of the results between the SEDAR 37 update WFS base model (S37U_WFS) and the SEDAR 37 update WFS base model containing the 'Full SRFS' catch timeseries (S37U_WFS_SRFS) for a) spawning stock biomass, b) age-0 recruitment, and c) exploitation rates.

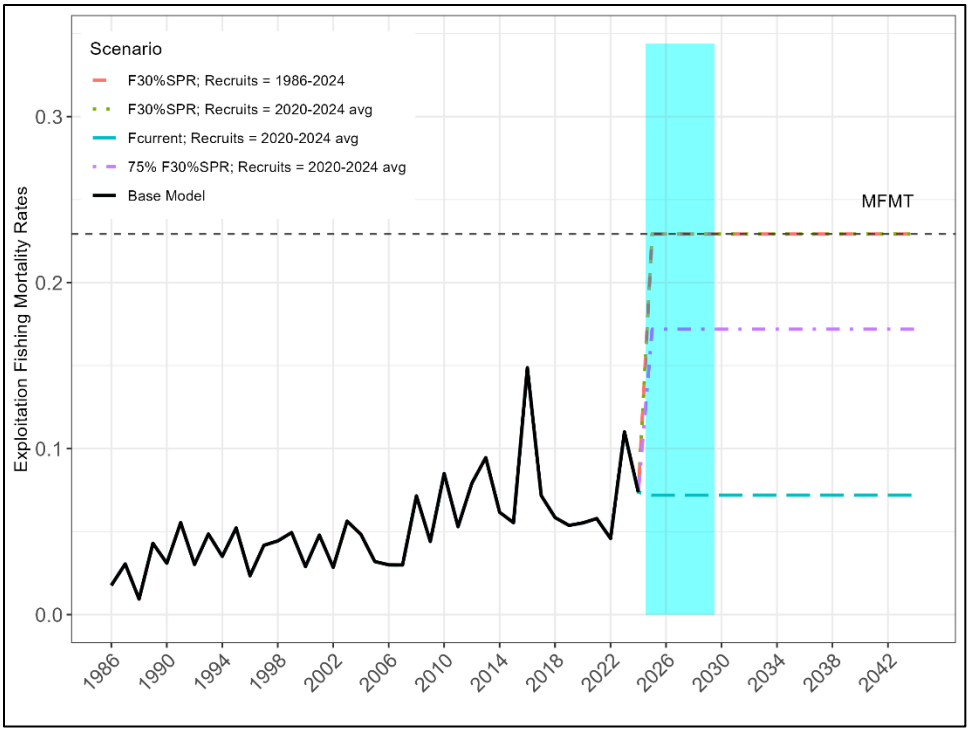


Figure 4.70. Exploitation fishing mortality rates based on projections under long-term equilibrium $F_{30\%SPR}$ (red dashed line), short-term $F_{30\%SPR}$ (green dotted line), $F_{current}$ (teal dashed line), the level that corresponds to 75% $F_{30\%SPR}$ (purple dot-dashed line), and as estimated by the SEDAR 94 WFS base model (black solid line). The cyan region highlights the first five years of the projection (2025-2029).

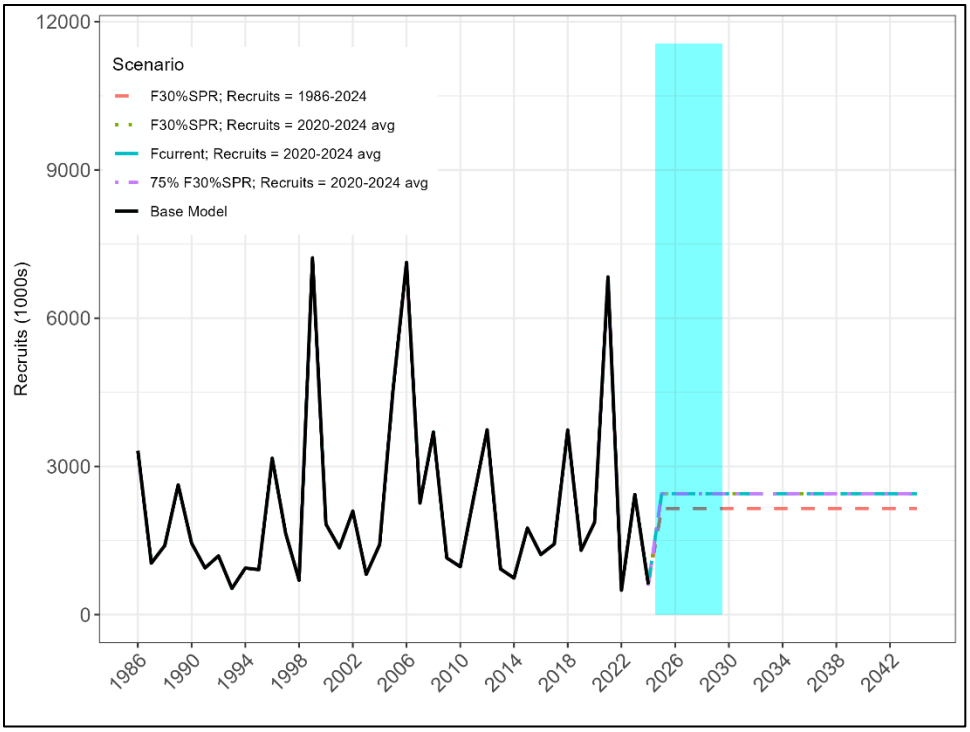


Figure 4.71. Age-0 recruits (in thousands) based on projections under long-term equilibrium $F_{30\%SPR}$ (red dashed line), short-term $F_{30\%SPR}$ (mustard dotted line), $F_{current}$ (teal dashed line), the level that corresponds to 75% $F_{30\%SPR}$ (purple dot-dashed line), and as estimated by the SEDAR 94 WFS base model (black solid line). The cyan region highlights the first five years of the projection (2025-2029).

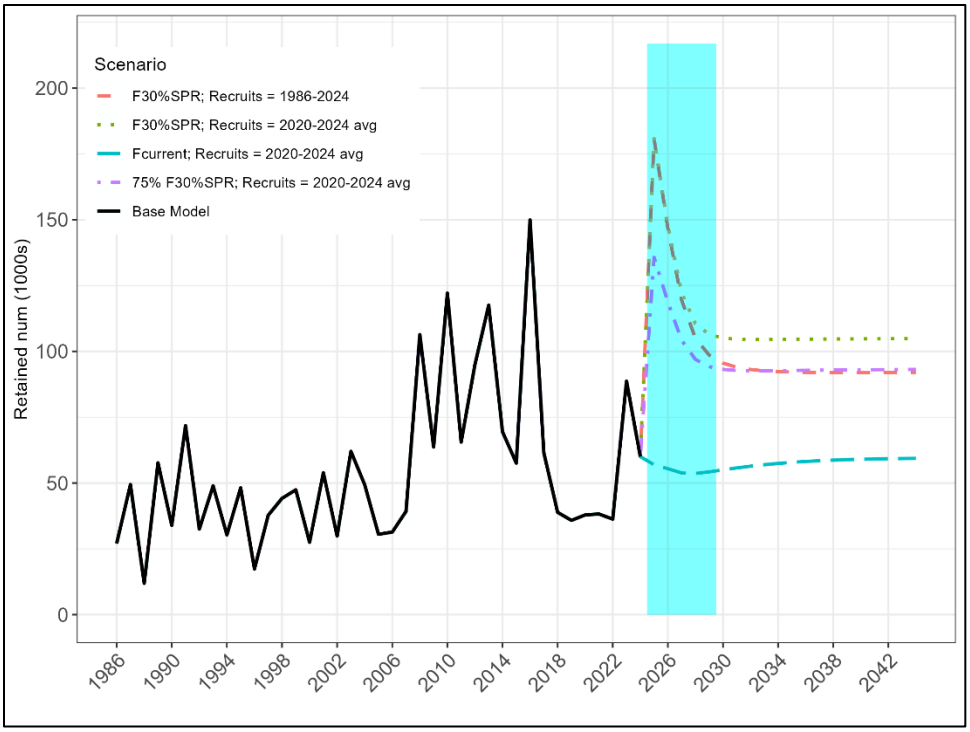


Figure 4.72. Retained yield (numbers) based on projections under long-term equilibrium $F_{30\%SPR}$ (red dashed line), short-term $F_{30\%SPR}$ (mustard dotted line), $F_{current}$ (teal dashed line), the level that corresponds to 75% $F_{30\%SPR}$ (purple dot-dashed line), and as estimated by the SEDAR 94 WFS base model (black solid line). The cyan region highlights the first five years of the projection (2025 – 2029).

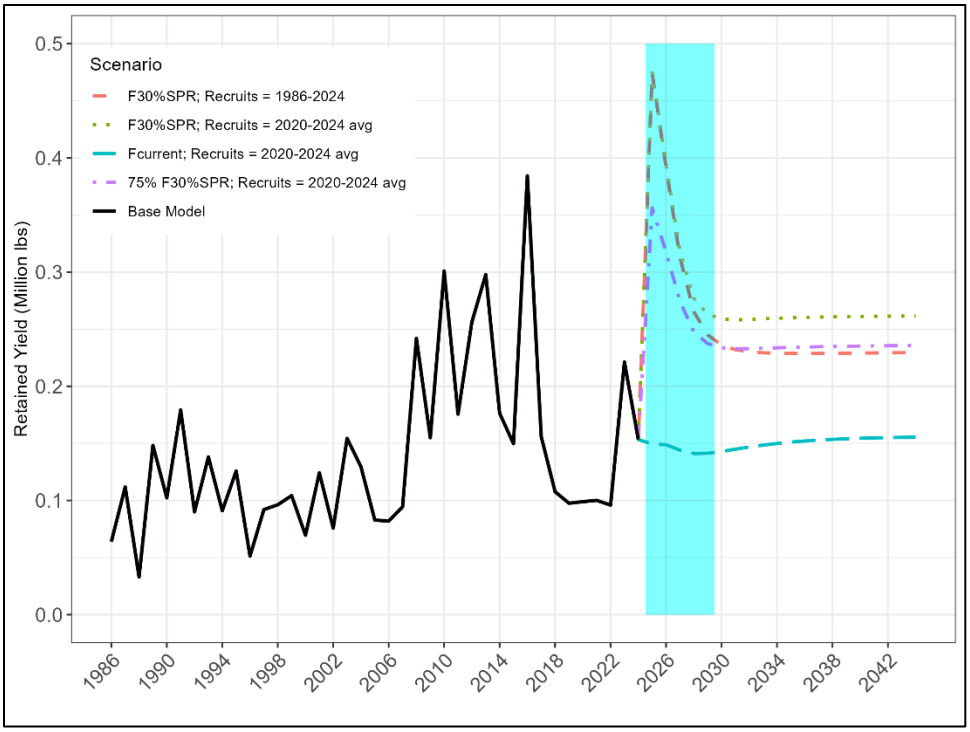


Figure 4.73. Retained yield (million pounds) based on projections under long-term equilibrium $F_{30\%SPR}$ (red dashed line), short-term $F_{30\%SPR}$ (mustard dotted line), $F_{current}$ (teal dashed line), the level that corresponds to 75% $F_{30\%SPR}$ (purple dot-dashed line), and as estimated by the SEDAR 94 WFS base model (black solid line). The cyan region highlights the first five years of the projection (2025 – 2029).

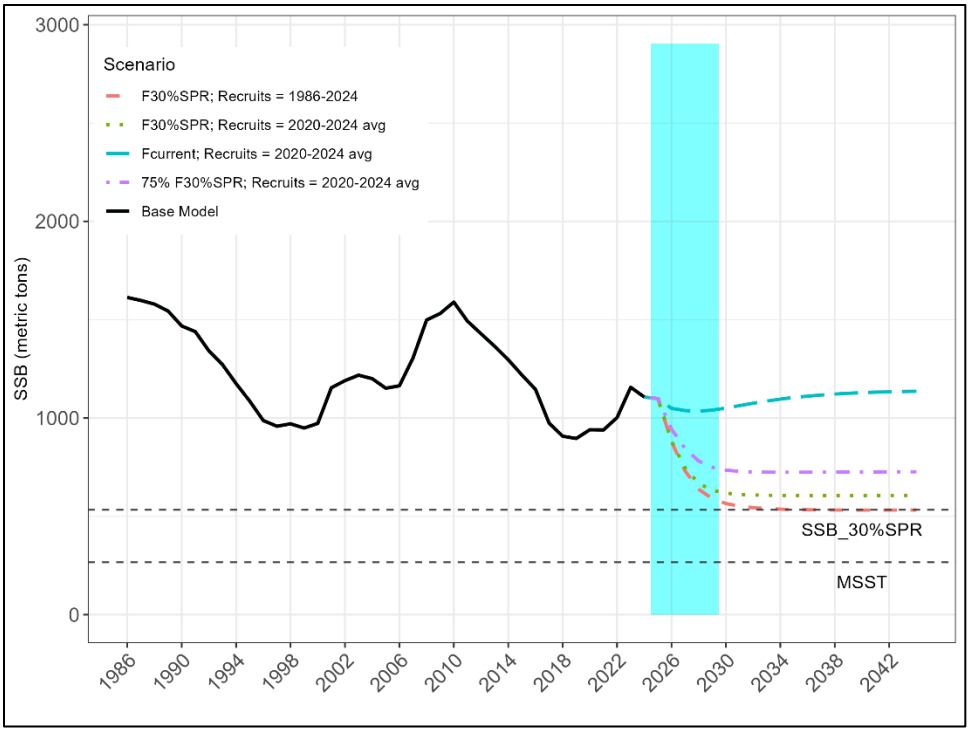


Figure 4.74. Spawning stock biomass (metric tons) based on projections under long-term equilibrium $F_{30\%SPR}$ (red dashed line), short-term $F_{30\%SPR}$ (mustard dotted line), $F_{current}$ (teal dashed line), the level that corresponds to 75% $F_{30\%SPR}$ (purple dot-dashed line), and as estimated by the SEDAR 94 WFS base model (black solid line). The cyan region highlights the first five years of the projection (2025 – 2029).

5 Literature Cited

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(1): 12–23.

Carvalho F., H. Winker, D. Courtney, M. Kapur, L. Kell, M. Cardinale, M. Schirripa, et al. 2021. A cookbook for using model diagnostics in integrated stock assessments. Fisheries Research, 240: 105959.

Francis, R.I.C.C. 2011. Data weighting in statistical fisheries stock assessment models. Canadian Journal of Fisheries and Aquatic Sciences 68(6):1124–1138.

Gelman, A. and D.B. Rubin. 1992. Inference from Iterative Simulation using Multiple Sequences. Statistical Science, 7:457-511.

Haddon, M. 2001. Modelling and Quantitative Methods in Fisheries. Chapman & Hall/CRC, Boca Raton, Florida. 406 pp.

Hamel, O.S. and J.M. Cope. 2022. Development and considerations for application of a longevity-based prior for the natural mortality rate. Fisheries Research. 256: 106477

Hurtado-Ferro, F., C.S. Szuwalski, J.L. Valero, S.C. Anderson, C.J. Cunningham, K.F. Johnson, R. Licandeo, C.R. McGilliard, C.C. Monnahan, M.L. Muradian, K. Ono, K.A. Vert-Pre, A.R. Whitten, and A.E. Punt. 2015. Looking in the rear-view mirror: bias and retrospective patterns in integrated, age-structured stock assessment models. ICES Journal of Marine Science 72(1):99–110.

Kell, L.T., Sharma, R., Kitakado, T., Winker, H., Mosqueira, I., Cardinale, M. and Fu, D., 2021. Validation of stock assessment methods: is it me or my model talking?. ICES Journal of Marine Science, 78(6), pp.2244-2255.

Kraak, S. B. M., M. L. Kraan, F. Quirijns, A. Daan, and J. J. Poos. 2019. The Rosa Lee phenomenon and its consequences for fisheries advice on changes in fishing mortality or gear selectivity. ICES Journal of Marine Science 76(7): 2179–2192

Lee, R. M. 1912. An investigation into the methods of growth determination in fishes by means of scales. International Council for the Exploration of the Sea (ICES), Publications de Circonstance, No. 63. 35 pp.

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): 627–647.

Lorenzen, K. 2022. Size- and age-dependent natural mortality in fish populations: Biology, models, implications, and a generalized length-inverse mortality paradigm. Fish. Res. 255, 106454.

Lowerre-Barbieri, S., Friess, C., Brown-Peterson, N., Moncrief-Cox, H., and Barnett, B. 2022. Best practices for standardized reproductive data and methodology to estimate reproductive parameters for Red Snapper in the Gulf of Mexico. SEDAR74-DW-36. SEDAR, North Charleston, SC. 43 pp.

Maunder, M. N., O. S. Hamel, H.-H. Lee, K. R. Piner, J. M. Cope, A. E. Punt, J. N. Ianelli, C. Castillo-Jordán, M. S. Kapur, and R. D. Methot. 2023. A review of estimation methods for natural

mortality and their performance in the context of fishery stock assessment. Fisheries Research 257: 106489.

McBride, R. S., and A. K. Richardson. 2007. Evidence of size-selective fishing mortality from an age and growth study of hogfish (Labridae: Lachnolaimus maximus), a hermaphroditic reef fish. Bulletin of Marine Science 80(2): 401–417.

Methot, R.D., I.G. Taylor. 2011. Adjusting for bias due to variability of estimated recruitments in fishery assessment models. Can. J. Fish. Aquat. Sci. 68, 1744–1760.

Methot, R.D., C.R. Wetzel. 2013. Stock synthesis: a biological and statistical framework for fish stock assessment and fishery management. Fish. Res. 142, 86–99. https://doi.org/10.1016/j.fishres.2012.10.012.

Methot, R.D., C.R. Wetzel, I.G. Taylor, K. Doering. 2020. Stock Synthesis User Manual Version 3.30.15. U.S. Department of Commerce. NOAA Processed Report NMFS-NWFSC-PR-2020-05. https://doi.org/10.25923/5wpn-qt71. https://vlab. ncep.noaa.gov/web/stock-synthesis.

Methot, R. D., C. R. Wetzel, I. G. Taylor, K. L. Doering, E. F. Perl, and K. F. Johnson. 2026. Stock Synthesis User Manual Version 3.30.24.2. NOAA Fisheries, Seattle, Washington. March 2026.

Mohn, R. 1999. The retrospective problem in sequential population analysis: an investigation using cod fishery and simulated data. ICES Journal of Marine Science 56(4):473–488.

Murphy, M. D., D. C. Chagaris, and D. T. Addis. 2011. An assessment of the status of spotted seatrout in Florida waters through 2009. Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, In-House Report IHR 2011-002, St. Petersburg, Florida.

Plummer M, Best N, Cowles K, Vines K (2006). "CODA: Convergence Diagnosis and Output Analysis for MCMC." *R News*, **6**(1), 7–11. https://journal.r-project.org/archive/.

Punt, A.E. 2017. Some insights into data weighting in integrated stock assessments. Fish. Res. 192:52-65.

R Core Team. 2024. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

Schueller, A., J. Cao, C. Collier, S. Crosson, J. Curtis, C. Dumas, G. Nesslage, F. Scharf, and E. Williams. 2022. SSC Catch Level Projections Workgroup Final Report. 33 pp. SEDAR 79-RD-11.

SEDAR. 2014. SEDAR 37 The 2013 Stock Assessment Report for Hogfish in the South Atlantic and Gulf of Mexico. SEDAR, North Charleston SC. 573 pp. available online at: https://sedarweb.org/assessments/sedar-37/

SEDAR. 2018. SEDAR 37U Stock Assessment of Hogfish in the West Florida Shelf Stock 1986-2016. SEDAR, North Charleston SC. 211 pp. available online at: https://sedarweb.org/assessments/sedar-37/

SEDAR. 2024. Southeastern U.S. Mutton Snapper Stock Assessment Report (SEDAR 79). SouthEast Data, Assessment, and Review, North Charleston, South Carolina.

SEDAR. 2024. Southeastern U.S. Yellowtail Snapper Stock Assessment Report (SEDAR 96). SouthEast Data, Assessment, and Review, North Charleston, South Carolina.

SEDAR. 2024. An update to the FHWAR Method Used to Estimate Historical Recreational Landings. SEDAR 98 Data Workshop Working Paper DW-08. SouthEast Data, Assessment, and Review, North Charleston, South Carolina.

Shertzer, K. W., and P. B. Conn. 2002. Power analysis of linear models used in fisheries stock assessments. Canadian Journal of Fisheries and Aquatic Sciences 59: 1574–1584.

Taylor, I.G., K.L. Doering, K.F. Johnson, C.R. Wetzel, I.J. Stewart. 2021. Beyond visualizing catch-at-age models: Lessons learned from the r4ss package about software to support stock assessments. Fisheries Research, 239:105924 https://doi.org/10.1016/j.fishres.2021.105924.

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

Towne, I. A., Arena, P. T., Collins, A.B. and Kerstetter, D.W. 2007. Evidence of size-selective fishing mortality from an age and growth study of hogfish (Labridae: Lachnolaimus maximus), a hermaphroditic reef fish. Bulletin of Marine Science 80: 401-417.

Van Beveren, E., HP Benoit, and DE Duplisea, 2021. Forecasting fish recruitment in age structured population models. Fish and Fisheries: 1-14.

Wald, A. and Wolfowitz, J., 1940. On a test whether two samples are from the same population. The Annals of Mathematical Statistics, 11(2), pp.147-162.

Winker, H., Carvalho, F. and Kapur, M., 2018. JABBA: just another Bayesian biomass assessment. Fisheries Research, 204, pp.275-288.

SEDAR

Southeast Data, Assessment, and Review

SEDAR 94

Florida Hogfish

SECTION IV: Research Recommendations

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

Table of Contents

1. DATA WORKSHOP RESEARCH RECOMMENDATIONS 2
1.1 LIFE HISTORY RESEARCH RECOMMENDATIONS 2
1.1.1 Stock Definition 2
1.1.2 Age and Growth 3
1.1.3 Natural Mortality 3
1.1.4 Reproduction 3
1.2 COMMERCIAL FISHERY STATISTICS RESEARCH RECOMMENDATIONS 4
1.3 RECREATIONAL FISHERY STATISTICS RESEARCH RECOMMENDATIONS 4
1.3.1 Research Recommendations 4
1.3.2 Other Recommendations 5
1.4 MEASURES OF POPULTAION ABUNDANCE RESEARCH RECOMMENDATIONS 5
2. ASSESSMENT PROCESS RESEARCH RECOMMENDATIONS 6
No consolidated research recommendations section was included in the assessment report. 6
3. REVIEW PANEL RESEARCH RECOMMENDATIONS 6

1. DATA WORKSHOP RESEARCH RECOMMENDATIONS

1.1 LIFE HISTORY RESEARCH RECOMMENDATIONS

1.1.1 Stock Definition

The LHWG recommended expanding genetic sampling in the currently defined unit stocks for Hogfish to reinforce or challenge respective boundaries. In the FLK/EFL stock, sampling does not exist from central (e.g., Cape Canaveral area) and northeastern Florida; investigating this could provide insight into the assumed connection with southeastern Florida as well as any potential source and sink dynamics. Furthermore, no Hogfish have been sampled in GA or SC; any fish here are currently assumed to be defined with the stock sampled off NC, but uncertainty in that boundary exists and whether portions may be further spillover from south Florida. The group also recommends the use of updated genetic methods (e.g., RADseq derived genomic data, SNPS; see Wallace et al. *in prep*. for Spotted Seatrout in Florida) to better inform these biological and managerial boundaries. Lastly, there is no genetic data published from Hogfish in the Caribbean, but preliminary results from mitochondrial DNA samples in Puerto Rico and St. Thomas indicate some degree of genetic connectivity exists with those from the WFS and southeast FL (A. Janosik, *pers. comm*. 5/15/25).

1.1.2 Age and Growth

The LHWG expressed the need to increase the annual fishery-dependent and -independent age sampling of Hogfish. Current sample sizes make detecting and tracking year classes difficult or inadequate in most years without the reliance on data from life history studies. However, the LHWG recognizes the challenge of this as the fisheries tend to be more opportunistic for Hogfish. For the FLK/EFL stock, sampling also needs to expand to include more areas of refuge (e.g., marine no-take reserves; Muñoz et al. 2010) and areas currently unsampled (e.g., northeast FL) to better inform population demographics. Hogfish in both the heavily fished areas of the FLK/EFL and the nearshore areas of the WFS where fishing predominantly occurs exhibit truncated age-at-length data but can grow larger and live longer when able to escape to refuge.

1.1.3 Natural Mortality

The field of natural mortality is not yet in a position to establish 'best practices' (Maunder et al. 2023) and suggested 'good practices' are often trade-offs between reliability and availability of the data. More direct methods of estimating mortality, such as mark-recapture or acoustic telemetry tagging, are generally recommended over empirical methods but have largely been unavailable for Hogfish until recently. Ellis et al. (2025) conducted a pilot study to estimate discard mortality and successfully tagged 42 Hogfish (including 38 tagged with acoustic tags) from 45 trips on the WFS between May 2019 and February 2025, showing the viability for a larger scale study. Effort into acoustic telemetry tagging requires a large enough array of detectors to minimize incomplete detections, but the high site fidelity of Hogfish seem to make it a good candidate as movement out of the array area for extended periods (i.e., are the change in numbers due to mortality or migration) may be minimized. Ellis et al. (2025) also reported 3 re-captured individuals, but none were reported by recreational anglers; rather, they were determined via acoustic detection which alleviates human reporting issues common in conventional tagging.

1.1.4 Reproduction

The LHWG commends the amount of histological data that has been available for Hogfish from life history research studies but also notes that all reproductive data used here were at least 18 years old. If the original histology slides are still available, it is recommended to re-analyze them

following current best practices (Lowerre-Barbieri et al. 2022, Lowerre-Barbieri and Friess 2023) which would also allow comparison with any reproductive data collected in the future for determining size- and age-at-maturity and spawning seasonality. The LHWG also notes the impact of top-down size selective fishing mortality on harem-disruption, social breakdown, reproduction, and possible sperm limitation for Hogfish and recommends additional *in situ* sampling (e.g., diver surveys; Muñoz et al. 2010) to help evaluate recovery of these from the impacts of fishing.

1.2 COMMERCIAL FISHERY STATISTICS RESEARCH RECOMMENDATIONS

Landings

- Improve gear, area, and effort data reported for each trip on state Trip Ticket programs to ensure more accurate data for future assessments.

Discards

- Continue to research alternative methods and analyses for estimating total effort during the closed season of a fishery.

- Recommend the observer program investigate the allocation of some observer coverage for focused trips to aid in future SEDARs as a subset of existing strata.
    - For Hogfish, this may include allocating addition effort to increase the probability of Hogfish encounters in areas of higher population density (SE FL, FL Keys, West Florida)

Biosampling

- Hold more frequent TIP trainings and increase port agent buy-in through information exchange with assessment and SEDAR staff focused on the usage of data collected by TIP staff to continue to refine data quality.
- Increase the priority of Hogfish sampling throughout its' distribution (potentially allocating funds to purchase landed Hogfish to increase the number of aged fish)

1.3 RECREATIONAL FISHERY STATISTICS RESEARCH RECOMMENDATIONS

1.3.1 Research Recommendations

- Additional release mortality research specially investigating mortality of surface released fish and/or vented fish caught by hook and line in the recreational fishery. This should include research into the incidence of barotrauma, its causes, and its relationship to release mortality.

- Improve precision of MRIP and SRFS estimates for all modes through increased sampling
- Additional age data collection from all recreational sources by region (WFS, FLK/Keys), by gear (spear, hook and line), and by fishing area
- Increasing sampling to intercept and collect biological information from private recreational Hogfish anglers
- Explore methods to acquire catch information from private boat anglers returning to private docks in addition to public access points

1.3.2 Other Recommendations

Issue: Providing a potential model start year recommendation according to recreational data availability and uncertainty. The RWG discussed a potential recommendation to start the assessment model in 1986, as has been done in the previous Hogfish assessment (SEDAR 37) and other SEDAR stock assessments for reef fishes.

Recommendation: Catch estimates from the early years of the MRIP survey (e.g., 1981-1985) are highly variable and tend to result in higher CVs than those estimated in subsequent years. Additionally, some early years (1984-1985) in the WFS have zero estimated landings. The group has no particular concerns with retaining and using the recreational data in these early years as inputs into the assessment model but recognizes the above reasons could be used for justification of removal. The RWG concluded that both options are valid and supported and recommends this decision be made during the assessment process based on other aspects of data availability and modeling needs.

1.4 MEASURES OF POPULTAION ABUNDANCE RESEARCH RECOMMENDATIONS

- **Evaluate the Integration of Supplemental SRFS Intercept Data:** The IWG recommends investigating the feasibility and utility of incorporating supplemental SRFS intercept data into MRIP indices of abundance to improve precision.
- **Expand Length Data Collection through REEF/SMILE:** Continue collecting additional length-frequency data via the SMILE project for consideration in future stock assessments.

- **Collect Genetic Data to Assess Stock Mixing:** Obtain genetic samples from broad-scale fishery-independent surveys (e.g., SEAMAP trawl) that encompass both the West Florida Shelf (WFS) and the Keys-East Florida (Keys-EFL) stocks to evaluate mixing rates between the two.
- **Assess Environmental Stressors:** Investigate the impacts of seagrass habitat decline in the Indian River Lagoon and the effects of red tide events on Hogfish population dynamics and distribution.
- **Develop a Juvenile Abundance Survey in the Keys-EFL Region:** Design and implement a fishery-independent survey targeting juvenile Hogfish to generate indices of abundance for the Keys-EFL stock, addressing a current data gap in early life history stages.
- **Examine Migration Patterns:** Study the seasonal and spatial timing of inshore and offshore migrations to better understand life history patterns and inform management strategies.

2. ASSESSMENT PROCESS RESEARCH RECOMMENDATIONS

No consolidated research recommendations section was included in the assessment report.

3. REVIEW PANEL RESEARCH RECOMMENDATIONS

The Review Panel supports the research recommendations developed during the Data and Assessment Workshops and identified several additional priorities that could improve future hogfish assessments.

1. Improve understanding and modeling of protogynous hermaphroditic population dynamics.
    - This represents a high research priority. Future work should investigate the recruitment and reproductive dynamics of protogynous, harem-forming species and evaluate how social structure affects sex transition. The current assessment represents sex transition primarily as an age-dependent process, whereas hogfish sex change may also depend strongly on the local abundance or density of males. Research should evaluate whether the probability of female-to-male transition changes with male density and how fishing-induced changes in population sex ratio affect reproductive output. Simulation studies and explicitly sex-structured population models could be particularly useful for evaluating these processes and the implications of size-selective harvest regulations for protogynous species.

- Related work should investigate the potential for sperm limitation or male limitation and the prevalence of skip spawning. These processes could influence the relationship between conventional measures of spawning biomass and realized reproductive output and may help explain why a conventional stock-recruit relationship is difficult to estimate for this species.

2. Improve recreational spearfishing information.

   - Uncertainty in recreational spear landings remains one of the more important data limitations for the WFS assessment. Existing intercept designs may inadequately sample portions of the spearfishing fleet, particularly fishers operating from private access points. Targeted survey designs should be considered to evaluate the magnitude and potential bias of recreational spear removals and to determine whether existing CPUE observations adequately represent the broader spearfishing population. Improvements in this area would increase confidence in historical fishing pressure, current stock status, and sustainable harvest reference points.

3. Evaluate fishery-independent survey coverage and data gaps.

   - Available fishery-independent indices, including those excluded during the DW, should be systematically evaluated with respect to geographic coverage of hogfish habitat, sample size, and availability of age and length information. This could identify important spatial or temporal gaps and help prioritize future monitoring.

4. Evaluate alternative assessment and uncertainty methods.

   - Future methodological work should compare uncertainty estimates derived from MCMC, parametric bootstrap, and asymptotic normal approximations. Comparisons on both normal and log scales could help determine circumstances in which conventional asymptotic approximations provide sufficiently reliable inference and when more computationally intensive MCMC or bootstrap procedures are warranted.

   - Alternative MCMC algorithms, including Hamiltonian Monte Carlo and related approaches, should be investigated where feasible to determine whether they improve convergence and posterior exploration relative to the current Metropolis-Hastings implementation.

   - Additional consideration should also be given to assessment frameworks capable of incorporating random effects or state-space processes, including time-varying fishing mortality where appropriate.

5. Evaluate Stock Synthesis implementation choices that are not well understood.

   - Additional research should examine the statistical properties and consequences of using super-periods to address sparse composition data. Sensitivity analyses should also evaluate the specification of growth platoons, given the limited experience of many assessment practitioners and reviewers with this feature.

   - The implications of removing the recruitment-deviation sum-to-zero constraint for MCMC proxy models should also be examined further. The current workaround

was considered acceptable for the WFS assessment, but a better understanding of the statistical consequences would benefit future applications.

6. Investigate sex-specific growth.
    - Although residual diagnostics supported the assumption of equal growth rates for males and females in the current assessment, additional biological and modeling work should evaluate whether sex-specific growth differences are important enough to affect future assessment results.
7. Evaluate environmental effects on hogfish population dynamics.
    - Future research should consider the effects of environmental disturbances and stressors, including red tides and other harmful algal blooms, cold events, and oil spills. Potential environmental effects on natural mortality, recruitment, movement, and habitat use could be important sources of temporal variability not explicitly represented in the current assessment.
8. Develop stochastic projections that propagate assessment uncertainty.
    - The MCMC framework provides an opportunity to propagate parameter uncertainty into future projections. Stochastic projections could quantify probabilities of SSB falling below biomass thresholds or fishing mortality exceeding applicable reference points under alternative management scenarios. Incorporating such approaches more routinely into the SEDAR process could improve communication of management risk and make fuller use of the uncertainty analyses already conducted as part of the assessment.

- **Provide recommendations on possible ways to improve the SEDAR process**

  The Review Panel commented that some TORs may need to be revisited or clarified. For example, the text on BSIA may need updating, and the evaluation of the projection results may be a task for the SSC, rather than a Review Panel. Also, the Review Panel noted that the bridging analysis (see TORs for the assessment phase) was not very informative given the length between assessments and resulting changes in the data and the model. It was therefore not evaluated by the Review Panel.

SEDAR

Southeast Data, Assessment, and Review

SEDAR 94

Florida Hogfish:

West Florida Shelf and East Florida/Florida Keys

SECTION V: Review Workshop Report

July 2026

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

1. INTRODUCTION 2
1.1 WORKSHOP TIME AND PLACE 2
1.2 TERMS OF REFERENCE 2
1.3 LIST OF PARTICIPANTS 3
1.4 LIST OF REVIEW WORKSHOP REFERENCE DOCUMENTS 5
2. REVIEW PANEL REPORT 5

1. INTRODUCTION

1.1 WORKSHOP TIME AND PLACE

The SEDAR 94 Florida Hogfish Review Workshop was held in Charleston, SC July 14-17, 2026.

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, and consider the following:
   a) Are data decisions made by the DW and AW panels sound and robust?
   b) Are data uncertainties acknowledged, reported, and within normal or expected levels?
   c) Are input data series reliable and applied properly within the assessment model?
2. Evaluate and discuss the strengths and weaknesses of the methods used to assess the stock, taking into account the available data, and considering the following:
   a) Are methods scientifically sound and robust?
   b) Are assessment models configured properly and consistent with standard practices?
   c) Are the methods appropriate for the available data?
3. Evaluate the assessment findings and consider the following:
   a) Are population estimates (model output – e.g. abundance, exploitation, biomass) reliable, consistent with input data and population biological characteristics, and useful to support status inferences?
   b) Is the stock overfished? What information helps you reach this conclusion?
   c) Is the stock undergoing overfishing? What information helps you reach this conclusion?
   d) Is there an informative stock recruitment relationship? Is the stock recruitment curve reliable and useful for evaluation of productivity and future stock conditions?

e) Are the quantitative estimates of the status determination criteria for this stock reliable? If not, are there other indicators that may be used to inform managers about stock trends and conditions?

4. Evaluate the stock projections, including discussing strengths and weaknesses, and consider the following:
   a) Are the methods consistent with accepted practices and available data?
   b) Are the methods appropriate for the assessment model and outputs?
   c) Are the results informative and robust, and useful to support inferences of probable future conditions?
   d) Are key uncertainties acknowledged, discussed, and reflected in the projection results?
5. Consider how uncertainties in the assessment, and their potential consequences, are addressed.
   - Comment on the degree to which methods used to evaluate uncertainty reflect and capture the significant sources of uncertainty in the population, data sources, and assessment methods
   - Ensure that the implications of uncertainty in technical conclusions are clearly stated
6. Consider the research recommendations provided by the Data and Assessment workshops and make any additional recommendations or prioritizations warranted.
   - Clearly denote research and monitoring that could improve the reliability of, and information provided by, future assessments
   - Provide recommendations on possible ways to improve the SEDAR process
7. Consider whether the stock assessment constitutes the best scientific information available using the following criteria as appropriate: relevance, inclusiveness, objectivity, transparency, timeliness, verification, validation, and peer review of fishery management information.
8. Provide suggestions on key improvements in data or modeling approaches that should be considered when scheduling the next assessment.
9. Prepare a Peer Review Summary summarizing the Panel's evaluation of the stock assessment and addressing each Term of Reference. Develop a list of tasks to be completed following the workshop. Complete and submit the Peer Review Summary Report in accordance with the project guidelines.

1.3 LIST OF PARTICIPANTS

Review Panel

Luiz Barbieri (Chair)	SAFMC/GFMC SSC
Lisa Chong	CIE Reviewer
Noel Cadigan	CIE Reviewer
A. Challen Hyman	GFMC SSC

Joe Powers	CIE Reviewer
Marcel Reichert	SAFMC SSC
Alexei Sharov	SAFMC SSC
Steve Saul (via webinar)	GFMC SSC

Analytic Team

Chris Swanson	USF/FWC-FWRI
Dustin Addis	FWC-FWRI
Heather Christiansen	FWC-FWRI

Staff

Julie A Neer	SEDAR
Chip Collier	SAFMC Staff
Leonardo Eguia	GFMCC Staff
Emily Ott	SEDAR
Ryan Rindone	GFMC Staff
Rachael Silvas	SAFMC Staff

Council Representative

CJ Sweetman	Gulf & South Atlantic Council

Workshop Observers

Chris Bradshaw	FWC-FWRI

Workshop Observers via Webinar

Shanae Allen	USF/FWC-FWRI
Manuel Coffill-Rivera	
Alena Figueroa	FWC-FWRI
Sarah Gardiner	GFMC Staff
Bob Hillard	Recreational Fisherman
Jennifer Loch	REEF
Danielle Morley	FWC-FWRI
Robert Muller	FWC-FWRI
Roldan Muñoz	NOAA
Hallie O'Farrell	FWC-FWRI
Tia Offner	FWC-FWRI
Jack Olsen	FWC-FWRI
Chloe Ramsay	FWC-FWRI
Ted Switzer	FWC-FWRI

1.4 LIST OF REVIEW WORKSHOP REFERENCE DOCUMENTS

Reference Documents		
SEDAR94-RD03	Modeling protogynous hermaphrodite fishes workshop	Gary Shepherd, Kyle Shertzer, Jessica Coakley, Megan Caldwell
SEDAR94-RD04	Stock assessment of protogynous fish: evaluating measures of spawning biomass used to estimate biological reference points	Elizabeth N. Brooks, Kyle W. Shertzer, Todd Gedamke, and Douglas S. Vaughan

2. REVIEW PANEL REPORT

Introduction

An independent peer review of the SEDAR 94 Hogfish (*Lachnolaimus maximus*) Stock Assessment was conducted during an in-person Review Workshop on July March 14-17, 2026, in Charleston, SC. The Review Panel consisted of Luiz Barbieri (Chair), Noel Cadigan (CIE), Joe Powers (CIE), Lisa Chong (CIE), Steven Saul (Gulf SSC), A. Challen Hyman (Gulf SSC), Alexei Sharov (SA SSC), and Marcel Reichert (SA SSC). The Review Panel was able to conduct a thorough review of two hogfish assessments: An East Florida/Florida Keys stock and a West Florida Shelf stock. The Review Panel thanks the Assessment Team for the significant amount of work involved and for the reports and presentations detailing the data, analyses, exploration, and modeling. In particular, the panel acknowledges Chris Swanson, Heather Christiansen, and Dustin Addis (Assessment Leads) who presented overviews of the assessments. The Review Panel appreciated the collegial nature of the review deliberations and Assessment Team's positive responsiveness to the Review Panel's comments, questions, and requests for additional information and analyses. The Review Panel also thanks SEDAR, South Atlantic Fisheries Management Council, and Gulf Council Staff for their invaluable assistance during the review process.

This report summarizes the Review Panel's findings and recommendations. Section 2.1 details the review for the West Florida Shelf stock, while 2.2 reports on the review of the East Florida-Florida Keys stock (2.2). Each follows the Terms of Reference provided to the Review Panel.

2.1 WEST FLORIDA SHELF STOCK

Executive Summary

SEDAR 94 developed a stock assessment of the West Florida Shelf (WFS) hogfish (*Lachnolaimus maximus*) stock using Stock Synthesis 3 (SS3). The assessment model

incorporated commercial and recreational removals, fishery-independent indices of abundance, length-composition and conditional age-at-length data, and biological information appropriate for the protogynous life history of hogfish. Model performance was evaluated using an extensive suite of diagnostics and sensitivity analyses. The Review Panel concluded that the assessment model was appropriately configured and applied, and the resulting population estimates were sufficiently reliable and consistent with the available fishery-dependent and fishery-independent data, and the known biology of hogfish. The WFS hogfish stock was found not to be overfished nor undergoing overfishing. Recent spawning stock biomass was estimated to be well above the minimum stock size threshold (MSST), and recent fishing mortality was estimated to be below the maximum fishing mortality threshold (MFMT). Although the Panel identified several important sources of uncertainty, it concluded that none were sufficient to alter acceptance of the assessment or its principal findings. An informative stock-recruitment relationship could not be estimated from the available data. Steepness (*h*) was fixed at 0.99, effectively representing average recruitment (with annual deviations) and SPR-based proxies (SPR30%) were used as the basis for stock-status reference points. The methodology used for stock projections were considered appropriate, informative, and suitable for management consideration. The Panel identified several research priorities that could improve future WFS hogfish assessments. In particular, it noted that the reproductive dynamics of hogfish—including protogynous sex change, haremic behavior, possible male limitation, and potential skip spawning—may complicate the relationship between conventional measures of spawning biomass and subsequent recruitment and remain important areas for future research. Overall, the Review Panel concluded that the SEDAR 94 West Florida Shelf hogfish assessment is scientifically sound, uses the available data appropriately, and provides a suitable basis for management advice. However, the uncertainties and research needs identified during the review should be considered in interpreting management quantities and in planning future assessments, but they do not materially change the Panel's conclusions regarding the current status of the WFS hogfish stock.

The Review Panel discussions and deliberations are summarized below for each of the Terms of Reference

1. **Evaluate the data used in the assessment, including discussion of the strengths and weaknesses of data sources and decisions, and consider the following:**

   a) Are data decisions made by the DW and AW panels sound and robust?

   The Review Panel concluded that, overall, the data decisions made by the Data Workshop (DW) and Assessment Workshop (AW) for the West Florida Shelf (WFS) stock were sound and robust given the available information and the data limitations associated with this stock. The assessment incorporated the principal data streams typically available for Gulf reef fish assessments, including commercial and recreational landings, reconstructed historical landings, fishery-independent abundance indices, length compositions, and conditional age-at-length (CAAL) data. Fishery-dependent indices, including the MRIP hook-and-line CPUE index, were explored during assessment development but were not

recommended for inclusion in the final model. The rationale for major data inclusion and exclusion decisions was adequately considered and documented.

The Review Panel considered aggregation of commercial gears into a single commercial fleet to be appropriate. Commercial landings represented a relatively small proportion of total WFS removals, and annual length and CAAL sample sizes were limited and variable among gears. Separating these gears would, therefore, have increased model complexity and the number of estimated parameters without a corresponding increase in information. Similarly, combining the relatively small SRHS landings and discards with SRFS hook-and-line estimates was considered reasonable.

The treatment of the recreational fishery warrants somewhat greater consideration. The WFS assessment retained separate recreational spear and hook-and-line fleets, in part because the hook-and-line component has continued to develop and has recently become an increasingly important source of removals. The Panel noted, however, that recreational composition data for the WFS are relatively sparse and that this decision differs from the aggregation approach applied to the Florida Keys hogfish stock (see below). Although the retained fleet structure was accepted for the current assessment, future assessments should continue to evaluate whether the available data adequately support separate recreational fleet parameterizations.

The Review Panel also discussed the natural mortality-at-age vector, particularly the relatively high mortality estimates for younger ages compared with those used in the Florida Keys assessment. This was considered in conjunction with the relatively young terminal age represented in the KEYS model compared to the WFS model (16 vs 23 years). Following discussion, the Panel accepted the natural mortality vector used in the base model.

b) Are data uncertainties acknowledged, reported, and within normal or expected levels?

The assessment adequately acknowledged the major sources of data uncertainty. The Review Panel considered these uncertainties generally within the range expected for the available information for this species and region, recognizing that hogfish can be a relatively rare-event species in several sampling programs. A principal concern involves recreational spearfishing data. Recreational spear landings are relatively uncertain because spearfishers are infrequently encountered by conventional dockside surveys at public-access boat ramps.The Panel also discussed whether CPUE information obtained from these intercepts is representative of spearfishers operating from private access points, who may differ in fishing behavior or efficiency. The same is true for the sector of the recreational fisheries that leave from and return to private docks. These limitations create uncertainty regarding both historical and current recreational spear removals.

Discard mortality, particularly for hook-and-line-caught hogfish, is another source of considerable uncertainty. Available information suggests that hogfish are highly susceptible

to barotrauma even at relatively shallow depths. However, sensitivity analyses using alternative discard mortality rates produced relatively small changes in spawning stock biomass (SSB) and fishing mortality trajectories. Thus, although discard mortality remains biologically uncertain, this uncertainty did not appear to have a substantial influence on the principal stock-status conclusions of the current assessment. This result may partly reflect the relatively low level of WFS discarding and the comparatively recent development of the recreational hook-and-line fishery. Consequently, accurate estimation of this probability may become increasingly important if the magnitude of hook-and-line discards continues to increase.

The catch and index time series provided limited contrast with respect to the stock-recruit relationship (i.e., estimate steepness). Notably, the fishery-independent indices showed no clear response to long-term increase in removals. The inclusion of reconstructed recreational catch data was also reported to be uninformative to the estimation of steepness. The Assessment Team acknowledged this limitation, and therefore fixed steepness to 0.99 in the model.

c) Are input data series reliable and applied properly within the assessment model?

The Review Panel concluded that the input data series were appropriately applied within the assessment model and were sufficiently reliable to support the assessment conclusions, subject to the qualifications described above. The fishery-independent indices provide an important independent perspective on stock trends and did not indicate a declining trend over the assessment period despite increases in removals. This pattern is broadly consistent with the population trajectory estimated by the assessment and provides additional support for the conclusion that the stock is not currently overfished. Overall, the Panel accepted the data inputs and their treatment in the WFS assessment, while identifying recreational spear removals and sampling as an important area for future improvement.

2. Evaluate and discuss the strengths and weaknesses of the methods used to assess the stock, taking into account the available data, and considering the following:

a) Are methods scientifically sound and robust?

The Review Panel concluded that the methods used to assess the WFS hogfish stock were scientifically sound and robust. Stock Synthesis 3 (SS3; version 3.30.24) is a widely used and extensively tested integrated stock assessment framework capable of incorporating the diverse and intermittent data streams available for the WFS hogfish stock. Its application to this assessment was considered appropriate. The Assessment Team conducted an extensive suite of diagnostics and sensitivity analyses. Model convergence was evaluated using final gradients, Hessian properties, parameter-bound checks, and jitter analyses from dispersed starting values. One hundred jitter runs using a relatively broad jitter magnitude did not identify a lower likelihood solution. Likelihood profiles, retrospective analyses, sensitivity runs, parametric bootstrap analyses, and Markov Chain Monte Carlo (MCMC) analyses

provided additional evaluation of model behavior and uncertainty. The Panel therefore considered the model to have been competently implemented and adequately diagnosed.

One qualification concerns the MCMC implementation. Two of eight MCMC chains did not satisfy convergence diagnostics and were excluded from posterior inference. The remaining chains provided broadly consistent results, but the cause of the failed chains was not fully understood and diagnosed. Future assessments should consider whether alternative sampling approaches, including Hamiltonian Monte Carlo or the No-U-Turn Sampler (NUTS), could improve sampling efficiency and convergence for complex SS models.

b) Are assessment models configured properly and consistent with standard practices?

The Review Panel concluded that the WFS model was properly configured and generally consistent with accepted stock assessment practices. The model appropriately accounted for the protogynous hermaphroditic life history of hogfish within the capabilities of SS3. Steepness was fixed at 0.99 because an informative stock-recruit relationship could not be estimated from the available data. The consequences of this assumption are considered further under TOR 3. The assessment used super-periods for commercial and recreational length-frequency data to address sparse sampling. Although this provided a practical means of reducing estimation problems associated with limited annual samples, the Panel noted that the statistical properties and potential consequences of using super-periods are not well understood by many practitioners and reviewers. Further evaluation of this approach is recommended.

A sum-to-zero constraint was applied to recruitment deviations in the base assessment model. Although initially motivated primarily by reducing retrospective behavior in the Florida Keys model, retaining the constraint in the WFS model was considered reasonable because removing it did not improve model fit and the constraint resolves potential indeterminacy between the scale of the stock-recruit relationship and the mean recruitment deviations. The sum-to-zero constraint, however, created difficulties for ADMB MCMC sampling and therefore was removed in a proxy model used for MCMC analyses. Estimates from the maximum-likelihood WFS model generally fell within the interquartile ranges of the posterior distributions from the proxy MCMC model, providing reassurance that this workaround did not materially alter the major assessment conclusions. Nevertheless, the need to use a modified proxy model for uncertainty analysis deserves additional methodological investigation.

c) Are the methods appropriate for the available data?

The Review Panel concluded that the assessment methods were appropriate for the available data. The age- and size-structured SS3 model accommodated the available length compositions, CAAL observations, abundance indices, uncertain catch information, and

historical changes in fishery regulations. Estimating growth internally within the model was considered a strength because this approach can account for interactions among growth, length-based selectivity, and size truncation in sampled fish. Use of CAAL information also helps address growth model biases associated with length-stratified and other size-selective sampling.

The model further incorporated the SS3 growth-platoon feature to represent and account for the effects of size-selective mortality on the distribution of size at age. Sensitivity analyses of this feature would nevertheless be useful because its consequences for estimation of major assessment quantities are not as well understood as many other components of SS3.

The model assumed equivalent growth rates for males and females. Available residual diagnostics (*see Addendum Section below*) supported this assumption for the current assessment, although further investigation of sex-specific growth is warranted.

3. Evaluate the assessment findings and consider the following:

a) Are population estimates (model output – e.g. abundance, exploitation, biomass) reliable, consistent with input data and population biological characteristics, and useful to support status inferences?

The Review Panel concluded that the population estimates generated by the WFS base model were sufficiently reliable, consistent with the available data and known biology, and appropriate for supporting stock-status inferences.

The base model converged successfully and exhibited generally acceptable diagnostics. The retrospective analysis showed a modest retrospective pattern, with Mohn's rho values of approximately -0.15 for SSB and 0.19 for fishing mortality. These values were near the range generally considered acceptable for a relatively long-lived species and therefore warrant recognition but did not invalidate the assessment results. The retrospective patterns likely reflect the recent increase and development of the recreational hook-and-line fishery. Importantly, the direction of the retrospective pattern suggests that terminal-year biomass historically tended to be underestimated, and fishing mortality overestimated. As additional data were incorporated, estimates therefore tended to become somewhat more favorable rather than indicating previously undetected depletion. The absence of a declining trend in the fishery-independent indices provides additional support for the estimated population trajectory.

b) Is the stock overfished? What information helps you reach this conclusion?

The Review Panel agreed with the assessment conclusion that the WFS hogfish stock is not overfished. Current spawning stock biomass, defined using the geometric mean for 2022–2024, was estimated at approximately 1,086 mt, substantially greater than the minimum stock size threshold (MSST) of approximately 259 mt based on the SPR30% reference point. The uncertainty analysis strongly supported this conclusion. The posterior distribution from the MCMC analysis for the ratio of current SSB to MSST was entirely

above 1. Thus, the conclusion that the stock is not overfished was robust to the parameter uncertainty represented by the MCMC analysis. This conclusion is also consistent with the lack of a declining trend in the available fishery-independent abundance indices.

c) Is the stock undergoing overfishing? What information helps you reach this conclusion?

The Review Panel agreed with the assessment conclusion that the WFS hogfish stock is not undergoing overfishing. The posterior distribution of the fishing mortality status ratio was entirely below 1, with a posterior median of approximately 0.28, also based on the SPR30% reference point. The available uncertainty analyses therefore provide strong evidence that recent fishing mortality is below the applicable maximum fishing mortality threshold ($F_{30\%SPR}$).

d) Is there an informative stock recruitment relationship? Is the stock recruitment curve reliable and useful for evaluation of productivity and future stock conditions?

An informative stock-recruit relationship could not be estimated for the WFS hogfish stock. Attempts to estimate steepness (h) resulted in estimates near 0.99, effectively indicating little information in the available data regarding the shape of the stock-recruit relationship. Steepness was therefore fixed at 0.99 and recruitment was represented primarily through average recruitment and annual recruitment deviations. This should not be interpreted as evidence that the biological stock-recruit relationship has an h of 0.99. Rather, it reflects the Panel's conclusion that the relationship cannot be reliably estimated with the available information. The Review Panel considered this approach appropriate given the available information. Consequently, SPR-based proxies rather than conventional MSY estimates derived from an estimated stock-recruit curve were deemed appropriate for determining stock status. The Panel supported use of the SPR30% reference point for this purpose, which was used in the previous SEDAR 94 assessment. The difficulty in estimating recruitment dynamics may be particularly relevant for hogfish because of their protogynous hermaphroditic life history and haremic spawning system. Sex change, population sex ratio, potential male limitation, and possible skip spawning could complicate the relationship between conventional measures of spawning biomass and subsequent recruitment.

e) Are the quantitative estimates of the status determination criteria for this stock reliable? If not, are there other indicators that may be used to inform managers about stock trends and conditions?

The Review Panel concluded that the SPR-based status determination criteria were appropriate and sufficiently reliable for management use. Use of proxies is warranted because the data do not support estimation of a sufficiently informative stock-recruit relationship for calculation of conventional MSY-based reference points. Nevertheless, uncertainty in recreational spear removals complicates inference regarding the absolute level of fishing pressure the stock can sustainably support. Managers should recognize this

uncertainty when developing management quantities derived from the assessment. Appropriate management buffers, including those considered in setting OFL and ABC, provide one mechanism for accounting for uncertainty that cannot be fully represented in the assessment itself.

4. Evaluate the stock projections, including discussing strengths and weaknesses, and consider the following:

a) Are the methods consistent with accepted practices and available data?

The Review Panel concluded that the projection methods were consistent with accepted practices and the available data.

Projections were conducted externally to SS3 using a projection tool developed by the Southeast Fisheries Science Center (SEFSC) that has been used in previous assessments and reviewed through the regional management process. The assessment presented deterministic projections under multiple fishing mortality/reference-point scenarios. Long-term equilibrium projections used average recruitment over 1986–2024, whereas short-term projections used the more recent 2020–2024 average. Given the inability to estimate an informative stock-recruit relationship and the fixed steepness value of 0.99, the Panel considered the use of empirical average recruitment appropriate. With steepness near 1, recruitment varies relatively little with spawning biomass except at very low stock sizes; consequently, constant average recruitment provides a reasonable practical approximation for the WFS projections.

b) Are the methods appropriate for the assessment model and outputs?

The Review Panel concluded that the projection methods were appropriate for the WFS assessment model and its outputs. The projections were based on accepted model estimates and reference points and appropriately reflected the recruitment assumptions required by the WFS model configuration. The Panel therefore accepted the projections as a suitable basis for subsequent consideration by the SSC and Council.

c) Are the results informative and robust, and useful to support inferences of probable future conditions?

The projections were considered informative and sufficiently useful for evaluating probable future stock conditions and developing management advice. However, the degree of robustness to alternative biological assumptions could not be fully evaluated because projections were not accompanied by sensitivity analyses for all potentially important inputs, such as natural mortality, discard mortality, and other externally specified parameters. Such analyses are not necessarily standard components of the projection process, and their absence does not invalidate the projections. Nevertheless, sensitivity analyses could provide useful information regarding the dependence of projected outcomes on key fixed assumptions.

d) Are key uncertainties acknowledged, discussed, and reflected in the projection results?

Important projection assumptions and uncertainties were acknowledged, including assumptions of constant fleet selectivity and allocation, growth, natural mortality, stock-recruitment parameters, other fixed quantities, terminal-year recruitment, and future recruitment. A limitation is that the projections were deterministic and therefore did not propagate parameter uncertainty forward through time. Although multiple management scenarios were considered, the projections did not directly estimate probabilities of future biomass or fishing mortality crossing management reference points.

The MCMC analyses provide a potential mechanism for incorporating this uncertainty. Future assessments should consider propagating posterior parameter draws through projections to estimate the probability of future stock conditions under alternative fishing scenarios. Such stochastic projections could provide managers with a more explicit representation of risk.

5. Consider how uncertainties in the assessment, and their potential consequences, are addressed.

- **Comment on the degree to which methods used to evaluate uncertainty reflect and capture the significant sources of uncertainty in the population, data sources, and assessment methods**
- **Ensure that the implications of uncertainty in technical conclusions are clearly stated**

The Review Panel concluded that uncertainty was evaluated extensively in the WFS assessment and that the analyses captured many of the important sources of parameter, data, and model uncertainty. The WFS model estimated a large number of biological, recruitment, catchability, selectivity, and retention parameters. Variance estimates associated with input data were incorporated into SS as appropriate, and alternative model configurations and parameter assumptions were evaluated through sensitivity analyses, likelihood profiles, and retrospective analyses. Jitter analyses and other standard model diagnostics were examined to assess estimation convergence.

The Assessment Team explored uncertainty of M through a set of sensitivity runs (alternative formulations and freely estimated M). This exploration demonstrated that the assessment is sensitive to M as the growth estimates, ln(R0), and reference points varied substantially across the different configurations. The Assessment Team acknowledged this sensitivity in the AW report and during the RW, noting that estimating M freely added considerable uncertainty to key assessment outputs (SSB, recruitment, exploitation rates). The sensitivity analysis on discard mortality showed that discard mortality had minimal influence on model outputs. High (59%) and low (23%) discard mortality rates produced outputs that closely tracked with the based model (41.1%), indicating that discard mortality is not a significant source of uncertainty for the WFS model.

The Assessment Team conducted ln(R0) likelihood profiles, and the total likelihood profile showed a single minimum, indicating identifiability of the ln(R0) parameter from the data. The data components profiles revealed directional conflict among data types, where the length and age composition pulled toward a lower ln(R0) and the survey indices pulled towards a higher ln(R0). The base ln(R0) estimate is largely informed by the composition (age and length) data, with some influence from the survey indices.

In addition to asymptotic uncertainty estimates derived from the covariance matrix, the Assessment Team conducted both MCMC and parametric bootstrap analyses. These analyses represented a substantial strength of the assessment because they provided alternative means of characterizing uncertainty beyond standard asymptotic Normal approximations.

The MCMC analysis produced posterior distributions for model parameters and important derived quantities, including current SSB and fishing mortality relative to their respective status thresholds. This permitted direct probabilistic evaluation of stock status and clearly demonstrated the strength of evidence supporting the conclusions that the stock is neither overfished nor undergoing overfishing.

Some qualifications apply to the MCMC analysis. Two of eight chains did not satisfy the selected convergence diagnostic and were excluded from inference. The six retained chains showed acceptable convergence according to other diagnostics, but the reason for failure of the two excluded chains was not fully determined. Further investigation of trace behavior, posterior geometry, and alternative sampling algorithms would help distinguish between inefficient sampling and more substantive features such as posterior multimodality.

The parametric bootstrap provided an additional evaluation of uncertainty associated with the observed data and potential model instability. A substantial fraction of bootstrap replicates produced at least one parameter estimate at a parameter-space bound, indicating that model behavior under resampled datasets was less stable than suggested by the convergence characteristics of the base model alone. However, the resulting distributions of key parameters and derived quantities were generally consistent with the base-model and MCMC estimates. The different uncertainty approaches therefore did not indicate materially different conclusions regarding stock status.

The Review Panel considered the implications of parameter uncertainty to have been clearly communicated, particularly for the stock-status criteria. The posterior distributions associated with current biomass and fishing mortality effectively conveyed the degree of risk relative to the management thresholds. Nevertheless, not all forms of uncertainty were propagated through every component of the analysis. In particular, the deterministic projections did not propagate parameter uncertainty into future stock trajectories. However, conducting stochastic projections were not in the TORs of the AW, which is why the Assessment Team did not consider uncertainty in the projections. Future assessments should

consider whether stochastic projections based on posterior parameter distributions could provide a more complete characterization of management risk.

6. **Consider the research recommendations provided by the Data and Assessment workshops and make any additional recommendations or prioritizations warranted.**

- **Clearly denote research and monitoring that could improve the reliability of, and information provided by, future assessments**

The Review Panel supports the research recommendations developed during the Data and Assessment Workshops and identified several additional priorities that could improve future hogfish assessments.

1. Improve understanding and modeling of protogynous hermaphroditic population dynamics.
    - This represents a high research priority. Future work should investigate the recruitment and reproductive dynamics of protogynous, harem-forming species and evaluate how social structure affects sex transition. The current assessment represents sex transition primarily as an age-dependent process, whereas hogfish sex change may also depend strongly on the local abundance or density of males. Research should evaluate whether the probability of female-to-male transition changes with male density and how fishing-induced changes in population sex ratio affect reproductive output. Simulation studies and explicitly sex-structured population models could be particularly useful for evaluating these processes and the implications of size-selective harvest regulations for protogynous species.
    - Related work should investigate the potential for sperm limitation or male limitation and the prevalence of skip spawning. These processes could influence the relationship between conventional measures of spawning biomass and realized reproductive output and may help explain why a conventional stock-recruit relationship is difficult to estimate for this species.
2. Improve recreational spearfishing information.
    - Uncertainty in recreational spear landings remains one of the more important data limitations for the WFS assessment. Existing intercept designs may inadequately sample portions of the spearfishing fleet, particularly fishers operating from private access points. Targeted survey designs should be considered to evaluate the magnitude and potential bias of recreational spear removals and to determine whether existing CPUE observations adequately represent the broader spearfishing population. Improvements in this area would increase confidence in historical fishing pressure, current stock status, and sustainable harvest reference points.
3. Evaluate fishery-independent survey coverage and data gaps.
    - Available fishery-independent indices, including those excluded during the DW, should be systematically evaluated with respect to geographic coverage of hogfish habitat, sample size, and availability of age and length information. This could identify important spatial or temporal gaps and help prioritize future monitoring.

4. Evaluate alternative assessment and uncertainty methods.
    - Future methodological work should compare uncertainty estimates derived from MCMC, parametric bootstrap, and asymptotic normal approximations. Comparisons on both normal and log scales could help determine circumstances in which conventional asymptotic approximations provide sufficiently reliable inference and when more computationally intensive MCMC or bootstrap procedures are warranted.
    - Alternative MCMC algorithms, including Hamiltonian Monte Carlo and related approaches, should be investigated where feasible to determine whether they improve convergence and posterior exploration relative to the current Metropolis-Hastings implementation.
    - Additional consideration should also be given to assessment frameworks capable of incorporating random effects or state-space processes, including time-varying fishing mortality where appropriate.
5. Evaluate Stock Synthesis implementation choices that are not well understood.
    - Additional research should examine the statistical properties and consequences of using super-periods to address sparse composition data. Sensitivity analyses should also evaluate the specification of growth platoons, given the limited experience of many assessment practitioners and reviewers with this feature.
    - The implications of removing the recruitment-deviation sum-to-zero constraint for MCMC proxy models should also be examined further. The current workaround was considered acceptable for the WFS assessment, but a better understanding of the statistical consequences would benefit future applications.
6. Investigate sex-specific growth.
    - Although residual diagnostics supported the assumption of equal growth rates for males and females in the current assessment, additional biological and modeling work should evaluate whether sex-specific growth differences are important enough to affect future assessment results.
7. Evaluate environmental effects on hogfish population dynamics.
    - Future research should consider the effects of environmental disturbances and stressors, including red tides and other harmful algal blooms, cold events, and oil spills. Potential environmental effects on natural mortality, recruitment, movement, and habitat use could be important sources of temporal variability not explicitly represented in the current assessment.
8. Develop stochastic projections that propagate assessment uncertainty.
    - The MCMC framework provides an opportunity to propagate parameter uncertainty into future projections. Stochastic projections could quantify probabilities of SSB falling below biomass thresholds or fishing mortality exceeding applicable reference points under alternative management scenarios. Incorporating such approaches more routinely into the SEDAR process could

improve communication of management risk and make fuller use of the uncertainty analyses already conducted as part of the assessment.

- **Provide recommendations on possible ways to improve the SEDAR process**

  The Review Panel commented that some TORs may need to be revisited or clarified. For example, the text on BSIA may need updating, and the evaluation of the projection results may be a task for the SSC, rather than a Review Panel. Also, the Review Panel noted that the bridging analysis (see TORs for the assessment phase) was not very informative given the length between assessments and resulting changes in the data and the model. It was therefore not evaluated by the Review Panel.

7. **Consider whether the stock assessment constitutes the best scientific information available using the following criteria as appropriate: relevance, inclusiveness, objectivity, transparency, timeliness, verification, validation, and peer review of fishery management information.**

The Review Panel concluded that the SEDAR 94 West Florida Shelf hogfish assessment is scientifically sound, uses the available data appropriately, and provides a suitable basis for management advice.

8. **Provide suggestions on key improvements in data or modeling approaches that should be considered when scheduling the next assessment.**

Completion of any of the research recommendations provided for ToR 6 is not required before scheduling the next assessment.

Revisions and recalibration of MRIP fishing effort may warrant a new assessment.

9. **Prepare a Peer Review Summary summarizing the Panel's evaluation of the stock assessment and addressing each Term of Reference. Develop a list of tasks to be completed following the workshop. Complete and submit the Peer Review Summary Report in accordance with the project guidelines.**

This report represents the Peer Review Summary summarizing the Panel's evaluation of the SEDAR 94 West Florida Shelf hogfish stock assessment and addressing each Term of Reference.

2.2 EAST FLORIDA-FLORIDA KEYS STOCK

Executive Summary

SEDAR 94 developed a stock assessment of the East Florida-Florida Keys (KEYS) hogfish (*Lachnolaimus maximus*) stock using Stock Synthesis 3 (SS3). The assessment model

incorporated commercial and recreational removals, fishery-independent indices of abundance, length-composition and conditional age-at-length data, and biological information appropriate for the protogynous life history of hogfish. Model performance was evaluated using an extensive suite of diagnostics and sensitivity analyses. The Review Panel concluded that the assessment model was appropriately configured and applied, and the resulting population estimates were sufficiently reliable and consistent with the available fishery-dependent and fishery-independent data, and the known biology of hogfish. A main outcome of the review was the Review Panel's recommendation to replace the Assessment Workshop base model with a revised Review Workshop base model (KEYS_RW_Base model) based on the high uncertainty in the reconstructed landings for the period 1950-198 . This revised 1986–2024 model could not reliably estimate steepness (*h*) of the stock-recruitment relationship from the available data. Therefore, *h* was fixed at 0.99, effectively representing average recruitment (with annual deviations) and SPR-based proxies (SPR30%) were used as the basis for stock-status reference points. Based on this revised model and associated SPR-based reference points the Review Panel agreed with the conclusion that the East Florida–Florida Keys hogfish stock is not overfished nor undergoing overfishing. The Panel concluded that the projection methodology was consistent with accepted practices and appropriate for the SS3 assessment framework. However, Markov Chain Monte Carlo (MCMC) analyses and parametric bootstrap analyses corresponding specifically to the KEYS_RW_Base model were not available for Review Panel evaluation during the Review Workshop. Consequently, although the Panel accepted the deterministic stock-status conclusions, it was not able to evaluate their probabilistic robustness using posterior distributions or bootstrap results for the final revised model during the workshop . The Review Panel also identified several research priorities that could improve future KEYS Hogfish assessments. High priorities include improving understanding and modeling of recruitment and reproductive dynamics in protogynous and haremic species; improving recreational harvest, discard, life-history, age, and length information; obtaining a more reliable estimate of maximum age to better inform natural mortality; and evaluating fishery-independent survey coverage and data gaps. Overall, the Review Panel concluded that the SEDAR 94 East Florida–Florida Keys hogfish assessment, as modified during the Review Workshop, provides an appropriate scientific basis for stock-status determination and management consideration. However, important uncertainties remain regarding stock productivity, the stock-recruit relationship, and several data sources. These qualifications should accompany interpretation and use of the assessment results but do not alter the Review Panel's acceptance of the revised model for determining current stock status and providing management advice.

The Review Panel discussions and deliberations are summarized below for each of the Terms of Reference

1. **Evaluate the data used in the assessment, including discussion of the strengths and weaknesses of data sources and decisions, and consider the following:**

    a) **Are data decisions made by the DW and AW panels sound and robust?**

The Review Panel concluded that most data decisions made during the Data Workshop (DW) and Assessment Workshop (AW) were well documented and appropriate. Decisions to aggregate commercial gears into a single commercial fleet, combine SRHS landings and discards with SRFS hook-and-line estimates, and aggregate the recreational fishery into a single fleet were considered reasonable given the available data and assessment objectives.

The principal exception concerned reconstruction of historical removals prior to 1986. The Assessment Workshop base model began in 1950 and incorporated reconstructed recreational catches for the period preceding the availability of more reliable recreational fishery data. The Review Panel recognized the value of the reconstruction as an attempt to characterize the historical development of the fishery and inform initial stock conditions. However, the Panel did not consider the reconstructed recreational removals sufficiently reliable for inclusion in the model used for management advice. In particular, recreational catch during the historical period was reconstructed using effort information from the National Survey of Fishing, Hunting, and Wildlife-Associated Recreation together with CPUE inferred from recreational data available for 1982, 1983, and 1985. This approach effectively required assumptions regarding the applicability of catch rates observed during those years to much earlier periods. Because the reconstructed removals substantially influenced estimates of historical stock size and the apparent stock-recruit relationship, the Panel concluded that uncertainty in the reconstruction had potentially important consequences for model results. Accordingly, the Panel recommended that the model used as the Review Workshop base model begin in 1986, when recreational catch information becomes more reliable. The resulting 1986–2024 model is referred to here as the KEYS_RW_Base model.

The Panel also discussed differences in estimated selectivity among fishery-independent surveys. In particular, the Reef Visual Census (RVC) exhibited dome-shaped selectivity, whereas the video survey exhibited a more flat-topped selectivity pattern. These differences were considered biologically and operationally plausible because the surveys differ in depth coverage, gear characteristics, availability of fish to the survey, fishing pressure, and the degree to which surveyed areas are protected from fishing. The Panel accepted the explanation that larger fish occurring in deeper waters may be less available to the shallower RVC survey than to video sampling conducted across a broader depth range.

The Review Panel also discussed the natural mortality-at-age vector, particularly the lower mortality estimates for younger ages compared with those used in the WFS assessment. This was considered in conjunction with the relatively young terminal age represented in the KEYS model compared to the WFS model (16 vs 23 years). Following discussion, the Panel accepted the natural mortality vector used in the base model.

b) Are data uncertainties acknowledged, reported, and within normal or expected levels?

The Review Panel concluded that important data uncertainties were acknowledged and adequately reported. Overall, uncertainty in the KEYS assessment was considered relatively high, reflecting limitations in several data streams. Recreational removals are an important source of uncertainty, in particular due to recreational fishers that leave from and return to private docks. This is particularly true for recreational spearfishing because relatively few positive trips are encountered through conventional intercept surveys. Consequently, MRIP estimates of recreational harvest and discards can have high coefficients of variation.

Discard information is also limited. Sensitivity analyses conducted during assessment development suggested that alternative discard assumptions had relatively little influence on major model results, but the Review Panel noted that the consequences of sparse discard information remain poorly understood. The historical recreational catch reconstruction represents a more consequential source of uncertainty because it influenced estimated initial stock conditions and the apparent stock-recruit relationship. Rather than accepting this uncertainty within the final model configuration, the Panel addressed it by recommending exclusion of the reconstructed period and adoption of 1986 as the starting year for the KEYS_RW_Base model.

With the reconstructed recreational landings included (in addition to the commercial landings), the catch series from 1950-1980 provided enough contrast to inform the stock-recruit relationship and steepness. However in the KEYS_RW_BASE model once the reconstructed time series was excluded, the shortened time series (1986-2024) no longer supported a reliable estimate of steepness (see TOR 3d).

c) Are input data series reliable and applied properly within the assessment model?

The Review Panel concluded that the data series retained in the KEYS_RW_Base model were appropriately applied and sufficiently reliable for assessment purposes, given the acknowledged uncertainties.

2. Evaluate and discuss the strengths and weaknesses of the methods used to assess the stock, taking into account the available data, and considering the following:

a) Are methods scientifically sound and robust?

The Review Panel concluded that Stock Synthesis 3 (SS3; version 3.30.24) is a scientifically sound and robust framework for assessing the East Florida–Florida Keys Hogfish stock. SS3 has been extensively applied and tested in U.S. and international stock assessments and can integrate the mixture of catch, abundance-index, length-composition, age, and biological information available for this stock.

The Assessment Team applied an extensive suite of diagnostics during model development. Model convergence was evaluated using final gradients, Hessian properties, parameter-bound checks, and jitter analyses. One hundred jittered starting values were evaluated over a broad range, and no lower-likelihood solution was identified. Sensitivity analyses and likelihood profiles were also used extensively to examine important model assumptions.

These analyses were particularly important for evaluating the influence of the reconstructed historical catches and assumptions regarding initial conditions and stock-recruit dynamics. The Panel concluded that the assessment framework itself was scientifically appropriate and competently applied, while recommending an alternative base-model configuration based on the results of those evaluations.

b) Are assessment models configured properly and consistent with standard practices?

The Review Panel concluded that the revised KEYS_RW_Base model was appropriately configured and consistent with accepted assessment practices.

The Panel also examined the treatment of the stock-recruit relationship. When the model began in 1986 and initial depletion was freely estimated, steepness and unfished recruitment were poorly identified and traded off against one another. Alternative assumptions regarding initial conditions produced substantially different steepness (h) estimates, and likelihood profiling indicated that the available data could not reliably identify h. Consequently, the Panel recommended fixing steepness at 0.99 in the KEYS_RW_Base model, effectively removing an informative stock-recruit relationship from the assessment and allowing average recruitment and recruitment deviations to describe recruitment dynamics.

Super-periods were used for commercial and recreational length-frequency data to reduce estimation difficulties caused by sparse annual sampling. The Panel accepted this treatment for the current assessment but noted that the strengths and weaknesses of super-periods are not sufficiently understood and recommended additional methodological research.

The model also used a sum-to-zero constraint on recruitment deviations, in part to reduce retrospective patterns and remove indeterminacy between the scale of the stock-recruit relationship and the mean recruitment deviations. This constraint created difficulties for ADMB MCMC sampling because it restricted efficient exploration of the parameter space. Consequently, MCMC analyses required a proxy model in which the sum-to-zero constraint was removed. This issue was particularly important because the proxy model produced some differences in estimated stock size relative to the corresponding base model. Moreover, an MCMC analysis for the final KEYS_RW_Base model was not available at the conclusion of the Review Workshop. The Panel considered the proxy approach an acceptable methodological workaround for investigating uncertainty but recommended further research into the issue.

c) Are the methods appropriate for the available data?

The Review Panel concluded that the methods were appropriate for the available data.

The age- and size-structured SS3 framework appropriately accommodated the available catch data, intermittent length compositions, conditional age-at-length observations, abundance indices, and changes in fishery size limits and other regulations.

Growth was estimated internally within the model, which provides an effective means of accounting for interactions among growth, length selectivity, and size truncation. Conditional age-at-length information was incorporated to improve estimation of growth and selectivity while reducing biases associated with length-stratified or otherwise size-selective sampling.

The assessment also used the SS3 growth-platoon feature to represent effects of size-selective mortality on the distribution of size at age. Additional sensitivity analyses of growth-platoon assumptions are recommended because this component of SS3 is less familiar to many assessment practitioners and reviewers.

The model assumed equivalent growth rates for males and females. Available external residual analyses supported this assumption for the current assessment, although further investigation of sex-specific growth is recommended.

3. Evaluate the assessment findings and consider the following:

The Review Panel's evaluation of the assessment findings resulted in an important change from the Assessment Workshop model. The Panel did not recommend carrying forward the proposed 1950-start model containing reconstructed historical recreational catches. Instead, the Panel recommended the KEYS_RW_Base model beginning in 1986 with steepness fixed at 0.99.

a) Are population estimates (model output – e.g. abundance, exploitation, biomass) reliable, consistent with input data and population biological characteristics, and useful to support status inferences?

The Panel concluded that the population estimates from the KEYS_RW_Base model were sufficiently reliable and useful for stock-status inference, subject to important qualifications regarding initial conditions, historical catches, and the stock-recruit relationship. The Panel's recommendation to replace the Assessment Workshop base model with the KEYS_RW_Base model was itself intended to improve reliability by preventing highly uncertain reconstructed historical catches from exerting substantial influence on estimates of historical population size and productivity.

Despite the substantial difference in starting years between the original 1950–2024 model and the revised 1986–2024 model, the two configurations produced broadly similar temporal trends in spawning stock biomass and fishing mortality. This consistency provided some reassurance that the principal recent stock trajectory was not solely an artifact of the historical reconstruction. The Panel therefore considered the KEYS_RW_Base model suitable for evaluating current stock status, while recognizing greater uncertainty regarding absolute population scale and productivity than would be desirable.

b) Is the stock overfished? What information helps you reach this conclusion?

Based on the KEYS_RW_Base model and the applicable SPR-based biomass reference point (SPR30%), the Review Panel agreed with the conclusion that the East Florida–Florida Keys Hogfish stock is not overfished.

Although the Panel considered the revised model suitable for this determination, MCMC and parametric bootstrap analyses corresponding specifically to the final KEYS_RW_Base configuration were not available for Panel evaluation during the Review Workshop. Consequently, the Panel could not evaluate the probabilistic robustness of this status determination using posterior distributions for the final revised model during the workshop.

c) Is the stock undergoing overfishing? What information helps you reach this conclusion?

Based on the KEYS_RW_Base model and applicable SPR-based fishing mortality reference point, the Panel agreed with the conclusion that the East Florida–Florida Keys Hogfish stock is not undergoing overfishing. As with the biomass determination, this conclusion is based on the selected SPR proxy (SPR30%) and did not rely on MCMC and bootstrap analyses. Therefore, although the Panel accepted the deterministic stock-status determination, the associated probabilistic characterization of uncertainty for the revised model remained to be completed before subsequent consideration by the SSC.

d) Is there an informative stock recruitment relationship? Is the stock recruitment curve reliable and useful for evaluation of productivity and future stock conditions?

The Review Panel concluded that the available data did not support reliable estimation of an informative stock-recruit relationship for the KEYS stock. This conclusion emerged from extensive consideration of both the original AW Base model and alternative model configurations. The original model beginning in 1950 appeared capable of estimating steepness, but the result was strongly influenced by reconstructed historical catches and recruitment estimates associated with the reconstructed period. Because the Panel did not consider those historical removals sufficiently reliable, it did not consider the resulting stock-recruit relationship sufficiently robust for management use.

Models beginning in 1986 also provided indications that *h* might be considerably below 0.99, but estimates were highly sensitive to assumptions regarding initial stock conditions and the estimation of R0. Likelihood profiles similarly indicated information favoring lower *h* but did not provide a sufficiently stable basis for estimating the parameter. The Panel therefore recommended fixing *h* at 0.99 in the KEYS_RW_Base model. This should not be interpreted as evidence that the biological stock-recruit relationship has an *h* of 0.99. Rather, it reflects the Panel's conclusion that the relationship cannot be reliably estimated with the available information.

This distinction has management implications. Analyses conducted during the review suggested that reference points derived under a lower-steepness stock-recruit relationship

could be more conservative than the SPR30% proxy used after fixing *h* at 0.99. Thus, although the evidence was insufficient to support an estimated stock-recruit relationship, the possibility of stronger density dependence than represented by the final model remains an important source of uncertainty.

The unusual reproductive biology of hogfish may further complicate recruitment dynamics. Protandry is not involved; rather, hogfish are protogynous hermaphrodites in which females transition to males, with sex change influenced by social and haremic dynamics. Changes in sex ratio, male abundance, or reproductive behavior could affect the relationship between conventional spawning biomass and effective reproductive output.

e) Are the quantitative estimates of the status determination criteria for this stock reliable? If not, are there other indicators that may be used to inform managers about stock trends and conditions?

The Review Panel considered SPR-based status determination criteria appropriate for the KEYS_RW_Base model because an informative stock-recruit relationship could not be reliably estimated. The Panel nevertheless emphasized that the choice of SPR proxies does not eliminate uncertainty regarding underlying stock productivity. Model explorations provided some evidence consistent with lower *h*, and reference points calculated under such assumptions could differ from those obtained using conventional SPR proxies. The SSC and Council should therefore recognize this structural uncertainty when interpreting assessment-derived management quantities.

4. Evaluate the stock projections, including discussing strengths and weaknesses, and consider the following:

a) Are the methods consistent with accepted practices and available data?

The Review Panel concluded that the projection methodology was consistent with accepted practices and appropriate for the available data. The projection framework is designed to operate with SS outputs and can evaluate future stock trajectories under alternative fishing mortality or catch scenarios. The Allocation Forecasting framework developed by the SEFSC provides an established mechanism for conducting forecasts using SS3 assessment results and allocating catches among fleets. The methodology can accommodate alternative recruitment assumptions, fishing mortality targets, catch limits, and fleet allocations and can provide projected SSB, allowable catches, and stock-status metrics.

b) Are the methods appropriate for the assessment model and outputs?

The Panel concluded that the projection methodology was appropriate for the assessment model and its outputs. The forecasting framework was developed specifically for use with SS and therefore provides an internally consistent means of projecting assessment results. The Assessment Team appropriately acknowledged several important caveats and advised that projection results be interpreted carefully.

c) Are the results informative and robust, and useful to support inferences of probable future conditions?

Final projections corresponding to the KEYS_RW_Base model were not available for evaluation by the Panel during the Review Workshop. The Panel therefore could not reach a conclusion regarding the informativeness or robustness of the projection results for the revised model.

The Panel requested that projections for the KEYS_RW_Base model be completed following the Review Workshop and prior to presentation of the assessment to the SAFMC's SSC. Accordingly, the Panel's endorsement under TOR 4 applies to the projection methodology, not to projection results that were unavailable for review.

d) Are key uncertainties acknowledged, discussed, and reflected in the projection results?

The Review Panel identified an important limitation of the projection framework: projections are deterministic and do not propagate assessment uncertainty from the terminal year into future stock trajectories. Likewise, using average recruitment in future years does not represent interannual recruitment variability. Although selection of long-term or recent average recruitment is a standard forecasting approach, actual future recruitment will vary around those expectations. However, conducting stochastic projections were not in the TORs of the AW, which is why the Assessment Team did not consider uncertainty in the projections.

The Panel therefore recommends development and evaluation of probabilistic projections that propagate relevant parameter and state uncertainty and, where appropriate, future recruitment variability. Such projections could provide explicit probabilities of future biomass falling below applicable thresholds or fishing mortality exceeding reference points. Because final projections from the KEYS_RW_Base model were not available during the workshop, the extent to which uncertainties are reflected in those specific projection results could not be evaluated.

5. Consider how uncertainties in the assessment, and their potential consequences, are addressed.

- **Comment on the degree to which methods used to evaluate uncertainty reflect and capture the significant sources of uncertainty in the population, data sources, and assessment methods**
- **Ensure that the implications of uncertainty in technical conclusions are clearly stated**

The Panel concluded that the assessment employed an extensive and generally appropriate suite of methods for evaluating uncertainty. These included variance estimates associated with input data, likelihood profiles, sensitivity analyses, jitter analyses, retrospective analyses, asymptotic standard errors, MCMC analyses, and parametric bootstrap analyses.

The assessment estimated a large number of biological, recruitment, catchability, selectivity, and retention parameters. Uncertainty associated with input datasets was incorporated into SS3 as appropriate, and likelihood profiles and sensitivity analyses were used to evaluate influential assumptions and model configurations. However, the MCMC and bootstrap analyses available in preparation for the Review Workshop corresponded to the Assessment Workshop model beginning in 1950. During the Review Workshop, the Panel recommended replacing that configuration with the 1986-start KEYS_RW_Base model. It was not possible to complete corresponding MCMC and bootstrap analyses for the revised model during the workshop. Consequently, although the Panel considered MCMC,bootstrap methods, sensitivity analyses, and R0 and steepness likelihood profiles appropriate and useful for characterizing assessment uncertainty, the Panel did not review completed full diagnostics for the final KEYS_RW_Base model during the Review Workshop. Those analyses were requested for completion before subsequent SSC consideration.

The need to use a proxy model for MCMC analysis introduces an additional methodological qualification. The sum-to-zero constraint on recruitment deviations used in the base assessment interferes with efficient MCMC exploration and therefore must be removed in the proxy configuration. Because the proxy model produced some differences in estimated stock size additional research is warranted to understand the consequences of this modification and to evaluate alternative approaches to posterior sampling.

6. Consider the research recommendations provided by the Data and Assessment workshops and make any additional recommendations or prioritizations warranted.

- **Clearly denote research and monitoring that could improve the reliability of, and information provided by, future assessments**

The Review Panel supports the research recommendations developed during the Data and Assessment Workshops and identified several additional priorities that could improve future assessments of the East Florida–Florida Keys Hogfish stock.

1. Improve understanding and modeling of protogynous hermaphroditic population dynamics.

    - This represents a high research priority. Future work should investigate the recruitment and reproductive dynamics of protogynous, harem-forming species and evaluate how social structure affects sex transition. The current assessment represents sex transition primarily as an age-dependent process, whereas hogfish sex change may also depend strongly on the local abundance or density of males. Research should evaluate whether the probability of female-to-male transition changes with male density and how fishing-induced changes in population sex ratio affect reproductive output. Simulation studies and explicitly sex-structured population models could be particularly useful for evaluating these processes and the implications of size-selective harvest regulations for protogynous species.

- Related work should investigate the potential for sperm limitation or male limitation and the prevalence of skip spawning. These processes could influence the relationship between conventional measures of spawning biomass and realized reproductive output and may help explain why a conventional stock-recruit relationship is difficult to estimate for this species.

2. Improve life-history, age, length, and discard information.

   - Improving and updating basic biological and fishery information should remain a high priority. Better age and length information would strengthen estimation of growth, selectivity, mortality, and population age structure.
   - For the KEYS stock specifically, obtaining a more reliable estimate of maximum age is recommended. Maximum age provides important information for evaluating natural mortality-at-age assumptions, and improved information would help validate the natural mortality vector used in future assessments.
   - Discard information also remains limited and should be improved, particularly where sample sizes are insufficient to characterize discard magnitude, composition, and mortality reliably.

3. Improve recreational fishery information.

   - Recreational harvest and discard estimates, particularly for the spear sector, remain relatively uncertain because of low positive-trip interception rates and correspondingly high sampling variability. Improved sampling approaches or supplemental data collection could reduce uncertainty in these removals.
   - The historical catch reconstruction considered during SEDAR 94 also demonstrates the importance of developing and maintaining reliable recreational fishery information. Future historical reconstructions should explicitly characterize uncertainty in both effort and CPUE assumptions and evaluate how those uncertainties affect population-scale and productivity estimates before such data are used to inform initial stock conditions.

4. Evaluate fishery-independent survey coverage and data gaps.

   - All available fishery-independent indices, including those excluded during the DW, should be evaluated systematically for geographic and habitat coverage, sample size, and availability of age and length information.
   - The differences in selectivity among surveys considered during SEDAR 94 illustrate the importance of understanding survey depth distributions, habitat coverage, fish availability, and spatial patterns of fishing pressure when interpreting fishery-independent indices. The Review Panel noted that two of the three fisheries independent surveys occurred in a region where fishing pressure was minimal and thus may not be reflective of the stock status in regions where fishing is actively occurring.

5. Evaluate uncertainty estimation methods.

   - Future research should compare uncertainty distributions obtained from MCMC, parametric bootstrap, and asymptotic normal approximations. Comparisons on

both arithmetic and log scales could help determine when conventional covariance-based uncertainty estimates provide adequate inference and when computationally intensive MCMC or bootstrap methods materially improve characterization of uncertainty.

- Alternative MCMC algorithms and assessment frameworks capable of incorporating random effects or state-space processes should also be evaluated where appropriate.
- Particular attention should be given to the MCMC proxy-model issue identified during SEDAR 94. The statistical consequences of removing the recruitment-deviation sum-to-zero constraint should be investigated, as should alternative methods that permit posterior sampling without requiring changes to the base-model configuration.

6. Evaluate super-period and growth-platoon assumptions.
    - Additional research should examine the statistical properties of super-periods used to address sparse composition data. The approach was accepted for the current assessment, but its potential effects on parameter estimation and uncertainty are not well understood.
    - Sensitivity analyses should also be conducted for the SS3 growth-platoon specification to identify whether alternative platoon assumptions materially influence growth, selectivity, population scale, or status estimates.
7. Investigate sex-specific growth.
    - Although available residual diagnostics supported the assumption of equal male and female growth for the current assessment, further biological and modeling work should evaluate whether sex-specific growth differences are important for hogfish assessment results.
8. Evaluate environmental effects and stressors.
    - Future research should investigate environmental influences on natural mortality, recruitment, movement, and habitat use. Potential factors include red tides and other harmful algal blooms, cold events, oil spills, and other disturbances that could affect hogfish population dynamics independently of fishing.
9. Revisit the Review Workshop Terms of Reference and alignment among SEDAR stages.
    - The Panel recommended reviewing the structure and wording of the Review Workshop TORs to improve clarity regarding the Panel's expected role. In particular, TORs requiring evaluation of the robustness of projection results may be difficult to address when final projections change following Review Workshop recommendations or when the SSC is expected to request alternative projection scenarios.
    - Greater alignment among Data Workshop, Assessment Workshop, and Review Workshop TORs would also be beneficial. Important Assessment Workshop

tasks, such as bridge analyses between previous and current assessments, should be reflected explicitly in Review Workshop TORs when evaluation of those analyses is expected.

- **Provide recommendations on possible ways to improve the SEDAR process**

  The RP commented that some TORs may need to be revisited or clarified. E.g., the text on BSIA may need updating, and the evaluation of the projection results may be a task for the SSC, rather than a RP. Also, the RP noted that the bridging analysis (see TORs for the assessment phase) was not very informative given the length between assessments and resulting changes in the data and the model. It was therefore not evaluated by the RP.

7. **Consider whether the stock assessment constitutes the best scientific information available using the following criteria as appropriate: relevance, inclusiveness, objectivity, transparency, timeliness, verification, validation, and peer review of fishery management information.**

The Review Panel concluded that the SEDAR 94 East Florida-Florida Keys hogfish stock assessment is scientifically sound, uses the available data appropriately, and provides a suitable basis for management advice.

8. **Provide suggestions on key improvements in data or modeling approaches that should be considered when scheduling the next assessment.**

Completion of any of the research recommendations provided for ToR 6 is not required before scheduling the next assessment.

Revisions and recalibration of MRIP fishing effort may warrant a new assessment.

9. **Prepare a Peer Review Summary summarizing the Panel's evaluation of the stock assessment and addressing each Term of Reference. Develop a list of tasks to be completed following the workshop. Complete and submit the Peer Review Summary Report in accordance with the project guidelines.**

This report represents the Peer Review Summary summarizing the Panel's evaluation of the SEDAR 94 East Florida-Florida Keys hogfish stock assessment and addressing each Term of Reference.

SEDAR

Southeast Data, Assessment, and Review

SEDAR 94

Florida Hogfish

SECTION VI: Addenda and Post-Review Workshop Report

July 2026

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

This information is distributed solely for the purpose of peer review. It does not represent and should not be construed to represent any agency determination or policy.

Table of Contents

Table of Contents....2
1 Introduction....3
2 Additional Data Requests....3
2.1 Data Plots....3
3 Additional Requests for Base Model Results....3
3.1 Florida Keys/East Florida....3
3.1.1 Stock-Recruitment....4
3.2 West Florida Shelf....5
4 FL KEYS/EFL Stock Synthesis Model Results: KEYS RW Base Model....5
4.1 Life History....5
4.2 Landings and Discards....6
4.3 Indices....6
4.4 Length and Age Composition....6
4.4.1 Data Weighting....6
4.4.2 Length Composition....7
4.4.3 Conditional Age-at-Length....7
4.5 Estimated Parameters and Derived Quantities....7
4.5.1 Stock Biomass (Total and Spawning)....7
4.5.2 Recruitment....7
4.5.3 Fishing Mortality....8
4.5.4 Selectivity and Retention....9
4.6 Model Diagnostics....9
4.6.1 Convergence....9
4.6.2 Goodness of fit....10
4.6.3 Model Consistency....10
4.6.4 Model Validation (Prediction Skill)....12
4.7 Per-recruit Analyses....12
4.8 Uncertainty in Parameters and Derived Quantities....13
4.8.1 MCMC Analysis....13
4.8.2 Parametric Bootstrap....13
4.9 Stock Status Determination Criteria....13
4.10 Projections....14
4.10.1 Results....15
5 Tables....17
6 Figures....36

1 Introduction

The SEDAR 94 Florida Hogfish Assessment Review Workshop (RW) took place July 14 – 17, 2026, in Charleston, SC. During the RW, the SEDAR 94 RW Panel requested additional details or analyses from the analytical team, which are summarized below.

2 Additional Data Requests

2.1 Data Plots

Residual plots from the external growth models for each stock were developed during the Data Workshop (DW) and are presented in the DW Report at Figure 2.13.31 for the Florida Keys/East Florida stock and Figure 2.13.38 for the West Florida Shelf stock. Figures 2.13.31g and 2.13.38g showed the residuals by age while Figures 2.13.31e and 2.13.38e showed the residuals by sex aggregated across ages. The RW Panel requested additional residual plots by age but separated by sex to further explore whether Hogfish exhibited sexual dimorphism. Here, Figure 1 and Figure 2 show the residuals by age and separated by sex from the Florida Keys/East Florida and West Florida Shelf external growth models, respectively.

The RW Panel wanted to further understand, for each stock, the contribution of each fleet to the total dead catch (i.e., retained landings plus dead discards), particularly in the post-2017 regulatory time block when discards were increasing in trend. Figures 3a and Figures 3b illustrate the proportion of total dead catch (in numbers) per fleet for the Florida Keys/East Florida stock and West Florida Shelf, respectively.

During the Assessment Workshop (AW) process, the AW panel determined for the WFS model to remove the conditional age-at-length data from the commercial, recreational hook-and-line, recreational spear, and fishery-independent trawl sources. The WFS base model, therefore, retained only the SEAMAP and fishery-independent spear conditional age-at-length data as the most reliable data sources to inform the internal estimation of growth and in effort to remove conflicting data sources in a model already relying primarily on composition data to inform population scale. The RW panel wished to see those age data, and they are presented in Figures 4 – 7.

3 Additional Requests for Base Model Results

3.1 Florida Keys/East Florida

In Figure 3.34b of the AW Report, estimates of spawning stock biomass separated by sex were presented which indicated trends in biomass were largely influenced by male biomass. Within the KEYS base model, male Hogfish are generally larger and heavier than females due to the combination of the length-weight and hermaphroditism functions input to the model. The RW panel wished to see the total abundance (in numbers) separated by sex to verify the model was estimating more numbers of females and that the trend in abundance was influenced more by the numbers of females within the population. This is presented in Table 1 and Figure 8.

Discussion arose over the retrospective analysis and why a pattern was presenting itself during model development in the AW process. The RW panel discussed treatment of the recruitment deviations in the terminal years, data weighting (whether using the Dirichlet-multinomial or Francis) and the use of lambdas, as well as catchability of the indices across retrospective peels. The RW panel requested to see

how estimates of catchability for the three indices, particularly for the RVC Dry Tortugas index, changed across the six retrospective peels. They are presented in Table 2 and Figure 9 and show that estimates of catchability for the RVC Dry Tortugas index generally increased with more successive peels while the RVC Florida Keys and combined video indices were more consistent across peels.

The RW panel wished to see how changes in assumptions of natural mortality impacted various parameter estimates and model derived quantities. Specifically, they were interested in seeing how model likelihood, growth and stock-recruitment parameters, as well as MSY- and SPR-based reference points responded. These results from the three natural mortality scenario sensitivity runs are presented in Table 3. The "HamelCope_age3" and "est_HamelCope_age3_noprior" scenarios showed similar estimates of model fit via total log likelihood, growth and stock-recruitment parameters, and F_{MSY}; however, they differed slightly in remaining reference point values. In contrast, the "est_HamelCope_age3" scenario estimated a larger asymptotic size, a larger virgin population size, worsened fits to the data via total log likelihood, and different reference point values.

3.1.1 Stock-Recruitment

During the RW, lengthy discussion occurred regarding the uncertainty of the stock-recruitment relationship within the KEYS base model. Of particular concern was the reliance of the reconstructed recreational landings data to inform the *steepness* parameter (h) and to better inform the *ln(R0)* parameter (i.e., create an 'anchor point') and the uncertainty surrounding those reconstructed landings data. Discussion was also brought up about the results of the "1986 Start Year" sensitivity run described in the AW Report (Sections 2.12.5.1 and 3.6.5.1) which assumed recruitment deviated around an average, yet showed a *steepness* parameter profile indicating the data were informing a value much lower than 0.99 (Figure 3.55g in the AW Report). However, upon further investigation during the RW, it was uncovered that when the "1986 Start Year" model was allowed to estimate the *steepness* parameter, it could no longer reliably estimate the *ln(R0)* parameter (i.e., it chased the upper bound at $ln(14)$), thereby making the profile plot misleading.

Further discussion occurred regarding how the results of the KEYS base model and the "1986 Start Year" sensitivity run were largely similar (see Section 3.6.5.1 in the AW Report), despite significantly different assumptions about the relationship between spawning stock size and recruitment. The RW panel requested whether any model diagnostics for the "1986 Start Year" sensitivity model had been conducted. As noted in Section 2.12.5.1 in the AW Report, this model was developed during the AW process alongside what would become the KEYS base model (indeed, it was the original preliminary base model) and was deliberated over by the AW panel. Therefore, model diagnostics (e.g., residual analyses, retrospective analyses, jitter analysis, and parameter profiling) were already completed and compiled within an AW presentation and shared with the RW panel.

Ultimately, the RW panel concluded that while the stock-recruitment relationship as estimated by the KEYS base model was informative, it was not reliable and useful for management. This was primarily due to the uncertainty of and the reliance on the reconstructed recreational landings data as well as the sensitivity of the *steepness* estimate to initial model conditions. The RW panel consented to reject the KEYS base model in favor of the "1986 Start Year" model which they concluded to also be stable, pass model diagnostics, but did not make the same assumptions for the stock-recruitment relationship. However, no uncertainty analyses (i.e., MCMC or bootstrapping) nor any projections were performed for this model given its rejection during the AW process. Therefore, the analytical team were tasked by the

RW panel with conducting these analyses post-RW. Furthermore, since the results of the "1986 Start Year" model were not presented in detail in the AW Report, but only as a comparative sensitivity run, the results will be presented in detail below in Section 4. The "1986 Start Year" sensitivity model for the Florida Keys/East Florida stock will, hereafter, be referred to as the "**KEYS RW base model**" and the original KEYS base model will, hereafter, be referred to as the "AW KEYS base model".

3.2 West Florida Shelf

As requested for the AW KEYS base model, the RW panel wished to see how changes to assumptions of natural mortality impacted various parameter estimates and model derived quantities for the WFS base model. These results from the three natural mortality scenario sensitivity runs are presented in Table 4 and show how the WFS base model compensates between mortality, growth, and recruitment to estimate population size, as noted in Section 4.6.5.1 in the AW Report.

The WFS base model was configured such that landings for all three fleets (COM, REChl, RECsp) were fit near exact within the model. This was accomplished using the F_{hybrid} configuration and was explored during the model development process of the AW. Since recreational landings for Hogfish were highly uncertain, the RW panel requested to see how the WFS base model incorporated that uncertainty for the REChl fleet by configuring it with F as a parameter (F_{par}). When annual fishing mortality rate parameters are estimated for any given fleet, estimated landings are not an exact fit to the observed landings and account for associated error in the landings data. Estimates of spawning stock biomass (Figure 10a) and exploitation rates (Figure 10b) were found to be relatively insensitive; however, the uncertainty surrounding these estimates, represented by the annual CVs, increased by 9.2% for spawning stock biomass (Figure 10c) and by 15.4% for exploitation rates (Figure 10d).

4 FL KEYS/EFL Stock Synthesis Model Results: KEYS RW Base Model

The KEYS RW base model was developed in Stock Synthesis (SS) version 3.30.24.1 and was largely identical in configuration to the AW KEYS base model apart from a few key model assumptions. First, the KEYS RW base model started in 1986 which therefore removed the influence of both the historic commercial landings data as well as the reconstructed recreational landings data for years 1950 – 1985. Secondly, it assumed that annual recruitment deviated around a long-term average (i.e., *steepness* = 0.99) rather than assuming a stock-recruitment relationship.

4.1 Life History

The KEYS RW base model internally estimated growth where asymptotic length (L_{inf}) was estimated at 51.9 cm FL and the growth coefficient (k) was estimated at 0.173. Using the platoons feature within SS, this corresponded to the 3rd platoon (of the 5 total platoons) which was apportioned 46.4% of annual recruitment. The estimated mean length-at-age was found similar to the results of the external growth model developed during the Data Workshop (Figure 11; see Section 2.3.5 in the Data Workshop Report) and the additional platoons allowed fish to grow faster (i.e., larger) and slower (i.e., smaller). For example, in the fourth platoon, where 23.7% of annual recruitment was apportioned, mean fish size was as large as 63.6 cm FL; but in the second platoon, also receiving 23.7% of recruitment, mean fish size was as large as 34.4 cm FL. These faster growing fish became vulnerable to the fisheries sooner whereas the

slower growing fish encountered the fisheries much less, helping to mimic the "Lee phenomenon" hypothesized to be occurring in this stock. Furthermore, the platoon within/between standard deviation ratio parameter was estimated at 0.77, suggesting a shift to lower mean size-at-age has been occurring for this population.

4.2 Landings and Discards

Fits to the landings data for the commercial and recreational fleets are presented in Figures 12 – 13. The fits to the commercial landings were nearly exact (total negative log-likelihood = 3.46e-05) while the recreational landings were allowed more flexibility given their higher observation error (total negative log-likelihood = 15.896). The KEYS RW base model generally fit the observed recreational landings well except in 1988 and 2005, which expected much higher landings, and in years 2008, 2012, and 2015, which expected lower landings. Figure 14a and Figure 14b compares model estimated landings across fleets in biomass and numbers of fish, respectively.

Fits to the recreational discard data were well (total negative log-likelihood = -0.169) as most estimates were close to the observed values and within the 95% confidence intervals (Figure 15) except for year 2009 which estimated higher numbers of fish discarded.

4.3 Indices

The KEYS RW base model fits to the three fishery-independent indices (RVC Florida Keys, RVC Dry Tortugas, and combined video) are presented in Figures 16 – 18. Model fits to the indices were overall well (total negative log-likelihood = 9.157) and seemed to follow a similar common trend.

Model fits to the RVC Florida Keys index were fair (RMSE = 0.2590), but misfit in certain years contributed the most to the model's overall total negative log-likelihood for the index component (Figure 16). The observed trend started very low and gradually increased through time until the series high in 2024. But the model expected higher abundances in those first two years before becoming more aligned through 2018. Fits to years 2022 and 2024 behaved as a flat average between the two observed values for two primary reasons: 1) the model balanced fitting the other two indices, and 2) the model's main recruitment deviations for 2022 – 2024 were configured to follow average recruitment (see Section 2.6 in the AW Report).

Fits to the RVC Dry Tortugas index were closest (RMSE = 0.1570) and the observed trend was similar to the RVC Florida Keys index. The fitted values followed the observed stable but variable trend through the 2000s and then increased from 2018 – 2024 (Figure 17).

Lastly, model fits to the combined video index were the worst of the three (RMSE = 0.3730), but this index also contained the greatest amount of observed error. The fitted values generally followed the observed trend which began as an initial high in 1993 and gradually decreased though 1997, became stable but variable through 2017, then began gradually increasing again (Figure 18).

4.4 Length and Age Composition

4.4.1 Data Weighting

Weighting of the length composition data using the Dirichlet-multinomial distribution resulted in $ln(\theta)$ parameters < 5 with most close to 0 (commercial landings: $\theta = 2.167$, recreational discards: $\theta = 1.052$, recreational landings: $\theta = -0.572$, combined video: $\theta = 0.434$, RVC indices: $\theta = -0.373$; Table 5). Thus,

theta ratios were all below 1.0 (commercial landings: 0.897, recreational discards: 0.741, recreational landings: 0.361, combined video: 0.607, RVC indices: 0.408).

4.4.2 Length Composition

The KEYS RW base model fits to the length composition data along with the Pearson residuals associated with the landings, discards, and indices are presented in Figures 19 – 23. The quality of the fit varied among fleets and indices and fits aggregated across time were reasonable (length component: total negative log-likelihood = 521.906; size component: total negative log-likelihood = 1103.6). Fits to these data were largely identical to the fits by the AW KEYS base model (see Section 3.4.2 of the AW Report) and therefore will not be repeated in description here.

4.4.3 Conditional Age-at-Length

The KEYS RW base model fits to the CAAL data associated with the landings as well as fishery-independent spear and trawl data are presented in Figures 24 – 28. The quality of the fit varied among data sources and fits to their aggregated mean ages were generally acceptable (total negative log-likelihood = 620.211). As with the length composition data, fits to the CAAL data were largely identical to the fits by the AW KEYS base model (see Section 3.4.3 of the AW Report) and will not be repeated here.

4.5 Estimated Parameters and Derived Quantities

The SEDAR 94 KEYS RW base model estimated most parameters reasonably well (i.e., $|CV| < 1$; Table 6). Of the 130 active parameters, 19 exhibited poor estimation (i.e., $|CV| > 1$); including 14 recruitment deviations and 5 parameters describing selectivity (mostly commonly the top logit and/or end logit parameters). No parameters were estimated near bounds.

4.5.1 Stock Biomass (Total and Spawning)

The predicted total biomass and spawning stock (mature female plus male) biomass are summarized in Table 7 and Figure 29a-b. Both trends in biomasses gradually decreased through time from 1986 until about the year 2000, then became stable but variable through 2017, then began increasing again through 2024 (Figure 29a-b).

The unfished spawning stock biomass (SSB_0) was estimated at 3,316.51 mt (Table 7, Figure 29b) where the estimated female spawning biomass was 831 mt and the male biomass was 2,485 mt (Table 8). In 1986, the depletion ratio (SSB/ SSB_0) was 0.786 and decreased to an average 0.406 from 1995 – 2017; it was lowest from 2006 – 2010 (avg. ratio = 0.337) but since 2018 has increased in trend from 0.435 to 0.674 in 2024 (Table 7). Temporal trends in the population reflected the model's configuration of the length-weight relationship as well as the hermaphroditism function. That is, trends in spawning biomass appeared to be influenced predominantly by changes in the male (i.e., larger and heavier) biomass (Table 8, Figure 30a), while the estimated numbers of the population were primarily influenced by changes to the females (i.e., smaller but more numerous; Table 8, Figure 30b).

4.5.2 Recruitment

The relationship between spawning stock biomass and age-0 fish was parameterized within SS using the Beverton-Holt stock-recruitment model and is presented in Figure 31. However, the *steepness* parameter was fixed at 0.99, thereby configuring recruitment to deviate annually around a long-term average. The

sigmaR parameter was estimated at 0.411, and the *ln(R0)* parameter was estimated at 7.484 (Table 6), which equates to 1,778,579 age-0 Hogfish.

Simple annual deviations from the stock-recruitment function, which were constrained to sum to zero, were estimated assuming a lognormal error structure. Main recruitment deviations were estimated for years of greater data-richness (1981 – 2021) and corresponded to when the length and age composition data for the fleets began to become available. Values were slightly above average from 1981 – 1992, below average from 1993 – 2001, then oscillated above and below through 2021 (Figure 31b). As observed during the AW model development process, estimated recruitment in the last three years (2022 – 2024) was highly elevated, following the index of abundance trends and corresponded to the stock continuing to recover after management intervention beginning in 2017. But this configuration also produced a retrospective pattern due to the model's inability to predict that recovery trend as the terminal years of the model withdraw. As with the AW KEYS base model (see Section 2.6 and Section 2.14.1.1 in the AW Report), introducing process error by removing the deviations for years 2022 – 2024 (i.e., recruitment followed the long-term average recruitment instead) eliminated the retrospective pattern for the KEYS RW base model.

The estimated annual recruitment of age-0 Hogfish to the biological population in the Florida Keys/East Florida is summarized in Table 7 and Figure 31a-b. Recruitment was above average from 1986 – 1992 (avg. 2.188 million fish), diminished considerably from 1993 – 1998 (avg. 0.995 million fish), then became stable but variable through 2021 to 2.319 million fish (Figure 31a). From 2022 – 2024, recruitment was 1.776 million fish. Recent notably high years of recruitment were estimated to be in 2007 (2.591 million fish), 2012 (2.580 million fish), 2013 (2.113 million fish), and 2015 (2.921 million fish).

The estimated (and applied) recruitment bias adjustment ramp as recommended by Methot and Taylor (2011) is shown in Figure 32. However, the recommended bias adjustment showed some instability in the KEYS RW base model, which was observed and discussed during the AW process. The recommended values tended to oscillate between two different vectors, rather than converge on a single solution, and may have been influenced by the recruitment deviation's sum-to-zero constraint.

4.5.3 Fishing Mortality

The annual exploitation fishing mortality rates on Florida Keys/East Florida Hogfish are presented in Table 9 and Figure 33. Exploitation rates generally followed the trend in catch; between 1986 and 1994 exploitation averaged 0.095 yr^{-1} with a high in 1988 (0.165 yr^{-1}). From 1995 – 2017, exploitation rates were variable with notable highs in 2005 (F = 0.262 yr^{-1}), 2009 (F = 0.209 yr^{-1}), and 2015 (F = 0.174 yr^{-1}; Table 9, Figure 33). After new regulations (SAFMC Snapper Grouper Amendment 37) were implemented near the end of 2017, exploitation averaged 0.021 yr^{-1} for years 2018 – 2024.

Fleet-specific fishing mortality rates (i.e., instantaneous apical rates representing the fishing mortality level on the most vulnerable age class) are also provided in Table 9 and Figure 34. Apical fishing mortality rates were considerably higher for the recreational fleet and, like the exploitation rates above, followed the trend in annual catch. In contrast, commercial fishing mortality rates were very low but were highest between 1986 – 2005 (Table 9, Figure 34).

4.5.4 Selectivity and Retention

Selectivity for all fleets and indices was estimated using length-based selectivity functions which the KEYS RW base model used to further derive age-based selectivity (Figures 35 – 39).

Selectivity of Hogfish for the commercial fleet was time-varying to follow changes in minimum size regulations; without discard estimates (which must be assumed negligible) or discard length composition data, selectivity here functioned as retention. Selectivity was dome-shaped generally between 27 – 41 cm FL from 1986 – 1994, 29 – 41 cm FL from 1995 – 2017, and 39 – 53 cm FL from 2018 – 2024; an asymptote of 55% was reached in all three time blocks (Figure 35). In the first two time blocks, fish became vulnerable beginning at age-2 before becoming more fully selected by ages 5 and 6; age-derived selectivity of fish in the 2018 – 2024 time block was more gradual due to the increase in minimum size, beginning around age-3 and continuing to age-16 (Figure 38).

Dome-shaped selectivity of Hogfish by the recreational fleet was generally between 23 – 54 cm FL, reaching an asymptote of 7% by 55 cm FL (Figure 36a-c). Age-derived selectivity was primarily across ages 2+ with fuller selectivity occurring between ages 4 – 6 (Figure 39). Retention was time-varying and fish were fully retained by 9 cm FL from 1986 – 1994 (Figure 36a), 33 cm FL from 1995 – 2017 (Figure 36b), and 55 cm from 2018 – 2024 (Figure 36c). Note that where retention was estimated to occur well below 23 cm FL from 1986 – 1994, it meant fish vulnerability still followed the estimated selectivity curve and that, given the absence of minimum size limits, whatever negligible number of fish were encountered were retained. Furthermore, this time period contained no discard length composition data; thus, discards-at-length from 1986 – 1994 followed selectivity and the additive inverse of retention. From 1995 – 2017, Hogfish were discarded largely between 21 – 33 cm FL (Figure 36b), whereas fish from 2018 – 2024 were discarded in greater proportion across a wider range from 21 – 51 cm FL due to the increased minimum size limit and reduction in daily bag limit (Figure 36c).

The selectivity (vulnerability to observations by divers) of Hogfish by the RVC Florida Keys index was dome-shaped, occurring mostly between 11 – 53 cm FL and reached an asymptote of 11% by 55 cm FL (Figure 37). Juvenile fish started to become vulnerable at about 9 cm and individuals became fully selected between 21 – 29 cm FL (Figure 37). Age-derived selectivity occurred across all ages with fish becoming more fully selected at ages 2 – 3 (Figure 39). In the RVC Dry Tortugas index, selectivity was dome-shaped and primarily occurred on larger individuals between 29 – 87 cm FL (Figure 37). As a result, age-derived selectivity appeared more flat-topped by gradually increasing from age 1 to the maximum age (Figure 39). Fish observed by the combined video index, which operated near and north of the Dry Tortugas but sampled deeper waters, began to be selected around 11 cm FL and became fully selected by 41 cm FL (Figure 37). Age-derived selectivity of this index started at age-1 and became more fully selected by ages 10+ (Figure 39).

4.6 Model Diagnostics

4.6.1 Convergence

The SEDAR 94 KEYS RW base model converged with a total objective function of 2253.57. The model contained no parameters on the bounds, had a small final gradient <0.0001, and had a positive definite Hessian matrix. Highly correlated parameters were inspected, but all were found to be structurally correlated and therefore left as-is estimated in their different model phases.

The results of the jitter analysis, where initial values for each parameter were jittered by 20%, found that no jittered runs contained a total likelihood lower than the KEYS RW base model and suggested that the base model had converged on a global solution (Figure 40). Furthermore, 91 jittered runs were found within 2 total likelihood units of the KEYS RW base model. All 100 jittered runs converged where 71% had a low gradient (<0.0001) and the maximum gradient observed was 0.0008605.

4.6.2 Goodness of fit

The residuals from the various data components of the KEYS RW base model were very similar to the residuals observed by the AW KEYS base model. Therefore, discussion will be more abbreviated here.

The joint residual plots for the indices (Figure 41a), mean length composition data (Figure 41b), the conditional age-at-length data (Figure 41c), and the mean general size composition data (Figure 41d) indicated reasonable fits to the data as combined RMSE values were 0.298, 0.023, 0.316, and 0.105 respectively. As illustrated by the loess-smoother and size of the boxplots, residual variability of the indices was more positively biased at the beginning of the timeseries due to the more poorly fit combined video index (RMSE = 0.373). When the RVC indices became available in 1999, the overall trend centered around zero through 2009 then became more negatively deviated until reaching near zero again in the terminal years (Figure 41a). Due to the application of super-periods, the frequency of mean length residuals was only during the start of those periods; residuals and interquartile ranges of these data were small and consistent across time, indicating general agreement with the fisheries and index data (Figure 41b). In the conditional age-at-length data, residuals were more negatively biased in the beginning and end of the timeseries as influenced by the poorer-fitting fishery-independent trawl ages (RMSE = 0.666) and, to a lesser extent, the recreational ages (RMSE = 0.235; Figure 41c). Lastly, the fits to the mean size data for the RVC indices were well and mostly centered around zero across the timeseries (Figure 41d).

The residual series of all three indices passed the runs test, indicating residuals were sufficiently random and without significant autocorrelation (Figure 42). Only the recreational length composition data had sufficient observations for the runs test and passed (Figure 43a). As was observed in the AW KEYS base model, the size composition data for both indices failed due to each having two years of residuals greater than three standard deviations with some possible temporal autocorrelation (Figure 43b). The conditional age-at-length residuals for the commercial landings and both fishery independent fleets passed the runs test, but the residuals for the recreational landings failed by showing some positive temporal autocorrelation from 2009 – 2016 as well as a residual in 2004 greater than three standard deviations (Figure 44).

4.6.3 Model Consistency

4.6.3.1 Likelihood Profiles

The likelihood profile on the *ln(R0)* parameter revealed that the parameter was influenced by the index and length composition components as well as by the recruitment and age data components, behaving as a middle-ground between these two sets of data components (Figure 45a). The profile minimum agreed with the KEYS RW base model estimate of 7.48, but also indicated a parameter estimate between ~7.3 – 7.7 would not produce a significantly worse fit to the data (i.e., change in log-likelihood <2 units).

The profile of the *steepness* parameter indicated that a substantially better model fit could be achieved at a value of approximately 0.35 (Figure 45b). This result was driven primarily by the recruitment component and both RVC size composition components, which consistently favored steepness values between 0.30

and 0.35. In contrast, the index component—particularly the RVC Dry Tortugas and combined video indices—supported substantially higher values (>0.6).

Figure 46 shows the relationship between the two correlated parameters, *steepness* and *ln(R0)*, during the *steepness* profiling exercise. As *steepness* decreased from 0.99, the freely estimated *ln(R0)* parameter became increasingly unstable. This instability was most pronounced at the lower *steepness* values identified by the profile, where *ln(R0)* approached its upper parameter bound of *ln*(14). This behavior motivated the inclusion of the historical and reconstructed landings time series during the AW process, as these data provided an important "anchor point" for estimating *ln(R0)*. Without these data, neither *steepness* nor *ln(R0)* was well informed at these lower values, causing the *steepness* profile to produce misleading results.

4.6.3.2 Age-structured Production Models

The results from the ASPM indicate that there is enough information in both the catch and index data for the production function to largely drive the stock dynamics and for the model to be adequately informed about scale (Figures 47 – 48). Catches were high in the mid-1980s through early 1990s, when the combined video index showed a decline in abundance, then catches and indices became stable but variable through 2017, then catches further declined while indices increased in trend through 2024. As seen in the AW KEYS base model diagnostic, the ASPM greatly benefited from the F as a parameter configuration (process error) which allowed the model to access the observational error of the catch in order to compensate for the lack of recruitment deviations. Here, the ASPM was able to artificially estimate significantly higher exploitation rates in 1999 and 2001 (Figure 47b), when all three indices become available, in order obtain a close enough estimate of absolute scale in which to adequately fit those indices (Figure 48b-d) and continue following the population trends of the KEYS RW base model.

The estimate of *ln(R0)* by all three models generally overlapped in distribution; however, the KEYS RW base model had the highest *ln(R0)* estimate, indicating the composition data contained some information on unfished population scale (Figure 48a). The ASPM with recruitment deviations (ASPMdev) estimated the lowest population scale (Figure 47a) with correspondingly larger exploitation rates, especially from 2012 – 2017 (Figure 47b), and followed the same trends as the KEYS RW base model and the ASPM, further indicating the inclusion of length and age composition data in the KEYS RW base model is still informative to estimates of population scale. The trend in age-0 recruitment and recruitment deviations of the ASPMdev was also very similar to the KEYS RW base model (Figure 47c-d), suggesting the model needed that process error in order to better fit the trends in the indices. Indeed, without the influence of the composition data, fits to all three indices by the ASPMdev were improved.

Fits to the RVC Dry Tortugas index ($RMSE_{ASPMdev}$ = 0.102; $RMSE_{ASPM}$ = 0.142; Figure 48c; Table 10) were the best, followed by the RVC Florida Keys index ($RMSE_{ASPMdev}$ = 0.208; $RMSE_{ASPM}$ = 0.339; Figure 48a; Table 10). The combined video survey was the worse fitting of the three indices ($RMSE_{ASPMdev}$ = 0.347; $RMSE_{ASPM}$ = 0.397; Figure 48d; Table 10).

4.6.3.3 Retrospective Analysis

The retrospective analysis showed a slight pattern in estimates of spawning stock biomass and exploitation after removing six successive years from the terminal year. Spawning stock biomass tended to decrease in trend while exploitation tended to increase in trend (Figure 49a-b). All runs were within the 95% confidence interval of the KEYS RW base model, converged, and contained no parameters on the bounds. Furthermore, the calculated values for Mohn's rho for SSB (ρ_M = -0.090; Table 11) and

exploitation (ρ_M = 0.076; Table 11) were within the "acceptable" range for longer-lived species according to Hurtado-Ferro et al. (2015). As observed in the AW KEYS base model, the KEYS RW base model needed the inclusion of process error in the form of recruitment deviations ending in 2021 and the sum-to-zero constraint to eliminate the stronger retrospective pattern observed in earlier developed models.

4.6.4 Model Validation (Prediction Skill)

Retrospective forecasting showed that the one year forward projections were largely consistent with the overall estimated trend in the reference model and were similar in trend to the results of the retrospective analysis (Figure 49a-b). All retrospective forecasts fell within the 95% confidence interval of the KEYS RW base model. The forecast rho value for spawning stock biomass increased slightly to ρ_F = -0.085 and exploitation decreased to ρ_F = -0.096 (Table 11), suggesting model stability as well as consistency when successive data became available.

A hindcast with cross-validation of the terminal seven years of data was performed to gauge predictive capacity of the KEYS RW base model. From the indices, eleven total observations were available, and a joint MASE score of 0.655 indicated the KEYS RW base model predicted these indices almost twice as accurately as a naïve forecast (Table 12). All three indices scored similar MASE values; the RVC Dry Tortugas index was the lowest (MASE = 0.552, Table 12), followed by the combined video survey (MASE = 0.632, Table 12), and the Florida Keys index (MASE = 0.750, Table 12). Only the RVC Dry Tortugas mean size data indicated predictive capacity (MASE = 0.597, Table 12) while the number of super-period observations for commercial, recreational, and combined video mean length data precluded computing of prediction residuals. The MASE values for the conditional age-at-length (CAAL) data demonstrated low mean absolute errors and all CAAL data sources were better predicted by the KEYS RW base model than a naïve baseline prediction (joint MASE = 0.170; Table 12).

4.7 Per-recruit Analyses

The yield-per-recruit (YPR), spawner-per-recruit (SSB/R), static spawning potential ratio (SPR), and equilibrium yield analyses were computed as a function of the instantaneous exploitation rate on Florida Keys/East Florida Hogfish and are presented in Table 13 and Figures 50 – 51a. The retained yield at $F_{30\%SPR}$ for Florida Keys/East Florida Hogfish was estimated to be 106.702 mt (235,238 lbs.; Figure 50d) while the total yield (retained yield plus dead discards) at $F_{30\%SPR}$ was estimated at 212.250 mt (467,931 lbs.; Figure 50c). At exploitation rates greater than 0.30, corresponding to a 20% SPR and below (Figure 51a), the retained yield declines (Figure 50d). In contrast, total yield remains relatively constant (Figure 50c), indicating that any additional catch is offset by increasing dead discards. The retained yield associated with $F_{40\%SPR}$ was estimated at 98.714 mt (217,628 lbs.; Figure 50d), marking that a 7.5% decrease in retained landings produces a 10% increase to SPR.

The SPR values by year were calculated and are presented in Figure 51b. The average SPR from 1986 – 1994 was 0.458, then increased slightly to an average value of 0.498 from 1995 – 2017, then increased again from 2018 – 2024 to an average value of 0.843. The KEYS RW base model indicated that SPR had declined below 30% in 4 years of the timeseries (1988, 2005, 2009, and 2015) but had declined below 40% in 11 years of the timeseries (Figure 51b).

4.8 Uncertainty in Parameters and Derived Quantities

4.8.1 MCMC Analysis

An MCMC 'proxy' model was developed from the KEYS RW base model using the same methodology as was performed for the AW KEYS base model (see Section 2.14.1.1 in the AW Report) and as supported for use by the RW panel.

Four MCMC chains were produced based on this MCMC 'proxy' model. For each chain, a total of 5,000,000 iterations were performed but only one out of every 1,000 iterations were saved, resulting in 5,000 potential iterations used to generate estimates of uncertainty in parameters and derived quantities. Visual inspection of trace plots to adjust appropriate levels of burn-in and thinning as well as to address any autocorrelation in the iterations led to a burn-in of 1,000 with further thinning of every 4, resulting in 1,000 samples per chain. Each chain was found to have converged based on Geweke's diagnostic and a total of 4,000 iterations were utilized. The four chains were combined, and convergence was evaluated using trace plots (Figure 52) and the Gelman and Rubin's (1992) potential scale reduction factor (PSRF) for selected model parameters (*ln(R0)*, SSB_0, and *steepness*) and derived quantities (exploitation in 2024, SSB in 2024, $F_{30\%SPR}$, SSB at $F_{30\%SPR}$, and the retained yield at $F_{30\%SPR}$). PSRF values for all selected parameters and stock status criteria were close to 1 and since none of the PSRF upper confidence intervals exceeded the 'rule of thumb' value of 1.1, it was concluded that the final combined MCMC converged (Table 14).

Posterior distributions from the MCMC 'proxy' model were produced for stock-recruitment parameters (Figure 53) as well as the derived quantities of $F_{current}$ (Figure 54a), $F_{30\%SPR}$ (Figure 54b), the retained yield associated with $F_{30\%SPR}$ (Figure 54c), $SSB_{current}$ (Figure 54d), SSB at $F_{30\%SPR}$ (Figure 54e), and 75% of the SSB at $F_{30\%SPR}$ (Figure 54f). Estimated values of the KEYS RW base model were generally found to fall within the interquartile ranges of these posterior distributions (Figures 53 – 53) which further evidenced the MLE values were not "captured in a strange neighborhood".

4.8.2 Parametric Bootstrap

Five hundred bootstrapped datasets were produced from the KEYS RW base model by randomly drawing datasets according to assumed error distributions centered on fitted values. Results of the bootstrap analysis indicated that the model exhibited a measure of instability when fitting to the randomly generated data sets. From the 500 bootstrapped data sets, 330 runs (66%) had a gradient >0.0001 yet the maximum gradient observed was still relatively low at 0.5489. A total of 345 runs (69%) had at least one parameter on the bounds. However, distributions of selected parameter estimates and derived quantities were largely consistent with those observed in the posterior distributions from the MCMC 'proxy' model and the KEYS RW base model estimates generally fell within the interquartile ranges (Figure 55).

4.9 Stock Status Determination Criteria

A summary of the Florida Keys/East Florida Hogfish stock status determination criteria and their values according to the SAFMC from the SEDAR 94 KEYS RW base model is presented in Table 15.

The Maximum Fishing Mortality Threshold (MFMT) for Florida Keys/East Florida Hogfish is currently defined by the SAFMC Snapper Grouper Amendment 37 as $F_{30\%SPR}$ and overfishing is occurring if the recent average of fishing mortality rates ($F_{current}$) exceeds the MFMT. $F_{current}$ is calculated as the geometric

mean of exploitation rates for 2022 – 2024. Based on this, the MFMT was estimated by the KEYS RW base model to be 0.186 yr^{-1}, $F_{current}$ was estimated to be 0.018 yr^{-1}, and F_{2024} was estimated to be 0.014 yr^{-1} (Figure 56a). The $F_{40\%SPR}$ was estimated to be 0.125 yr^{-1} (Figure 56a). Using either of these reference points, the Florida Keys/East Florida Hogfish stock was not found to be experiencing overfishing ($F_{current}/F_{30\%SPR}$ = 0.099; $F_{current}/F_{40\%SPR}$ = 0.147).

The minimum stock size threshold (MSST) for Florida Keys/East Florida Hogfish is currently defined as 75 percent of the spawning stock biomass associated with $F_{30\%SPR}$ (i.e., 0.75* $SSB_{F30\%SPR}$). The stock is overfished if the recent average spawning stock biomass ($SSB_{current}$) is less than MSST. The $SSB_{current}$ is calculated as the geometric mean of the spawning stock biomass for 2022 – 2024 and was estimated to be 2,098.706 mt (4,626,855 lbs.) with SSB_{2024} estimated to be 2,236.94 mt (4,931,609 lbs.). The $SSB_{F30\%SPR}$ was estimated by the KEYS RW base model at 989.077 mt (2,180,542 lbs.) and MSST was therefore defined as 741.808 mt (1,635,406 lbs.; Figure 56b). The $SSB_{F40\%SPR}$ was estimated at 1,321.570 mt (2,913,563 lbs.; Figure 56b). Based on either of these results, the Florida Keys/East Florida Hogfish stock was not found to be overfished ($SSB_{current}/SSB_{F30\%SPR}$ = 2.829; $SSB_{current}/SSB_{F40\%SPR}$ = 2.117).

From the posterior distributions of the MCMC 'proxy' model, the median value for $F_{current}$ was estimated to be 0.018 yr^{-1} (Figure 54a), $F_{30\%SPR}$ was estimated to be 0.193 yr^{-1} (Figure 54b), $SSB_{F30\%SPR}$ was estimated to be 1,023.120 mt (2,255,593 lbs.; Figure 54e), MSST was 767.340 mt (1,691,695 lbs.; Figure 54f), and $SSB_{current}$ was estimated to be 2,130.268 mt (4,696,437 lbs.; Figure 54d). The MCMC distribution of the retained yield at $F_{30\%SPR}$ had a median value of 112.526 mt (248,077 lbs.; Figure 54c). Additional posterior distributions of the F_{ratio} ($F_{current}$/ MFMT) and SSB_{ratio} ($SSB_{current}$/MSST) are presented in Figure 57 where median values were 0.093 and 2.776, respectively. The estimates for these reference points as derived by the KEYS RW base model were also within the interquartile ranges of these posterior distributions. The distribution of the F_{ratio} was entirely below one, indicating a high probability that overfishing is currently not occurring and the distribution for the SSB_{ratio} was entirely above one, indicating a high probability that the stock is not currently overfished.

4.10 Projections

Short- and long-term deterministic projections were conducted to estimate Florida Keys/East Florida Hogfish spawning stock biomass and yield under a range of harvest scenarios. These were performed under several assumed conditions: growth, and stock-recruitment parameters were kept constant (at values estimated by the SEDAR 94 KEYS RW base model) while relative apical F, selectivity, and discarding and retention associated with the terminal three years (2022 – 2024) would remain the same into the future. The average relative apical F values from 2022 – 2024 as estimated by the base model were used to determine the fleet allocations in the projection scenarios. These were 1.43% for the commercial fleet and 98.57% for the recreational fleet. The method to project the assessment results was developed in the R statistical computing environment by SEFSC assessment scientists (https://github.com/SEFSC/SFD-AllocationForecasting).

First, long-term deterministic projections were conducted to determine the equilibrium fishing mortality rate that achieves $F_{30\%SPR}$ (or $F_{40\%SPR}$) as well as the associated spawning stock biomass, $SSB_{F30\%SPR}$ (or $SSB_{F40\%SPR}$), by using an iterative process to set exploitation rates each year that ensures 1) the MSY_{proxy} (i.e. SPR 30% or 40%) is achieved at equilibrium, and 2) annual relative apical fishing mortality between fleets is maintained at the average of the base model's terminal three years (2022 – 2024). Projections were for 100 years (2025 – 2124) where recruitment was held constant at the long-term (1986 – 2024)

average; equilibrium was assumed to have been obtained in the final 10 years of the projection (i.e., 2115 – 2124) as recommended by Van Beveren et al. (2021). Please note, however, that due to the configuration of the KEYS RW base model where main recruitment deviations ended in 2021, projected recruitment within all scenarios began in 2022. This was a limitation imposed by the structural framework of SS and could not be changed.

Next, short-term deterministic projections, which used a similar iterative process as the long-term projections, were conducted under a range of harvest scenarios and assumed age-0 recruitment remained constant at the recent 5-year average (2020 – 2024) estimated by the KEYS RW base model (Schueller et al. 2022; Van Beveren et al. 2021). Per the TORs, short-term projections explored the effects of holding fishing mortality rates constant at the equilibrium $F_{30\%SPR}$ or $F_{40\%SPR}$ (as determined via the long-term projection above), at 75% of that equilibrium $F_{30\%SPR}$ or $F_{40\%SPR}$, and at $F_{current}$ in order to produce annual yield values. Reported short-term projections extend until 2034 but only the first 5 years are recommended for use.

4.10.1 Results

The projection results for the constant F scenarios including the associated fishing mortality rates, retained landings (in pounds and numbers), spawning stock biomass (mt), and age-0 recruitment (in numbers) as estimated for assessment years (1986 – 2024) and forecast years (2025 – 2044) are presented in Figures 58 – 65 and Tables 16 – 19. The equilibrium fishing mortality rate that achieved 30% SPR ($F_{30\%SPR}$) in the long-term projections was 0.185 yr^{-1} (Figure 58, Table 16) and was near exact to the KEYS RW base model estimate (0.186 yr^{-1}). Likewise, the equilibrium $F_{40\%SPR}$ in the long-term projection was 0.125 yr^{-1} (Figure 62, Table 18) and was identical the KEYS RW base model.

Retained landings from the long-term constant $F_{30\%SPR}$ projection scenario initially increased to values similar to yields prior to 2018, then quickly declined through the 5-yr projection period from 583,898 lbs. in 2025 to 320,222 lbs. in 2029 (Table 16, Figure 59). Spawning stock biomass immediately declined in response to the higher exploitation rates, becoming more like the mid-2000s years (Table 16, Figure 60). Projected recruitment based on the whole time series average (1.698 million fish) began in 2022 (Table 16, Figure 61) but was lower than recruitment in the terminal three years of the KEYS RW base model (1.776 million fish).

In the short-term projection scenarios, $F_{30\%SPR}$ (0.185 yr^{-1}; Table 16, Figure 58) is higher than nearly all exploitation rates estimated throughout the KEYS RW base model's timeseries and was ten times higher than recent exploitation rates ($F_{30\%SPR}/F_{current}$ = 10.12). When exploitation rates were held at 75% $F_{30\%SPR}$ (0.139 yr^{-1}; Table 17, Figure 58), they were still higher than the whole timeseries (1986 – 2024) average of 0.083 yr^{-1} and were seven-and-a-half times higher than recent exploitation rates (75% $F_{30\%SPR}/F_{current}$ = 7.59). In the short-term $F_{30\%SPR}$ scenario, retained landings were 589,100 lbs. (177,234 fish) in 2025 and 340,462 lbs. (106,330 fish) in 2029 (Table 16, Figure 59). In the 75% $F_{40\%SPR}$ scenario, retained landings were 441,788 lbs. (133,099 fish) in 2025 and 311,748 lbs. (95,121 fish) in 2029 (Table 17, Figure 59). In both scenarios, projected SSB immediately declined (Tables 16 – 17, Figure 60) but remained above the $SSB_{F30\%SPR}$ target due to the above-average assumptions on recruitment (Tables 16 – 17, Figure 61).

Short-term projections for the $F_{current}$ scenario estimated comparatively lower F values (0.018 yr^{-1}; Table 17, Figure 58) and resulted in retained landings increasing to 57,954 lbs. (17,525 fish) in 2025 and 67,730 lbs. (19,735 fish) in 2029 (Table 17, Figure 59). Projected SSB continued to increase to values estimated

similar to the beginning of the KEYS RW base model time series, reaching 2,661.45 mt in 2029 (Table 17, Figure 60).

The exploitation rate at $F_{40\%SPR}$ (Table 18, Figure 62) was nearly seven times greater than the current exploitation rate ($F_{40\%SPR}/F_{current} = 6.82$) and higher than most years across the KEYS RW base model's timeseries. The 75% $F_{40\%SPR}$ (0.094 yr^{-1}; Table 19, Figure 63) was five times greater (75% $F_{40\%SPR}/F_{current} = 5.12$) but closer to the average exploitation rate across the whole timeseries (1986 – 2024). Retained landings from the short-term constant $F_{40\%SPR}$ scenario were 397,607 lbs. (119,842 fish) in 2025 and 297,722 lbs. (90,271 fish) in 2029 (Table 18, Figure 63). In the 75% $F_{40\%SPR}$ scenario, retained landings were 298,150 lbs. (89,955 fish) in 2025 and 254,879 lbs. (76,270 fish) in 2029 (Table 19, Figure 63). Since recruitment in the short-term is held constant at values higher than the long-term average (Tables 18 – 19, Figure 65), SSB under the constant $F_{40\%SPR}$ scenario declined to values just above the $SSB_{F40\%SPR}$ target (Table 18, Figure 64); however, SSB under the constant 75% $F_{40\%SPR}$ scenario declined slightly values similar to the terminal three years of the KEYS RW base model's timeseries (Table 19, Figure 64).

5 Tables

Table 1. Predicted spawning stock biomass (SSB; metric tons, pounds) by sex, total female abundance (1000s of fish), male age 1+ abundance (1000s of fish), and total abundance (1000s of fish) as estimated by the KEYS base model for Florida Keys/East Florida Hogfish. Virgin is the estimated unfished condition while Initial is the estimated initial conditions of the stock before the model start year.

Year	Female SSB (mt)	Female SSB (lbs)	Male SSB (mt)	Male SSB (lbs)	Total Female Abundance (000s)	Male Age 1+ Abundance (000s)	Total Abundance (000s)
Virgin	1,391	3,066,167	4,071	8,975,790	7,513	2,057	9,570
Initial	1,391	3,066,167	4,071	8,975,790	7,513	2,057	9,570
1950	1,391	3,066,167	4,071	8,975,790	7,513	2,057	9,570
1951	1,364	3,007,745	4,016	8,852,816	7,469	2,023	9,491
1952	1,340	2,955,142	3,952	8,712,073	7,426	1,986	9,413
1953	1,322	2,914,467	3,884	8,561,762	7,387	1,950	9,337
1954	1,308	2,884,683	3,814	8,408,453	7,350	1,915	9,265
1955	1,298	2,861,027	3,744	8,253,490	7,314	1,882	9,196
1956	1,289	2,840,965	3,676	8,104,788	7,278	1,852	9,130
1957	1,280	2,822,292	3,613	7,965,632	7,243	1,825	9,068
1958	1,273	2,805,713	3,557	7,841,358	7,211	1,801	9,012
1959	1,265	2,789,377	3,505	7,726,695	7,180	1,780	8,959
1960	1,255	2,766,735	3,450	7,606,852	7,145	1,756	8,900
1961	1,245	2,744,821	3,398	7,492,145	7,111	1,732	8,844
1962	1,233	2,717,550	3,343	7,369,613	7,073	1,707	8,780
1963	1,224	2,698,943	3,294	7,261,608	7,042	1,685	8,727
1964	1,216	2,680,182	3,245	7,153,185	7,010	1,663	8,673
1965	1,206	2,658,091	3,193	7,040,110	6,975	1,640	8,615
1966	1,195	2,634,612	3,142	6,927,828	6,939	1,617	8,556
1967	1,184	2,610,868	3,091	6,815,238	6,902	1,593	8,495
1968	1,171	2,580,996	3,035	6,691,360	6,860	1,567	8,426
1969	1,159	2,554,651	2,981	6,571,230	6,819	1,541	8,361
1970	1,146	2,527,357	2,925	6,448,698	6,777	1,515	8,292
1971	1,131	2,493,781	2,864	6,313,554	6,728	1,486	8,214
1972	1,103	2,432,382	2,779	6,127,219	6,653	1,442	8,095
1973	1,077	2,373,739	2,691	5,931,559	6,576	1,396	7,973
1974	1,051	2,316,507	2,597	5,724,391	6,494	1,349	7,843
1975	1,022	2,253,918	2,493	5,497,006	6,401	1,297	7,698
1976	994	2,191,393	2,386	5,261,133	6,301	1,244	7,545
1977	975	2,149,068	2,293	5,054,296	6,214	1,201	7,415
1978	965	2,128,153	2,216	4,885,311	6,145	1,170	7,315
1979	964	2,124,857	2,161	4,763,175	6,096	1,151	7,247
1980	954	2,103,045	2,104	4,638,129	6,036	1,128	7,165
1981	954	2,102,553	2,068	4,559,556	5,953	1,119	7,072
1982	877	1,933,009	1,925	4,244,273	5,652	1,035	6,686
1983	902	1,988,391	1,920	4,233,779	5,489	1,045	6,533
1984	881	1,941,691	1,863	4,107,410	5,313	1,017	6,330
1985	810	1,786,558	1,751	3,859,677	5,829	951	6,780

Table 1 continued. Predicted spawning stock biomass (SSB; metric tons, pounds) by sex, total female abundance (1000s of fish), male age 1+ abundance (1000s of fish), and total abundance (1000s of fish) as estimated by the KEYS base model for Florida Keys/East Florida Hogfish. Virgin is the estimated unfished condition while Initial is the estimated initial conditions of the stock before the model start year.

Year	Female SSB (mt)	Female SSB (lbs)	Male SSB (mt)	Male SSB (lbs)	Total Female Abundance (000s)	Male Age 1+ Abundance (000s)	Total Abundance (000s)
1986	767	1,690,946	1,671	3,683,638	5,428	908	6,336
1987	783	1,726,138	1,629	3,591,308	5,827	895	6,722
1988	801	1,766,375	1,567	3,453,784	5,861	869	6,729
1989	657	1,449,445	1,306	2,879,502	5,134	710	5,844
1990	721	1,588,539	1,266	2,791,978	5,702	712	6,414
1991	720	1,587,571	1,193	2,630,005	5,041	687	5,729
1992	775	1,707,513	1,208	2,662,170	5,079	723	5,802
1993	710	1,565,275	1,114	2,456,721	3,849	671	4,520
1994	669	1,473,997	1,074	2,367,632	3,702	654	4,356
1995	581	1,280,101	1,001	2,207,158	2,945	606	3,551
1996	490	1,079,330	932	2,054,761	2,398	562	2,961
1997	459	1,010,901	916	2,020,329	2,500	555	3,054
1998	422	931,241	921	2,030,537	2,009	557	2,566
1999	382	843,215	905	1,994,987	2,763	540	3,302
2000	324	715,314	825	1,818,624	2,530	477	3,007
2001	327	721,884	803	1,771,386	2,610	461	3,071
2002	374	823,658	783	1,725,968	3,269	448	3,717
2003	410	904,991	778	1,715,765	3,540	450	3,990
2004	435	958,610	750	1,652,515	3,693	438	4,131
2005	453	997,649	700	1,542,305	3,306	413	3,719
2006	392	863,377	575	1,268,123	3,274	339	3,613
2007	430	947,937	571	1,258,831	4,457	352	4,810
2008	452	995,619	579	1,277,365	3,787	373	4,159
2009	510	1,123,551	600	1,322,379	3,995	400	4,396
2010	496	1,093,707	557	1,227,779	3,170	375	3,545
2011	550	1,212,953	610	1,345,230	3,317	423	3,740
2012	593	1,307,901	688	1,516,256	4,488	481	4,969
2013	555	1,222,770	747	1,646,425	4,643	513	5,156
2014	543	1,196,859	776	1,711,268	3,897	519	4,416
2015	562	1,238,639	755	1,663,699	5,095	493	5,588
2016	535	1,179,978	705	1,554,916	4,573	456	5,028
2017	555	1,224,527	694	1,529,977	4,136	456	4,592
2018	631	1,391,410	715	1,576,217	4,143	482	4,625
2019	695	1,531,225	798	1,758,528	4,100	549	4,649
2020	730	1,609,507	910	2,007,223	4,284	626	4,911
2021	741	1,634,207	1,035	2,280,682	4,522	698	5,220
2022	720	1,587,935	1,134	2,500,659	4,609	740	5,349
2023	729	1,606,795	1,232	2,716,977	4,739	778	5,517
2024	763	1,681,477	1,322	2,914,467	4,896	813	5,710

Table 2. Estimates of catchability by the KEYS base model across six retrospective peels for the three indices of abundance. Retro-0 is the KEYS base model reference run.

	RVC Florida Keys	RVC Dry Tortugas	Combined Video
Retro-0	0.000741311	0.001700624	0.000979577
Retro-1	0.000713905	0.002043523	0.001122014
Retro-2	0.000680624	0.001969629	0.001006506
Retro-3	0.000719424	0.002388475	0.001163561
Retro-4	0.000738042	0.00271197	0.001253419
Retro-5	0.000746489	0.002824398	0.001266029
Retro-6	0.000743821	0.002917962	0.001335299

Table 3. Comparison of the total log-likelihood, selected parameters, and derived quantities as estimated by the KEYS base model ('KEYS Base Model') against sensitivity runs exploring assumptions on natural mortality for Florida Keys/East Florida Hogfish. 'HamelCope_age3' uses the Hamel and Cope (2022) longevity-based estimate (M=0.338 yr^{-1}) for age-3 fish, 'est_HamelCope_age3' estimates M using the standard deviation (0.31) prior in log-space, and 'est_HamelCope_age3_noprior' removes the standard deviation prior to freely estimate.

Label	KEYS Base Model	HamelCope_age3	est_HamelCope_age3	est_HamelCope_age3_noprior
TOTAL like	2314.27	2315.13	2324.79	2315.2
SR_LN(R0)	8.000	8.472	9.356	8.135
Steepness (h)	0.472	0.439	0.404	0.463
L_{inf}	51.2	54.0	64.2	52.5
SSB_MSY	1952.40	1925.45	1888.75	1937.46
F_MSY	0.077	0.077	0.077	0.078
SSB_SPR	912.573	616.930	251.990	834.452
F_40%SPR	0.128	0.146	0.169	0.133

Table 4. Comparison of the total log-likelihood, selected parameters, and derived quantities as estimated by the WFS base model ('WFS Base Model') against sensitivity runs exploring assumptions on natural mortality for West Florida Shelf Hogfish. Sensitivity runs included the Lorenzen (1996) mortality-at-weight, Hamel and Cope (2022) longevity-based estimate (M=0.235 yr^{-1}) for age-3 fish, and Hamel and Cope (2022) longevity-based M as freely estimable.

Label	WFS Base Model	Lorenzen96	HamelCope_age3	est_HamelCope_age3_23_noprior
TOTAL like	916.605	941.65	945.112	914.294
SR_LN(R0)	7.65708	5.89814	5.76754	8.95173
Steepness (h)	0.99	0.99	0.99	0.99
L_{inf}	89.5804	114.728	54.1924	86.5378
SSB_SPR	518.9	844.481	377.638	712.598
F_30%SPR	0.229282	0.0694546	0.167258	0.394587

Table 5. Dirichlet-multinomial weights applied to length and size composition data of the SEDAR 94 KEYS RW base model. Theta ratios are calculated as theta/(1+theta).

Data Type	Fleet/Index	*ln(theta)*	*theta*	*theta ratio*
Length Composition	Commercial landings	2.167	8.734	0.897
	Recreational discards	1.052	2.862	0.741
	Recreational landings	-0.572	0.564	0.361
	Combined video index	0.434	1.543	0.607
Size Composition	RVC Florida Keys and RVC Dry Tortugas indices	-0.373	0.689	0.408

Table 6. List of Stock Synthesis parameters for the SEDAR 94 KEYS RW base model. The list includes expected parameter values (Value), lower (Min) and upper (Max) bounds of the parameters, associated standard deviation (Std Dev) and coefficients of variation (CV), prior type (Prior), prior standard deviation (Prior Std Dev), and the phase (Phase) of estimation. Parameters designated as fixed were held at their initial values and have no associated range or SE.

	Parameter Label	Value	Min	Max	Std Dev	CV	Prior	Prior Std Dev	Phase
1	LatAminFemGP1	6.546	2	20	0.743	0.113			3
2	LatAmaxFemGP1	51.870	30	80	3.618	0.070			3
3	VonBertKFemGP1	0.173	0.05	0.4	0.025	0.144			4
4	CVyoungFemGP1	0.481	0.05	0.9	0.052	0.108			7
5	CVoldFemGP1	0.369	0.05	0.9	0.046	0.125			7
6	Wtlen1FemGP1	2.55E-05	-3	3					Fixed
7	Wtlen2FemGP1	2.927	-3	4					Fixed
8	Mat50%FemGP1	2.080	1	4					Fixed
9	MatslopeFemGP1	-3.034	-4	-0.1					Fixed
10	EggsscalarFemGP1	1.000	-3	3					Fixed
11	EggsexpwtFemGP1	1.000	-3	3					Fixed
12	LatAminMalGP1	0.000	-1	1					Fixed
13	LatAmaxMalGP1	0.000	-1	1					Fixed
14	VonBertKMalGP1	0.000	-1	1					Fixed
15	CVyoungMalGP1	0.000	-1	1					Fixed
16	CVoldMalGP1	0.000	-1	1					Fixed
17	Wtlen1MalGP1	2.55E-05	-3	3					Fixed
18	Wtlen2MalGP1	2.927	-3	4					Fixed
19	HermInflage	6.080	1	11					Fixed
20	Hermstdev	2.330	1	5					Fixed
21	Hermasymptote	0.999	0.01	1					Fixed
22	CohortGrowDev	1.000	0	1					Fixed
23	PlatoonSDRatio	0.772	0.1	3	0.308	0.399			1
24	FracFemaleGP1	1.000	0	1					Fixed
25	SRLN(R0)	7.484	6	14	0.136	0.018			1
26	SRBHsteep	0.990	0.2	0.99					Fixed
27	SRsigmaR	0.411	0.1	2	0.095	0.230			7
28	SRregime	0.000	-5	5					Fixed
29	SRautocorr	0.000	0	0					Fixed
30	MainInitAge5	0.167	-4	4	0.401	2.406			3
31	MainInitAge4	0.154	-4	4	0.397	2.578			3
32	MainInitAge3	0.139	-4	4	0.392	2.823			3
33	MainInitAge2	0.127	-4	4	0.388	3.059			3
34	MainInitAge1	0.408	-4	4	0.391	0.959			3
35	MainRecrDev1986	0.138	-4	4	0.361	2.610			3
36	MainRecrDev1987	0.406	-4	4	0.339	0.834			3
37	MainRecrDev1988	0.361	-4	4	0.312	0.863			3
38	MainRecrDev1989	0.166	-4	4	0.290	1.747			3
39	MainRecrDev1990	0.496	-4	4	0.227	0.457			3
40	MainRecrDev1991	0.090	-4	4	0.217	2.417			3
41	MainRecrDev1992	0.259	-4	4	0.174	0.672			3
42	MainRecrDev1993	-0.463	-4	4	0.208	-0.448			3
43	MainRecrDev1994	-0.065	-4	4	0.159	-2.448			3
44	MainRecrDev1995	-0.588	-4	4	0.193	-0.329			3
45	MainRecrDev1996	-0.755	-4	4	0.200	-0.265			3
46	MainRecrDev1997	-0.363	-4	4	0.161	-0.444			3
47	MainRecrDev1998	-1.018	-4	4	0.250	-0.246			3
48	MainRecrDev1999	-0.010	-4	4	0.148	-14.656			3
49	MainRecrDev2000	-0.455	-4	4	0.228	-0.500			3
50	MainRecrDev2001	-0.303	-4	4	0.221	-0.730			3
51	MainRecrDev2002	0.079	-4	4	0.197	2.479			3
52	MainRecrDev2003	0.028	-4	4	0.216	7.739			3
53	MainRecrDev2004	0.025	-4	4	0.198	7.844			3
54	MainRecrDev2005	-0.269	-4	4	0.227	-0.846			3
55	MainRecrDev2006	-0.049	-4	4	0.176	-3.560			3
56	MainRecrDev2007	0.463	-4	4	0.119	0.257			3
57	MainRecrDev2008	-0.249	-4	4	0.169	-0.677			3
58	MainRecrDev2009	0.093	-4	4	0.131	1.410			3
59	MainRecrDev2010	-0.498	-4	4	0.185	-0.371			3
60	MainRecrDev2011	-0.113	-4	4	0.142	-1.256			3
61	MainRecrDev2012	0.457	-4	4	0.101	0.222			3

62	MainRecrDev2013	0.257	-4	4	0.112	0.434	3
63	MainRecrDev2014	-0.247	-4	4	0.156	-0.631	3
64	MainRecrDev2015	0.581	-4	4	0.118	0.203	3
65	MainRecrDev2016	0.067	-4	4	0.191	2.835	3
66	MainRecrDev2017	-0.056	-4	4	0.196	-3.510	3
67	MainRecrDev2018	0.053	-4	4	0.203	3.810	3
68	MainRecrDev2019	-0.003	-4	4	0.231	-78.771	3
69	MainRecrDev2020	0.143	-4	4	0.232	1.626	3
70	MainRecrDev2021	0.346	-4	4	0.212	0.612	3
71	InitFseas1flt1COM	0.004	1.00E-06	0.1	0.001	0.346	1
72	InitFseas1flt2REC	0.076	1.00E-06	0.3	0.046	0.599	1
73	Ffleet1YR1986s1	0.010					
74	Ffleet1YR1987s1	0.010					
75	Ffleet1YR1988s1	0.010					
76	Ffleet1YR1989s1	0.010					
77	Ffleet1YR1990s1	0.010					
78	Ffleet1YR1991s1	0.010					
79	Ffleet1YR1992s1	0.010					
80	Ffleet1YR1993s1	0.010					
81	Ffleet1YR1994s1	0.010					
82	Ffleet1YR1995s1	0.010					
83	Ffleet1YR1996s1	0.010					
84	Ffleet1YR1997s1	0.010					
85	Ffleet1YR1998s1	0.010					
86	Ffleet1YR1999s1	0.010					
87	Ffleet1YR2000s1	0.010					
88	Ffleet1YR2001s1	0.010					
89	Ffleet1YR2002s1	0.010					
90	Ffleet1YR2003s1	0.010					
91	Ffleet1YR2004s1	0.010					
92	Ffleet1YR2005s1	0.010					
93	Ffleet1YR2006s1	0.010					
94	Ffleet1YR2007s1	0.010					
95	Ffleet1YR2008s1	0.010					
96	Ffleet1YR2009s1	0.010					
97	Ffleet1YR2010s1	0.010					
98	Ffleet1YR2011s1	0.010					
99	Ffleet1YR2012s1	0.010					
100	Ffleet1YR2013s1	0.010					
101	Ffleet1YR2014s1	0.010					
102	Ffleet1YR2015s1	0.010					
103	Ffleet1YR2016s1	0.010					
104	Ffleet1YR2017s1	0.010					
105	Ffleet1YR2018s1	0.010					
106	Ffleet1YR2019s1	0.010					
107	Ffleet1YR2020s1	0.010					
108	Ffleet1YR2021s1	0.010					
109	Ffleet1YR2022s1	0.010					
110	Ffleet1YR2023s1	0.010					
111	Ffleet1YR2024s1	0.010					
112	Ffleet2YR1986s1	0.149	0	3	0.093	0.621	2
113	Ffleet2YR1987s1	0.189	0	3	0.090	0.476	2
114	Ffleet2YR1988s1	0.523	0	3	0.249	0.476	2
115	Ffleet2YR1989s1	0.147	0	3	0.078	0.530	2
116	Ffleet2YR1990s1	0.254	0	3	0.116	0.456	2
117	Ffleet2YR1991s1	0.094	0	3	0.072	0.764	2
118	Ffleet2YR1992s1	0.350	0	3	0.131	0.373	2
119	Ffleet2YR1993s1	0.242	0	3	0.118	0.489	2
120	Ffleet2YR1994s1	0.338	0	3	0.155	0.458	2
121	Ffleet2YR1995s1	0.380	0	3	0.180	0.473	2
122	Ffleet2YR1996s1	0.203	0	3	0.096	0.475	2
123	Ffleet2YR1997s1	0.106	0	3	0.050	0.474	2
124	Ffleet2YR1998s1	0.168	0	3	0.076	0.453	2
125	Ffleet2YR1999s1	0.397	0	3	0.200	0.504	2
126	Ffleet2YR2000s1	0.121	0	3	0.072	0.596	2
127	Ffleet2YR2001s1	0.121	0	3	0.073	0.608	2
128	Ffleet2YR2002s1	0.070	0	3	0.045	0.643	2
129	Ffleet2YR2003s1	0.210	0	3	0.090	0.428	2
130	Ffleet2YR2004s1	0.356	0	3	0.158	0.445	2
131	Ffleet2YR2005s1	0.882	0	3	0.266	0.302	2
132	Ffleet2YR2006s1	0.241	0	3	0.102	0.423	2

133	Ffleet2YR2007s1	0.224	0	3	0.083	0.369			2
134	Ffleet2YR2008s1	0.217	0	3	0.092	0.424			2
135	Ffleet2YR2009s1	0.590	0	3	0.202	0.343			2
136	Ffleet2YR2010s1	0.093	0	3	0.054	0.582			2
137	Ffleet2YR2011s1	0.051	0	3	0.028	0.546			2
138	Ffleet2YR2012s1	0.177	0	3	0.075	0.427			2
139	Ffleet2YR2013s1	0.260	0	3	0.094	0.359			2
140	Ffleet2YR2014s1	0.404	0	3	0.124	0.307			2
141	Ffleet2YR2015s1	0.491	0	3	0.145	0.295			2
142	Ffleet2YR2016s1	0.339	0	3	0.131	0.387			2
143	Ffleet2YR2017s1	0.258	0	3	0.134	0.519			2
144	Ffleet2YR2018s1	0.091	0	3	0.051	0.557			2
145	Ffleet2YR2019s1	0.040	0	3	0.017	0.420			2
146	Ffleet2YR2020s1	0.058	0	3	0.031	0.534			2
147	Ffleet2YR2021s1	0.155	0	3	0.047	0.304			2
148	Ffleet2YR2022s1	0.102	0	3	0.038	0.369			2
149	Ffleet2YR2023s1	0.073	0	3	0.023	0.318			2
150	Ffleet2YR2024s1	0.060	0	3	0.018	0.298			2
151	LnQbaseRVCKEYS(3)	-7.236	-18	5					Fixed
152	LnQbaseRVCDRTO(4)	-6.474	-18	5					Fixed
153	LnQbaseCOMBVIDEO(5)	-6.999	-18	5					Fixed
154	SizeDblNpeakCOM(1)	29.939	15	60	2.730	0.091			3
155	SizeDblNtoplogitCOM(1)	-9.919	-15	15	71.224	-7.181			4
156	SizeDblNascendseCOM(1)	3.188	0.01	15	0.860	0.270			5
157	SizeDblNdescendseCOM(1)	3.183	0.01	5	0.687	0.216			5
158	SizeDblNstartlogitCOM(1)	-999	-15	15					Fixed
159	SizeDblNendlogitCOM(1)	0.216	-15	15	0.384	1.779			3
160	SizeDblNpeakREC(2)	32.722	15	50	0.660	0.020			3
161	SizeDblNtoplogitREC(2)	-12.129	-15	15	47.996	-3.957			4
162	SizeDblNascendseREC(2)	3.874	0.1	15	0.151	0.039			5
163	SizeDblNdescendseREC(2)	4.663	0.1	15	0.207	0.044			5
164	SizeDblNstartlogitREC(2)	-999	-15	7					Fixed
165	SizeDblNendlogitREC(2)	-2.647	-15	15	0.356	-0.134			3
166	RetainLinflREC(2)	6.272	4	50	46.983	7.491			3
167	RetainLwidthREC(2)	0.680	0.01	10	12.960	19.053			4
168	RetainLasymptotelogitREC(2)	2.604	-15	15	0.349	0.134			5
169	RetainLmaleoffsetREC(2)	0.000	-1	1					Fixed
170	DiscMortLinflREC(2)	0.100	0	1					Fixed
171	DiscMortLwidthREC(2)	0.100	0	1					Fixed
172	DiscMortLleveloldREC(2)	0.414	0.01	1					Fixed
173	DiscMortLmaleoffsetREC(2)	0.000	-1	2					Fixed
174	SizeDblNpeakRVCKEYS(3)	22.088	5	50	0.673	0.030			3
175	SizeDblNtoplogitRVCKEYS(3)	-2.765	-15	15	0.602	-0.218			4
176	SizeDblNascendseRVCKEYS(3)	3.795	0.1	15	0.129	0.034			3
177	SizeDblNdescendseRVCKEYS(3)	4.951	0.1	15	0.353	0.071			5
178	SizeDblNstartlogitRVCKEYS(3)	-999	-15	15					Fixed
179	SizeDblNendlogitRVCKEYS(3)	-2.113	-15	15	0.342	-0.162			3
180	SizeDblNpeakRVCDRTO(4)	54.390	30	70	3.111	0.057			3
181	SizeDblNtoplogitRVCDRTO(4)	-1.954	-15	15	2.297	-1.176			4
182	SizeDblNascendseRVCDRTO(4)	6.151	0.1	15	0.115	0.019			3
183	SizeDblNdescendseRVCDRTO(4)	6.473	0.1	15	3.292	0.509			5
184	SizeDblNstartlogitRVCDRTO(4)	-999	-5	5					Fixed
185	SizeDblNendlogitRVCDRTO(4)	-1.213	-15	15	1.528	-1.260			3
186	SizeinflectionCOMBVIDEO(5)	27.316	15	40	2.952	0.108			3
187	Size95%widthCOMBVIDEO(5)	11.197	0.1	15	2.814	0.251			4
188	ln(DMtheta)LenP1	2.167	-5	20	0.840	0.387	0	1.813	2
189	ln(DMtheta)LenP2	1.052	-5	20	0.910	0.865	0	1.813	2
190	ln(DMtheta)LenP3	-0.572	-5	20	0.221	-0.387	0	1.813	2
191	ln(DMtheta)LenP4	0.434	-5	20	0.612	1.410	0	1.813	2
192	ln(DMtheta)SzP5	-0.373	-5	20	0.138	-0.370	0	1.813	2
193	SizeDblNpeakCOM(1)BLK1repl1995	31.016	15	60	0.452	0.015			3
194	SizeDblNpeakCOM(1)BLK1repl2018	41.784	15	60	1.173	0.028			3
195	SizeDblNascendseCOM(1)BLK1repl1995	1.875	0.01	15	0.295	0.157			5
196	SizeDblNascendseCOM(1)BLK1repl2018	1.452	0.01	6	0.775	0.533			5
197	RetainLinflREC(2)BLK1repl1995	28.577	6	50	0.303	0.011			3
198	RetainLinflREC(2)BLK1repl2018	42.594	6	50	2.080	0.049			3
199	RetainLwidthREC(2)BLK1repl1995	1.273	0.1	10	0.178	0.139			4
200	RetainLwidthREC(2)BLK1repl2018	4.947	0.1	10	1.236	0.250			4
201	RetainLasymptotelogitREC(2)BLK1repl1995	3.205	-15	15	0.568	0.177			5
202	RetainLasymptotelogitREC(2)BLK1repl2018	9.579	-15	15	74.635	7.791			5

Table 7. Predicted total biomass (metric tons, pounds), spawning stock biomass (SSB; metric tons, pounds), age-0 recruits (1000s of fish), age 1+ abundance (1000s of fish), and depletion (SSB/SSB0) for Florida Keys/East Florida Hogfish from the SEDAR 94 KEYS RW base model. Virgin is the estimated unfished condition while Initial is the estimated initial conditions of the stock before the model start year.

Year	Biomass (mt)	Biomass (lbs.)	SSB (mt)	SSB (lbs.)	Age-0 Recruits (000s)	Age-1+ Abundance (000s)	B/B0	SSB/SSB0
Virgin	3,496	7,706,986	3,317	7,311,653	1,779	3,929	1.000	1.000
Initial	2,705	5,962,953	2,527	5,571,566	1,777	3,553	0.774	0.762
1986	2,823	6,224,069	2,606	5,745,864	1,917	4,142	0.808	0.786
1987	2,785	6,139,389	2,564	5,651,660	2,492	3,945	0.797	0.773
1988	2,717	5,989,210	2,496	5,502,959	2,368	4,118	0.777	0.753
1989	2,386	5,261,288	2,162	4,766,041	1,935	3,895	0.683	0.652
1990	2,388	5,264,837	2,169	4,781,826	2,689	3,763	0.683	0.654
1991	2,319	5,113,247	2,098	4,625,254	1,791	4,038	0.663	0.633
1992	2,381	5,249,096	2,161	4,764,520	2,121	3,810	0.681	0.652
1993	2,213	4,878,742	2,029	4,473,179	1,030	3,674	0.633	0.612
1994	2,112	4,656,185	1,957	4,315,527	1,533	3,034	0.604	0.590
1995	1,940	4,277,629	1,815	4,002,118	909	2,870	0.555	0.547
1996	1,759	3,877,248	1,645	3,626,626	769	2,404	0.503	0.496
1997	1,676	3,694,198	1,586	3,496,333	1,137	2,111	0.479	0.478
1998	1,636	3,606,741	1,545	3,406,054	591	2,164	0.468	0.466
1999	1,566	3,453,475	1,473	3,247,894	1,618	1,850	0.448	0.444
2000	1,409	3,105,233	1,301	2,868,126	1,036	2,145	0.403	0.392
2001	1,400	3,085,678	1,273	2,805,779	1,207	2,074	0.400	0.384
2002	1,410	3,108,937	1,289	2,842,199	1,768	2,142	0.403	0.389
2003	1,467	3,234,446	1,319	2,908,228	1,680	2,522	0.420	0.398
2004	1,478	3,258,829	1,311	2,889,885	1,675	2,657	0.423	0.395
2005	1,432	3,155,961	1,271	2,802,582	1,248	2,687	0.409	0.383
2006	1,190	2,622,597	1,050	2,314,347	1,552	2,277	0.340	0.317
2007	1,234	2,720,526	1,083	2,386,857	2,591	2,421	0.353	0.326
2008	1,309	2,884,749	1,117	2,461,549	1,272	3,104	0.374	0.337
2009	1,388	3,059,002	1,200	2,645,062	1,791	2,788	0.397	0.362
2010	1,285	2,833,910	1,138	2,508,618	991	2,748	0.368	0.343
2011	1,390	3,064,756	1,251	2,757,696	1,458	2,476	0.398	0.377
2012	1,517	3,343,994	1,377	3,035,920	2,580	2,612	0.434	0.415
2013	1,596	3,518,159	1,400	3,087,001	2,113	3,267	0.456	0.422
2014	1,637	3,609,673	1,422	3,134,312	1,276	3,366	0.468	0.429
2015	1,599	3,525,699	1,417	3,123,818	2,921	2,899	0.457	0.427
2016	1,536	3,387,226	1,336	2,944,340	1,747	3,504	0.440	0.403
2017	1,561	3,440,953	1,346	2,966,739	1,545	3,271	0.446	0.406
2018	1,611	3,552,507	1,442	3,178,426	1,723	3,075	0.461	0.435
2019	1,760	3,880,114	1,596	3,517,519	1,630	3,173	0.503	0.481
2020	1,921	4,235,411	1,751	3,860,426	1,887	3,212	0.550	0.528
2021	2,072	4,568,044	1,890	4,166,649	2,319	3,390	0.593	0.570
2022	2,176	4,797,457	1,972	4,347,824	1,776	3,715	0.622	0.595
2023	2,297	5,064,128	2,095	4,619,522	1,776	3,639	0.657	0.632
2024	2,418	5,331,681	2,237	4,931,609	1,776	3,630	0.692	0.674

Table 8. Predicted female spawning stock biomass (SSB; metric tons, pounds), male spawning stock biomass (SSB; metric tons, pounds), Female age 1+ abundance (1000s of fish), and Male age 1+ abundance (1000s of fish) for Florida Keys/East Florida Hogfish from the SEDAR 94 KEYS RW base model. Virgin is the estimated unfished condition while Initial is the estimated initial conditions of the stock before the model start year.

Year	Female SSB (mt)	Female SSB (lbs)	Male SSB (mt)	Male SSB (lbs)	Female Age 1+ Abundance (000s)	Male Age 1+ Abundance (000s)
Virgin	831	1,832,881	2,485	5,478,774	2,703	1,227
Initial	744	1,639,902	1,783	3,931,680	2,624	930
1986	810	1,784,653	1,797	3,961,222	3,195	947
1987	803	1,770,998	1,760	3,880,665	3,017	928
1988	795	1,752,582	1,701	3,750,372	3,222	896
1989	678	1,493,656	1,484	3,272,387	3,129	766
1990	726	1,601,597	1,443	3,180,212	3,002	761
1991	731	1,610,739	1,367	3,014,513	3,303	735
1992	788	1,736,542	1,373	3,027,983	3,046	764
1993	745	1,643,330	1,284	2,829,832	2,953	720
1994	713	1,572,965	1,244	2,742,573	2,326	708
1995	636	1,401,571	1,180	2,600,551	2,200	670
1996	539	1,187,291	1,106	2,439,327	1,778	626
1997	499	1,101,059	1,086	2,395,278	1,496	615
1998	457	1,007,832	1,088	2,398,233	1,549	615
1999	411	905,278	1,063	2,342,610	1,257	593
2000	343	755,855	958	2,112,264	1,627	518
2001	345	760,562	928	2,045,220	1,576	498
2002	392	863,315	898	1,978,889	1,659	483
2003	433	955,047	886	1,953,172	2,039	483
2004	461	1,016,959	850	1,872,937	2,188	470
2005	480	1,057,436	792	1,745,142	2,244	443
2006	406	895,513	644	1,418,825	1,919	358
2007	448	986,976	635	1,399,878	2,050	371
2008	476	1,048,371	641	1,413,185	2,711	393
2009	539	1,188,082	661	1,456,971	2,366	422
2010	524	1,154,393	614	1,354,218	2,352	396
2011	580	1,279,523	670	1,478,173	2,030	446
2012	624	1,376,478	753	1,659,453	2,105	507
2013	585	1,290,050	815	1,796,948	2,726	541
2014	573	1,263,855	848	1,870,453	2,817	549
2015	591	1,302,335	826	1,821,492	2,377	522
2016	562	1,239,417	773	1,704,914	3,022	482
2017	584	1,287,085	762	1,679,651	2,788	482
2018	660	1,454,524	782	1,723,896	2,568	507
2019	727	1,602,776	869	1,914,732	2,596	576
2020	764	1,684,984	987	2,175,431	2,556	657
2021	773	1,703,993	1,117	2,462,652	2,660	730
2022	749	1,651,231	1,223	2,696,584	2,940	774
2023	767	1,691,605	1,328	2,927,915	2,824	815
2024	813	1,792,197	1,424	3,139,405	2,777	853

Table 9. Annual exploitation rates on Florida Keys/East Florida Hogfish combined across all fleets as well as annual estimates of instantaneous apical fishing mortality rates by fleet from the SEDAR 94 KEYS RW base model. Apical fishing mortality rates represent the instantaneous fishing mortality level on the most vulnerable age class for each fleet.

Year	Exploitation (Biomass)	Commercial (Biomass)	Recreational (Numbers)
InitF	_	0.0041	0.0764
1986	0.0548	0.0136	0.1490
1987	0.0702	0.0185	0.1890
1988	0.1648	0.0203	0.5225
1989	0.0618	0.0265	0.1473
1990	0.0967	0.0260	0.2541
1991	0.0456	0.0238	0.0939
1992	0.1333	0.0320	0.3501
1993	0.1000	0.0345	0.2416
1994	0.1242	0.0243	0.3382
1995	0.1261	0.0214	0.3801
1996	0.0738	0.0209	0.2030
1997	0.0458	0.0234	0.1061
1998	0.0601	0.0177	0.1682
1999	0.1227	0.0193	0.3971
2000	0.0450	0.0187	0.1210
2001	0.0443	0.0143	0.1205
2002	0.0299	0.0142	0.0696
2003	0.0742	0.0153	0.2099
2004	0.1209	0.0169	0.3559
2005	0.2625	0.0112	0.8816
2006	0.0855	0.0103	0.2409
2007	0.0830	0.0101	0.2241
2008	0.0811	0.0087	0.2169
2009	0.2088	0.0093	0.5899
2010	0.0394	0.0075	0.0933
2011	0.0241	0.0072	0.0515
2012	0.0692	0.0078	0.1765
2013	0.0950	0.0093	0.2603
2014	0.1437	0.0115	0.4040
2015	0.1737	0.0122	0.4908
2016	0.1212	0.0101	0.3385
2017	0.0967	0.0058	0.2578
2018	0.0242	0.0031	0.0910
2019	0.0106	0.0014	0.0397
2020	0.0151	0.0016	0.0581
2021	0.0375	0.0017	0.1547
2022	0.0245	0.0014	0.1021
2023	0.0176	0.0011	0.0730
2024	0.0144	0.0010	0.0601

Table 10. Index root mean square error (RMSE) values from the SEDAR 94 KEYS RW base model (RW Base), the age-structured production model (ASPM), and the ASPM with estimated recruitment deviations (ASPMdev).

Index	RW Base	ASPM	ASPMdev
RVC Florida Keys	0.2590	0.3388	0.2076
RVC Dry Tortugas	0.1570	0.1416	0.1015
Combined Video	0.3730	0.3970	0.3467

Table 11. Mohn's rho (ρ_M) and forecast Mohn's rho (ρ_F) values calculated from the retrospective and retrospective forecasting analyses, respectively, on estimates of spawning stock biomass (SSB) and exploitation fishing mortality rates (F) from the SEDAR 94 KEYS RW base model. Analyses were performed across 6 successive years of removal from the terminal year 2024.

Quantity	Year Peel	Mohn's Rho (ρ_M)	Forecast Mohn's Rho (ρ_F)
SSB	2023	-0.065	-0.080
SSB	2022	-0.006	-0.029
SSB	2021	-0.084	-0.069
SSB	2020	-0.101	-0.076
SSB	2019	-0.135	-0.116
SSB	2018	-0.149	-0.140
SSB	Combined	-0.090	-0.085
F	2023	0.089	0.137
F	2022	0.068	-0.377
F	2021	0.043	-0.158
F	2020	0.058	0.253
F	2019	0.036	-0.163
F	2018	0.165	-0.269
F	Combined	0.076	-0.096

Table 12. Hindcast cross-validation summary statistics for the SEDAR 94 KEYS RW base model. N = number of observations to compute each statistic. MASE = mean absolute scaled error, with values < 1 (in green) indicative of superior prediction skill over a naïve baseline forecast (random walk) and values > 1 (in red) indicative of poor prediction skill. Model MAE = mean absolute error of model prediction residuals. Naïve MAE = mean absolute error of naïve predictions.

Model Component	Data Source	MASE	Model MAE	Naïve MAE	N
Index of Abundance	RVC_KEYS	0.750	0.336	0.448	2
	RVC_DRTO	0.552	0.098	0.177	3
	COMB_VIDEO	0.632	0.140	0.221	6
	joint	0.655	0.164	0.250	11
Conditional Age-at-Length	REC	0.321	0.096	0.298	3
	FI_LHR_SP	0.178	0.024	0.134	1
	FI_LHR_TW	0.026	0.024	0.944	1
	joint	0.170	0.067	0.395	5
Size Composition	RVC_KEYS	1.984	0.120	0.060	2
	RVC_DRTO	0.597	0.038	0.064	3
	joint	1.132	0.071	0.063	5

Table 13. The yield-per-recruit (YPR), spawner-per-recruit (SSB/R), static spawning potential ratio (SPR), and total equilibrium yield in metric tons computed over a range of exploitation rates on Florida Keys/East Florida Hogfish from the SEDAR 94 KEYS RW base model.

Exploitation	YPR	SSB/R	SPR	Total Yield (mt)
0.000	0.000	1.864	1.000	0.070
0.039	0.054	1.306	0.700	95.940
0.082	0.086	0.961	0.516	151.843
0.128	0.105	0.737	0.395	186.427
0.176	0.118	0.584	0.313	208.798
0.226	0.127	0.476	0.255	223.798
0.275	0.133	0.398	0.213	234.163
0.324	0.137	0.340	0.182	241.507
0.371	0.141	0.295	0.158	246.824
0.417	0.143	0.261	0.140	250.744
0.460	0.145	0.233	0.125	253.676
0.502	0.147	0.211	0.113	255.895
0.541	0.148	0.192	0.103	257.587
0.579	0.149	0.177	0.095	258.885
0.614	0.150	0.164	0.088	259.880
0.648	0.151	0.153	0.082	260.641
0.680	0.151	0.144	0.077	261.216
0.711	0.152	0.135	0.073	261.643
0.740	0.153	0.128	0.069	261.951
0.768	0.153	0.122	0.065	262.160
0.795	0.153	0.116	0.062	262.288
0.821	0.154	0.111	0.059	262.347
0.846	0.154	0.106	0.057	262.350
0.870	0.154	0.102	0.054	262.304
0.894	0.155	0.098	0.052	262.217
0.916	0.155	0.094	0.050	262.093
0.938	0.155	0.091	0.049	261.939
0.959	0.155	0.088	0.047	261.758
0.980	0.155	0.085	0.046	261.554
1.000	0.155	0.082	0.044	261.328
1.019	0.156	0.080	0.043	261.085
1.038	0.156	0.077	0.042	260.825
1.056	0.156	0.075	0.040	260.552
1.074	0.156	0.073	0.039	260.265
1.092	0.156	0.071	0.038	259.968
1.109	0.156	0.070	0.037	259.660
1.126	0.156	0.068	0.036	259.343
1.142	0.156	0.066	0.036	259.018
1.158	0.156	0.065	0.035	258.685
1.174	0.157	0.063	0.034	258.346

Table 14. Gelman and Rubin's (1992) potential scale reduction factor (PSRF) values from the combined four MCMC chains for selected model parameters (*ln(R0)*) and derived quantities (SSB_0, SSB in 2024, F exploitation in 2024, $F_{30\%SPR}$, SSB at $F_{30\%SPR}$, and the retained yield at $F_{30\%SPR}$) of the SEDAR 94 KEYS RW base model.

PSRF	PSRF Upper CI	Parameter or Derived Quantity
1.005	1.012	*ln(R0)*
1.013	1.035	SSB_0
1.024	1.059	SSB_{2024}
1.014	1.043	F_{2024}
1.008	1.027	$F_{30\%SPR}$
1.013	1.035	$SSB_{F30\%SPR}$
1.022	1.066	Retained yield at $F_{30\%SPR}$

Table 15. The stock status determination criteria for Florida Keys/East Florida Hogfish according to the South Atlantic Fishery Management Council (SAFMC). All SPR proxy values of 30%SPR and 40%SPR were derived from the SEDAR 94 KEYS RW base model.

South Atlantic Fishery Management Council			
Criteria	Definition	30% SPR	40% SPR
MSY	The retained yield at F_{MSY} or $F_{SPRproxy}$	106.702 mt (235,238 lbs.)	98.714 mt (217,628 lbs.)
$F_{MSY\ or\ proxy}$	The fishing mortality rate associated with MSY or SPR proxy	0.186 yr^{-1}	0.125 yr^{-1}
MFMT (Maximum Fishing Mortality Threshold)	$F_{MSY\ or\ SPR\ proxy}$	0.186 yr-1	0.125 yr-1
$F_{current}$ (recent average fishing mortality rate)	The geometric mean of F exploitation for 2022 – 2024	0.018 yr^{-1}	
$SSB_{MSY\ or\ SPRproxy}$	The estimated spawning stock biomass associated with F_{MSY} or $F_{SPRproxy}$	989.077 mt (2,180,542 lbs.)	1,321.570 mt (2,913,563 lbs.)
MSST (Minimum Stock Size Threshold)	$0.75*SSB_{MSY\ or\ SPRproxy}$	741.808 mt (1,635,406 lbs.)	991.178 mt (2,185,172 lbs.)
$SSB_{current}$ (recent average of SSB)	The geometric mean of SSB for 2022 – 2024	2,098.706 mt (4,626,855 lbs.)	

Table 16**.** Projection results when exploitation rates = $F_{30\%SPR}$ (0.185) for Florida Keys/East Florida Hogfish. Equilibrium projections assume predicted recruitment follows the long-term average from 1986 – 2024 (1.698 million fish) while short-term projections assume predicted age-0 recruitment is equal to the average from 2020 to 2024 (1.906 million). Recruitment (Recruits) is in thousands of age-0 fish, F is the exploitation rate, SSB is in metric tons (female plus male SSB), Retained Yield is in pounds (whole weight), and Retained Num is in numbers of fish.

	$F_{30\%SPR}$ Equilibrium Long-Term Projections					**$F_{30\%SPR}$ Short-Term Projections**				
Year	**Age-0 Recruits**	**F**	**SSB**	**Retained Yield**	**Retained Num**	**Age-0 Recruits**	**F**	**SSB**	**Retained Yield**	**Retained Num**
2025	1,698.40	0.185	2,295.34	583,898	174,020	1,906.89	0.185	2,323.28	589,100	177,234
2026	1,698.40	0.185	1,956.68	501,183	147,446	1,906.89	0.185	2,005.20	510,561	152,211
2027	1,698.40	0.185	1,673.27	426,677	126,007	1,906.89	0.185	1,739.11	440,246	132,088
2028	1,698.40	0.185	1,452.93	366,147	109,961	1,906.89	0.185	1,532.58	383,417	117,062
2029	1,698.40	0.185	1,288.80	320,222	98,485	1,906.89	0.185	1,378.95	340,462	106,330
2030	1,698.40	0.185	1,170.41	286,955	90,528	1,906.89	0.185	1,268.32	309,433	98,902
2031	1,698.40	0.185	1,087.38	263,685	85,170	1,906.89	0.185	1,190.94	287,788	93,916
2032	1,698.40	0.185	1,030.14	247,747	81,624	1,906.89	0.185	1,137.76	272,996	90,630
2033	1,698.40	0.185	992.12	237,231	79,377	1,906.89	0.185	1,102.63	263,286	88,565
2034	1,698.40	0.185	967.83	230,546	78,024	1,906.89	0.185	1,080.37	257,150	87,336

Table 17. Projection results when exploitation rates 75% $F_{30\%SPR}$ (0.139) and $F_{current}$ (0.018) for Florida Keys/East Florida Hogfish. Short-term projections assume predicted age-0 recruitment is equal to the average from 2020 to 2024 (1.906 million). Recruitment (Recruits) is in thousands of age-0 fish, F is the exploitation rate, SSB is in metric tons (female plus male SSB), Retained Yield is in pounds (whole weight), and Retained Num is in numbers of fish.

	0.75 * $F_{30\%SPR}$ Short-Term Projections					**$F_{current}$ Short-Term Projections**				
Year	**Age-0 Recruits**	**F**	**SSB**	**Retained Yield**	**Retained Num**	**Age-0 Recruits**	**F**	**SSB**	**Retained Yield**	**Retained Num**
2025	1,906.89	0.139	2,323.28	441,788	133,099	1,906.89	0.018	2,323.28	57,954	17,525
2026	1,906.89	0.139	2,121.83	405,518	120,971	1,906.89	0.018	2,427.87	60,963	18,229
2027	1,906.89	0.139	1,938.41	369,662	110,373	1,906.89	0.018	2,518.58	63,587	18,823
2028	1,906.89	0.139	1,783.98	337,942	101,787	1,906.89	0.018	2,596.21	65,837	19,322
2029	1,906.89	0.139	1,659.37	311,748	95,121	1,906.89	0.018	2,661.45	67,730	19,735
2030	1,906.89	0.139	1,562.11	291,121	90,102	1,906.89	0.018	2,715.95	69,314	20,075
2031	1,906.89	0.139	1,488.33	275,432	86,426	1,906.89	0.018	2,761.54	70,640	20,359
2032	1,906.89	0.139	1,432.95	263,679	83,755	1,906.89	0.018	2,798.08	71,704	20,585
2033	1,906.89	0.139	1,392.78	255,173	81,878	1,906.89	0.018	2,828.15	72,582	20,770
2034	1,906.89	0.139	1,364.42	249,184	80,599	1,906.89	0.018	2,853.01	73,309	20,922

Table 18. Projection results when exploitation rates = $F_{40\%SPR}$ (0.125) for Florida Keys/East Florida Hogfish. Equilibrium projections assume predicted recruitment follows the long-term average from 1986 – 2024 (1.698 million fish) while short-term projections assume predicted age-0 recruitment is equal to the average from 2020 to 2024 (1.906 million). Recruitment (Recruits) is in thousands of age-0 fish, F is the exploitation rate, SSB is in metric tons (female plus male SSB), Retained Yield is in pounds (whole weight), and Retained Num is in numbers of fish.

	$F_{40\%SPR}$ Equilibrium Long-Term Projections					**$F_{40\%SPR}$ Short-Term Projections**				
Year	**Age-0 Recruits**	**F**	**SSB**	**Retained Yield**	**Retained Num**	**Age-0 Recruits**	**F**	**SSB**	**Retained Yield**	**Retained Num**
2025	1,698.40	0.125	2,295.34	394,067	117,670	1,906.89	0.125	2,323.28	397,607	119,842
2026	1,698.40	0.125	2,106.38	364,469	107,387	1,906.89	0.125	2,156.88	371,078	110,726
2027	1,698.40	0.125	1,929.17	333,832	98,104	1,906.89	0.125	2,000.65	343,802	102,528
2028	1,698.40	0.125	1,775.63	305,696	90,358	1,906.89	0.125	1,865.48	318,895	95,707
2029	1,698.40	0.125	1,648.32	281,684	84,178	1,906.89	0.125	1,753.52	297,722	90,271
2030	1,698.40	0.125	1,546.30	262,187	79,395	1,906.89	0.125	1,663.90	280,581	86,071
2031	1,698.40	0.125	1,466.85	246,930	75,795	1,906.89	0.125	1,594.22	267,200	82,915
2032	1,698.40	0.125	1,405.59	235,176	73,104	1,906.89	0.125	1,540.52	256,897	80,559
2033	1,698.40	0.125	1,359.85	226,412	71,150	1,906.89	0.125	1,500.51	249,228	78,853
2034	1,698.40	0.125	1,326.48	220,036	69,765	1,906.89	0.125	1,471.45	243,670	77,651

Table 19. Projection results when exploitation rates = 75% $F_{40\%SPR}$ (0.094) for Florida Keys/East Florida Hogfish. Short-term projections assume predicted age-0 recruitment is equal to the average from 2020 to 2024 (1.906 million). Recruitment (Recruits) is in thousands of age-0 fish, F is the exploitation rate, SSB is in metric tons (female plus male SSB), Retained Yield is in pounds (whole weight), and Retained Num is in numbers of fish.

0.75 * $F_{40\%SPR}$ Short-Term Projections

Year	Age-0 Recruits	F	SSB	Retained Yield	Retained Num
2025	1,906.89	0.094	2,323.28	298,150	89,955
2026	1,906.89	0.094	2,235.95	288,580	86,163
2027	1,906.89	0.094	2,145.08	277,119	82,437
2028	1,906.89	0.094	2,059.99	265,550	79,106
2029	1,906.89	0.094	1,984.30	254,879	76,270
2030	1,906.89	0.094	1,919.64	245,608	73,937
2031	1,906.89	0.094	1,866.24	237,871	72,074
2032	1,906.89	0.094	1,822.26	231,499	70,591
2033	1,906.89	0.094	1,787.42	226,440	69,443
2034	1,906.89	0.094	1,760.47	222,523	68,576

6 Figures

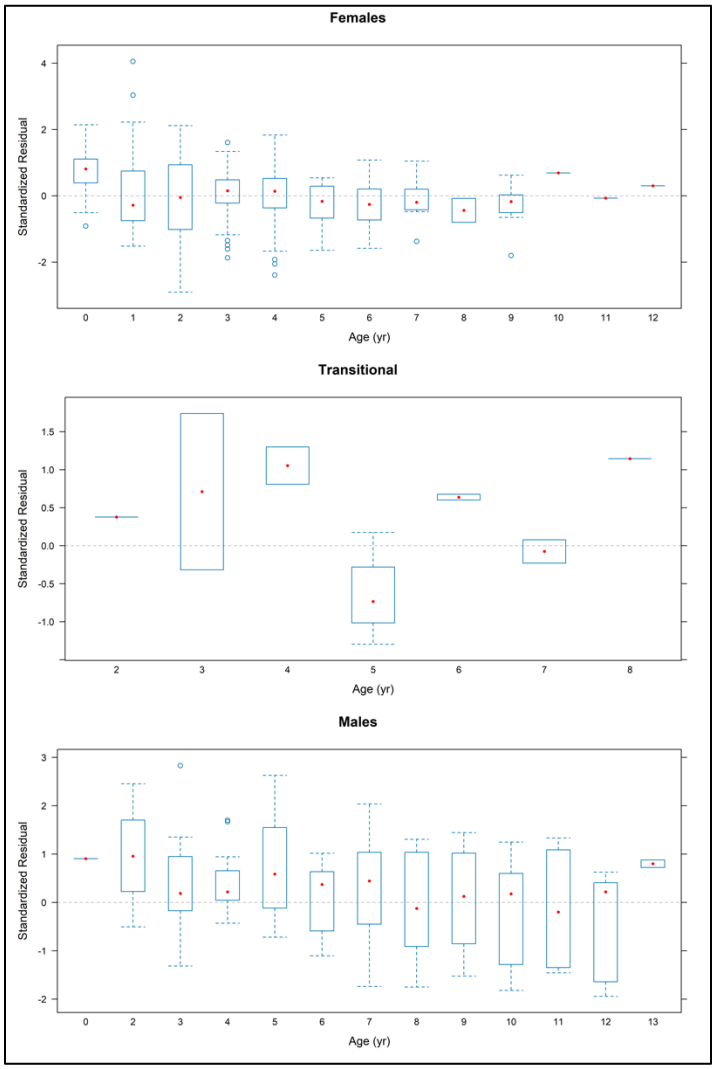


Figure 1. Boxplots of standardized residuals by age and sex from the Florida Keys/East Florida size-truncated von Bertalanffy growth model applied to inverse-weighted data where CV was constant across age. Boxplots include the median (red dots), upper and lower quartiles, and outliers (open circles).

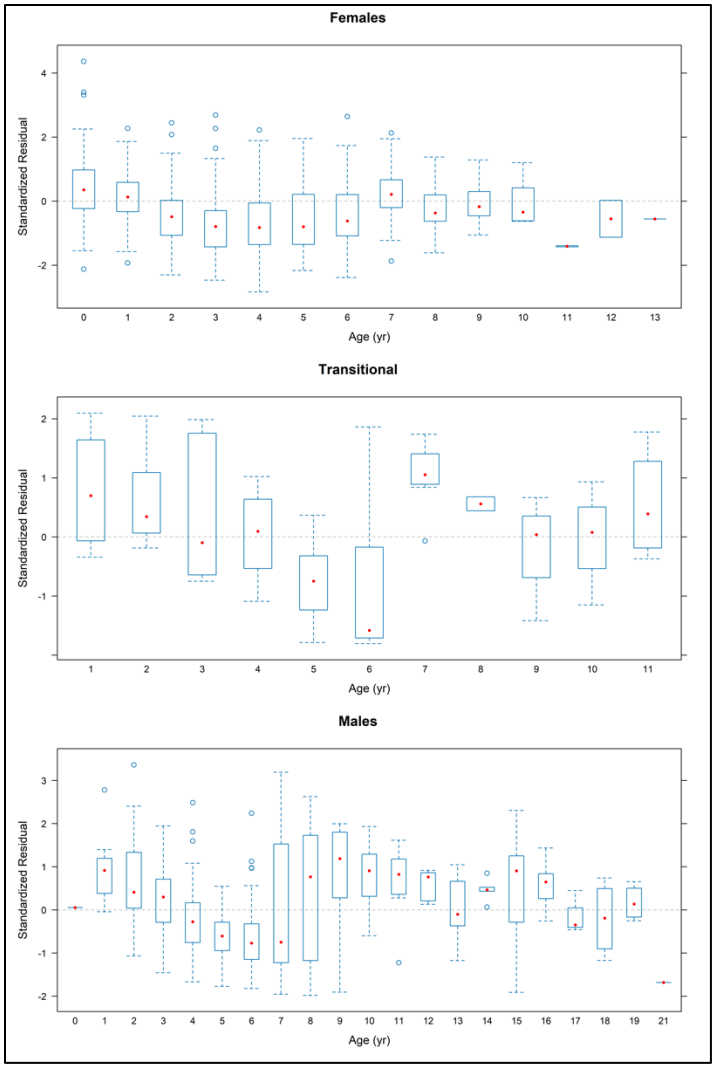
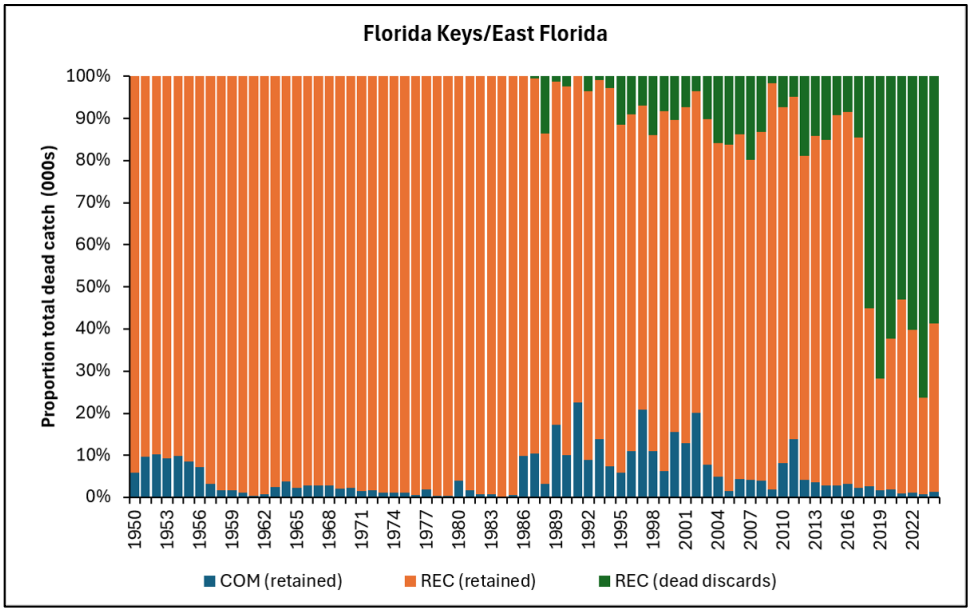


Figure 2. Boxplots of standardized residuals by age and sex plots from the West Florida Shelf size-truncated von Bertalanffy growth model applied to inverse-weighted data where CV changed linearly with age. Boxplots include the median (red dots), upper and lower quartiles, and outliers (open circles).

a)



b)

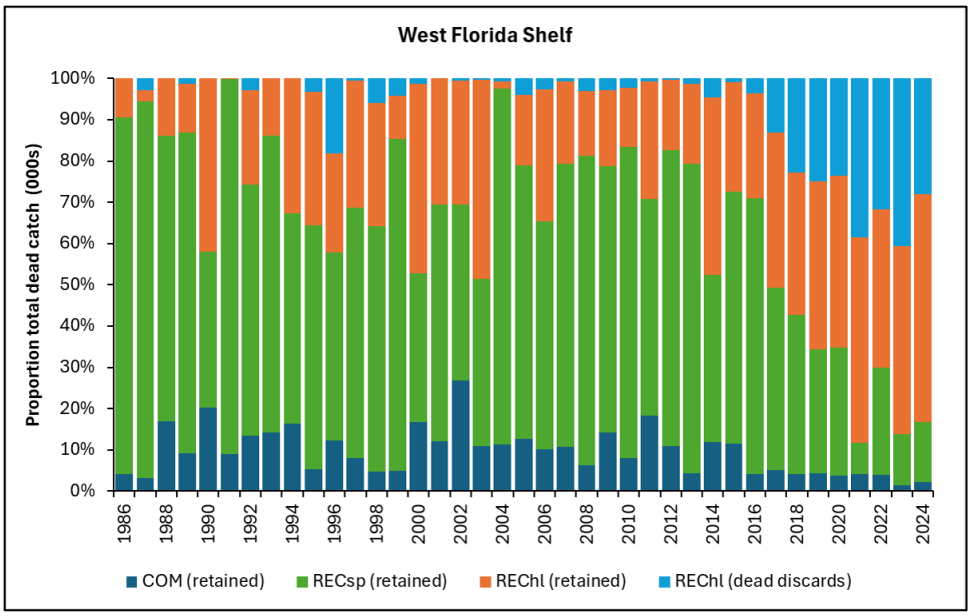


Figure 3. The proportion of total dead catch (in numbers) of Hogfish for (a) the Florida Keys/East Florida stock and (b) the West Florida Shelf stock. Recreational dead discards assumed a discard mortality rate of 41.4%.

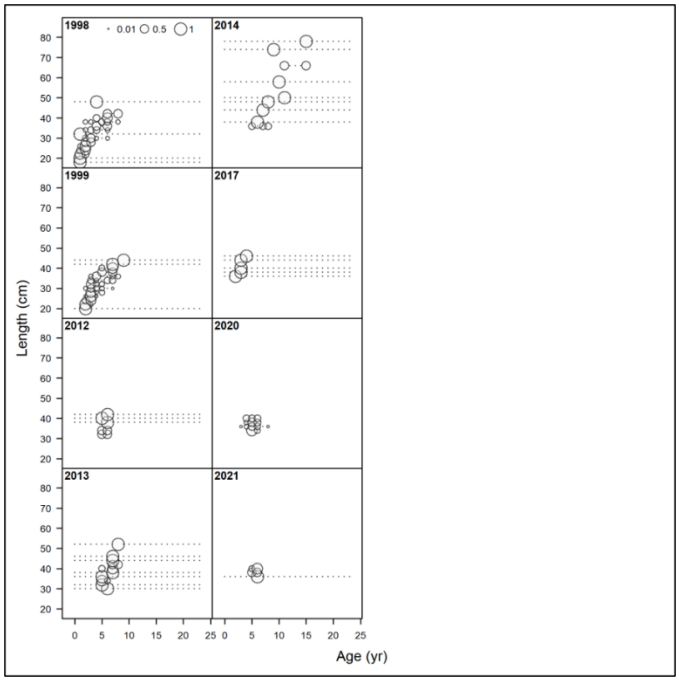


Figure 4. Observed conditional age-at-length in 2 cm FL bins of West Florida Shelf Hogfish for the commercial fleet during years 1998 – 2021.

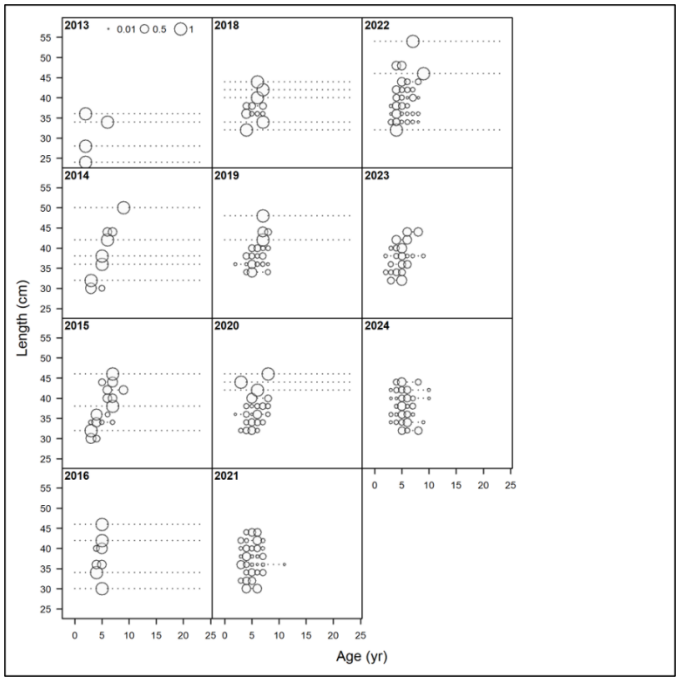


Figure 5. Observed conditional age-at-length in 2 cm FL bins of West Florida Shelf Hogfish for the recreational hook-and-line fleet during years 2013 – 2024.

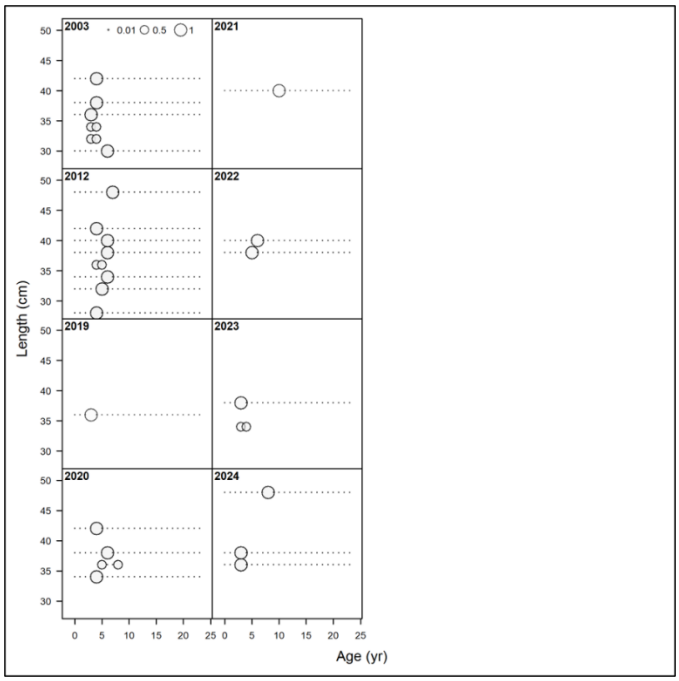


Figure 6. Observed conditional age-at-length in 2 cm FL bins of West Florida Shelf Hogfish for the recreational spear fleet during years 2003 – 2024.

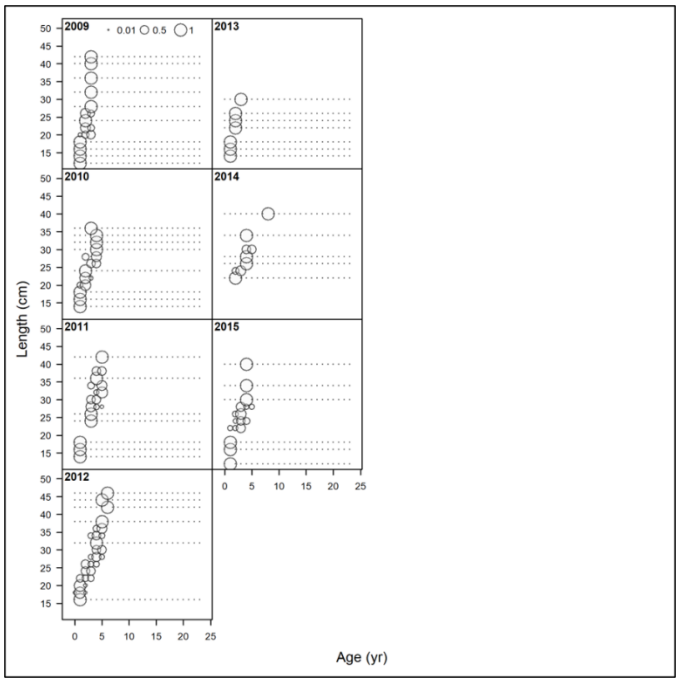


Figure 7. Observed conditional age-at-length in 2 cm FL bins of West Florida Shelf Hogfish from fishery-independent trawl sources during years 2009 – 2015.

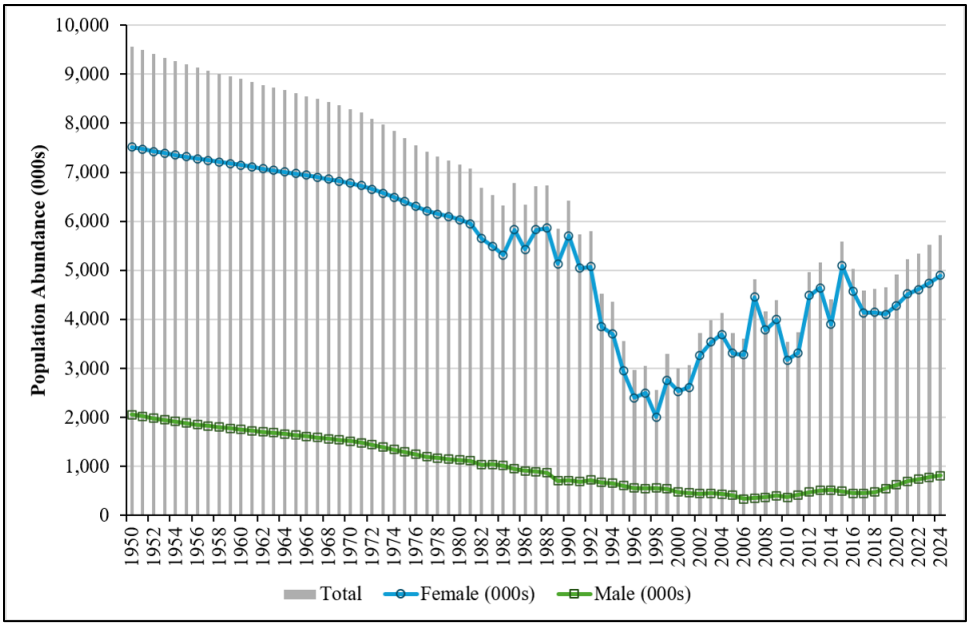


Figure 8. Estimates of total abundance separated by sex (female = blue circles, male = green squares, combined = grey bars) for Florida Keys/East Florida Hogfish from 1950 – 2024.

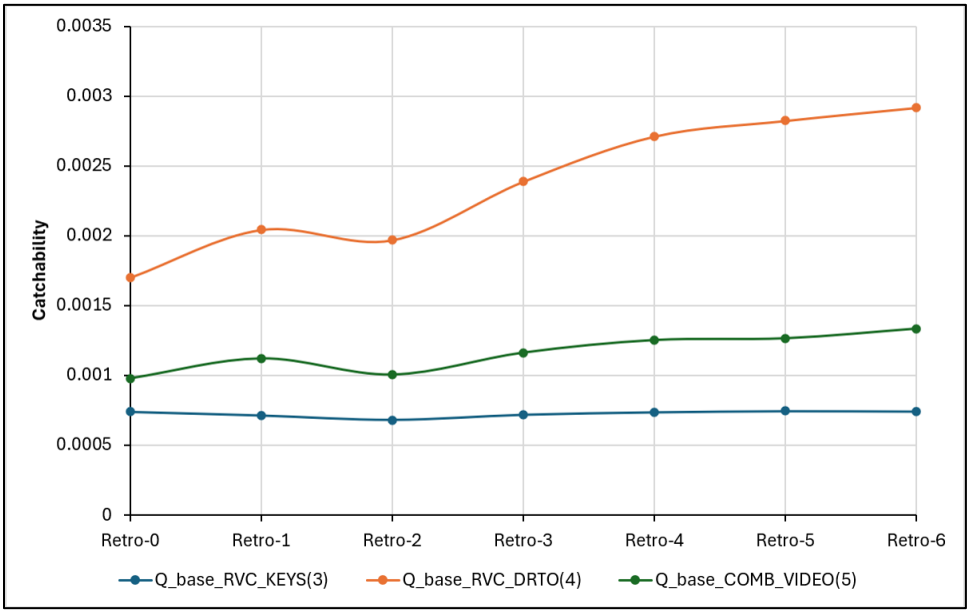


Figure 9. Estimates of catchability (Q_base) by the KEYS base model across six retrospective peels for the three indices of abundance. Retro-0 is the KEYS base model reference run.

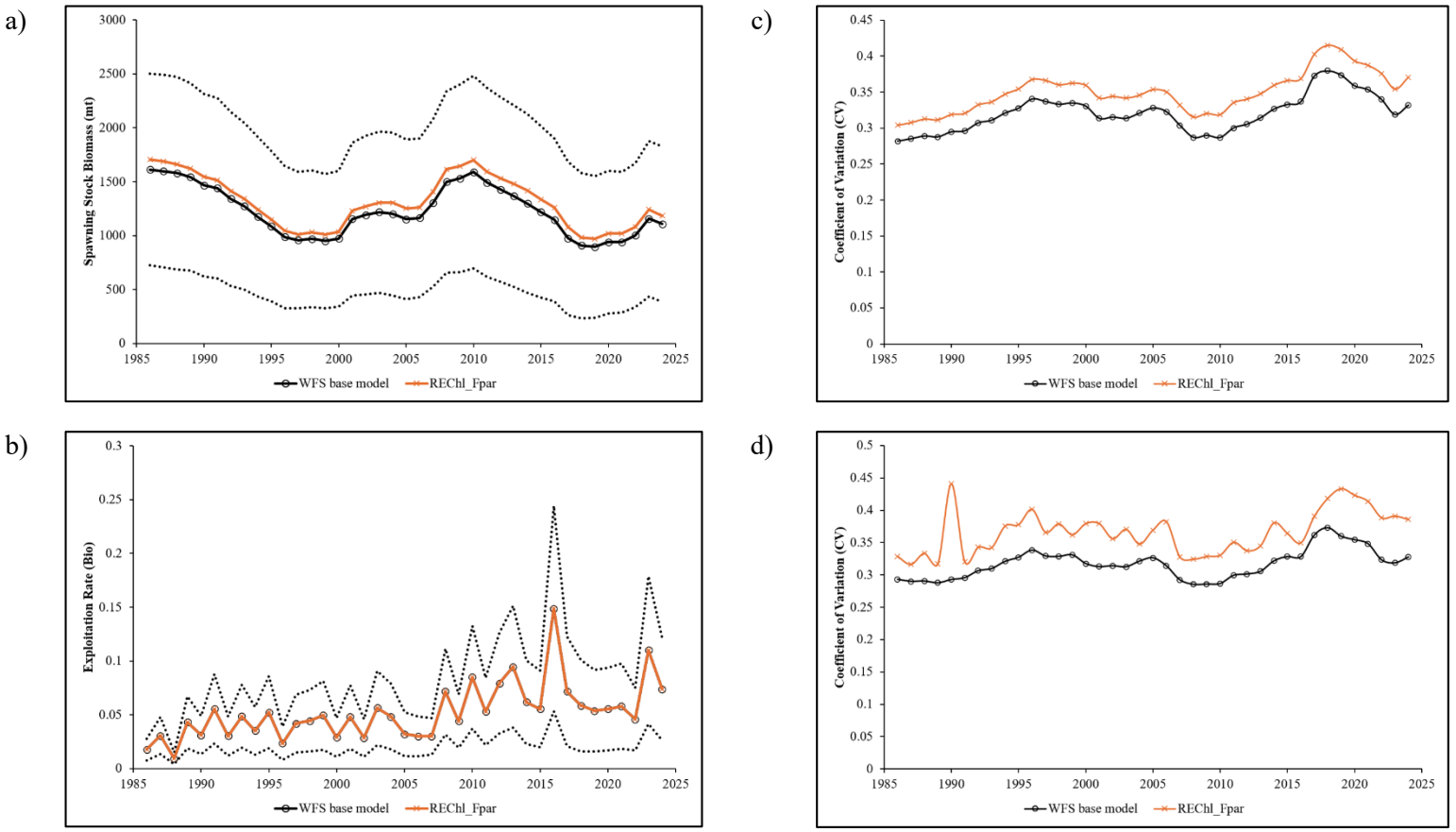


Figure 10. The a) spawning stock biomass, b) exploitation rate, c) annual CV estimates for spawning stock biomass, and d) annual CV estimates for exploitation rates from the WFS base compared to a sensitivity run where the Recreational hook-and-line (REChl) fleet was configured using F as parameter (Fpar).

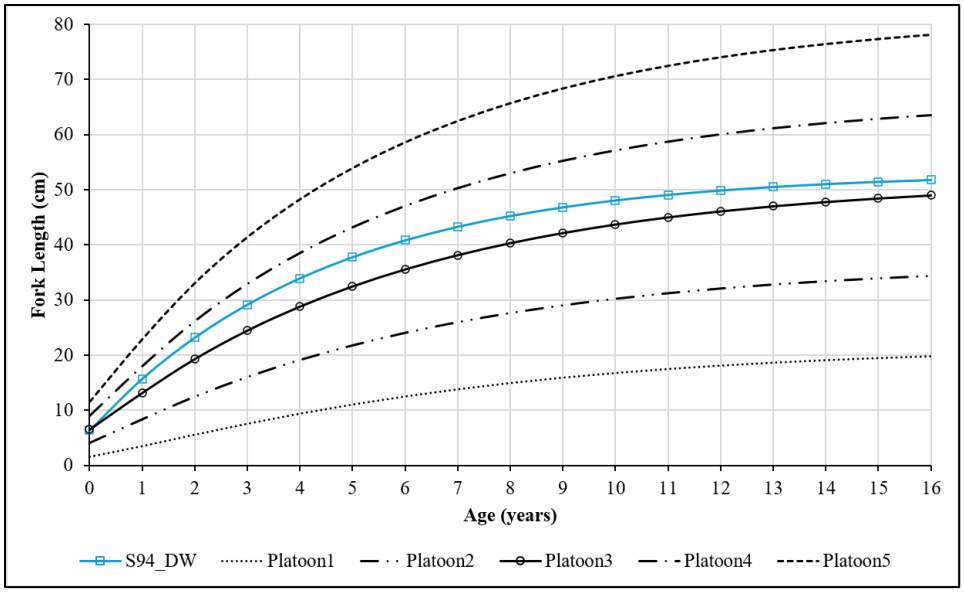


Figure 11. Mean size-at-age across 5 platoons for Florida Keys/East Florida Hogfish as estimated by the SEDAR 94 KEYS RW base model. Distribution of recruitment among platoons approximated a normal distribution (0.031, 0.237, 0.464, 0.237, 0.031) and the 3rd platoon (black circles) followed the L_{inf} (51.9 cm FL) and k (0.173) parameters estimated by the SEDAR 94 KEYS RW base model. A comparison with the external growth model developed during the Data Workshop is shown by the blue squares.

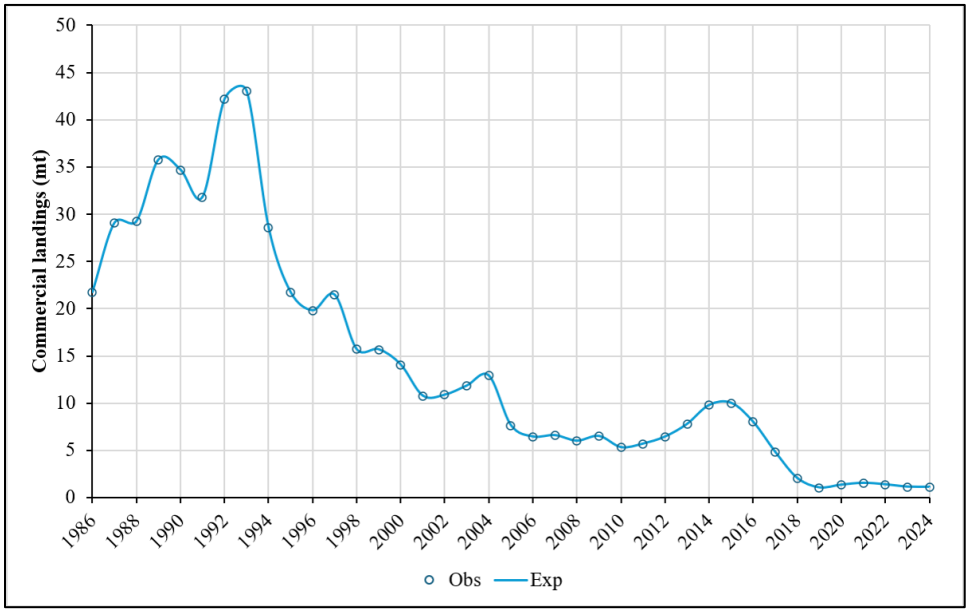


Figure 12. Florida Keys/East Florida Hogfish observed (dots) and expected (solid line) landings by the commercial fleet (in metric tons) from the SEDAR 94 KEYS RW base model.

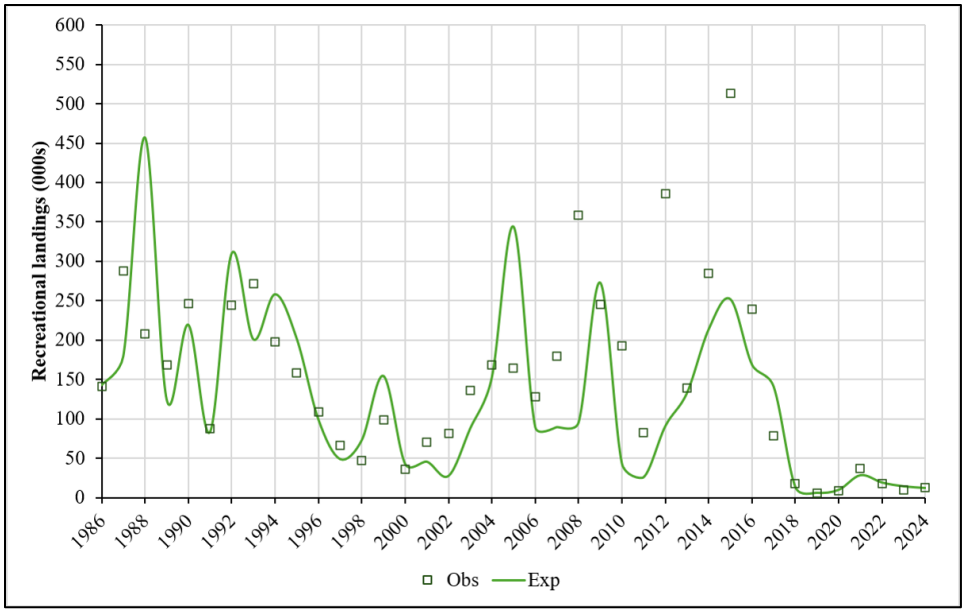
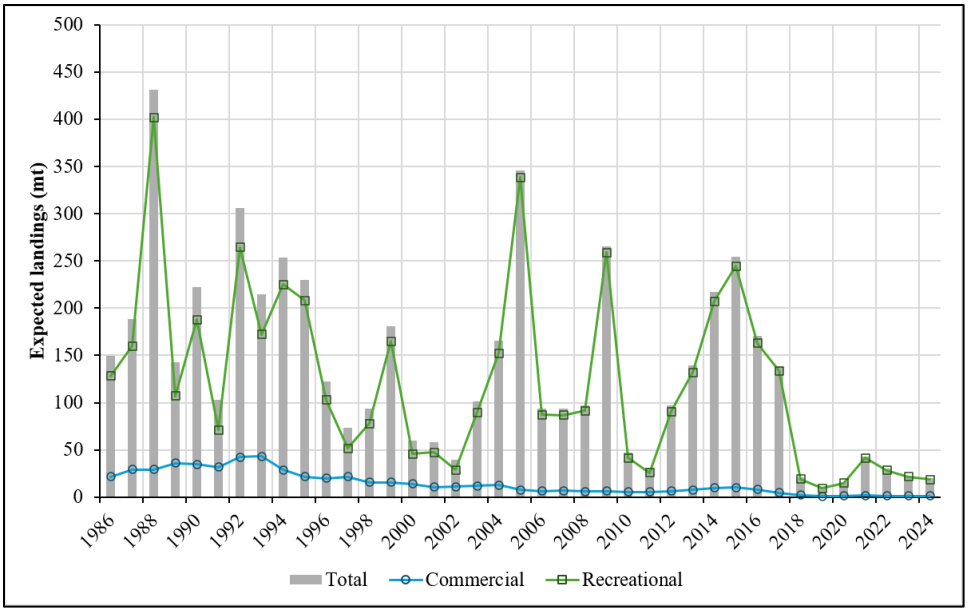


Figure 13. Florida Keys/East Florida Hogfish observed (squares) and expected (solid line) landings by the recreational fleet (in thousands of fish) from the SEDAR 94 KEYS RW base model.

a)



b)

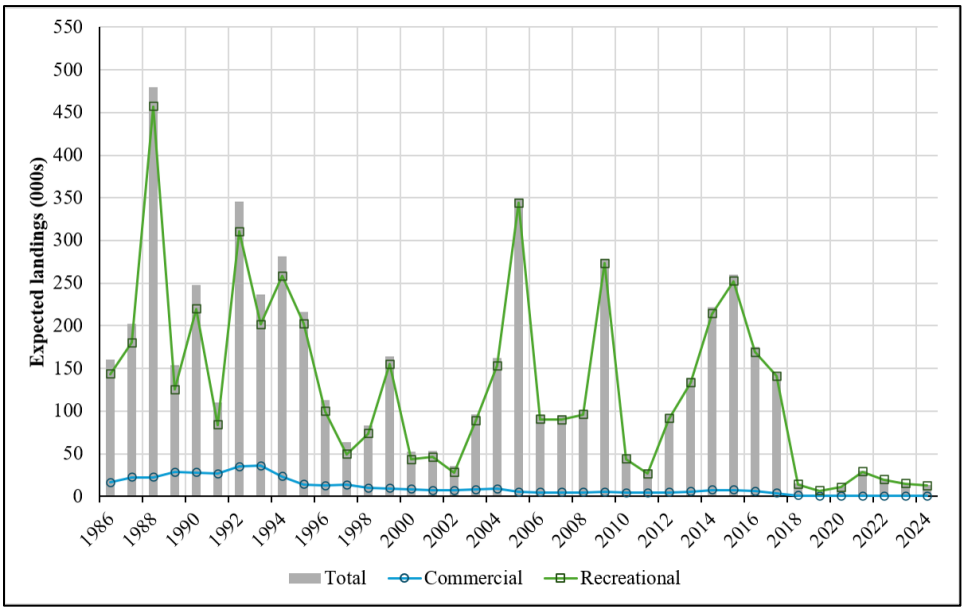


Figure 14. Expected landings of Florida Keys/East Florida Hogfish by fleet a) in metric tons, and b) in thousands of fish, as estimated from the SEDAR 94 KEYS RW base model.

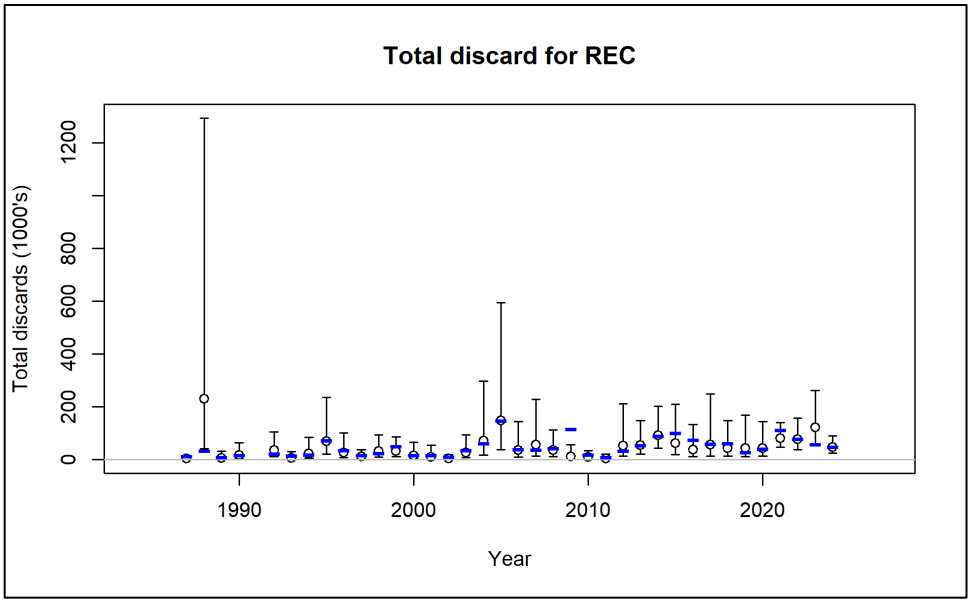


Figure 15. Florida Keys/East Florida Hogfish observed (dots with 95% confidence intervals) and expected (blue dashes) discards (i.e., before applying the discard mortality rate for each fleet) by the recreational fleet (in thousands of fish) from the SEDAR 94 KEYS RW base model.

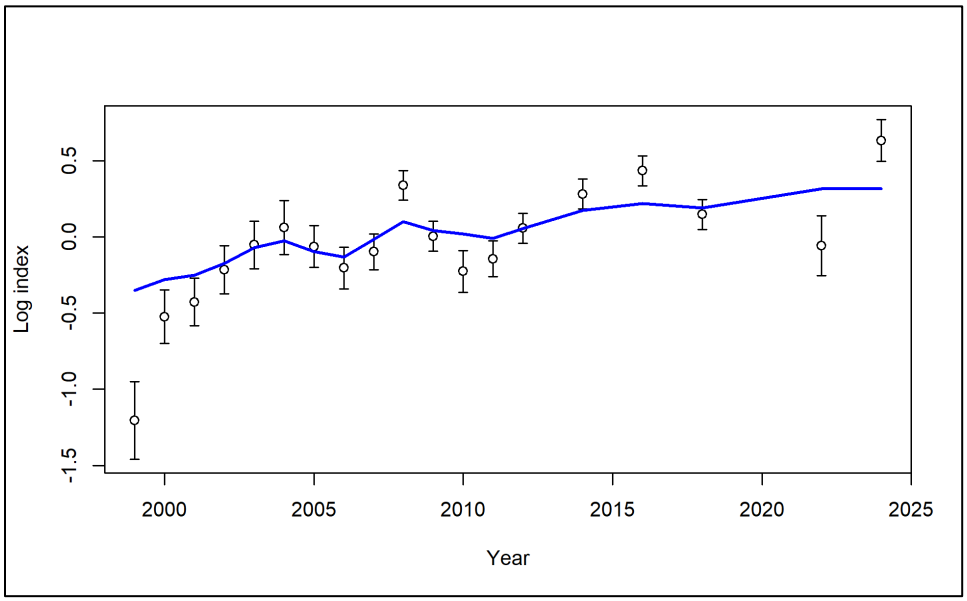


Figure 16. The Florida Keys/East Florida Hogfish observed (dots with 95% confidence intervals) and predicted (blue line) RVC Florida Keys index of relative abundance (log-transformed) from the SEDAR 94 KEYS RW base model.

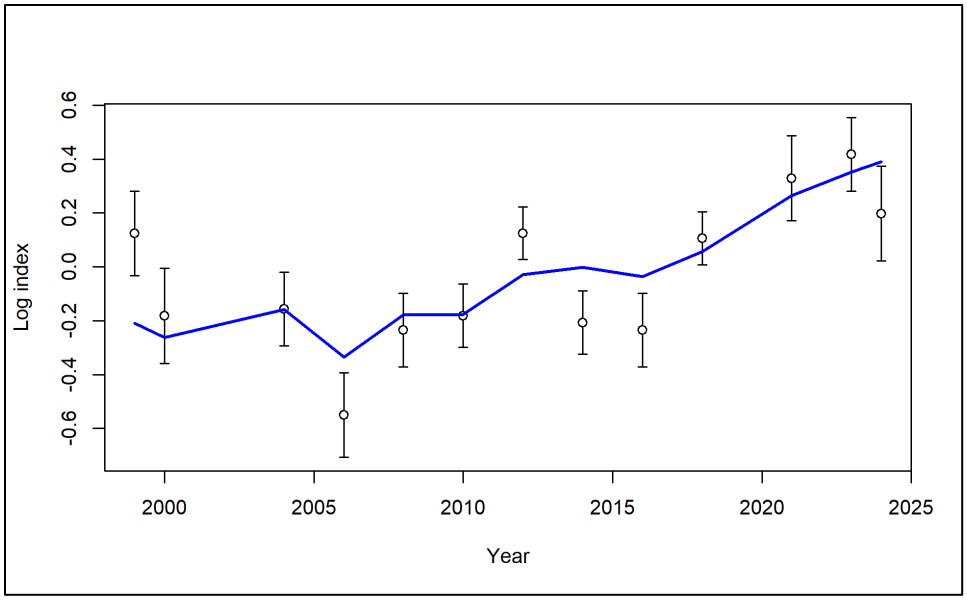


Figure 17. The Florida Keys/East Florida Hogfish observed (dots with 95% confidence intervals) and predicted (blue line) RVC Dry Tortugas index of relative abundance (log-transformed) from the SEDAR 94 KEYS RW base model.

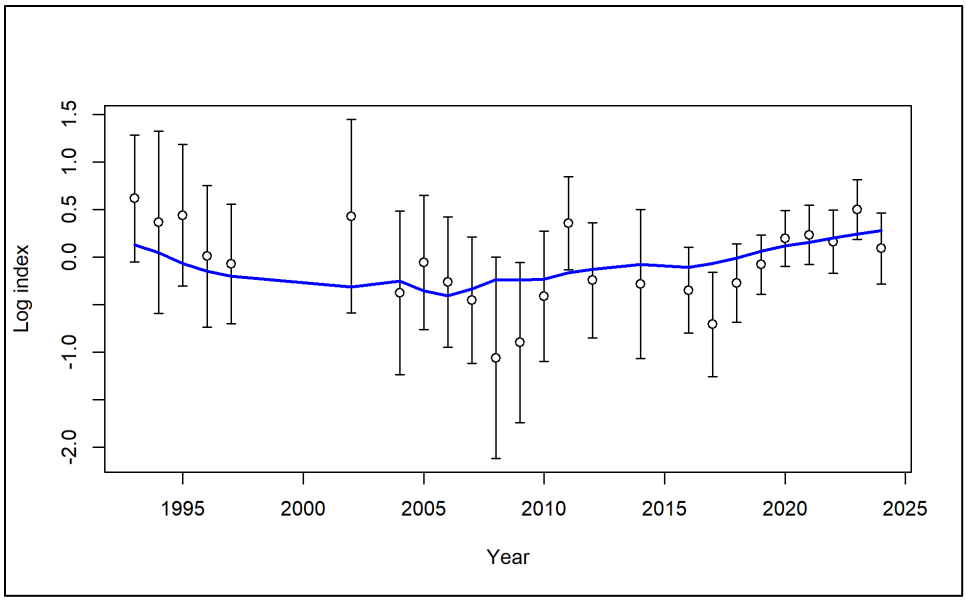


Figure 18. The Florida Keys/East Florida Hogfish observed (dots with 95% confidence intervals) and predicted (blue line) combined video index of relative abundance (log-transformed) from the SEDAR 94 KEYS RW base model.

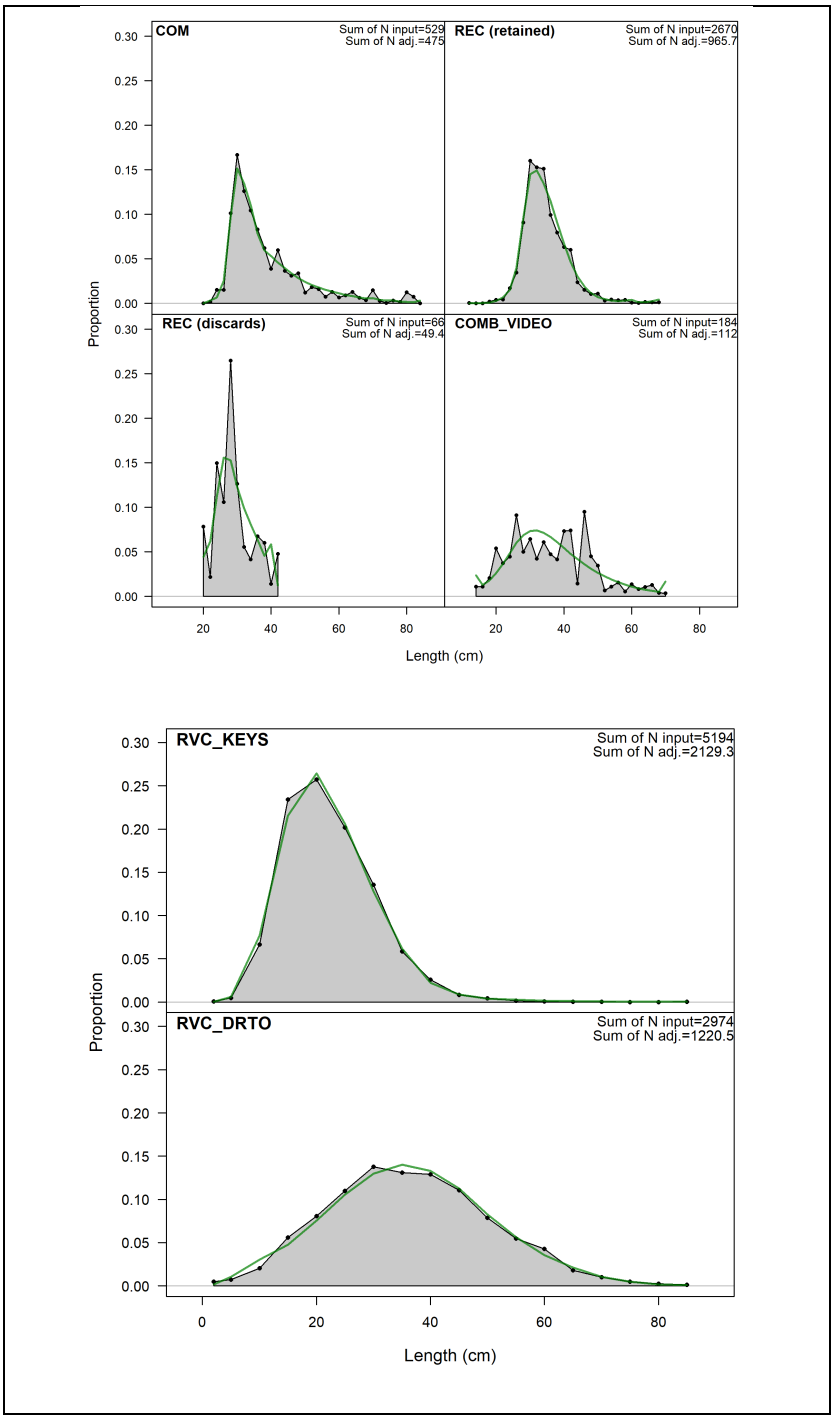


Figure 19. Model fits to the length composition of retained and discarded catch within a given fleet or survey aggregated across years for Florida Keys/East Florida Hogfish. Green lines represent predicted length compositions, while grey shaded regions represent observed length compositions. In the upper right hand corners, 'N input.' is the input sample size while 'N adj.' is the effective sample size calculated using the Dirichlet-Multinomial data-weighting adjustment.

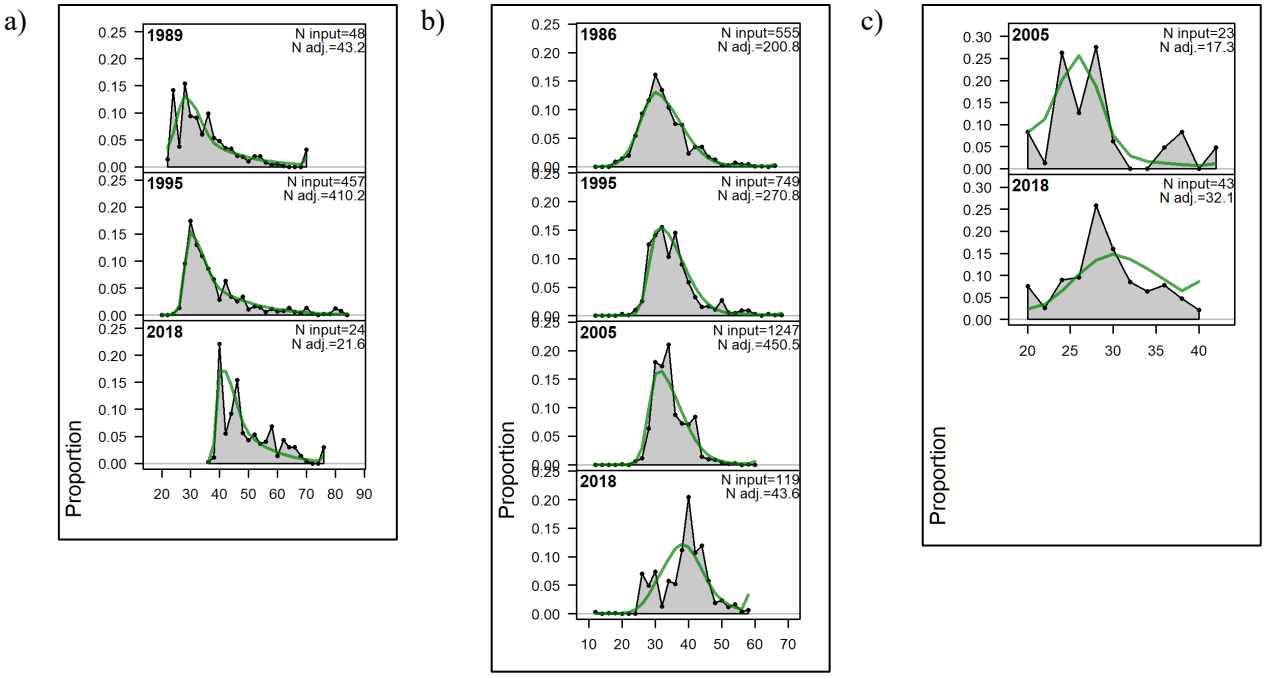


Figure 20. Model fits to the length composition of a) retained catch by the commercial fleet, b) retained catch by the recreational fleet, and c) discards for the recreational fleet by super-period for Florida Keys/East Florida Hogfish. Green lines represent predicted length compositions, while grey shaded regions represent observed length compositions. In the upper right hand corners, 'N input.' is the input sample size while 'N adj.' is the effective sample size calculated using the Dirichlet-Multinomial data-weighting adjustment. Data are in 2 cm fork length bins.

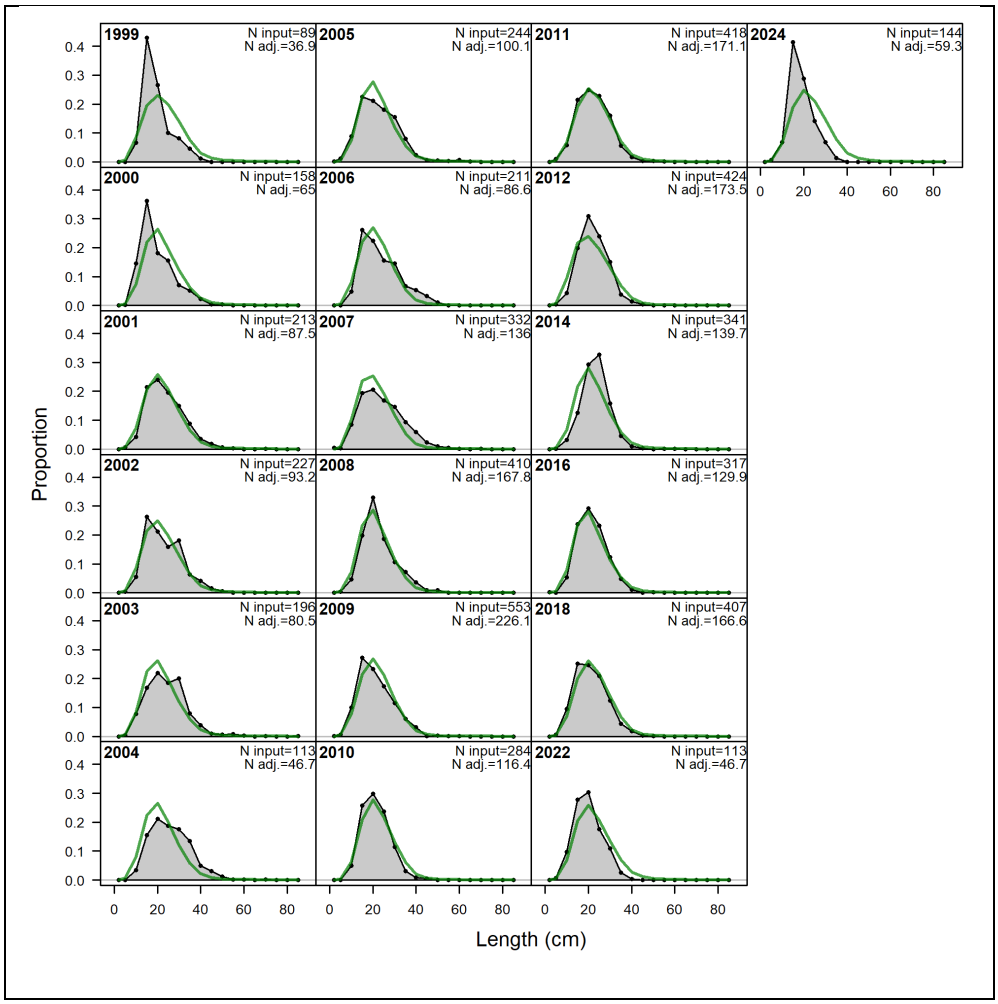


Figure 21. Model fits to the length composition data by the RVC Florida Keys index for Florida Keys/East Florida Hogfish. Green lines represent predicted length compositions, while grey shaded regions represent observed length compositions. In the upper right hand corners, 'N input.' is the input sample size while ‘N adj.’ is the effective sample size calculated using the Dirichlet-Multinomial data-weighting adjustment. Data are in 5 cm fork length bins.

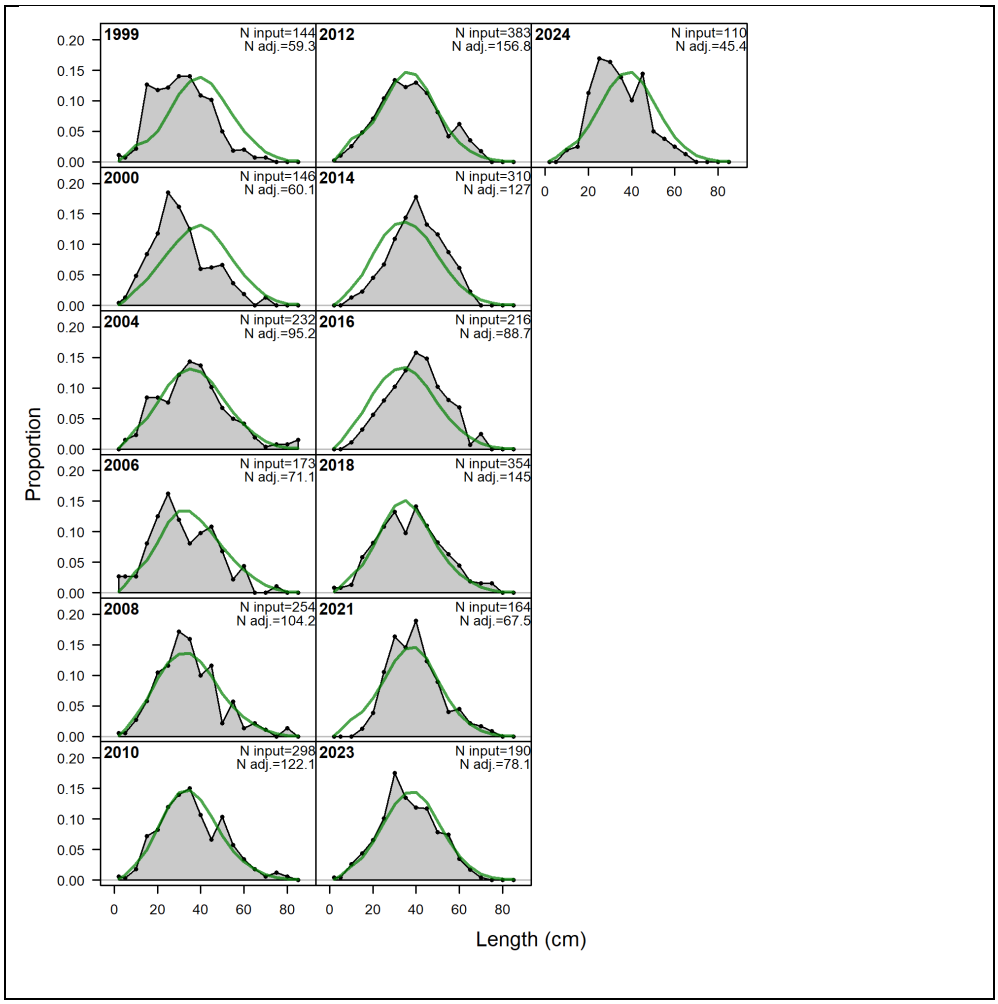


Figure 22. Model fits to the length composition data by the RVC Dry Tortugas index Florida Keys/East Florida Hogfish. Green lines represent predicted length compositions, while grey shaded regions represent observed length compositions. In the upper right hand corners, 'N input.' is the input sample size while 'N adj.' is the effective sample size calculated using the Dirichlet-Multinomial data-weighting adjustment. Data are in 5 cm fork length bins.

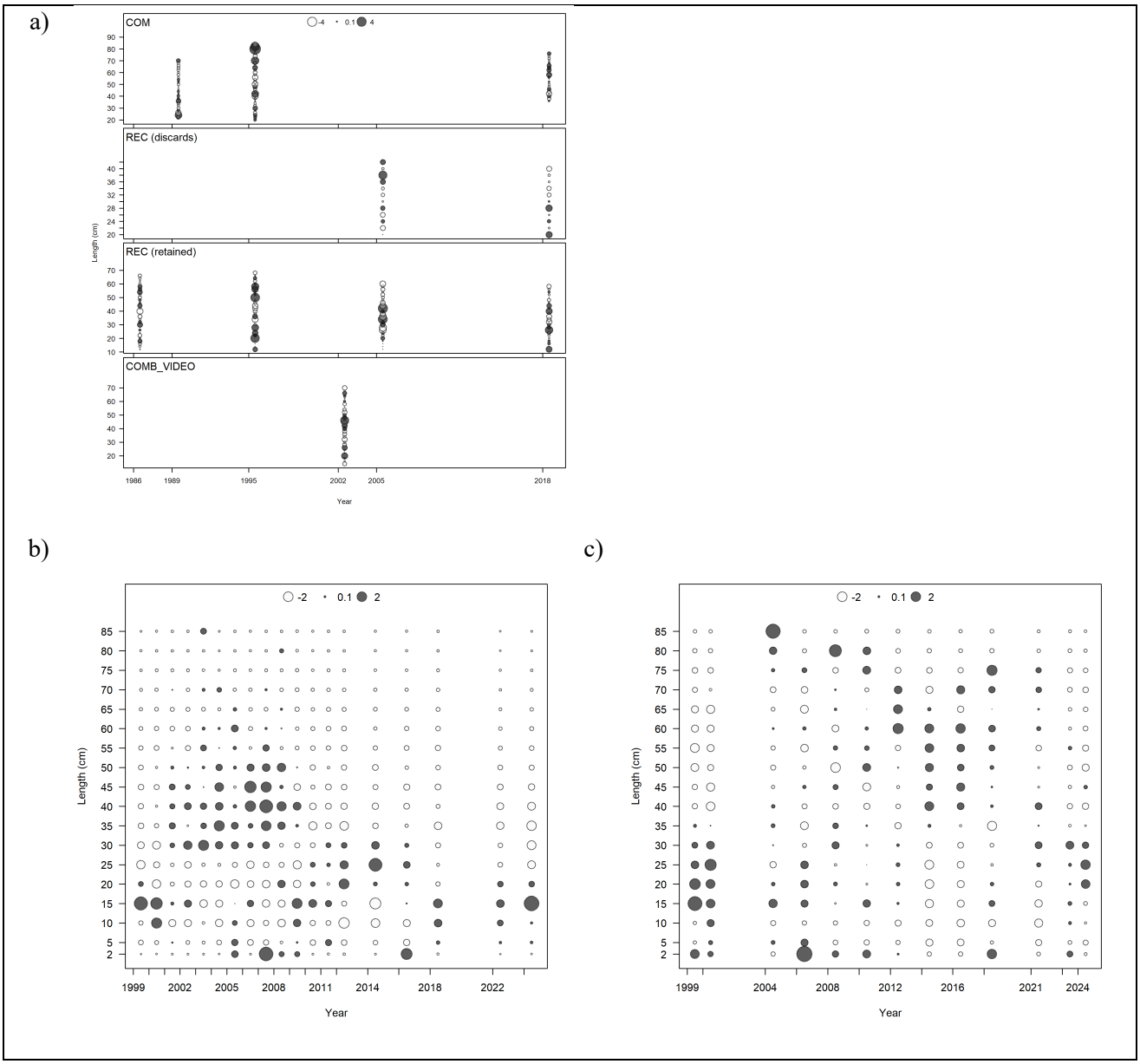


Figure 23. Pearson residuals for length composition data for a) the commercial and recreational fleets as well as the combined video index by super-period, b) the RVC Florida Keys index by year, and c) the RVC Dry Tortugas index by year for Florida Keys/East Florida Hogfish. Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected).

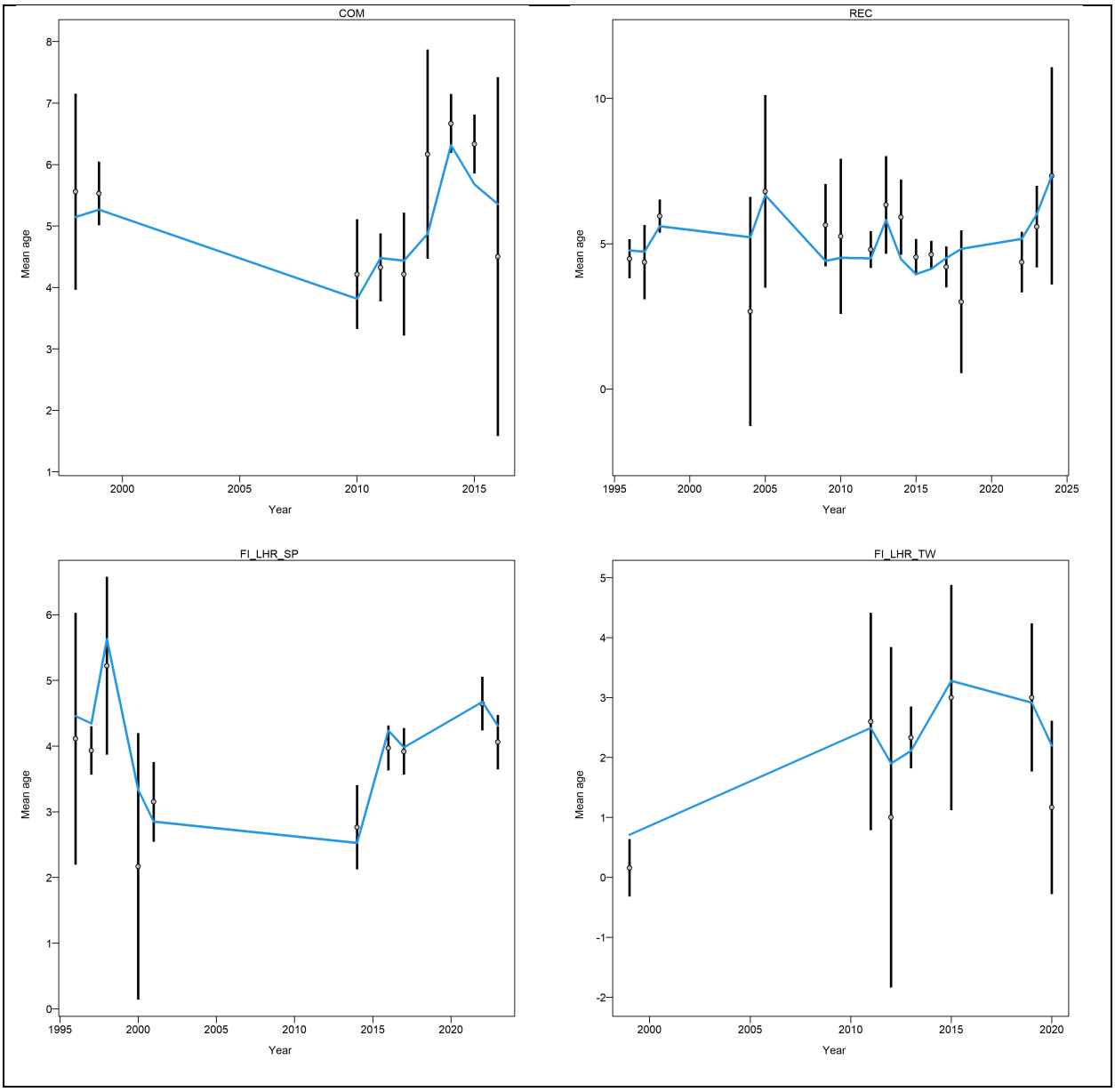


Figure 24. Mean ages of Florida Keys/East Florida Hogfish from conditional age-at-length data (commercial retained catch, recreational retained catch, fishery-independent spear, and fishery-independent trawl) aggregated across length bins. Observed values are dots with 95% confidence intervals and predicted values are the blue lines).

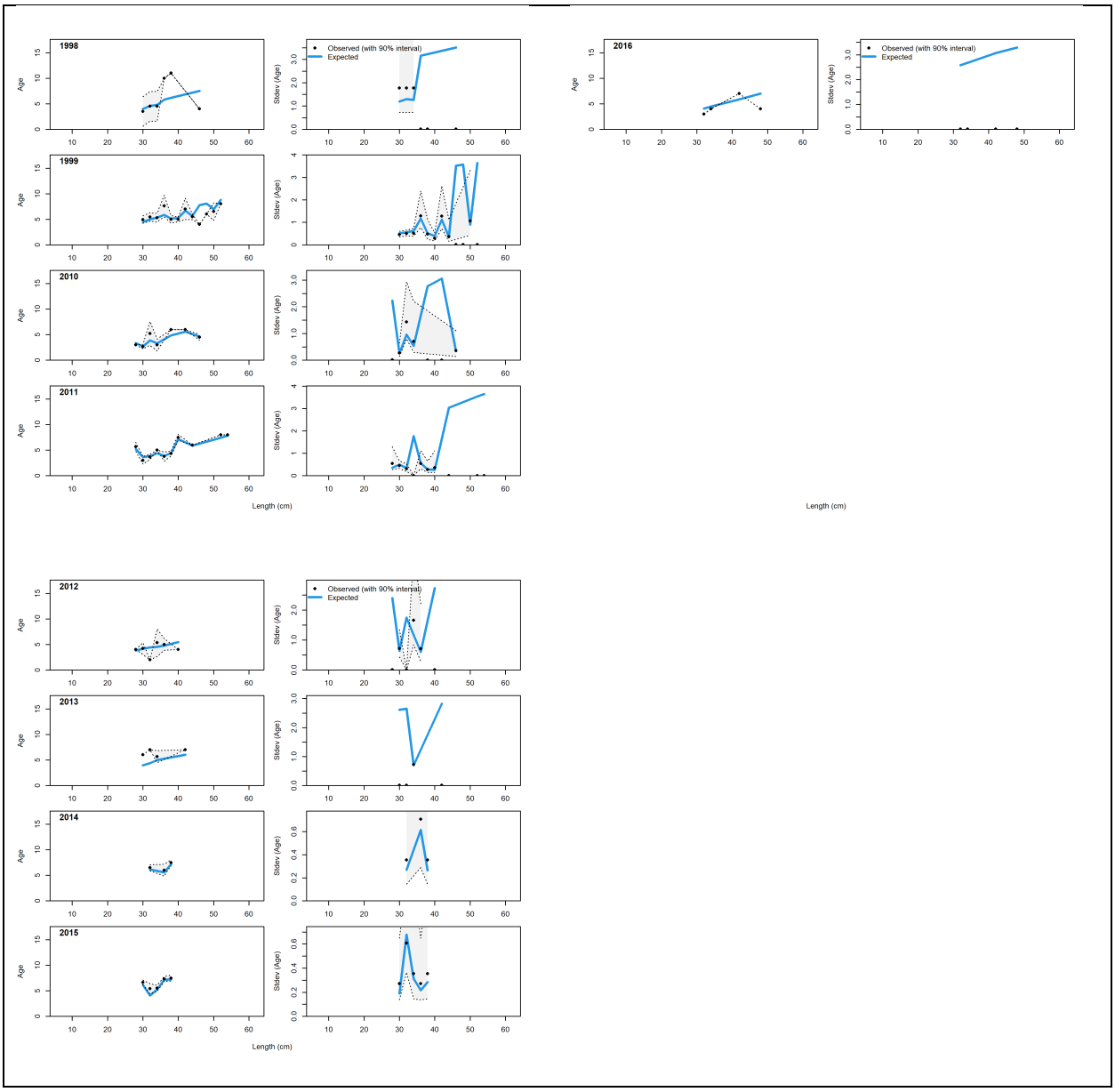


Figure 25. Model fits to the annual conditional age-at-length data from retained catch by the commercial fleet for Florida Keys/East Florida Hogfish. In the left plots, the blue lines represent predicted mean age-at-length by size class while the black dots and grey shaded regions represent the observed mean age-at-length by size class with 90% confidence intervals. In the right plots, the blue lines represent predicted standard error of mean age-at-length by size class while the black dots and grey shaded regions represent the observed standard error of mean age-at-length by size class with 90% confidence intervals.

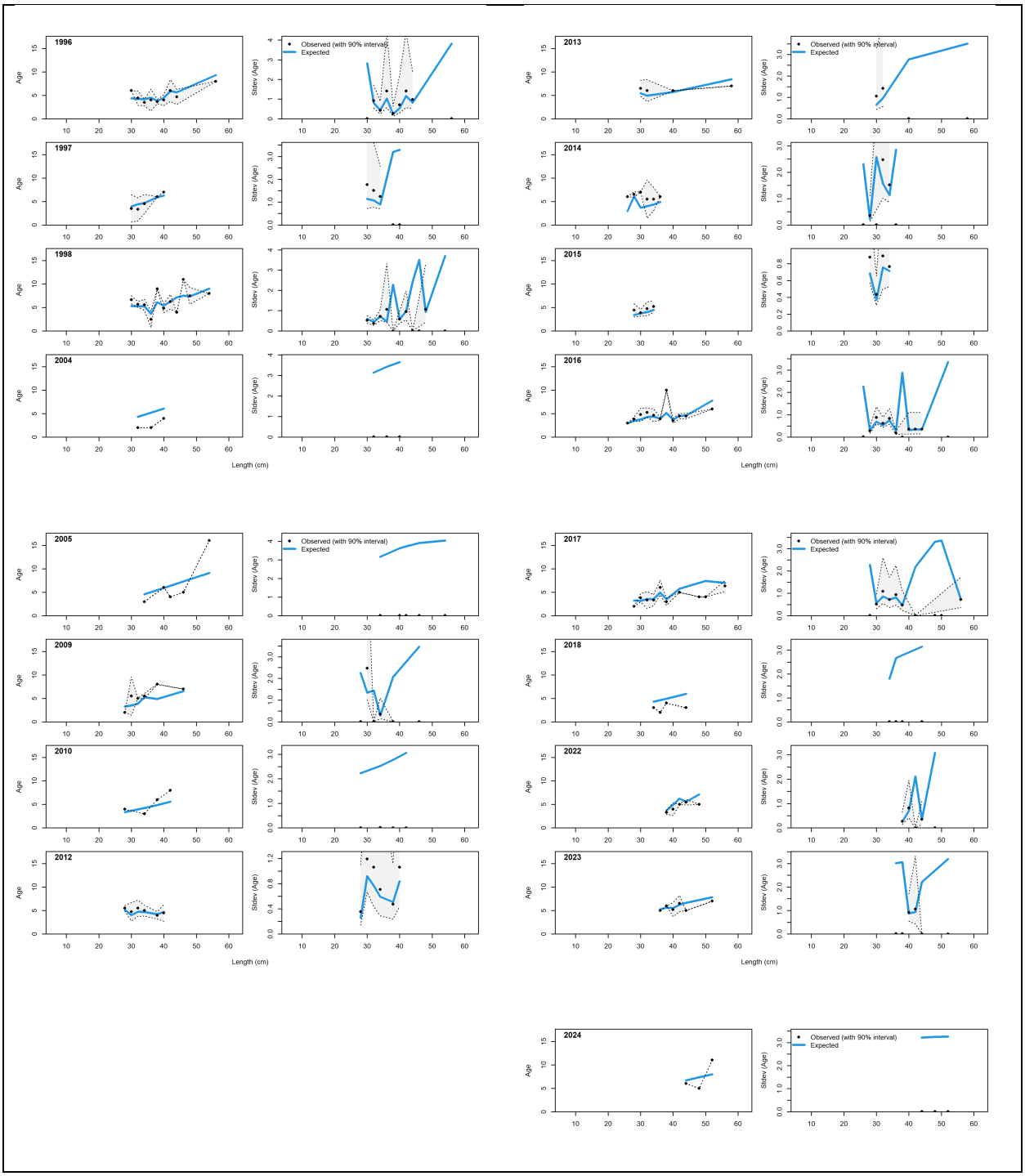


Figure 26. Model fits to the annual conditional age-at-length data from retained catch by the recreational fleet for Florida Keys/East Florida Hogfish. In the left plots, the blue lines represent predicted mean age-at-length by size class while the black dots and grey shaded regions represent the observed mean age-at-length by size class with 90% confidence intervals. In the right plots, the blue lines represent predicted standard error of mean age-at-length by size class while the black dots and grey shaded regions represent the observed standard error of mean age-at-length by size class with 90% confidence intervals.

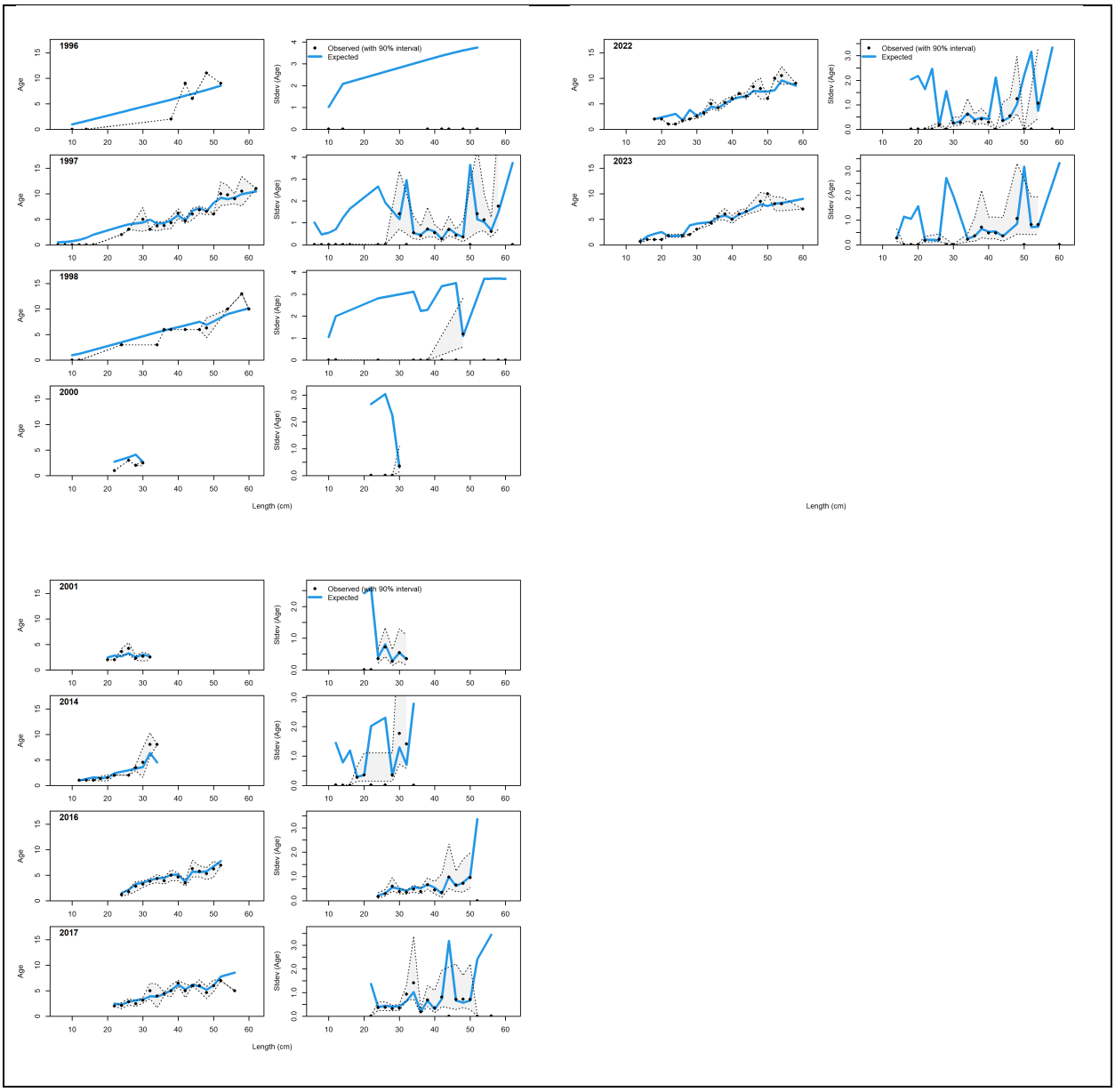


Figure 27. Model fits to the annual conditional age-at-length data from fishery-independent spear data sources for Florida Keys/East Florida Hogfish. In the left plots, the blue lines represent predicted mean age-at-length by size class while the black dots and grey shaded regions represent the observed mean age-at-length by size class with 90% confidence intervals. In the right plots, the blue lines represent predicted standard error of mean age-at-length by size class while the black dots and grey shaded regions represent the observed standard error of mean age-at-length by size class with 90% confidence intervals.

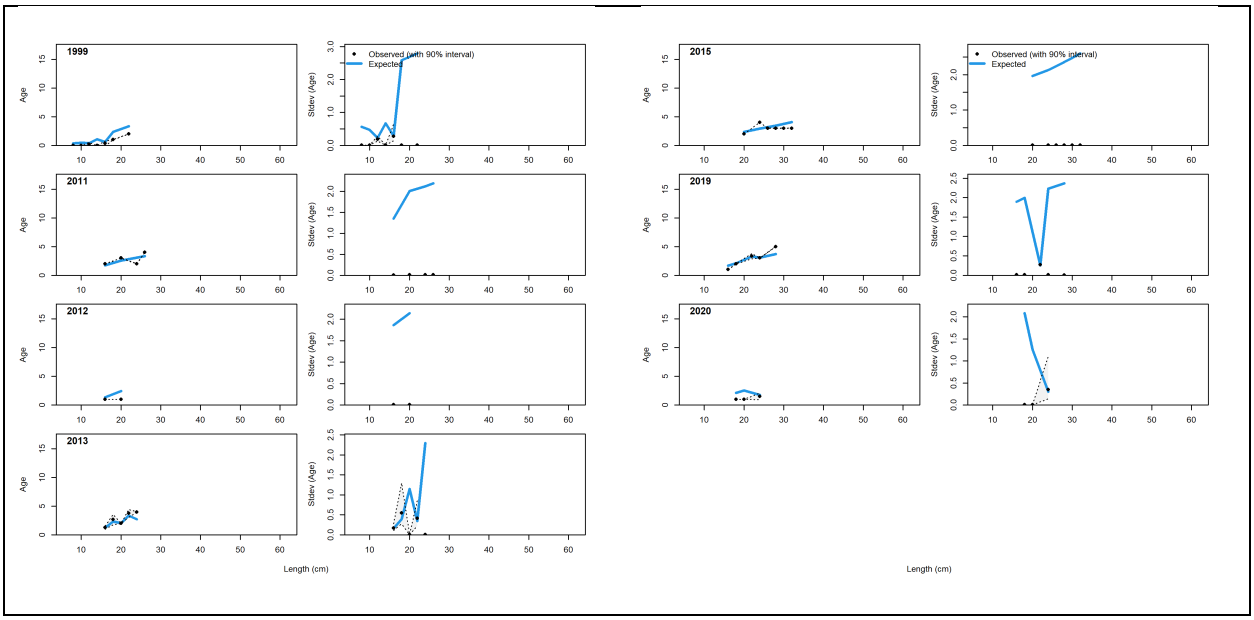
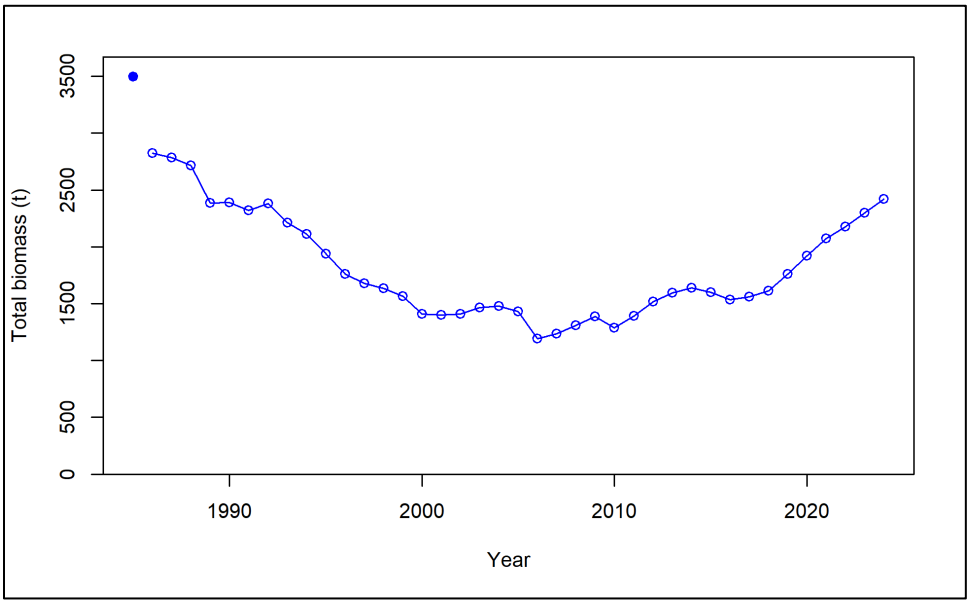


Figure 28. Model fits to the annual conditional age-at-length data from fishery-independent trawl data sources for Florida Keys/East Florida Hogfish. In the left plots, the blue lines represent predicted mean age-at-length by size class while the black dots and grey shaded regions represent the observed mean age-at-length by size class with 90% confidence intervals. In the right plots, the blue lines represent predicted standard error of mean age-at-length by size class while the black dots and grey shaded regions represent the observed standard error of mean age-at-length by size class with 90% confidence intervals.

a)



b)

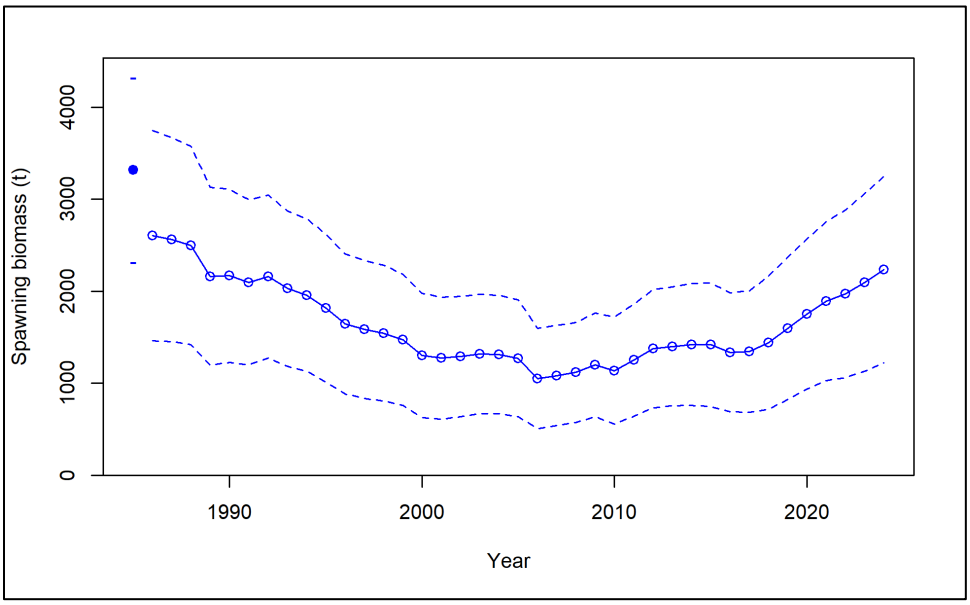
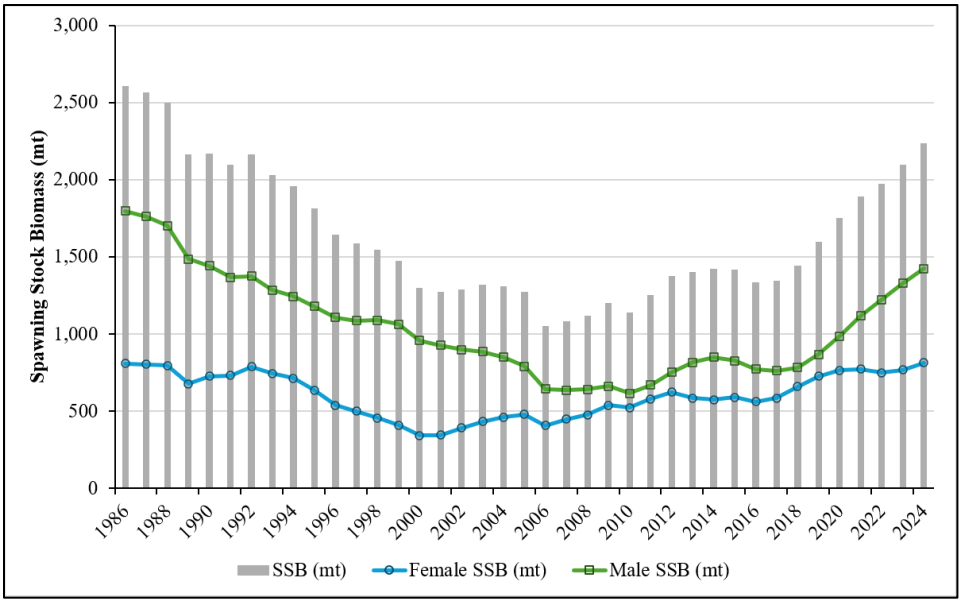


Figure 29. Estimates of a) total biomass and b) mature female and male spawning stock biomass (in metric tons) of Florida Keys/East Florida Hogfish (open circles) from 1986 – 2024. The solid blue circles are the estimated unfished biomasses.

a)



b)

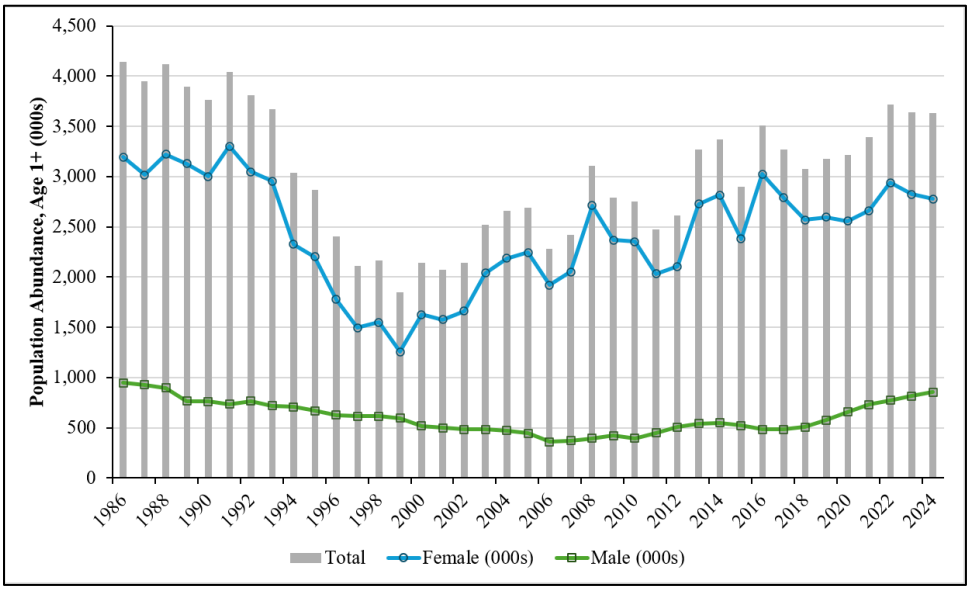


Figure 30. Estimates of a) mature female and male spawning stock biomass (in metric tons), and b) population abundance for age 1+ fish (in thousands), separated by sex (female = blue circles, male = green squares, combined = grey bars) for Florida Keys/East Florida Hogfish from 1986 – 2024.

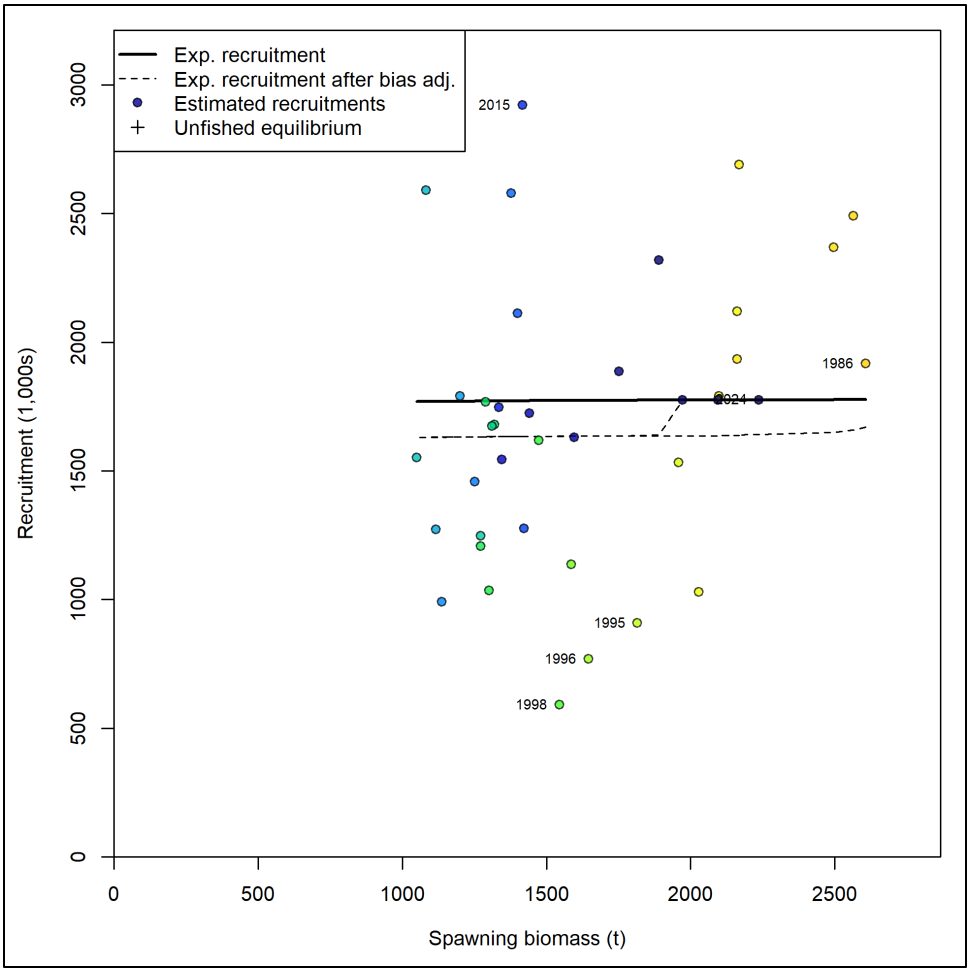


Figure 31. Expected stock-recruitment relationship for Florida Keys/East Florida Hogfish. Steepness was fixed at 0.99 and sigmaR was estimated at 0.411. Plotted are expected annual recruitments from the SEDAR 94 KEYS RW base model (circles), expected recruitment from the stock-recruitment relationship (black line), and bias adjusted recruitment from the stock-recruit relationship (dashed line). Point colors indicate year, with warmer colors indicating earlier years and cooler colors showing later years.

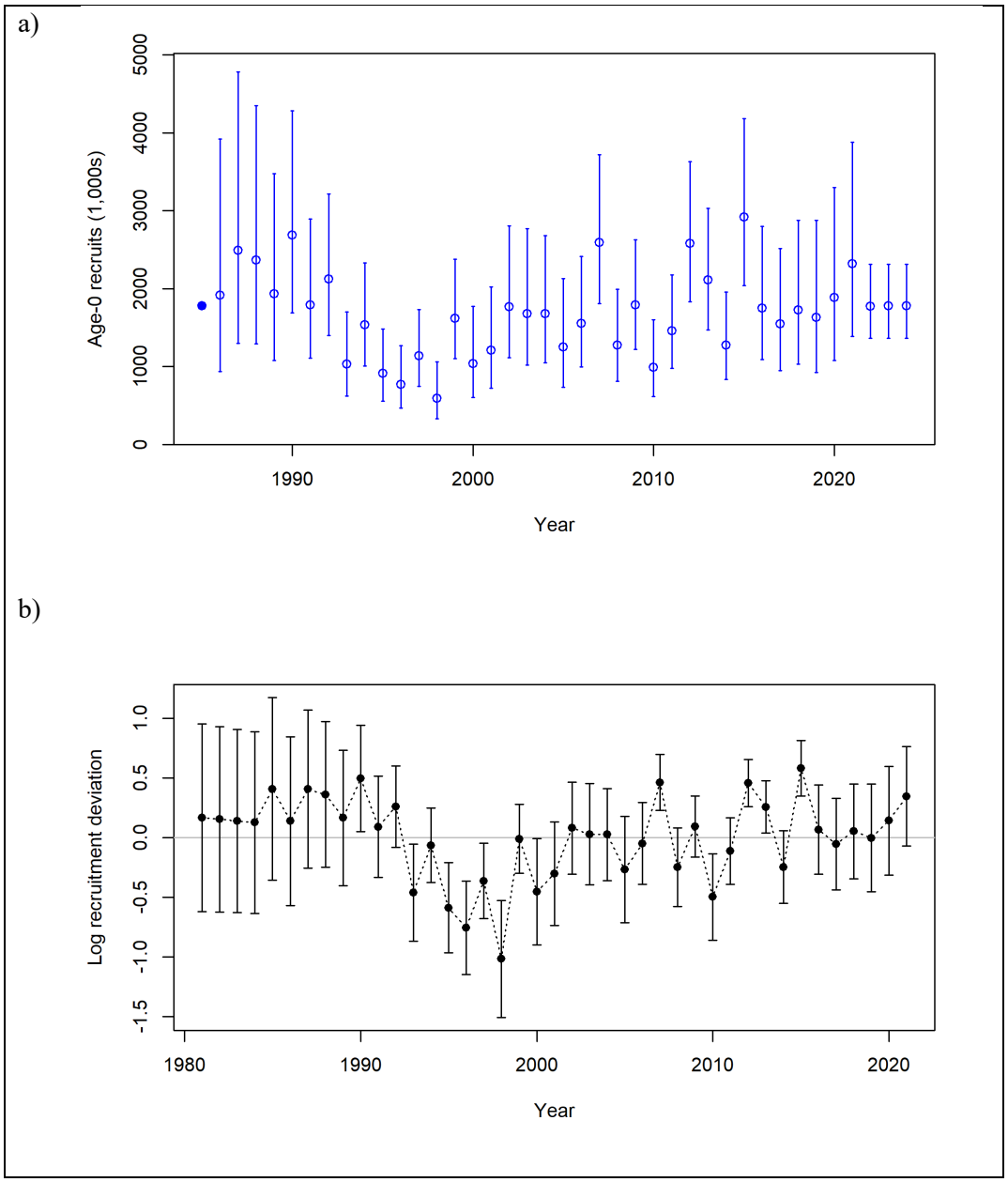


Figure 31. Estimated recruitment for Florida Keys/East Florida Hogfish. a) Annual estimated age-0 recruitment (open circles) with 95% confidence intervals (lines) as well as estimated initial equilibrium recruitment (blue dot). b) Log-scaled main recruitment deviations (dots) with 95% confidence intervals (lines) from 1981 – 2021. Recruitment for years 2022 – 2024 was estimated following the expected stock-recruitment curve (i.e., average recruitment).

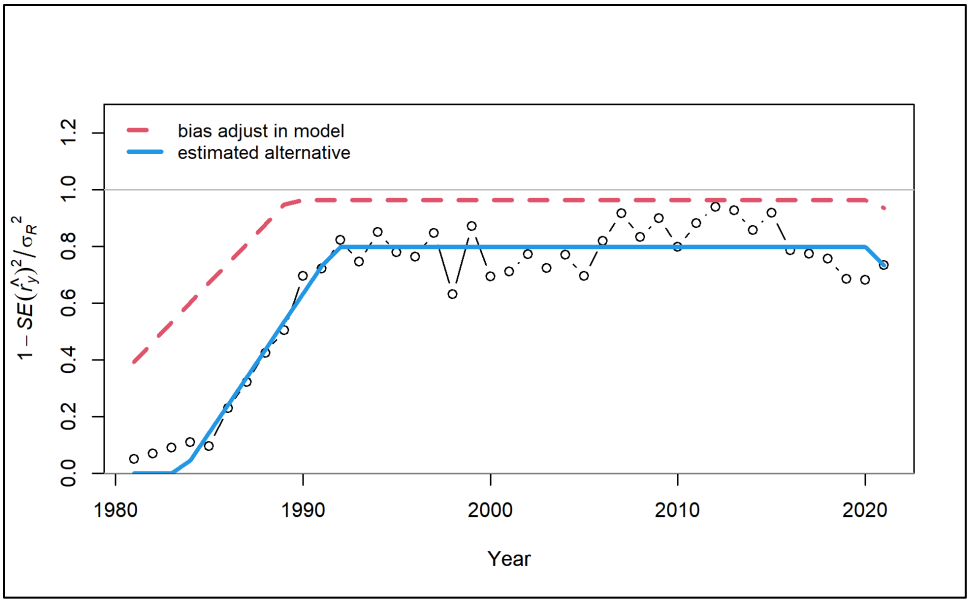


Figure 32. Recommended bias adjustment for recruitment deviations. The red dashed line shows the bias adjustment specified for the SEDAR 94 KEYS RW base model, which deviated from the least squares estimate of an alternative bias adjustment relationship for recruitment deviations (blue line). Points are transformed variances. For more information, see Methot and Taylor (2011).

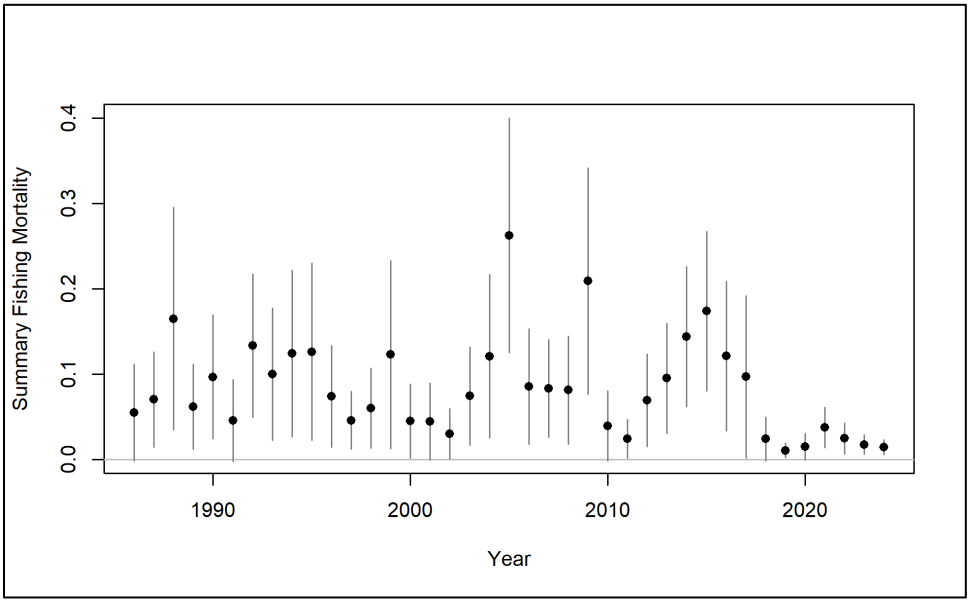


Figure 33. Annual exploitation fishing mortality rates, calculated as the ratio of the total annual catch in biomass to the age 1+ biomass at the beginning of the year, for Florida Keys/East Florida Hogfish with 95% confidence intervals from the SEDAR 94 KEYS RW base model.

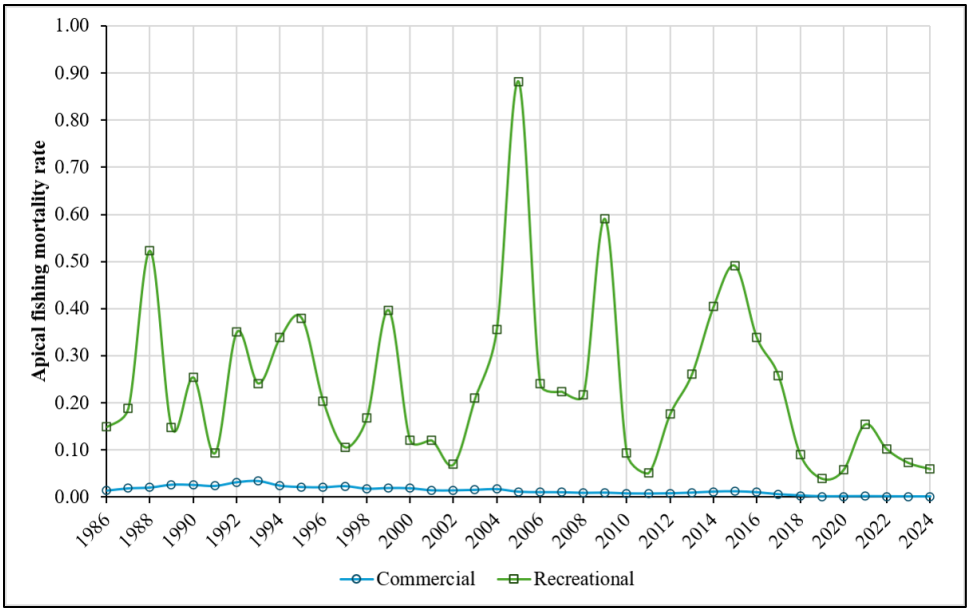


Figure 34. Annual fleet-specific instantaneous apical fishing mortality rates for Florida Keys/East Florida Hogfish for years 1986 – 2024 from the SEDAR 94 KEYS RW base model. This represents the instantaneous fishing mortality level on the most vulnerable (i.e., selectivity = 1) age class for each fleet.

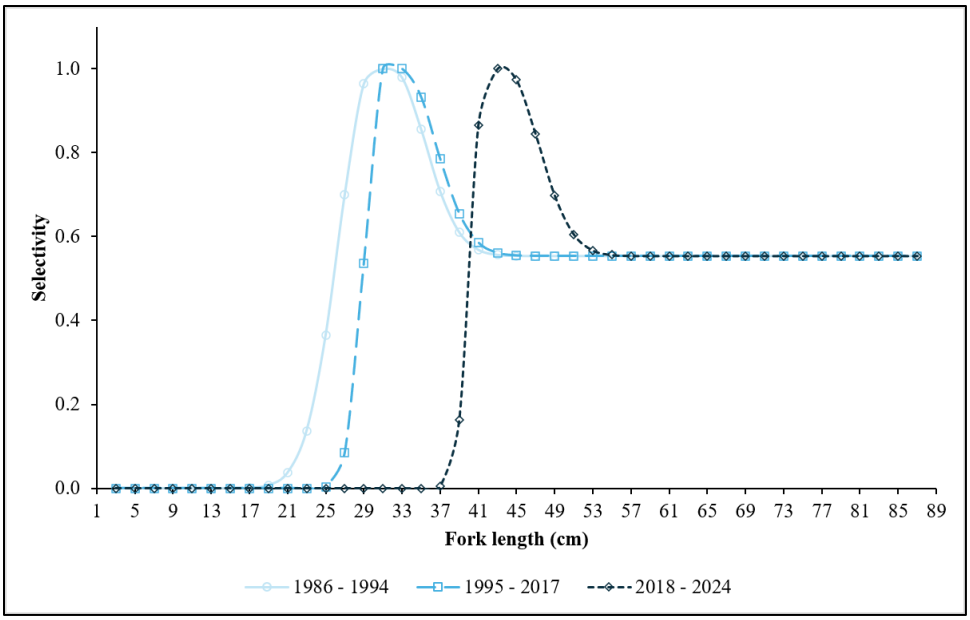


Figure 35. Length-based selectivity of the commercial fleet by time block for Florida Keys/East Florida Hogfish from the SEDAR 94 KEYS RW base model.

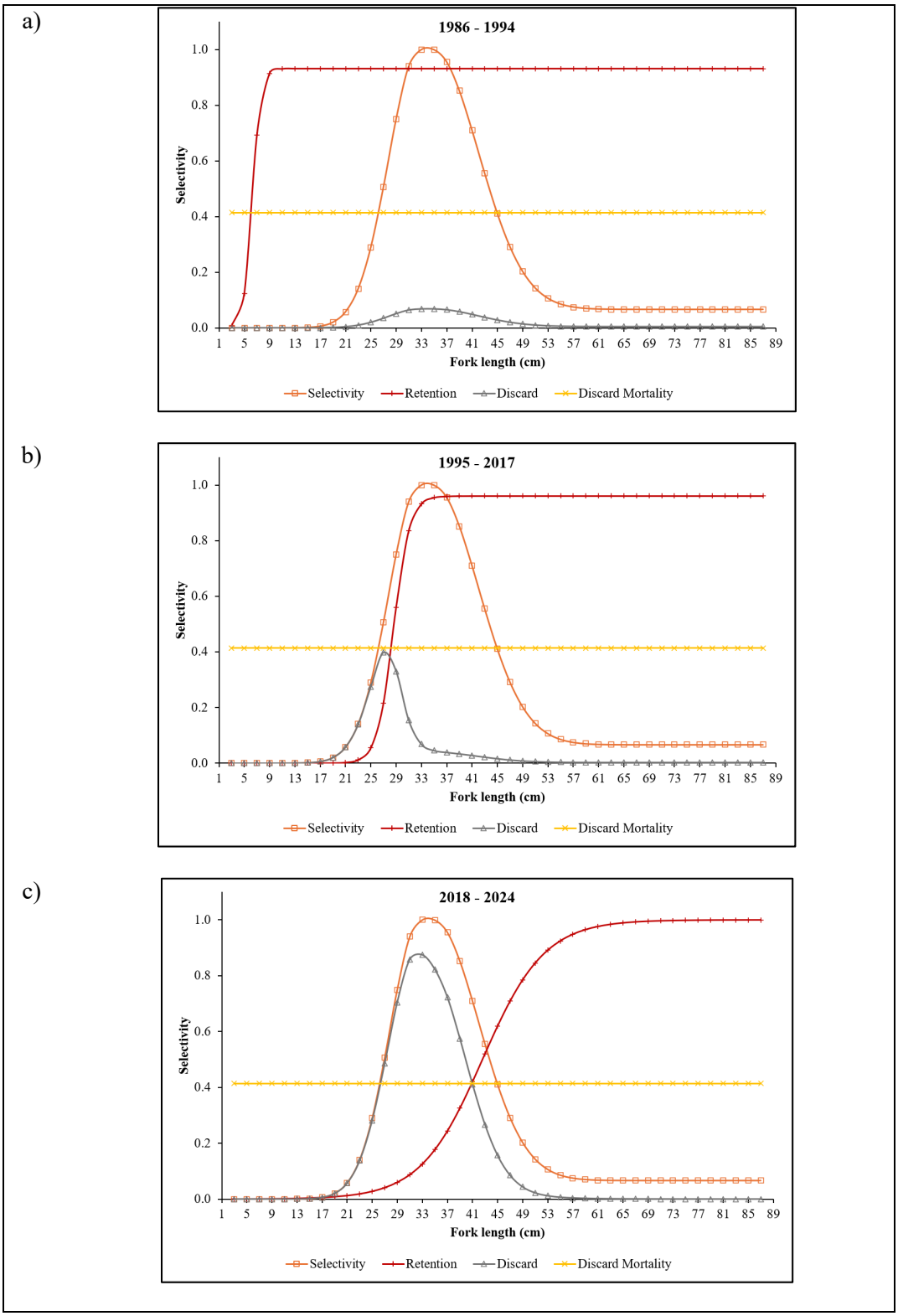


Figure 36. Length-based selectivity, retention, discard, and discard mortality (41.4%) patterns of the recreational fleet by time block a) 1986 – 1994, b) 1995 – 2017, and c) 2018 – 2024 for Florida Keys/East Florida Hogfish from the SEDAR 94 KEYS RW base model.

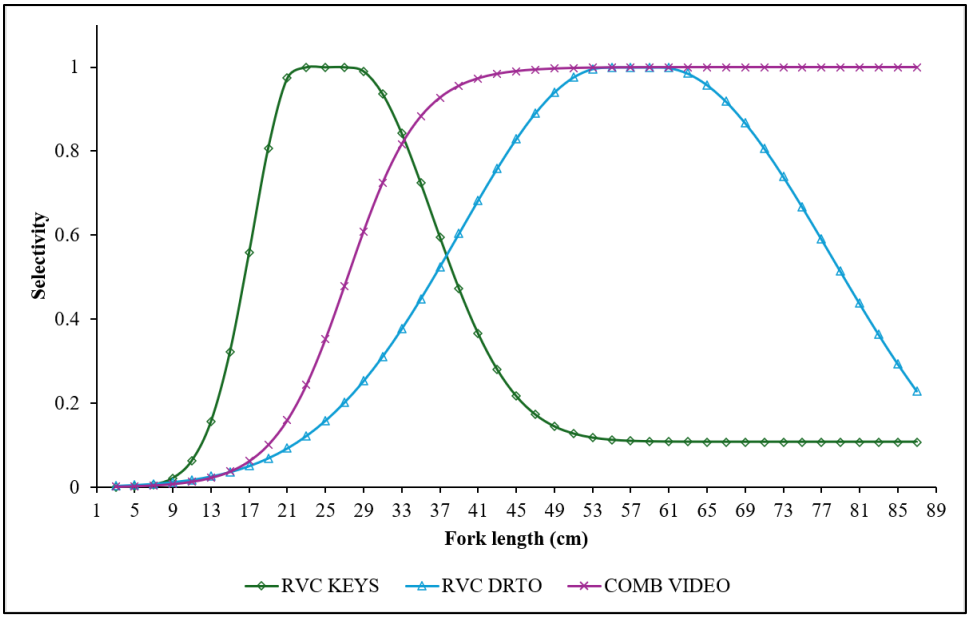


Figure 37. Length-based selectivity of the RVC Florida Keys index (green diamonds), RVC Dry Tortugas index (blue triangles), and combined video index (purple x's) for Florida Keys/East Florida Hogfish from the SEDAR 94 KEYS RW base model.

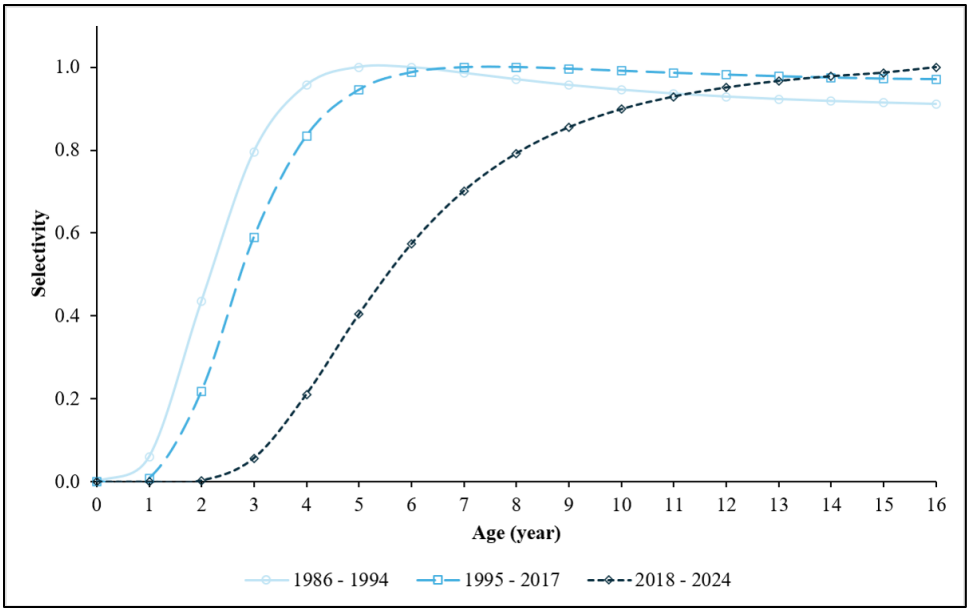


Figure 38. Age-derived selectivity of the commercial fleet by time block for Florida Keys/East Florida Hogfish from the SEDAR 94 KEYS RW base model.

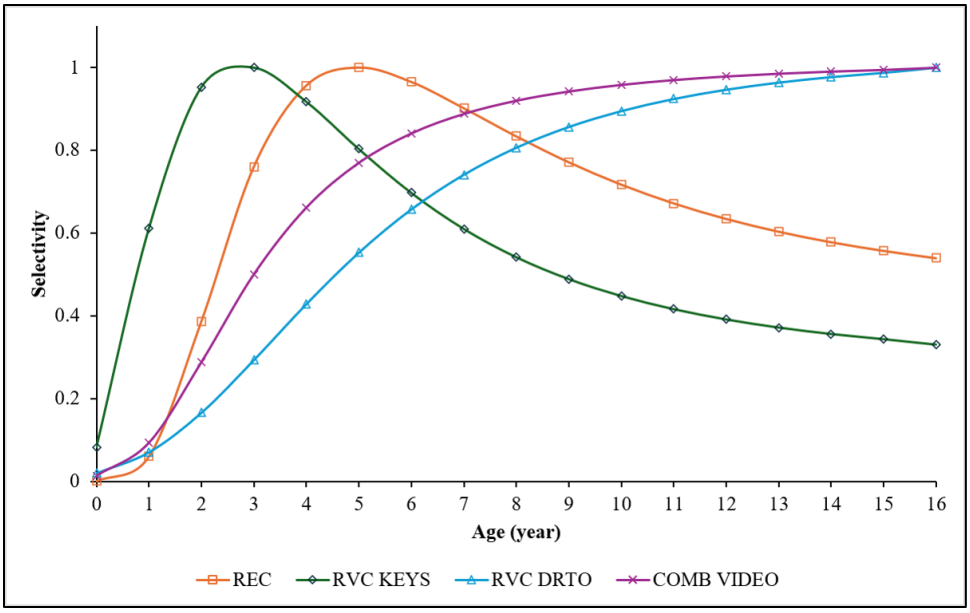


Figure 39. Age-derived selectivity of the recreational fleet (orange square), RVC Florida Keys index (green diamonds), RVC Dry Tortugas index (blue triangles), and combined video index (purple x's) for Florida Keys/East Florida Hogfish from the SEDAR 94 KEYS RW base model.

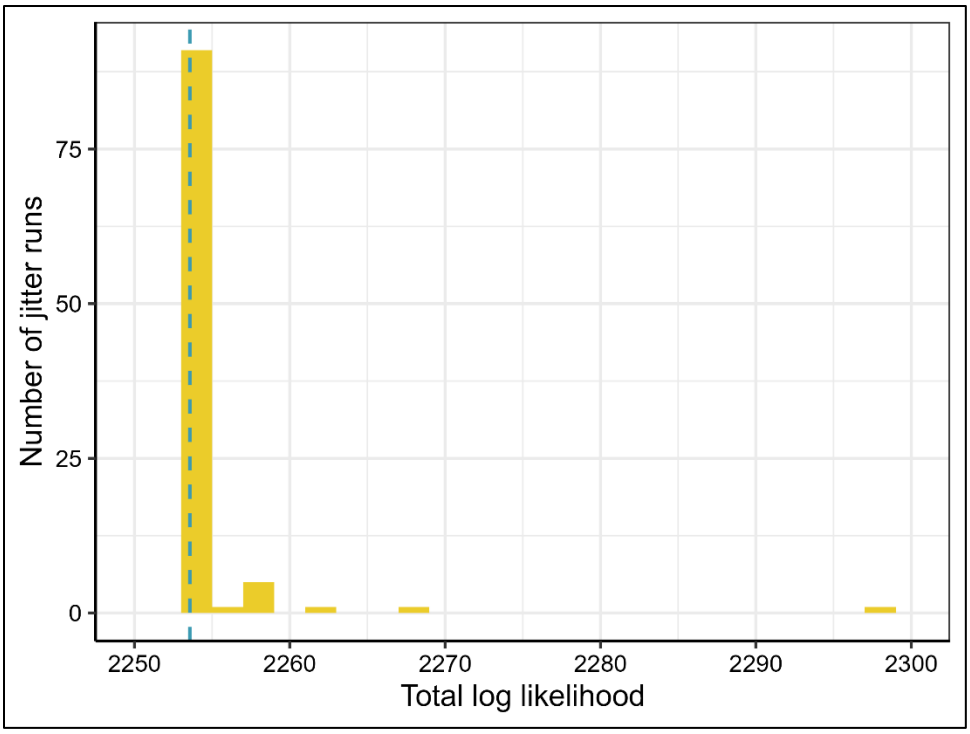


Figure 40. Total log-likelihood values of model runs performed by the jitter analysis (yellow bars) and the SEDAR 94 KEYS RW base model (blue dashed line).

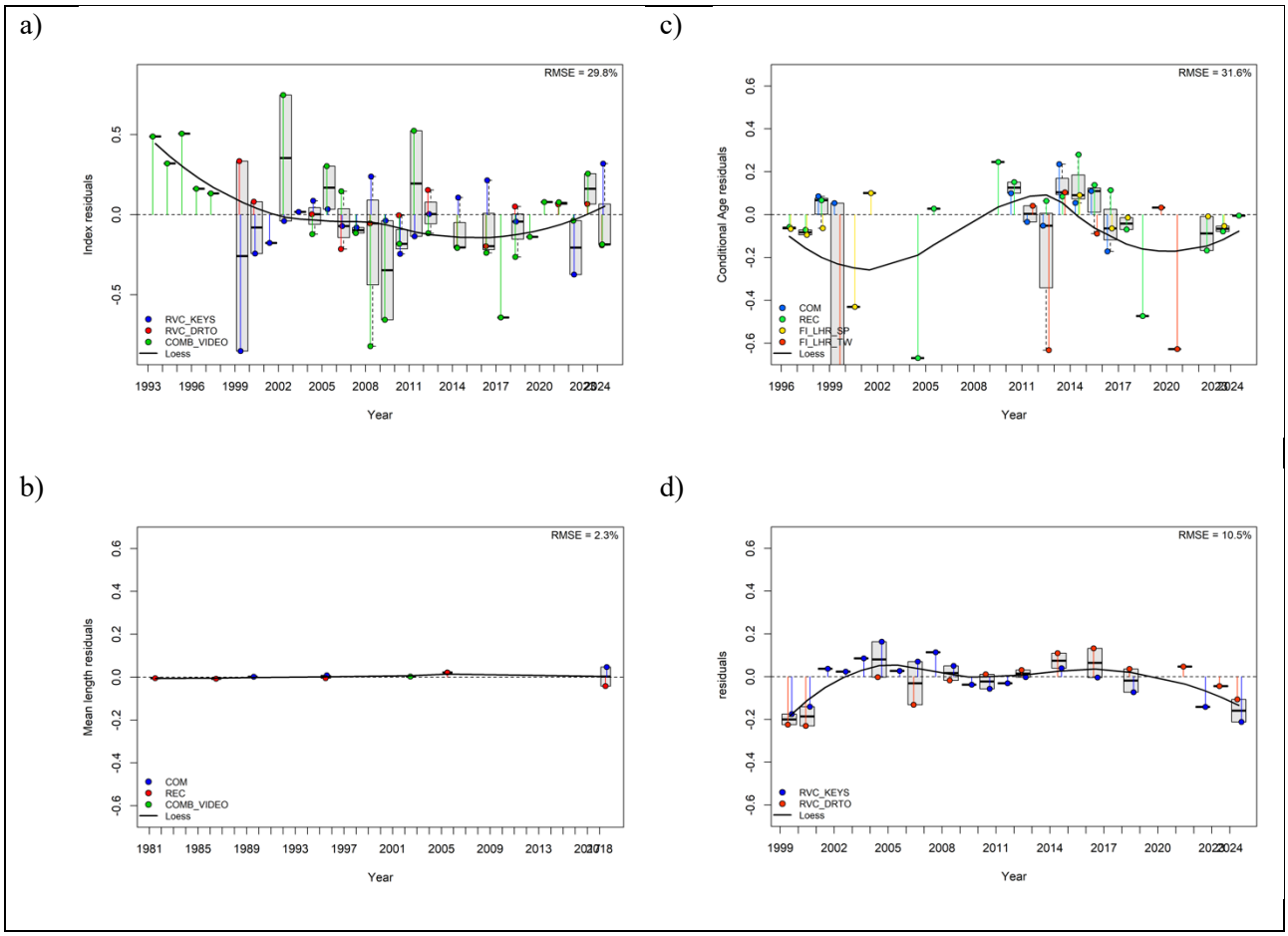


Figure 41. Joint residual plots for a) the indices of abundance, b) the annual mean length estimates, and c) the annual conditional age-at-length estimates, and d) the annual mean general size composition (i.e., RVC lengths) of available fleets and indices from the SEDAR 94 KEYS RW base model. Vertical lines with points show the residuals, boxplots show residual medians and quantiles, and solid black lines are a loess smoother. Root-mean squared errors (RMSE) are included in the upper right-hand corner of each plot.

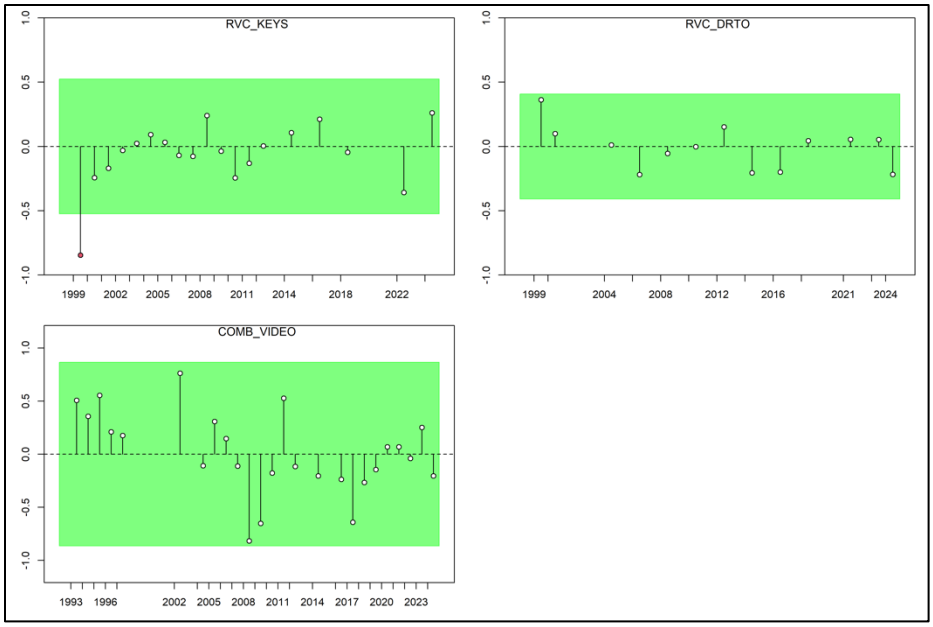


Figure 42. Runs tests results for the indices of abundance from the SEDAR 94 KEYS RW base model. Green shading indicates no evidence ($p \geq 0.05$) and red shading evidence ($p < 0.05$) to reject the hypothesis of a randomly distributed time-series of residuals, respectively. Shaded regions span three residual standard deviations to either side from zero and red points outside of the shading indicate a violation of that 'three-sigma limit'.

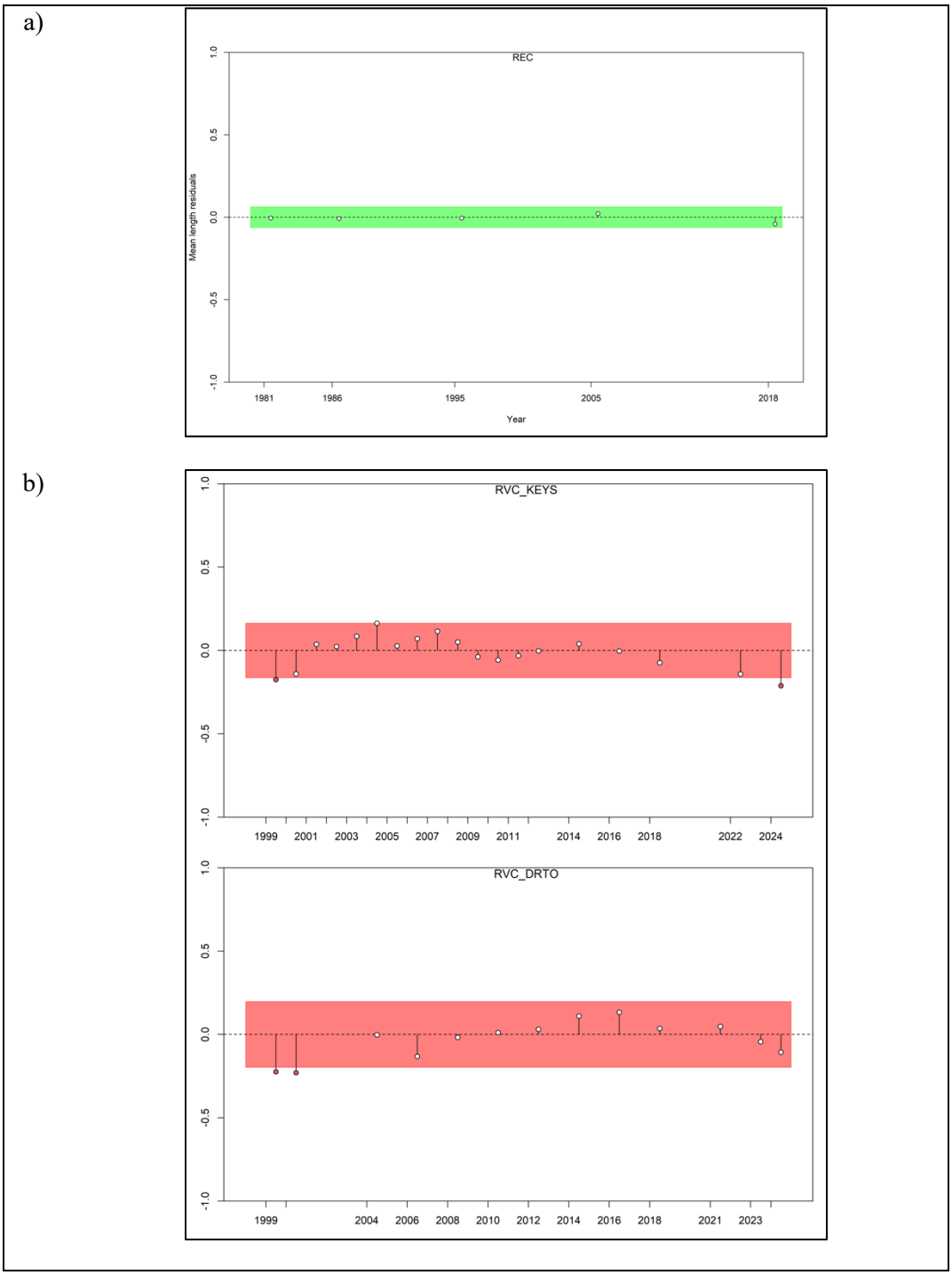


Figure 43. Runs tests results for a) the annual mean length estimates of the recreational fleet and b) the annual mean general size composition (i.e., RVC lengths) from the SEDAR 94 KEYS RW base model. Green shading indicates no evidence ($p \geq 0.05$) and red shading evidence ($p < 0.05$) to reject the hypothesis of a randomly distributed time-series of residuals, respectively. Shaded regions span three residual standard deviations to either side from zero and red points outside of the shading indicate a violation of that 'three-sigma limit'.

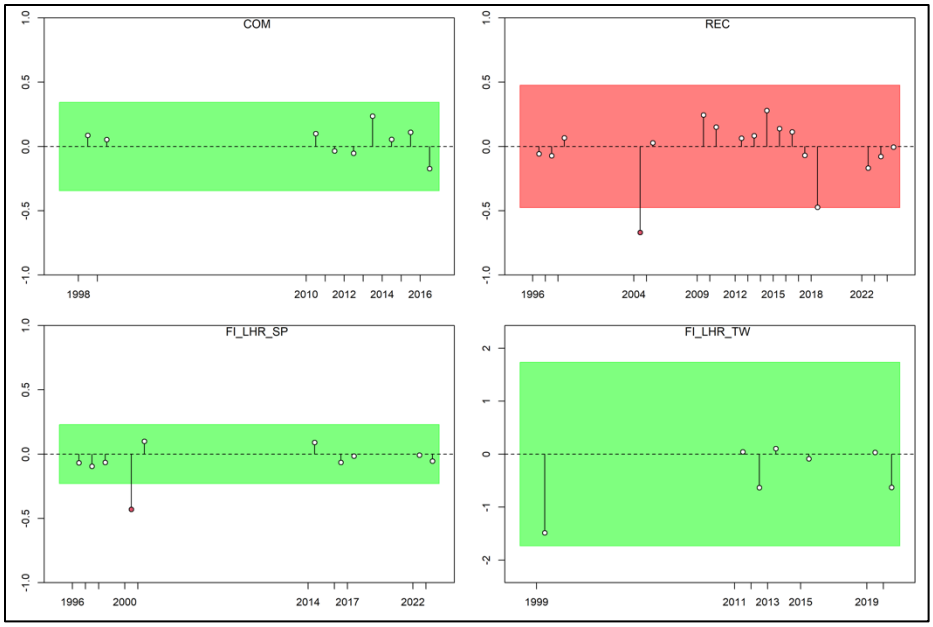
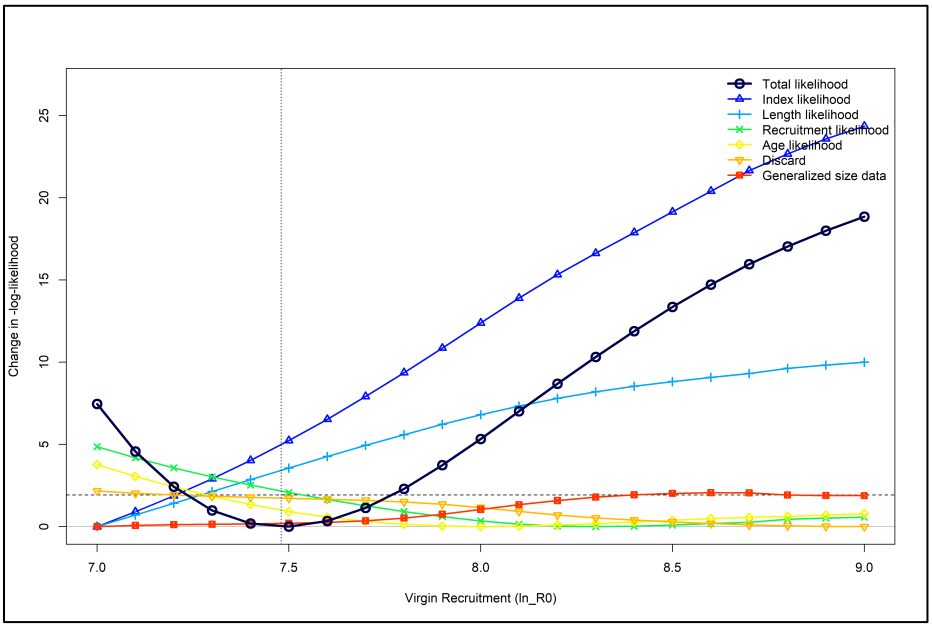


Figure 44. Runs tests results for the conditional age-at-length estimates from the SEDAR 94 KEYS RW base model. Green shading indicates no evidence ($p \geq 0.05$) and red shading evidence ($p < 0.05$) to reject the hypothesis of a randomly distributed time-series of residuals, respectively. Shaded regions span three residual standard deviations to either side from zero and red points outside of the shading indicate a violation of that 'three-sigma limit'.

a)



b)

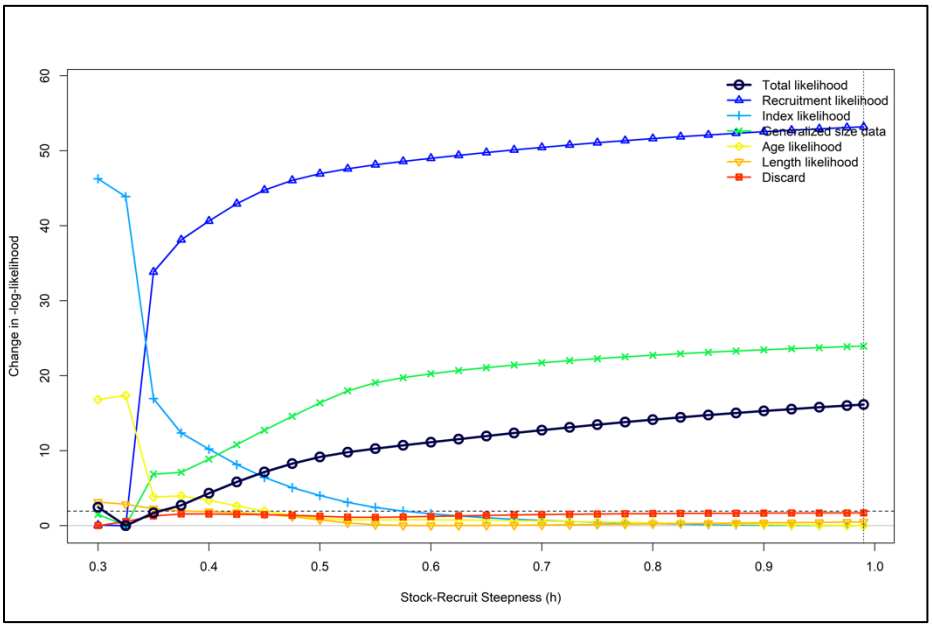


Figure 45. Log-likelihood profiles of a) the unfished (i.e., virgin) recruitment (*ln(R0)*) parameter, and b) the *steepness (h)* parameter for various data components in the SEDAR 94 KEYS RW base model. The horizontal dashed line indicates a 2 unit difference in log-likelihood while the vertical dotted line is the estimate from the SEDAR 94 KEYS RW base model.

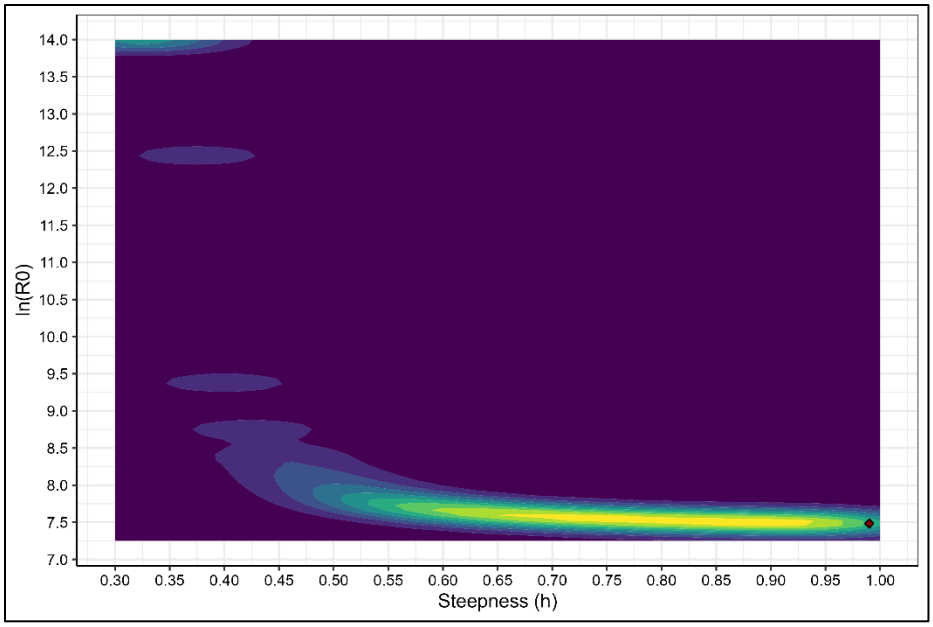


Figure 46. Contour plot showing corresponding estimates of the unfished (i.e., virgin) recruitment (*ln(R0)*) parameter to the profiled *steepness (h)* parameter from the SEDAR 94 KEYS RW base model. The *steepness (h)* parameter was profiled (i.e., fixed) on values from 0.3 – 0.99; the *ln(R0)* parameter was estimated during each profile iteration but bound between values from 6 – 14. The red diamond is the value used in the KEYS RW base model.

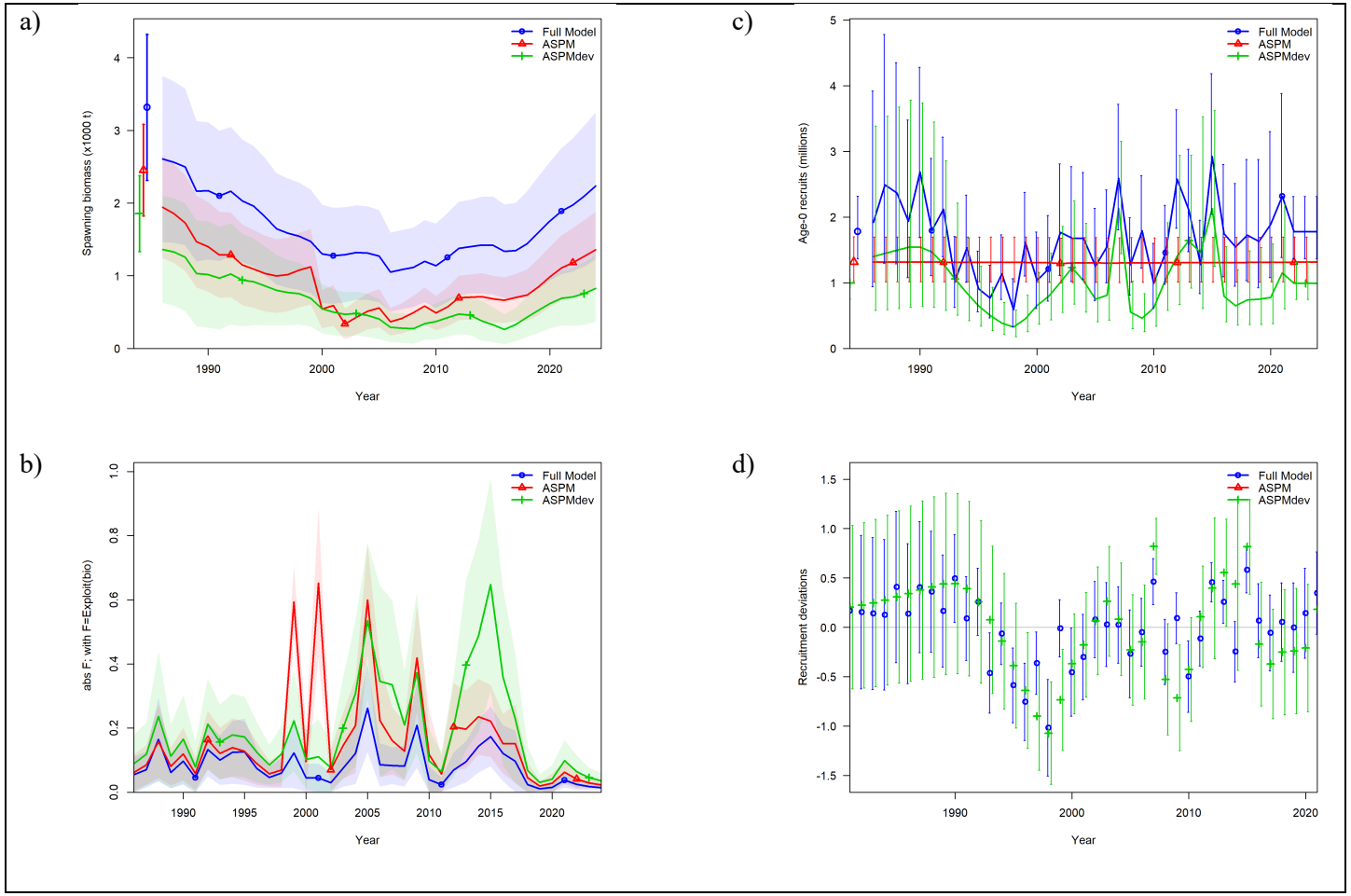


Figure 47. Results comparison between the SEDAR 94 KEYS RW base model (Full Model), the deterministic Age-Structured-Production Model (ASPM), and the ASPM with recruitment deviations (ASPMdev) showing a) spawning stock biomass, b) exploitation rates, c) estimates of age-0 recruitment, and d) estimates of recruitment deviations.

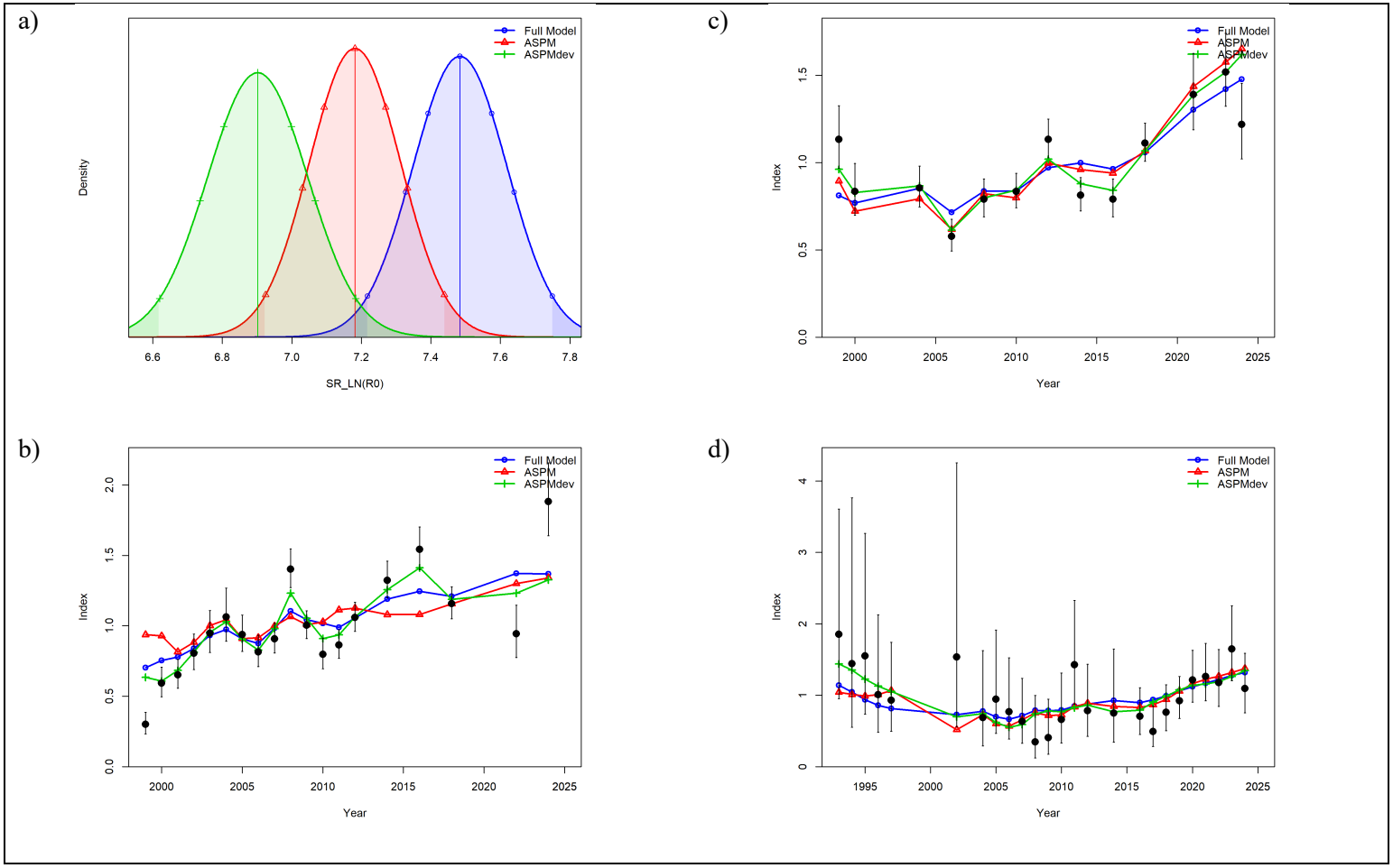


Figure 48. Results comparison between the SEDAR 94 KEYS RW base model (Full Model), the deterministic Age-Structured-Production Model (ASPM), and the ASPM with recruitment deviations (ASPMdev) showing a) estimates of the virgin recruitment parameter in log-space *ln(R0)*, b) observed and predicted values for the RVC Florida Keys index, c) observed and predicted values for the RVC Dry Tortugas index., and d) observed and predicted values for the combined video index.

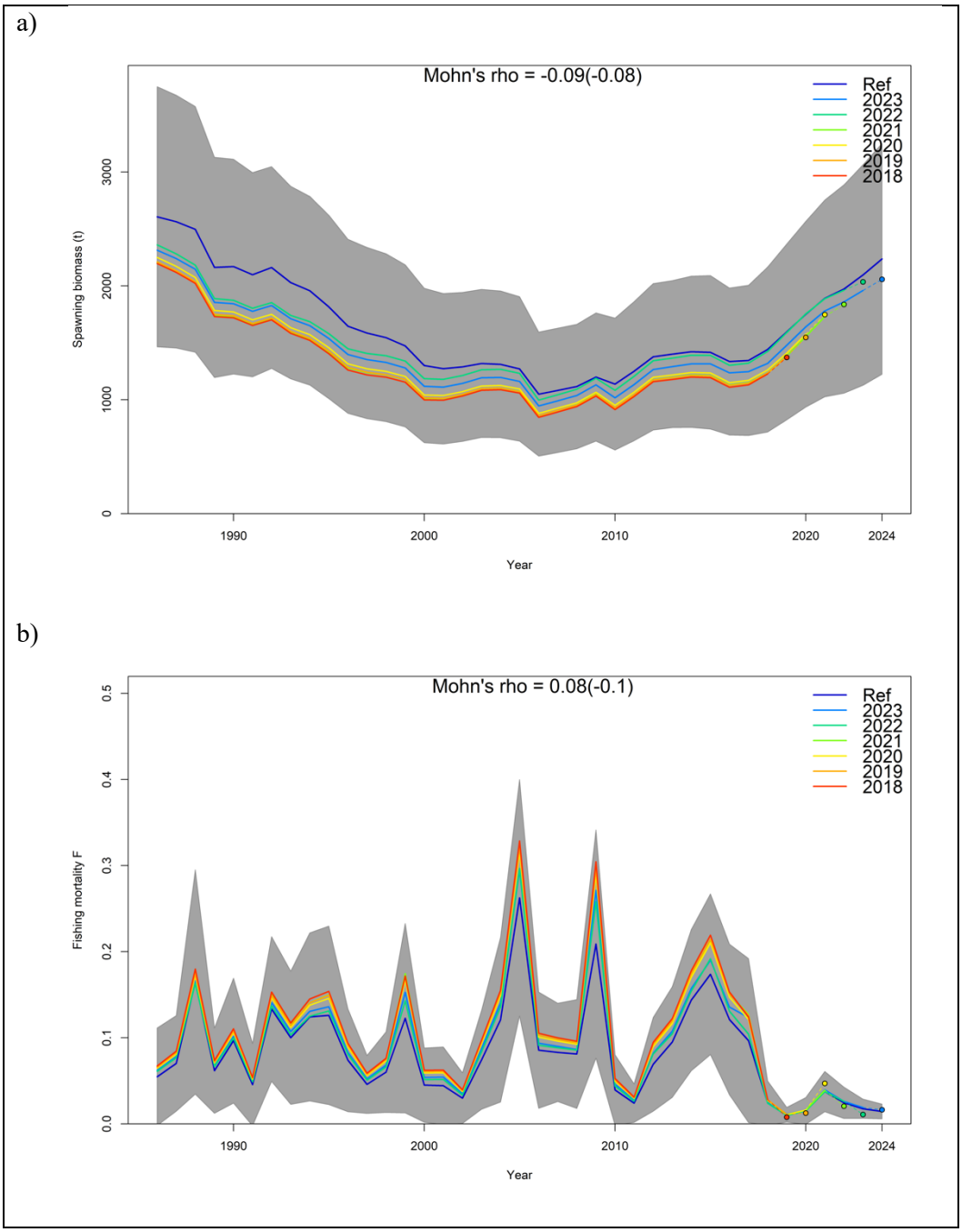


Figure 49. Retrospective forecast results of a) spawning stock biomass and b) exploitation rates conducted by re-fitting the SEDAR 94 KEYS RW base model (Ref) after sequentially removing seven years of observations. The Mohn's rho (ρ_M) statistic and corresponding forecast rho (ρ_F) values (in parenthesis) are provided at the top of each panel. One-year-ahead projections denoted by color-coded dashed lines with terminal points are shown for each peel. Grey shaded areas are the 95 % confidence intervals from the SEDAR 94 KEYS RW base model.

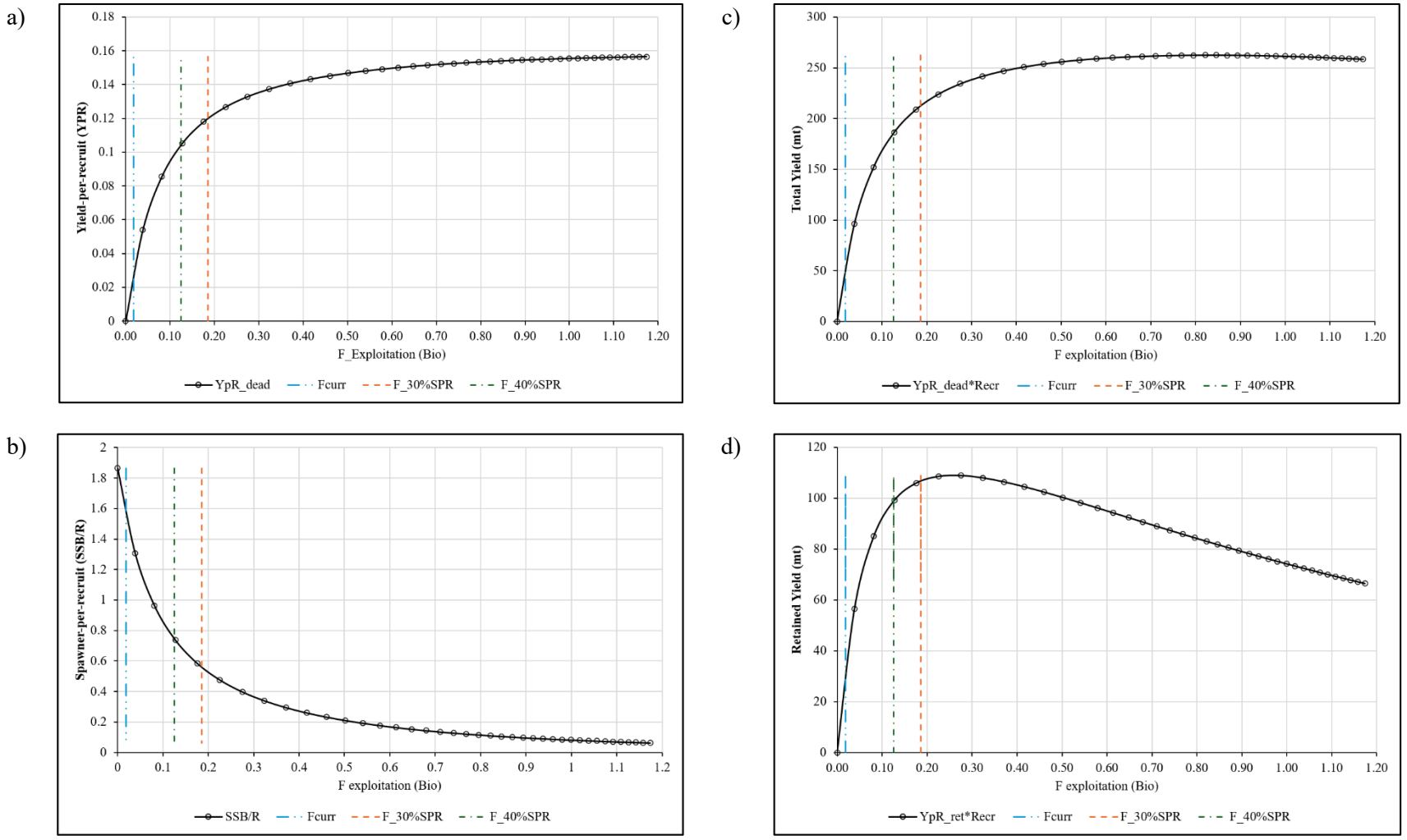


Figure 50. The a) yield-per-recruit, b) spawner-per-recruit, c) total equilibrium yield, and d) retained equilibrium yield computed as a function of the instantaneous exploitation rate on Florida Keys/East Florida Hogfish from the SEDAR 94 KEYS RW base model.

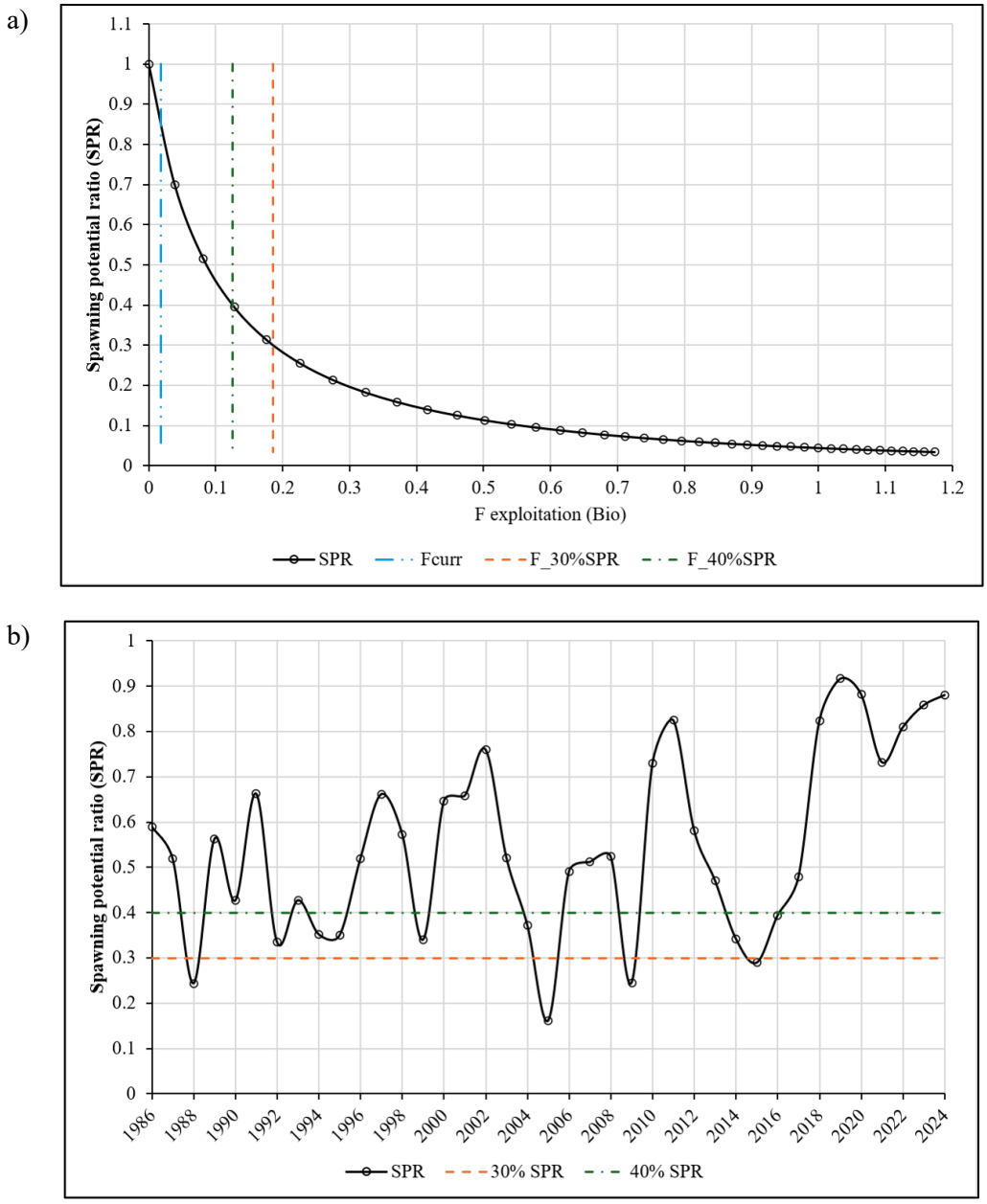


Figure 51. The a) static spawning potential ratio (SPR) computed as a function of the instantaneous exploitation rate, and b) static spawning potential ratio (SPR) by year for Florida Keys/East Florida Hogfish from the SEDAR 94 KEYS RW base model.

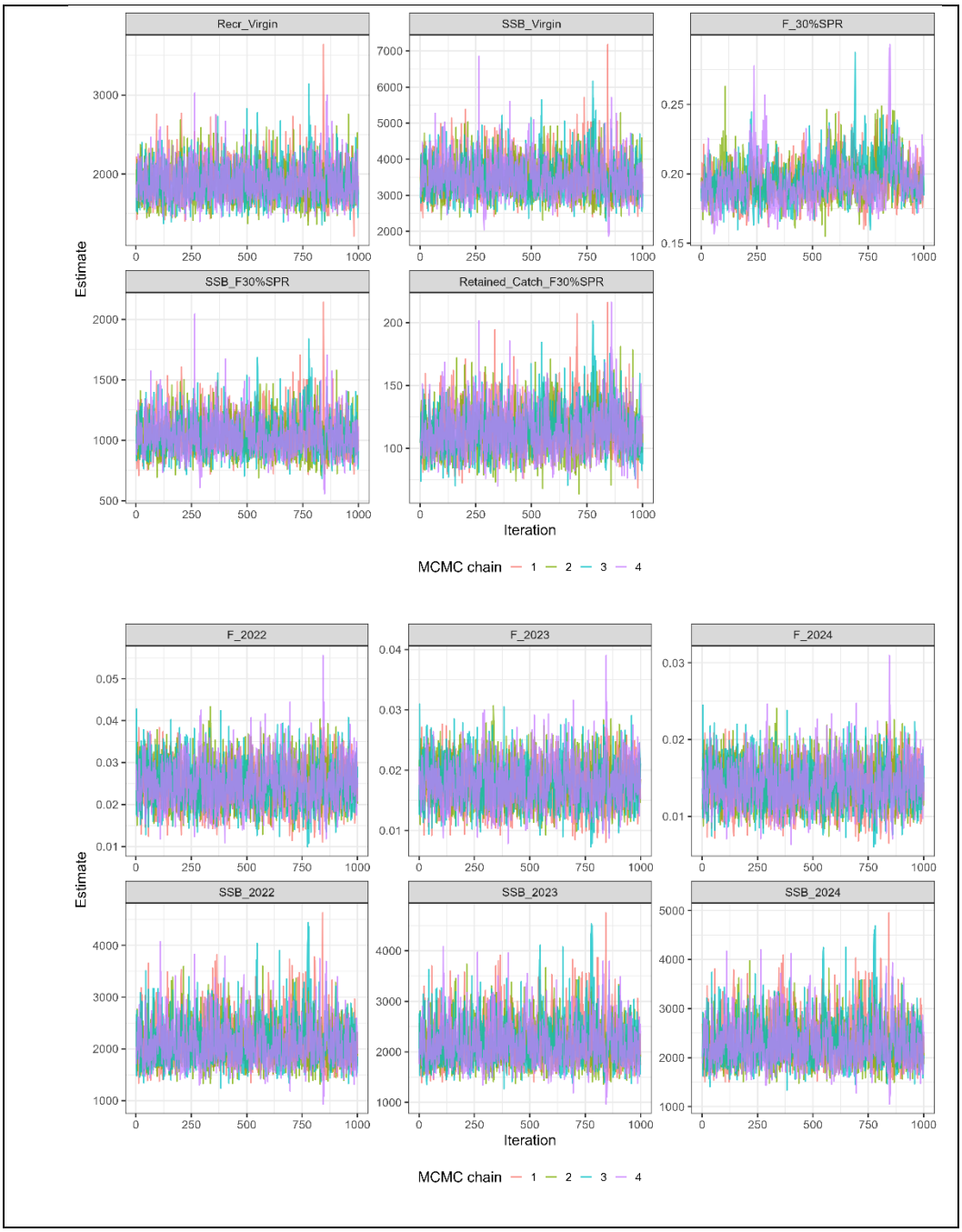


Figure 52. Combined trace plots of the four MCMC chains for selected parameters and derived quantities from the MCMC 'proxy' model based on the SEDAR 94 KEYS RW base model.

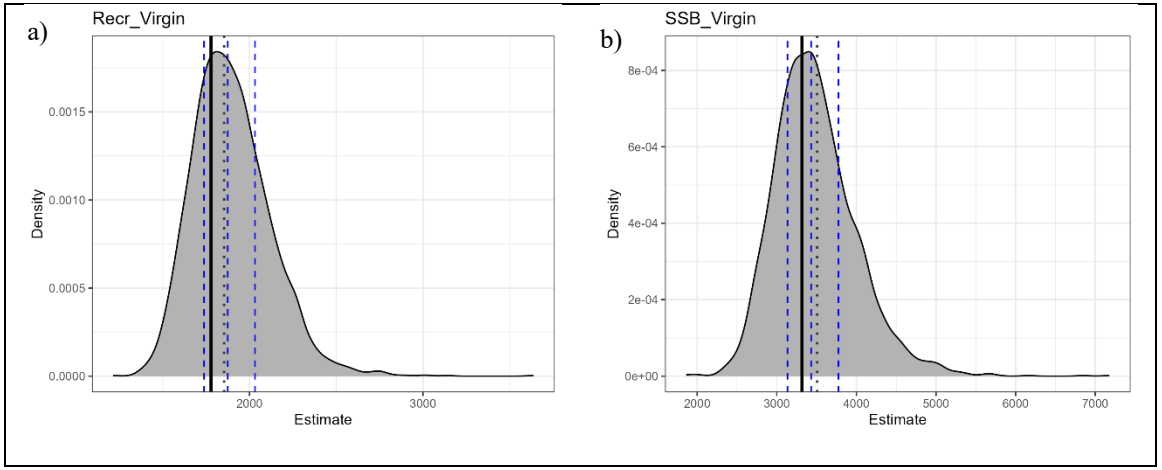


Figure 53. The posterior distributions for a) R_0 (i.e., virgin recruitment), and b) SSB_0 (i.e., virgin spawning stock biomass) from the combined four-chain MCMC of the MCMC 'proxy' model based on the SEDAR 94 KEYS RW base model. The blue dashed lines indicate the median and interquartile range, the black dotted line is the estimate from the MCMC 'proxy' model, and the solid black line is the estimate from the SEDAR 94 KEYS RW base model.

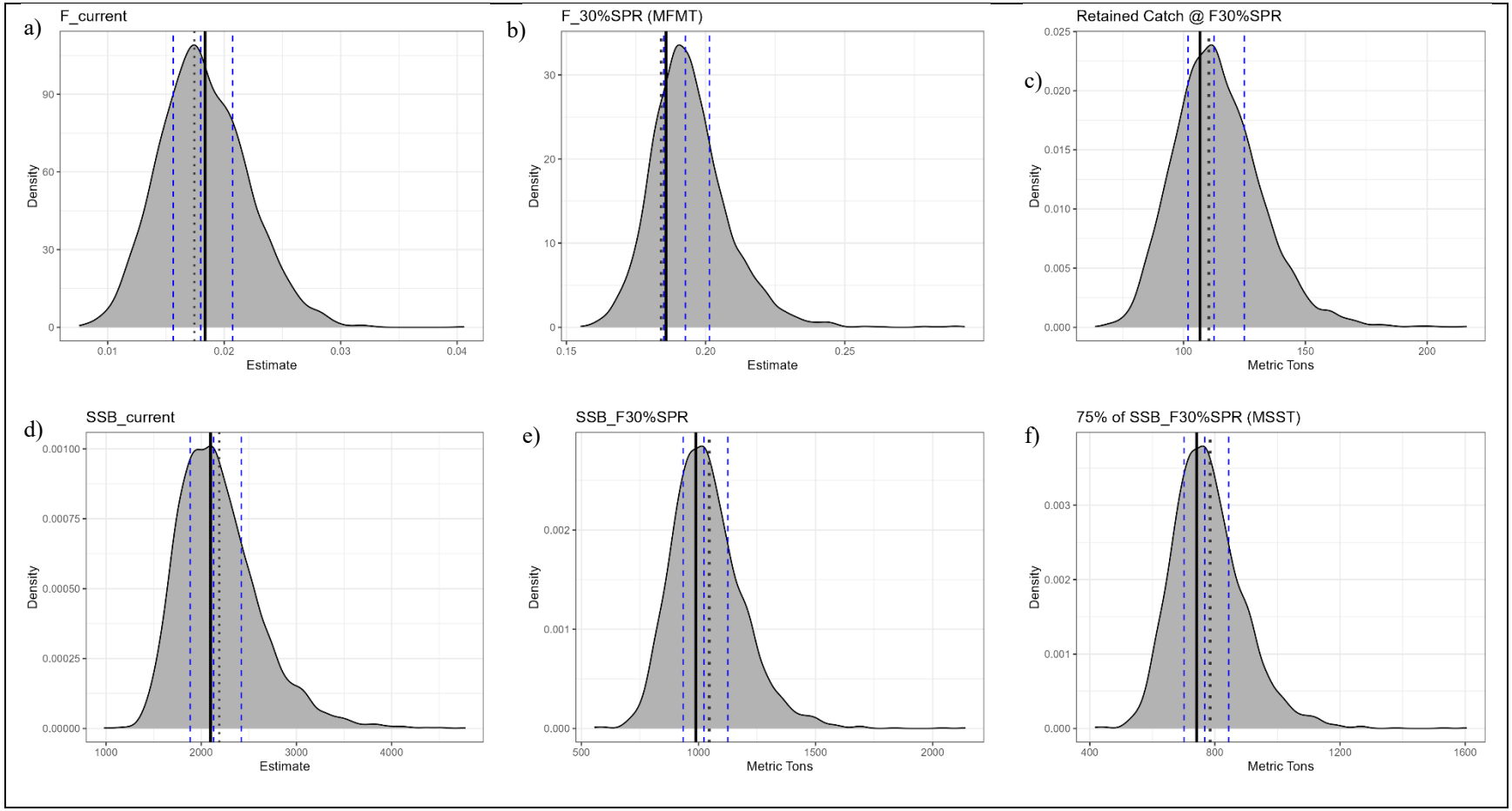


Figure 54. The posterior distributions for a) $F_{current}$ (i.e., geometric mean of F for years 2022 – 2024), b) $F_{30\%SPR}$ (i.e., MFMT), and c) the retained yield associated with $F_{30\%SPR}$, d) $SSB_{current}$ (i.e., geometric mean of SSB for years 2022 – 2024), e) SSB at $F_{30\%SPR}$, and f) 75% of SSB at $F_{30\%SPR}$ (i.e., MSST) from the combined four-chain MCMC of the MCMC 'proxy' model based on the SEDAR 94 KEYS RW base model. The blue dashed lines indicate the median and interquartile range, the black dotted line is the estimate from the MCMC 'proxy' model, and the solid black line is the estimate from the SEDAR 94 KEYS RW base model.

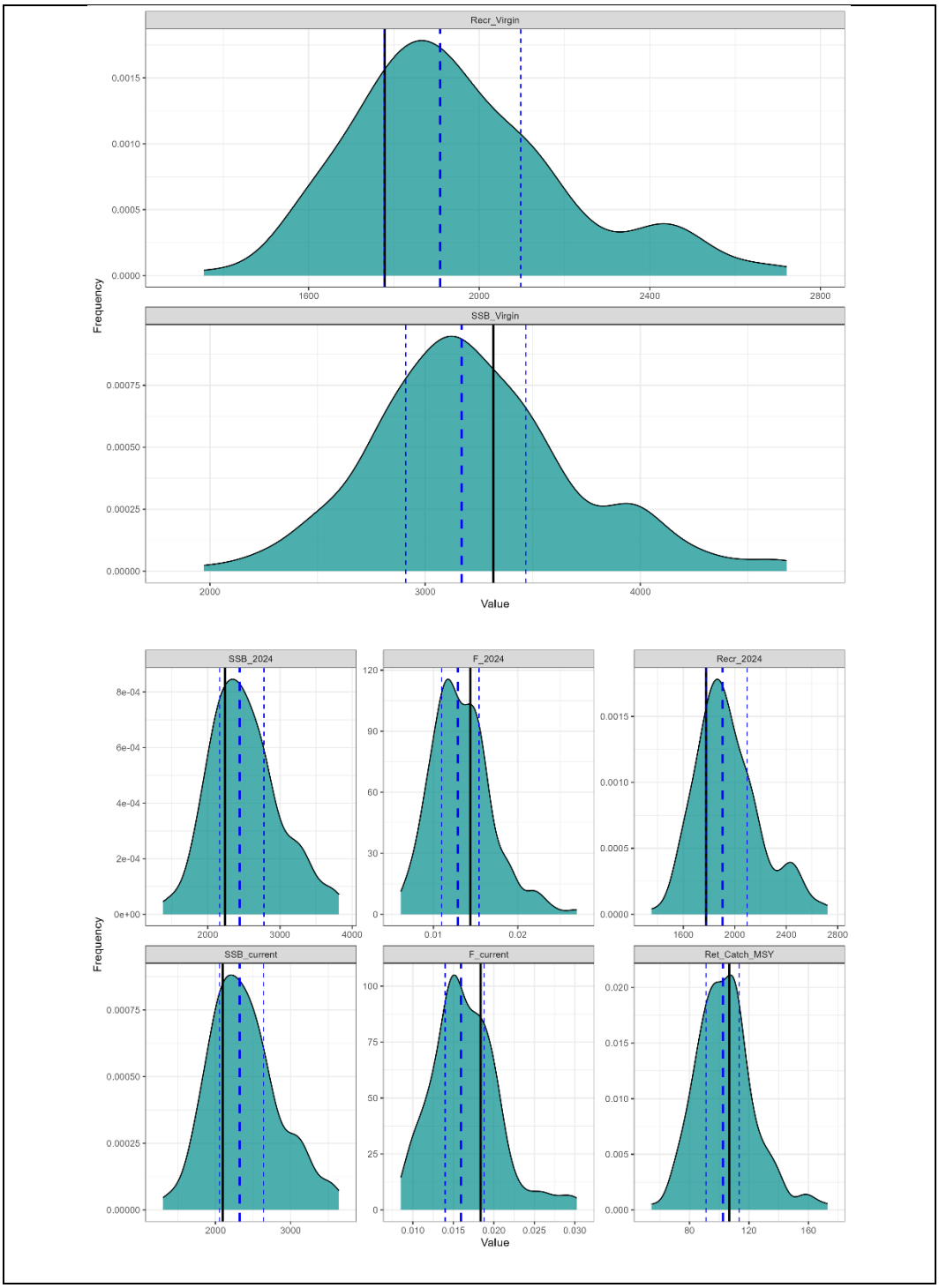


Figure 55. Distributions of selected parameter estimates and derived quantities from the parametric bootstrapping analysis. The blue dashed lines indicate the median and interquartile range and the solid black line is the estimate from the SEDAR 94 KEYS base model.

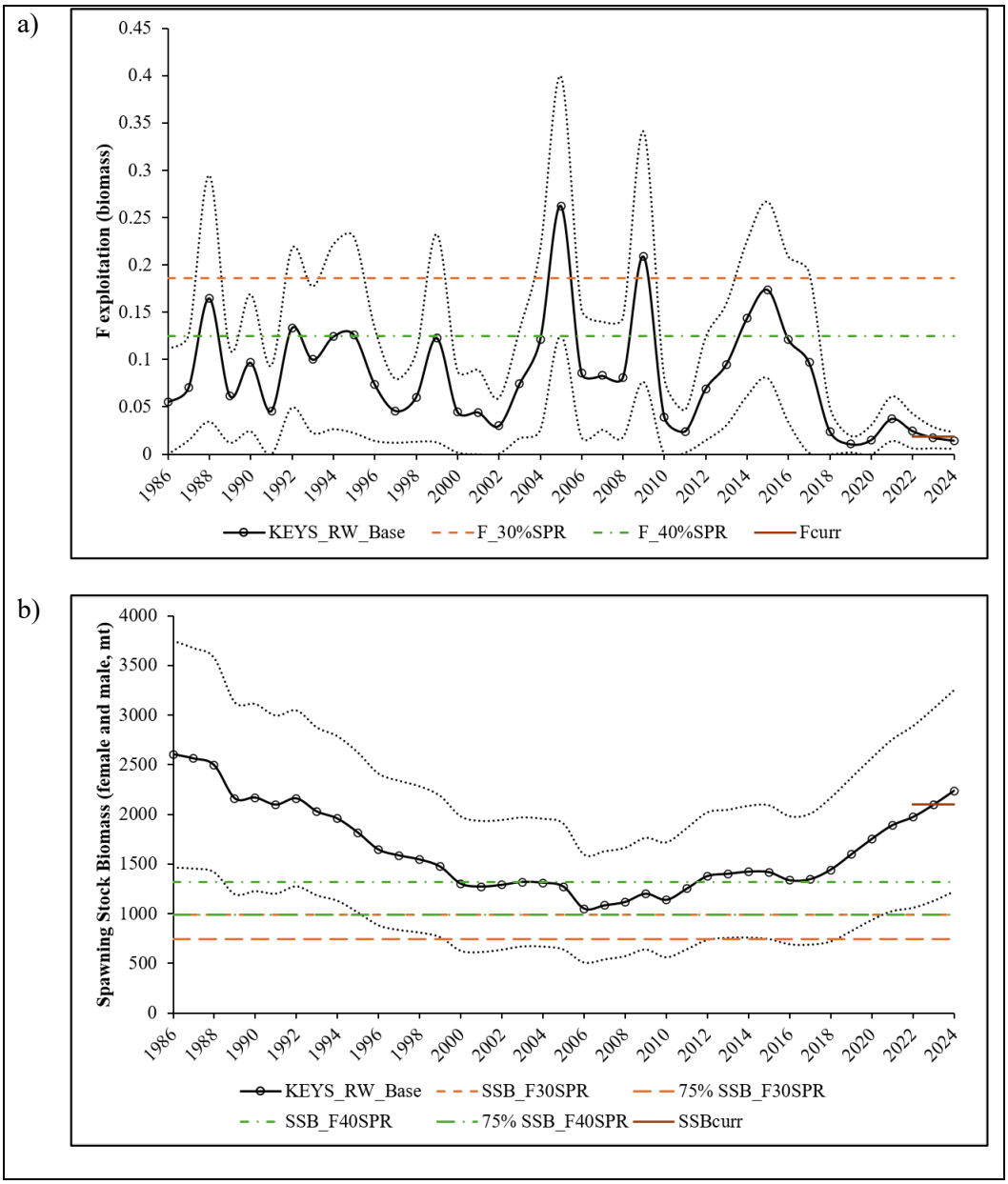


Figure 56. Annual estimates of a) exploitation relative to $F_{30\%SPR}$, $F_{40\%SPR}$, and the geometric mean of exploitation in the last three years ($F_{current}$), and b) spawning stock biomass (SSB) relative to 75% $SSB_{F30\%SPR}$, $SSB_{F40\%SPR}$, and the geometric mean of SSB in the last three years ($SSB_{current}$) by the SEDAR 94 KEYS RW base model. Dotted lines represent 95% confidence intervals.

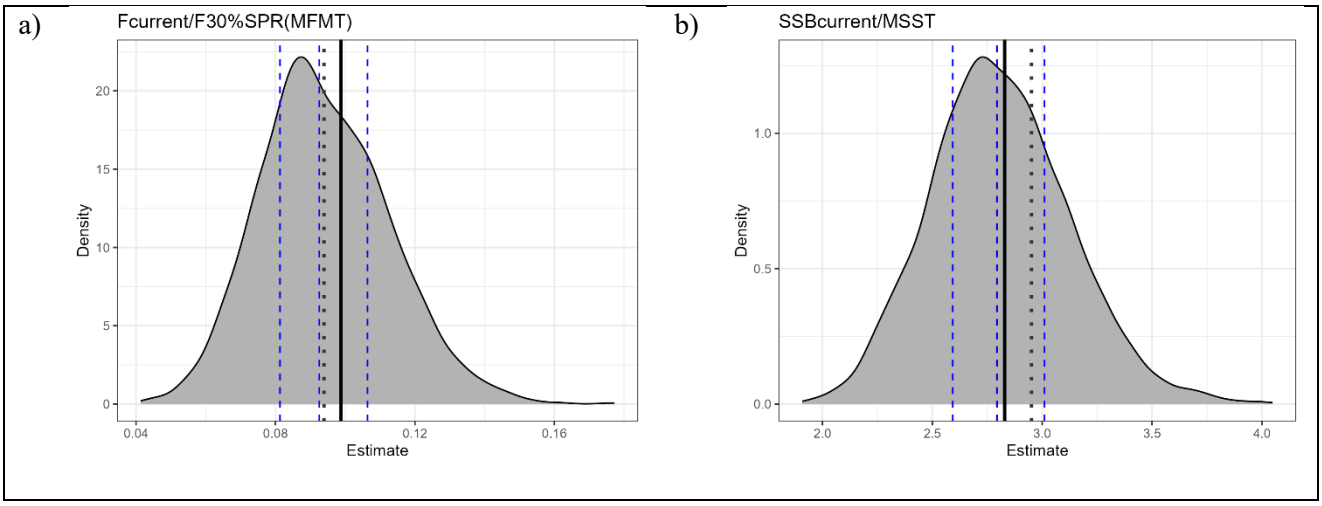


Figure 57. The posterior distribution for the F ratio ($F_{current}/F_{30\%SPR}$) and SSB ratio ($SSB_{current}$/MSST) values from the combined four-chain MCMC of the MCMC 'proxy' model based on the SEDAR 94 KEYS RW base model. The blue dashed lines indicate the median and interquartile range, the black dotted line is the estimate from the MCMC 'proxy' model, and the solid black line is the estimate from the SEDAR 94 KEYS RW base model.

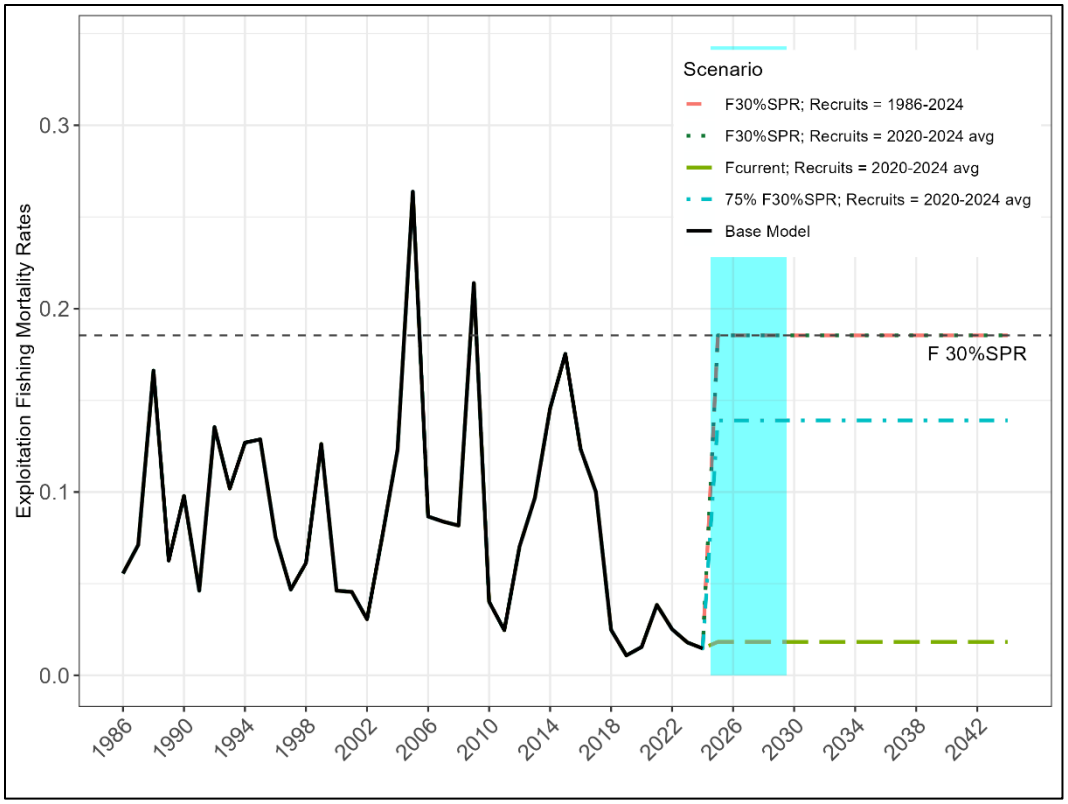


Figure 58. Projected exploitation rates under various constant F scenarios as estimated by the SEDAR 94 KEYS RW base model (black solid line). Long-term equilibrium $F_{30\%SPR}$ used average recruitment from 1986 – 2024 (red dashed line) while short-term $F_{30\%SPR}$ (dark green dotted line), $F_{current}$ (mustard dashed line), and 75% of short-term $F_{30\%SPR}$ (teal dot-dashed line) used average recruitment from 2020 – 2024. The cyan region highlights the first five years of the projection (2025 – 2030).

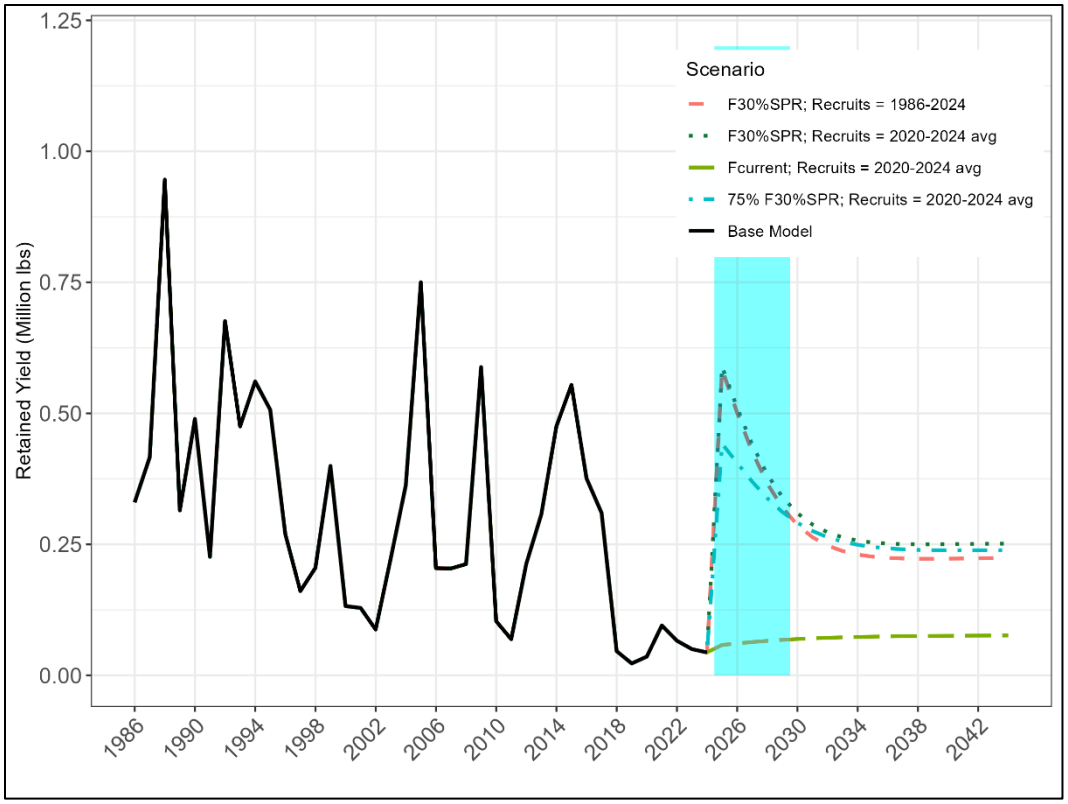


Figure 59. Projected retained yield (million pounds) under various constant F scenarios as estimated by the SEDAR 94 KEYS RW base model (black solid line). Long-term equilibrium $F_{30\%SPR}$ used average recruitment from 1986 – 2024 (red dashed line) while short-term $F_{30\%SPR}$ (dark green dotted line), $F_{current}$ (mustard dashed line), and 75% of short-term $F_{30\%SPR}$ (teal dot-dashed line) used average recruitment from 2020 – 2024. The cyan region highlights the first five years of the projection (2025 – 2030).

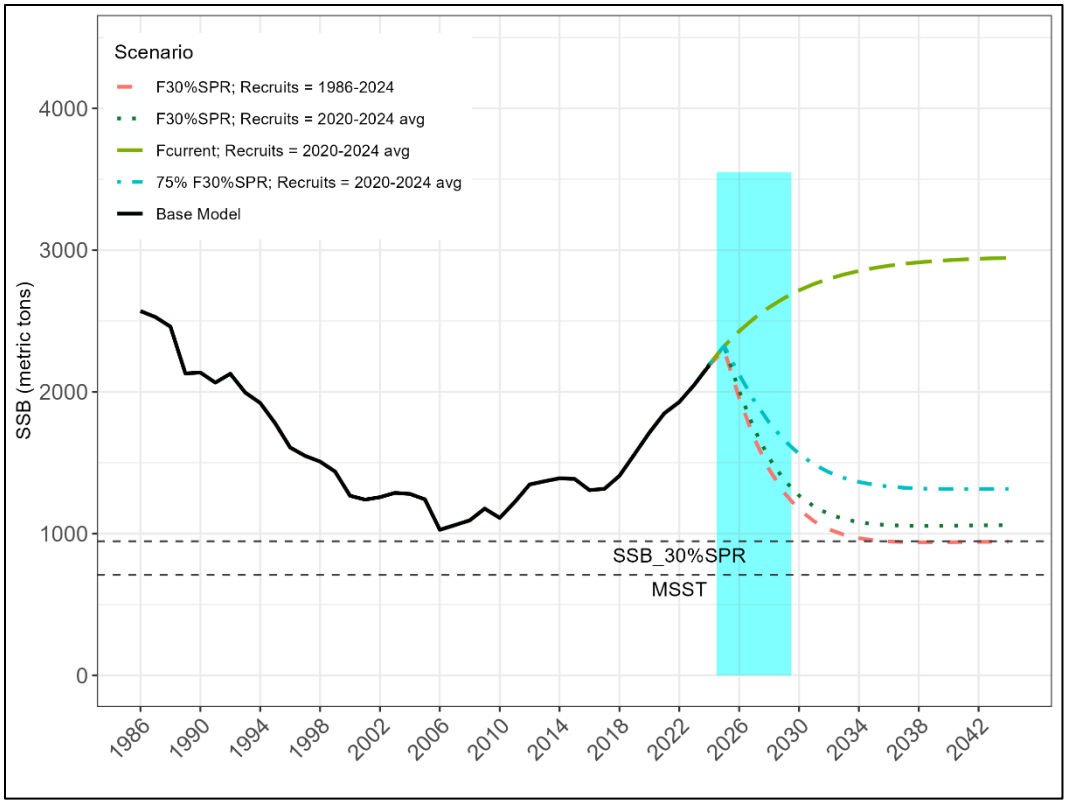


Figure 60. Projected spawning stock biomass (SSB, metric tons) under various constant F scenarios as estimated by the SEDAR 94 KEYS RW base model (black solid line). Long-term equilibrium $F_{30\%SPR}$ used average recruitment from 1986 – 2024 (red dashed line) while short-term $F_{30\%SPR}$ (dark green dotted line), $F_{current}$ (mustard dashed line), and 75% of short-term $F_{30\%SPR}$ (teal dot-dashed line) used average recruitment from 2020 – 2024. The cyan region highlights the first five years of the projection (2025 – 2030).

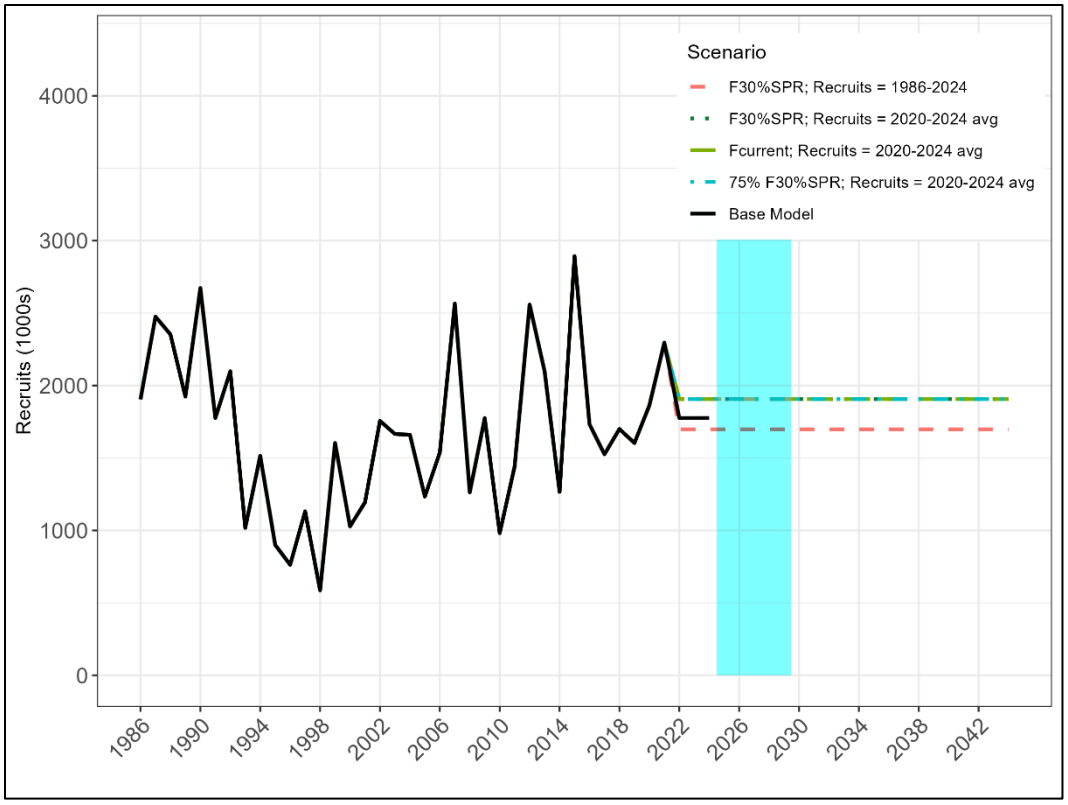


Figure 61. Projected age-0 recruitment (in thousands) under various constant F scenarios as estimated by the SEDAR 94 KEYS RW base model (black solid line). Long-term equilibrium $F_{30\%SPR}$ used average recruitment from 1986 – 2024 (red dashed line) while short-term $F_{30\%SPR}$ (dark green dotted line), $F_{current}$ (mustard dashed line), and 75% of short-term $F_{30\%SPR}$ (teal dot-dashed line) used average recruitment from 2020 – 2024. The cyan region highlights the first five years of the projection (2025 – 2030).

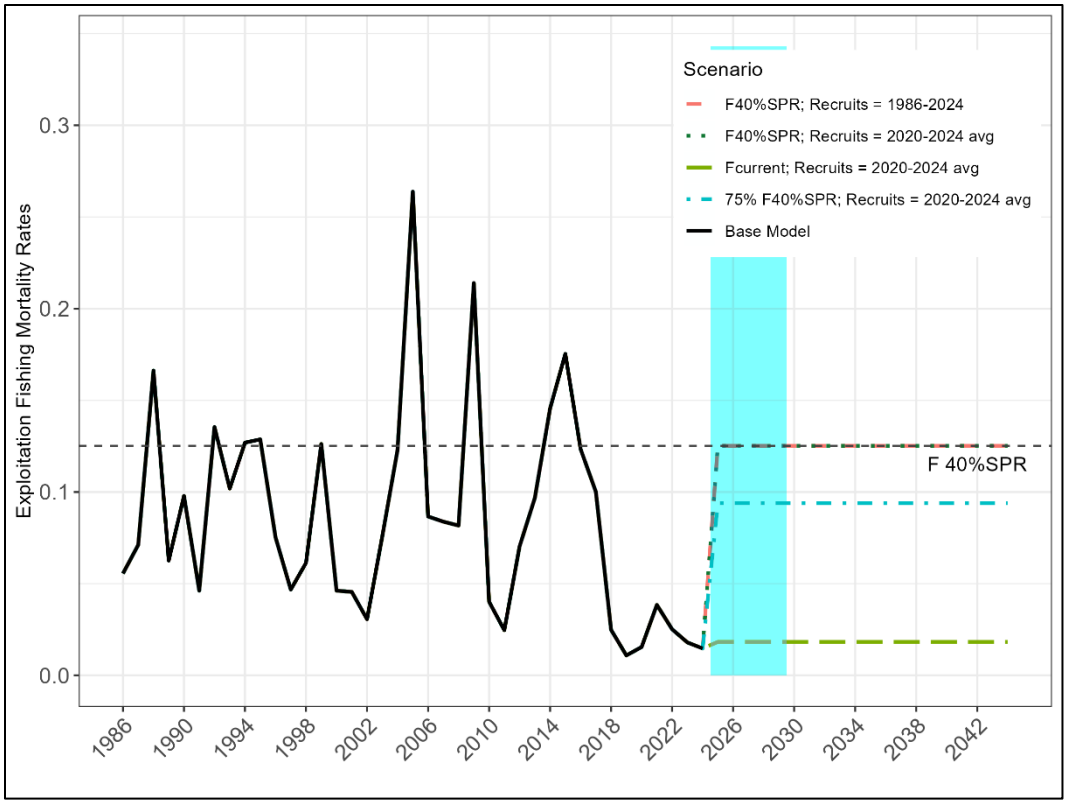


Figure 62. Projected exploitation rates under various constant F scenarios as estimated by the SEDAR 94 KEYS RW base model (black solid line). Long-term equilibrium $F_{40\%SPR}$ used average recruitment from 1986 – 2024 (red dashed line) while short-term $F_{40\%SPR}$ (dark green dotted line), $F_{current}$ (mustard dashed line), and 75% of short-term $F_{40\%SPR}$ (teal dot-dashed line) used average recruitment from 2020 – 2024. The cyan region highlights the first five years of the projection (2025 – 2030).

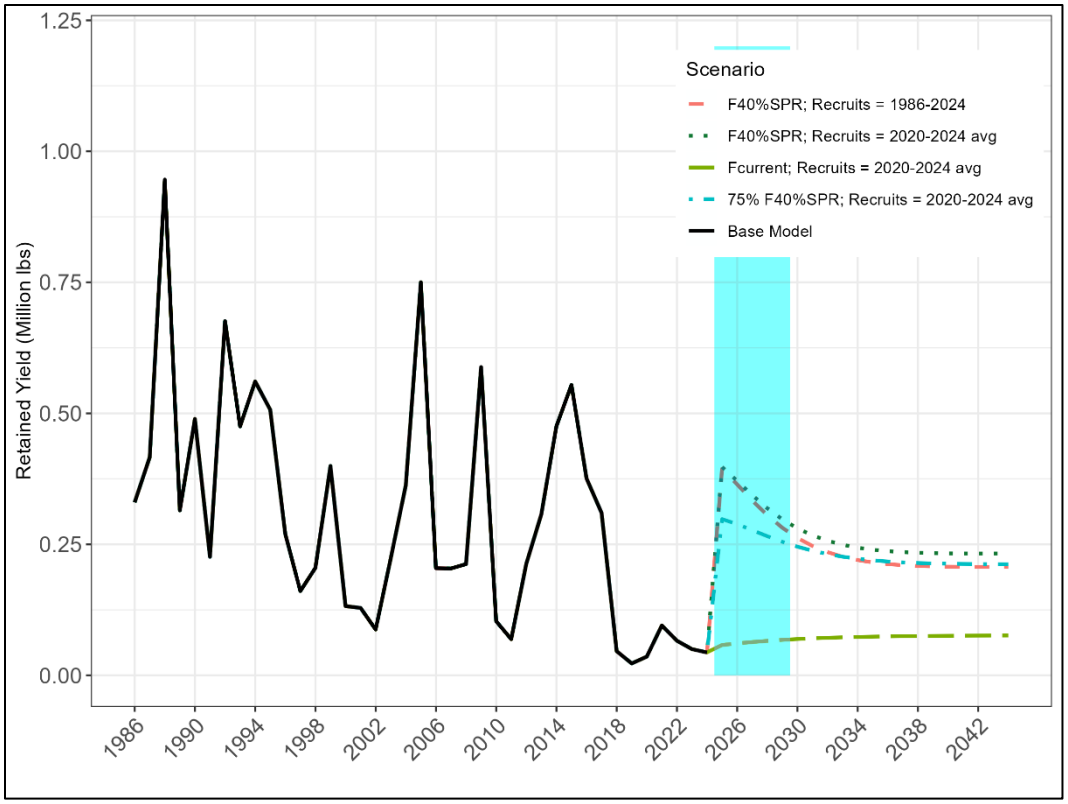


Figure 63. Projected retained yield (million pounds) under various constant F scenarios as estimated by the SEDAR 94 KEYS RW base model (black solid line). Long-term equilibrium $F_{40\%SPR}$ used average recruitment from 1986 – 2024 (red dashed line) while short-term $F_{40\%SPR}$ (dark green dotted line), $F_{current}$ (mustard dashed line), and 75% of short-term $F_{40\%SPR}$ (teal dot-dashed line) used average recruitment from 2020 – 2024. The cyan region highlights the first five years of the projection (2025 – 2030).

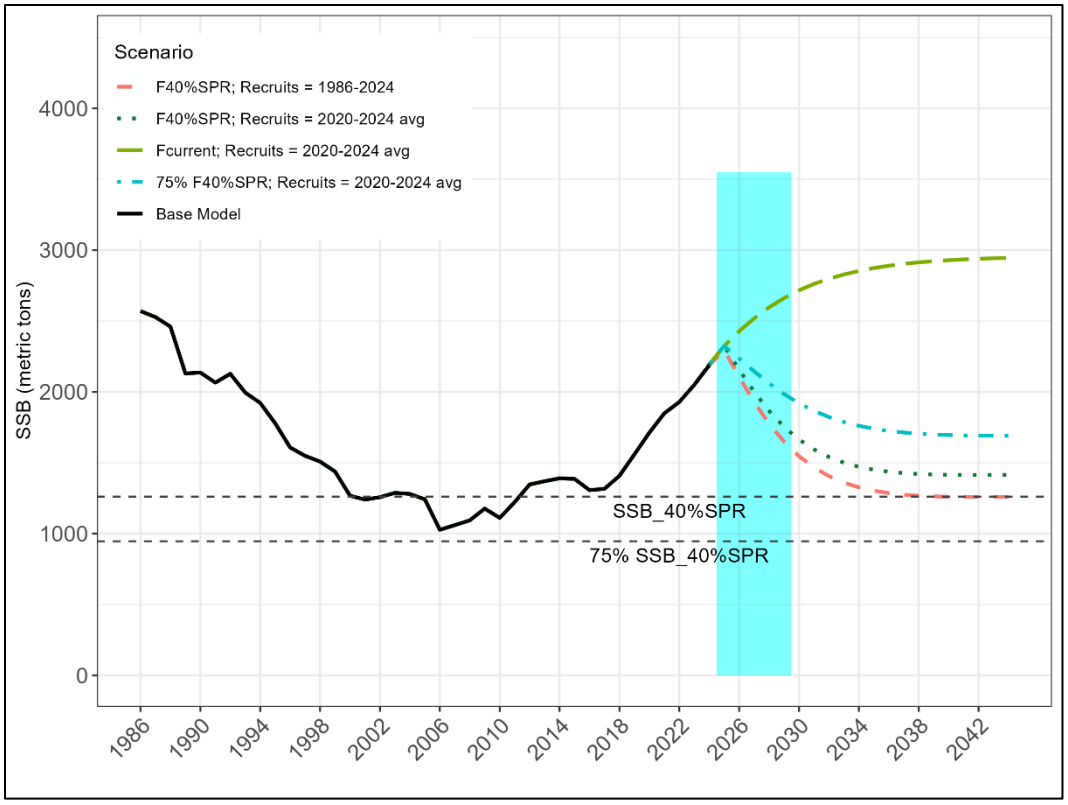


Figure 64. Projected spawning stock biomass (SSB, metric tons) under various constant F scenarios as estimated by the SEDAR 94 KEYS RW base model (black solid line). Long-term equilibrium $F_{40\%SPR}$ used average recruitment from 1986 – 2024 (red dashed line) while short-term $F_{40\%SPR}$ (dark green dotted line), $F_{current}$ (mustard dashed line), and 75% of short-term $F_{40\%SPR}$ (teal dot-dashed line) used average recruitment from 2020 – 2024. The cyan region highlights the first five years of the projection (2025 – 2030).

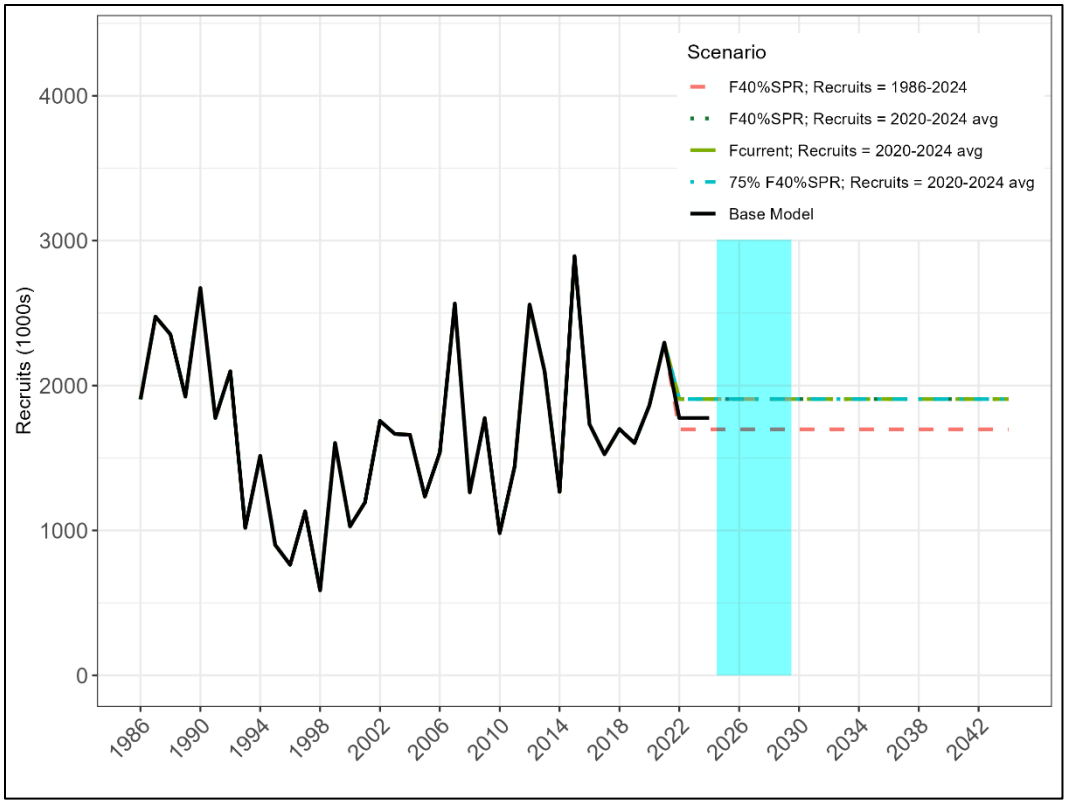


Figure 65. Projected age-0 recruitment (in thousands) under various constant F scenarios as estimated by the SEDAR 94 KEYS RW base model (black solid line). Long-term equilibrium $F_{40\%SPR}$ used average recruitment from 1986 – 2024 (red dashed line) while short-term $F_{40\%SPR}$ (dark green dotted line), $F_{current}$ (mustard dashed line), and 75% of short-term $F_{40\%SPR}$ (teal dot-dashed line) used average recruitment from 2020 – 2024. The cyan region highlights the first five years of the projection (2025 – 2030).