Tab B, No. 7(c)

SEDAR
Southeast Data, Assessment, and Review

SEDAR 96
Stock Assessment Report

Southeastern US Yellowtail Snapper

January 2025

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

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Southeast Data, Assessment, and Review

SEDAR 96

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SECTION I: Introduction

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Overview

SEDAR 96 addressed the stock assessment for southeastern US yellowtail snapper. The assessment was conducted by the FWC. One Topical Working Group (TWG) was convened by SEDAR to review and provide recommendations on data and modeling modifications from SEDAR 64. The TWG focused its discussion on the State of Florida's State Reef Fish Survey. The TWG meet twice via webinar in May and August 2024.

The Stock Assessment Report is organized into 2 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. Section II is the Assessment Process report. This section details the assessment model, as well as documents any data recommendations that arise for new data sets presented during this assessment process, or changes to data sets used previously.

The final Stock Assessment Report (SAR) for southeastern US yellowtail snapper was disseminated to the public in January 2025. The Council's Scientific and Statistical Committee (SSC) will review the SAR for its stock. The SSCs are tasked with recommending whether the assessments represent Best Available Science, whether the results presented in the SARs are useful for providing management advice and developing fishing level recommendations for the Council. An SSC may request additional analyses be conducted or may use the information provided in the SAR as the basis for their Fishing Level Recommendations (e.g., Overfishing Limit and Acceptable Biological Catch). The Gulf of Mexico and South Atlantic Fishery Management Councils' SSCs will review the assessment in February 2025, followed by the Councils receiving that information in Spring or Summer 2025. Documentation on SSC recommendations is not part of the SEDAR process and is handled through each Council.

1 SEDAR PROCESS DESCRIPTION

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

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

SEDAR 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 SOUTHEASTERN US YELLOWTAIL SNAPPER MANAGEMENT OVERVIEW

2.1 Fishery Management Plans and Amendments

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 of Mexico Fishery Management Council (GMFMC), and the Florida Fish and Wildlife Conservation Commission (FWC) that were likely to affect yellowtail snapper fisheries and harvest.

Original SAMFC FMP

The Fishery Management Plan (FMP), Regulatory Impact Review, and Final Environmental Impact Statement for the Snapper Grouper Fishery of the South Atlantic Region, approved in 1983 and implemented in August of 1983, establishes a management regime for the fishery for snappers, groupers, and related demersal species of the continental shelf of the southeastern United States in the fishery exclusive economic zone (EEZ) 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. Regulations apply only to federal waters.

SAFMC FMP Amendments affecting yellowtail snapper

Description of Action	FMP/Amendment	Effective Date
4” trawl mesh; 12” (305mm) TL minimum size limit for yellowtail snapper; gear limitations (poisons, explosives, fish traps, trawls)	Snapper Grouper FMP	08/31/1983
Trawls prohibited south of Cape Hatteras, NC and north of Cape Canaveral, FL	Amendment 1 (1988)	01/12/1989
Fish traps prohibited, entanglement nets & longlines within 50 fathoms prohibited, 12” TL limit – red porgy, vermilion snapper (commercial only), gray, yellowtail, mutton, schoolmaster, queen, blackfin, cubera, dog, mahogany, and silk snappers; aggregate bag limit of 10 snappers (including yellowtail snapper, and excluding lane, vermilion, and allowing no more than 2 red snappers); spawning season closure – commercial harvest greater amberjack > 3 fish bag prohibited	Amendment 4 (1991)	01/01/1992

in April and commercial harvest mutton snapper > snapper aggregate prohibited during May and June.		
Limited entry program: transferable permits and 225-lb non-transferable permits	Amendment 8 (1997)	12/14/1998
Greater amberjack: 1 fish rec. bag limit; no harvest or possession > bag limit, and no purchase or sale, during April; began fishing year May 1. Black grouper: 24” TL (recreational and commercial); no harvest or possession > bag limit, and no purchase or sale, during March and April.	Amendment 9 (1998)	2/24/1999
MSY proxy for yellowtail snapper is 30% static SPR; OY proxy is 40% static SPR; MSST = [(1-M) or 0.5 whichever is greater]*B_{MSY}. MFMT = F_{MSY}.	Amendment 11 (1998)	12/02/1999
Commercial trip limit for greater amberjack	Amendment 9 (1998) resubmitted	10/13/2000
Established eight deepwater Type II marine protected areas to protect a portion of the population and habitat of long-lived deepwater snapper grouper species	Amendment 14 (2007)	02/12/2009
Prohibited the sale of snapper grouper species harvested or possessed in the EEZ under the bag limits and prohibited the sale of snapper-grouper harvested or possessed under the bag limits by vessels with a Federal charter vessel/headboat permit for South Atlantic snapper-grouper regardless of where harvested;	Amendment 15B (2008)	12/16/2009
Required commercial and recreational fishermen to use, as needed, dehooking devices when catching snapper grouper species to reduce recreational and commercial bycatch mortality.	Amendment 16 (2009)	07/29/2009
Required use of non-stainless-steel circle hooks when fishing for snapper grouper species with hook-and-line gear with natural baits north of 28 deg. N latitude in the South Atlantic EEZ;	Amendment 17A (2010)	03/03/2011
Reorganized FMU into 6 complexes (deepwater, jacks, snappers, grunts, shallow-water groupers, porgies) (see final rule for species list); established acceptable biological catch (ABC) control rules and established ABCs, ACLs, and AMs for species not undergoing overfishing, including yellowtail snapper; established jurisdictional ABC allocation between SAFMC and GMFC for yellowtail snapper, mutton snapper, and black grouper;	Amendment 25 (included in the Comprehensive ACL Amendment) (2011)	4/16/2012

removed some species from South Atlantic FMU and designated others as ecosystem component species; specified allocations between the commercial and, recreational sectors for species not undergoing overfishing, including yellowtail snapper.		
Modified AMs for snapper grouper species, including yellowtail snapper	Amendment 34 (included in the Generic AMs Amendment) (2015)	2/22/2016
Removed black snapper, dog snapper, mahogany snapper, and schoolmaster from the FMU	Amendment 35 (2015)	6/22/2016
Established SMZs to enhance protection for snapper grouper species in spawning condition	Amendment 36 (2016)	7/31/2017

SAFMC FMP Regulatory Amendments

Description of Action	FMP/Amendment	Effective Date
Established trip limits for vermilion snapper and gag; increased trip limit for greater amberjack	Regulatory Amendment 9 (2010)	7/15/2011
Modified ACLs and OY for yellowtail snapper: Comm ACL = 1,596,510 lbs ww Rec ACL = 1,440,990 lbs ww Rec ACT = 1,253,661 lbs ww	Regulatory Amendment 15 (2013)	9/12/2013
Modified the definition of the overfished threshold (MSST) for red snapper, blueline tilefish, gag, black grouper, yellowtail snapper, vermilion snapper, red porgy, and greater amberjack. MSST=75%SSB_{MSY}	Regulatory Amendment 21 (2014)	11/6/2014
Changed the commercial and recreational fishing year for yellowtail snapper from calendar year to August-July.	Regulatory Amendment 25 (2016)	8/12/2016
Modify in-season accountability measures to reduce possibility of in-season closures	Regulatory Amendment 32	TBD

ORIGINAL GMFMC 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 is confined to the waters of the fishery conservation zone (FCZ). The estimated area of the FCZ is 6.82 x 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. Yellowtail snapper 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.

Measures in the original FMP that would have affected the harvest of yellowtail snapper are maximum sustainable yield (MSY and optimum yield (OY) estimates for all grouper and snapper species in aggregate, permits and gear specifications for fish traps along with a limit 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 the taking of reef fish was prohibited, and a prohibition on the use of poison or explosives for taking reef fish.

GMFMC FMP AMENDMENTS AFFECTING YELLOWTAIL SNAPPER

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	[Submitted 8/1981] 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, 12” TL minimum size limit for yellowtail snapper adopted, 10 fish aggregate recreational bag limit for snappers (including yellowtail snapper) implemented, prohibited use of entangling gear for direct harvest, reef fish vessel permit established with an income qualification.	Amendment 1 (1990)	[Submitted 8/1989] 02/21/1990
Moratorium on new reef fish permits which was extended at various times and was in effect through 2005.	Amendment 4	05/1992
Established a 10-year phase-out of fish traps.	Amendment 14	03-04/1997

Prohibited harvest of reef fish from traps other than permitted reef fish traps, stone crab traps, or spiny lobster traps.	Amendment 15	01/1998
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.	Amendment 16A	01/2000
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.	Amendment 19	08/19/2002
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.	Amendment 27	02/2008
Established ABCs, ACLs, and AMs for species not undergoing overfishing, including yellowtail snapper; established jurisdictional ABC allocation between SAFMC and GMFMC for yellowtail snapper	Generic ACL/AM Amendment	01/2012

GMFMC FMP Regulatory Amendments

Increased the Gulf yellowtail snapper ACL from 725,000 lbs round weight to 901,125 lbs round weight, and removes the requirement to have onboard and use venting tools when releasing reef fish.	Reef Fish Framework Action	09/2013
Changed the commercial and recreational yellowtail snapper fishing year so that it opens on August 1 and runs through July 31, each year. Modified the circle hook requirement so that the use of circle hooks is not required while commercial fishing with natural bait for yellowtail snapper south of Cape Sable (the line extending due west from 25°09’ N. latitude off the west coast of Monroe County, Florida, to the Gulf and South Atlantic Councils’ shared boundary).	Reef Fish Framework Action	03/2017

ORIGINAL FWC REGULATIONS

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 12" TL size limits for red, mutton, and yellowtail snapper. Later rules sought to achieve a higher level of conformance between state and federal (Council) regulations to reduce potential conflicts between state and federal management. After the merger of the Florida Department of Environmental Protection and the Florida Game and Freshwater Fish Commission by the Florida Legislature on July 1, 1999, the management functions of the MFC became part of the Florida Fish and Wildlife Conservation Commission (FWC).

FWC REGULATIONS AFFECTING YELLOWTAIL SNAPPER

Description of Action	Rule chapter	Effective Date
Established 12" TL minimum size for yellowtail snapper from state waters	F.A.C. Chap. 68-14	07/1985
Established a 10 fish aggregate bag limit for snappers (included yellowtail snapper, excluded lane, vermilion, and yelloweye [= silk] snappers). Stab nets (anchored, bottom gill nets) for the harvest of reef fish prohibited.	F.A.C. Chap. 68-14	12/1986
Required the appropriate federal permit to exceed the recreational bag limit in state waters.	F.A.C. Chap. 68-14	12/1992
Temporarily allowed fishermen to land reef fish in the Florida Keys if they possessed either South Atlantic snapper grouper permits or Gulf reef fish permits, with subsequent extensions of these provisions in July 1995 and January 1996.	F.A.C. Chap. 68-14	10/1993
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

2.2 Emergency and Interim Rules

SAFMC:

- Increased the commercial ACL for yellowtail snapper from 1,142,589 lbs to 1,596,510 lbs – Effective 11/7/2012 through 5/6/2013.

GMFMC: None

2.3 Secretarial Amendments

SAFMC: None
GMFMC: None

2.4 Control Date Notices

SAFMC:
Notice of Control Date (07/30/91 56 FR 36052) - Anyone entering federal snapper grouper fishery (other than for wreckfish) in the EEZ off S. Atlantic states after 07/30/91 was not assured of future access if limited entry program developed.

Notice of Control Date (10/14/05 70 FR 60058) - Anyone entering federal snapper grouper fishery off S. Atlantic states after 10/14/05 was not assured of future access if limited entry program developed.

Notice of Control Date (3/8/07 72 FR 60794) - Considered measures to limit participation in the snapper grouper for-hire sector effective 3/8/07.

Notice of Control Date (01/31/11 76 FR 5325) - Anyone entering federal snapper grouper fishery off S. Atlantic states after 09/17/10 was not assured of future access if limited entry program developed.

Notice of Control Date (06/15/2016 81 FR 66244) - fishermen who enter the federal for-hire recreational sector for the Snapper Grouper fishery after June 15, 2016, will not be assured of future access should a management regime that limits participation in the sector be prepared and implemented.

GMFMC: None

2.5 Management Program Specifications

Table 2.5.1. General Management Information

South Atlantic

Species	Yellowtail Snapper (*Ocyurus chrysurus*)
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
Management Contacts SERO/Council	Rick DeVictor/Michael Schmidtke
Stock exploitation status (as of SEDAR 27A, 2012)	Not undergoing overfishing
Stock biomass status as of SEDAR 27A, 2012)	Not overfished

Gulf of Mexico

Species	Yellowtail Snapper (*Ocyurus chrysurus*)
Management Unit	U. S. Gulf of Mexico
Management Unit Definition	All waters within the Gulf of Mexico Fishery Management Council boundaries. Defined as the economic zone (EEZ), 200 miles from state boundary line.
Management Entity	Gulf of Mexico Fishery Management Council
Management Contacts SERO/Council	Peter Hood/Ryan Rindone
Stock exploitation status (as of SEDAR 27A, 2012)	Not undergoing overfishing
Stock biomass status as of SEDAR 27A, 2012)	Not overfished

Table 2.5.2. Specific Management Criteria

South Atlantic and Gulf of Mexico*				
Criteria	Current (SEDAR 27A, 2012)		Results from SEDAR 64	
	Definition	Value**	Definition	Value
MSST	$(1-M)*SSB_{MSY}$	583.6 mt (5.49 mp)	[(1-M) or 0.5, whichever is greater] $*SSB_{MSY}$ (The estimated spawning stock biomass at MSY)	TBD
MFMT	F_{MSY}	0.24 per year	F_{MSY}	TBD
MSY	Yield at F_{MSY} at equilibrium	4.51 mp	Yield at F_{MSY}	TBD
F_{MSY}	F that produces MSY	0.24 per year	F that produces MSY	TBD
$SSB_{30\%SPR}$	Spawning stock biomass at equilibrium when $F=F_{30\%SPR}$	3,072 mt (6.77 mp)	Spawning stock biomass at equilibrium when $F=F_{MSY}$	
B_{MSY}	Total biomass at equilibrium when $F=F_{MSY}$		Total biomass at equilibrium when $F=F_{MSY}$	
OY	Yield at F_{OY} at equilibrium		Yield at F_{OY}	TBD
F_{TARGET} (i.e. F_{OY})	F at 40% SPR	0.19	$F_{\text{at 40\% SPR}}$	TBD
Yield at F_{TARGET} (equilibrium)	Landings and discards, pounds and numbers			
M	Natural mortality rate used to scale Age-Specific M	0.194	Natural mortality rate used to scale Age-Specific M	TBD
Current F	Exploitation in terminal year (F_{2010})	0.0454 per year	Exploitation in terminal year (F_{2017})	TBD
Terminal Biomass[1]	Biomass in terminal year (SSB_{2010})	10,311 mt (22,732 mp)	Biomass in terminal year (SSB_{2017})	TBD
Exploitation Status (F)	F_{2010}/F_{MSY}	0.189	F_{2017}/F_{MSY}	TBD
Biomass Status[1] (SSB)	$SSB_{2010}/MSST$	4.144	$SSB_{2017}/MSST$	TBD
	$SSB_{2010}/SSB_{30\%SPR}$	3.357	$SSB_{2017}/SSB_{30\%SPR}$	TBD
Generation Time				
$T_{REBUILD}$ (if appropriate)				

Table 2.5.3. Stock Rebuilding Information
The yellowtail snapper is not under a rebuilding plan.

Table 2.5.4. Stock projection information.

First Year of Management	2021
Interim basis	Recent SEDAR assessments have asked for ACL, if ACL is met Average exploitation, if ACL is not met
Projection Outputs	
Landings	Pounds and numbers
Discards	Pounds and numbers
Exploitation	F & Probability F>MFMT
Biomass (total or SSB, as appropriate)	B & Probability B>MSST (and Prob. B>B_{MSY} if under rebuilding plan)
Recruits	Number

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

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

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

Table 2.5.6. P-star projections. Short term specifications for OFL and ABC recommendations. Additional P-star projections may be requested by the SSC once the ABC control rule is applied. NOTE: The South Atlantic Council will need to set a stock risk rating to apply its new ABC control rule. Council staff will update with a timeline when available.

Basis	Value	Years to project	P* applies to
P*	50%	Interim + 5	Probability of overfishing
P*	40%	Interim + 5	Probability of overfishing
Exploitation	Fmsy	Interim + 5	NA
Exploitation	75% Fmsy	Interim + 5	NA

Table 2.5.7. South Atlantic Quota Calculation Details (Values are in lbs. whole weight)

	Commercial	Recreational	Total Annual Catch Limit
Current ACL Value	1,596,510	1,440,990	3,037,500
Next Scheduled Quota Change			
Annual or averaged quota?	Annual	Annual	
If averaged, number of years to average			
Does the quota account for bycatch/discard?	No	No	NO

How is the quota calculated - conditioned upon exploitation or average landings?
The ACL is set equal to the ABC, which comes directly from the assessment projections. The yellowtail snapper total ACL is allocated 52.56% and 47.44% to the commercial and recreational sectors, respectively. Sector allocation = (0.5 * catch history) + (0.5 * current trend), where *catch history* = average landings 1986-2008 and the *current trend* = average landings 2006-2008.

Does the quota include bycatch/discard estimates? If so, what is the source of the bycatch/discard values? What are the bycatch/discard allowances?
The quota does not explicitly include estimates of discards in it. However, the projections assume a certain number of dead discards will occur when the quota is met and that the total F associated with both the landings and discards will not result in overfishing.

Are there additional details of which the analysts should be aware to properly determine quotas for this stock?
The yellowtail snapper ABC is apportioned 75% to the South Atlantic and 25% to the Gulf of Mexico Fishery Management Council jurisdictions. The stock is managed separately in each region.

Table 2.5.8. Gulf of Mexico Quota Calculation Details (Values are in lbs. whole weight)

	Total Annual Catch Limit
Current ACL Value	901,125
Next Scheduled Quota Change	-
Annual or averaged quota?	Annual
If averaged, number of years to average	-
Does the quota account for bycatch/discard?	No

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

Conditioned on exploitation.

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

No.

2.6 Management and Regulatory Timeline

Table 2.6.1. Pertinent Federal Management Regulations – South Atlantic Region

Harvest Restrictions – Trip Limits*
*Trip limits do not apply during closures (if season is closed, then trip limit is 0).

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	8/31/83	Ongoing	Comm	None	None	South Atlantic	Snapper Grouper FMP
1983	8/31/83	12/31/91	Rec	None	None	South Atlantic	Snapper Grouper FMP
1992	1/1/92	Ongoing	Rec	Aggregate bag limit of 10 snappers (including yellowtail snapper, and excluding lane, vermilion, and allowing no more than 2 red snappers)		South Atlantic	Amendment 4

Harvest Restrictions (Size Limits*)

*Size limits do not apply during closures

First Yr In Effect	Effective Date	End Date	Fishery	Size Limit	Length Type	Region Affected	FR Reference	Amendment Number or Rule Type
1983	8/31/98	12/31/91	Commercial	12 inches	TL	South Atlantic		Sanpper Grouper FMP
1983	8/31/98	12/31/91	Rec	12 inches	TL	South Atlantic		Sanpper Grouper FMP
1992	1/1/92	Ongoing	Commercial	12 inches	TL	South Atlantic	56 FR 56016	Amendment 4
1992	1/1/92	Ongoing	Rec	12 inches	TL	South Atlantic	56 FR 56016	Amendment 4

Harvest Restrictions (Fishery Closures*)
*Area specific regulations are documented under spatial restrictions

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
2015	10/31/15	12/31/15	Commercial	ACL	10/31/15	12/31/15	SA	80 FR 65970	Temporary Rule
2017	6/3/17	8/1/17	Commercial	ACL	6/3/17	7/31/17	SA	82 FR 25205	Temporary Rule
2018	6/5/18	8/1/18	Commercial	ACL	6/5/18	7/31/18	SA	83 FR 24944	Temporary Rule

Harvest Restrictions (Spatial Restrictions)

There are no spatial restrictions for yellowtail snapper in the South Atlantic.

Harvest Restrictions (Gear Restrictions*)

*Area specific gear regulations 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	8/31/83	ongoing	Prohibited	South Atlantic EEZ	48 FR 39463	SG FMP
Explosives	1983	8/31/83	ongoing	Prohibited	South Atlantic EEZ	48 FR 39463	SG FMP
Fish traps	1983	8/31/83	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	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	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	Amendment 4
Entanglement nets	1992	1/1/92	ongoing	Prohibited	South Atlantic EEZ	56 FR 56016	Amendment 4
Longline	1992	1/1/92	ongoing	Prohibited inside of 50 fathoms	specified area within the South Atlantic EEZ	56 FR 56016	Amendment 4

Powerheads and bangsticks	1992	1/1/92	ongoing	Prohibited in SMZs off South Carolina	specific areas off SC	56 FR 56016	Amendment 4
Allowable gear	1995	1/23/95	ongoing	Specified allowable gear in the SG fishery	South Atlantic EEZ	59 FR 66270	Amendment 7
Non-stainless steel circle hooks	2011	3/3/11	ongoing	Required to fish for SG species with natural baits north of 28 degrees N Lat.	specified area within the South Atlantic EEZ	75 FR 76874	Amendment 17A

Quota History – Recreational

First Yr In Effect	Effective Date	End Date	Quota or ACL	Region Affected	FR Reference	Amendment Number or Rule Type
2012	4/16/12	9/11/13	1,031,286 lbs ww	South Atlantic	77 FR 15916	Comp ACL Amendment (SG Am 25)
2013	9/12/13	current	1,440,990 lbs ww	South Atlantic	78 FR 49183	Regulatory Amendment 15

Quota History – Commercial

First Yr In Effect	Effective Date	End Date	Quota or ACL	Species Complex	Region Affected	FR Reference	Amendment Number or Rule Type
2012	4/16/12	11/6/12	1,142,589 lbs ww	SG	South Altantic	77 FR 15916	Comp ACL Amendment (SG Am 25)
2012/2013	11/7/12	5/5/13	1,596,510 lbs ww	SG	South Altantic	77 FR 66744	Temporary Rule
2013	5/6/13	11/28/13	1,596,510 lbs ww	SG	South Altantic	78 FR 25213	Temporary Rule Extension
2013	9/12/13	Ongoing	1,596,510 lbs ww	SG	South Altantic	78 FR 49183	Regulatory Amendment 15

Table 2.6.2. Pertinent Federal Management Regulations – Gulf of Mexico Region

Harvest Restrictions – Trip Limits*
*Trip limits do not apply during closures (if season is closed, then trip limit is 0).

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	Present	Comm	-	-	Gulf of Mexico	Original Reef Fish FMP
1984	11/8/84	2/20/90	Rec	-	-	Gulf of Mexico	Original Reef Fish FMP
1990	2/21/90	Present	Rec	10 fish	-	Gulf of Mexico	Reef Fish Amendment 1

Harvest Restrictions (Size Limits*)

*Size limits do not apply during closures

First Yr In Effect	Effective Date	End Date	Fishery	Size Limit	Length Type	Region Affected	Amendment Number or Rule Type
1990	2/21/90	Present	Comm	12"	TL	Gulf of Mexico and South Atlantic	Reef Fish Amendment 1
1990	2/21/90	Present	Rec	12"	TL	Gulf of Mexico and South Atlantic	Reef Fish Amendment 1

Harvest Restrictions (Fishery Closures*)
There were no fishery closures for yellowtail snapper in the Gulf of Mexico.

Harvest Restrictions (Spatial Restrictions)

Area	First Yr In Effect	Last Yr In Effect	Effective Date	End Date	Fishery	First Day Closed	Last Day Closed	Restriction in Area	FR Reference	FR Section	Amendment Number or Rule Type
Gulf of Mexico Stressed Areas	1984	Ongoing	11/8/84	Ongoing	Both	Year round		Prohibited powerheads for Reef FMP	49 FR 39548	641.7	Original Reef Fish FMP
	1984	Ongoing	11/8/84	Ongoing	Both	Year round		Prohibited pots and traps for Reef FMP	49 FR 39548	641.7	Original Reef Fish FMP
Alabama Special Management Zones	1994	Ongoing	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	641.23	Reef Fish Amendment 5
EEZ, inside 50 fathoms west of Cape San Blas, FL	1990	Ongoing	2/21/90	Ongoing	Both	Year round		Prohibited longline and buoy gear for Reef FMP	55 FR 2078	641.7	Reef Fish Amendment 1
EEZ, inside 20 fathoms east of Cape San Blas, FL	1990	Ongoing	2/21/90	Ongoing	Both	Year round		Prohibited longline and buoy gear for Reef FMP	55 FR 2078	NA	Reef Fish Amendment 1
EEZ, inside 50 fathoms east of Cape San Blas, FL	2009	2009	5/18/09	10/15/09	Both	18-May	28-Oct	Prohibited bottom longline for Reef FMP	74 FR 20229	622.34	Emergency Rule
EEZ, inside 35 fathoms east of Cape San Blas, FL	2009	2010	10/16/09	5/25/10	Both	Year round		Prohibited bottom longline for Reef FMP	74 FR 53889	223.206	Sea Turtle ESA Rule
	2010	Ongoing	5/26/10	Ongoing	Rec	Year round		Prohibited bottom longline for Reef FMP	75 FR 21512	622.34	Reef Fish Amendment 31

	2010	Ongoing	5/26/10	Ongoing	Com	1-Jun	31-Aug	Prohibited bottom longline for Reef FMP	75 FR 21512	622.34	Reef Fish Amendment 31
Madison-Swanson	2000	2004	6/19/00	6/2/04	Both	Year round		Fishing prohibited except HMS[1]	65 FR 31827	622.34	Reef Fish Regulatory Amendment
	2004	Ongoing	6/3/04	Ongoing	Both	1-May	31-Oct	Fishing prohibited except surface trolling	70 FR 24532 74 FR 17603	622.34 NA	Reef Fish Amendment 21 Reef Fish Amendment 30B
	2004	Ongoing	6/3/04	Ongoing	Both	1-Nov	30-Apr	Fishing prohibited except HMS[1]	70 FR 24532 74 FR 17603	622.34 NA	Reef Fish Amendment 21 Reef Fish Amendment 30B
Steamboat Lumps	2000	2004	6/19/00	6/2/04	Both	Year round		Fishing prohibited except HMS[1]	65 FR 31827	622.34	Reef Fish Regulatory Amendment
	2004	Ongoing	6/3/04	Ongoing	Both	1-May	31-Oct	Fishing prohibited except surface trolling	70 FR 24532 74 FR 17603	622.34 NA	Reef Fish Amendment 21 Reef Fish Amendment 30B
	2004	Ongoing	6/3/04	Ongoing	Both	1-Nov	30-Apr	Fishing prohibited except HMS[1]	70 FR 24532 74 FR 17603	622.34 NA	Reef Fish Amendment 21 Reef Fish Amendment 30B
The Edges	2010	Ongoing	7/24/09	Ongoing	Both	1-Jan	30-Apr	Fishing prohibited	74 FR 30001	622.34	Reef Fish Amendment 30B Suppleme
20 Fathom Break	2014	Ongoing	7/5/13	Ongoing	Rec	1-Feb	31-Mar	Fishing for SWG prohibited[2]	78 FR 33259	622.34	Reef Fish Framework Action
Flower Garden	1992	Ongoing	1/17/92	Ongoing	Both	Year round		Fishing with bottom gears prohibited[3]	56 FR 63634 70 FR 76216	934 622.34	Sanctuary Designation Essential Fish Habitat Amendment 3
Riley's Hump	1994	2002	2/7/94	8/18/02	Both	1-May	30-Jun	Fishing prohibited	59 FR 966	641.23	Reef Fish Amendment 5
Tortugas Reserves	2002	Ongoing	8/19/02	Ongoing	Both	Year round		Fishing prohibited	67 FR 47467 70 FR 76216	635.71 622.34	Tortugas Amendment Essential Fish Habitat Amendment 3
Pulley Ridge	2006	Ongoing	1/23/06	Ongoing	Both	Year round		Fishing with bottom gears prohibited[3]	70 FR 76216	622.34	Essential Fish Habitat Amendment 3

McGrail Bank	2006	Ongoing	1/23/06	Ongoing	Both	Year round	Fishing with bottom gears prohibited[3]	70 FR 76216	622.34	Essential Fish Habitat Amendment 3
Stetson Bank	2006	Ongoing	1/23/06	Ongoing	Both	Year round	Fishing with bottom gears prohibited[3]	70 FR 76216	622.34	Essential Fish Habitat Amendment 3

[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

Harvest Restrictions (Gear Restrictions*)

*Area specific gear regulations are documented under Spatial Restrictions

Gear Type	First Yr In Effect	Last Yr In Effect	Effective Date	End Date	Gear/Harvesting Restrictions	Region Affected	FR Reference	FR Section	Amendment Number or Rule Type
Poison	1984	Ongoing	11/8/84	Ongoing	Prohibited for Reef FMP	Gulf of Mexico EEZ	49 FR 39548	641.24	Original Reef Fish FMP
Explosives	1984	Ongoing	11/8/84	Ongoing	Prohibited for Reef FMP	Gulf of Mexico EEZ	49 FR 39548	641.24	Original Reef Fish FMP
Pots and Traps	1984	1994	11/23/84	2/6/94	Established fish trap permit	Gulf of Mexico EEZ	49 FR 39548	641.4	Original Reef Fish FMP
	1984	1990	11/23/84	2/20/90	Set max number of traps fish by a vessel at 200	Gulf of Mexico EEZ	49 FR 39548	641.25	Original Reef Fish FMP
	1990	1994	2/21/90	2/6/94	Set max number of traps fish by a vessel at 100	Gulf of Mexico EEZ	55 FR 2078	641.22	Reef Fish Amendment 1
	1994	1997	2/7/94	2/7/97	Moratorium on additional commercial trap permits	Gulf of Mexico EEZ	59 FR 966	641.4	Reef Fish Amendment 5
	1997	2007	3/25/97	2/7/07	Phase out of fish traps begins	Gulf of Mexico EEZ	62 FR 13983	622.4	Reef Fish Amendment 14
	1997	2007	1/29/88	2/7/07	Prohibited harvest of reef fish from traps other than permited reef fish, stone crab, or spiny lobster traps.	Gulf of Mexico EEZ	62 FR 67714	622.39	Reef Fish Amendment 15
	2007	Ongoing	2/8/07	Ongoing	Traps prohibited	Gulf of Mexico EEZ	62 FR 13983	622.31	Reef Fish Amendment 14
All	1992	1995	5/8/92	12/31/95	Moratorium on commercial permits for Reef FMP	Gulf of Mexico EEZ	59 FR 11914 59 FR 39301	641.4 641.4	Reef Fish Amendment 4 Reef Fish Amendment 9
	1994	Ongoing	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 966	641.21	Reef Fish Amendment 5
	1996	2005	7/1/96	12/31/05	Moratorium on commercial permits for Gulf reef fish	Gulf of Mexico EEZ	61 FR 34930 65 FR 41016	622.4 622.4	Interim Rule Reef Fish Amendment 17

	2006	Ongoing	9/8/06	Ongoing	Use of Gulf reef fish as bait prohibited[1]	Gulf of Mexico EEZ	71 FR 45428	622.31	Reef Fish Amendment 18A
Vertical Line	2008	Ongoing	6/1/08	Ongoing for Rec only: See Next	Requires non-stainless steel circle hooks and dehooking devices	Gulf of Mexico EEZ	74 FR 5117	322.41	Reef Fish Amendment 27
	2017	Ongoing	3/13/17	Ongoing: Comm only	Use of circle hooks is not required while commercial fishing with natural bait for yellowtail snapper south of Cape Sable (the line extending due west from 25°09' N. latitude off the west coast of Monroe County, Florida, to the Gulf and South Atlantic Councils' shared boundary	Gulf of Mexico EEZ	link	622	Reef Fish Framework Action
	2008	2013	6/1/08	9/3/13	Requires venting tools	Gulf of Mexico EEZ	74 FR 5117 78 FR 46820	322.41 NA	Reef Fish Amendment 27 Framework Action
Bottom Longline	2010	Ongoing	5/26/10	Ongoing	Limited to 1,000 hooks of which no more than 750 hooks are rigged for fishing or fished	Gulf of Mexico EEZ	75 FR 21512	622.34	Reef Fish Amendment 31

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

Gulf of Mexico Quota History

First Yr In Effect	Effective Date	End Date	Stock ACL	Stock ACT*	Region Affected	Amendment Number or Rule Type
2012	1/30/12	9/2/13	725,000 lbs ww	645,000 lbs ww	Gulf of Mexico	Generic ACL/AM Amendment
2013	9/3/13	12/31/13	901,125 lbs ww		Gulf of Mexico	Reef Fish Framework Action
2014	9/3/13	12/31/14	901,125 lbs ww		Gulf of Mexico	Reef Fish Framework Action
2015	9/3/13	12/31/15	901,125 lbs ww		Gulf of Mexico	Reef Fish Framework Action
2016	9/3/13	12/31/16	901,125 lbs ww		Gulf of Mexico	Reef Fish Framework Action
2017	9/3/13	12/31/17	901,125 lbs ww		Gulf of Mexico	Reef Fish Framework Action
2018	9/3/13	12/31/18	901,125 lbs ww		Gulf of Mexico	Reef Fish Framework Action

*Stock ACL removed in 2013

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

South Atlantic:
Commercial: October 31, 2015; June 3, 2017; June 5, 2018
Recreational: None

Gulf of Mexico:
Commercial: None
Recreational: None

Table 7. State Regulatory History

	Florida	
Year	Minimum size (TL, inches)	Aggregate bag limit
1982	-----	-----
1983	-----	-----
1984	-----	-----
1985	12	-----
1986	12	10
1987	12	10
1988	12	10
1989	12	10
1990	12	10
1991	12	10
1992	12	10
1993	12	10
1994	12	10
1995	12	10
1996	12	10
1997	12	10
1998	12	10
1999	12	10
2000	12	10
2001	12	10
2002	12	10
2003	12	10
2004	12	10
2005	12	10
2006	12	10
2007	12	10
2008	12	10
2009	12	10
2010	12	10

3 ASSESSMENT HISTORY AND REVIEW

Prior to the first SEDAR for southeastern U.S. Yellowtail Snapper (SEDAR 3 2003), Huntsman *et al.* (1992) reviewed catches of Yellowtail Snapper and performed catch curve and yield-per-recruit analyses to examine stock status using data through 1990. Huntsman *et al.* (1992) estimated that the first fully recruited age to the fishery was age-3 fish that the fishing mortality rate in 1988 was 0.28 yr^{-1} and in 1990 was 0.48 yr^{-1}, and the spawning stock-per-recruit ratio to fishing mortality in 1988 was 0.38 yr^{-1} and in 1990 was 0.19 yr^{-1}.

In SEDAR 3 (Muller *et al.* 2003), an age-structured assessment model (Integrated Catch-at-Age, ICA) was used to estimate stock status through 2001. ICA was a hybrid model (i.e., a combination of separable and classical virtual population analysis) which used a backward projection instead of the more familiar forward projection method; thus, ICA solved for the population numbers in the most recent year and the number of the fish in the oldest age bin which together with the selectivity and annual fishing mortality rates allowed the calculation of the numbers of fish by age and year and the corresponding predicted catch-at-age. Muller *et al.* (2003) estimated that the age-6 fishing mortality rate in 2001 (F_{2001}) was 0.21 yr^{-1} and SSB in 2001 (SSB_{2001}) was 5,198 metric tons. SSB_{MSST} was defined as 0.8 * SSB_{MSY} and the Maximum Fishing Mortality Threshold (MFMT) as F_{MSY}. SSB_{2001}/SSB_{MSST} was 1.06 (not overfished) and F_{2001}/F_{MFMT} was 0.65 (not overfishing). Model estimates for age-6 fishing mortality rates during 1988 and 1990 were 0.24 yr^{-1} and 0.28 yr^{-1}, respectively (Muller *et al.* 2003).

The second SEDAR assessment for southeastern U.S. Yellowtail Snapper (SEDAR 27A, O'Hop *et al.* 2012) was completed in 2012 and applied a forward-projecting, statistical catch-at-age model (ASAP2) to data from 1981 – 2010. This type of model required catch-at-age and mean weight-at-age matrices, as well as age-based selectivities. O'Hop *et al.* (2012) estimated that the age-5 fishing mortality rate in 2010 was 0.05 yr^{-1} and SSB in 2010 was 10,311 metric tons. SSB_{MSST} was defined as 0.806 * $SSB_{30\%SPR}$ and the MFMT as $F_{30\%SPR}$. SSB_{2010}/SSB_{MSST} was 3.36 (not overfished) and F_{2010}/F_{MFMT} was 0.15 (not overfishing). Model estimates for age-5 fishing mortality rates during 1988, 1990, and 2001 were 0.10 yr^{-1}, 0.11 yr^{-1}, 0.06 yr^{-1} respectively (O'Hop et al. 2012).

The SEDAR 64 benchmark assessment (SEDAR 2020), completed in 2020, estimated the status of the southeastern U.S. Yellowtail Snapper population through 2017 and ultimately projected landings under five projection scenarios from 2021 through 2025 (Joint SSC 2020). The base model was developed in Stock Synthesis 3 (SS3, version 3.30.14), an age- and size-structured assessment model in the integrated analysis class of models. The model was configured with three fleets (commercial, headboat, and MRIP [a combination of charter, private, and shore modes]), two fishery-dependent indices (commercial CPUE and MRIP CPUE), and two fishery-independent indices (RVC juvenile and RVC adult). Unlike ASAP models, SS3 allows for length-based selectivities and explicitly models length-based retention to align with fishery regulations. SSB_{MSST} was defined as 0.75 * $SSB_{30\%SPR}$ and the MFMT as $F_{30\%SPR}$. SEDAR 64 (2020) estimated that the age-4 fishing mortality in 2017 was 0.343 yr^{-1} and SSB in 2017 was 3,207 metric tons. SSB_{2017}/SSB_{MSST} was 2.25 (not overfished) and F_{2017}/F_{MFMT} was 0.77 (not overfishing).

An interim analysis (Allen & Swanson 2022) was conducted for Yellowtail Snapper following the benchmark SEDAR 64 stock assessment (SEDAR 2020) after concerns were raised that management changes would require the use of projections beyond five years from the terminal year (i.e., 2017) of the SEDAR 64 benchmark assessment. Both Councils' Scientific and Statistical Committees discourage the use of projections beyond five years from the terminal data year in a stock assessment due to increases in uncertainty in the projections beyond that time frame (Schueller et al. 2022). Therefore, the analysis updated the SEDAR 64 base model by applying updated landings and discards data for each fleet for years 2018 – 2020. Allen & Swanson (2022) estimated that the age-4 fishing mortality in 2020 was 0.281 yr^{-1} and SSB in 2020 was 2,810.33 metric tons. SSB_{2020}/SSB_{MSST} was 1.47 (not overfished) and F_{2020}/F_{MFMT} was 0.68 (not overfishing).

Allen, S.D. and C.E. Swanson. 2022. Interim analysis for Southeastern U.S. Yellowtail Snapper. SEDAR 64. Florida Fish and Wildlife Conservation Commission. St. Petersburg, FL. 62p. (https://sedarweb.org/documents/2022-interim-analysis-of-sedar-64-se-us-yellowtail-snapper/)

Huntsman. O.R, Potts, J.C., Mays, R., Dixon, R.L., Willis. P., Burton, M.L., Harvey, B.W., 1992. A stock assessment of the snapper-grouper complex in the US South Atlantic based on fish caught in 1990. Report Submitted to the South Atlantic Fishery Management Council, Charleston, SC. This report may be obtained from Michael L. Burton, NOANNOS/CCFHR. Beaufort, NC.

Joint Gulf of Mexico and South Atlantic Scientific and Statistical Committees (2020, October 30). Meeting Report. SEDAR, North Charleston SC. 5 pp. Available online at: https://sedarweb.org/documents/sa-gulf-sscs-oct-2020-joint-webinar-report-sedar-64-yellowtail-snapper/

Muller, R. G., M. D. Murphy, J. deSilva, L. R. Barbieri. 2003. A stock assessment report of yellowtail snapper, *Ocyurus chrysurus*, in the southeast United States. SEDAR 3 Assessment Report 1. South Atlantic Fishery Management Council. Charleston, SC. 330p. (http://www.sefsc.noaa.gov/sedar/download/SEDAR3_SAR1_Final.pdf?id=DOCUMENT)

O'Hop, J., M.D. Murphy, and D. Chagaris. 2012. The 2012 stock assessment report for yellowtail snapper in the South Atlantic and Gulf of Mexico. South East Data, Assessment, and Review. SEDAR. 27A. Technical Report, Florida Fish and Wildlife Conservation Commission. St. Petersburg, FL. 341p.

Schueller, Amy, Jie Cao, Chip Collier, Scott Crosson, Judd Curtis, Chris Dumas, Genny Nesslage, Fred Scharf, and Erik Williams. 2022. SSC Catch Level Projections Workgroup Final Report. 33 pp. SEDAR 79-RD-11.

SEDAR. 2020. SEDAR 64 Southeastern US Yellowtail Snapper Stock Assessment Report. SEDAR, North Charleston SC. 457 pp. available online at: http://sedarweb.org/sedar-64.

4 REGIONAL MAPS

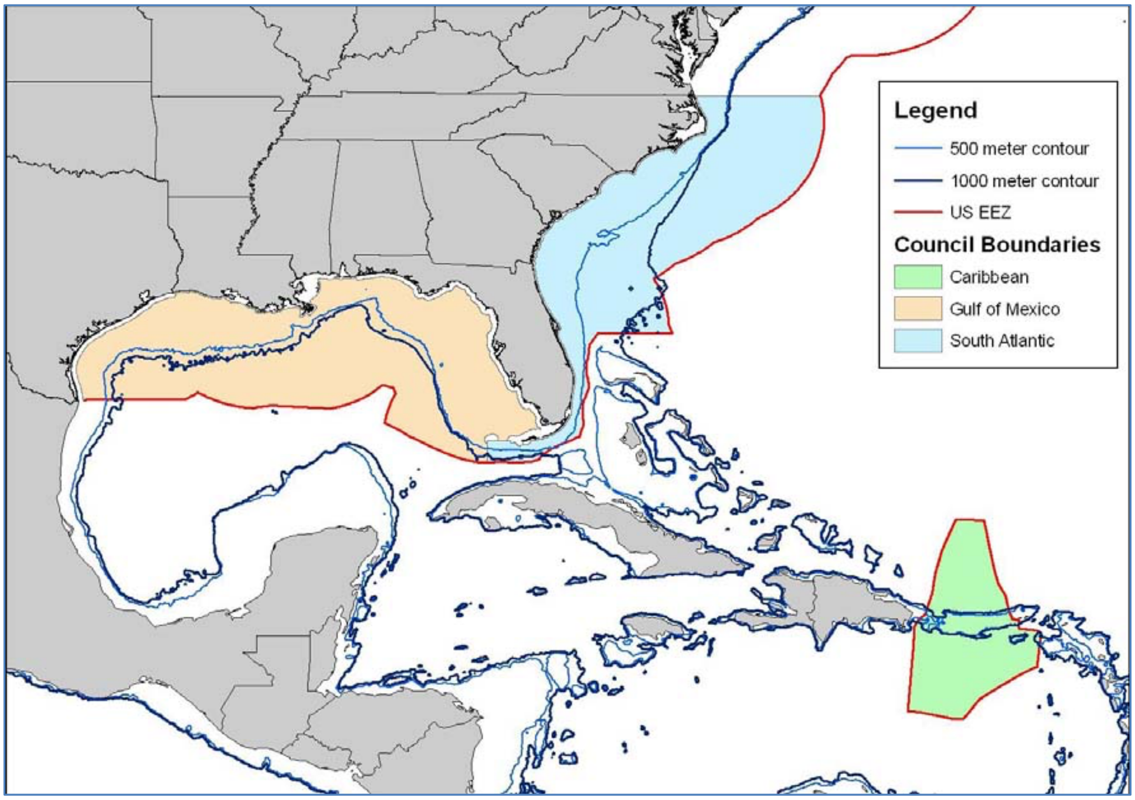

Figure 4.1 Southeast Region including Council and EEZ Boundaries.

5 SEDAR ABBREVIATIONS

ABC	Acceptable Biological Catch
ACCSP	Atlantic Coastal Cooperative Statistics Program
ADMB	AD Model Builder (software program)
ALS	Accumulated Landings System: SEFSC fisheries data collection program
AMRD	Alabama Marine Resources Division
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 96

Southeastern U.S. Yellowtail Snapper

SECTION II: Assessment Report

January 2025

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

Table of Contents

1 Introduction

An operational assessment was conducted for Yellowtail Snapper following the SEDAR 64 benchmark stock assessment (SEDAR 2020) and subsequent Interim Analysis (Allen and Swanson 2022; http://sedarweb.org/sedar-64) and implemented in the Stock Synthesis integrated modeling framework in version 3.30.15 (Methot and Wetzel 2013). This assessment updated all data streams available in the SEDAR 64 base model and Interim Analysis for years 1992 – 2023 and included several changes to the data or modifications in methodology. A major change in this assessment was the inclusion of recreational private mode catch data from Florida's State Reef Fish Survey (SRFS) for years 2021 – 2023 and calibration ratios to adjust historic (1981 – 2020) MRIP private mode estimates. This decision was brought about not only due to the availability of the SRFS private mode catch data but largely because the results of the recent MRIP study showed that the current MRIP Fishing Effort Survey design was likely overestimating fishing effort (NOAA 2023). Therefore, the SRFS estimates replaced the MRIP private mode catch estimates and combined with the other MRIP shore and charter modes to generate a 'full SRFS' catch timeseries. Other modifications included reconfiguring of fishery-independent indices and accompanying length composition data, methodological changes to the standardization of fishery-dependent indices, and reconfiguring of recreational age composition data. Adjusted projections of spawning stock biomass, recruitment, and retained yield to inform the Acceptable Biological Catch (ABC) and the Annual Catch Limit (ACL) account for the updated data components.

1.1 Workshop Time and Place

SEDAR 96 addressed the stock assessment for southeastern U.S. Yellowtail Snapper. The assessment was conducted by the FWC. One Topical Working Group (TWG) was convened in May 2024 by SEDAR to review and provide recommendations on data and modeling modifications from SEDAR 64. The TWG focused its discussion on the State of Florida's State Reef Fish Survey.

1.2 Terms of Reference

1. Update the SEDAR 64 Southeastern U.S. Yellowtail Snapper base model (including modifications approved in the 2022 Interim analysis) with data through 2023.
    - Explore the State of Florida's State Reef Fish Survey (SRFS) to inform private recreational landings data, and consider its use in the current assessment.
    - Document any changes or corrections made to model and input datasets and provide updated input data tables.
    - Update life history data (e.g., growth, reproduction, natural mortality) if warranted.

2. Update model parameter estimates and their variances, model uncertainties, estimates of stock status and management benchmarks, and provide the probability of overfishing occurring at specified future harvest and exploitation levels. Provide commercial and recreational landings and discards in pounds (whole weight) and numbers.
    - Use the following status determination criteria (SDC):
        - MSY = yield at F_{MSY} (or proxy; currently 30%SPR)
        - MSST = $0.75*SSB_{MSY}$
        - MFMT = F_{MSY} (or proxy, currently $F_{30\%SPR}$) and $F_{Rebuild}$ (if overfished)
        - OY = ABC, based on the SAFMC ABC control rule
        - If different SDC are recommended, provide outputs for both the requested and recommended SDC.
    - Unless otherwise recommended, use the geometric mean of the previous three years' fishing mortality to determine $F_{Current}$. If an alternative approach is recommended, provide justification and outputs for the current and alternative approach.

- Once projections are parameterized and the scientific uncertainty evaluated, provide yield and spawning stock biomass streams for the overfishing limit and acceptable biological catch in pounds (whole weight):
    - Annually for five years using constant F
    - Under a “constant catch” scenario for both three and five years
    - For the equilibrium yield at F_{MSY}, when estimable

3. Develop a stock assessment report to address these terms of reference and fully document the input data, methods, and results of the analyses.

1.3 List of Participants

Topical Working Group Members

Chris Swanson (Lead Analyst)	FWC/FWRI
Dustin Addis	FWC/FWRI
Shanae Allen	FWC/FWRI
Samantha Binion-Rock	SEFSC
Bridget Cermak	FWC/FWRI
Rob Cheshire	SEFSC
Heather Christiansen	FWC/FWRI
Ellie Corbett	FWC/FWRI
Tiffanie Cross	FWC/FWRI
Jim Gartland	SAFMC SSC
Jim Nance	GMFMC SSC
Steve Papen	Industry Representative
Chloe Ramsey	FWC/FWRI
Beverly Sauls	FWC/FWRI
Ted Switzer	FWC/FWRI
Steve Turner	SAFMC SSC

Attendees

Kelly Adler	NMFS/SEFSC
Leonardo Eguia	FWC
Matthew Green	SEFSC
Doug Gregory	Florida Stakeholder
Janette Huber	FWC
Rich Malinowski	NMFS
Maria McGirl	FWC
Robert Muller	FWC/FWRI
Halie O’Farrell	FWC/FWRI
Julia Reeves	FWC/FWRI
Jasmine Silvennoinen	FWC/FWRI
Rebecca Scott	FWC
CJ Sweetman	GMFMC
Jim Tolan	Texas Stakeholder

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Julie Neer	SEDAR
Judd Curtis	SAFMC Staff
Lisa Hollensead	GMFMC Staff
Allie Iberle	SAFMC Staff

Emily Ott	SEDAR
Ryan Rindone	GMFMC Staff
Mike Schmidtke	SAFMC Staff

1.4 List of Working Papers & Reference Documents

Document #	Title	Authors	Date Submitted
Documents Prepared for the Operational Assessment			
SEDAR96-WP-01	General Recreational Survey Data for Yellowtail Snapper in the Gulf of Mexico and South Atlantic	Samantha M. Binion-Rock	5 August 2024
SEDAR96-WP-02	Headboat Data for Yellowtail Snapper in the Southeast U.S. Atlantic and Gulf of Mexico	Robin T. Cheshire, Kenneth Brennan, Matthew E. Green, Ariel Poholek and Jasmine Silvennoinen	9 August 2024
SEDAR96-WP-03	Estimated Commercial Discards of Florida Yellowtail Snapper (*Ocyurus chrysurus*) for the Vertical Line Fishery	Sarina Atkinson, Kevin Thompson, Gary Decossas	14 August 2024
SEDAR96-WP-04	Standardized catch rates of Yellowtail Snapper from the United States Gulf of Mexico and South Atlantic commercial handline fishery, 1993-2023	Michaela Pawluk and Kevin Thompson	22 August 2024
SEDAR96-WP-05	A ratio-based method for calibrating MRIP-SRFS recreational fisheries estimates for southeastern US Yellowtail Snapper (*Ocyurus chrysurus*)	Chloe Ramsay, Tiffanie A. Cross, Colin P. Shea, and Beverly Sauls	9 August 2024
SEDAR96-WP-06	Proxy Discard Estimates of Yellowtail Snapper (*Ocyurus chrysurus*) from the US Gulf of Mexico and South Atlantic Headboat Fishery	Matthew A. Nuttall	23 August 2024
SEDAR96-WP-07	Size and age information for Southeastern US Yellowtail Snapper, *Ocyurus chrysurus*, collected in association with fishery-dependent projects	Maria McGirl, Jessica Carroll, and Bridget Cermak	12 September 2024
SEDAR96-WP-08			
SEDAR96-WP-09			
Final Stock Assessment Report			
SEDAR96-SAR1	Southeastern US Yellowtail Snapper		
Reference Documents			

SEDAR96-RD01	Certification Review of Florida's Proposed MRIP-SRFS Calibration Methodology for Mutton and Yellowtail Snapper	NOAA Fisheries Office of Science and Technology and the Southeast Fishery Science Center
SEDAR96-RD02	Transition Plan for Gulf State Recreational Fishing Surveys	Gulf of Mexico Subgroup of the MRIP Transition Team
SEDAR96-RD03	SAFMC SSC Catch Level Projections Workgroup Final Report	SAFMC SSC Catch Level Projections Workgroup

2 Data Review and Update

The first term of reference for SEDAR 96 requires that the SEDAR 64 base model (including modifications approved in the 2022 Interim Analysis) be updated with data through 2023. This includes any updates to life history information (if warranted), to document any changes or corrections made to model and input datasets (providing updated input data tables), and to explore the State of Florida's State Reef Fish Survey (SRFS) to inform private recreational landings data. A review of the available data and updates which have occurred for SEDAR 96 are provided in the subsections below to satisfy this term of reference.

2.1 Stock Structure and Management Unit

The Yellowtail Snapper fishery is managed in the U.S. by the South Atlantic Fishery Management Council (SAFMC) and the Gulf of Mexico Fishery Management Council (GMFMC) as separate stock units, with the boundary being U.S. Highway 1 in the Florida Keys west to the Dry Tortugas (Figure 1). The State of Florida also participates in the management of this species in state waters. Other states in the SAFMC and GMFMC jurisdictions defer to the federal management regulations for this species.

Both SEDAR 3 (Muller et al. 2003) and SEDAR 27A (O'Hop et al. 2012) used data from genetic analyses available at the time (e.g., Hoffman et al. 2003) to treat Yellowtail Snapper in the SAFMC and GMFMC jurisdictions as a single stock for assessment purposes. This approach was discussed and recommended in the SEDAR 64 benchmark assessment and, as a result, continues to be applied here.

2.2 Life History

2.2.1 Morphometric and Conversion Factors

The management regulations on minimum legal size for Yellowtail Snapper specify a 12" total length (TL) and that the fish can be measured either with the tail flat in its normal shape ("relaxed") or with the tips of the tail compressed to its maximum length ("maximum"). Multiple types of length measurements (standard [SL], fork [FL], and TL) are taken for Yellowtail Snapper by the various fishery-dependent and -independent data collection programs (e.g. Trip Interview Program [TIP], Marine Recreational Information Program [MRIP], Southeast Region Headboat Survey [SRHS], and FWRI-FDM), but FL is commonly measured since this species has a deeply forked tail. The FWRI fishery-dependent monitoring program has measured SL, FL, and TL ("relaxed" and "max") measurements to provide a way of converting between the different measurement methods. SEDAR 3 (Muller et al. 2003) treated the headboat TL measurements without correction for the $TL_{relaxed}$ measurement method. SEDAR 27A (O'Hop et al. 2012) converted all FL measurements and headboat TL measurements (when a FL was not measured) to "maximum" TL. SEDAR 64 converted all TL measurements to FL to match most data collection programs. Length-length (simple linear regression; Table 1) and length-weight (nonlinear power function; Table 2) equations were developed and presented in the benchmark assessment and were applied here to updated data from fishery collection programs.

2.2.2 Age and Growth

The National Marine Fisheries Service Panama City laboratory (PCLAB), the National Marine Fisheries Service Beaufort laboratory (NCLAB), and the Florida Fish and Wildlife Research Institute (FWRI) age and growth laboratory supplied data from 74,402 otoliths sampled from years 1980 – 2023. These otoliths were collected by various federal and state biologists involved in fishery-dependent (e.g., TIP, SRHS, and MRIP; McGirl et al. 2024) and fishery-independent (FWRI's Fisheries Independent Monitoring and Fish Biology) data collection programs on both the Atlantic and Gulf of Mexico coasts. Sectioned otoliths are the preferred structures for ageing Yellowtail Snapper (Johnson 1983, Manooch and Drennon 1987, Garcia et al. 2003) and were used to count annuli, score the edge type, and adjust the annuli counts to provide age estimates in years.

Yellowtail Snapper otoliths sampled from Florida waters came primarily (71%) from the Florida Keys region (Monroe County; n = 52,759 otoliths) while 25% (n = 18,708 otoliths) came from the southeast Florida region (Indian River County south to Miami-Dade County; Table 3, Figure 2). Age data for Yellowtail Snapper remain predominantly from fishery-dependent age sources (55% commercial, 35% headboat, and 8% MRIP [private, charter, and shore modes]), while the number of ages from fishery-independent sources is very low, 2% (Table 4, Figure 3). Table 5 displays the number of Yellowtail Snapper ages sampled by year in the state of Florida (n = 74,402 otoliths); half (50%) of the Yellowtail Snapper age data were of fish aged 2 and 3 years and fish aged 2 – 6 comprised 89% of the data.

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 advanced by one year if a large translucent zone was visible on the margin and the capture date was between January 1 and June 30. For all fish collected after June 30, age was assigned to be annulus count. Calendar ages were then converted to fractional or monthly biological ages based on an April 1 hatch date and month of capture following McGirl et al. (2024) and the methods used in SEDAR 64.

2.2.2.1 Subsampling

Subsampling of the age data for years 2021 – 2023 was required due to the unanticipated request for this assessment and the available resources of FWRI's age and growth lab at the time of request. Personnel from the PCLAB shared with FWRI a subsampling methodology that they have implemented in recent assessments (e.g., Gulf of Mexico Scamp Grouper for SEDAR 68 (2021)). In brief, the strategy was developed by Clay Porch and Gary Fitzhugh (Steve Garner, PCLAB, pers. comm.) and based on simulation work resulting in a required minimum sample size of 500 otoliths per strata. To generate the subsample, landings from the 5-year period prior to the subsampling years are parsed by strata and averaged across the 5 years. A single set of landings proportions is then derived and applied to each of the years in the subsampling period. A target number of randomly selected subsamples is designated (i.e., n = 500 samples per strata per year) which is then multiplied by the landings proportion within each stratum. If the number of samples available does not meet or exceed the targeted number of subsamples, only the number available are sampled.

Landings were averaged by fleet (Commercial, Headboat, MRIP) and region (northeast FL, southeast FL, Florida Keys, southwest FL, and northwest FL) for years 2016 – 2020 and a single proportion was derived for each fleet and applied to years 2021 – 2023. The proportion of averaged landings from the northeast and northwest regions of each fleet was found to be less than 1%; consequently, those regions did not have targeted subsamples assigned to them. This resulted in nine strata encompassing three regions (southeast FL, Florida Keys, southwest FL) and three fleets (Commercial, Headboat, and MRIP). Furthermore, a targeted number of 500 subsamples per strata results in 4,500 total subsampled otoliths processed – more than the FWRI age and growth lab could process by the required deadline. The targeted subsample size was therefore adjusted to 300 subsamples per strata which amounts to 2,700 total subsampled otoliths targeted.

Table 6 describes the results of the utilized subsampling routine. For the commercial fleet, 6 otoliths from the southeast region, 291 otoliths from the Florida Keys, and 3 otoliths from the southwest region were targeted for each year. The targeted number of 300 subsamples was reached in 2022 and 2023, however, only 266 fish were aged in 2021. For the headboat fleet, 84 otoliths from the southeast region, 197 otoliths from the Florida Keys, and 18 otoliths from the southwest region were targeted for each year. There were 139 fish aged in 2021, 298 fish aged in 2022, and 299 fish aged in 2023. Lastly, the MRIP fleet targeted 129 otoliths from the southeast region, 149 otoliths from the Florida Keys, and 22 otoliths from the southwest region for each year. A total of 254 fish were aged in 2021, 292 fish in 2022, and 291 fish were aged in 2023. Thus, of the total number of targeted subsamples (2,700 otoliths), only 2,439 could be aged. This discrepancy was largely attributed to broken otoliths and a handful of wrongly identified species.

2.2.2.2 Growth

In SEDAR 64, length-at-age data based on fractional (monthly biological) ages and observed fork lengths at capture were modeled externally from the assessment model using a size-truncated von Bertalanffy growth model (Diaz et al. 2004) executed in AD Model Builder version 11.6 (Fournier et al. 2012, admb-project.org) to account for the minimum size limits imposed on the fishery-dependent age data. The von Bertalanffy growth parameters were estimated to be: *Linf* = 42.3 cm FL, *k* = 0.207 year^{-1}, *t0* = -1.636 year, and CV = 0.179 based on 47,886 otoliths. The external growth model was not updated for this assessment as growth model parameters were used as initial values (i.e., not fixed inputs) in the SEDAR 64 base model which continued to be applied here. The predicted mean length-at-age according to the von Bertalanffy growth model is described in Table 7.

2.2.3 Natural Mortality

In SEDAR 64, the natural mortality rate of Yellowtail Snapper was estimated with the assumption that the instantaneous natural mortality, which followed the Hoenig$_{\text{all taxa}}$ (1983) equation, should be inversely related to fish length (Lorenzen 2005) and held constant over time. The maximum age used in the Hoenig$_{\text{all taxa}}$ (1983) equation was the maximum age observed in Florida (20 years) which aligned with other Yellowtail Snapper life history data coming exclusively from Florida and the focus of providing management advice for this predominantly Florida-based fishery. Lengths-at-age were predicted using the size-truncated von Bertalanffy growth model as described above and were used to estimate natural mortality-at-age.

The instantaneous natural mortality estimate was calculated to be 0.223 yr^{-1} and was used as the constant-*M* scaled between ages 3 – 20. Applying the parameters from the external growth model, estimated age-specific natural mortality rates ranged from 0.558 yr^{-1} to 0.198 yr^{-1} for ages 0 to 20 years (Table 7). These were used in the SEDAR 64 base model as a fixed input vector and continued to be applied as a fixed input here.

2.2.4 Reproduction

An age-based maturity schedule was developed during SEDAR 64 using a logistic regression on available female Yellowtail Snapper histological data collected from 1999 – 2002. The data included 205 individuals up to age-12 that were collected during spawning season between April and October. The analysis was performed using PROC NLIN (SAS version 9.2) and showed that 50% of the females were mature at 1.7 years old and 100% by age 4 years. The maturity-at-age ogive was used in the SEDAR 64 base model as a fixed input with predicted maturity proportions extended to age-20. As no further data have become available, the maturity schedule continued to be applied here (Table 7).

Estimates of fecundity in Yellowtail Snapper are limited. In the Florida Keys, Collins and Finucane (1989) estimated ovarian egg numbers between 11,000 and 1,391,000 from 44 fish ranging in size and weight between 200 – 480 mm FL and 168 – 1,784 g total weight. Egg number estimates from 4 fish off western Cuba reported by Piedra (1969; and corrected by Collins and Finucane 1989) ranged between 99,666 – 618,742 eggs from fish ranging in size and weight between 292 – 382 mm FL and 402 – 920 g total weight. Cummings (2004) cites and presents additional model results of fecundity at-age and at-weight estimates from Collins and Finucane (1989; 60 fish) and de Albornoz and Grillo (1993; 60 fish). The SEDAR 64 base model was configured to use spawning biomass as a proxy of fecundity and that configuration continued to be applied here.

2.3 Landings

2.3.1 Commercial

Commercial landings (whole pounds, metric tons) of Yellowtail Snapper were informed by the NMFS Accumulated Landings System (ALS) data for years 1981 – 1985 and from Florida’s Marine Fisheries Trip Ticket program for years 1986 – 2023 (Table 8). Landings in Table 8 are presented by concatenated Florida regions to protect any potential confidential data. Hook and line gear types continued to be the dominant fishing gear for Yellowtail Snapper by commercial fishermen. Recent landings decreased in trend from the timeseries high in 2017 (2,781,286 lbs., 1,261.540 mt) through 2020 (1,395,705 lbs., 633.081 mt) and remained at lower levels post-COVID-19 pandemic through 2023. Landings were 1,621,388 lbs. (735.449 mt) in 2021, were 1,778,533 lbs. (806.729 mt) in 2022, and 1,453,573 lbs. (659.330 mt) in 2023. Landings continued to be predominantly from the Florida Keys region (Table 8, Figure 4) and represented 97.9%, 94.0%, and 96.8% of the 2021 – 2023 landings, respectively. Percent composition of total landings from the south Atlantic region of Florida (northeast and southeast Florida regions) has been consistently less than 5% of the total landings in Florida since 2013. The CVs for commercial landings were assumed to equal 0.10 for years 1981 – 1985 and 0.05 for years 1986 – 2023 as recommended during SEDAR 64.

Commercial landings in whole weight kilograms were converted to landings in numbers based on mean weight (in kilograms whole weight) from the TIP data for each year, Florida region, and gear (hook and line, other/unknown). When the TIP sample size (number of fish) by year and Florida region for both hook and line and other gear was greater than or equal to 50, estimates of mean weight were applied to the corresponding landings in weight and this was the preferred method. However, adequate sample sizes do not exist at this resolution for all years. Consequently, for years when sample size at this resolution was less than 50, one of three approaches was applied in ascending order. First, years were aggregated into 5-year blocks (e.g., 1984 – 1988, 1989 – 1993, etc.) by Florida region and gear category and a mean weight was calculated. Next, where sample sizes were still below the threshold, the data further aggregated the Florida regions into east Florida (northeast and southeast), Florida Keys, or west Florida (northwest and southwest) for each 5-year block and gear category and a mean weight was calculated. If the remaining sample sizes continued to be less than 50, then the data were further aggregated by year (i.e., all years combined) for each aggregated region (east, west, Florida Keys) and gear and mean weights were calculated. The calculated numbers of fish can be found in Table 9 and Figure 5 where numbers of fish are presented by concatenated region to mask any potential confidential data.

2.3.2 Southeast Region Headboat Survey (SRHS)

Estimates of headboat landings of Yellowtail Snapper from 1981 – 2023 were obtained from the Southeast Region Headboat Survey (SRHS). Details on this survey and as it pertains to Yellowtail Snapper are available in Cheshire et al. (2024). In addition, early landings estimates from the headboat mode of the Marine Recreational Information Program (MRIP) were available and included for years 1981 – 1985. Headboat landings continued to be a small component of the total recreational Yellowtail Snapper landings and were 214,744 fish (290,894 lbs.) in 2021, 113,868 fish (98,471 lbs.) in 2022, and 102,332 fish (85,081 lbs.) in 2023 (Tables 10 and 11, Figure 6). Since 2017, landings were highest from the FL Keys region, averaging 64% of the total headboat landings while southeast FL has averaged 19% (Table 10).

For SEDAR 64 and the Interim Analysis, the annual CVs were assumed equal to the recommended value of 0.05 and continued to be applied here. However, estimates of uncertainty were recently developed by the SRHS based on logbook reporting compliance and were provided in the form of both weighted and unweighted proxy CVs in Cheshire et al. (2024).

2.3.3 Marine Recreational Information Program (MRIP)

Estimates of recreational landings of Yellowtail Snapper from 1981 – 2023 by anglers fishing from shore or using private, rental boats, or charterboats were available and provided by the Marine Recreational Information Program (MRIP, Binion-Rock 2024). Estimates were fully calibrated based on the Access Point Angler Intercept Survey (APAIS) and Fishing Effort Survey (FES). Estimated MRIP landings were 1,228,153 fish (1,185,684 lbs.) in 2021, 1,684,682 fish (1,999,334 lbs.) in 2022, and 1,682,210 fish (1,636,276 lbs.) in 2023 (Table 12). Landings from 2021 – 2023 were predominantly from the Florida Keys and southeast Florida regions (Tables 13 and 14, Figure 7) and comprised 98%, 90%, and 90% of the annual landings, respectively. Estimated landings from southwest Florida have been recently increasing with a timeseries high of 304,551 fish in 2017, followed by 174,795 fish in 2022, and 169,210 fish in 2023 (Table 13, Figure 7) and could suggest a possible shift beginning for this region. Recreational landings of Yellowtail Snapper in Florida came primarily from the private mode (Table 15, Figure 8) which have averaged 80% of the landings since 2017, followed by the charter mode (averaged 18%). Private mode landings estimates were 921,184 fish (825,672 lbs.) in 2021, 1,261,603 fish (1,561,707 lbs.) in 2022, and 1,413,282 fish (1,340,561 lbs.) in 2023 (Table 15, Figure 8). The annual CVs for the estimated landings were provided by MRIP and are listed in Table 12.

2.3.4 Florida's State Reef Fish Survey (SRFS)

In response to a need for more precise estimates of recreational catch for reef fishes, particularly from the private mode, FWC developed and implemented a new survey that runs side-by-side with the historic MRIP. While the MRIP is a general survey of all saltwater recreational fishing in both state and federal waters, the State Reef Fish Survey (SRFS) is a supplemental, more specialized survey that directly targets participants in the reef fish fishery to collect information on effort and catch (Ramsay et al. 2024). Initially named the Gulf Reef Fish Survey and started in 2015 on only the west coast of Florida, the survey was renamed when it expanded statewide in July 2020 to include Monroe country and the Atlantic coast of Florida. The survey was peer reviewed in 2022 by NOAA OS&T statistical consultants (NOAA 2022) and deemed fit for use in stock assessments.

The first TOR for this assessment requests exploration of the SRFS data to inform private mode recreational landings and discard estimates for Yellowtail Snapper. Therefore, a topical working group was created in the beginning stages of this assessment to discuss the survey, its ratio-based approach to calibrate historic MRIP estimates to SRFS currency, its use in other assessments (most recently SEDAR

79 (2024) Mutton Snapper and also SEDAR 72 (2021) Gulf of Mexico Gag Grouper), and its appropriateness here. Ultimately, the working group approved the use of the SRFS estimates for survey years 2021 – 2023 and its ratio-based approach to calibrate MRIP private mode landings from 1981 – 2020. Further details on the survey and methods can be found in Ramsay et al. (2024).

Private mode landings from SRFS were estimated to be 953,254 fish (917,031 lbs.) in 2021, 744,795 fish (1,033,522 lbs.) in 2022, and 550,656 fish (530,718 lbs.) in 2023 (Table 16, Figure 9). While the SRFS estimate in 2021 was similar to the MRIP estimate for the same year, SRFS landings trended downward through 2023 whereas MRIP estimates trended upward. To calibrate the historic MRIP estimates for years 1981 – 2020, the ratio 0.625323 was applied to the MRIP private mode landings for units in numbers of fish while the ratio 0.665588 was applied to the MRIP private mode landings in units of pounds (Table 16, Figure 9). To generate the full SRFS landings timeseries, the SRFS (2021 – 2023) and SRFS-calibrated MRIP (1981 – 2020) private mode landings estimates were added to the MRIP charter (1981 – 2023) and shore mode (1981 – 2023) landings estimates. Thus, the SRFS landings estimates were 1,260,223 fish (1,277,043 lbs.) in 2021, 1,167,874 fish (1,471,149 lbs.) in 2022, and 819,584 fish (826,434 lbs.) in 2023 (Table 17, Figure 9). A comparison between the full SRFS landings estimates and the MRIP landings is also shown in Figure 10.

To calculate the annual CVs for the SRFS timeseries, the annual variance from each fishing mode was summed and then square-root transformed to obtain the standard deviation, which was then divided by the summed landing estimate across each fishing mode. Annual CVs for the SRFS and SRFS-calibrated private mode landings estimates are provided in Table 16 and the CVs for the SRFS landings timeseries are provided in Table 17.

2.4 Discards

2.4.1 Commercial

Commercial discards of Yellowtail Snapper have primarily been estimated using commercial discard logbook data (McCarthy & Diaz 2019), where catches were predominantly from the Florida Keys region. However, a recent analysis conducted by the Southeast Fisheries Science Center (SEFSC) concluded they no longer recommend the use of discard logbook data for estimating discards for SEDAR (Alhale et al. 2024). Alternative methods were therefore explored and implemented here using commercial observer data and are described in more detail in Atkinson et al. (2024). The general approach for estimating discards for the commercial vertical line fleet utilized a discard rate, or discards-per-unit-effort from the reef fish observer programs, and total fishing effort from the Coastal Fisheries Logbook Program (CFLP). Only the FL Keys, southeast FL, and southwest FL regions contained information on discards of Yellowtail Snapper and observer coverage differed across these regions. Consequently, two methodologies were recommended from the working paper which 1) estimated discards within the Florida Keys, where sampling was more available, and 2) estimated discards within the southeast and southwest Florida regions where data were more limited. The recommended method for the data-limited regions calculated discard rates based on discards in numbers and effort as cumulative fishing time (i.e., total hours fished).

Commercial discards of Yellowtail Snapper within Florda for years 1993 – 2023 and associated annual CVs are presented in Table 18. A total of 72,321 fish were estimated to have been discarded in 2021, 71,161 fish in 2022, and 78,748 fish in 2023 (Table 18, Figure 11). Discards were predominantly from the Florida Keys region with discards from southeast FL declining consistently through time (Table 19, Figure 11). Figure 12 compares the estimates of commercial discards provided here with those produced for SEDAR 64 and the Interim Analysis. Discards begin to significantly differ in trend from year 2008 onward; previous estimates continue to decline though time while those provided here increase and become stable but variable.

2.4.2 Southeast Region Headboat Survey (SRHS)

Estimates of recreational discards of Yellowtail Snapper by headboats were provided by the SRHS and recommended for use for years 2008 – 2023 (Cheshire et al. 2024). Discards were not added to the SRHS logbook form until 2004; therefore, a proxy method is needed to construct discard estimates either for prior years (e.g., 1981 – 2003) and/or for any years which the SRHS discard estimates are considered inaccurate (e.g., 2004 – 2007). Construction of proxy discards was therefore explored for years 1981 – 2007 using both the 'super-ratio' and 'SRHS-Mean' approaches (Nuttall 2024). While the 'super-ratio' approach is considered the current "best practice", it produced proxy discards that were highly variable and not believed to be representative of a true trend in SRHS headboat catch in some years given the method's influence from the MRIP charterboat mode (particularly in 1991). The 'super-ratio' approach was used in SEDAR 64 (Allen et al. 2019), but the alternative 'SRHS-Mean' approach was ultimately recommended here (Nuttall 2024). Proxy discards were constructed by concatenating regions such that northwest, southwest, and Florida Keys regions were combined into a 'West' region while northeast and southeast Florida regions were combined into an 'East' region.

The constructed timeseries of headboat discards by concatenated region is presented in Table 20 and Figure 13. Headboat discards were 50,646 fish in 2021, 70,332 fish in 2022, and 66,215 fish in 2023. Discards were highest in the West region due to the Florida Keys and were 92.8%, 90.1%, and 90.4% of the total discards for years 2021 – 2023, respectively. Annual CVs were assumed to equal 0.5 as in SEDAR 64. Figure 14 compares the estimates of headboat discards provided here with those produced for SEDAR 64 and the Interim Analysis. The most significant difference, as mentioned in the working paper (Nuttall 2024), are in years 1987 – 1991 where the influence of the MRIP data using the 'super-approach' produces very large estimates of discarded fish.

2.4.3 Marine Recreational Information Program (MRIP)

Recreational estimates of live released Yellowtail Snapper from shore, private, and charter modes were provided by MRIP for years 1981 – 2023 (Binion-Rock 2024). Estimated live releases (i.e., B2 fish) were typically higher than estimated landings (i.e., A + B1 fish) by MRIP and since 2017 have averaged ~65% of the total catch (i.e., A + B1 + B2). Estimated discards were 2,663,648 fish in 2021, 2,575,739 fish in 2022, and 5,035,270 fish in 2023 (Table 21, Figure 15). Following the timeseries high of 13,560,780 fish discarded in 1991, which was considered highly suspicious by panel members at the SEDAR 64 Data Workshop, year 2023 was the second highest estimate of discarded Yellowtail Snapper. Similar to the trends in the landings, discarded Yellowtail Snapper are mostly from the Florida Keys and southeast FL regions (Table 22, Figure 15), averaging 97% across years 2021 – 2023. Discards by fishing mode (Table 23, Figure 16) are largely from the private mode (averaged 58% since 2017); however, discards estimated from the shore mode comprise a larger component (averaged 36% since 2017) compared to the trend observed in the landings. The annual CVs for the estimated discards were provided by MRIP and are listed in Table 21.

2.4.4 Florida's State Reef Fish Survey (SRFS)

Private mode discards from SRFS were estimated to be 1,351,912 fish in 2021, 1,062,409 fish in 2022, and 1,043,359 fish in 2023 (Table 24, Figure 17). To calibrate the historic MRIP estimates for years 1981 – 2020, the ratio 0.547875 was applied to the MRIP private mode discards. To generate the full SRFS discard timeseries, the SRFS (2021 – 2023) and SRFS-calibrated MRIP (1981 – 2020) private mode discard estimates were added to the MRIP charter (1981 – 2023) and shore mode (1981 – 2023) discard estimates. The full SRFS discard estimates from 1981 – 2023 is provided in Table 24 and Figure 17 where estimates were 2,309,118 fish in 2021, 2,018,906 fish in 2022, and 3,093,235 fish in 2023. A comparison between the full SRFS discard estimates and the MRIP discards is also shown in Figures 18.

To calculate the annual CVs for the SRFS timeseries, the annual variance from each fishing mode was summed and then square-root transformed to obtain the standard deviation. The standard deviation was then divided by the summed discard estimate across each fishing mode to obtain the CV. Annual CVs for the SRFS discard timeseries are provided in Table 24.

2.4.5 Discard Mortality

Discard mortality rates were treated here as fixed model inputs for each fishing fleet equal to the values recommended by the SEDAR 64 Data Workshop panel and as used in the SEDAR 64 base model (10% discard mortality rate for the commercial, headboat, and MRIP fleets). No sensitivity runs were conducted here as they were performed in the benchmark assessment using a 15% discard mortality rate for the commercial fleet and then a 20% and 30% discard mortality rate for the headboat and MRIP fleets.

2.5 Indices of Abundance

2.5.1 Coastal Fisheries Logbook Program (CFLP) Commercial Index

Available catch per unit effort data from the CFLP were used to construct a standardized index of relative abundance for Yellowtail Snapper landed with handlines (manual handline and electric reel) from 1993 – 2023. The index was constructed using data reported from commercial vertical line (handline and bandit rig) trips in southern Florida. Thus, the size and age range of fish included in the index is the same as that of landings from the commercial handline fleet. Since this index is retained catch per unit effort, the index was linked to the commercial fleet within the base model configuration. The updated commercial index and CVs are presented in Table 25 and Figure 19.

Details on the methodology for this index and how it differed from the one provided in SEDAR 64 are available in Pawluk and Thompson (2024). In brief, differences in the updated index, particularly between 2006-2014, were likely a function of the updated data affecting the subsetting procedure with Stephens and MacCall and, to a lesser extent, a change in the error distribution of the positive submodel to the more appropriate gamma distribution rather than the previously used lognormal. The CVs associated with this updated index are also considerably more precise (avg. CV = 0.04) compared to the prior submitted index (avg. CV = 0.18), as well as compared to the other available indices. A comparison of this index with the one submitted for SEDAR 64 is available in Figure 20.

2.5.2 Marine Recreation Information Program (MRIP) Index

Data from the MRIP were used to construct and update a standardized abundance index from recreational anglers who landed or released Yellowtail Snapper primarily in the Florida Keys (including the Dry Tortugas; Monroe County) and southeast Florida (Palm Beach, Broward, and Miami-Dade Counties) regions from 1991 – 2023. The MRIP collects data on both harvested (Types A + B1) and live released fish (Type B2); data on total catch (A + B1 + B2) at the trip level using only hook and line gear were utilized. Species clustering (Shertzer and Williams 2008) was performed on the updated data to identify trips that were either directly or indirectly targeting Yellowtail Snapper, and a delta-lognormal approach was used to generate the index (Lo et al. 1992; Dick 2004; Maunder and Punt 2004). The updated index and CVs are presented in Table 25 and Figure 19.

Following completion of the SEDAR 64 benchmark assessment, the analytical team discovered that the MRIP CPUE was mischaracterized in the final stock assessment report as a ‘total catch per trip’ index, but was in fact developed in units of ‘total catch per angler’. While this characterization of effort was consistent with the SEDAR 27A (O'Hop et al. 2012) benchmark assessment, it was the original intent of the S64 analytical team to update the index to units of 'total catch per trip' during the benchmark assessment process. For transparency, and given the level of influence this index had on the SEDAR 64 base model, a sensitivity run with an MRIP CPUE index correctly configured as total catch per trip was performed and presented during the SEDAR 64 Interim Analysis to evaluate any potential changes in stock abundance and trend. This change was also implemented here for SEDAR 96. A comparison of this index with the one submitted for SEDAR 64 is available in Figure 21.

2.5.3 Reef Fish Visual Census (RVC) Florida Keys and Dry Tortugas Indices

Personnel from the National Marine Fisheries Service began the Reef Fish Visual Census (RVC) in 1979 to provide long term monitoring data for reef fish populations along the Florida Reef Tract (Bohnsack and Bannerot 1986; Bohnsack et al. 1999; Ault et al. 2001; and Smith et al. 2011). The survey is now conducted by several agencies in three regions of the south Florida coral reef ecosystem domain: (1) the Florida Keys (Key Biscayne to west of Key West); (2) the Dry Tortugas; and (3) the southeast Florida region (Key Biscayne to Martin County). The survey originally employed a two-stage stratified random survey design (Cochran 1977; Brandt et al. 2009; Smith et al. 2011) in shallow water (<30 m) with sampling frames by hard-bottom habitat that were created by dividing the Florida Reef Tract into 200-m x 200-m grid cells, or primary sampling units (PSUs), and listing the habitat strata in each PSU. Over the years, the survey's methodology has undergone reviews and refinements have been made to the sampling design. Improvements in mapping resolution have led to more accurate benthic habitat classification and the survey has now evolved to a one-stage sampling design with 50-m x 50-m PSUs (Ault et al. 2021) to improve spatial resolution. This change, however, does not affect the index because the measuring unit for Yellowtail Snapper is the average abundance within a secondary sampling unit (SSU; a diver cylinder).

In SEDAR 64, the RVC indices combined the Florida Keys and Dry Tortugas regions, utilized the design-based approach, and were separated according to maturity-at-length where fish less than 19 cm fork length were used to create a juvenile index while fish greater than that were used to create an adult index (Herbig et al. 2019). Furthermore, only years containing overlapping sampling information between the two regions could be included. Neither survey sampled in year 2020 due to the COVID-19 pandemic, and the sampling periodicity post-COVID-19 for the Dry Tortugas region changed and became staggered to the Florida Keys region (e.g., Florida Keys sampling occurred in years 2022 and 2024 while the Dry Tortugas sampling occurred in years 2021 and 2023). Consequently, the indices can no longer be combined as they were in SEDAR 64. The RVC indices were therefore separated by region and retained for use for SEDAR 96. Moreover, indices used here were no longer parsed by maturity-at-length; instead, all Yellowtail Snapper observed were retained within the index. This change allows for a more unimodal length distribution for estimating selectivity. Beforehand, the split at 19 cm fork length split the length distribution at or near the mode, causing selectivity to be extremely knife-edged at either the beginning (e.g., adult sizes) or end (e.g., juvenile sizes) of the curve.

2.5.3.1 RVC Florida Keys Index

A design-based approach was used to model Yellowtail Snapper abundance within the Florida Keys region from June – September for years 1999 – 2012, 2014, 2016, 2018, and 2022). The analysis was performed in R (R Core Team 2024) using the package 'rvc', the function 'getRvcData' to gather the data by region, and the function 'getDomainDensity' to calculate the index of abundance. The index and CVs are presented in Table 25 and Figure 22.

2.5.3.2 RVC Dry Tortugas Index

A design-based approach was used to model Yellowtail Snapper abundance within the Dry Tortugas region from May – July for years 1999, 2000, 2004, 2006, 2008, 2010, 2012, 2014, 2016, 2018, 2021, and 2023). The analysis was performed in R (R Core Team 2024) using the package 'rvc', the function 'getRvcData' to gather the data by region, and the function 'getDomainDensity' to calculate the index of abundance. The index and CVs are presented in Table 25 and Figure 22.

2.6 Length and Age Composition Data

Updated length and age compositions of Yellowtail Snapper in Florida were compiled for catch (landings and discards) by fishery and primary gear type. However, raw length and age composition data from fishery-dependent sources may be a biased reflection of the composition of the catch due to uneven sampling in space and time. Therefore, it is recommended to weight the sampled lengths and ages of landed or released fish at the finest possible scale by the inverse of the sampling proportion (SEDAR 2016; Maunder et al. 2020) to produce the landings-at-length or -age and the discards-at-length (i.e., fish landed or released per length [2 cm] or age [1-year] bin in numbers). Length and age compositions of landings and releases were attempted to be catch-weighted by year and Florida region (e.g., northwest, southwest, Florida Keys, southeast, northeast) and primary gear type (e.g., hook and line) to satisfy a minimum level of sampling and capture key differences. If the number of annual samples by Florida region was insufficient, then compositions were aggregated by year and an aggregated region (e.g., east or west Florida), or finally aggregated by year at all spatial scales (i.e., all of Florida). Length bins were set at 2 cm width for fork lengths 2 – 80 cm while 1 year age bins were set from 0 to the maximum age observed in Florida, 20 years.

Conditional age-at-length (CAAL) compositions of Yellowtail Snapper by fishery were also compiled. This configuration allows the integrated assessment model to use the information from sparse age-at-length data without assuming that the data were representative of ages across the full range of sizes. It contains more detailed information about the relationship between size and age, therefore providing a stronger ability to estimate growth parameters and the variance of size-at-age.

2.6.1 Landings

2.6.1.1 Commercial

Commercial length samples of landed Yellowtail Snapper were obtained from dockside sampling under the TIP for years 1984 – 2023 and aggregated by year and three regions (east [northeast and southeast], Florida Keys, and west [northwest and southwest]). Commercial landings (in numbers) were then apportioned at this scale and applied to raise the length compositions into weighted landings-at-length. Lastly, the weighted landings-at-length were aggregated by year and are presented in Figure 23.

Age samples from dockside sampling under the TIP for years 1992 – 2023 were configured as CAAL data and are presented in Figure 24.

2.6.1.2 Southeast Region Headboat Survey

Length samples of Yellowtail Snapper landed from headboats were obtained for years 1981 – 2023. Due to lower sample sizes in the northwest and southwest, length composition data by year had to be aggregated by region into east (northeast and southeast) and west (northwest, southwest, and the Florida Keys). Headboat landings were distributed at this scale and applied to raise the length compositions. The weighted landings-at-length were then aggregated by year and are presented in Figure 23.

Headboat age composition data were compiled for years 1981 – 2023. Sampling of ages was insufficient outside of the Florida Keys region, so age composition data were aggregated by year at the largest spatial scale (Florida). Annual headboat landings were applied to raise the age composition data into weighted landings-at-age and are presented in Figure 25.

2.6.1.3 MRIP

Recreational length samples of landed Yellowtail Snapper were obtained from the MRIP for years 1981 – 2023. Both imputed and non-imputed measurements were retained in the analysis. Sampling was also limited outside of the Florida Keys and southeast Florida and length composition data by year were therefore aggregated by region into east (northeast and southeast) and west (northwest, southwest, and the Florida Keys). MRIP landings were apportioned at this scale and applied to raise the length compositions. The weighted landings-at-length were then aggregated by year and are presented in Figure 23.

Age composition data for MRIP were compiled for years 1981 – 2023. Like the headboat fishery, sampling of ages was insufficient outside of the Florida Keys region and were aggregated by year at the largest spatial scale (Florida). Annual MRIP landings were applied to raise the age composition data into weighted landings-at-age and are presented in Figure 25.

2.6.2 Discards

2.6.2.1 Commercial

Commercial length samples of discarded Yellowtail Snapper were obtained from several commercial at-sea observer programs (Reef Fish Observer Program [RFOP], the South Atlantic Vertical Line Observer Program [SAVLOP], and the Southeast Shark Bottom Longline Observer Program [SBLOP]) for years 2009 – 2023. Sample sizes were low across Florida regions outside of the Florida Keys; therefore, length samples were aggregated by year at the largest spatial scale (Florida). Commercial discards were then applied to raise the length composition data into weighted discards-at-length and are presented in Figure 23.

2.6.2.2 Southeast Region Headboat Survey and MRIP

Data collected from the Florida At-Sea Observer Sampling program were used to compile headboat and charter boat sampled length frequencies of discards for years 2005 – 2023. In SEDAR 64 (Allen 2019), these recreational modes were combined due to similar length frequencies to increase sample sizes across years, with the assumption that the discard length composition of the charter mode was similar to that of the private and shore modes for which data are unavailable. The combined discard length composition data were then aggregated by year at the largest spatial scale (Florida) as sampling was still insufficient outside of the Florida Keys.

Annual headboat discards were then applied to raise the combined discard length composition data into weighted discards-at-length for the headboat fishery. Similarly, and separately, annual MRIP discards were applied to the combined discard length composition data into weighted discards-at-length for the MRIP fishery. Headboat weighted discards-at-length and MRIP weighted discards-at-length are presented in Figure 23.

2.6.3 Indices

2.6.3.1 Commercial Index

The selectivity of the commercial index is linked to the retention of the commercial fishery within the assessment model since it is a retained catch per unit effort index. This configuration allows the retained length and age composition data input for the commercial fishery to be used for the commercial index and does not require duplication of data input.

2.6.3.2 MRIP Index

The MRIP index selectivity is configured to mirror to the MRIP fishery selectivity within the assessment model. Therefore, the MRIP index (as a total catch per unit effort index) assumes the same combined retained and discarded length and age composition data input for the MRIP fishery and does not require duplication of data input.

2.6.3.3 RVC Florida Keys and Dry Tortugas Indices

Length composition data for the RVC indices were compiled in R (R Core Team 2024) using the ‘rvc’ package. While a noticeable degree of digit bias exists within the data (e.g., at 5 cm intervals), length distributions were still reasonable at 2 cm bin widths. For both indices, length compositions were weighted by their respective extrapolated abundances using the function ‘getDomainAbundance’. Weighted length composition data for the RVC Florida Keys and for the Dry Tortugas are presented in Figure 23.

2.6.4 Additional Fishery Independent Age Data

Additional fishery-independent age data (Vose and Shank [2003], FWRI Fisheries-Independent Monitoring, SEAMAP) were used in SEDAR 64 and configured as CAAL composition data to help estimate growth within the assessment model. The data were primarily younger fish and smaller than the regulatory minimum size limit, filling the size-at-age gap left by the truncated fishery-dependent age data. The fishery-independent CAAL data are presented in Figure 26.

3 Stock Synthesis Model Configuration

3.1 Overview

The base model for the SEDAR 96 southeastern U.S. Yellowtail Snapper stock assessment updated the SEDAR 64 Interim Analysis (Allen and Swanson 2022) base model and attempted to keep the original configuration, unless changes to the data sources necessitated changes to the model configuration. All models were developed in Stock Synthesis (SS) version 3.30.15. 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. 2020). Further descriptions of SS options, equations, and algorithms can be found in the SS user’s manual (Methot et al. 2020), the NOAA Fisheries Toolbox website (http://nft.nefsc.noaa.gov/), and Methot and Wetzel (2013).

The SEDAR 96 base model was moderately complex and informed by three fishing fleets (including landings, discards, compositional landings-at-length and -age, and compositional discards-at-length where available), two fishery-independent indices of relative abundance (including length compositions), two fishery-dependent indices of relative abundance or biomass (including length compositions), and fishery-independent CAAL data that were not associated with any fleet or survey.

The first term of reference for SEDAR 96 (sub-bullet 1) asked to explore the SRFS data to inform private mode recreational landings and discard data. The Recreational Landings TWG reviewed the SRFS data and its impact to the SEDAR 64 base model and determined that the MRIP fleet for the SEDAR 96 base model should be informed by SRFS private mode data. Therefore, the landings and discard data for the MRIP fleet was configured to be comprised of the full SRFS timeseries (see Sections 2.3.4 and 2.4.4).

The model estimated 88 out of 123 parameters including, but not limited to, growth parameters (asymptotic length [*Linf*], von Bertalanffy growth coefficient [*k*], and the reference length for the start of von Bertalanffy growth [*Lmin*]) , 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, length-based selectivity parameters for fleets, landings, discards, retention and indices with length composition data. Model-derived estimates include maximum sustainable yield (MSY) and MSY-proxy reference points (e.g., $F_{30\%SPR}$), and a full time series of population abundance-at-age (units: 1,000s of fish) and biomass (female 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.

3.2 Initial Conditions

The start year of the SEDAR 96 base model was 1992 and the population was not assumed to be in equilibrium. Initial equilibrium catch was configured to be 25% of the landings observed for 1981; however, the lambdas for the initial equilibrium catch values were set to zero as it is known the stock was exploited during (and before) this time but the catch associated with equilibrium conditions is unknown. Setting the lambdas for the initial equilibrium catch values to zero removes goodness of fit of the equilibrium catches from the objective function. Early population structure prior to the model start year was constructed using available length and age composition data beginning in 1980, which primarily informed estimates of early recruitment deviations (see section 3.5 below). Steepness was not used in the initial equilibrium calculation, thereby assuming the initial equilibrium catch was not large enough to have reduced expected recruitment below unfished levels.

3.3 Spatio-Temporal Structure

The base model was configured as a single area model which encompassed only Florida waters as recommended during SEDAR 64. Within Florida, fleets were aggregated state-wide but separated by fishery (e.g., Commercial, Headboat, MRIP SRFS), each having a separate selectivity. While the stock is currently managed by two Councils, sample sizes at finer regional spatial scales across time were low across data components and precluded the ability to further separate fleets within Florida by region. Yellowtail Snapper are observed outside of Florida (e.g., off the Carolinas); however, that very small component of the population is assumed to be a sink outside core population and fishery areas (i.e., the Florida Keys and southeast Florida), as suggested by life history and catch data.

Yellowtail Snapper were modeled from age-0 through age-20 years (maximum age observed in Florida) and recruits were defined as fish which recruited to the biological population at calendar age-0. The base model was configured with one season (i.e., annual) from January through December where fishing was treated to have occurred across the whole season. Spawning continued to be configured to occur on January 1 and, given the structural limitation of the model framework for a single season model, recruitment was co-occurring. Surveys, length and age composition data, and CAAL data were configured to occur mid-year (July 1).

3.4 Life History

Growth was estimated within SS according to the von Bertalanffy growth function where initial values for the asymptotic length (*Linf*), 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 SEDAR 64 (see Section 2.2.2 above). The *Lmax* parameter in SS was specified as equivalent to *Linf*. The CV parameter was used in SS to describe the variability in length-at-age for the minimum (*CVyoung*) and the maximum (*CVold*) observed ages. In the base model, growth was initially configured such that fish grew according to the von Bertalanffy growth model immediately upon 'settlement' at age-0 (*Amin* = 0) beginning at a length of 2 cm (*Lmin*), but *Lmin* was freely estimated.

Natural mortality was assumed to be constant over time and inversely related to fish length following Lorenzen (2005, 2022); the natural mortality-at-age vector was based upon the external von Bertalanffy growth model (Section 2.2.3) and treated as a fixed input. The SS base model was configured as a single gender model where the spawning biomass would be multiplied by a user-defined fraction female, here defined as frac_female = 0.50. Maturity-at-age followed the vector described in Section 2.2.4 and was a fixed input within the SS base model. A fixed length-weight relationship ($w = a*L^b$) was used to convert body length (cm) to body weight (kg) with parameters $a = 2.574e-5$; b = 2.8797. Fecundity was configured as linear eggs/kg on body weight ($eggs = a + b * wt$) and parameterized such that the number of eggs was equivalent to spawning biomass by fixing $a = 0$ and $b = 1$.

3.5 Recruitment Dynamics

The SEDAR 96 base model used the Beverton-Holt stock-recruitment model. 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. 2020). All three stock-recruitment parameters were estimated within the base model.

Simple annual deviations from the stock-recruitment function, which were not constrained to sum to zero, were estimated assuming a lognormal error structure. The main recruitment deviations were estimated for the time period of greatest data-richness (1991 – 2023) and corresponds to when the age composition data for the three fleets largely became available. However, early recruitment deviations were estimated for 1981 – 1990 with the assumption that length composition data and a small amount of age composition data, along with information on removals from natural mortality and fishing, could provide some indication of recruitment level trends. 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. 2020). Following the recommendation from Methot and Taylor (2011) to use the full bias adjustment on data-rich years, the SS base model used full bias adjustment between 1992 – 2021 after which it phased out to no bias adjustment through 2023.

3.6 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. 2020). 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. The SEDAR 96 base model, as in SEDAR 64 and the Interim Analysis, configured fishing mortality as F_{hybrid}.

3.7 Catchability

Constant catchability was assumed for all surveys except for the commercial index. Catchability for the commercial index was allowed to change for years 2009 – 2023 compared to the base period of 1992 – 2008.

During the SEDAR 64 Assessment Workshop, the sudden increase in trend of the commercial CPUE beginning in 2007 to a higher average rate was thought to be attributed to improved fishing efficiency in the commercial fleet rather than an increase in the underlying population. Input from several commercial fishermen during the Data and Assessment Workshops indicated that the 'power chumming' technique, which had already somewhat been in use for a few decades, had become increasingly prolific starting around 2005 and was considered standard practice by 2009/2010. Power chumming involves hanging multiple frozen chum bags (usually sardine or menhaden chum and possibly oats) overboard to thaw and disperse in a short period of time (less than 4-5 hours). However, the updated commercial CPUE index trend provided here shows a more gradual increase to a new higher average occurring later in the timeseries rather than an abrupt one (Figure 20). It's unclear, though perhaps unlikely, whether the same decisions concerning changes in catchability for this index would have been made if this updated trend (with terminal year 2017) been observed during the benchmark. During initial stages of base model development, a configuration removing this time-varying catchability was explored. Results showed greater estimates of spawning stock biomass and lower age-4 fishing mortality rates occurring after 2009. Nevertheless, the time-varying catchability block was retained here as in the SEDAR 64 base model and may necessitate reconsideration at the next benchmark assessment process.

3.8 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. The SEDAR 64 base model was configured using length-based selectivity for all fleets and indices. Selectivity patterns across fleets and indices were configured to be constant over time as no major changes in the regulation of the Yellowtail Snapper fishery have occurred which would alter these patterns since the model's start year. Stock Synthesis also estimates a derived age-based selectivity for fleets and indices with length-based selectivity.

Selectivity of the commercial fleet was configured as flat-topped using the two-parameter single logistic function, as it was determined by fishermen input and composition data that the commercial fishery operates in areas and depths where Yellowtail Snapper at the minimum size limit are both available and vulnerable to the gear and become fully selected with increasing in size/age. Selectivity patterns for the headboat and MRIP fleets were estimated to be dome-shaped, based on fishermen input and composition data, using the six-parameter double normal function where five of the six parameters were freely estimated. The fixed parameters (p5 – initial selectivity at start bin) were configured as such to extend the logistic decay of small fish selectivity down to the start bin. The MRIP index, which is based on total catch, was configured to mirror the MRIP fleet's selectivity.

Both RVC indices (Florida Keys and Dry Tortugas) were also 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. Larger Yellowtail Snapper can occur in deeper depths. For both indices, five of the six parameters were freely estimated where p5 (initial selectivity at start bin) was fixed as above.

3.8.1 Retention

Size regulations for southeastern U.S. Yellowtail Snapper are in the form of a minimum size limit, as opposed to a slot limit; therefore, retention was modeled as an asymptotic function of size using a four-parameter logistic function. Asymptotic retention was utilized for each of the three fleets with the first three retention parameters freely estimated and assumed to be constant through time. The fourth parameter (male offset) was not applicable to this single gender model and was fixed at zero.

3.8.2 Discards

Live and dead discards for each fleet were calculated and fit within the 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). Fleet specific discard mortality rates were treated as fixed model inputs (10% for each fleet, see section 2.4.5). 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. For all fleets, the discard mortality rates were treated as constant across sizes by setting a very large positive value for the descending slope (i.e. 1E+06), resulting in a denominator approximately equal to 2, and a negative value for p3 that produces a specified discard mortality rate. Discard mortality rates were assumed constant through time.

3.9 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 and age 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.

Certain model components were not given any weight in the loglikelihood function, that is, the likelihood component multiplied by the weight (lambda) value was set to zero. Setting the weight in the loglikelihood function to zero reflects a lack of confidence in values for these components and they were not used for fitting the model to the data and parameters. These zero weight components included the initial equilibrium catch values for each fleet (see Section 3.2).

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 2.3.1) 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 became available for this assessment, assumed values were used (see Section 2.3.2). Commercial discards were assumed to have a normal error structure with specified CVs since CVs and standard deviations provided by SEFSC applied to discard rates on the arithmetic scale, as opposed to discards on the logarithmic scale (see Section 2.4.1). Uncertainty in the index observations was estimated through the standardization techniques used therein to determine final observed index CV values (see Section 2.5).

Multinomial distributions were assumed for the length and age composition data of the landings, discards, and indices as well as the CAAL data of the landings and fishery-independent dataset, 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 Yellowtail Snapper for length composition data (or the number of aged Yellowtail Snapper for the age composition data) to avoid over-weighting observations of lengths or ages in the likelihoods. The input sample sizes for CAAL data were set to the number of Yellowtail Snapper sampled because there are fewer fish aged at a given length.

3.10 Data Weighting

Francis (2011) and Punt (2017) developed re-weighting procedures to adjust the effective sample sizes of length and conditional age-at-length 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). Francis weights were applied to the length and age composition data as well as to the CAAL data using the same method (TA1.8 in Francis 2011) as in the SEDAR 64 base model. Iterations were performed until the decrease in total likelihood of the new iterations resulted in a difference of two units or less.

An alternative weighting method for composition data is to use the Dirichlet-Multinomial distribution which estimates a parameter (theta, θ) that internally scales the input sample size (Thorson et al. 2017; Methot et al. 2020). Weighting of these components using the Dirichlet-Multinomial method was explored during initial phases of model development; however, for certain data components (e.g. commercial length composition) theta parameters were estimated greater than 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. 2020). Applying a normal prior N(0, 1.813), as recommended by Ian Taylor (Methot et al. 2020), slightly reduced the theta parameter from the upper bound (value of 20), but it was still much larger than 5 with a ratio close to 1.0. Therefore, the iterative Francis method was utilized.

3.11 Model Diagnostics

Model diagnostics of the SEDAR 96 base model were performed in R using the ‘r4ss’ and ‘ss3diags’ (github.com/JABBAmodel/ss3diags) packages and largely follow 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.

3.11.1 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.

3.11.1.1 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.

3.11.1.2 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 200 iterations were performed.

3.11.2 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 and age compositions, and CAAL data were evaluated via visual inspection of residuals. Overall residual patterns for each model component (indices, length compositions, and conditional age-at-length) 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 conditional age-at-length 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%.

3.11.3 Model Consistency

3.11.3.1 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: 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 9.0 – 11.0 by 0.1 and the change in total and data-component likelihoods were examined. Likewise, the steepness parameter was fixed to values ranging from 0.5 – 0.99 by 0.01. 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.

3.11.3.2 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 and age composition 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.

3.11.3.3 Retrospective Analysis

The base model was subjected to a retrospective analysis which removed seven successive years of data from the model (i.e., years 2017 – 2023) corresponding to the terminal year of the SEDAR 64 base model. 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, as in the S64 benchmark assessment, the 'rule of thumb' ρ values (-0.15 to 0.20) as proposed by Hurtado-Ferro et al. (2015) for longer-lived species are used to characterize retrospective bias.

3.11.4 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.

3.12 Uncertainty in Parameters and Derived Quantities

A total of 88 out of 123 parameters were estimated within the SEDAR 96 base model for southeastern U.S. Yellowtail Snapper. Of the 123 total parameters, 18 were used to describe life history components, 11 estimated deviations from the initial age composition, 33 estimated annual recruitment dynamics, 3 estimated initial fishing mortality rates, 5 were related to index catchabilities, and 52 described selectivity, retention and discard mortality for the 3 fleets and 4 indices. 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). The SEDAR 96 base model also used the soft bounds option which moves parameters away from the bounds with a weak penalty (Methot et al. 2020).

Derived quantities include annual numbers- and biomass-at-age, spawning stock biomass, fishing mortality rates-at-age, and internally calculated reference points (e.g., $F_{MSYproxy}$, $SSB_{MSYproxy}$, MSY_{proxy}). 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.

3.12.1 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 (2021 – 2023) were compared to associated reference points (i.e., MSST, MFMT).

Two MCMC chains were produced. For each chain, a total of 10,000,000 iterations were performed but only one out of every 2,000 iterations was saved, resulting in 5,000 potential iterations used to generate estimates of uncertainty in fishing mortality and spawning stock biomass. Visual inspection of trace plots was used to adjust appropriate levels of burn-in and thinning as well as to address any autocorrelation in the iterations. Convergence of a single chain was assessed by Geweke's diagnostic to determine whether the mean of the first 10% of the chain is not significantly different from the last 50% of the chain, while convergence of two chains was assessed using Gelman and Rubin's (1992) potential reduction scale factor implemented in the 'coda' package (Plummer et al. 2006) in R.

3.12.2 Parametric Bootstrap

Parametric bootstrap resampling methods were used to analyze the uncertainty associated with the data and to detect possible model misspecification. Five hundred 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. 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).

3.13 Stock Status Determination Criteria

The jurisdictional allocation of Yellowtail Snapper ABC is 75% to the south Atlantic and 25% to the Gulf of Mexico; therefore, the overfishing and overfished criterion for Yellowtail Snapper is according to the SAFMC.

For SEDAR 96, Yellowtail Snapper in the southeastern U.S. is managed using the following stock status determination criteria as documented in the second term of reference:

- Maximum Sustainable Yield (MSY) = yield at F_{MSY} (or proxy)
- Minimum Stock Size Threshold (MSST) = $0.75*SSB_{MSY}$
- Maximum Fishing Mortality Threshold (MFMT) = F_{MSY} (or proxy) and $F_{Rebuild}$ (if overfished)
- Optimum Yield (OY) = ABC, based on the SAFMC ABC control rule

3.14 Bridge Building

A bridge building exercise was performed which compared the estimates of spawning stock biomass, fishing mortality rates, and recruitment from the SEDAR 64 base model and the Interim Analysis with those developed here for SEDAR 96. During the initial stages of this assessment, an exploratory model which investigated the impacts to the SEDAR 64 base model when replacing the MRIP catch data with the full SRFS timeseries (see Sections 2.3.4 and 2.4.4) was developed and shared with the Recreational Landings Topical Working Group. The changes to the recreational catch data primarily impacted the scale of the model-estimated biomass with modest influence on the estimates of fishing mortality and recruitment.

4 Stock Synthesis Model Results

4.1 Landings and Discards

Fits to the landings data for the Commercial, Headboat, and MRIP SRFS fleets are presented in Figures 27 – 29 and were nearly exact (total negative log-likelihood = 1.459e-011). Fits to the discard data were reasonable (total negative log-likelihood = 94.330) as most estimates were close to the observed values and within the 95% confidence intervals (Figures 30 – 32); however, estimated discards for the MRIP SRFS fleet were fit poorly for years 1997, 2002, 2016, and 2023 (Figure 32). Figures 33 and 34 compare model estimated landings across fleets in biomass and numbers of fish, respectively.

4.2 Indices

The base model fits to two fishery-dependent (Commercial, MRIP) and two fishery-independent indices (RVC Florida Keys, RVC Dry Tortugas) are presented in Figures 35 – 38. Model fits to the indices were overall well (total negative log-likelihood = -29.551).

Fits to the commercial CPUE index were closest (RMSE = 0.0967), which was expected given the low input values of observed error. The fitted values followed the observed increasing trend with poorest fit occurring in outlying years 1996, 2017, and 2020 (Figure 35). A slight increase was observed between 2009 and 2010 when catchability was configured to change, but this may have also influenced the lack of fit in year 2009. A distinct ‘v’ shape is observed in the index for years 2017 – 2023 and the model attempts to fit it but only slightly captures this trend. Given the model influence of this index, the ‘v’ shape is seen in all other fitted index trends below.

The MRIP CPUE index was fit reasonably well as the second-best fitting index (RMSE = 0.1770), but was influenced by the base model’s fit to the commercial CPUE index. The observed MRIP CPUE index trend is variable but relatively stable; therefore, model fits tended to underestimate earlier years and overestimate latter years as it had more flexibility to move within the observed error (Figure 36). In year 2019, a larger decrease in abundance was observed and the model fit the vertex of the latter year's 'v' shaped trend there. This occurred in the year prior to the large decrease observed in the commercial CPUE's index (i.e., year 2020). While the specific 'v' shape may be a model artifact from fitting the commercial CPUE index, it appears that both indices are suggesting a decrease in abundance for that component of the population. The MRIP CPUE index is a total catch index, tracking smaller and younger fish compared to the commercial CPUE index (i.e., a retained catch index); therefore, the decrease which occurred in 2019 (in the MRIP CPUE index) may have carried over into the age classes observed in 2020 (in the commercial CPUE index), and then began to recover and stabilize (both indices).

Model fits to the RVC Florida Keys index were fair (RMSE = 0.2439). The observed trend is relatively stable with increased abundance occurring in later years 2016 and 2018 (Figure 37). However, the model fit year 2018 poorly as it tried to pin the vertex of the 'v' shape there. This also led to a complete lack of fit for year 2022 as it overestimated the observation.

Model fits to the RVC Dry Tortugas index were acceptable but contained the highest RMSE (0.2868). Lack of fit occurred in years 2000 and 2006 and later again in years 2018 – 2023 when the model attempted to fit a 'v' shape through it, underestimating the observed values (Figure 38). But while the RVC Florida Keys index decreased in abundance from year 2018 to 2022, the RVC Dry Tortugas index showed an increasing trend beginning in 2018 through staggered sampling years 2021 and 2023.

4.3 Length and Age Composition

4.3.1 Data Weighting

Iterative reweighting of length and age 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 26, which occurred on the 6th iteration. All composition data were down-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 39. Applying the Francis weights resulted in large reductions to the unweighted base model's objective function. While this mostly occurred in the length and age composition data's likelihood components, improvements to index likelihood components were particularly observed in the commercial CPUE index (Δ negative log-likelihood 90.667 units) and the MRIP CPUE index (Δ negative log-likelihood 11.992 units). Improvements to these indices produced a slight reduction in fit to the RVC Florida Keys index (Δ negative log-likelihood -4.263 units) and the RVC Dry Tortugas index (Δ negative log-likelihood -4.314 units).

4.3.2 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 39 – 48. The quality of the fit varied among fleets and indices and fits aggregated across time were reasonable (total negative log-likelihood = 382.757; Figure 39). The model's predicted distributions were able to match the observed overall distributions but slightly underestimated the peak for the commercial and MRIP SRFS discards as well as the RVC Florida Keys index.

Fits to the retained length composition data of the commercial fleet generally agreed with observed distributions for most years (Figures 40 and 48). In years where more smaller fish were available to the fishery, the model underestimated the number of smaller fish and overestimated the number of larger fish (e.g., years 2019, 2020, 2023); when those age classes moved through and more larger fish were available, the model underestimated the number of larger fish and overestimated the number of smaller fish (e.g., years 2018 and 2022). Sample size was much lower in year 2021 due to Covid-19 and resulted in a worse fit to those data. Fits to the commercial discard length composition data were reasonable for years 2018 – 2023, except in year 2020 where larger fish were sampled than were estimated by the model (Figures 41 and 48).

For the retained length composition data of the headboat fleet, model fits were reasonable for most years but in recent years (e.g., years 2019, 2022, and 2023) showed similar patterns to the commercial fishery where greater numbers of smaller fish were sampled compared to larger ones (Figures 42 and 48). Sample sizes were quite low in years 2020 and 2021 due to Covid-19 and resulted in very poor fit to year 2021 data. Fits to recent years discard length composition data were good with slight peak underestimation in year 2023 (Figures 43 and 48).

Fits to the MRIP SRFS retained length compositions in recent years showed similar patterns observed in the other two fleets above. More smaller fish were sampled in years 2021 and 2023 (and to a lesser extent in 2019 and 2020), causing model underestimation of those sizes, while many larger fish were sampled in 2022, causing underestimation of those larger fish (Figures 44 and 48). Fits to the MRIP SRFS discard length composition data in recent years continued to show sharp peaks resulting in underestimation at those sizes and slight overestimation on adjacent smaller and larger sizes (Figures 45 and 48).

The observed length distributions for the RVC Florida Keys index tended to be more jagged as influenced from the digit bias at 5 cm increments with mean lengths generally around 18 cm FL. The model fit the overall shape of the distributions reasonably well but often at the cost of either underestimation at the mode with overestimation at adjacent sizes or vice-versa (Figures 46 and 48). Observed length compositions by year for the RVC Dry Tortugas index were comparatively more uniform in recent years with slightly larger mean lengths around 20 cm FL when compared to the other RVC index. The base model fit the data fairly well; however more larger fish were observed in years 2021 and 2023, resulting in underestimation at those sizes and overestimation at smaller sizes (Figures 47 and 48).

4.3.3 Age Composition

The base model fits to the age composition and CAAL data associated with the landings as well as fishery-independent data are presented in Figures 49 – 53. The quality of the fit varied among data sources and fits to their aggregated mean ages were generally acceptable (total negative log-likelihood = 169.971; Figure 49).

The fits to the annual mean ages for the commercial fleet followed the trends of the observations generally well with some underestimation occurring during the latter half of the timeseries (Figure 49). The model didn’t fit year 2018 when mean age was higher than surrounding years, but was able to track better through 2023. The annual fits to the observed ages at smaller sizes was generally adequate for most years but the model also tended to underestimate the ages observed for sizes larger than the externally predicted asymptotic length-at-age (i.e., ~42 cm; Figure 50). While this could be a product of sampling mismatch between the proportion of where fish are landed versus sampled within Florida’s commercial fishery (i.e. observation error), it could also be influenced by application of the Francis weighting (i.e., process error) as fit to the older ages was moderately improved in an unweighted model. Poorer fits to these ages-at-length were also seen in the SEDAR 64 base model.

For the headboat landings, the trend of the observed mean ages aggregated across time was mostly stable and the model fit this trend quite reasonably (Figure 49). Observed mean age tended to be younger with greater uncertainty in recent years 2020 – 2023; but this is likely reflective of a poor sample size in 2020 due to Covid-19 and the subsampling procedure utilized for years 2021 – 2023, rather than a shift in the true age of the retained catch. This was also observed in the annual fits to the age composition data as underestimation of younger ages at the peak and slight overestimation of adjacent older ages occurred in years 2018, 2019, and 2021 (Figure 51).

Model fits to the mean ages aggregated across time for the MRIP SRFS landings were good with mean ages for years 2018 – 2023 similar to prior years and uncertainty lower in years 2018 – 2019 due to increased sample sizes from the charter mode (Figure 49). The annual fits to the age composition data were adequate for years 2015 and greater where sample sizes tended to be more sufficient (Figure 52).

The fits to the mean ages aggregated across time for the fishery-independent data source that was not linked to any fleet or index followed the variable trends of the observations quite well (Figure 49). The annual fits to the conditional age-at-length compositions were also reasonable (Figure 53). Beginning in 2008, the number of observed ages per length bin decreased markedly but the model was largely able to match those observed values.

4.4 Estimated Parameters and Derived Quantities

The SEDAR 96 base model estimated most parameters reasonably well (i.e., |CV| < 1; Table 27). Of the 123 active parameters, 28 exhibited poor estimation (i.e., |CV| > 1); including 9 initial age composition adjustments, 12 recruitment deviations, the initial fishing mortality rates for the commercial and MRIP SRFS fleets, and 5 parameters describing selectivity (i.e., top logit parameters from the headboat and MRIP SRFS fleets as well as from both RVC indices; end logit parameter from the RVC Florida Keys index). No parameters were estimated near bounds.

4.4.1 Stock Biomass (Total and Spawning)

The predicted total biomass and spawning stock biomass are summarized in Table 28 and Figures 54 – 55 and largely followed the trends produced by the two fishery-dependent indices. The total biomass has generally increased in trend across the timeseries through 2017, then decreased a little through 2019, but then increased again to a timeseries high in 2023 (6,612.14 mt; Table 28, Figure 54). The predicted female spawning stock biomass largely followed this trend; it increased in trend through 2017, but declined through 2020 before increasing again to a high of 2,684.12 mt in 2023 (Table 28, Figure 55). The depletion (SSB/virgin SSB) ratio has been increasing in trend since the timeseries low in 1996 (0.145) and averaged 0.325 from 2017 – 2023 (Table 28).

4.4.2 Recruitment

The relationship between spawning output and age-0 fish as parameterized by the Beverton-Holt stock-recruitment model is presented in Figure 56. The *steepness* parameter was estimated at 0.767, the *sigmaR* parameter was estimated at 0.266, and the *ln(R0)* parameter was estimated at 9.823 (Table 27), which equates to 18.448 million age-0 Yellowtail Snapper.

The estimated annual recruitment of age-0 Yellowtail Snapper to the biological population is summarized in Table 28 and Figure 57a-b. The base model estimated age-0 recruitment as a stable but variable trend to a high in 2012 (23.657 million fish); recruitment then declined through 2018 but then increased again to a timeseries high in 2022 (25.552 million fish; Figure 57a). Estimated recruitment declined in 2023 to 17.600 million fish but uncertainty was also largest for years 2022 and 2023.

Annual deviations of estimated recruitment from the stock-recruitment curve followed the annual trend of the estimated recruitment above (Figure 57b). Values tended to be negatively deviated through year 2000, then deviated around the stock-recruitment curve through 2018 before positively deviating in trend from 2019 – 2023. The estimated (and applied) recruitment bias adjustment ramp as recommended by Methot and Taylor (2011) is shown in Figure 58.

4.4.3 Fishing Mortality

The annual instantaneous fishing mortality rates on age-4 Yellowtail Snapper are presented in Table 29 and Figure 59. This age was designated in the S64 benchmark assessment based on the mid-point of the relative fleet-specific maximum selectivities, allows for a comparison of fishing mortality rates across time, and reduces the variability around this estimate caused by varying levels of fishing mortality on different ages over different years. The annual fishing mortality rate on age-4 Yellowtail Snapper declined in trend from 1993 – 2001, and then became variable but stable from 2002 through the terminal year (mean age-4 F = 0.331 yr^{-1}). Fishing mortality since 2017 generally declined in trend to a timeseries low in 2023 estimated at 0.200 yr^{-1} (Table 29, Figure 59) and had an average of 0.294 yr^{-1} from 2017 – 2023.

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 29 and Figure 60. Apical fishing mortality rates by fleet were highest for both commercial and MRIP SRFS fleets and generally followed their respective trends in annual catch. Commercial fishing mortality rates declined in trend from 2017 – 2023 and became similar to those estimated for the years 2005 – 2008 (Table 29, Figure 60). The MRIP SRFS fleet experienced wider fluctuations across a mean trend over time (Table 29, Figure 60). The headboat fleet exerted the least amount of fishing mortality but saw an increase in 2021 following its highest reported landings since the early- and mid-1990s (Figure 60).

4.4.4 Selectivity and Retention

Selectivity for all fleets and indices was estimated using length-based selectivity functions which the base model used to further derive age-based selectivity (Figure 61). Fleet-specific length-based selectivity and retention patterns, as well as assumed discard mortality rates, are illustrated in Figures 62 – 66.

Selectivity for the commercial fleet was estimated to be more knife-edge, beginning at 21 cm FL and becoming fully selected by 31 cm FL (Figure 62). Yellowtail Snapper were retained at the minimum size limit of 24 cm FL and full retention occurred by 29 cm FL. The number of fish discarded by the commercial fleet was low and fish ranged primarily between 23 – 25 cm FL.

For the headboat fleet, dome-shaped selectivity of Yellowtail Snapper was generally between 23 – 33 cm FL and reached an asymptote of 27% by 39 cm FL (Figure 63). Retention of Yellowtail Snapper for the headboat fleet primarily started at the minimum size limit of 24 cm FL and full retention occurred at 27 cm FL. Discarded fish ranged between 17 – 27 cm FL.

Dome-shaped selectivity of Yellowtail Snapper by the MRIP SRFS fleet was generally between 19 – 33 cm FL, reaching an asymptote of 36% by 39 cm FL (Figure 64). Retention of Yellowtail Snapper generally occurred at 27 cm FL with full retention occurring by 31 cm FL. The number of live releases by the MRIP SRFS fleet was the highest of the fleets and discards largely ranged between 15 – 29 cm FL.

The selectivity (vulnerability to observations by divers) of Yellowtail Snapper by the RVC Florida Keys had a wider bell shape than the other fleets with dome-shaped selectivity, occurring mostly between 11 – 37 cm FL and terminating by 61 cm FL (Figure 65). Juvenile fish started to become vulnerable at the lowest length bin (2 cm FL) and became fully selected between 17 – 25 cm FL. In the RVC Dry Tortugas, fish were primarily selected between 15 – 31 cm FL, a narrower range compared to the RVC Florida Keys, but reached an asymptote of 10% by 43 cm FL (Figure 66).

4.5 Model Diagnostics

4.5.1 Convergence

The SEDAR 96 base model converged with a total objective function of 595.362. 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 67). From the 200 jittered runs, 110 runs (55%) had a low gradient (<0.0001) and no other run had a gradient >0.01.

4.5.2 Goodness of fit

The joint residual plots for the indices (Figure 68a), mean length composition data (Figure 68b), mean age composition data (Figure 69a), and the conditional age-at-length data (Figure 69b) indicated a good fit to the data as combined RMSE values were 0.190, 0.052, 0.190, and 0.214 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 by the MRIP CPUE index. However, when the RVC indices become available in 1999, the trend stabilizes but becomes slightly negatively biased (Figure 68a). Residuals and interquartile ranges of the mean length data were small and consistent across time, indicating general agreement with the fisheries and index data (Figure 68b). Residuals of the mean age data showed the model tended to fit the headboat age data with greater variability being attributed to the MRIP age composition data (Figure 69a). Residuals were more positively biased in the beginning of the timeseries and then became more negatively biased at the end of the timeseries; both time periods were characterized by lower sample sizes and the model under- or overestimated mean age. In the conditional age-at-length data, residuals were more positively biased throughout the timeseries following the commercial data with greater variability seen in some years by the inclusion of fishery-independent age data (Figure 69b).

The residual series of the all the indices except for the MRIP CPUE passed the runs test (Figure 70). The MRIP CPUE had one year where the residuals were greater than three standard deviations and several sequentially positive or negative years, suggesting possible temporal autocorrelation of the residuals. The non-randomness of these residuals is likely influenced by the model's need to fit the commercial CPUE index (given the low input CVs) and the conflict of these two indices in the beginning and end of the timeseries.

Results of the runs tests for length and age composition data were mixed and appeared to illustrate intra-fleet conflicts arising between data sources. A pattern was seen where fleets failed a runs test in one data source but passed in the other, suggesting the model may have relied more on one data source over the other. For example, the mean length residual series of the commercial and headboat fleets failed the runs test (Figure 71). The mean length residuals of both fleets exhibited non-random variation and possible temporal autocorrelation, especially for the headboat fleet in years 1992 – 1997 and 2021 where residuals were sequentially positive and greater than three standard deviations. However, the mean age or conditional age-at-length residuals for both fleets passed the runs test (Figure 72a-b). Likewise, the MRIP SRFS mean length residuals passed the runs test (Figure 71) but failed the mean age residual series (Figure 72a).

4.5.3 Model Consistency

4.5.3.1 Likelihood Profiles

The profile likelihood on the *ln(R0)* parameter revealed that the parameter is largely influenced by the recruitment deviations component of the model and the profile minimum primarily agreed with the base model estimate of 9.823 (Figure 73). The age composition data component agreed more with the minimum value found on the profile and was primarily influenced by the commercial age data. The index, length, and discard composition data components were in conflict with the age composition and recruitment deviation components, favoring a lower *ln(R0)* value.

Profiling the *steepness* parameter also indicated that it was chiefly influenced by the recruitment deviations component of the model and the profile minimum agreed with the base model estimate of 0.767 (Figure 74). The length and age composition data components tended to favor values larger than 0.7 while the index data component favored smaller values. Discard data components were flat and mostly non-informative. A closer look at these data components revealed that the commercial index, commercial length composition, commercial conditional age-at-length data, and MRIP SRFS discard data were the main drivers for the particular profile shape in each component. While the base model estimated a value for the steepness parameter, the likelihood profile suggested that *steepness* values ranging from 0.64 to 0.99 result in a model fit that is not significantly different than the base model (i.e., is 2 total log-likelihood units or less different than the base model).

4.5.3.2 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 (Figure 75a-b). Fits to the Commercial CPUE (RMSE = 0.281; Figure 75c; Table 30) were slightly worse than to the MRIP CPUE (RMSE = 0.218; Figure 75d; Table 30) and trends for the RVC Florida Keys (RMSE = 0.236; Figure 76c; Table 30) and RVC Dry Tortugas (RMSE = 0.406; Figure 76d; Table 30) indices were mostly flat given the lack of any variability in recruitment in the ASPM (Figure 76a-b). When the recruitment deviations were included (i.e., in the ASPMdev), fits to all indices resembled the fits to the base model (Table 30) and the estimated spawning stock biomass and age-4 fishing mortality rates became near identical to that estimated by the base model (Figure 75a-b), suggesting that the process error as captured by the variability of age-0 recruitment (Figure 76a-b) was needed to better fit the trends in the indices.

The ASPM estimated spawning stock biomass and age-4 fishing mortality at a similar scale and trend to the ASPMdev and the base model, but began to deviate from the other models around year 2015 (Figure 75a-b). The base model and the ASPMdev suggested recruitment was more above average for years 2011 – 2015 and 2019 – 2022. The ASPM, however, was unable to deviate from the stock-recruitment function and marginal increases in spawning stock biomass were unable to produce large enough increases in recruitment as estimated in the ASPMdev and base model. Therefore, estimates of spawning stock biomass decreased but stabilized while age-4 fishing mortality rates responded inversely.

4.5.3.3 Retrospective Analysis

The retrospective analysis showed no discernable patterns in estimates of spawning stock biomass or fishing mortality rates after removing successive terminal years (Figure 77a-b). All runs converged and no parameters were found on the bounds. The calculated values for Mohn’s rho for SSB (ρ_M = 0.032; Table 31) and age-4 F (ρ_M = -0.028; Table 31) were well within the “acceptable” range for longer-lived species according to Hurtado-Ferro et al. (2015).

4.5.4 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 77). Most retrospective peels and retrospective forecasts fell within the 95% confidence interval of the base model. However, forecast years 2016 and 2018 – 2019 were consistently just outside the confidence intervals when the trend in spawning stock biomass began to take the 'v' shape. The forecast rho value for spawning stock biomass decreased slightly to $\rho_F = 0.027$ and for age-4 fishing mortality increased slightly to $\rho_F = -0.008$ (Table 31), suggesting model stability with the historical data 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 base model (Figures 78 – 79). This resulted in seven observations to measure the ability of base model to predict the commercial CPUE index and the MRIP CPUE index, but only two observations for the RVC Florida Keys index and three observations for the RVC Dry Tortugas index (given the RVC sampling design and covid-19 disruption). Both the RVC Florida Keys index and MRIP CPUE index had MASE scores <1 which suggested the base model contained reasonable prediction skill for these when compared to a naïve forecast (Figure 78b-c). The MRIP CPUE index contained the lowest MASE score = 0.71, indicating the ability to predict is closer to twice as accurately as a naïve baseline prediction. The commercial CPUE index and the RVC Dry Tortugas index, on the other hand, were not predicted well as the MASE scores were at or greater than one. The MASE score was the highest for the RVC Dry Tortugas index (2.57).

The model exhibited predictive capacity (MASE<1) for the mean length data of the MRIP SRFS fleet and the RVC Dry Tortugas index (Figure 79c,e) but all predicted mean length values across fleets were within the observed confidence intervals. MASE scores for the commercial and headboat mean length data were 1.01 and 1.03, respectively (Figure 79a-b), while the RVC Florida Keys index length data was much worse at 3.67 (Figure 79d). The base model did not exhibit predictive capacity for the mean age data available from the headboat and MRIP SRFS fleets, but all predicted mean age values were within the observed confidence intervals. The headboat and MRIP SRFS fleets had MASE scores of 1.32 and 1.42, respectively, and tended to predict larger mean age values (Figure 80). Hindcast cross-validation was unavailable for the conditional age-at-length data.

4.6 Uncertainty in Parameters and Derived Quantities

4.6.1 MCMC Analysis

Of the 5,000 iterations from each chain, burn-in was set at 1,000 with a thinning rate of 2 to help eliminate starting point bias and some early serial correlation. Thus, a total of 2,000 iterations remained for each chain. The two chains were combined, and convergence was evaluated using trace plots (Figure 81) 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 (age-4 F in 2023, SSB in 2023, $F_{30\%SPR}$, 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 MCMC converged (Table 32).

Posterior distributions were produced for stock-recruitment parameters (Figure 82) as well as the derived quantities of $F_{current}$ (Figure 83a), $F_{30\%SPR}$ (Figure 83b), the retained yield associated with $F_{30\%SPR}$ (Figure 83c), $SSB_{current}$ (Figure 83d), SSB at $F_{30\%SPR}$ (Figure 83e), and 75% of the SSB at $F_{30\%SPR}$ (Figure 83f). Results of the base model were found to fall within the interquartile range of the posterior distributions for all considered criteria (Figures 82 and 83).

4.6.2 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, 410 model runs converged (82%); however, most of the runs (85%, n = 428) had a gradient >0.0001 and 86% (n = 479) had at least one parameter on the bounds. Distributions of selected parameter estimates and derived quantities were much wider than observed in the MCMC posterior distributions, yet base model estimates generally fell within the interquartile ranges near median values (Figure 84).

4.7 Stock Status Determination Criteria

A summary of the stock status determination criteria and their values as presented in the TORs and according to the SAFMC and the GMFMC for SEDAR 96 are presented in Table 33. Stock status of Yellowtail Snapper in the southeastern U.S. has largely been determined in recent assessments according to MSY_{proxy} based reference points (e.g., SPR 30%) because it's uncertain whether a stock-recruitment relationship truly exists for this species. Nevertheless, since the SEDAR 96 base model (and the SEDAR 64 and Interim Analysis base models) estimated the *steepness* parameter with the assumption of a relationship, the associated MSY-based reference point estimates are also provided below.

The Maximum Fishing Mortality Threshold (MFMT) for Yellowtail Snapper is 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 age-4 Yellowtail Snapper fishing mortality rates for 2021 – 2023. The MFMT for SEDAR 96 was estimated by the base model to be 0.398 yr^{-1}, $F_{current}$ was estimated to be 0.263 yr^{-1}, and F_{2023} was estimated to be 0.200 yr^{-1} (Figure 85). Lastly, F_{MSY} was estimated to be 0.423 yr^{-1} and $F_{40\%SPR}$ was estimated to be 0.249 yr^{-1}. Based on the results of the base model, the southeastern U.S. Yellowtail Snapper stock continues to not be experiencing overfishing ($F_{current}$/MFMT = 0.660).

The minimum stock size threshold (MSST) for Yellowtail Snapper is defined as 75 percent of the spawning stock biomass associated with $F_{30\%SPR}$ (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 2021 – 2023. The $SSB_{F30\%SPR}$ for SEDAR 96 was estimated by the base model to be 1,816.54 mt (4,004,785 lbs.) with MSST therefore defined as 1,362.41 mt (3,003,589 lbs.). The $SSB_{current}$ was estimated to be 2,518.21 mt (5,551,692 lbs.) and SSB_{2023} was estimated to be 2,684.12 mt (5,917,472 lbs.; Figure 86). The SSB_{MSY} was estimated at 1,720.18 mt (3,792,348 lbs.) and the $SSB_{F40\%SPR}$ was estimated at 2,627.71 mt (5,793,109 lbs.). Based on the results of the base model, the southeastern U.S. Yellowtail Snapper stock continues to not be overfished ($SSB_{current}$/MSST = 1.848).

The posterior distributions produced by the MCMC analysis were for the stock status determination criteria and benchmark reference points of $F_{30\%SPR}$ (MFMT), the retained yield associated with $F_{30\%SPR}$, $SSB_{F30\%SPR}$, and MSST (Figure 83). Based on the median values of the posterior distributions, MFMT was estimated to be 0.398 yr^{-1}, $F_{current}$ was estimated to be 0.264 yr^{-1}, $SSB_{F30\%SPR}$ was estimated to be 1,820.46 mt (4,013,438 lbs.), MSST was 1,365.35 mt (3,010,079 lbs.), and $SSB_{current}$ was estimated to be 2,456.02 mt (5,414,595 lbs.). Additional posterior distributions of the F_{ratio} ($F_{current}$/MFMT) and SSB_{ratio} ($SSB_{current}$/MSST) are presented in Figure 87 where the F_{ratio} = 0.662 and the SSB_{ratio} = 1.799. The estimates for these reference points as derived by the 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 retained yield at F_{MSY} for Yellowtail Snapper was estimated to be 1,391.24 mt (3,067,159 lbs.) while the retained yield associated with the MSY_{proxy} ($F_{30\%SPR}$) was estimated at 1,391.44 mt (3,067,600 lbs.). The MCMC distribution of the retained yield at $F_{30\%SPR}$ (Figure 83c) had a median value of 1,394.99 mt (3,075,437 lbs.) and was used in SEDAR 64 and the Interim Analysis to potentially inform the overfishing limit (OFL). The MCMC distribution of the retained yield at $F_{30\%SPR}$ was also compared to an approximate normal distribution which had a mean and standard deviation based on the SEDAR 96 base model derived quantities; the two distributions were found to be similar (Figure 88). The retained yield associated with $F_{40\%SPR}$ was 1,321.04 mt (2,912,395 lbs.). The TORs specify that optimum yield (OY) is defined as the Acceptable Biological Catch (ABC) value based on the SAFMC P* method. In SEDAR 64 and the Interim Analysis, P* was the 37.5th quantile of the median of the MCMC distribution of retained yield at $F_{30\%SPR}$, which corresponded here to 1,368.60 mt (3,017,235 lbs.; 98.1% of the OFL).

4.8 Bridge Building

As part of the bridge building exercises between the SEDAR 96 base model with the SEDAR 64 base model and Interim Analysis, a comparison was performed by replacing the MRIP catch timeseries in the SEDAR 64 base model and the Interim Analysis with that of the ‘Full SRFS’ catch timeseries. The results of these ‘SEDAR 64 SRFS’ and ‘SEDAR 64 Interim SRFS’ models showed primarily a reduction in scale for estimated spawning stock biomass (Figure 89a), which was expected given the ‘Full SRFS’ catch timeseries was in essence a scalar reduction to most of the MRIP catch timeseries. Reductions in the estimated $SSB_{F30\%SPR}$ reference point by 453 mt and 435 mt were also observed in these models, respectively. Since estimated spawning stock biomass and reference points decreased concurrently, this resulted in similar annual estimates of SSB/MSST ratios (Figure 89b). Estimates of age-4 fishing mortality and $F_{30\%SPR}$ were minimally impacted, however, and showed similar annual trends with the largest differences occurring in the beginning of the timeseries (Figure 89c-d).

These results were then compared with the SEDAR 96 base model which contained not only the ‘Full SRFS’ catch timeseries, but changes to all indices (see section 2.5) as well as configuration changes to headboat and MRIP SRFS age composition data sets (see section 4.3). Annual estimates of spawning stock biomass in the SEDAR 96 base model were similar in scale to those by the SEDAR 64 Interim SRFS model (Figure 90a); however, the $SSB_{F30\%SPR}$ reference point estimated by the SEDAR 96 base model (1,816 mt) did not decrease as seen in the SEDAR 64 Interim SRFS model (1,480 mt). This resulted in lower SSB/MSST ratio values which straddled above and below 1.0 in the beginning of the timeseries then increased to 1.97 in the terminal year (Figure 90b). Differences in the estimated stock-recruitment dynamics were also observed between models. The estimated SSB_0 by the Interim Analysis was 7,350 mt and the R_0 estimate was 19.483 million fish, both of which decreased to an estimated SSB_0 of 6,214 mt and R_0 of 17.635 million fish in the SEDAR 64 Interim SRFS model (Figure 90c). The SEDAR 96 base model estimated an SSB_0 similar to the Interim Analysis at 7,495 mt but a reduced R_0 of 18.447 million fish (Figure 90c). Similar ranges of spawning stock values aggregated across time were predicted by all three models; but the differences between the stock-recruitment curves of the Interim Analysis and the SEDAR 96 base model demonstrate that for similar values of spawning stock biomass, the SEDAR 96 base model will correspondingly estimate a much lower amount of age-0 recruitment to the population (Figure 90c), indicating a less productive stock.

Annual estimates of age-4 fishing mortality in the SEDAR 96 base model were slightly higher than the SEDAR 64 models, but become more aligned by year 2016 (Figure 91a). The estimated F30%SPR reference point for SEDAR 96 (0.398 yr^{-1}) was slightly lower than in the Interim Analysis (0.429 yr^{-1}) or the SEDAR 64 Interim SRFS model (0.447 yr^{-1}; Figure 91b) and resulted in higher F/F30%SPR ratio values which were above 1.0 in the beginning of the timeseries, then wavered above and below 1.0 through year 2015 before decreasing to 0.5 in the terminal year (Figure 91c).

5 Discussion

This operational assessment for SEDAR 96 1) updated input data components from the SEDAR 64 base model and Interim Analysis for commercial and recreational fleets for years 1981 – 2023, and 2) provided updated projections of yield and spawning stock biomass to inform Annual Catch Limit (ACL) and Acceptable Biological Catch (ABC) values of southeastern U.S. Yellowtail Snapper based on several constant F and constant catch scenarios.

While changes to the data occurred for nearly every component, the most significant changes occurred to the recreational private mode catch timeseries which has historically been the largest source of recreational landings and discards for Yellowtail Snapper. The incorporation of Florida's SRFS, which in essence acted as a scalar reduction to the pre-2021 private mode catch timeseries, led to a scalar change in model estimated spawning stock size and productivity. This dynamic was also seen recently in the SEDAR 79 (2024) Mutton Snapper benchmark assessment when incorporating those data. But this is not the first time a Yellowtail Snapper assessment has been characterized by scalar changes to estimated stock size or by changes to recreational private, shore, or charter mode data; interestingly, it's occurred with each SEDAR assessment. The estimated stock size increased significantly between SEDAR 3 and SEDAR 27a; but while this was later found to be largely driven by changes to and limitations imposed by model framework (i.e., moving from an ICA model to ASAP v.2; see bridge building in SEDAR 64), the modification from the original MRFSS to the ad-hoc calibrated MRFSS-MRIP also co-occurred. Between SEDAR 27a and SEDAR 64, the MRFSS-MRIP data had further evolved into the fully calibrated MRIP-FES timeseries. Although the MRIP-FES data estimated significantly higher catch and effort, a significant reduction in model estimated stock size to magnitudes similarly estimated in SEDAR 3 was observed and primarily due to the change in model framework from ASAP v2. to Stock Synthesis (see bridge building in SEDAR 64). Florida's SRFS program will continue to develop in its monitoring of Florida's recreational fisheries, and annual catch trends may differ from the MRIP as seen here already for years 2021 – 2023. The MRIP is also slated to complete its research of the measurement error in the FES (anticipated deadline Spring 2026) where changes in estimated scale or trend may be likely. Thus, assessments of Yellowtail Snapper have been characterized by changes to recreational private, shore, or charter mode catch data, but have also been greatly impacted by changes to model framework, and future assessments may wish to account for this.

The SEDAR 96 base model continued to be chiefly influenced by a fishery-dependent index which guided the shape of the annual trend in estimated spawning stock biomass. The commercial CPUE and MRIP CPUE indices were longer timeseries compared to both RVC indices and were not characterized by missing years owing to biennial sampling designs. In SEDAR 64, the trend of spawning stock biomass estimates was largely driven by the MRIP CPUE index (i.e., the fit to the index contained the lowest RMSE); but here, it was influenced more by the commercial CPUE index. This shift was largely due to the base model effectively being forced to fit the commercial CPUE index, as specified by the updated CVs that were considerably smaller (e.g., avg. = 0.04). Early base model runs developed in the beginning stages of this assessment explored artificially adding 0.10 units of standard error to this index within SS (i.e., 0.05 becomes 0.15). This resulted in a model fit with lower total log-likelihood and a shift back to the MRIP CPUE index containing the lowest RMSE. In addition, a decision was made during SEDAR 64 to apply a change in catchability to the commercial CPUE index after talking with commercial fishermen who identified the 'power-chumming' technique to be standard amongst them around 2009, when the abrupt increase in CPUE and commercial landings occurred. However, the updated commercial CPUE index did not exhibit that abrupt change in trend (specifically 2007 – 2014) when new data and updated standardization methods were applied. Instead, the updated commercial CPUE index showed a more gradually increasing trend. Nevertheless, the change in catchability was retained within the base model for this assessment as the rationale for its implementation still stands (i.e., the technique of 'power-chumming' becoming standard for commercial fishing of Yellowtail Snapper around that time period). It's unclear if a change in catchability would have been decided had this gradual trend been presented during SEDAR 64; therefore, these configurations and data changes regarding the commercial CPUE index may warrant re-evaluation during the next benchmark assessment process.

The subsampling of the age data in the terminal three years (2021 – 2023) of the assessment was another source of uncertainty in the SEDAR 96 base model. Total sample sizes of nearly 900 otoliths or less per year were considerably small compared to years 2012 – 2019 which contained 5,000 – 7,000 otoliths per year; but were similar enough to prior years extending back to the model start year (i.e., 1992 – 2011) which averaged around 1,000 total otoliths. Observed mean ages for the commercial fleet during these years showed a decreasing trend, but not atypical when compared to prior fluctuating years, and mean ages for the MRIP SRFS fleet were consistent with prior years (Figure 49). Mean ages observed for the headboat fleet were likely more unrepresentative (especially in year 2020 with a sample size of 39 otoliths), but the larger confidence intervals allowed the base model to estimate older mean ages consistent with adjacent prior years (Figure 49). While sample sizes for 2021 – 2023 initially sought to have 500 subsampled ages per year per strata, the base model results suggest that 300 was sufficient and that this methodology was a reasonable short-term compromise to the sudden heavy lift of processing and aging thousands of available otoliths. Furthermore, the otoliths which were sampled but not aged during this assessment should be available for inclusion in the next benchmark assessment.

Reconfiguring the headboat and MRIP SRFS fleet's CAAL to catch-weighted age composition data appeared to stabilize internal estimates of asymptotic length (*Linf*) when applying the Francis weights. When all fleets were configured as CAAL, the SEDAR 96 base model's growth parameters were influenced by the dome-shaped selectivity of the headboat and MRIP SRFS fleets as well as by the greater presence of smaller and younger sampled fish; this was in conflict with the commercial fleet whose selectivity was flat-topped and caught larger and older fish. In SEDAR 64 and the Interim Analysis, analysts also observed that an unweighted model estimated *Linf* similar to those produced by the external growth model (e.g., 42.3 cm FL), but when Francis weights were applied, the base model's estimates of asymptotic length reduced to 36.2 cm FL and 36.6 cm FL, respectively, accompanied by a narrowing of the domed shape in selectivity. By adjusting the configuration of the headboat and MRIP SRFS age data, the SEDAR 96 base model's growth parameters were now primarily informed by the commercial CAAL data and the fishery-independent CAAL data. Keeping the fishery-independent age data configured as CAAL was important because it largely informed the younger portions of the growth curve where regulatory minimum size limits caused sampling bias in the fishery-dependent data. After applying the Francis weights, the SEDAR 96 base model estimated *Linf* at 38.8 cm FL, which seemed more representative of the data and provided more reasonable estimates of each fleet's selectivity-at-length when compared to the SEDAR 64 and Interim Analysis base models.

How fishing mortality rates were configured here and in both SEDAR 64 and the Interim Analysis was another source of uncertainty. As discussed in section 3.6 above, annual fishing mortality rates were configured using SS' hybrid approach (i.e., method 3), which tunes F sequentially using the harvest rate and the Baranov catch equation for each fleet and is based on the retained catch. This method allows the model to obtain near-exact fits to the retained catch data (thereby essentially ignoring the input error to the retained catch) while sacrificing fits to available discard data. This method may be reasonable for fleets whose CVs are 0.05 or less (Methot et al. 2020), like the assumed error for the commercial and headboat fleets, but may become a possible source of misspecification for fleets whose catch data contain greater amounts of uncertainty, like the MRIP SRFS fleet. A potential resolution to this is by configuring F as an estimable parameter (i.e., method 2) within SS. While this adds many more parameters to the model (i.e., an F parameter for each fleet and each year), early exploratory models implementing this configuration showed improvements to fits of the discard data as well as to the model's total likelihood. However, this also led to some instability during the MCMC and bootstrapping analyses as model parameter and derived quantity distributions from the simulated or resampled datasets characterized very different spaces than those estimated by the model. Further work would need to be done to address those issues for use in the next assessment. Alternatively, newer versions of SS (e.g., v.3.30.22) have a fleet-specific superset of these two F configurations (i.e., method 4) which can allow for the hybrid approach (e.g. for the commercial and headboat fleets) alongside the parameter approach (e.g., for the MRIP SRFS fleet). This may warrant further exploration in the next benchmark assessment which utilizes SS.

Future southeastern U.S. Yellowtail Snapper assessments would greatly benefit from updated reproduction data and related analyses that follow recent recommendations (Lowerre-Barbieri et al. 2022), information on movement and recruitment, and a better understanding of how each data component varies spatially. Potential model changes to consider in the future may include reducing the reliance on fishery dependent indices, improving fits to the data (e.g., conditional age-at-length for lengths greater than 42 cm), and the consideration of a spatially implicit or explicit model, along with the recommended explorations previously mentioned.

The results of the model diagnostics suggest the SEDAR 96 base model may be suitable for use in the management of southeastern U.S. Yellowtail Snapper. The base model demonstrated adequate fits to the various data components while the jitter analysis and low gradient (<0.0001) lent support that the base model converged to a global solution. The base model also exhibited model consistency as the removal of successive years of data back to the terminal year of the benchmark assessment (i.e., 2017) showed no discernable retrospective patterns in estimates of fishing mortality 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 base model exhibited more predictive skill than a random-walk for several data sources.

According to the SEDAR 96 base model, the southeastern U.S. Yellowtail Snapper population is not overfished ($SSB_{current}/MSST > 1.0$) nor experiencing overfishing ($F_{current}/MFMT < 1.0$) and the population is estimated around one-and-three-quarters times the MSST. The age-4 fishing mortality rates rose above the MFMT from 1992 – 1997, oscillated below and slightly above the MFMT through 2014, and then began to decline below the MFMT through 2023. The estimated spawning stock biomass was below MSST for years 1994 – 1998 and remained below the target $SSB_{F30\%SPR}$ from 1992 – 2010, but then increased above the target through 2023. Compared to the results of SEDAR 64 and the Interim Analysis, these results suggested the stock has been managed closer to the target and threshold reference points across most of the timeseries than previously estimated. This was because the SEDAR 96 base model estimated higher annual age-4 fishing mortality rates with a lower $F_{30\%SPR}$ (0.398 yr^{-1}) compared to the SEDAR 64 base model (0.438 yr^{-1}) as well as much lower spawning stock biomass estimates, yet with similar $SSB_{F30\%SPR}$ (1,816.54 mt) compared to the SEDAR 64 base model (1,904.08 mt). Despite these changes, status designation of this stock has not changed since SEDAR 64 nor since the first assessment by Muller et al. (2003).

6 Projections

Short- and long-term deterministic projections were conducted to estimate Yellowtail Snapper 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 96 base model) while relative apical F, selectivity, and discarding and retention associated with the terminal three years (2021 – 2023) would remain the same into the future. The average relative apical F values from 2021 – 2023 as estimated by the base model were used to determine the fleet allocations in the projection scenarios. These were 40.8% for the commercial fleet, 5.0% for the headboat fleet, and 54.2% for the MRIP SRFS 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 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 (2021 – 2023). 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. 2020). Projections were for 100 years (2024 – 2123) where recruitment followed the Beverton-Holt stock-recruitment relationship as parameterized by the base model and that equilibrium was assumed to have been obtained in the final 10 years of the projection (i.e., 2114 – 2123), 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 (2019 – 2023) 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) and a derived P* fishing mortality rate explored a potential acceptable biological catch (ABC) scenario. In section 4.7 above, P* (0.375, as determined in the prior assessment) was shown to correspond to 98.1% of the median of the MCMC distribution of retained yield at $F_{30\%SPR}$. This percentage was therefore applied to the equilibrium $F_{30\%SPR}$ to obtain the derived P* fishing mortality rate. Additionally, a constant fishing mortality rate scenario utilizing the $F_{current}$ (from section 4.7) was conducted.

The second set of short-term projections assumed a constant catch based on the retained yield associated with either the OFL or the P* scenario. These were averaged over 3-year (2024 – 2026) and 5-year (2024 – 2028) projection periods. The TORs also stated to provide projections when catch is held constant at the equilibrium yield at F_{MSY}. However, since Yellowtail Snapper in the southeastern U.S. is currently managed using $F_{30\%SPR}$ as an F_{MSY} proxy, this projection scenario assumed a constant catch based on the equilibrium retained yield at $F_{30\%SPR}$ from the long-term projections. As previously stated, age-0 recruitment in the short-term projections was equal to the 5-year recent average (2019 – 2023) estimated by the base model, as recommended by Schueller et al. (2022) and Van Beveren et al. (2021). Note, however, that the estimated recruitment for these years was consistently positively deviated from the stock-recruitment curve (Figures 56 and 57b) and therefore considered above average recruitment. Furthermore, while only the first 5 years of the short-term projection are recommended for use, reported projections were extended until 2033.

6.1 Results

The projection results for the constant F scenarios including the associated fishing mortality rates, retained landings (in pounds and numbers), releases (in numbers), spawning stock biomass (mt), and age-0 recruitment (in numbers) as estimated for assessment years (1992 – 2023) and forecast years (2024 – 2043) are presented in Figures 92 – 95 and Tables 34 – 35. The equilibrium fishing mortality rate that achieved 30% SPR ($F_{30\%SPR}$) in the long-term projections was 0.392 yr^{-1} and was near exact to the base model estimate (0.398 yr^{-1}). By applying the 98.1% to this value (i.e., 0.392 * 0.981), the derived P* constant F value was 0.385 yr^{-1}. Both are of 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 ($F_{current}$ = 0.263 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 5.076 million lbs. in 2024 to 3.646 million lbs. in 2028 (Table 34, Figure 93). Spawning stock biomass immediately declined as well (Table 34, Figure 94) to estimates similar to the mid-2010 years as recruitment followed the stock-recruitment curve (Table 34, Figure 95).

The results from the short-term $F_{30\%SPR}$ and P* scenarios were quite comparable given the similarity between the two F values (i.e., 0.392 yr^{-1} and 0.385 yr^{-1}, respectively). Retained landings increased as in the long-term projections, however, the differing assumptions on recruitment led to sustained projected yields above historic yields. In the short-term $F_{30\%SPR}$ scenario, retained landings were 5.076 million lbs. (4.288 million fish) in 2024 and 4.307 million lbs. (4.669 million fish) in 2028 (Table 34, Figure 93) while the number of releases were 3.588 million fish in 2024 and 3.421 million fish in 2028 (Table 34). In the P* scenario, retained landings were 4.993 million lbs. (4.217 million fish) in 2024 and 4.284 million lbs. (3.639 million fish) in 2028 (Table 35, Figure 93) while the number of releases were 3.525 million fish in 2024 and 3.368 million fish in 2028 (Table 35). In both scenarios, projected SSB immediately declined (Table 34, Figure 94) and stabilized near recent year values due to the assumed above average recruitment (Table 34, Figure 95). Short-term projections for the $F_{current}$ scenario estimated comparatively lower F values (i.e., 0.263 yr^{-1}; Table 35, Figure 92) and resulted in retained landings increasing to 3.578 million lbs. (3.011 million fish) in 2024 and 3.742 million lbs. (3.035 million fish) in 2028 (Table 35, Figure 93). The number of releases were 2.469 million fish in 2024 and 2.442 million fish in 2028 (Table 35). Projected SSB continued to increase above historic estimates, but soon stabilized at 3,259 metric tons in 2028 (Table 35, Figure 94) given the above average recruitment assumption (Table 35, Figure 95).

Projection results for the short-term constant catch scenarios were evaluated and the associated fishing mortality rates, retained landings (in pounds and numbers), releases (in numbers) spawning stock biomass (mt), and age-0 recruitment (in numbers) are shown in Figures 96 – 99 and Tables 36 – 37. The retained yield averaged over the initial 3 and 5 years of the short-term $F_{30\%SPR}$ scenario was 4.779 and 4.602 million lbs., respectively (Table 36, Figure 96). The retained yield averaged over the initial 3 and 5 years of the P* scenario was 4.772 and 4.557 million lbs., respectively (Table 36, Figure 96). The retained yields in both of these scenarios were very similar and well above historic yield estimates. Fishing mortality rates in these scenarios were projected to increase above the MFMT by 2028 and continually increase (Table 36, Figure 97). Spawning stock biomass declined in trend towards the $SSB_{F30\%SPR}$ but remained above the MSST (Table 36, Figure 98) as influenced by the constant mean recruitment (Table 36, Figure 99).

The equilibrium retained yield at $F_{30\%SPR}$ estimated during the last 10 years of the long-term projection scenario was 3.001 million lbs., which informed the associated short-term constant catch scenario. This yield estimate differed slightly from the analytical solution provided by the base model (3.067 million lbs.; see section 4.7) and was similar in magnitude to the estimated average retained yield since the terminal year of SEDAR 64 (i.e., 2017 – 2023) at 3.116 million lbs. (Table 37, Figure 96). Given the constant above average recruitment (Table 37, Figure 99) and the lower rate of removals, spawning stock biomass in this scenario continued to rise well above historic estimates (Table 37, Figure 98) and fishing mortality rates declined below historic lows (Table 37, Figure 97).

6.2 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 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. This can especially be true for Yellowtail Snapper whose recruitment appears cyclical and recent recruitment was considered above average.

The estimates of retained yield from the short-term $F_{30\%SPR}$ and P* scenarios for this assessment were similar in trend to those provided to both SAFMC and GMFMC SSCs by the Interim Analysis, but differed in scale. Changes to the SEDAR 96 base model catch data influenced the historic yield estimates while changes to the projection assumptions influenced the projected retained yield. In the Interim Analysis, historic retained yield was estimated higher than in SEDAR 96 and, in the projections, recruitment was assumed to follow the stock-recruitment relationship. Therefore, this resulted in retained yields under $F_{30\%SPR}$ and P* to be similar in magnitude to historic yields. Here, projected retained yield for both the $F_{30\%SPR}$ and P* scenarios were much higher (e.g., 5-year averages were 4.602 million lbs. and 4.558 million lbs., respectively) than recent yield averages (e.g., 3.116 million lbs. averaged from 2017 – 2023) or the highest estimated historic yield (e.g., 4.055 million lbs. in 2017). Furthermore, the projected retained yield for the $F_{30\%SPR}$ and P* scenarios in this assessment was on average 1.1 – 1.2 million lbs. greater when comparing overlapping projection years between here and the Interim Analysis (i.e., years 2024 – 2025).

In contrast, the results of the $F_{current}$ scenario appeared more consistent with historic yields. The projected retained yield was more conservative than under the $F_{30\%SPR}$ and P* (e.g., 5-year averaged 3.679 million lbs.) and similar to the retained yield estimated for years 1993 – 1995 and 2013 – 2018. Historically, the stock was either undergoing or approaching overfishing during those years; but the estimated SSB averaged over those years was also 57% and 90% of the $SSB_{current}$, respectively. The projected SSB, which appeared intermediate between the increased rate of recruitment and the lower rate of removals, may in reality decline similarly as the other constant F scenarios. Nevertheless, of the three constant F scenarios provided here and as requested by the TORs, the $F_{current}$ scenario seems to be the most conservative. However, it remains unclear whether the uncertainty in this assessment is better accounted for in this scenario to inform the ABC, rather than the P* scenario, or if additional scenarios are warranted (e.g., updated P*, 75% $F_{30\%SPR}$ or $F_{40\%SPR}$).

Constant catch projection scenarios are appealing for management as they may result in greater market stability and consistency in regulations. However, the 3- and 5-year short-term projections associated with both the OFL and P* scenarios led to fishing mortality rates which far exceeded the MFMT after only a few years into the projections as well as declines in spawning stock biomass that approached the $SSB_{F30\%SPR}$ yet remained above the MSST. The behavior of these results was akin to the ones provided for the same constant catch scenarios in the Interim Analysis and continued to appear as high-risk options to inform either the OFL or the ABC. Furthermore, the underlying assumptions depicted a population which may ‘sustainably’ undergo overfishing in the long-term without ever being considered overfished.

When catch was held constant at the equilibrium yield at $F_{30\%SPR}$ (i.e., 3.001 million lbs.), the population was sustained above the spawning stock threshold and below the fishing mortality threshold. This scenario was the most risk-averse in the long-term of the three constant catch scenarios, and was even more conservative compared to the constant F scenario at $F_{current}$.

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8 Tables

Table 1. Length-length (mm) relationships for southeastern U.S. Yellowtail Snapper as developed during SEDAR 64. Length-length regressions are in the form Y = a + bX. SL: standard length (mm); FL: fork length (mm); TL: total length (mm); TW: total weight (kg), GW: gutted weight (kg).

Source	Y (mm)	a (mm)	b	X (mm)	n	Min X (mm)	Max X (mm)	Avg. X* (mm)	MSE*	Adj. r^2	Σx^2*	Σxy*	Σy^2*
SEDAR 64	SL [a]	-8.5525	0.8961	FL	5,873	230	548	309.8	24.19173	0.99	14972186	13416498	12164483
	$TL_{relaxed}$ [b]**	-14.7197	1.2727	FL	16,212	205	550	304.8	75.76723	0.98	32304485	41115136	53556972
	TL_{max} [c]	-16.4139	1.2969	FL	6,827	225	548	308.1	32.20539	0.99	16365228	21223575	27744022

[a] reverse prediction: FL = 9.5441 + 1.1159 * SL

[b] reverse prediction: FL = 11.5657 + 0.7857 * $TL_{relaxed}$

[c] reverse prediction: FL = 12.6563 + 0.7711 * TL_{max}

Table 2. Length-weight relationships (nonlinear estimation) for southeastern U.S. Yellowtail Snapper as developed during SEDAR 64. FL: fork length (mm); TL: total length (mm); TW: total weight (kg), GW: gutted weight (kg). Length-weight regressions were calculated with a nonlinear model: weight = a * $Length^b$.

Source	Y (kg)	a	b	X(mm)	n	Min (mm)	Max (mm)	MSE
SEDAR 64	TW	3.40E-08	2.8797	FL	16,540	202	550	0.002
	TW	4.04E-08	2.7487	$TL_{relaxed}$	10,792	247	697	0.00267
	TW	3.21E-08	2.7849	TL_{max}	1,763	284	654	0.00367
	GW	6.15E-08	2.7691	FL	4,052	232	548	0.00311
	GW	5.16E-08	2.7086	$TL_{relaxed}$	1,955	277	662	0.0043
	GW	5.27E-08	2.6935	TL_{max}	1,838	281	684	0.00403

Source	Y (kg)	a	b	X(cm)	n	Min (cm)	Max (cm)	MSE
SEDAR 64	TW	2.07E-05	2.8797	FL	16,540	20.2	55	0.002
	TW	2.46E-05	2.7487	$TL_{relaxed}$	10,792	24.7	69.7	0.00267
	TW	1.96E-05	2.7849	TL_{max}	1,763	28.4	65.4	0.00367
	GW	3.75E-05	2.7691	FL	4,052	23.2	54.8	0.00311
	GW	3.14E-05	2.7086	$TL_{relaxed}$	1,955	27.7	66.2	0.0043
	GW	3.21E-05	2.6935	TL_{max}	1,838	28.1	68.4	0.00403

Table 3. Number of southeastern U.S. Yellowtail Snapper otoliths sampled in Florida by region for years 1980 – 2023. Regions: northeast Florida (Nassau County to Brevard County), southeast Florida (Indian River County to Miami-Dade County), Florida Keys (Monroe County), southwest Florida (Levy County to Collier County), northwest Florida (Escambia County to Dixie County), and unknown (regionally unknown but from Florida).

Year	Northeast Florida	Southeast Florida	Florida Keys	Southwest Florida	Northwest Florida	Unknown	Total
1980	1	32	153	0	0	102	288
1981	5	100	242	0	0	0	347
1982	15	114	60	0	0	0	189
1983	20	202	12	0	0	0	234
1984	18	141	0	0	0	0	159
1985	24	18	0	0	0	0	42
1986	33	22	0	9	0	0	64
1987	28	22	0	0	0	0	50
1988	4	6	0	1	0	0	11
1991	2	0	28	0	0	0	30
1992	4	73	1	6	0	23	107
1993	0	130	32	11	1	0	174
1994	0	200	119	1	0	18	338
1995	7	437	123	0	0	0	567
1996	0	313	143	1	0	0	457
1997	6	504	363	26	0	136	1,035
1998	0	518	332	6	0	0	856
1999	13	796	290	1	0	0	1,100
2000	1	634	459	11	0	0	1,105
2001	0	318	496	0	0	1	815
2002	0	19	521	3	0	0	543
2003	0	87	211	3	0	0	301
2004	0	627	262	9	0	0	898
2005	4	573	756	28	0	0	1,361
2006	3	782	767	20	0	0	1,572
2007	6	695	718	32	0	0	1,451
2008	8	485	1,084	171	0	25	1,773
2009	29	397	1,223	154	1	0	1,804
2010	10	342	1,026	63	0	0	1,441
2011	8	502	1,251	43	0	0	1,804
2012	11	696	5,412	43	0	0	6,162
2013	15	1,164	5,505	21	0	0	6,705
2014	12	2,025	4,778	77	1	0	6,893
2015	4	1,963	5,230	150	1	0	7,348
2016	20	1,273	4,746	173	1	4	6,217
2017	18	717	4,550	164	2	0	5,451
2018	11	678	4,767	152	6	0	5,614
2019	49	442	4,285	452	4	0	5,232
2020	28	33	1,115	197	52	0	1,425
2021	0	190	445	24	0	0	659
2022	0	220	625	45	0	0	890
2023	0	218	629	43	0	0	890
Total	417	18,708	52,759	2,140	69	309	74,402
Percent	0.6%	25.1%	70.9%	2.9%	0.1%	0.4%	100.0%

Table 4. Number of southeastern U.S. Yellowtail Snapper otoliths sampled in Florida by year and mode of fishing for years 1980 – 2023.

Year	Commercial	Headboat	Private	Shore	Charter	Other	Scientific Survey	Unknown	Total
1980	16	272	0	0	0	0	0	0	288
1981	153	194	0	0	0	0	0	0	347
1982	0	189	0	0	0	0	0	0	189
1983	0	234	0	0	0	0	0	0	234
1984	0	159	0	0	0	0	0	0	159
1985	0	42	0	0	0	0	0	0	42
1986	0	60	0	0	4	0	0	0	64
1987	0	50	0	0	0	0	0	0	50
1988	0	11	0	0	0	0	0	0	11
1991	0	30	0	0	0	0	0	0	30
1992	74	33	0	0	0	0	0	0	107
1993	158	5	7	0	4	0	0	0	174
1994	252	76	10	0	0	0	0	0	338
1995	267	299	0	0	0	0	1	0	567
1996	398	59	0	0	0	0	0	0	457
1997	933	81	16	0	5	0	0	0	1,035
1998	457	96	32	0	0	0	271	0	856
1999	735	13	51	0	9	0	292	0	1,100
2000	481	9	0	0	2	0	613	0	1,105
2001	449	0	39	0	18	0	309	0	815
2002	448	0	0	0	5	0	90	0	543
2003	213	36	1	0	51	0	0	0	301
2004	271	501	13	0	113	0	0	0	898
2005	537	748	6	0	70	0	0	0	1,361
2006	618	873	0	0	81	0	0	0	1,572
2007	281	1,146	1	0	0	0	23	0	1,451
2008	574	1,054	17	0	103	0	25	0	1,773
2009	674	1,028	26	0	49	0	27	0	1,804
2010	476	752	30	0	90	1	92	0	1,441
2011	699	1,041	3	0	49	3	9	0	1,804
2012	4,428	1,695	0	0	0	0	39	0	6,162
2013	4,812	1,846	0	0	31	0	16	0	6,705
2014	4,496	2,224	0	0	124	0	49	0	6,893
2015	4,686	2,199	0	0	431	0	32	0	7,348
2016	3,152	2,875	2	0	188	0	0	0	6,217
2017	2,837	2,004	103	0	507	0	0	0	5,451
2018	2,741	1,558	145	0	1,170	0	0	0	5,614
2019	2,392	1,689	227	0	906	0	0	18	5,232
2020	1,185	39	74	0	127	0	0	0	1,425
2021	266	139	150	0	104	0	0	0	659
2022	300	298	172	0	120	0	0	0	890
2023	300	299	207	1	83	0	0	0	890
Total	40,759	25,956	1,332	1	4,444	4	1,888	18	74,402
Percent	54.8%	34.9%	1.8%	<0.1%	6.0%	<0.1%	2.5%	<0.1%	100.0%

Table 5. Number of southeastern U.S. Yellowtail Snapper otoliths sampled in Florida by year and age for years 1980 – 2023 and ages 0 – 20 years.

	Age (years)																				
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	20	Total
1980	0	6	78	73	48	33	28	8	3	5	4	1	0	0	0	0	0	1	0	0	288
1981	0	7	101	89	51	34	18	19	13	7	1	4	2	0	0	0	1	0	0	0	347
1982	0	2	25	96	32	16	6	7	4	0	1	0	0	0	0	0	0	0	0	0	189
1983	0	5	105	69	36	4	6	3	2	0	2	1	0	0	1	0	0	0	0	0	234
1984	0	2	73	50	17	10	4	2	0	0	0	0	1	0	0	0	0	0	0	0	159
1985	0	3	17	14	6	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	42
1986	0	4	33	11	9	4	1	2	0	0	0	0	0	0	0	0	0	0	0	0	64
1987	0	4	28	14	3	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	50
1988	0	0	4	6	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11
1991	0	0	6	4	11	5	0	0	0	1	0	2	1	0	0	0	0	0	0	0	30
1992	0	0	23	58	15	4	3	3	0	0	0	1	0	0	0	0	0	0	0	0	107
1993	0	0	54	57	21	10	10	6	9	2	2	1	0	0	2	0	0	0	0	0	174
1994	0	2	46	148	68	20	9	11	13	3	5	4	3	2	2	0	2	0	0	0	338
1995	0	2	112	251	133	36	14	7	5	7	0	0	0	0	0	0	0	0	0	0	567
1996	0	18	185	97	73	41	20	4	8	5	2	2	2	0	0	0	0	0	0	0	457
1997	0	3	264	318	148	107	85	47	20	16	8	12	6	1	0	0	0	0	0	0	1,035
1998	0	27	233	320	125	51	40	28	14	5	6	5	0	1	1	0	0	0	0	0	856
1999	0	75	505	227	127	73	38	20	17	8	5	0	1	1	3	0	0	0	0	0	1,100
2000	1	175	372	196	128	90	57	31	19	20	6	7	0	2	1	0	0	0	0	0	1,105
2001	1	35	231	168	139	83	70	33	16	13	9	8	6	1	0	1	0	1	0	0	815
2002	0	0	47	118	107	109	78	32	25	7	7	4	5	2	1	0	1	0	0	0	543
2003	0	11	53	69	46	22	33	28	9	12	3	3	7	4	0	1	0	0	0	0	301
2004	0	11	385	293	110	42	26	15	7	3	0	3	1	0	1	1	0	0	0	0	898
2005	0	15	296	555	229	126	69	29	14	12	7	4	2	1	2	0	0	0	0	0	1,361
2006	0	22	634	329	254	120	68	51	35	26	12	7	7	2	5	0	0	0	0	0	1,572
2007	17	30	396	565	201	96	66	31	19	5	13	4	2	2	3	0	1	0	0	0	1,451
2008	0	40	339	465	449	184	113	69	50	22	9	15	6	4	1	3	3	0	1	0	1,773
2009	0	30	397	431	297	297	132	94	52	25	17	4	11	10	4	2	1	0	0	0	1,804
2010	0	37	317	358	308	160	136	51	29	20	5	10	3	3	1	1	2	0	0	0	1,441
2011	0	77	352	585	330	203	90	84	36	17	11	7	5	2	2	0	1	2	0	0	1,804
2012	0	82	876	1,437	1,612	880	584	266	201	76	56	41	21	14	5	3	6	1	1	0	6,162
2013	0	137	1,373	1,541	1,270	1,195	512	330	141	99	52	29	16	3	3	0	1	1	2	0	6,705
2014	1	130	2,132	1,879	998	584	581	283	145	66	44	15	13	9	5	5	3	0	0	0	6,893
2015	4	203	1,682	2,483	1,316	630	399	325	135	76	37	19	16	8	7	4	2	0	2	0	7,348
2016	0	93	1,708	1,487	1,545	734	258	135	121	74	21	18	12	3	6	1	0	0	0	1	6,217
2017	0	70	1,105	1,731	1,038	781	327	150	100	77	30	17	13	6	3	2	1	0	0	0	5,451
2018	0	58	582	1,611	1,316	662	592	286	148	110	110	59	33	17	15	8	4	3	0	0	5,614
2019	0	81	860	1,336	1,617	647	262	181	98	43	24	35	16	15	7	9	0	1	0	0	5,232
2020	0	10	70	306	273	423	143	75	46	29	13	9	18	3	3	2	1	0	1	0	1,425
2021	0	29	192	124	125	73	62	24	10	11	4	2	1	1	0	1	0	0	0	0	659
2022	0	30	191	324	148	103	33	27	16	6	5	3	1	1	1	1	0	0	0	0	890
2023	0	31	213	183	272	112	38	22	9	5	3	1	0	1	0	0	0	0	0	0	890
Total	24	1,597	16,695	20,476	15,052	8,804	5,014	2,819	1,589	913	534	357	231	119	85	45	30	10	7	1	74,402
Percent	<0.1%	2.1%	22.4%	27.5%	20.2%	11.8%	6.7%	3.8%	2.1%	1.2%	0.7%	0.5%	0.3%	0.2%	0.1%	0.1%	<0.1%	<0.1%	<0.1%	<0.1%	100.0%

Table 6. Results of the subsampling routine for southeastern U.S. Yellowtail Snapper in Florida by fishery and region (2-strata scenario) for years 2021 – 2023. ‘Subsample Target’ is the number of targeted subsamples for each fleet and region (n = 300), ‘Available’ is the potential number of otoliths available to be aged, ‘Subsampled’ is the number of randomly selected otoliths subsampled according to the number targeted, and ‘Aged’ is the number of subsampled otoliths successfully aged.

Region	Fishery	YTS Region	Avg. Landings** (2016 - 2020)	Proportion	Subsample Target	2021			2022			2023		
						Available	Subsampled	Aged	Available	Subsampled	Aged	Available	Subsampled	Aged
Florida	Commercial	NE	201	0.0001	0.0	35	0	0	18	0	0	3	0	0
		SE	41,524	0.0193	5.8	38	6	6	70	6	6	120	6	6
		KY	2,090,976	0.9715	291.5	269	269	257	1,630	291	291	957	291	291
		SW	19,451	0.0090	2.7	101	3	3	161	3	3	239	3	3
		NW	63	0.0000	0.0	17	0	0	5	0	0	25	0	0
	Headboat	NE	225	0.0014	0.4	5	0	0	9	0	0	15	0	0
		SE	46,149	0.2815	84.5	232	85	86	484	85	85	977	85	85
		KY	107,518	0.6559	196.8	57	57	43	1,132	197	194	999	197	196
		SW	10,016	0.0611	18.3	12	12	10	36	18	19	51	18	18
		NW	28	0.0002	0.1	0	0	0	0	0	0	0	0	0
	MRIP	NE	2,422	0.0017	0.5	2	0	0	3	0	0	0	0	0
		SE	607,424	0.4284	128.5	145	129	98	263	129	129	328	129	127
		KY	705,717	0.4977	149.3	393	149	145	437	149	140	321	149	142
		SW	102,310	0.0722	21.6	15	15	11	26	22	23	47	22	22
		NW	0	0.0000	0.0	0	0	0	1	0	0	1	0	0

** Landings units: Commercial (pounds), Headboat (numbers), MRIP (numbers)

Table 7. Predicted length-at-age, natural mortality-at-age ($M_{at\text{-}age}$), and proportion mature-at-age of southeastern U.S. Yellowtail Snapper in Florida using observed maximum age of 20 years and as developed during SEDAR 64. $M_{at\text{-}age}$ is derived following Lorenzen (2005) using the $Hoenig_{all\ taxa}$ (1983) constant mortality-at-age as the target M scaled between vulnerable ages 3 – 20 years (M_{target} = 0.223 yr^{-1}) and the external von Bertalanffy growth model parameters: *Linf* = 42.3 cm FL, *k* = 0.207 yr^{-1}, and *t0* = -1.636 yr. Proportion mature-at-age calculated using logistic regression (PROC NLIN, SAS version 9.2) on female Yellowtail Snapper maturity-at-age data from the southeast Florida and the Florida Keys regions.

Age (yr)	Predicted FL (cm)	$M_{at\text{-}age}$	Proportion Mature
0	12.2	0.558	0.01
1	17.8	0.414	0.13
2	22.4	0.343	0.69
3	26.1	0.301	0.97
4	29.1	0.273	1.00
5	31.6	0.255	1.00
6	33.6	0.241	1.00
7	35.2	0.231	1.00
8	36.5	0.224	1.00
9	37.6	0.218	1.00
10	38.5	0.214	1.00
11	39.2	0.210	1.00
12	39.8	0.208	1.00
13	40.3	0.205	1.00
14	40.6	0.204	1.00
15	40.9	0.202	1.00
16	41.2	0.201	1.00
17	41.4	0.200	1.00
18	41.6	0.200	1.00
19	41.7	0.199	1.00
20	41.8	0.198	1.00

Table 8. Commercial landings (whole lbs., metric tons) of southeastern U.S. Yellowtail Snapper in Florida by concatenated region for years 1981 – 2023 from the NMFS ALS (1981 – 1985) and Florida's Marine Fisheries Trip Ticket Program (1986 – 2023). Regions are concatenated due to confidentiality in landings. 'FL Gulf of Mexico' is Florida regions northwest and southwest while 'FL South Atlantic' is Florida regions northeast and southeast.

	Landings (whole lbs.)				Landings (mt)			
Year	FL Gulf of Mexico	Florida Keys	FL South Atlantic	Total	FL Gulf of Mexico	Florida Keys	FL South Atlantic	Total
1981	54,325	639,863	37,434	731,622	24.641	290.237	16.980	331.858
1982	76,846	1,257,985	35,884	1,370,715	34.857	570.612	16.277	621.746
1983	48,163	846,222	67,333	961,718	21.846	383.840	30.542	436.228
1984	49,835	861,773	35,697	947,305	22.605	390.894	16.192	429.690
1985	22,047	762,048	41,126	825,221	10.000	345.659	18.654	374.314
1986	23,605	1,093,758	124,475	1,241,839	10.707	496.120	56.461	563.289
1987	20,284	1,385,910	98,298	1,504,493	9.201	628.638	44.587	682.426
1988	28,198	1,395,543	144,189	1,567,931	12.791	633.008	65.403	711.201
1989	68,175	1,820,906	164,038	2,053,119	30.924	825.949	74.406	931.279
1990	46,940	1,751,188	150,212	1,948,340	21.291	794.325	68.135	883.752
1991	25,621	1,851,441	187,926	2,064,989	11.621	839.799	85.242	936.663
1992	79,568	1,535,108	236,836	1,851,512	36.091	696.313	107.427	839.832
1993	57,346	2,068,476	252,911	2,378,733	26.012	938.245	114.719	1,078.975
1994	31,381	1,903,381	270,743	2,205,506	14.234	863.359	122.807	1,000.400
1995	38,344	1,587,849	230,597	1,856,790	17.392	720.236	104.597	842.226
1996	28,535	1,195,418	235,145	1,459,097	12.943	542.232	106.660	661.835
1997	17,730	1,305,918	350,257	1,673,906	8.042	592.354	158.874	759.271
1998	6,801	1,224,100	293,793	1,524,694	3.085	555.242	133.262	691.589
1999	20,031	1,538,243	287,868	1,846,142	9.086	697.735	130.575	837.396
2000	6,742	1,369,165	215,873	1,591,780	3.058	621.043	97.918	722.019
2001	6,125	1,194,741	219,287	1,420,153	2.778	541.925	99.467	644.171
2002	2,994	1,163,673	240,911	1,407,578	1.358	527.833	109.275	638.466
2003	5,590	1,145,718	253,367	1,404,675	2.536	519.689	114.925	637.150
2004	4,381	1,245,166	227,899	1,477,446	1.987	564.798	103.373	670.158
2005	3,409	1,125,648	184,760	1,313,817	1.546	510.585	83.806	595.937
2006	6,122	1,104,558	118,808	1,229,488	2.777	501.019	53.890	557.686
2007	3,102	850,506	116,241	969,848	1.407	385.783	52.726	439.915
2008	4,616	1,246,604	102,776	1,353,996	2.094	565.450	46.618	614.162
2009	2,937	1,781,795	146,531	1,931,263	1.332	808.209	66.465	876.006
2010	603	1,492,324	162,382	1,655,309	0.273	676.907	73.655	750.835
2011	4,422	1,731,358	118,392	1,854,173	2.006	785.331	53.702	841.038
2012	13,029	1,931,823	128,380	2,073,232	5.910	876.260	58.232	940.402
2013	10,701	1,951,818	69,782	2,032,300	4.854	885.329	31.653	921.836
2014	9,885	1,932,281	68,019	2,010,186	4.484	876.468	30.853	911.805
2015	13,060	2,044,602	96,370	2,154,032	5.924	927.416	43.713	977.052
2016	14,362	2,155,539	89,938	2,259,839	6.515	977.736	40.795	1,025.046
2017	14,102	2,703,616	63,568	2,781,286	6.396	1,226.339	28.834	1,261.570
2018	21,012	1,874,356	58,183	1,953,551	9.531	850.193	26.392	886.116
2019	21,697	2,061,636	85,956	2,169,288	9.841	935.142	38.989	983.972
2020	12,937	1,327,148	55,620	1,395,705	5.868	601.984	25.229	633.081
2021	9,935	1,587,092	24,361	1,621,388	4.506	719.893	11.050	735.449
2022	49,857	1,672,562	56,113	1,778,533	22.615	758.661	25.453	806.729
2023	15,041	1,407,326	31,206	1,453,573	6.822	638.352	14.155	659.330

Table 9. Commercial landings (numbers) of southeastern U.S. Yellowtail Snapper in Florida by concatenated region for years 1984 – 2023. Estimated landings in numbers are based on landings in pounds from Florida's Marine Fisheries Trip Ticket Program and converted to numbers using mean weights sampled from the Trip Interview Program. Regions are concatenated due to confidentiality in landings. 'FL Gulf of Mexico' is Florida regions northwest and southwest while 'FL South Atlantic' is Florida regions northeast and southeast.

Landings (numbers)

Year	FL Gulf of Mexico	Florida Keys	FL South Atlantic	Total
1984	68,442	1,605,644	58,359	1,732,444
1985	24,475	3,021,194	99,625	3,145,294
1986	39,069	1,805,889	183,331	2,028,289
1987	33,572	2,257,492	144,777	2,435,840
1988	46,671	1,757,928	212,366	2,016,965
1989	79,476	2,795,481	187,315	3,062,272
1990	54,720	2,506,682	171,573	2,732,976
1991	26,540	1,782,353	214,571	2,023,464
1992	111,575	2,016,222	242,029	2,369,826
1993	78,134	2,564,436	264,491	2,907,060
1994	35,478	2,410,463	381,025	2,826,966
1995	43,276	1,728,516	283,784	2,055,577
1996	29,946	1,345,351	230,628	1,605,925
1997	20,080	1,620,178	353,172	1,993,430
1998	7,636	1,421,483	300,613	1,729,732
1999	32,956	1,889,722	312,662	2,235,340
2000	11,320	1,744,074	246,007	2,001,401
2001	10,179	1,383,758	306,002	1,699,939
2002	4,948	1,444,927	284,430	1,734,306
2003	10,176	1,491,235	274,976	1,776,387
2004	6,271	1,532,022	229,454	1,767,747
2005	5,846	1,483,156	227,440	1,716,442
2006	9,310	1,509,686	129,067	1,648,063
2007	4,499	1,239,989	128,336	1,372,824
2008	6,924	1,779,001	109,387	1,895,312
2009	4,280	2,532,668	144,389	2,681,337
2010	953	2,085,671	180,535	2,267,159
2011	6,606	2,491,250	126,388	2,624,244
2012	20,806	2,468,292	148,435	2,637,532
2013	16,050	2,539,533	68,021	2,623,604
2014	14,886	2,535,242	63,829	2,613,958
2015	22,193	2,466,659	90,225	2,579,077
2016	24,192	2,603,274	81,934	2,709,399
2017	21,508	3,479,293	60,246	3,561,047
2018	37,203	2,654,868	54,423	2,746,494
2019	34,397	2,380,003	82,164	2,496,564
2020	17,218	1,726,615	63,051	1,806,885
2021	16,765	1,842,029	27,468	1,886,262
2022	105,381	1,999,261	73,571	2,178,213
2023	28,695	1,458,770	31,314	1,518,779

Table 10. Headboat landings (numbers) of southeastern U.S. Yellowtail Snapper in Florida by region for years 1981 – 2023. The asterisk (*) denotes that the northwest Florida region was combined with southwest Florida region due to confidentiality of northwest Florida data. Years 1981 – 1985 are comprised of both SRHS data and headboat mode data from MRIP.

Year	Southwest FL*	FL Keys	Southeast FL	Northeast FL	Total
1981	0	91,767	84,928	616	177,311
1982	97	233,125	60,071	450	293,743
1983	5,800	221,519	34,177	807	262,303
1984	4,926	146,760	33,557	390	185,633
1985	411	135,978	25,179	590	162,158
1986	2,955	172,664	29,035	1,495	206,149
1987	4,731	193,756	34,736	2,304	235,527
1988	5,559	230,565	53,087	2,161	291,372
1989	5,729	115,666	43,794	1,248	166,437
1990	3,565	165,977	47,198	2,023	218,763
1991	4,172	155,182	51,289	2,146	212,789
1992	6,033	143,843	54,365	1,126	205,367
1993	8,140	164,595	45,274	692	218,701
1994	6,099	160,086	76,348	625	243,158
1995	1,576	119,525	35,954	441	157,496
1996	3,212	110,978	23,378	31	137,599
1997	739	112,110	26,729	260	139,838
1998	3,077	101,312	16,007	130	120,526
1999	7,244	77,243	24,512	224	109,223
2000	2,056	95,029	12,027	188	109,300
2001	544	96,312	4,770	243	101,869
2002	536	117,674	2,382	420	121,012
2003	674	97,738	10,267	175	108,854
2004	473	109,363	8,118	468	118,422
2005	1,691	130,487	16,160	749	149,087
2006	2,160	94,199	2,157	458	98,974
2007	1,875	83,873	17,232	1,618	104,598
2008	1,150	69,631	31,857	724	103,362
2009	1,248	66,854	19,329	949	88,380
2010	294	63,102	38,577	201	102,174
2011	1,051	68,229	29,310	178	98,768
2012	1,224	74,104	35,265	222	110,815
2013	1,901	79,299	31,146	596	112,942
2014	5,395	92,393	65,601	601	163,990
2015	5,013	94,481	73,498	625	173,617
2016	5,936	80,144	98,313	183	184,576
2017	7,309	76,190	26,861	320	110,680
2018	5,935	80,909	26,241	197	113,282
2019	8,025	92,486	20,078	169	120,758
2020	7,497	57,687	19,586	43	84,813
2021	27,214	149,618	37,812	100	214,744
2022	12,712	82,210	18,908	38	113,868
2023	12,496	67,305	22,488	43	102,332

Table 11. Headboat landings (whole lbs., metric tons) of southeastern U.S. Yellowtail Snapper in Florida by region for years 1981 – 2023. The asterisk (*) denotes that the northwest Florida region was combined with southwest Florida region due to confidentiality of northwest Florida data. Years 1981 – 1985 are comprised of both SRHS data and headboat mode data from MRIP.

	Landings (whole lbs.)					Landings (mt)				
Year	Southwest FL*	FL Keys	Southeast FL	Northeast FL	Total	Southwest FL*	FL Keys	Southeast FL	Northeast FL	Total
1981	0	108,354	134,400	527	243,280	0.000	49.148	60.963	0.239	110.350
1982	118	305,364	99,052	463	404,997	0.053	138.511	44.929	0.210	183.703
1983	6,552	252,719	48,906	859	309,035	2.972	114.631	22.183	0.389	140.176
1984	6,412	189,667	48,643	428	245,150	2.909	86.031	22.064	0.194	111.198
1985	913	187,039	33,834	526	222,311	0.414	84.839	15.347	0.239	100.839
1986	3,910	216,256	42,523	1,165	263,853	1.773	98.092	19.288	0.529	119.682
1987	4,209	236,538	39,325	2,017	282,088	1.909	107.292	17.837	0.915	127.953
1988	4,335	329,668	68,559	2,853	405,415	1.966	149.535	31.098	1.294	183.893
1989	6,488	158,117	60,736	1,241	226,582	2.943	71.721	27.549	0.563	102.776
1990	4,693	268,550	52,771	1,586	327,600	2.129	121.812	23.937	0.719	148.597
1991	7,349	220,994	49,403	1,749	279,496	3.334	100.241	22.409	0.793	126.777
1992	7,376	194,998	55,530	1,046	258,951	3.346	88.450	25.188	0.475	117.458
1993	12,812	312,850	52,314	832	378,809	5.811	141.906	23.729	0.377	171.825
1994	6,021	178,725	84,680	444	269,871	2.731	81.068	38.410	0.202	122.411
1995	1,726	118,181	43,525	504	163,936	0.783	53.606	19.743	0.229	74.360
1996	2,854	112,199	25,858	24	140,936	1.295	50.893	11.729	0.011	63.927
1997	1,260	111,823	36,577	252	149,912	0.571	50.722	16.591	0.114	67.999
1998	3,111	98,947	20,720	117	122,896	1.411	44.882	9.398	0.053	55.744
1999	7,109	69,760	28,748	312	105,929	3.224	31.643	13.040	0.141	48.049
2000	2,851	81,824	12,653	192	97,521	1.293	37.115	5.739	0.087	44.235
2001	725	93,396	5,221	205	99,548	0.329	42.364	2.368	0.093	45.154
2002	637	106,985	2,737	577	110,936	0.289	48.528	1.241	0.262	50.320
2003	811	84,112	12,080	196	97,199	0.368	38.152	5.480	0.089	44.089
2004	580	95,258	7,786	446	104,071	0.263	43.208	3.532	0.202	47.206
2005	1,635	129,396	17,229	676	148,937	0.742	58.693	7.815	0.306	67.556
2006	2,264	80,537	2,109	489	85,400	1.027	36.531	0.957	0.222	38.737
2007	2,395	64,883	16,392	1,084	84,754	1.086	29.430	7.435	0.492	38.444
2008	1,246	58,615	33,441	767	94,070	0.565	26.587	15.169	0.348	42.669
2009	1,285	58,347	19,261	1,226	80,119	0.583	26.466	8.737	0.556	36.341
2010	522	52,376	36,621	220	89,739	0.237	23.757	16.611	0.100	40.705
2011	3,523	56,414	32,429	186	92,552	1.598	25.589	14.709	0.084	41.981
2012	3,881	75,911	41,430	195	121,418	1.760	34.433	18.793	0.088	55.074
2013	5,968	75,384	32,812	513	114,676	2.707	34.193	14.883	0.233	52.016
2014	18,081	89,434	69,307	510	177,332	8.201	40.567	31.437	0.231	80.436
2015	14,574	88,424	74,053	547	177,598	6.611	40.108	33.590	0.248	80.557
2016	11,524	75,512	100,398	625	188,059	5.227	34.252	45.540	0.284	85.302
2017	16,701	77,462	23,491	276	117,930	7.575	35.136	10.655	0.125	53.492
2018	5,074	76,761	22,967	133	104,935	2.302	34.818	10.418	0.060	47.598
2019	15,990	80,515	21,051	131	117,687	7.253	36.521	9.549	0.059	53.382
2020	6,976	54,095	12,543	27	73,641	3.164	24.537	5.689	0.012	33.403
2021	40,132	199,827	50,799	137	290,894	18.203	90.640	23.042	0.062	131.947
2022	17,849	62,730	17,860	32	98,471	8.096	28.454	8.101	0.014	44.666
2023	17,008	49,582	18,452	39	85,081	7.715	22.490	8.370	0.018	38.592

Table 12. Recreational landings (A+B1; numbers, whole lbs.) of southeastern U.S. Yellowtail Snapper in Florida from the Marine Recreational Information Program (MRIP) for years 1981 – 2023 with annual CVs.

Year	Landings (numbers)	CV	Landings (whole lbs.)	CV
1981	5,775,906	0.33	3,959,763	0.56
1982	6,098,713	0.34	6,939,566	0.39
1983	1,566,289	0.35	949,361	0.47
1984	4,067,863	0.46	2,792,608	0.49
1985	1,754,715	0.52	2,304,917	0.54
1986	1,475,112	0.42	2,381,740	0.46
1987	1,162,387	0.25	1,683,781	0.29
1988	1,137,940	0.34	1,906,458	0.41
1989	4,685,673	0.52	9,813,453	0.54
1990	3,440,760	0.48	5,187,284	0.49
1991	4,210,209	0.51	9,412,657	0.54
1992	969,581	0.20	1,364,256	0.26
1993	1,964,950	0.17	2,317,676	0.28
1994	1,301,688	0.18	1,677,563	0.25
1995	1,859,946	0.29	2,001,555	0.32
1996	871,358	0.23	1,214,245	0.27
1997	785,974	0.22	1,102,169	0.27
1998	878,573	0.28	1,066,025	0.36
1999	659,544	0.20	803,164	0.25
2000	722,441	0.32	694,277	0.34
2001	521,603	0.45	586,810	0.46
2002	951,985	0.27	879,179	0.29
2003	1,491,566	0.38	1,601,261	0.39
2004	1,459,769	0.37	1,598,445	0.38
2005	609,636	0.18	618,840	0.20
2006	1,527,089	0.26	1,700,688	0.28
2007	1,580,351	0.26	1,841,598	0.28
2008	2,351,513	0.31	2,701,562	0.34
2009	925,484	0.27	904,564	0.30
2010	849,533	0.25	979,428	0.26
2011	619,515	0.26	940,553	0.27
2012	910,906	0.29	1,013,547	0.31
2013	1,723,631	0.24	1,589,444	0.27
2014	1,906,725	0.23	1,972,518	0.28
2015	1,322,040	0.14	1,382,301	0.18
2016	1,524,592	0.17	1,505,679	0.20
2017	1,550,296	0.18	1,878,889	0.23
2018	1,696,551	0.19	1,555,158	0.22
2019	805,637	0.20	839,020	0.25
2020	1,509,868	0.21	1,507,840	0.26
2021	1,228,153	0.20	1,185,684	0.24
2022	1,684,682	0.19	1,999,334	0.24
2023	1,682,210	0.12	1,636,276	0.17

Table 13. Recreational landings (A+B1; numbers) of southeastern U.S. Yellowtail Snapper in Florida by region from the Marine Recreational Information Program (MRIP) for years 1981 – 2023.

Year	Northwest FL	Southwest FL	FL Keys	Southeast FL	Northeast FL
1981	0	0	4,401,034	1,374,872	0
1982	0	155	4,467,816	1,624,554	6,187
1983	0	9,273	1,148,270	393,075	15,670
1984	0	7,876	3,886,442	173,474	72
1985	77,869	658	881,120	794,865	203
1986	1,753	0	967,944	505,415	0
1987	18,307	22,568	1,036,488	85,024	0
1988	0	3,322	944,308	190,309	0
1989	0	7,454	4,545,713	132,506	0
1990	0	0	3,244,008	196,752	0
1991	0	22,627	4,002,139	185,442	0
1992	0	52,760	697,081	216,960	2,781
1993	0	36,247	1,413,803	514,001	898
1994	0	11,092	1,054,567	225,731	10,299
1995	0	0	1,714,527	145,419	0
1996	0	0	760,415	110,943	0
1997	0	1,122	703,325	77,412	4,115
1998	0	1,445	714,747	151,564	10,817
1999	0	48,023	475,459	122,797	13,265
2000	0	4,070	524,983	182,505	10,884
2001	0	10,357	413,637	88,335	9,274
2002	0	8,905	841,618	90,988	10,474
2003	0	9,017	1,356,296	120,454	5,800
2004	26	30,725	1,080,375	348,007	636
2005	25	36,684	230,070	328,372	14,484
2006	0	69,711	919,036	525,740	12,602
2007	0	16,068	925,816	597,207	41,260
2008	0	4,242	1,993,374	353,699	199
2009	0	27,485	555,846	341,873	280
2010	0	10,448	560,700	274,958	3,428
2011	0	28,963	409,552	181,000	0
2012	0	93	681,903	228,910	0
2013	0	3,634	1,270,448	449,502	46
2014	0	9,159	681,226	1,215,990	350
2015	0	47,869	659,207	614,965	0
2016	0	14,809	813,370	695,874	538
2017	0	304,551	839,815	400,493	5,437
2018	0	74,051	658,794	960,244	3,462
2019	0	76,392	478,745	250,499	0
2020	0	41,747	737,861	730,010	249
2021	0	23,053	689,593	512,746	2,762
2022	0	174,795	984,390	525,105	392
2023	0	169,210	847,963	665,037	0

Table 14. Recreational landings (A+B1; whole lbs.) of southeastern U.S. Yellowtail Snapper in Florida by region from the Marine Recreational Information Program (MRIP) for years 1981 – 2023.

Year	Northwest FL	Southwest FL	FL Keys	Southeast FL	Northeast FL
1981	0	0	3,115,068	844,695	0
1982	0	578	4,854,986	2,076,937	7,171
1983	0	15,691	484,910	433,833	21,478
1984	0	19,900	2,613,313	166,321	126
1985	129,368	2,006	1,184,836	989,350	270
1986	4,501	0	1,654,087	723,152	0
1987	17,106	35,251	1,508,869	122,555	0
1988	0	5,518	1,573,657	327,283	0
1989	0	9,583	9,549,483	254,387	0
1990	0	0	4,885,051	302,233	0
1991	0	55,707	9,100,598	256,352	0
1992	0	132,049	993,708	235,676	2,823
1993	0	37,099	1,524,351	755,215	1,011
1994	0	14,687	1,401,075	248,577	13,224
1995	0	0	1,689,519	312,037	0
1996	0	0	1,103,317	110,928	0
1997	0	1,459	1,030,285	66,868	3,557
1998	0	2,145	902,720	151,116	10,044
1999	0	56,498	594,883	131,963	19,819
2000	0	3,759	461,969	214,849	13,700
2001	0	12,809	432,291	128,880	12,830
2002	0	10,319	779,525	79,221	10,113
2003	0	9,723	1,468,844	116,738	5,956
2004	28	42,597	1,230,275	324,958	586
2005	30	35,858	257,127	312,075	13,749
2006	0	94,291	1,152,048	443,312	11,037
2007	0	21,044	1,220,831	563,230	36,494
2008	0	5,411	2,356,995	338,952	204
2009	0	26,127	503,932	374,194	310
2010	0	12,704	669,669	293,380	3,676
2011	0	51,989	679,240	209,324	0
2012	0	156	765,556	247,835	0
2013	0	3,138	1,182,506	403,762	38
2014	0	9,598	702,763	1,259,835	322
2015	0	50,123	762,362	569,816	0
2016	0	15,952	795,592	693,365	770
2017	0	372,686	1,072,657	428,078	5,468
2018	0	70,262	658,456	822,996	3,444
2019	0	70,977	518,150	249,893	0
2020	0	52,346	829,449	625,813	232
2021	0	22,568	653,237	506,878	3,002
2022	0	272,406	1,193,804	532,685	440
2023	0	160,868	843,936	631,473	0

Table 15. Recreational landings (A+B1; numbers, whole lbs.) of southeastern U.S. Yellowtail Snapper in Florida by mode from the Marine Recreational Information Program (MRIP) for years 1981 – 2023.

	Landings (numbers)			Landings (whole lbs.)		
Year	Charter	Private	Shore	Charter	Private	Shore
1981	61,732	4,595,595	1,118,579	63,074	3,194,099	702,590
1982	199,621	5,627,107	271,984	466,332	6,398,186	75,049
1983	126,671	1,113,853	325,765	131,926	599,939	217,496
1984	66,713	3,815,675	185,474	111,187	2,600,609	80,812
1985	44,641	1,570,557	139,517	72,358	2,005,990	226,570
1986	33,653	1,047,088	394,372	92,467	1,705,294	583,979
1987	58,040	1,088,170	16,177	210,319	1,443,521	29,941
1988	38,417	1,060,088	39,435	67,730	1,770,553	68,175
1989	24,805	4,591,441	69,426	50,705	9,636,632	126,115
1990	36,867	3,273,719	130,174	68,064	4,915,868	203,353
1991	67,906	4,036,275	106,028	166,145	9,023,370	223,142
1992	138,482	775,816	55,283	335,618	924,445	104,194
1993	82,473	1,795,887	86,590	148,739	2,102,925	66,012
1994	81,612	1,182,063	38,012	145,692	1,480,469	51,401
1995	36,696	1,758,399	64,851	72,897	1,842,017	86,641
1996	46,423	792,490	32,444	68,788	1,100,620	44,836
1997	28,928	743,325	13,721	76,579	1,001,735	23,855
1998	34,242	844,331	0	54,784	1,011,241	0
1999	35,249	613,354	10,942	51,469	737,280	14,414
2000	33,055	640,956	48,429	46,040	582,917	65,319
2001	70,234	448,160	3,209	107,163	475,810	3,836
2002	102,920	841,307	7,759	136,911	734,137	8,131
2003	108,136	1,368,061	15,369	147,648	1,434,861	18,752
2004	142,633	1,294,750	22,386	173,627	1,400,347	24,470
2005	141,336	424,258	44,043	166,855	410,515	41,469
2006	99,678	1,401,335	26,076	111,880	1,566,695	22,112
2007	191,167	1,367,273	21,911	223,489	1,593,440	24,670
2008	119,411	2,221,232	10,870	141,558	2,549,617	10,387
2009	105,873	813,890	5,721	105,890	792,129	6,545
2010	151,636	688,166	9,731	168,258	801,109	10,061
2011	113,308	506,206	0	142,439	798,114	0
2012	244,333	662,937	3,636	287,996	721,367	4,183
2013	329,207	1,354,854	39,569	324,920	1,226,448	38,076
2014	236,399	1,264,804	405,522	286,349	1,263,411	422,758
2015	354,653	941,561	25,826	409,356	942,727	30,218
2016	284,603	1,188,881	51,108	326,723	1,122,977	55,980
2017	249,308	1,263,207	37,781	293,713	1,538,435	46,742
2018	191,511	1,457,173	47,867	250,164	1,252,090	52,905
2019	211,734	586,532	7,371	284,645	547,186	7,189
2020	223,688	1,255,996	30,184	329,275	1,137,603	40,962
2021	267,848	921,184	39,122	316,746	825,672	43,266
2022	258,325	1,261,603	164,754	334,958	1,561,707	102,669
2023	243,240	1,413,282	25,688	268,609	1,340,561	27,107

Table 16. SRFS and SRFS-calibrated private mode landings (numbers, whole lbs.) of southeastern U.S. Yellowtail Snapper in Florida for years 1981 – 2023 and annual CVs. ‘SRFS & SRFS-calibrated Private’ estimates are comprised of SRFS private mode (2021 – 2023) and SRFS ratio-calibrated MRIP private mode (1981 – 2020) landings.

SRFS & SRFS-calibrated Private Mode

Year	Landings (numbers)	CV	Landings (whole lbs.)	CV
1981	2,873,732	0.43	2,125,953	0.67
1982	3,518,760	0.40	4,258,554	0.46
1983	696,518	0.49	399,312	0.61
1984	2,386,030	0.53	1,730,933	0.57
1985	982,106	0.60	1,335,162	0.63
1986	654,768	0.51	1,135,023	0.53
1987	680,458	0.31	960,790	0.36
1988	662,898	0.39	1,178,458	0.40
1989	2,871,134	0.56	6,414,024	0.59
1990	2,047,132	0.53	3,271,941	0.55
1991	2,523,976	0.55	6,005,844	0.57
1992	485,136	0.29	615,299	0.34
1993	1,123,010	0.24	1,399,681	0.30
1994	739,171	0.25	985,382	0.32
1995	1,099,568	0.34	1,226,024	0.39
1996	495,562	0.29	732,559	0.34
1997	464,818	0.28	666,742	0.31
1998	527,980	0.32	673,070	0.37
1999	383,544	0.26	490,724	0.33
2000	400,805	0.39	387,982	0.43
2001	280,245	0.54	316,693	0.55
2002	526,089	0.34	488,633	0.37
2003	855,480	0.44	955,026	0.45
2004	809,637	0.43	932,054	0.45
2005	265,298	0.29	273,234	0.33
2006	876,287	0.32	1,042,773	0.35
2007	854,987	0.33	1,060,574	0.38
2008	1,388,988	0.36	1,696,994	0.38
2009	508,944	0.34	527,231	0.37
2010	430,326	0.33	533,208	0.36
2011	316,542	0.35	531,215	0.37
2012	414,550	0.43	480,133	0.47
2013	847,221	0.33	816,309	0.40
2014	790,911	0.26	840,911	0.35
2015	588,780	0.24	627,467	0.29
2016	743,435	0.26	747,440	0.30
2017	789,913	0.26	1,023,963	0.32
2018	911,204	0.26	833,376	0.30
2019	366,772	0.32	364,200	0.40
2020	785,403	0.32	757,175	0.38
2021	953,254	0.13	917,031	0.09
2022	744,795	0.11	1,033,522	0.09
2023	550,656	0.13	530,718	0.09

Table 17. SRFS landings (numbers, whole lbs.) of southeastern U.S. Yellowtail Snapper in Florida for years 1981 – 2023 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 – 2023) and SRFS ratio-calibrated MRIP private mode (1981 – 2020).

	Full SRFS			
Year	Landings (numbers)	CV	Landings (whole lbs.)	CV
1981	4,054,042	0.33	2,891,617	0.51
1982	3,990,366	0.35	4,799,935	0.41
1983	1,148,954	0.33	748,734	0.36
1984	2,638,217	0.48	1,922,932	0.51
1985	1,166,263	0.51	1,634,090	0.52
1986	1,082,793	0.45	1,811,469	0.46
1987	754,674	0.28	1,201,050	0.30
1988	740,750	0.35	1,314,363	0.37
1989	2,965,366	0.54	6,590,844	0.58
1990	2,214,173	0.49	3,543,358	0.51
1991	2,697,910	0.52	6,395,131	0.53
1992	678,900	0.22	1,055,111	0.24
1993	1,292,073	0.21	1,614,432	0.26
1994	858,796	0.22	1,182,475	0.28
1995	1,201,115	0.32	1,385,562	0.34
1996	574,430	0.25	846,183	0.30
1997	507,467	0.26	767,176	0.28
1998	562,221	0.30	727,854	0.34
1999	429,735	0.24	556,607	0.29
2000	482,289	0.33	499,341	0.35
2001	353,688	0.43	427,692	0.41
2002	636,767	0.28	633,675	0.29
2003	978,985	0.38	1,121,426	0.39
2004	974,656	0.36	1,130,151	0.37
2005	450,677	0.19	481,558	0.20
2006	1,002,041	0.28	1,176,765	0.31
2007	1,068,065	0.27	1,308,733	0.31
2008	1,519,268	0.33	1,848,939	0.35
2009	620,538	0.28	639,666	0.31
2010	591,693	0.25	711,527	0.27
2011	429,850	0.26	673,654	0.29
2012	662,519	0.28	772,312	0.30
2013	1,215,998	0.25	1,179,305	0.29
2014	1,432,832	0.29	1,550,018	0.31
2015	969,259	0.17	1,067,041	0.19
2016	1,079,146	0.19	1,130,143	0.22
2017	1,077,001	0.20	1,364,418	0.25
2018	1,150,582	0.22	1,136,445	0.23
2019	585,877	0.23	656,034	0.26
2020	1,039,275	0.25	1,127,412	0.27
2021	1,260,223	0.11	1,277,043	0.09
2022	1,167,874	0.13	1,471,149	0.10
2023	819,584	0.11	826,434	0.10

Table 18. Commercial discards (numbers) of southeastern U.S. Yellowtail Snapper in Florida for years 1993 – 2023 and annual CVs.

Year	Discards	CV
1993	96,881	0.68
1994	116,821	0.83
1995	112,018	0.77
1996	98,813	0.75
1997	119,459	0.75
1998	100,798	0.74
1999	104,585	0.63
2000	100,578	0.62
2001	91,103	0.61
2002	91,438	0.69
2003	86,077	0.70
2004	81,855	0.68
2005	70,389	0.67
2006	70,042	0.60
2007	102,479	0.50
2008	99,047	0.41
2009	119,483	0.40
2010	96,365	0.36
2011	106,142	0.40
2012	117,333	0.37
2013	110,722	0.32
2014	118,388	0.37
2015	107,921	0.32
2016	108,702	0.33
2017	89,504	0.31
2018	92,116	0.29
2019	95,587	0.30
2020	74,717	0.30
2021	72,321	0.31
2022	71,161	0.35
2023	78,748	0.33

Table 19. Commercial discards (numbers) of Yellowtail Snapper in Florida by region for years 1993 – 2023.

Year	Southwest FL	Florida Keys	Southeast FL
1993	583	69,876	26,422
1994	488	74,754	41,579
1995	367	75,058	36,593
1996	451	67,231	31,130
1997	328	81,122	38,009
1998	296	69,070	31,432
1999	325	77,955	26,305
2000	247	75,202	25,129
2001	242	68,526	22,335
2002	131	64,898	26,409
2003	135	60,794	25,149
2004	208	58,620	23,026
2005	292	51,101	18,996
2006	269	53,205	16,568
2007	112	83,139	19,228
2008	68	84,854	14,125
2009	195	103,254	16,034
2010	54	85,104	11,207
2011	135	91,541	14,466
2012	258	103,612	13,463
2013	267	100,428	10,027
2014	370	104,267	13,751
2015	642	98,454	8,825
2016	834	98,709	9,159
2017	910	82,093	6,501
2018	1,019	85,912	5,184
2019	718	88,400	6,468
2020	596	68,781	5,340
2021	831	66,696	4,794
2022	674	63,744	6,742
2023	712	71,697	6,338

Table 20. Headboat discards (numbers) of Yellowtail Snapper in Florida by concatenated region for years 1981 – 2023. 'West' is comprised of the northwest, southwest, and Florida Keys regions while 'East' is comprised of northeast and southeast Florida regions.

Year	West	East	Total
1981	35,251	18,045	53,296
1982	66,667	12,766	79,433
1983	80,675	7,379	88,054
1984	57,951	7,161	65,112
1985	52,982	5,435	58,417
1986	83,179	6,440	89,619
1987	94,011	7,813	101,824
1988	111,837	11,654	123,491
1989	57,497	9,501	66,998
1990	80,301	10,383	90,684
1991	75,476	11,271	86,747
1992	70,987	11,705	82,692
1993	81,813	9,696	91,509
1994	78,711	16,237	94,948
1995	57,358	7,677	65,035
1996	54,084	4,938	59,022
1997	53,449	5,693	59,142
1998	49,442	3,404	52,846
1999	40,016	5,217	45,233
2000	45,983	2,576	48,559
2001	45,874	1,057	46,931
2002	55,988	591	56,579
2003	46,611	2,202	48,813
2004	52,022	1,811	53,833
2005	62,604	3,566	66,170
2006	45,639	551	46,190
2007	40,613	3,976	44,589
2008	39,680	2,202	41,882
2009	36,736	2,004	38,740
2010	33,837	3,094	36,931
2011	23,086	1,628	24,714
2012	26,420	4,539	30,959
2013	32,358	7,419	39,777
2014	52,518	11,974	64,492
2015	35,823	30,021	65,844
2016	26,306	42,331	68,637
2017	27,560	6,258	33,818
2018	37,239	9,359	46,598
2019	59,492	3,007	62,499
2020	40,789	4,217	45,006
2021	46,985	3,661	50,646
2022	63,340	6,992	70,332
2023	59,833	6,382	66,215

Table 21. Recreational discards (B2; numbers) of southeastern U.S. Yellowtail Snapper in Florida from the Marine Recreational Information Program (MRIP) for years 1981 – 2023 and annual CVs.

Year	Discards	CV
1981	958,375	0.36
1982	1,120,300	0.37
1983	563,421	0.63
1984	3,787,895	0.41
1985	321,611	0.43
1986	1,050,654	0.35
1987	2,103,332	0.24
1988	1,116,803	0.34
1989	3,107,529	0.40
1990	1,980,252	0.23
1991	13,560,780	0.23
1992	3,406,179	0.15
1993	4,779,787	0.15
1994	2,815,507	0.18
1995	3,311,798	0.20
1996	3,282,277	0.25
1997	3,485,100	0.20
1998	2,435,771	0.18
1999	2,080,940	0.22
2000	1,781,311	0.29
2001	1,100,164	0.26
2002	1,259,174	0.22
2003	1,799,551	0.31
2004	2,505,699	0.21
2005	1,648,308	0.29
2006	2,664,445	0.29
2007	3,481,530	0.20
2008	3,235,121	0.19
2009	2,394,375	0.29
2010	1,526,499	0.29
2011	1,665,608	0.27
2012	1,675,632	0.23
2013	4,887,298	0.20
2014	4,092,275	0.17
2015	2,711,547	0.14
2016	1,539,521	0.17
2017	2,272,998	0.23
2018	2,760,814	0.20
2019	1,601,356	0.21
2020	2,514,831	0.27
2021	2,663,648	0.13
2022	2,575,739	0.11
2023	5,035,270	0.12

Table 22. Recreational discards (B2; numbers) of southeastern U.S. Yellowtail Snapper in Florida by region from the Marine Recreational Information Program (MRIP) for years 1981 – 2023.

Year	Northwest FL	Southwest FL	FL Keys	Southeast FL	Northeast FL
1981	0	22,967	292,405	643,003	0
1982	0	0	960,307	76,493	83,500
1983	0	4,952	444,091	111,274	3,105
1984	0	471	3,704,911	82,512	0
1985	28,955	0	200,450	92,205	0
1986	3,445	0	526,285	520,925	0
1987	88,405	7,874	1,686,591	320,463	0
1988	0	0	1,107,183	9,620	0
1989	1,530	809	2,996,331	108,860	0
1990	0	3,817	1,573,892	402,542	0
1991	0	17,064	13,067,494	476,222	0
1992	0	93,220	2,468,041	844,919	0
1993	0	87,134	4,054,449	635,846	2,358
1994	0	45,390	2,384,552	385,565	0
1995	0	8,545	2,897,975	405,278	0
1996	0	27,104	2,918,254	336,919	0
1997	0	148,972	3,110,494	225,634	0
1998	0	63,403	2,099,948	272,419	0
1999	0	175,776	1,490,951	401,442	12,770
2000	0	13,951	1,337,014	415,831	14,514
2001	0	99,127	782,475	215,046	3,517
2002	0	72,851	937,609	243,234	5,479
2003	0	15,990	1,449,880	332,172	1,508
2004	0	10,993	2,005,649	489,058	0
2005	0	259,438	971,304	417,565	0
2006	0	120,415	1,944,655	596,674	2,701
2007	6,299	45,747	2,757,224	659,141	13,119
2008	0	22,136	2,662,844	550,141	0
2009	0	13,632	1,441,073	938,950	720
2010	0	5,185	1,217,365	300,529	3,421
2011	0	19,166	1,451,390	195,052	0
2012	0	7,424	1,422,206	246,003	0
2013	0	5,114	3,645,258	1,236,829	98
2014	0	34,460	3,010,249	1,044,952	2,613
2015	0	31,010	1,403,570	1,274,690	2,277
2016	0	14,417	1,001,077	523,481	546
2017	0	114,382	1,669,138	487,509	1,968
2018	456	50,630	1,513,459	1,151,028	45,240
2019	0	47,969	1,081,940	471,446	0
2020	0	96,067	1,982,903	433,940	1,921
2021	0	33,331	1,487,510	1,140,476	2,331
2022	0	101,681	1,670,662	803,396	0
2023	0	184,362	3,880,985	968,527	1,395

Table 23. Recreational discards (B2; numbers) of southeastern U.S. Yellowtail Snapper in Florida by mode from the Marine Recreational Information Program (MRIP) for years 1981 – 2023.

Year	Charter	Private	Shore
1981	14,447	350,642	593,287
1982	3,584	1,045,387	71,330
1983	28,154`	467,036	68,230
1984	17,045	3,536,617	234,233
1985	519	215,981	105,110
1986	2,293	767,195	281,165
1987	44,491	1,612,069	446,772
1988	33,492	892,739	190,572
1989	5,439	2,372,095	729,995
1990	29,690	1,564,316	386,246
1991	272,343	11,691,255	1,597,182
1992	95,361	2,570,452	740,366
1993	18,722	3,675,978	1,085,088
1994	23,286	2,385,943	406,278
1995	13,648	2,879,031	419,119
1996	17,977	2,870,471	393,829
1997	16,680	3,175,409	293,010
1998	26,784	1,770,389	638,597
1999	15,224	1,868,764	196,951
2000	13,870	1,485,846	281,595
2001	56,729	736,512	306,923
2002	34,654	1,093,559	130,960
2003	59,385	1,408,416	331,750
2004	41,908	1,329,118	1,134,673
2005	45,697	1,133,593	469,017
2006	37,412	2,519,821	107,211
2007	69,574	2,864,653	547,303
2008	68,273	2,521,214	645,634
2009	55,092	1,535,050	804,233
2010	59,053	1,442,850	24,596
2011	78,621	768,575	818,412
2012	90,840	1,217,864	366,928
2013	124,702	3,896,488	866,107
2014	106,206	3,229,733	756,336
2015	111,562	1,787,122	812,863
2016	91,095	1,243,011	205,414
2017	70,578	1,167,080	1,035,340
2018	108,902	2,234,347	417,565
2019	178,722	709,306	713,328
2020	103,946	1,147,231	1,263,654
2021	137,961	1,706,442	819,245
2022	173,010	1,619,242	783,487
2023	149,870	2,985,394	1,900,006

Table 24. SRFS and SRFS-calibrated private mode discards (numbers) as well as the full SRFS discards (numbers) of southeastern U.S. Yellowtail Snapper in Florida for years 1981 – 2023 with annual CVs. ‘SRFS & SRFS-calibrated Private’ estimates are comprised of SRFS private mode (2021 – 2023) and SRFS ratio-calibrated MRIP private mode (1981 – 2020) discards. The ‘Full SRFS’ discards estimates are comprised of ‘SRFS & SRFS-calibrated Private’ mode, MRIP charter mode, and MRIP shore mode discard estimates.

	SRFS & SRFS-calibrated Private Mode		Full SRFS	
Year	Discards (numbers)	CV	Discards (numbers)	CV
1981	192,108	0.48	799,841	0.40
1982	572,741	0.42	647,654	0.37
1983	255,877	0.77	352,262	0.57
1984	1,937,623	0.50	2,188,901	0.45
1985	118,331	0.60	223,960	0.39
1986	420,327	0.43	703,785	0.36
1987	883,212	0.31	1,374,475	0.26
1988	489,109	0.44	713,173	0.33
1989	1,299,611	0.48	2,035,045	0.44
1990	857,049	0.31	1,272,985	0.25
1991	6,405,343	0.29	8,274,868	0.23
1992	1,408,286	0.23	2,244,013	0.17
1993	2,013,975	0.20	3,117,784	0.18
1994	1,307,198	0.24	1,736,762	0.20
1995	1,577,348	0.26	2,010,115	0.21
1996	1,572,658	0.31	1,984,465	0.26
1997	1,739,726	0.25	2,049,417	0.22
1998	969,951	0.25	1,635,333	0.21
1999	1,023,849	0.27	1,236,024	0.23
2000	814,057	0.35	1,109,522	0.29
2001	403,516	0.30	767,169	0.30
2002	599,133	0.28	764,748	0.23
2003	771,636	0.41	1,162,770	0.30
2004	728,190	0.29	1,904,771	0.25
2005	621,067	0.38	1,135,781	0.30
2006	1,380,546	0.33	1,525,169	0.31
2007	1,569,471	0.26	2,186,348	0.21
2008	1,381,309	0.26	2,095,216	0.20
2009	841,015	0.35	1,700,340	0.32
2010	790,501	0.33	874,150	0.30
2011	421,083	0.41	1,318,116	0.29
2012	667,237	0.32	1,125,005	0.24
2013	2,134,787	0.28	3,125,597	0.22
2014	1,769,489	0.23	2,632,031	0.22
2015	979,119	0.22	1,903,544	0.16
2016	681,014	0.24	977,524	0.19
2017	639,414	0.23	1,745,331	0.29
2018	1,224,142	0.28	1,750,609	0.21
2019	388,611	0.23	1,280,661	0.26
2020	628,539	0.28	1,996,139	0.33
2021	1,351,912	0.12	2,309,118	0.11
2022	1,062,409	0.10	2,018,906	0.10
2023	1,043,359	0.13	3,093,235	0.15

Table 25. Indices of relative biomass or abundance values and associated CVs for southeastern U.S. Yellowtail Snapper from years 1991 – 2023.

	Commercial		MRIP		RVC Florida Keys		RVC Dry Tortugas	
Year	Index	CV	Index	CV	Index	CV	Index	CV
1991			2.960	0.09				
1992			1.960	0.08				
1993	0.650	0.04	2.150	0.09				
1994	0.603	0.04	1.690	0.10				
1995	0.553	0.04	2.000	0.10				
1996	0.418	0.04	1.520	0.11				
1997	0.530	0.04	1.760	0.10				
1998	0.561	0.04	1.770	0.09				
1999	0.712	0.04	1.450	0.10	3.254	0.21	5.274	0.37
2000	0.580	0.04	1.410	0.10	3.440	0.11	4.618	0.11
2001	0.643	0.04	1.470	0.09	3.023	0.13		
2002	0.635	0.04	1.150	0.09	3.776	0.20		
2003	0.588	0.04	1.390	0.09	2.671	0.19		
2004	0.702	0.04	1.760	0.09	2.715	0.15	9.050	0.13
2005	0.833	0.04	1.920	0.09	5.138	0.14		
2006	0.886	0.04	1.950	0.08	4.131	0.26	4.957	0.11
2007	0.866	0.04	2.050	0.08	4.258	0.09		
2008	1.045	0.04	1.680	0.09	5.437	0.10	10.611	0.12
2009	0.987	0.04	1.560	0.09	4.246	0.09		
2010	1.104	0.04	1.710	0.10	2.750	0.21	10.143	0.09
2011	1.015	0.04	1.780	0.09	4.162	0.17		
2012	1.063	0.04	1.650	0.09	4.071	0.13	9.692	0.08
2013	1.183	0.04	2.620	0.08				
2014	1.138	0.04	1.960	0.08	4.178	0.29	10.032	0.09
2015	1.344	0.04	2.070	0.09				
2016	1.484	0.04	1.770	0.09	5.445	0.27	11.175	0.10
2017	1.909	0.04	1.910	0.09				
2018	1.636	0.04	2.160	0.11	6.598	0.19	13.869	0.08
2019	1.447	0.05	1.560	0.10				
2020	1.077	0.05	2.220	0.08				
2021	1.293	0.05	2.090	0.08			18.468	0.10
2022	1.689	0.05	2.300	0.07	4.360	0.15		
2023	1.826	0.04	2.250	0.11			16.714	0.10

Table 26. Francis weights applied to length and age composition data and conditional age-at-length data of the SEDAR 96 base model.

Data Type	Fleet/Index	Francis Weights S96 Base
Length Composition	Commercial	0.465232
	Headboat	0.046876
	MRIP SRFS	0.087468
	RVC Florida Keys	0.031747
	RVC Dry Tortugas	0.049979
Age Composition (Age or Conditional Age-at-length)	Commercial	0.013936
	Headboat	0.064705
	MRIP	0.041647
	FI Ages	0.038818

Table 27. List of Stock Synthesis parameters for the SEDAR 96 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
1	L_at_Amin_Fem_GP_1	5.301	2	20	1.342	0.25		3
2	L_at_Amax_Fem_GP_1	38.853	25	60	1.352	0.03		3
3	VonBert_K_Fem_GP_1	0.293	0.1	0.5	0.030	0.10		4
4	CV_young_Fem_GP_1	0.263	0.1	0.5	0.025	0.10		7
5	CV_old_Fem_GP_1	0.177	0.005	0.4	0.015	0.08		7
6	Wtlen_1_Fem_GP_1	2.57E-05	0	3				Fixed
7	Wtlen_2_Fem_GP_1	2.8797	1	4				Fixed
8	Mat50%_Fem_GP_1	1.700	0	5				Fixed
9	Mat_slope_Fem_GP_1	-2.706	-4	-1				Fixed
10	Eggs_intercept_Fem_GP_1	0.000	-3	3				Fixed
11	Eggs_slope_Wt_Fem_GP_1	1.000	-3	3				Fixed
12	CohortGrowDev	1.000	0	1				Fixed
13	FracFemale_GP_1	0.500	0.5	0.5				Fixed
14	SR_LN(R0)	9.823	8	12	0.124	0.01		1
15	SR_BH_steep	0.767	0.3	0.99	0.083	0.11		2
16	SR_sigmaR	0.266	0.1	0.8	0.043	0.16		7
17	SR_regime	0.000	-5	5				Fixed
18	SR_autocorr	0.000	0	0				Fixed
19	Early_InitAge_11	0.008	-4	4	0.267	31.59		6
20	Early_InitAge_10	0.014	-4	4	0.268	19.21		6
21	Early_InitAge_9	0.021	-4	4	0.269	12.76		6
22	Early_InitAge_8	0.033	-4	4	0.269	8.23		6
23	Early_InitAge_7	0.043	-4	4	0.270	6.27		6
24	Early_InitAge_6	0.019	-4	4	0.267	13.79		6
25	Early_InitAge_5	-0.065	-4	4	0.261	-3.99		6
26	Early_InitAge_4	-0.225	-4	4	0.245	-1.09		6
27	Early_InitAge_3	-0.349	-4	4	0.220	-0.63		6
28	Early_InitAge_2	-0.264	-4	4	0.197	-0.75		6
29	Main_InitAge_1	-0.011	-4	4	0.171	-15.96		3
30	Main_RecrDev_1992	-0.111	-4	4	0.131	-1.19		3
31	Main_RecrDev_1993	-0.336	-4	4	0.136	-0.40		3
32	Main_RecrDev_1994	-0.278	-4	4	0.135	-0.49		3
33	Main_RecrDev_1995	0.080	-4	4	0.122	1.54		3
34	Main_RecrDev_1996	0.080	-4	4	0.136	1.70		3
35	Main_RecrDev_1997	-0.117	-4	4	0.136	-1.16		3
36	Main_RecrDev_1998	-0.351	-4	4	0.135	-0.38		3
37	Main_RecrDev_1999	-0.257	-4	4	0.126	-0.49		3
38	Main_RecrDev_2000	-0.210	-4	4	0.127	-0.61		3
39	Main_RecrDev_2001	-0.108	-4	4	0.119	-1.10		3
40	Main_RecrDev_2002	0.292	-4	4	0.096	0.33		3

41	Main_RecrDev_2003	-0.118	-4	4	0.109	-0.93		3
42	Main_RecrDev_2004	0.142	-4	4	0.090	0.63		3
43	Main_RecrDev_2005	-0.044	-4	4	0.094	-2.12		3
44	Main_RecrDev_2006	-0.121	-4	4	0.094	-0.78		3
45	Main_RecrDev_2007	-0.191	-4	4	0.091	-0.48		3
46	Main_RecrDev_2008	-0.009	-4	4	0.081	-8.88		3
47	Main_RecrDev_2009	-0.080	-4	4	0.081	-1.01		3
48	Main_RecrDev_2010	-0.069	-4	4	0.081	-1.17		3
49	Main_RecrDev_2011	0.190	-4	4	0.074	0.39		3
50	Main_RecrDev_2012	0.479	-4	4	0.068	0.14		3
51	Main_RecrDev_2013	0.233	-4	4	0.075	0.32		3
52	Main_RecrDev_2014	0.321	-4	4	0.075	0.23		3
53	Main_RecrDev_2015	0.232	-4	4	0.079	0.34		3
54	Main_RecrDev_2016	-0.021	-4	4	0.090	-4.29		3
55	Main_RecrDev_2017	-0.099	-4	4	0.103	-1.04		3
56	Main_RecrDev_2018	-0.197	-4	4	0.137	-0.69		3
57	Main_RecrDev_2019	0.372	-4	4	0.119	0.32		3
58	Main_RecrDev_2020	0.255	-4	4	0.128	0.50		3
59	Main_RecrDev_2021	0.300	-4	4	0.144	0.48		3
60	Main_RecrDev_2022	0.483	-4	4	0.171	0.35		3
61	Main_RecrDev_2023	0.084	-4	4	0.267	3.19		3
62	ForeRecr_2024	0.000	-4	4				8
63	Impl_err_2024	0.000	_	_				Fixed
64	InitF_seas_1_flt_1COM	0.105	0	1	0.145	1.38	Sym_Beta	1
65	InitF_seas_1_flt_2HB	0.443	0	1	0.320	0.72	Sym_Beta	1
66	InitF_seas_1_flt_3MRIP SRFS	0.368	0	1	0.380	1.03	Sym_Beta	1
67	LnQ_base_COM(1)	-8.055	-18	5	0.068	-0.01		5
68	LnQ_base_RVC_Keys(4)	-8.301	-18	5				Fixed
69	LnQ_base_MRIP_CPUE(5)	-8.496	-18	5				Fixed
70	LnQ_base_RVC_DRTO(7)	-7.242	-18	5				Fixed
71	LnQ_base_COM(1)_BLK1repl_2009	-7.805	-12	5	0.071	-0.01		5
72	Size_inflection_COM(1)	25.920	10	35	0.187	0.01		3
73	Size_95%width_COM(1)	3.426	1	20	0.200	0.06		4
74	Retain_L_infl_COM(1)	24.305	5	35	0.119	0.00		3
75	Retain_L_width_COM(1)	0.799	0.6	5	0.079	0.10		4
76	Retain_L_asymptote_logit_COM(1)	6.284	-0.5	10	0.783	0.12		5
77	Retain_L_maleoffset_COM(1)	0.000	-1	1				Fixed
78	DiscMort_L_infl_COM(1)	1.000	0.5	1.5				Fixed
79	DiscMort_L_width_COM(1)	1.00E+06	10000	1.00E+08				Fixed
80	DiscMort_L_level_old_COM(1)	-0.800	-1.5	0				Fixed
81	DiscMort_L_male_offset_COM(1)	0.000	-1	2				Fixed
82	Size_DblN_peak_HB(2)	27.212	11.1	40	0.482	0.02		3
83	Size_DblN_top_logit_HB(2)	-13.829	-20	-5	106.658	-7.71		4
84	Size_DblN_ascend_se_HB(2)	3.418	0.1	12	0.137	0.04		5
85	Size_DblN_descend_se_HB(2)	2.855	1	6	0.477	0.17		5
86	Size_DblN_start_logit_HB(2)	-999.000	-15	5				Fixed

87	Size_DblN_end_logit_HB(2)	-1.023	-10	5	0.301	-0.29	3
88	Retain_L_infl_HB(2)	24.229	15	35	0.128	0.01	3
89	Retain_L_width_HB(2)	0.667	0.1	12	0.080	0.12	4
90	Retain_L_asymptote_logit_HB(2)	4.679	-0.5	10	0.814	0.17	5
91	Retain_L_maleoffset_HB(2)	0.000	-1	1			Fixed
92	DiscMort_L_infl_HB(2)	1.000	0.5	1.5			Fixed
93	DiscMort_L_width_HB(2)	1.00E+06	10000	1.00E+08			Fixed
94	DiscMort_L_level_old_HB(2)	-0.800	-1.5	0			Fixed
95	DiscMort_L_male_offset_HB(2)	0.000	-1	2			Fixed
96	Size_DblN_peak_MRIP(3)	22.305	11.1	30	0.560	0.03	3
97	Size_DblN_top_logit_MRIP SRFS(3)	-14.102	-20	-5	99.748	-7.07	4
98	Size_DblN_ascend_se_MRIP SRFS (3)	2.814	0.1	5	0.221	0.08	5
99	Size_DblN_descend_se_MRIP SRFS (3)	3.931	0.01	6	0.427	0.11	5
100	Size_DblN_start_logit_MRIP SRFS (3)	-999.000	-20	7			Fixed
101	Size_DblN_end_logit_MRIP SRFS (3)	-0.586	-10	5	0.255	-0.44	3
102	Retain_L_infl_MRIP SRFS (3)	26.223	11.1	33	0.188	0.01	3
103	Retain_L_width_MRIP SRFS (3)	1.175	0.1	10	0.094	0.08	4
104	Retain_L_asymptote_logit_MRIP SRFS (3)	4.133	-0.5	10	1.199	0.29	5
105	Retain_L_maleoffset_MRIP SRFS (3)	0.000	-1	1			Fixed
106	DiscMort_L_infl_MRIP SRFS (3)	1.000	0.5	1.5			Fixed
107	DiscMort_L_width_MRIP SRFS (3)	1.00E+06	10000	1.00E+08			Fixed
108	DiscMort_L_level_old_MRIP SRFS (3)	-0.800	-1.5	0			Fixed
109	DiscMort_L_male_offset_MRIP SRFS (3)	0.000	-1	2			Fixed
110	Size_DblN_peak_RVC_Keys(4)	18.933	5	35	1.988	0.10	3
111	Size_DblN_top_logit_RVC_Keys(4)	-11.703	-20	-1	140.937	-12.04	4
112	Size_DblN_ascend_se_RVC_Keys(4)	4.271	0.01	8	0.505	0.12	3
113	Size_DblN_descend_se_RVC_Keys(4)	5.893	0.01	10	0.661	0.11	5
114	Size_DblN_start_logit_RVC_Keys(4)	-999.000	-5	5			Fixed
115	Size_DblN_end_logit_RVC_Keys(4)	-5.745	-15	6	84.325	-14.68	3
116	SizeSel_P1_MRIP_CPUE(5)	-1.000	-1	-1			Fixed
117	SizeSel_P2_MRIP_CPUE(5)	-1.000	-1	-1			Fixed
118	Size_DblN_peak_RVC_DRTO(7)	21.031	5	30	1.537	0.07	3
119	Size_DblN_top_logit_RVC_DRTO(7)	-10.941	-20	-1	176.371	-16.12	4
120	Size_DblN_ascend_se_RVC_DRTO(7)	4.038	0.01	6	0.305	0.08	3
121	Size_DblN_descend_se_RVC_DRTO(7)	4.570	0.01	10	0.645	0.14	5
122	Size_DblN_start_logit_RVC_DRTO(7)	-999.000	-5	5			Fixed
123	Size_DblN_end_logit_RVC_DRTO(7)	-2.301	-10	5	1.812	-0.79	3

Table 28. Predicted total biomass (metric tons, pounds), spawning stock biomass (SSB; metric tons, pounds), abundance (1000s of fish), age-0 recruits (1000s of fish), and depletion (SSB/SSB0) for southeastern U.S. Yellowtail Snapper. 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.)	Abundance (000s)	Age-0 Recruits (000s)	B/B0	SSB/SSB0
Virgin	16,000	35,273,521	7,495	16,523,117	58,340	18,448	1.000	1.000
Initial	4,639	10,228,060	1,830	4,033,908	42,488	18,448	0.290	0.244
1992	3,821	8,424,502	1,489	3,281,603	32,893	12,296	0.239	0.199
1993	3,933	8,670,825	1,586	3,496,576	29,216	9,965	0.246	0.212
1994	3,484	7,680,663	1,447	3,189,648	26,387	10,289	0.218	0.193
1995	3,141	6,925,249	1,289	2,842,442	28,857	14,189	0.196	0.172
1996	2,846	6,275,304	1,088	2,399,445	29,236	13,391	0.178	0.145
1997	3,065	6,756,286	1,173	2,585,670	28,251	11,294	0.192	0.156
1998	3,241	7,146,174	1,298	2,862,394	25,700	9,242	0.203	0.173
1999	3,335	7,351,799	1,392	3,069,408	25,486	10,386	0.208	0.186
2000	3,284	7,239,782	1,371	3,022,736	25,675	10,835	0.205	0.183
2001	3,269	7,207,396	1,346	2,968,105	26,962	11,922	0.204	0.180
2002	3,438	7,579,933	1,397	3,080,938	34,041	18,002	0.215	0.186
2003	3,671	8,094,162	1,428	3,149,017	31,930	12,023	0.229	0.191
2004	3,816	8,413,722	1,521	3,354,311	34,566	15,883	0.239	0.203
2005	3,998	8,813,883	1,612	3,554,711	33,528	13,404	0.250	0.215
2006	4,405	9,712,311	1,818	4,008,798	33,120	12,822	0.275	0.243
2007	4,533	9,992,871	1,913	4,218,193	31,862	12,107	0.283	0.255
2008	4,618	10,181,653	1,969	4,341,828	33,753	14,618	0.289	0.263
2009	4,347	9,583,098	1,810	3,989,816	32,830	13,342	0.272	0.241
2010	4,324	9,532,876	1,791	3,948,391	32,872	13,443	0.270	0.239
2011	4,448	9,806,095	1,853	4,084,526	37,230	17,583	0.278	0.247
2012	4,719	10,404,033	1,917	4,225,953	45,877	23,657	0.295	0.256
2013	5,079	11,198,248	1,980	4,366,035	45,667	18,645	0.317	0.264
2014	5,346	11,786,420	2,122	4,677,658	47,486	20,698	0.334	0.283
2015	5,576	12,293,130	2,252	4,965,736	46,844	19,178	0.349	0.301
2016	5,888	12,981,259	2,421	5,336,421	42,909	15,117	0.368	0.323
2017	5,927	13,065,850	2,513	5,539,820	39,556	14,091	0.370	0.335
2018	5,599	12,344,762	2,408	5,307,849	35,787	12,665	0.350	0.321
2019	5,372	11,844,115	2,310	5,092,766	43,374	22,189	0.336	0.308
2020	5,486	12,093,678	2,249	4,957,336	45,346	19,618	0.343	0.300
2021	5,844	12,884,763	2,373	5,231,592	48,030	20,767	0.365	0.317
2022	6,131	13,517,004	2,507	5,527,209	54,105	25,553	0.383	0.335
2023	6,612	14,577,273	2,684	5,917,472	49,880	17,600	0.413	0.358

Table 29. Annual instantaneous fishing mortality rates on age-4 southeastern U.S. Yellowtail Snapper 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	Age-4 F	Commercial	Headboat	SRFS MRIP
1992	0.440	0.400	0.055	0.271
1993	0.624	0.517	0.056	0.496
1994	0.573	0.517	0.069	0.363
1995	0.662	0.504	0.054	0.604
1996	0.481	0.438	0.050	0.310
1997	0.466	0.464	0.044	0.241
1998	0.394	0.373	0.034	0.239
1999	0.400	0.420	0.031	0.180
2000	0.375	0.364	0.033	0.213
2001	0.320	0.323	0.031	0.157
2002	0.370	0.315	0.036	0.277
2003	0.428	0.315	0.031	0.412
2004	0.401	0.308	0.030	0.364
2005	0.266	0.246	0.035	0.156
2006	0.303	0.206	0.022	0.319
2007	0.270	0.152	0.022	0.331
2008	0.389	0.216	0.023	0.495
2009	0.345	0.329	0.021	0.216
2010	0.305	0.281	0.024	0.200
2011	0.293	0.303	0.022	0.140
2012	0.349	0.335	0.024	0.212
2013	0.412	0.326	0.023	0.369
2014	0.406	0.302	0.030	0.387
2015	0.340	0.297	0.030	0.245
2016	0.340	0.289	0.030	0.259
2017	0.375	0.347	0.018	0.260
2018	0.321	0.248	0.020	0.295
2019	0.287	0.282	0.023	0.159
2020	0.272	0.185	0.017	0.290
2021	0.315	0.208	0.038	0.322
2022	0.288	0.215	0.018	0.276
2023	0.200	0.158	0.015	0.174

Table 30. Index root mean square error (RMSE) values from the SEDAR 96 base model (Base), the age-structured production model (ASPM), and the ASPM with estimated recruitment deviations (ASPMdev).

Index	Base	ASPM	ASPMdev
Commercial CPUE	0.0967	0.2813	0.0967
MRIP CPUE	0.1770	0.2183	0.1770
RVC Florida Keys	0.2438	0.2364	0.2438
RVC Dry Tortugas	0.2868	0.4060	0.2868

Table 31. 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 age-4 fishing mortality rates (F) from the SEDAR 96 base model. Analyses were performed across 5 successive years of removal from the terminal year 2020.

Quantity	Year Peel	Mohn's Rho (ρ_M)	Forecast Mohn's Rho (ρ_F)
SSB	2022	0.010	-0.038
SSB	2021	-0.041	-0.049
SSB	2020	0.006	-0.046
SSB	2019	0.123	0.165
SSB	2018	0.131	0.226
SSB	2017	0.040	0.037
SSB	2016	-0.049	-0.107
SSB	Combined	0.032	0.027
F	2022	-0.007	0.068
F	2021	0.048	0.047
F	2020	-0.002	0.078
F	2019	-0.121	-0.146
F	2018	-0.131	-0.209
F	2017	-0.046	-0.041
F	2016	0.065	0.146
F	Combined	-0.028	-0.008

Table 32. Gelman and Rubin's (1992) potential scale reduction factor (PSRF) values from the combined two MCMC chains for selected model parameters (*ln(R0)* and *steepness*) and derived quantities (SSB_0, SSB in 2023, age-4 F in 2023, $F_{30\%SPR}$, SSB at $F_{30\%SPR}$, and the retained yield at $F_{30\%SPR}$) of the SEDAR 96 base model.

PSRF	PSRF Upper CI	Parameter or Derived Quantity
1.02	1.03	*ln(R0)*
1.02	1.02	*steepness*
1.01	1.01	SSB_0
1.00	1.00	SSB_{2023}
1.00	1.00	F_{2023}
1.00	1.00	$F_{30\%SPR}$
1.00	1.01	$SSB_{F30\%SPR}$
1.00	1.00	Retained yield at $F_{30\%SPR}$

Table 33. The stock status determination criteria for southeastern U.S. Yellowtail Snapper according to the South Atlantic Fishery Management Council (SAFMC) and the Gulf of Mexico Fishery Management Council (GMFMC). Values were derived from either the SEDAR 96 base model (Base) using the MSY_{proxy} of 30%SPR or using the median value from the MCMC distribution (MCMC).

South Atlantic and Gulf of Mexico Fishery Management Councils

Criteria	Definition	Base	MCMC
MSY	The retained yield at F_{MSY} (or proxy, $F_{30\%SPR}$)	1,391.44 mt (3,067,600 lbs.)	1394.99 mt (3,075,437 lbs.)
$F_{MSY\ or\ proxy}$	The fishing mortality rate associated with MSY (or proxy, 30% SPR)	0.398 yr^{-1}	0.398 yr^{-1}
MFMT (Maximum Fishing Mortality Threshold)	$F_{MSY\ or\ 30\%\ SPR}$	0.398 yr^{-1}	0.398 yr^{-1}
$F_{current}$ (recent average fishing mortality rate on age-4 fish)	The geometric mean of F on age-4 fish for 2021 – 2023	0.263 yr^{-1}	0.264 yr^{-1}
$SSB_{MSY\ or\ proxy}$	The estimated spawning stock biomass associated with F_{MSY} or $F_{30\%SPR}$	1,816.54 mt (4,004,785 lbs.)	1,820.46 mt (4,013,438 lbs.)
MSST (Minimum Stock Size Threshold)	$0.75*SSB_{MSY\ or\ F30\%SPR}$	1,362.41 mt (3,003,589 lbs.)	1,365.35 mt (3,010,079 lbs.)
$SSB_{current}$ (recent average of SSB)	The geometric mean of SSB for 2021 – 2023	2,518.21 mt (5,551,692 lbs.)	2,456.02 mt (5,414,597 lbs.)
OY (Optimum Yield)	ABC, based on SAFMC control rule	TBD	TBD

Table 34**.** Projection results when age-4 fishing mortality rates = $F_{30\%SPR}$ (0.392) for southeastern U.S. Yellowtail Snapper. Equilibrium projections assume predicted recruitment follows the spawner-recruit curve. Short-term projections assume predicted age-0 recruitment is equal to the average from 2019 to 2023 (21.145 million). Recruitment (Recruits) is in millions of age-0 fish, F is age-4 instantaneous 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.

	$F_{30\%SPR}$ Equilibrium Long-Term Projections						**$F_{30\%SPR}$ Short-Term Projections**					
Year	**Age-0 Recruits**	**F**	**SSB**	**Retained Yield**	**Retained Num**	**Released Num**	**Age-0 Recruits**	**F**	**SSB**	**Retained Yield**	**Retained Num**	**Released Num**
2024	16.639	0.392	3,085.780	5,076,521	4,288,054	3,583,339	21.145	0.392	3,085.870	5,076,490	4,288,033	3,588,738
2025	16.468	0.392	2,904.670	4,746,037	3,944,622	3,078,951	21.145	0.392	2,914.430	4,767,230	3,976,233	3,369,553
2026	16.175	0.392	2,632.100	4,293,261	3,525,017	2,822,632	21.145	0.392	2,738.200	4,495,187	3,762,820	3,392,229
2027	15.880	0.392	2,397.790	3,913,453	3,219,569	2,704,561	21.145	0.392	2,653.260	4,364,600	3,691,391	3,414,446
2028	15.639	0.392	2,229.630	3,646,868	3,026,274	2,633,062	21.145	0.392	2,613.600	4,307,856	3,668,980	3,421,988
2029	15.455	0.392	2,113.690	3,465,646	2,900,937	2,580,093	21.145	0.392	2,595.010	4,282,255	3,660,473	3,424,137
2030	15.318	0.392	2,032.950	3,339,999	2,814,534	2,539,297	21.145	0.392	2,586.070	4,270,093	3,656,546	3,424,712
2031	15.215	0.392	1,975.600	3,250,658	2,752,462	2,508,182	21.145	0.392	2,581.690	4,264,116	3,654,562	3,424,835
2032	15.138	0.392	1,934.200	3,185,992	2,706,983	2,484,745	21.145	0.392	2,579.510	4,261,118	3,653,519	3,424,866
2033	15.080	0.392	1,903.970	3,138,660	2,673,394	2,467,137	21.145	0.392	2,578.410	4,259,604	3,652,945	3,424,876

Table 35. Projection results when age-4 fishing mortality rates correspond to a P* value of 0.375 (0.385) and $F_{current}$ (0.263) for southeastern U.S. Yellowtail Snapper. Short-term projections assume predicted age-0 recruitment was equal to the average from 2019 to 2023 (21.145 million). Recruitment (Recruits) is in millions of age-0 fish, F is age-4 instantaneous 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.

	P* Short-Term Projections						**$F_{current}$ Short-Term Projections**					
Year	**Age 0 Recruits**	**F**	**SSB**	**Retained Yield**	**Retained Num**	**Released Num**	**Age 0 Recruits**	**F**	**SSB**	**Retained Yield**	**Retained Num**	**Released Num**
2024	21.145	0.385	3,086	4,993,888	4,217,378	3,525,498	21.145	0.263	3,086	3,578,236	3,011,385	2,469,509
2025	21.145	0.385	2,930	4,713,550	3,928,046	3,314,804	21.145	0.263	3,192	3,673,941	3,019,198	2,378,446
2026	21.145	0.385	2,763	4,459,580	3,726,746	3,338,164	21.145	0.263	3,205	3,687,988	2,998,784	2,410,988
2027	21.145	0.385	2,682	4,337,661	3,660,110	3,360,399	21.145	0.263	3,233	3,714,369	3,014,787	2,433,338
2028	21.145	0.385	2,645	4,284,939	3,639,695	3,368,003	21.145	0.263	3,259	3,742,512	3,035,179	2,442,209
2029	21.145	0.385	2,627	4,261,219	3,632,120	3,370,182	21.145	0.263	3,279	3,764,516	3,049,924	2,445,566
2030	21.145	0.385	2,619	4,249,964	3,628,648	3,370,788	21.145	0.263	3,293	3,779,761	3,059,223	2,446,901
2031	21.145	0.385	2,615	4,244,436	3,626,871	3,370,942	21.145	0.263	3,303	3,789,806	3,064,875	2,447,475
2032	21.145	0.385	2,613	4,241,649	3,625,932	3,370,962	21.145	0.263	3,309	3,796,242	3,068,269	2,447,743
2033	21.145	0.385	2,611	4,240,239	3,625,420	3,370,972	21.145	0.263	3,313	3,800,302	3,070,311	2,447,875

Table 36. Projection results when constant catch corresponded to the 3-year and 5-year average retained yield estimated under a P* value of 0.375 (0.385) for southeastern U.S. Yellowtail Snapper. The 3-year average was 2,168.006 metric tons and the 5-year average was 2,087.556 metric tons. Short-term projections assumed predicted age-0 recruitment was equal to the average from 2019 to 2023 (21.145 million). Recruitment (Recruits) is in millions of age-0 fish, F is age-4 instantaneous 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.

	P* 3-yr Constant Catch Short-Term Projections						**P* 5-yr Constant Catch Short-Term Projections**					
Year	**Age 0 Recruits**	**F**	**SSB**	**Retained Yield**	**Retained Num**	**Released Num**	**Age 0 Recruits**	**F**	**SSB**	**Retained Yield**	**Retained Num**	**Released Num**
2024	21.145	0.360	3,085.870	4,722,359	3,985,322	3,318,889	21.145	0.346	3,085.870	4,557,928	3,844,986	3,194,734
2025	21.145	0.378	2,979.810	4,722,330	3,926,200	3,278,647	21.145	0.359	3,010.220	4,557,928	3,782,708	3,130,409
2026	21.145	0.404	2,808.250	4,722,348	3,936,619	3,504,666	21.145	0.379	2,867.580	4,557,944	3,784,165	3,313,524
2027	21.145	0.427	2,674.680	4,722,363	3,986,783	3,692,461	21.145	0.395	2,759.730	4,557,933	3,822,422	3,458,937
2028	21.145	0.447	2,564.600	4,722,355	4,034,996	3,839,712	21.145	0.409	2,672.160	4,557,929	3,859,290	3,566,122
2029	21.145	0.466	2,471.000	4,722,344	4,075,669	3,968,299	21.145	0.422	2,598.410	4,557,929	3,889,537	3,655,897
2030	21.145	0.483	2,389.700	4,722,333	4,110,809	4,086,358	21.145	0.434	2,534.720	4,557,943	3,915,009	3,736,101
2031	21.145	0.500	2,318.340	4,722,348	4,142,040	4,196,192	21.145	0.444	2,479.060	4,557,910	3,937,187	3,809,089
2032	21.145	0.516	2,255.360	4,722,348	4,170,151	4,298,471	21.145	0.454	2,430.130	4,557,929	3,956,887	3,875,846
2033	21.145	0.531	2,199.570	4,722,339	4,195,602	4,393,615	21.145	0.463	2,386.970	4,557,929	3,974,482	3,936,835

Table 37. Projection results when constant catch corresponded to the equilibrium retained yield at $F_{30\%SPR}$ (1,361.385 metric tons) estimate for southeastern U.S. Yellowtail Snapper. Short-term projections assumed predicted age-0 recruitment was equal to the average from 2019 to 2023 (21.145 million). Recruitment (Recruits) is in millions of age-0 fish, F is age-4 instantaneous 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.

Constant Catch at Equilibrium Retained Yield at $F_{30\%SPR}$ Short-Term Projections

Year	Age 0 Recruits	F	SSB	Retained Yield	Retained Num	Released Num
2024	21.145	0.216	3,085.870	3,001,338	2,522,496	2,053,286
2025	21.145	0.203	3,299.560	3,001,341	2,452,599	1,876,995
2026	21.145	0.194	3,433.950	3,001,340	2,410,631	1,838,760
2027	21.145	0.187	3,574.380	3,001,338	2,388,480	1,793,513
2028	21.145	0.180	3,704.250	3,001,340	2,370,092	1,744,605
2029	21.145	0.174	3,820.410	3,001,341	2,352,946	1,700,300
2030	21.145	0.170	3,922.300	3,001,338	2,337,394	1,662,562
2031	21.145	0.166	4,010.790	3,001,342	2,323,729	1,630,980
2032	21.145	0.163	4,087.180	3,001,340	2,311,953	1,604,674
2033	21.145	0.160	4,152.810	3,001,343	2,301,903	1,582,751

9 Figures

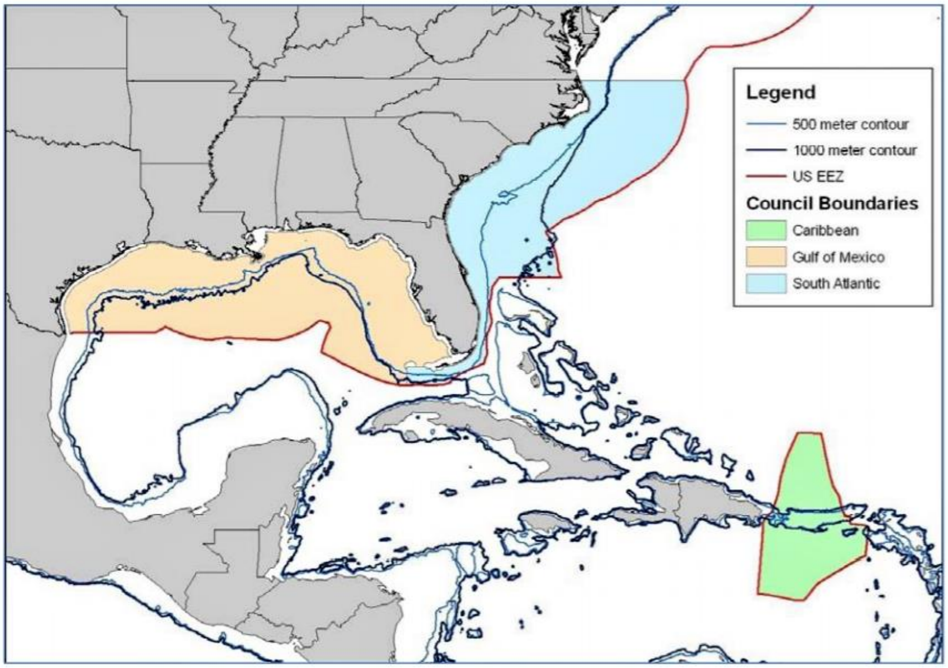

Figure 1. Jurisdictional boundaries in the Southeast Region for the South Atlantic Fishery Management Council, the Gulf of Mexico Fishery Management Council, and the Caribbean Fishery Management Council.

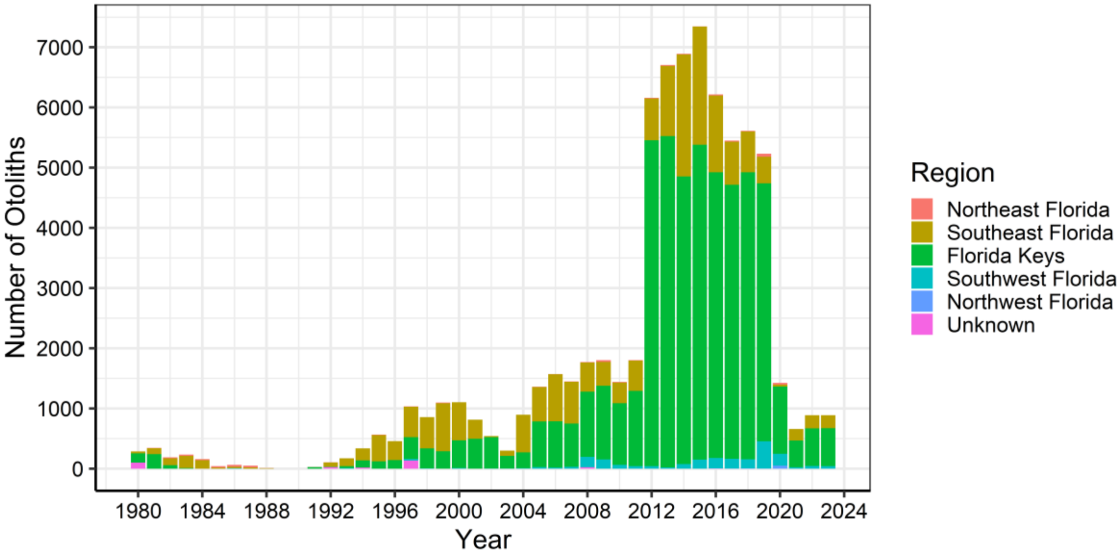

Figure 2. Number of southeastern U.S. Yellowtail Snapper otoliths sampled by region in Florida waters from 1980 – 2023.

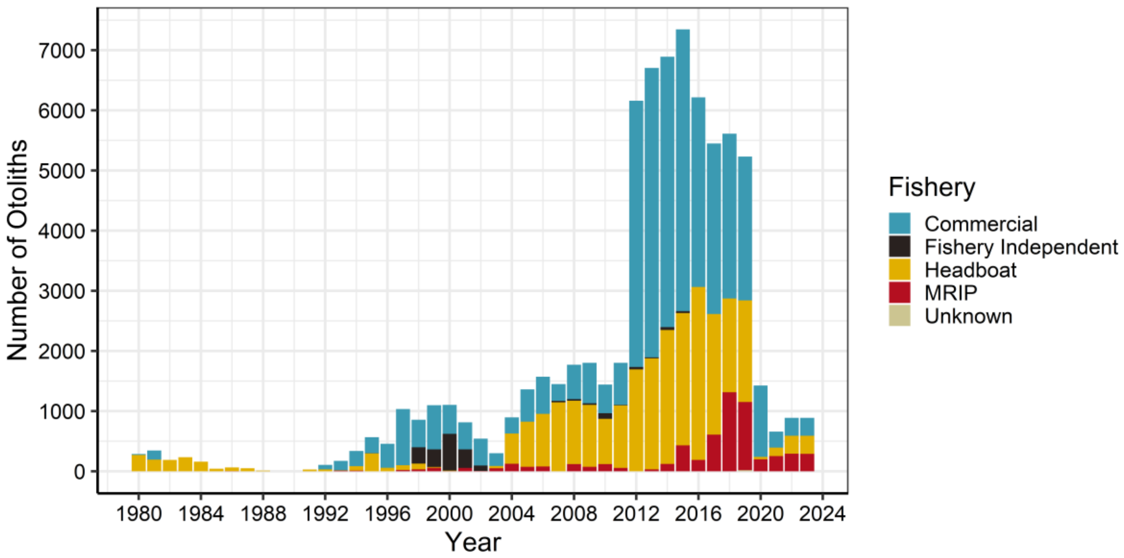

Figure 3. Number of southeastern U.S. Yellowtail Snapper otoliths sampled by fishery in Florida waters from 1980 – 2023.

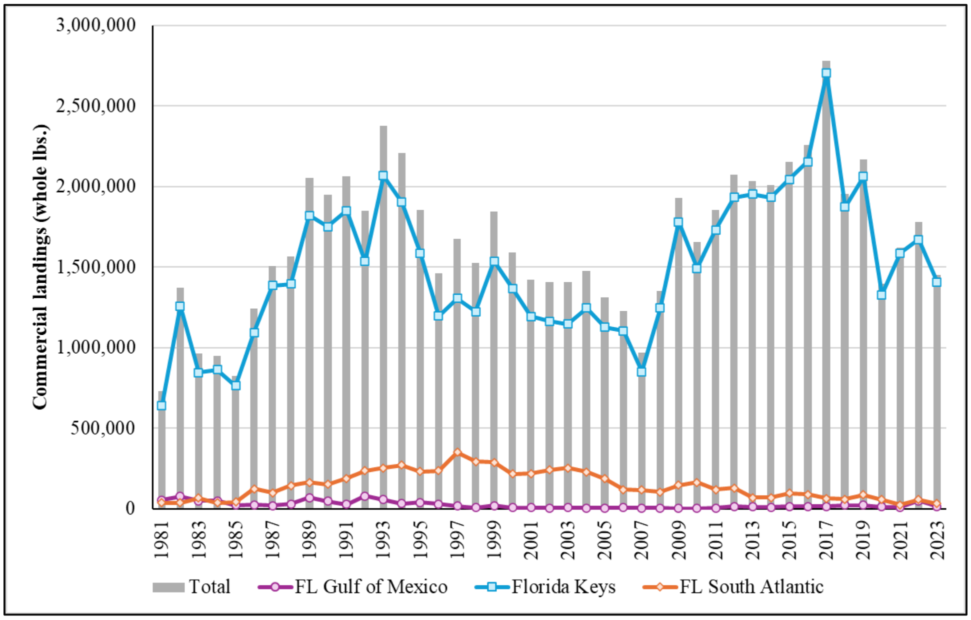

Figure 4. Commercial landings (whole lbs.) of Yellowtail Snapper in Florida by concatenated region for years 1981 – 2023 from the NMFS ALS (1981 – 1985) and Florida's Marine Fisheries Trip Ticket Program (1986 – 2023). 'FL Gulf of Mexico' is northwest and southwest Florida and 'FL South Atlantic' is northeast and southeast Florida regions. Regions are concatenated to protect any potential confidential data.

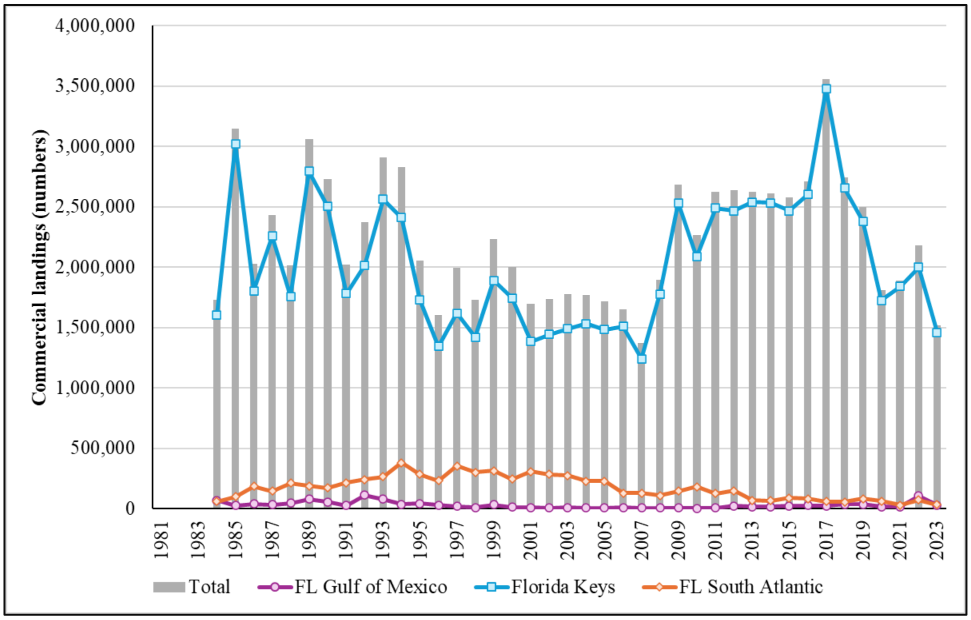

Figure 5. Commercial landings (numbers) of Yellowtail Snapper in Florida by concatenated region for years 1984 – 2023. Estimated landings in numbers are based on landings in pounds from Florida's Marine Fisheries Trip Ticket Program and converted to numbers using mean weights sampled from the Trip Interview Program. 'FL Gulf of Mexico' is northwest and southwest Florida and 'FL South Atlantic' is northeast and southeast Florida regions. Regions are concatenated to protect any potential confidential data.

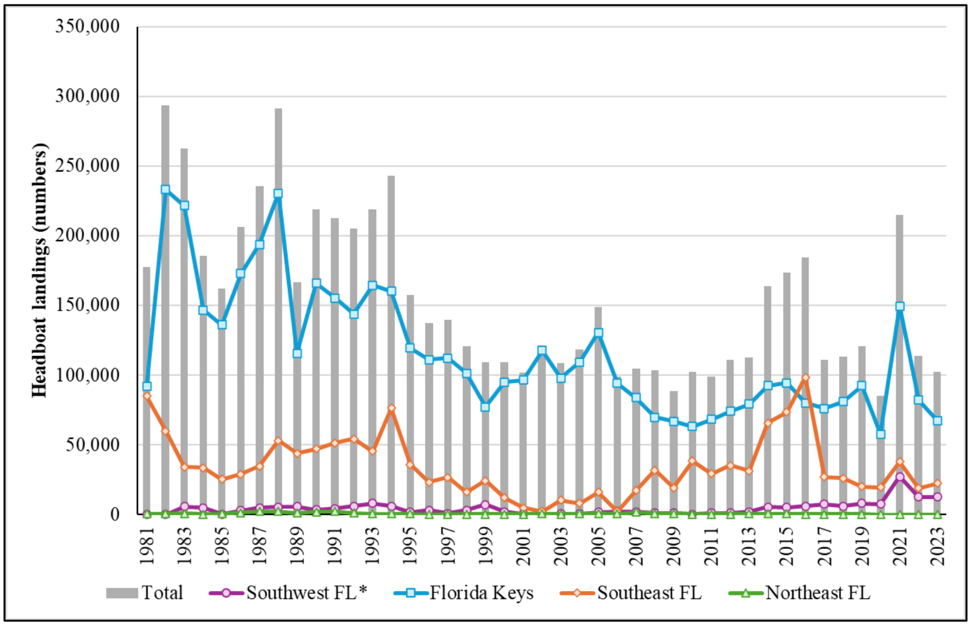

Figure 6. Headboat landings (numbers) of southeastern U.S. Yellowtail Snapper in Florida by region for years 1981 – 2023. The asterisk (*) denotes that the northwest Florida region was combined with southwest Florida region due to confidentiality of northwest Florida data. Years 1981 – 1985 are comprised of both SRHS data and headboat mode data from MRIP.

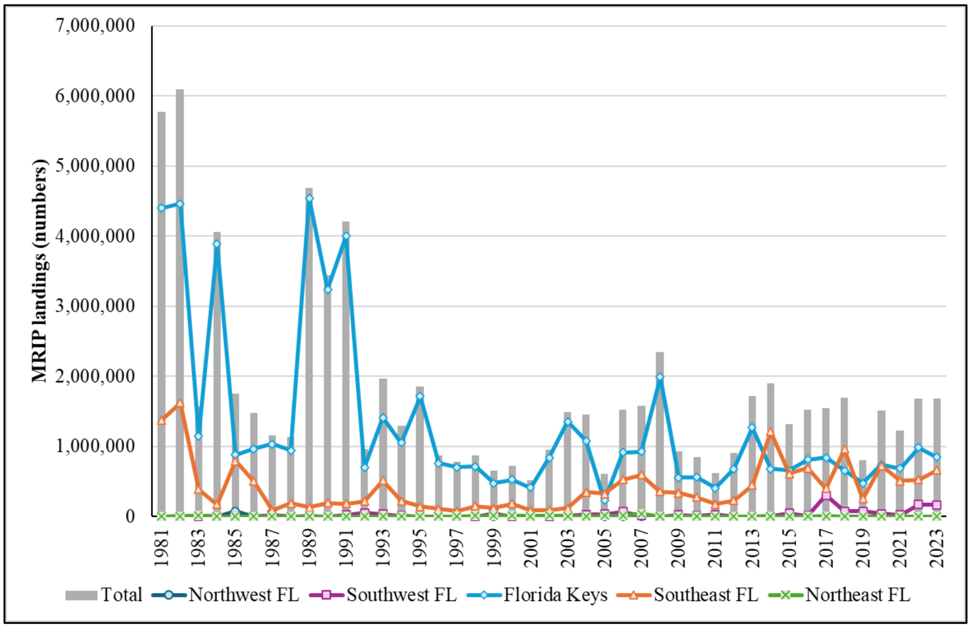

Figure 7. Recreational landings (A+B1, numbers) of southeastern U.S. Yellowtail Snapper from the Marine Recreational Information Program (MRIP) in Florida by region from years 1981 – 2023.

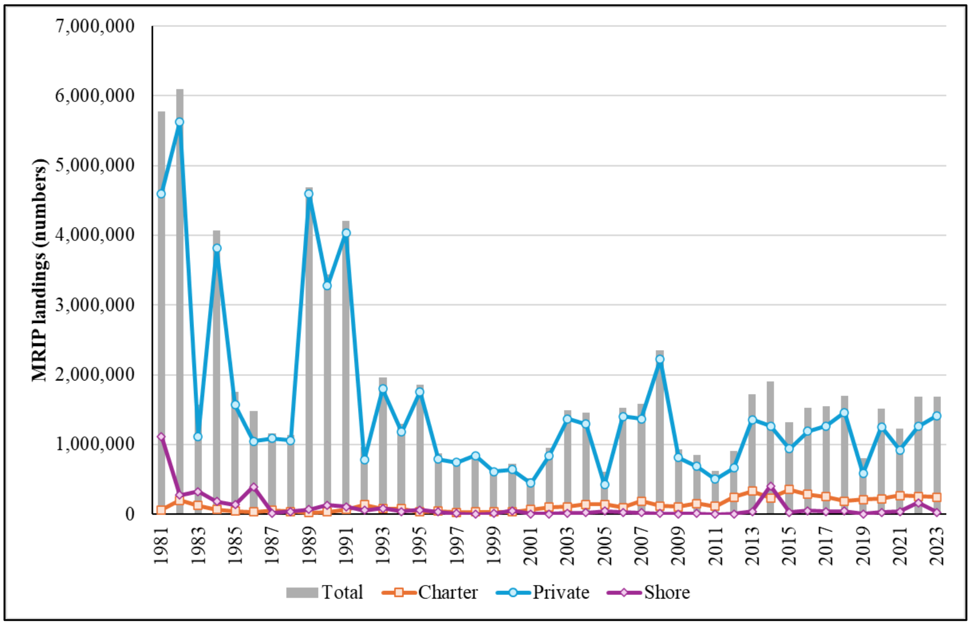

Figure 8. Recreational landings (A+B1; numbers) of southeastern U.S. Yellowtail Snapper from the Marine Recreational Information Program (MRIP) in Florida by mode for years 1981 – 2023.

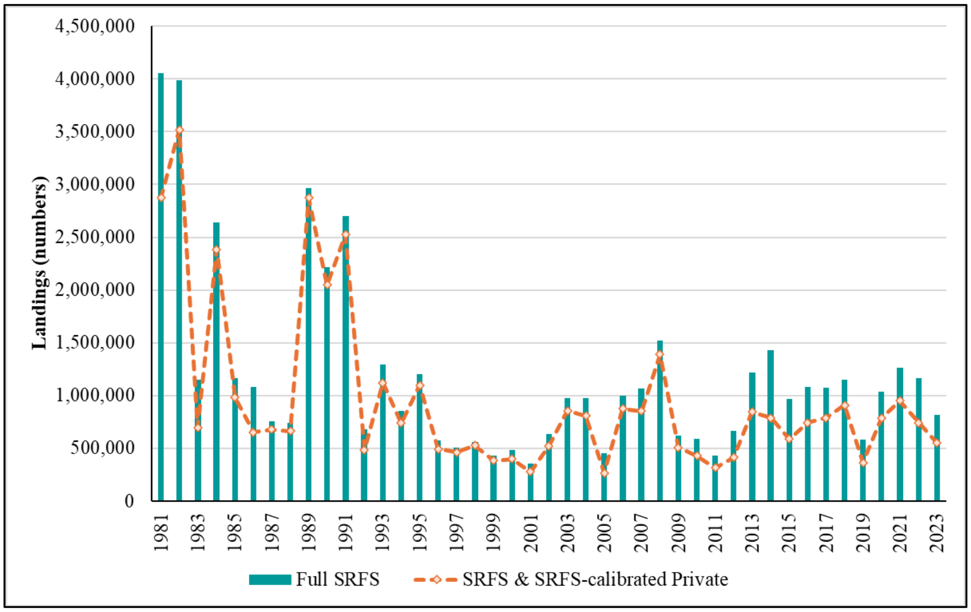

Figure 9. The ‘SRFS & SRFS-calibrated Private’ mode landings (numbers) as well as the ‘Full SRFS’ landings (numbers) of southeastern U.S. Yellowtail Snapper in Florida for years 1981 – 2023. ‘SRFS & SRFS-calibrated Private’ estimates are comprised of SRFS private mode (2021 – 2023) and SRFS ratio-calibrated MRIP private mode (1981 – 2020). The ‘Full SRFS’ estimates are comprised of ‘SRFS & SRFS-calibrated Private’ mode (1981 – 2023), MRIP charter mode (1981 – 2023), and MRIP shore mode (1981 – 2023) landings estimates.

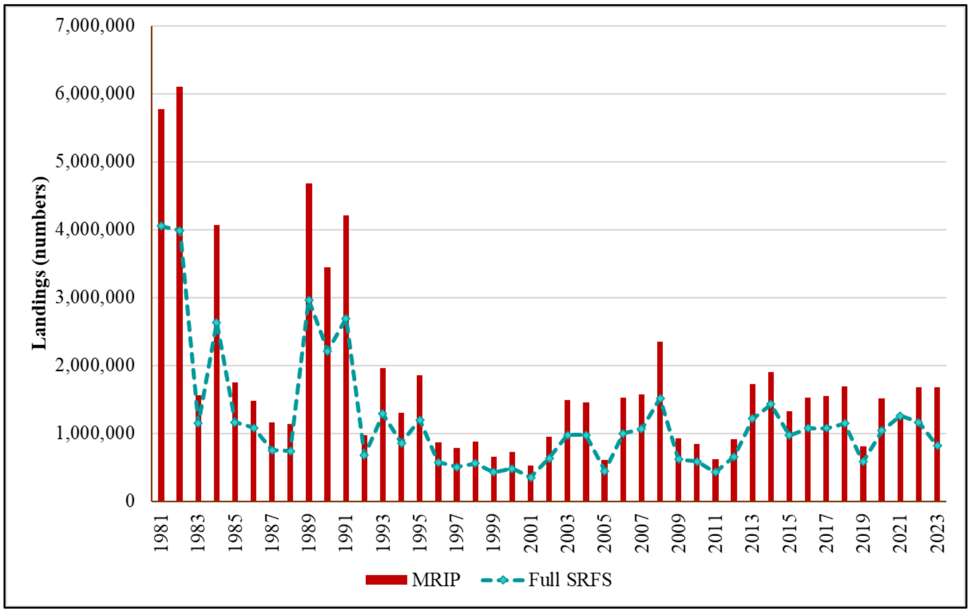

Figure 10. A comparison of the ‘Full SRFS’ landings (numbers) with the recreational landings of southeastern U.S. Yellowtail Snapper from the Marine Recreational Information Program (MRIP) in Florida for years 1981 – 2023. The ‘Full SRFS’ estimates are comprised of ‘SRFS & SRFS-calibrated Private’ mode (1981 – 2023), MRIP charter mode (1981 – 2023), and MRIP shore mode (1981 – 2023) landings estimates.

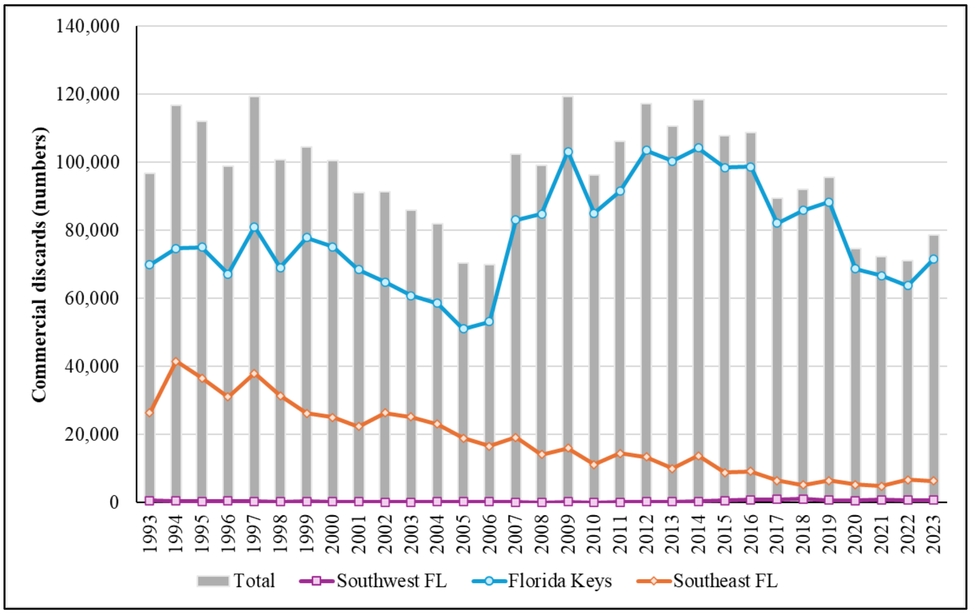

Figure 11. Commercial discards (numbers) of southeastern U.S. Yellowtail Snapper in Florida by region for years 1993 – 2023 from commercial reef fish observer program data.

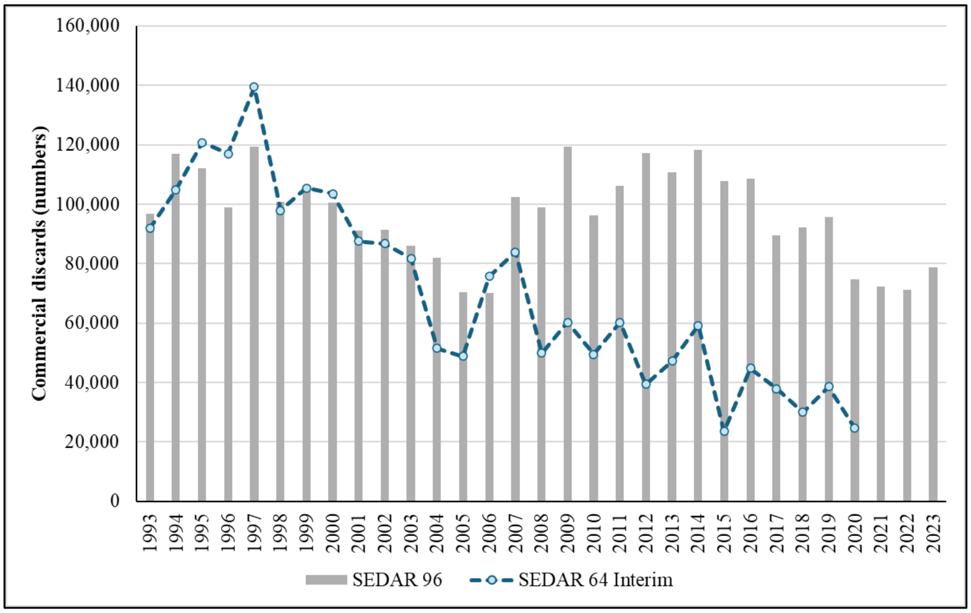

Figure 12. A comparison of commercial discards (numbers) of southeastern U.S. Yellowtail Snapper in Florida for years 1993 – 2023. Estimated discards provided here (SEDAR 96) were from commercial reef fish observer program data while those from SEDAR 64 and the Interim Analysis (SEDAR 64 Interim) were based on commercial discard logbook data.

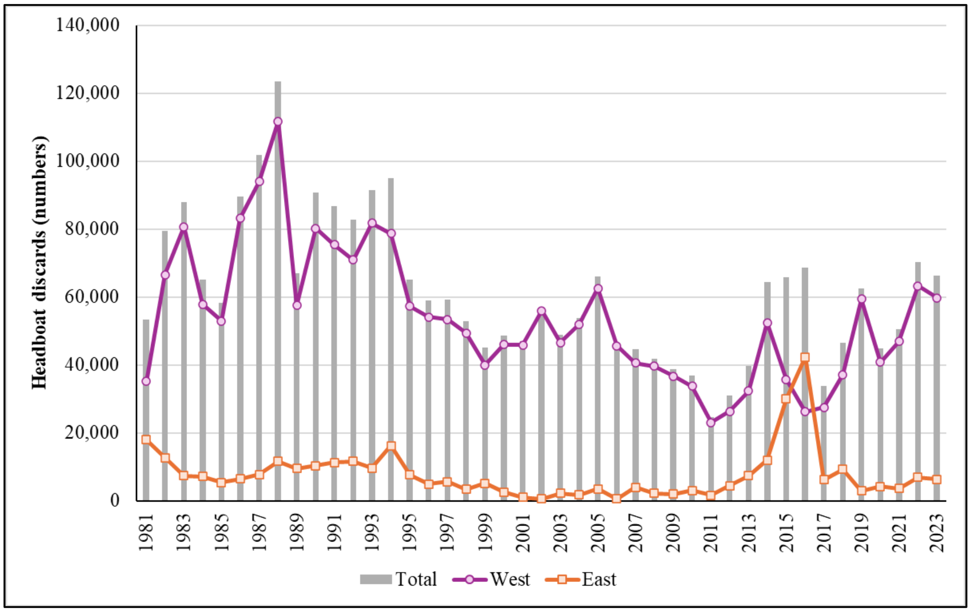

Figure 13. Headboat proxy discards (numbers) of southeastern U.S. Yellowtail Snapper in Florida by concatenated region for years 1981 – 2023 using the 'SRHS-Mean' approach. 'West' is northwest, southwest, and Florida Keys regions while 'East' is northeast and southeast Florida regions.

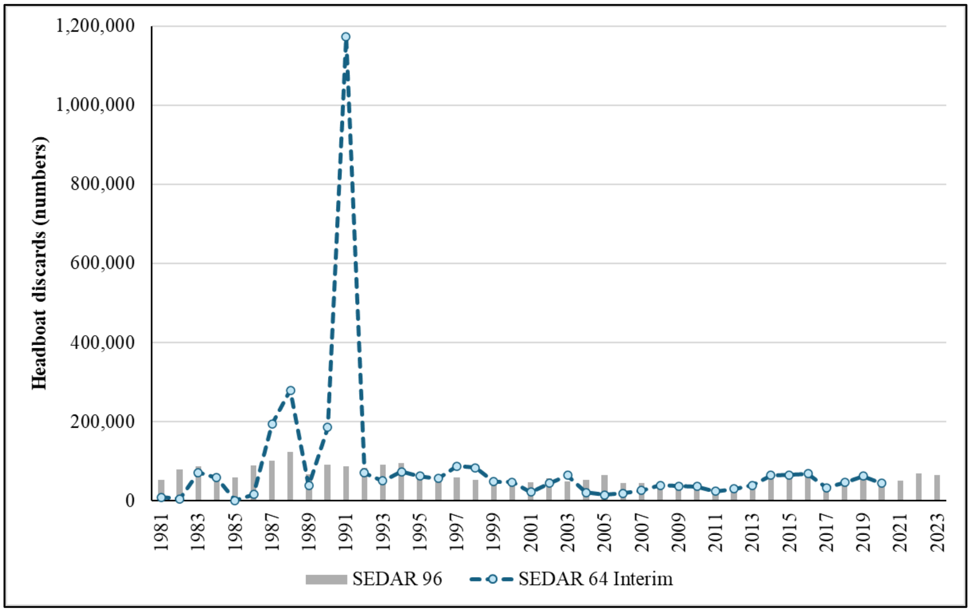

Figure 14. A comparison of headboat proxy discards (numbers) of southeastern U.S. Yellowtail Snapper in Florida for years 1981 – 2023. Estimated discards provided here (SEDAR 96) were used the 'SRHS-Mean' approach while those from SEDAR 64 and the Interim Analysis (SEDAR 64 Interim) were based on the 'super-ratio' approach.

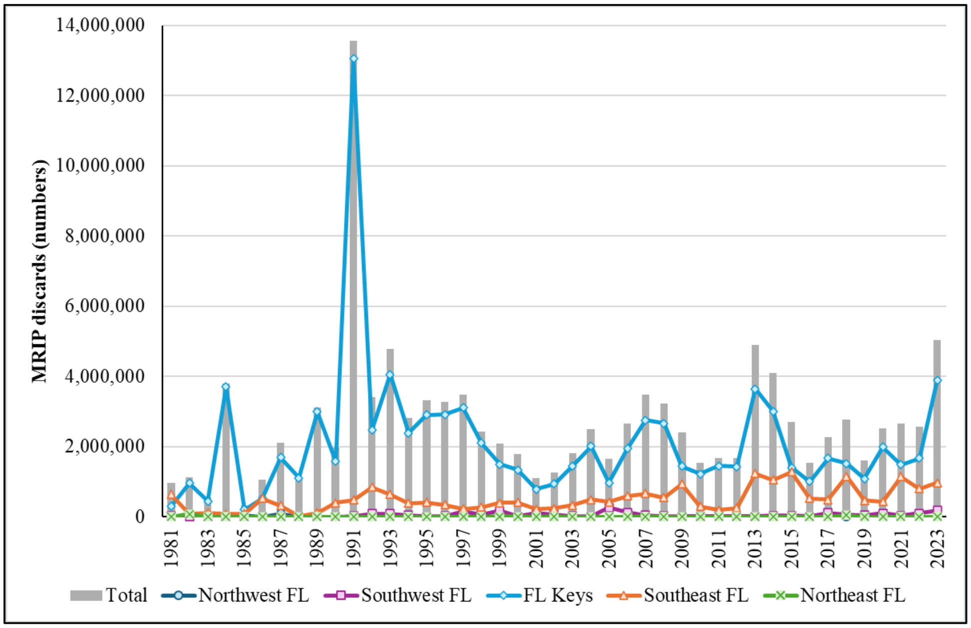

Figure 15. Recreational discards (B2, numbers) of southeastern U.S. Yellowtail Snapper from the Marine Recreational Information Program (MRIP) in Florida by region for years 1981 – 2023.

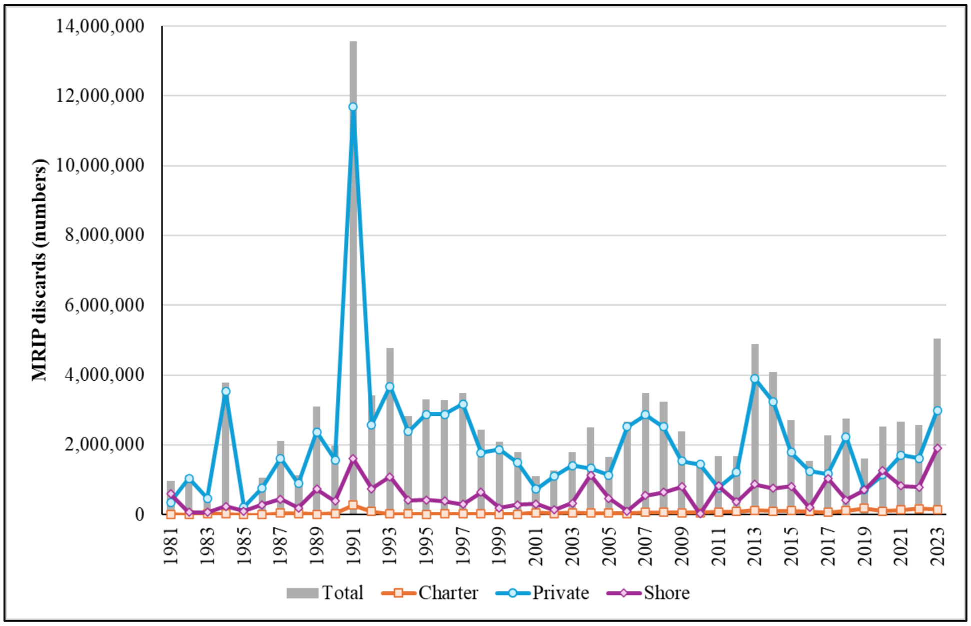

Figure 16. Recreational discards (B2, numbers) of southeastern U.S. Yellowtail Snapper from the Marine Recreational Information Program (MRIP) in Florida by mode for years 1981 – 2023.

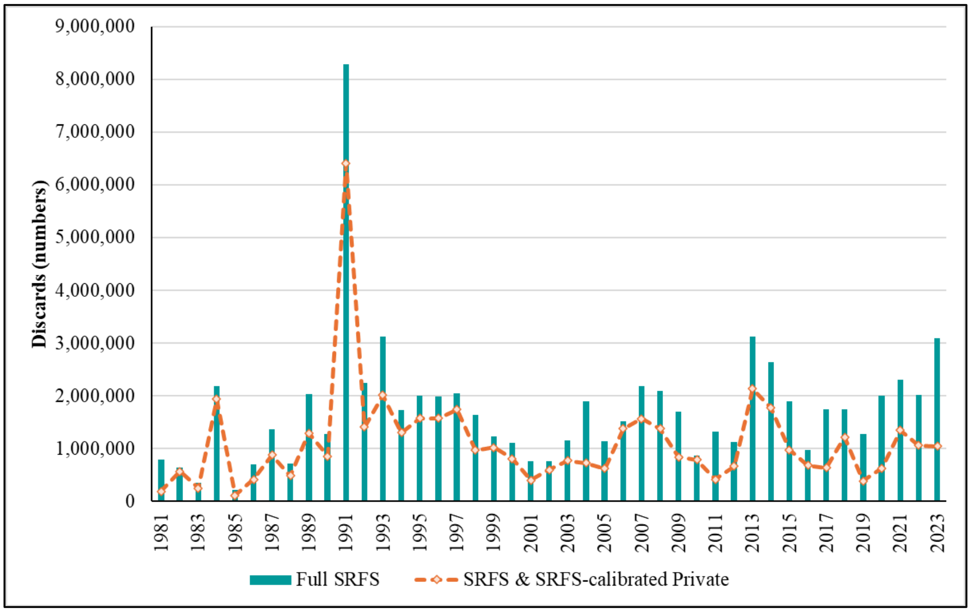

Figure 17. The ‘SRFS & SRFS-calibrated Private’ mode discards (numbers) as well as the ‘Full SRFS’ discards (numbers) of southeastern U.S. Yellowtail Snapper in Florida for years 1981 – 2023. ‘SRFS & SRFS-calibrated Private’ estimates are comprised of SRFS private mode (2021 – 2023) and SRFS ratio-calibrated MRIP private mode (1981 – 2020). The ‘Full SRFS’ estimates are comprised of ‘SRFS & SRFS-calibrated Private’ mode (1981 – 2023), MRIP charter mode (1981 – 2023), and MRIP shore mode (1981 – 2023) discard estimates.

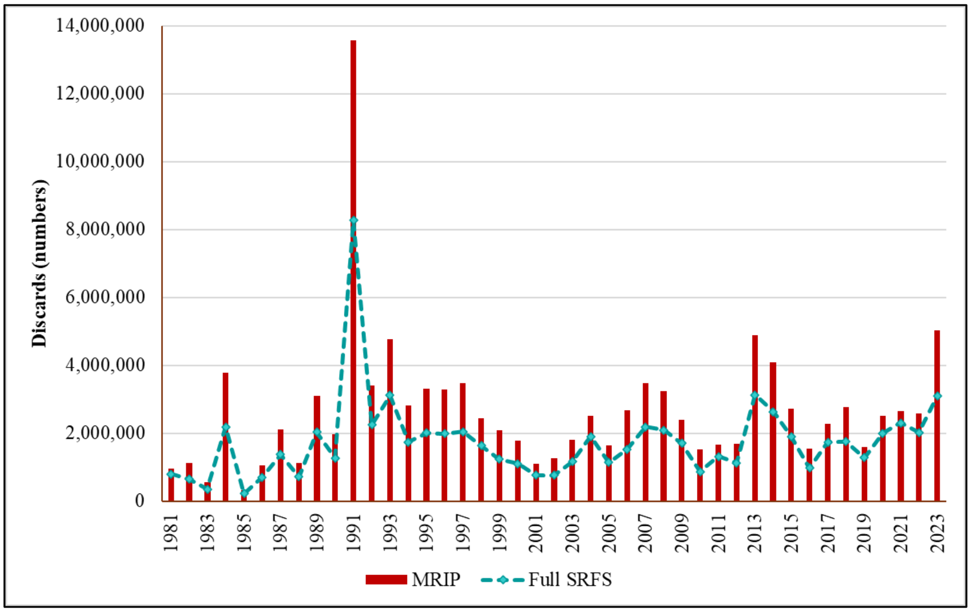

Figure 18. A comparison of the ‘Full SRFS’ discards (numbers) with the recreational discards of southeastern U.S. Yellowtail Snapper from the Marine Recreational Information Program (MRIP) in Florida for years 1981 – 2023. The ‘Full SRFS’ estimates are comprised of ‘SRFS & SRFS-calibrated Private’ mode (1981 – 2023), MRIP charter mode (1981 – 2023), and MRIP shore mode (1981 – 2023) discard estimates.

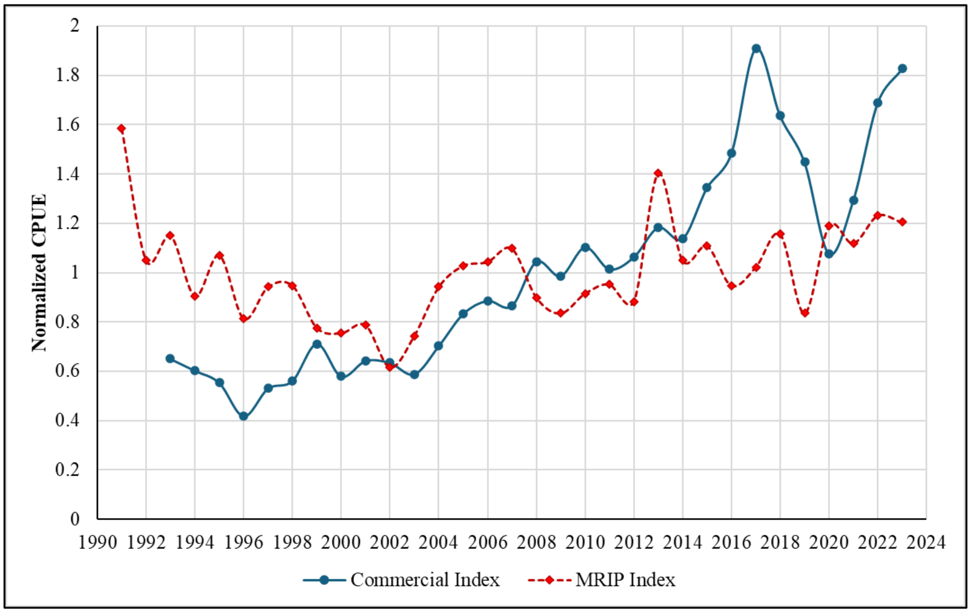

Figure 19. Normalized indices of relative abundance for southeastern U.S. Yellowtail Snapper from 1991 – 2023. The commercial CFLP retained catch per unit effort index (Commercial Index) was from 1993 – 2023 while the MRIP total catch per trip index (MRIP Index) was from 1991 – 2023.

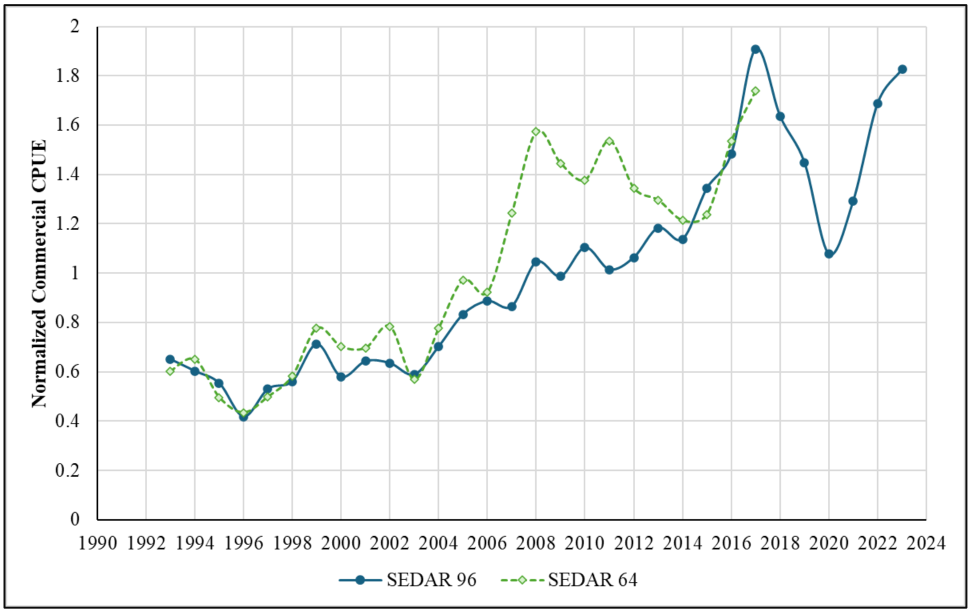

Figure 20. A comparison of the normalized commercial CFLP retained catch per unit effort indices of relative abundance for southeastern U.S. Yellowtail Snapper for years 1993 – 2023 as provided here (SEDAR 96) and SEDAR 64.

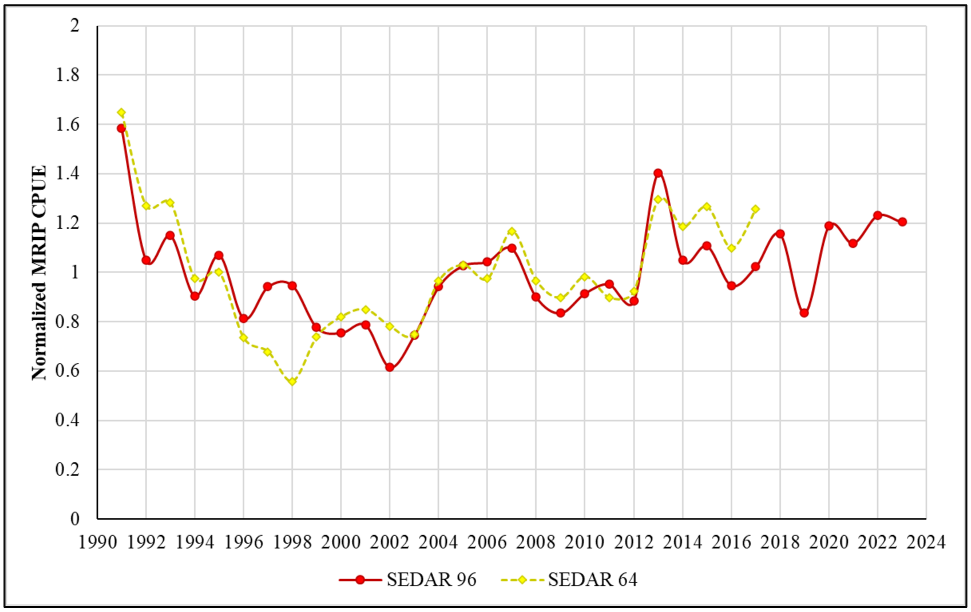

Figure 21. A comparison of the normalized MRIP indices of relative abundance for southeastern U.S. Yellowtail Snapper for years 1991 – 2023. The MRIP index provided here (SEDAR 96) is in units of total catch per trip while the one provided for SEDAR 64 was in units of total catch per angler.

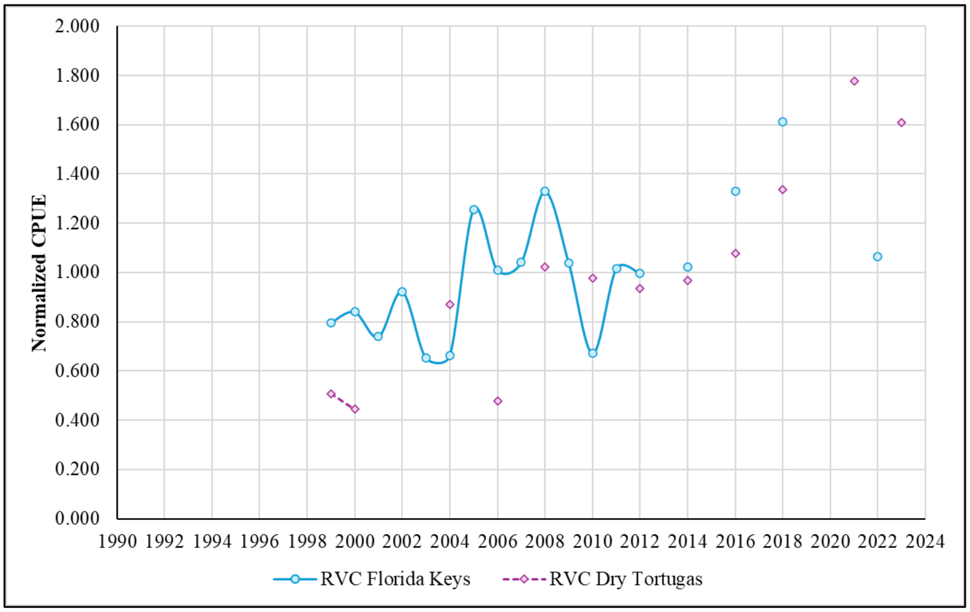

Figure 22. Normalized design-based indices of relative abundance for southeastern U.S. Yellowtail Snapper from 1999 – 2023 from the Reef Fish Visual Census (RVC). The RVC Florida Keys was from 1999 – 2012, 2014, 2016, 2018, and 2022 while the RVC Dry Tortugas was from 1999 – 2000, biennially from 2004 – 2018, and 2021, 2023.

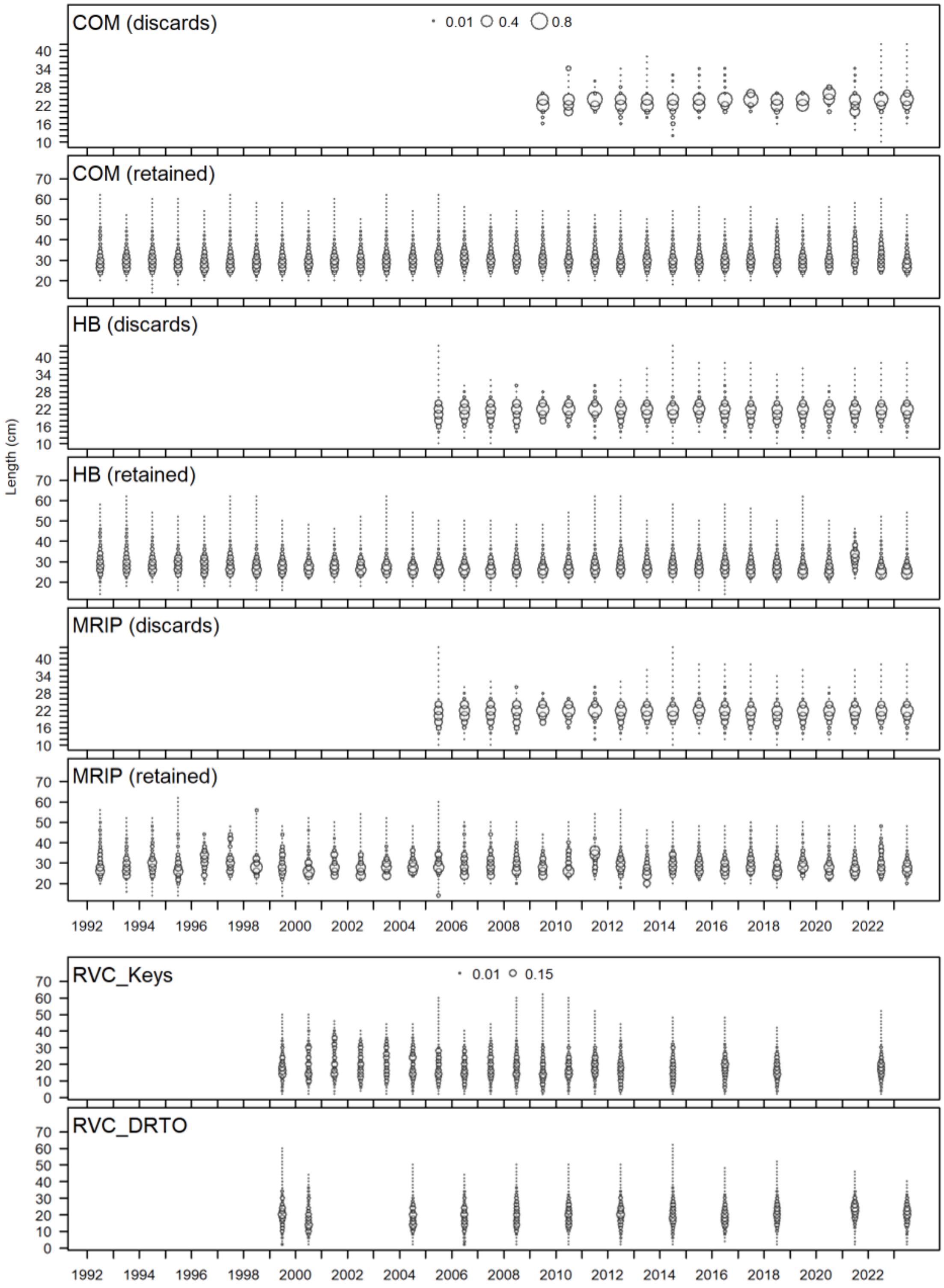

Figure 23. Catch-weighted length compositions (2 cm FL bins) of southeastern U.S. Yellowtail Snapper landings (retained) and discards by fishery for years 1992 – 2023. Commercial = COM, Headboat = HB, MRIP and SRFS = MRIP, RVC Florida Keys Index = RVC_Keys, and RVC Dry Tortugas Index = RVC_DRTO.

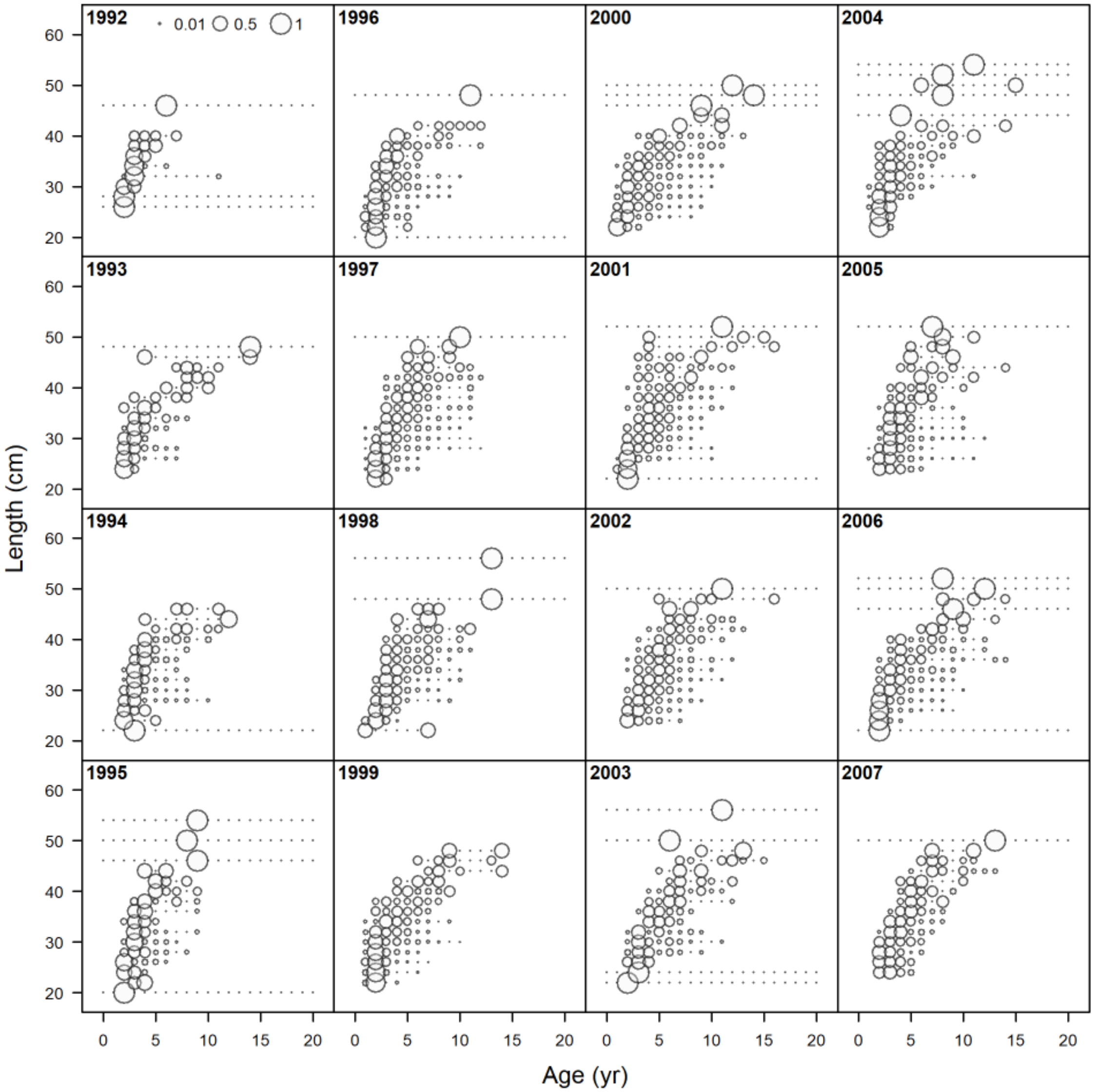

Figure 24. Observed conditional age-at-length in 2 cm FL bins of southeastern U.S. Yellowtail Snapper for the Commercial fishery during years 1992 – 2023.

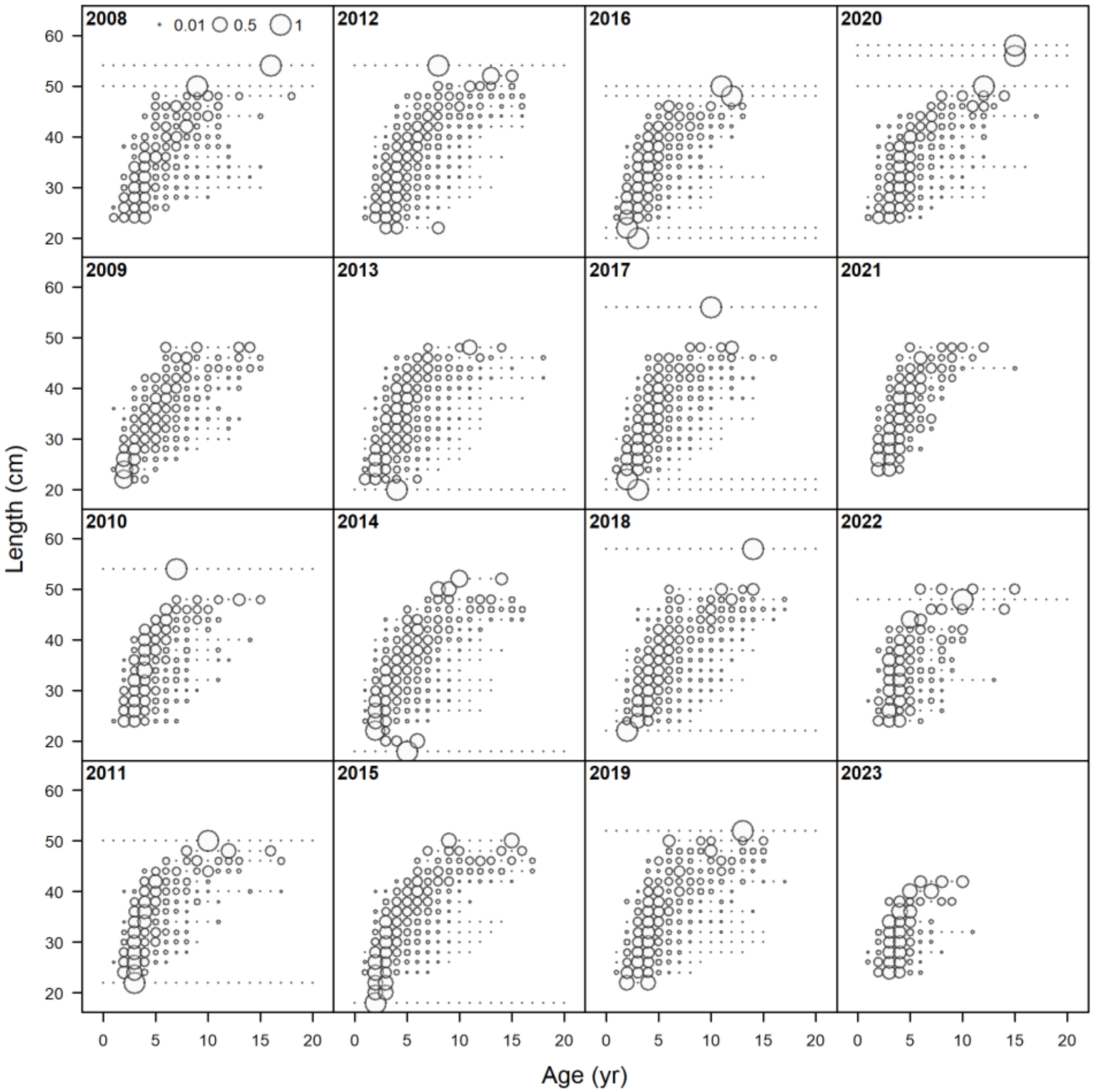

Figure 24 (continued). Observed conditional age-at-length in 2 cm FL bins of southeastern U.S. Yellowtail Snapper for the Commercial fleet during years 1992 – 2023.

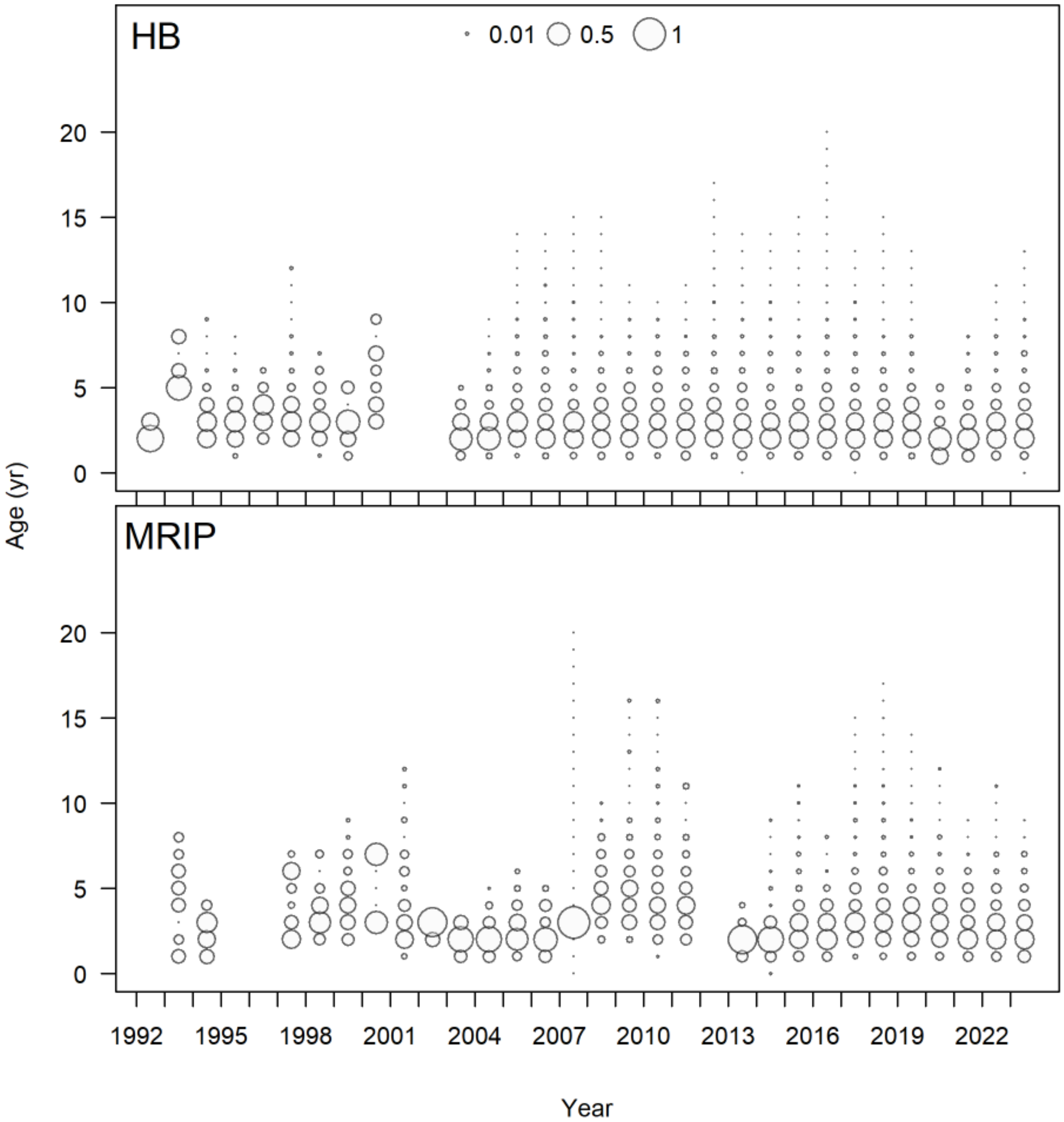

Figure 25. Catch-weighted age compositions (1 year bins) of southeastern U.S. Yellowtail Snapper for the Headboat (HB) and MRIP/SRFS (MRIP) fisheries for years 1992 – 2023.

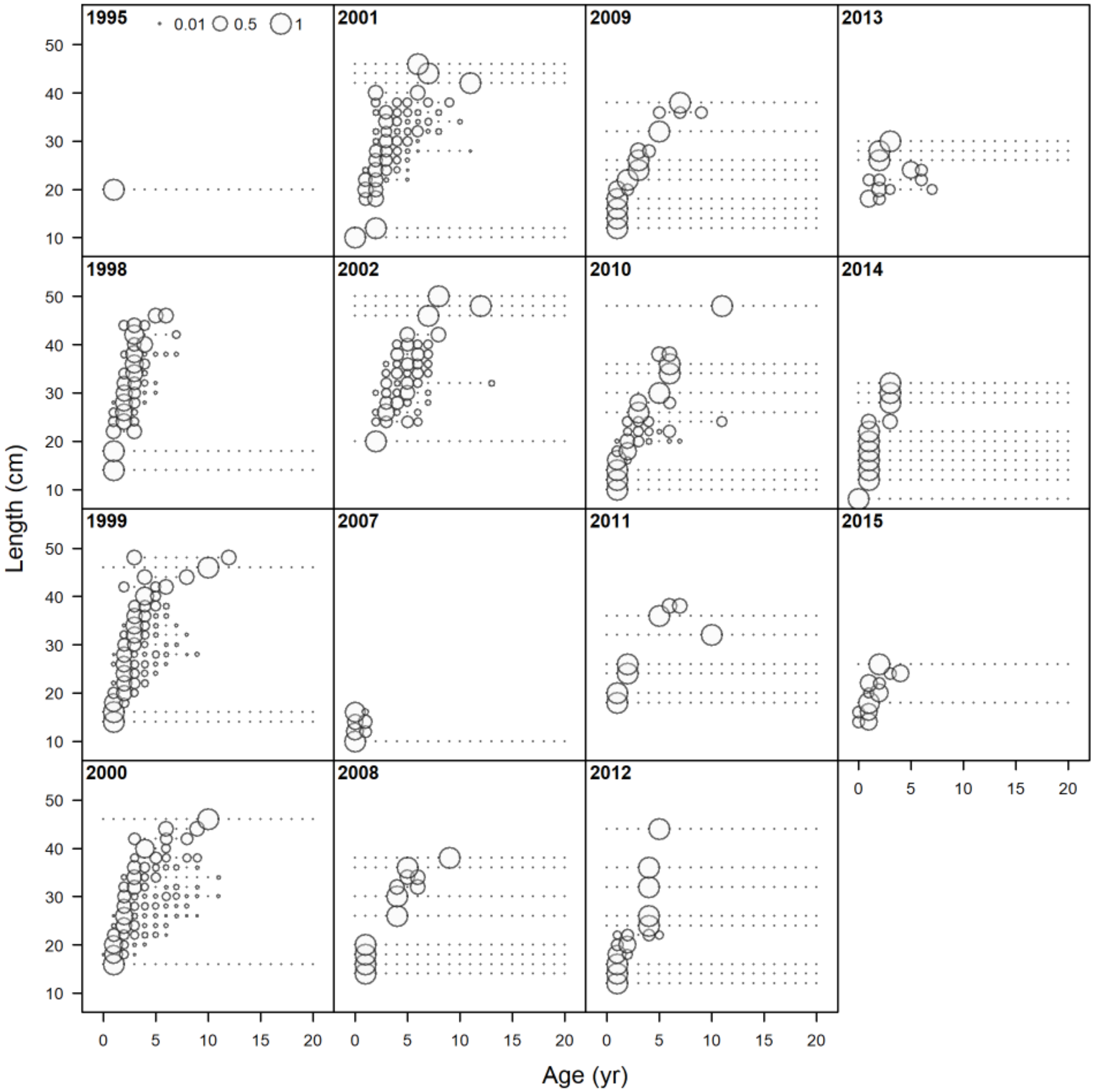

Figure 26. Observed conditional age-at-length in 2 cm FL bins of southeastern U.S. Yellowtail Snapper from fishery independent data sources during years 1995, 1998 – 2002, and 2007 – 2015.

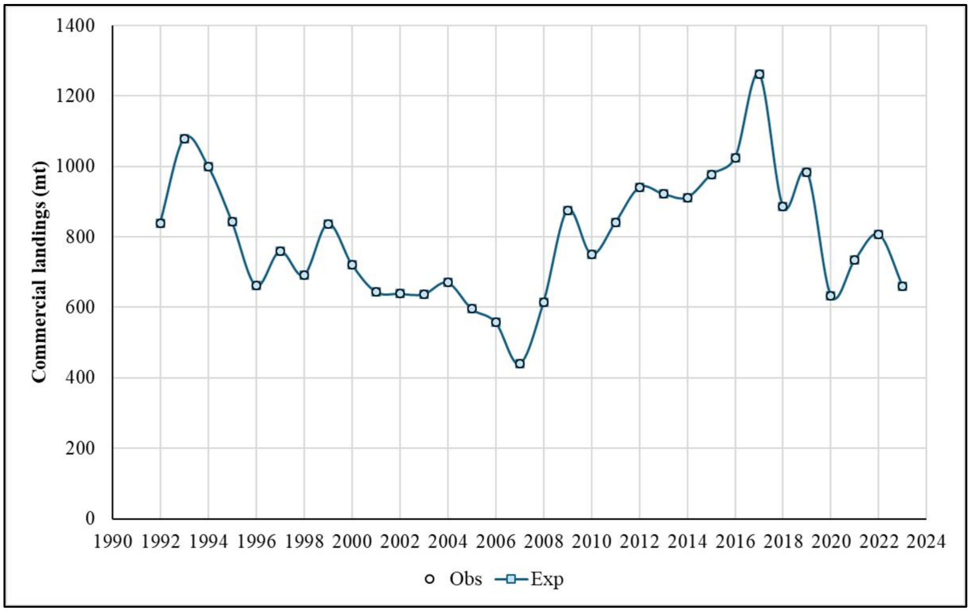

Figure 27. Southeastern U.S. Yellowtail Snapper observed (black dots) and expected (blue box and solid line) landings by the Commercial fleet (in metric tons) from the SEDAR 96 base model.

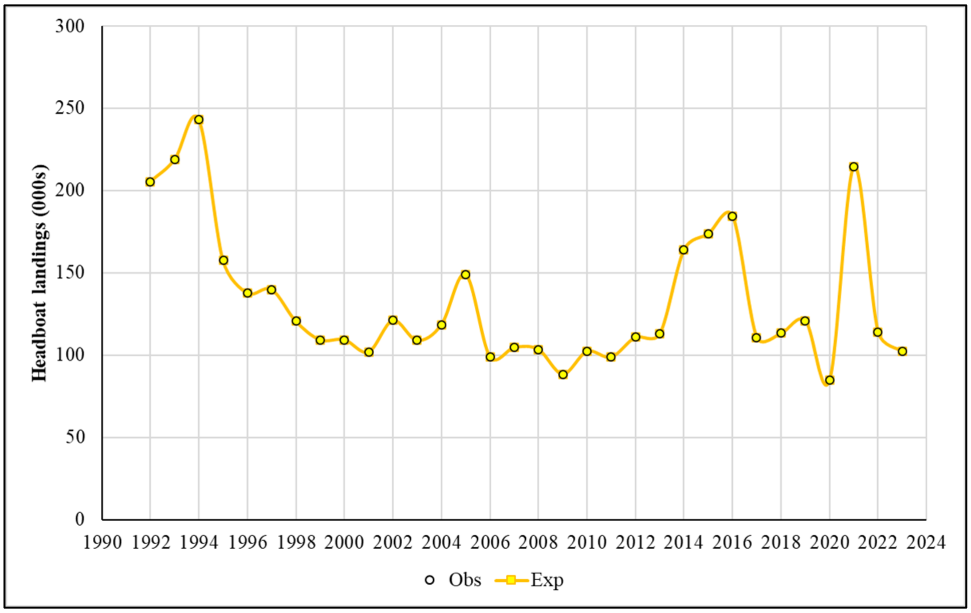

Figure 28. Southeastern U.S. Yellowtail Snapper observed (black dots) and expected (yellow box and solid line) landings by the Headboat fleet (in thousands of fish) from the SEDAR 96 base model.

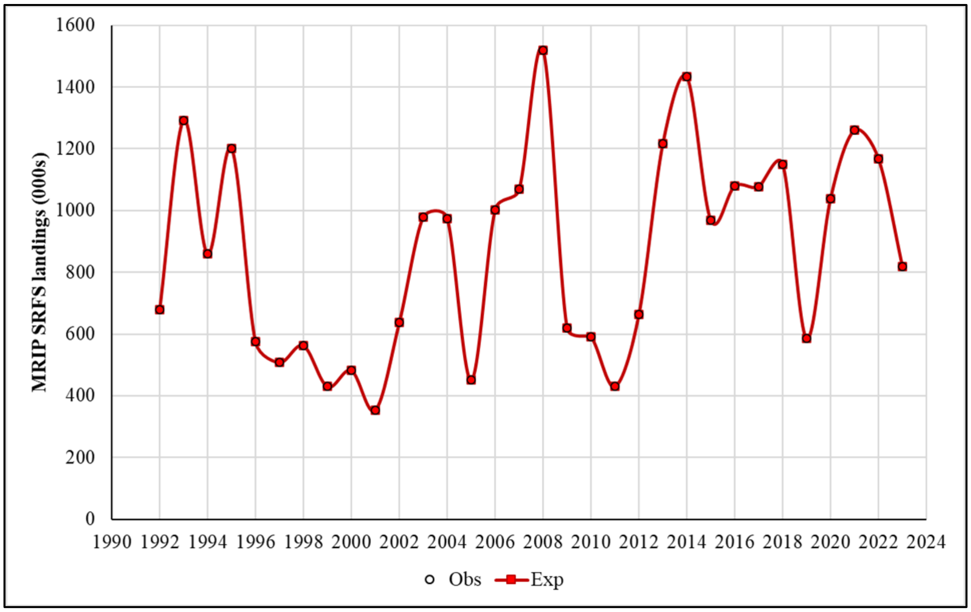

Figure 29. Southeastern U.S. Yellowtail Snapper observed (black dots) and expected (red box and solid line) landings by the MRIP SRFS fleet (in thousands of fish) from the SEDAR 96 base model.

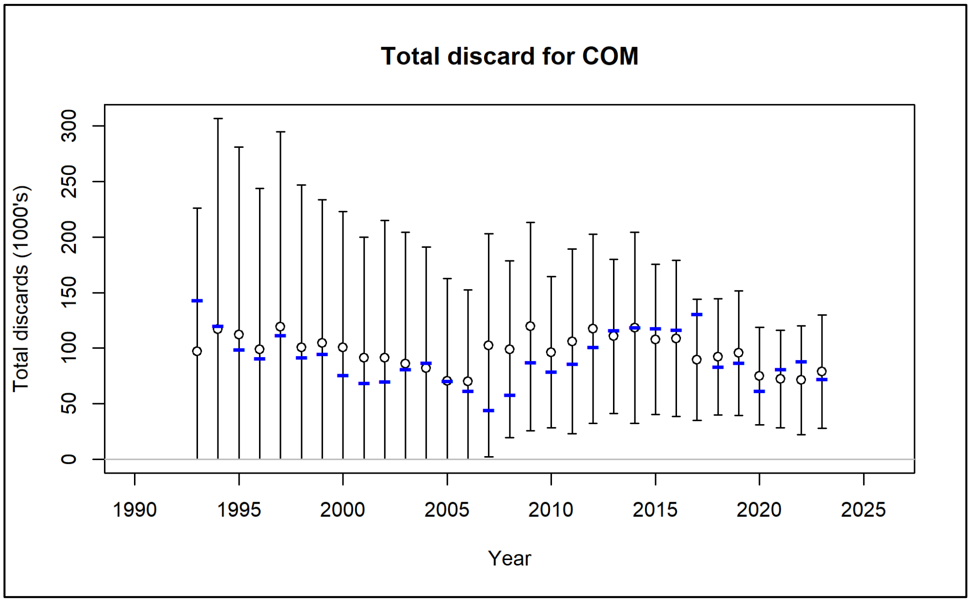

Figure 30. Southeastern U.S. Yellowtail Snapper observed (dots with 95% confidence intervals) and expected (blue dashes) discards (i.e., before applying the discard mortality rate for each fleet) by the Commercial fleet (in thousands of fish) from the SEDAR 96 base model.

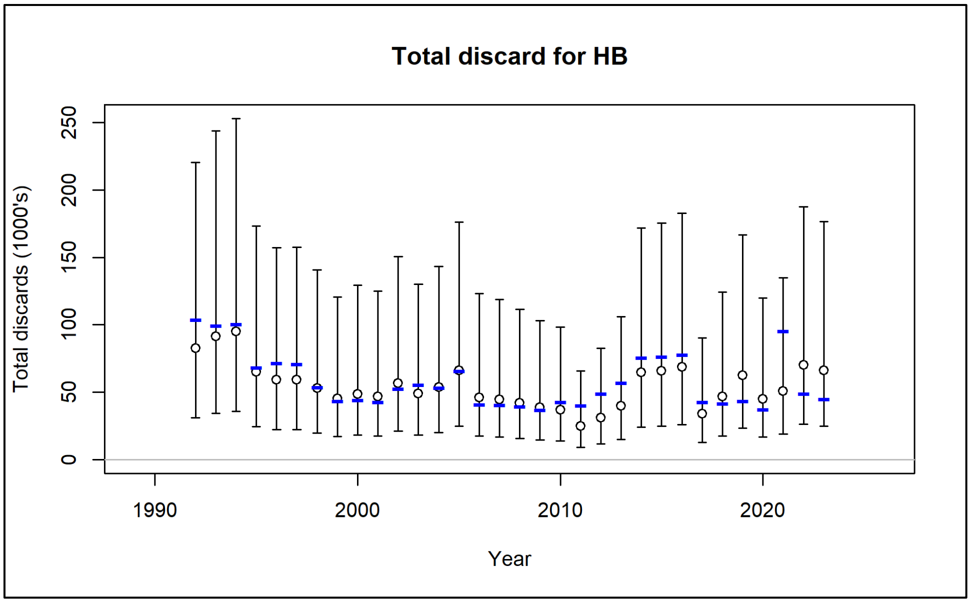

Figure 31. Southeastern U.S. Yellowtail Snapper observed (dots with 95% confidence intervals) and expected (blue dashes) discards (i.e., before applying the discard mortality rate for each fleet) by the Headboat fleet (in thousands of fish) from the SEDAR 96 base model.

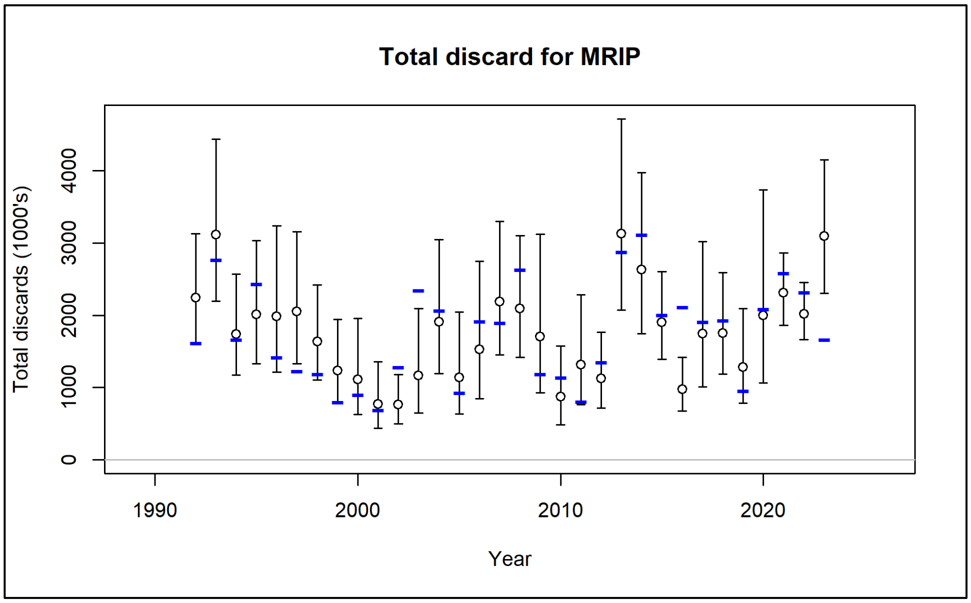

Figure 32. Southeastern U.S. Yellowtail Snapper observed (dots with 95% confidence intervals) and expected (blue dashes) discards (i.e., before applying the discard mortality rate for each fleet) by the MRIP SRFS fleet (in thousands of fish) from the SEDAR 96 base model.

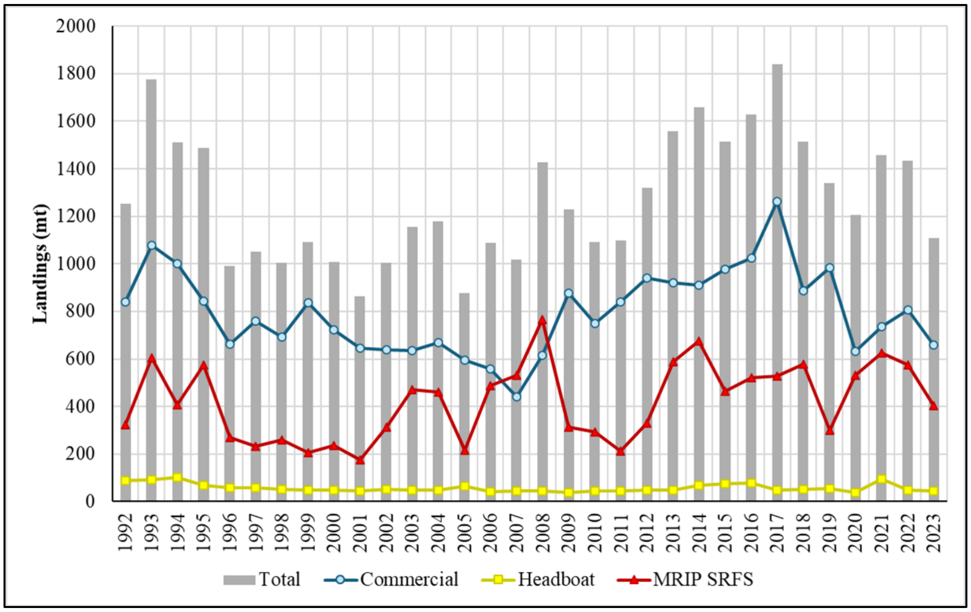

Figure 33. Expected landings of southeastern U.S. Yellowtail Snapper by fleet (in metric tons) as estimated from the SEDAR 96 base model.

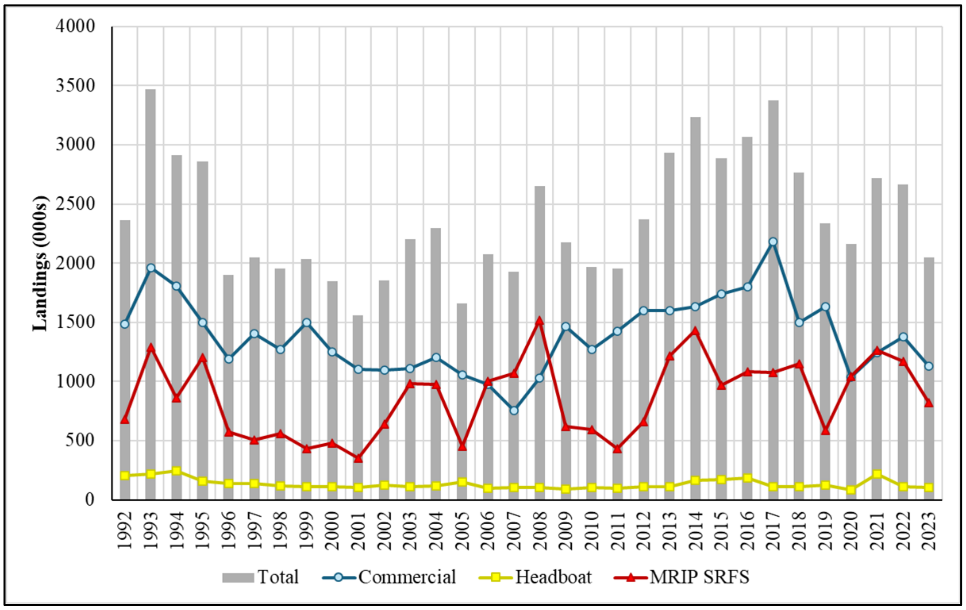

Figure 34. Expected landings of southeastern U.S. Yellowtail Snapper by fleet (in thousands of fish) as estimated from the SEDAR 96 base model.

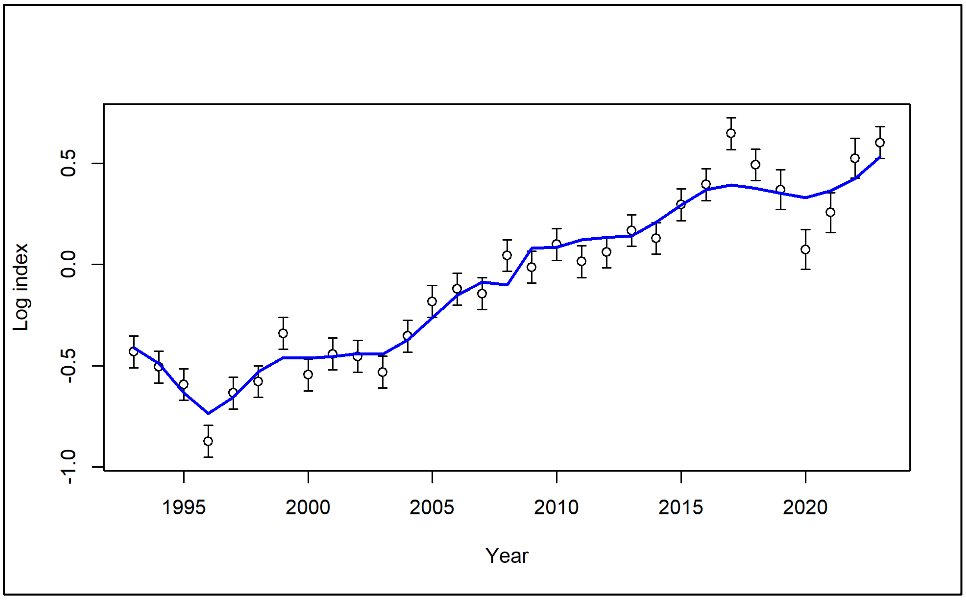

Figure 35. The southeastern U.S. Yellowtail Snapper observed (dots with 95% confidence intervals) and predicted (blue line) commercial CPUE index of relative biomass (log-transformed) for SEDAR 96.

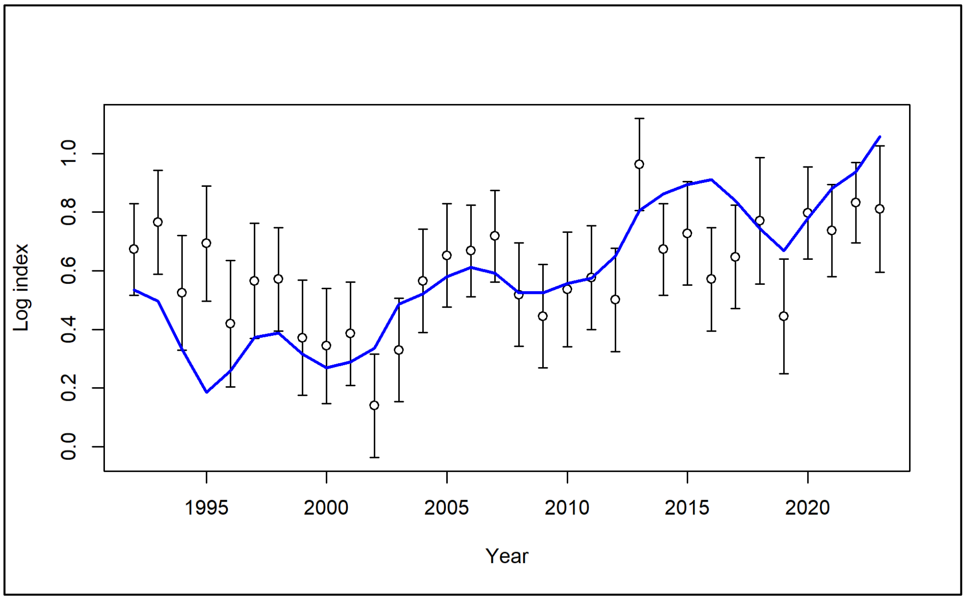

Figure 36. The southeastern U.S. Yellowtail Snapper observed (dots with 95% confidence intervals) and predicted (blue line) MRIP CPUE index of relative abundance (log-transformed) for SEDAR 96.

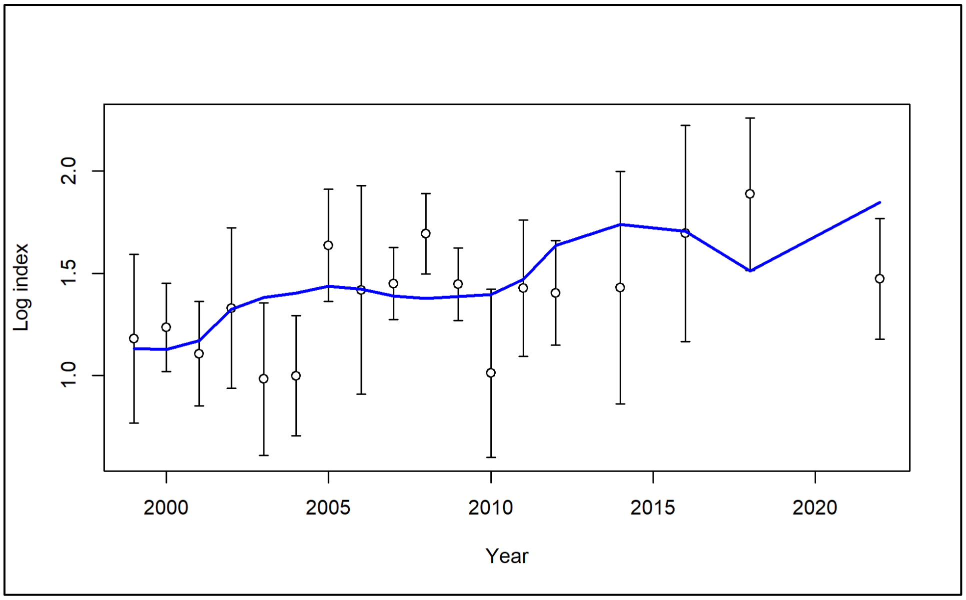

Figure 37. The southeastern U.S. Yellowtail Snapper observed (dots with 95% confidence intervals) and predicted (blue line) RVC Florida Keys index of relative abundance (log-transformed) for SEDAR 96.

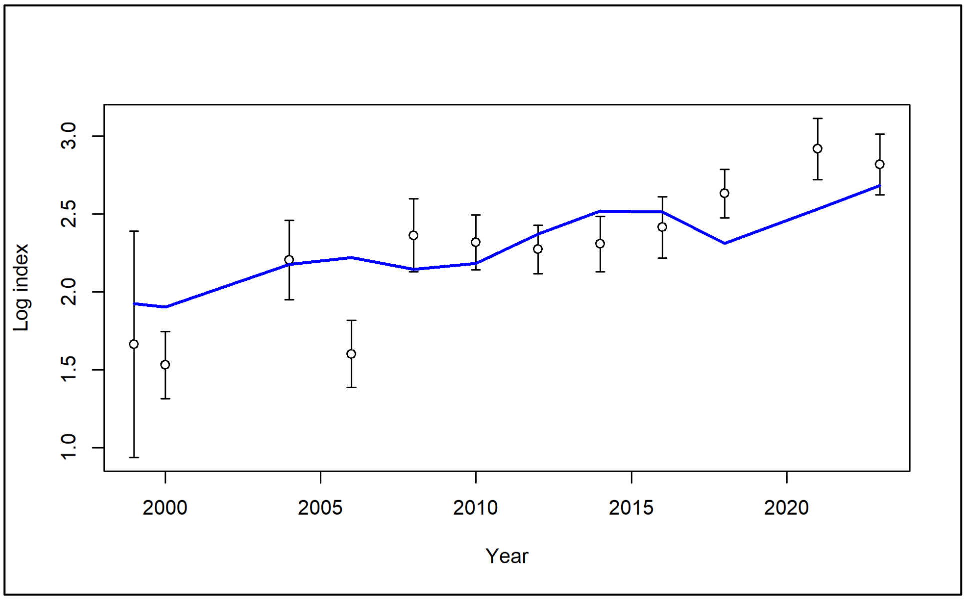

Figure 38. The southeastern U.S. Yellowtail Snapper observed (dots with 95% confidence intervals) and predicted (blue line) RVC Dry Tortugas index of relative abundance (log-transformed) for SEDAR 96.

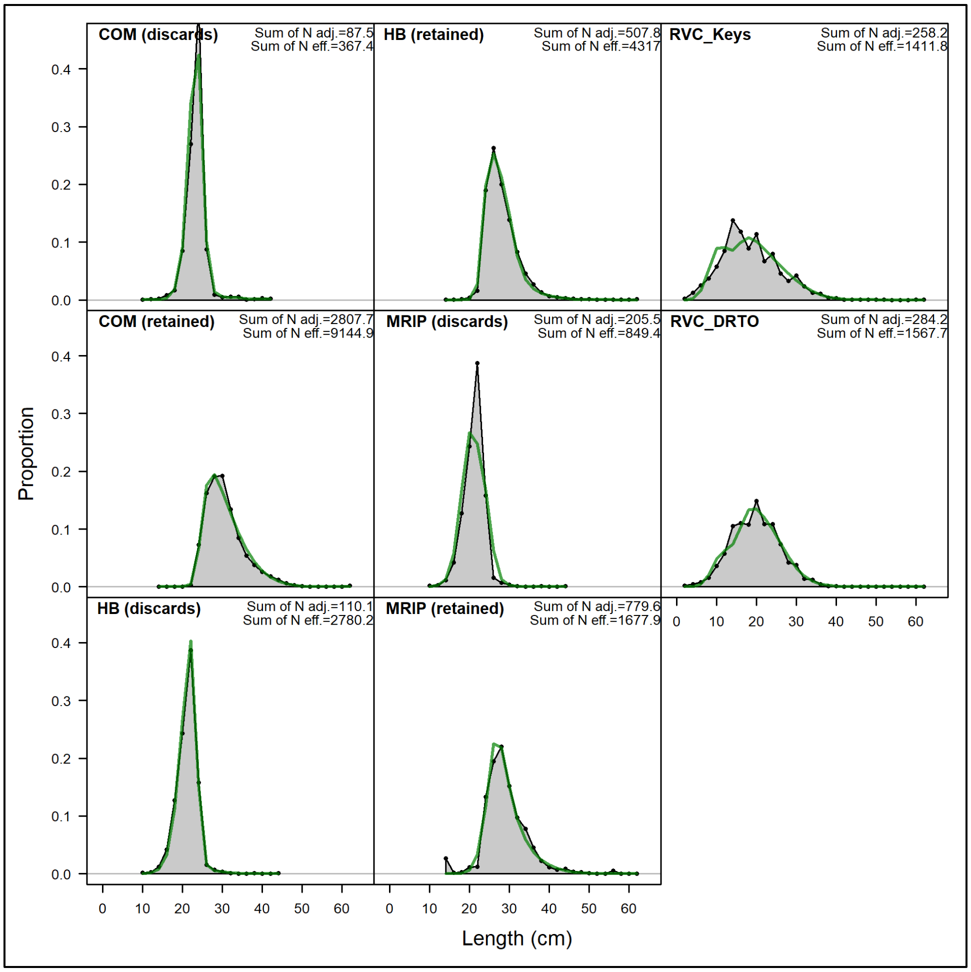

Figure 39. Model fits to the length composition of retained and discarded catch aggregated across years within a given fleet or survey for southeastern U.S. Yellowtail Snapper. Green lines represent predicted length compositions, while grey shaded regions represent observed length compositions. In the 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.

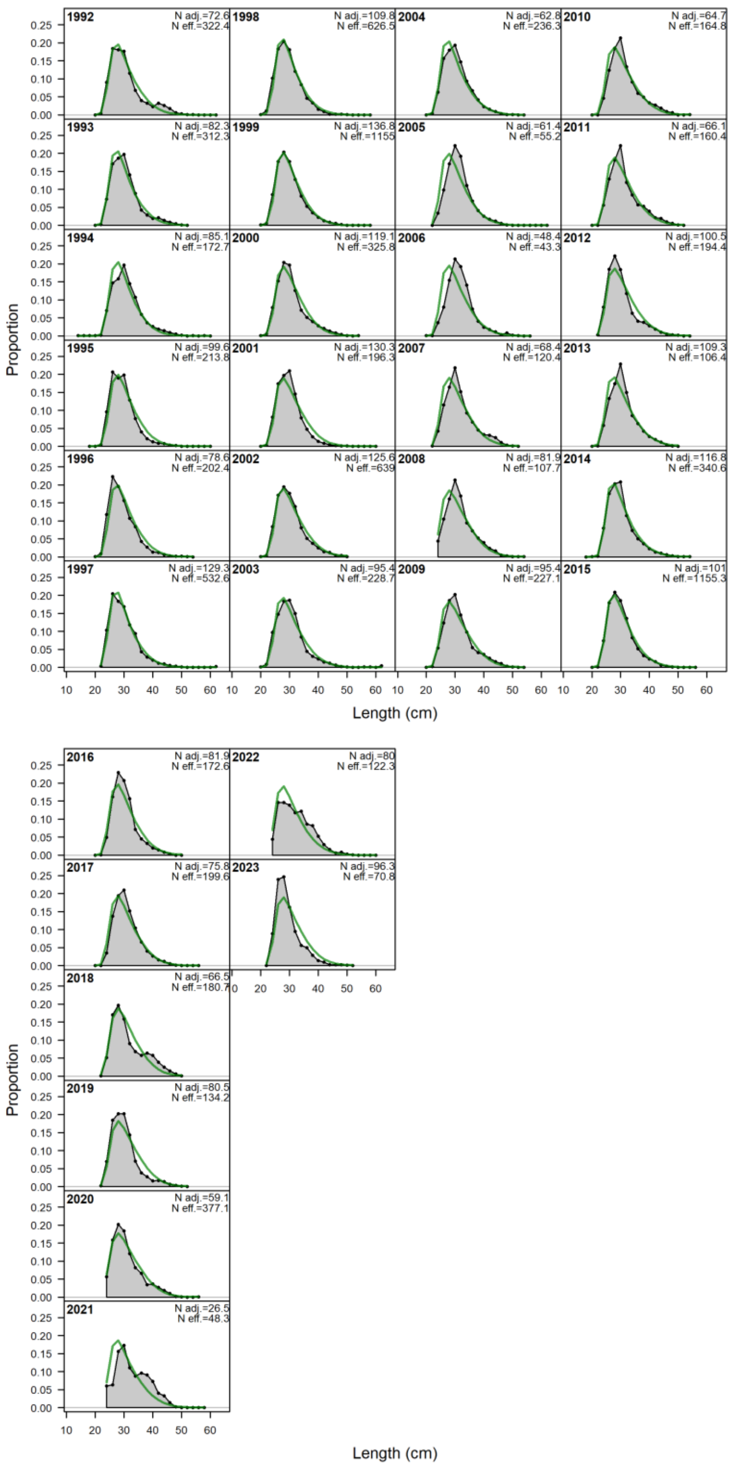

Figure 40. Model fits to the length composition of retained catch by the commercial fleet for southeastern U.S. Yellowtail Snapper. Green lines represent predicted length compositions, while grey shaded regions represent observed length compositions. In the upper right hand corners, 'N adj.' is the input 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.

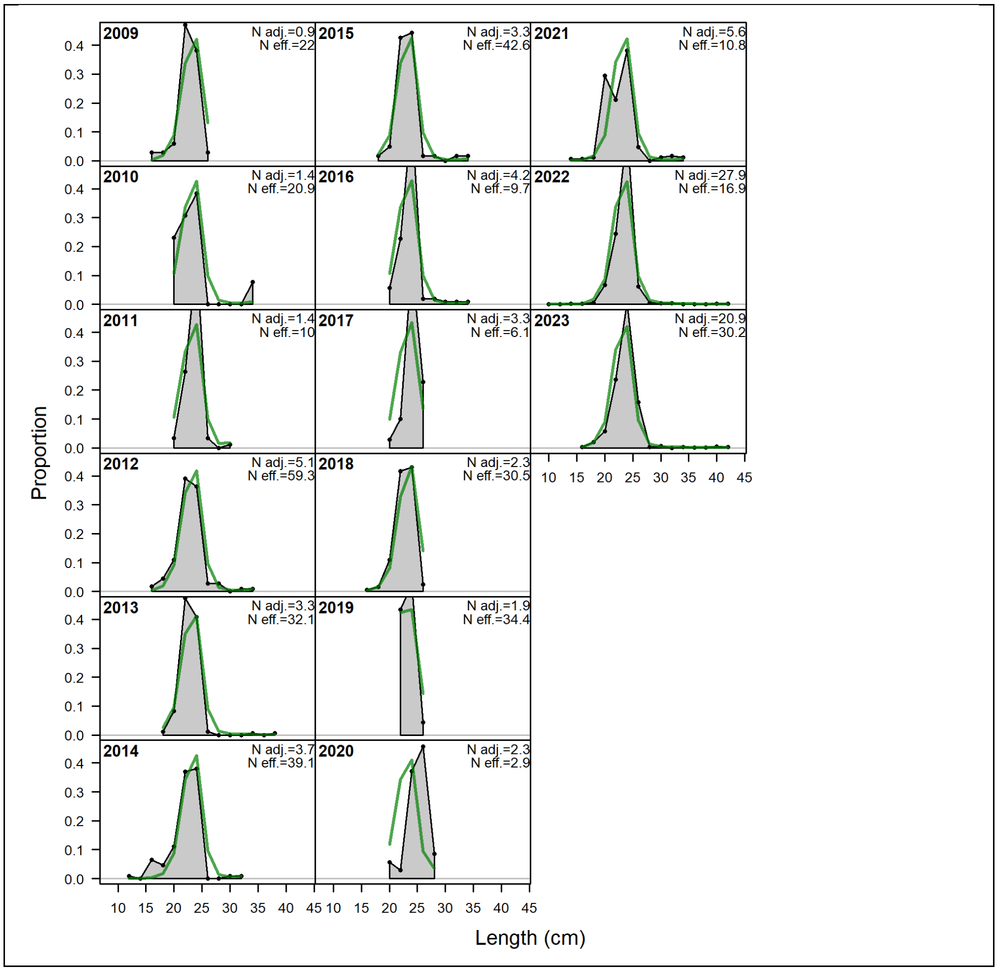

Figure 41. Model fits to the discard length composition data by the commercial fleet for southeastern U.S. Yellowtail Snapper. Green lines represent predicted length compositions, while grey shaded regions represent observed length compositions. In the upper right hand corners, 'N adj.' is the input 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.

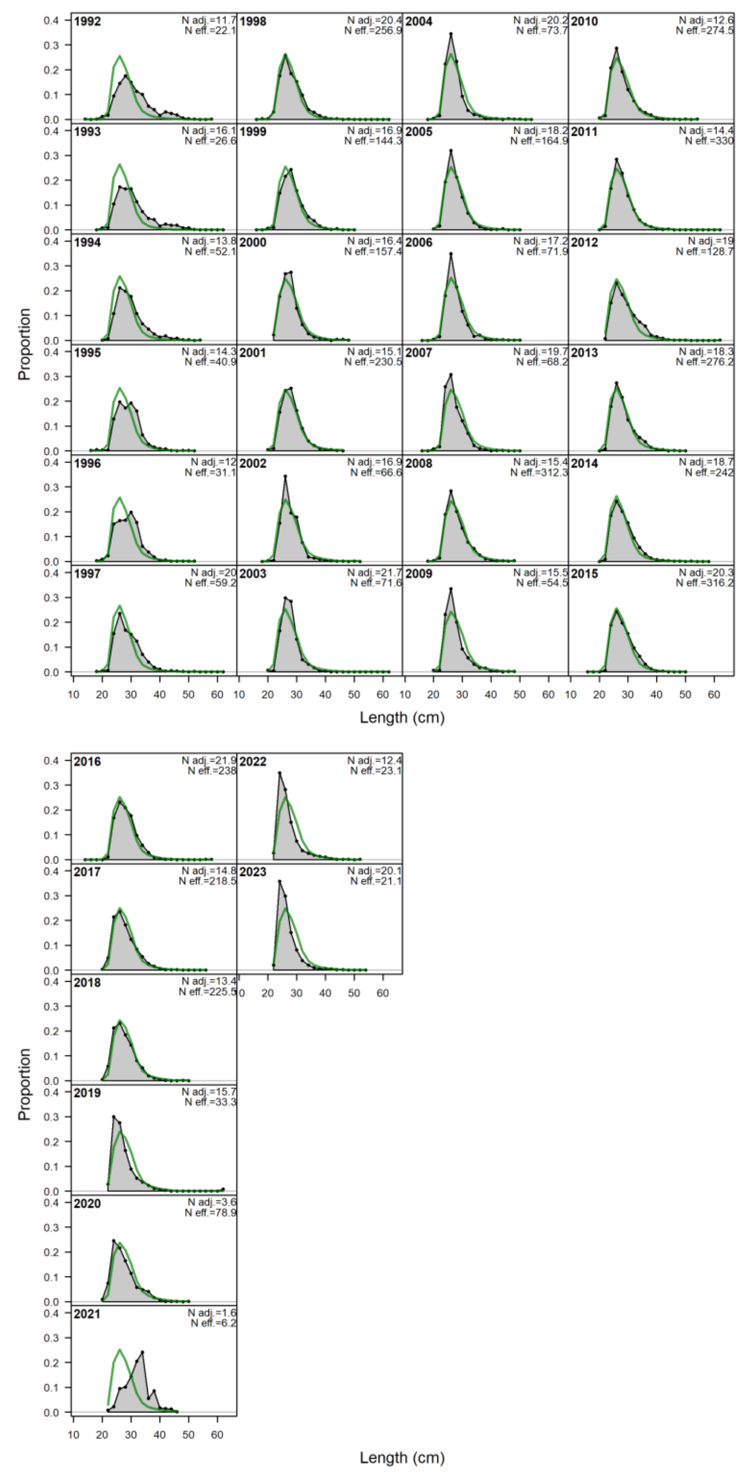

Figure 42. Model fits to the length composition of retained catch by the headboat fleet for southeastern U.S. Yellowtail Snapper. Green lines represent predicted length compositions, while grey shaded regions represent observed length compositions. In the upper right hand corners, 'N adj.' is the input 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.

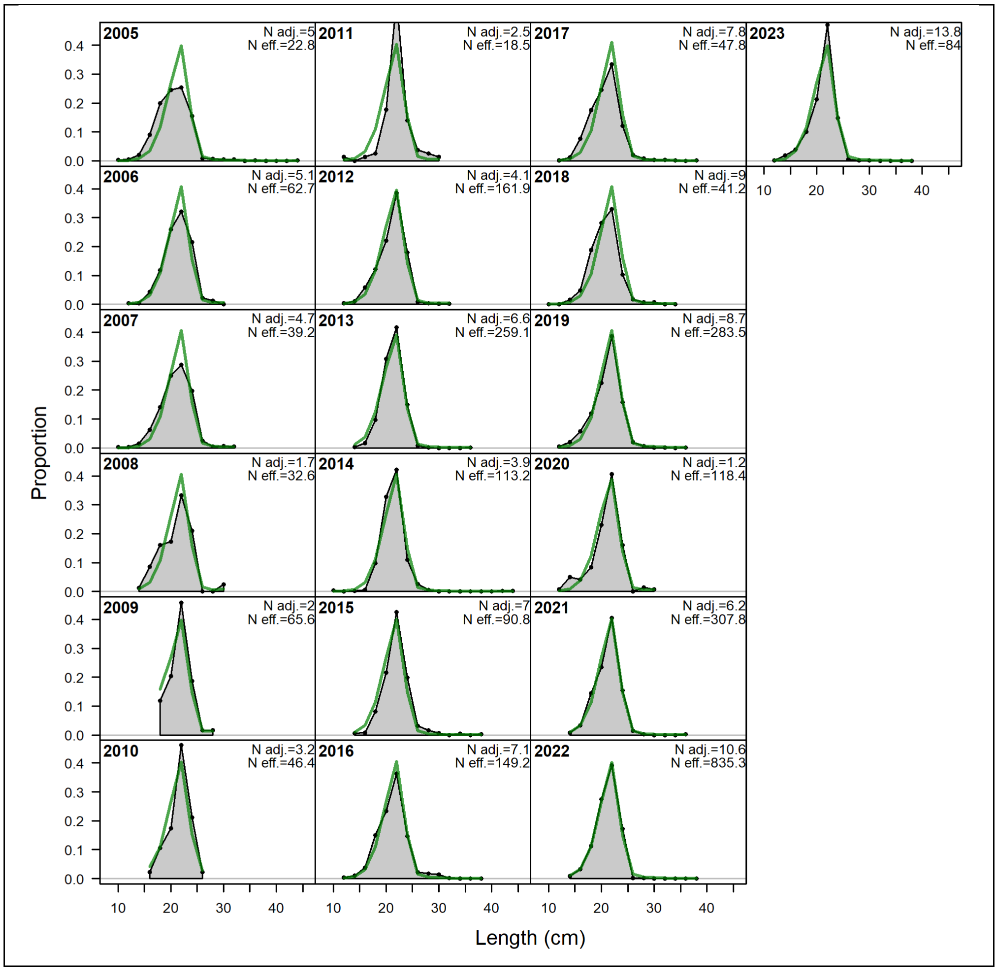

Figure 43. Model fits to the discard length composition data by the headboat fleet for southeastern U.S. Yellowtail Snapper. Green lines represent predicted length compositions, while grey shaded regions represent observed length compositions. In the upper right hand corners, 'N adj.' is the input sample size after applying the Francis data-weighting adjustment while ‘N eff.’ is the calculated effective sample size used in the McAllister-Ianelli tuning method.

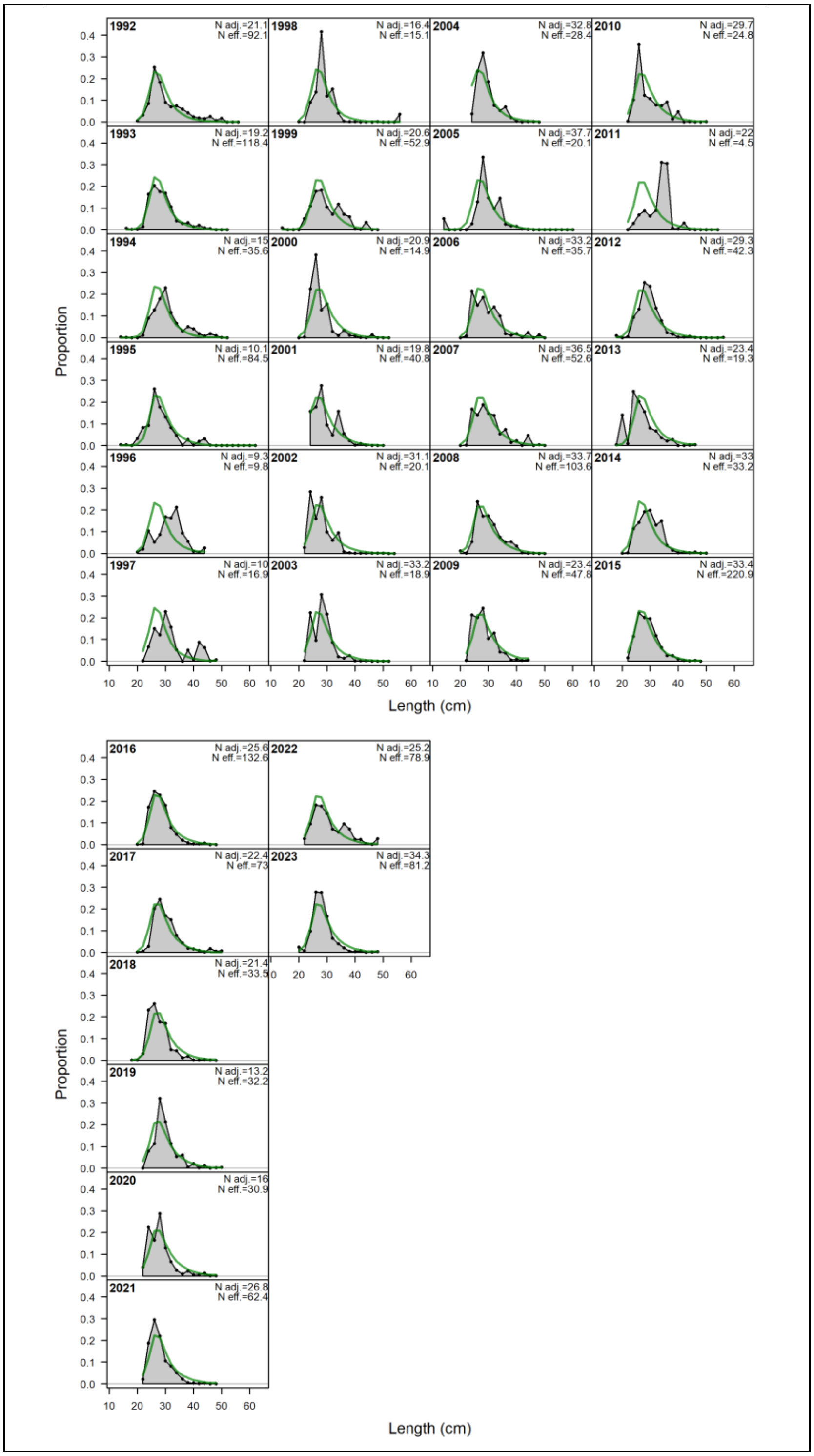

Figure 44. Model fits to the length composition of retained catch by the MRIP SRFS fleet for southeastern U.S. Yellowtail Snapper. Green lines represent predicted length compositions, while grey shaded regions represent observed length compositions. In the upper right hand corners, 'N adj.' is the input 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.

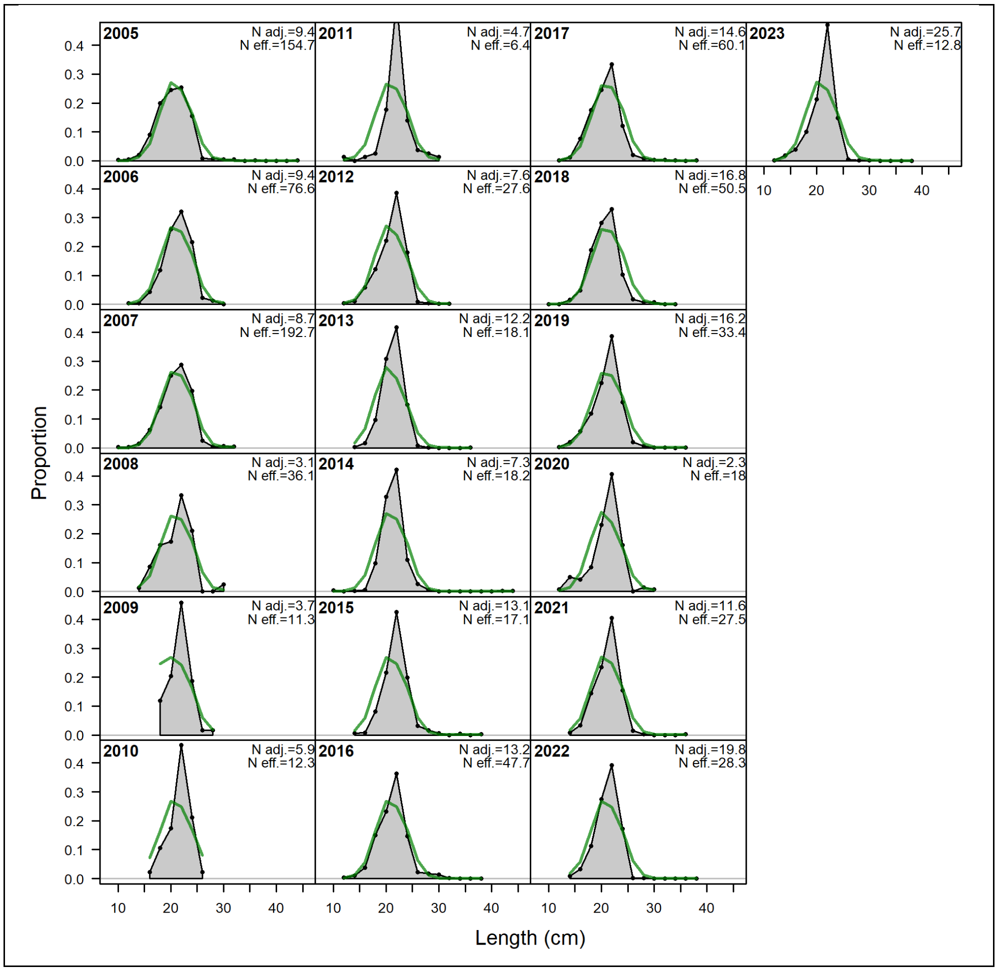

Figure 45. Model fits to the discard length composition data by the MRIP SRFS fleet for southeastern U.S. Yellowtail Snapper. Green lines represent predicted length compositions, while grey shaded regions represent observed length compositions. In the upper right hand corners, 'N adj.' is the input sample size after applying the Francis data-weighting adjustment while ‘N eff.’ is the calculated effective sample size used in the McAllister-Ianelli tuning method.

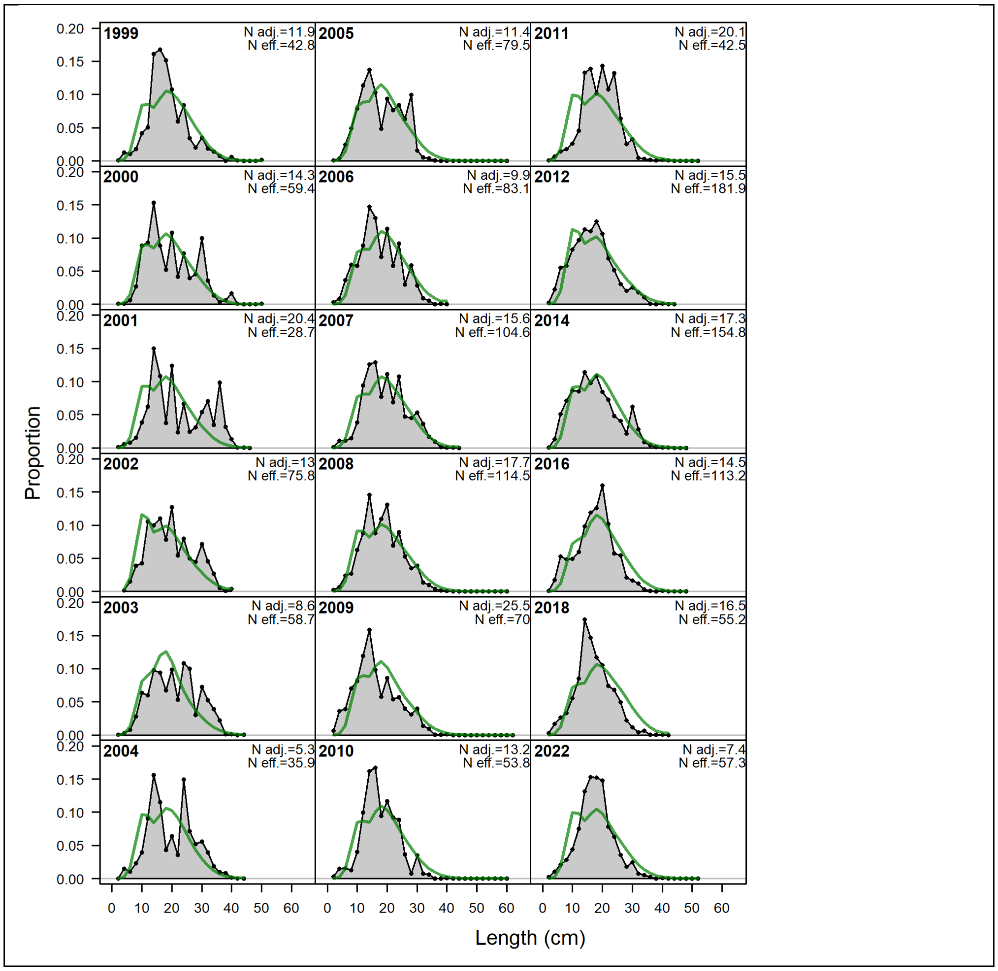

Figure 46. Model fits to the length composition data by the RVC Florida Keys index for southeastern U.S. Yellowtail Snapper. Green lines represent predicted length compositions, while grey shaded regions represent observed length compositions. In the upper right hand corners, 'N adj.' is the input sample size after applying the Francis data-weighting adjustment while ‘N eff.’ is the calculated effective sample size used in the McAllister-Ianelli tuning method.

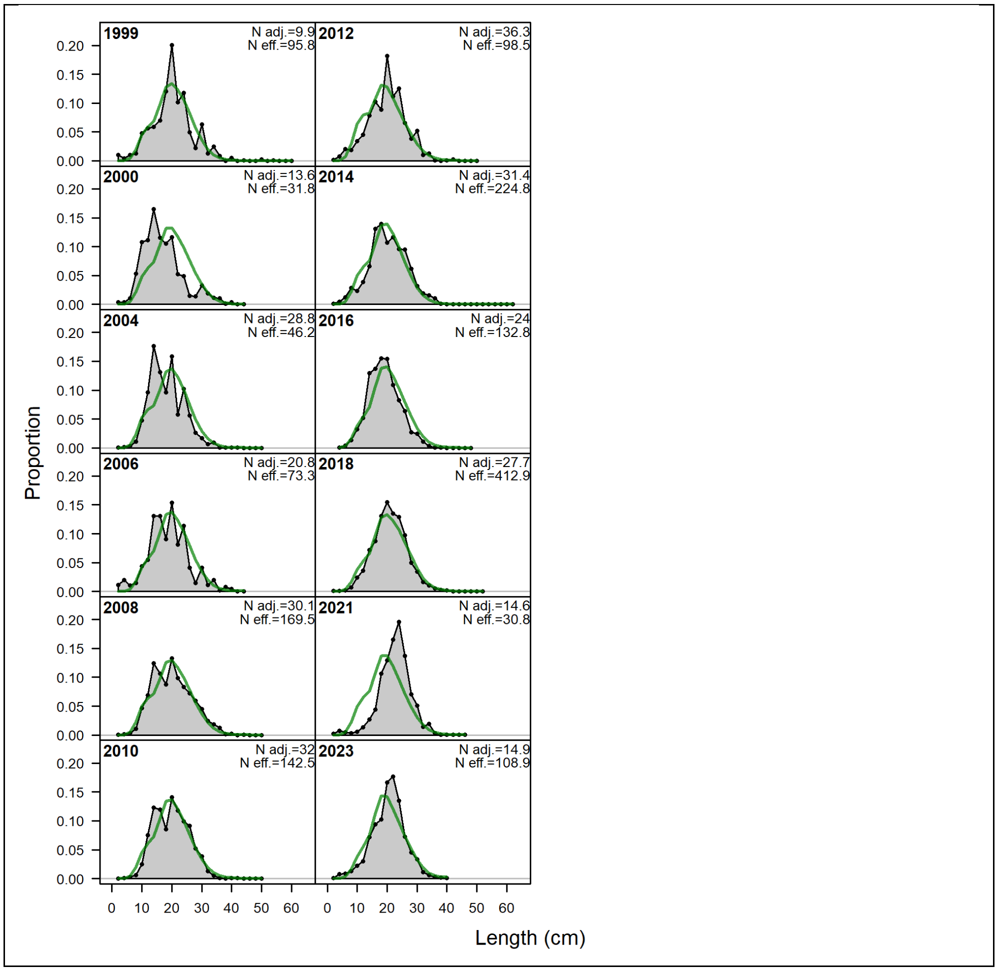

Figure 47. Model fits to the length composition data by the RVC Dry Tortugas index for southeastern U.S. Yellowtail Snapper. Green lines represent predicted length compositions, while grey shaded regions represent observed length compositions. In the upper right hand corners, 'N adj.' is the input sample size after applying the Francis data-weighting adjustment while ‘N eff.’ is the calculated effective sample size used in the McAllister-Ianelli tuning method.

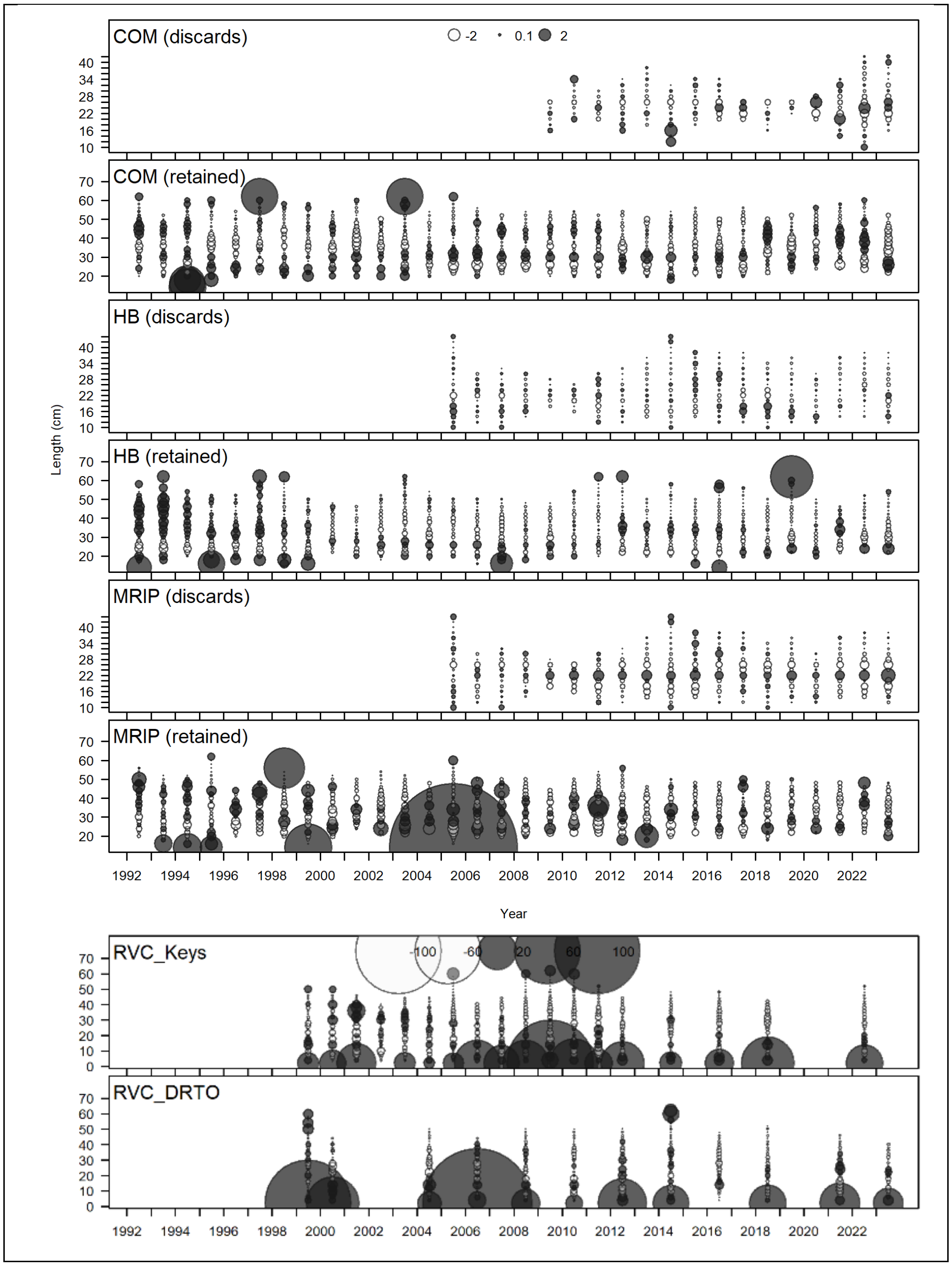

Figure 48. Pearson residuals for length composition data by year compared across a given fleet or survey for southeastern U.S. Yellowtail Snapper. Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected).

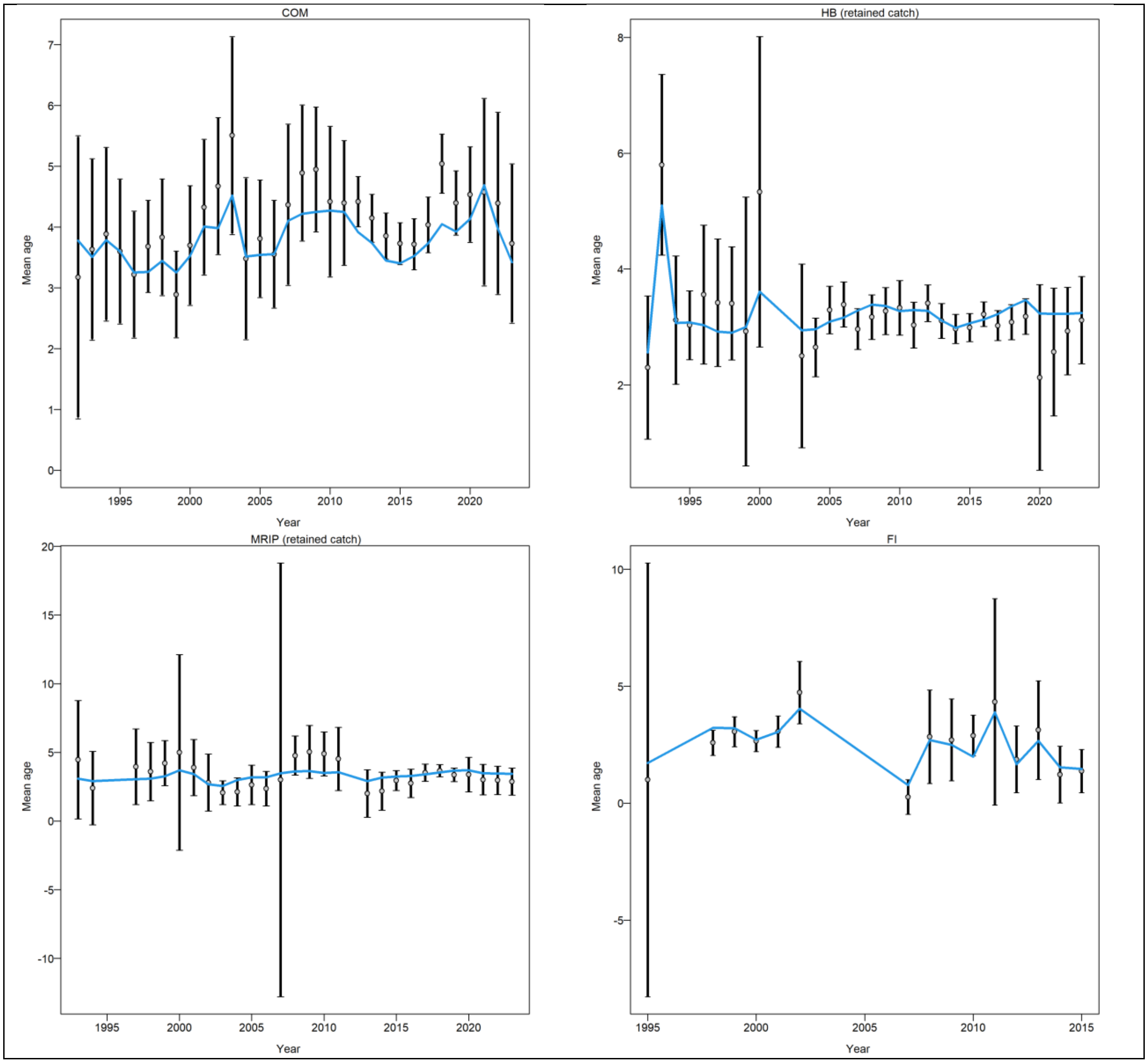

Figure 49. Mean ages of southeastern U.S. Yellowtail Snapper from age composition data (headboat and MRIP SRFS retained catch fleets) and conditional age-at-length data (commercial retained catch fleet and fishery-independent) aggregated across length bins. Observed values are dots with 95% confidence intervals and predicted values are the blue lines).

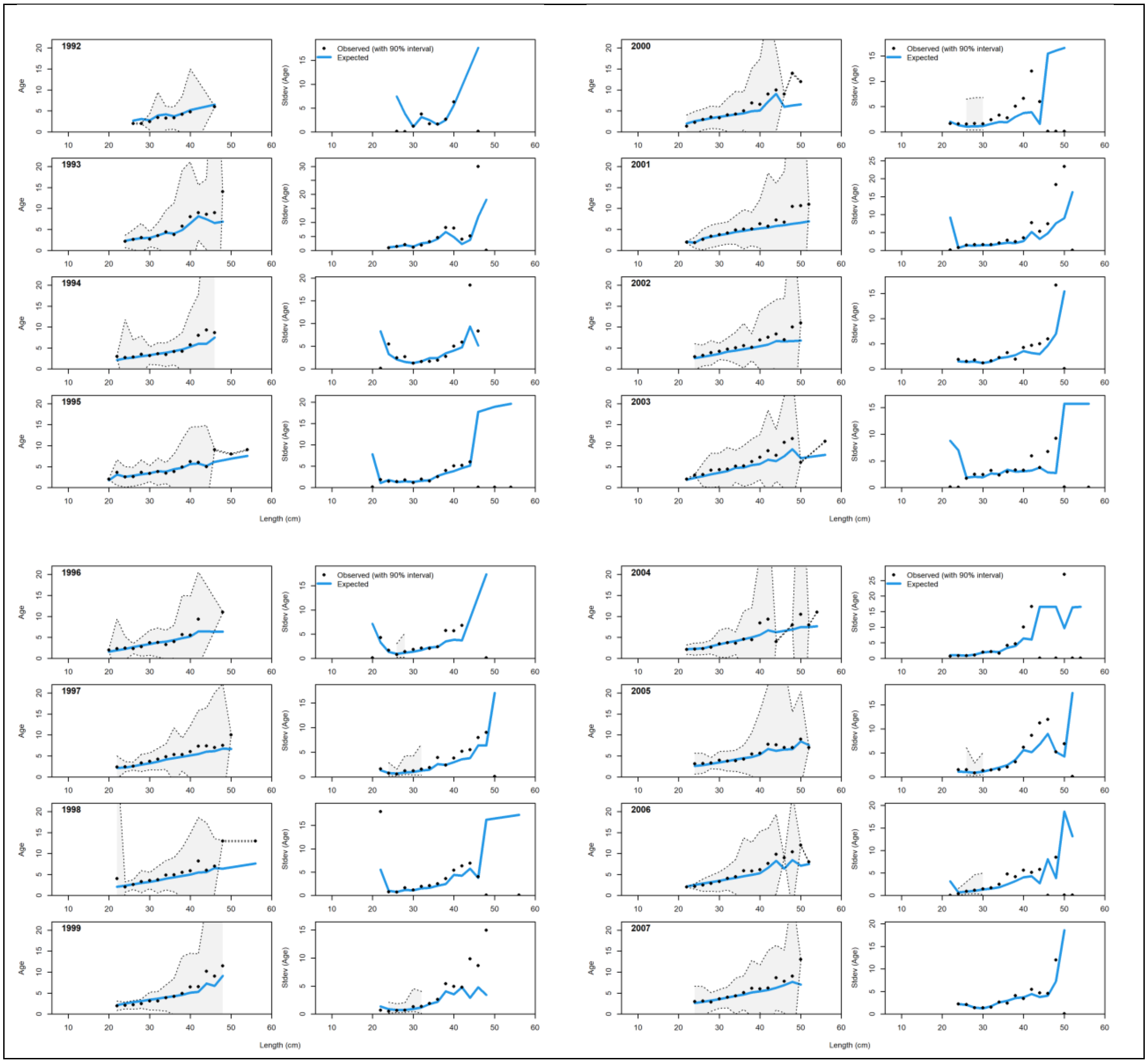

Figure 50. Model fits to the annual conditional age-at-length data from retained catch by the commercial fleet for southeastern U.S. Yellowtail Snapper. In the left plots, the blue lines represent predicted mean age-at-length by size class while the black dots and grey shaded regions represent the observed 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.

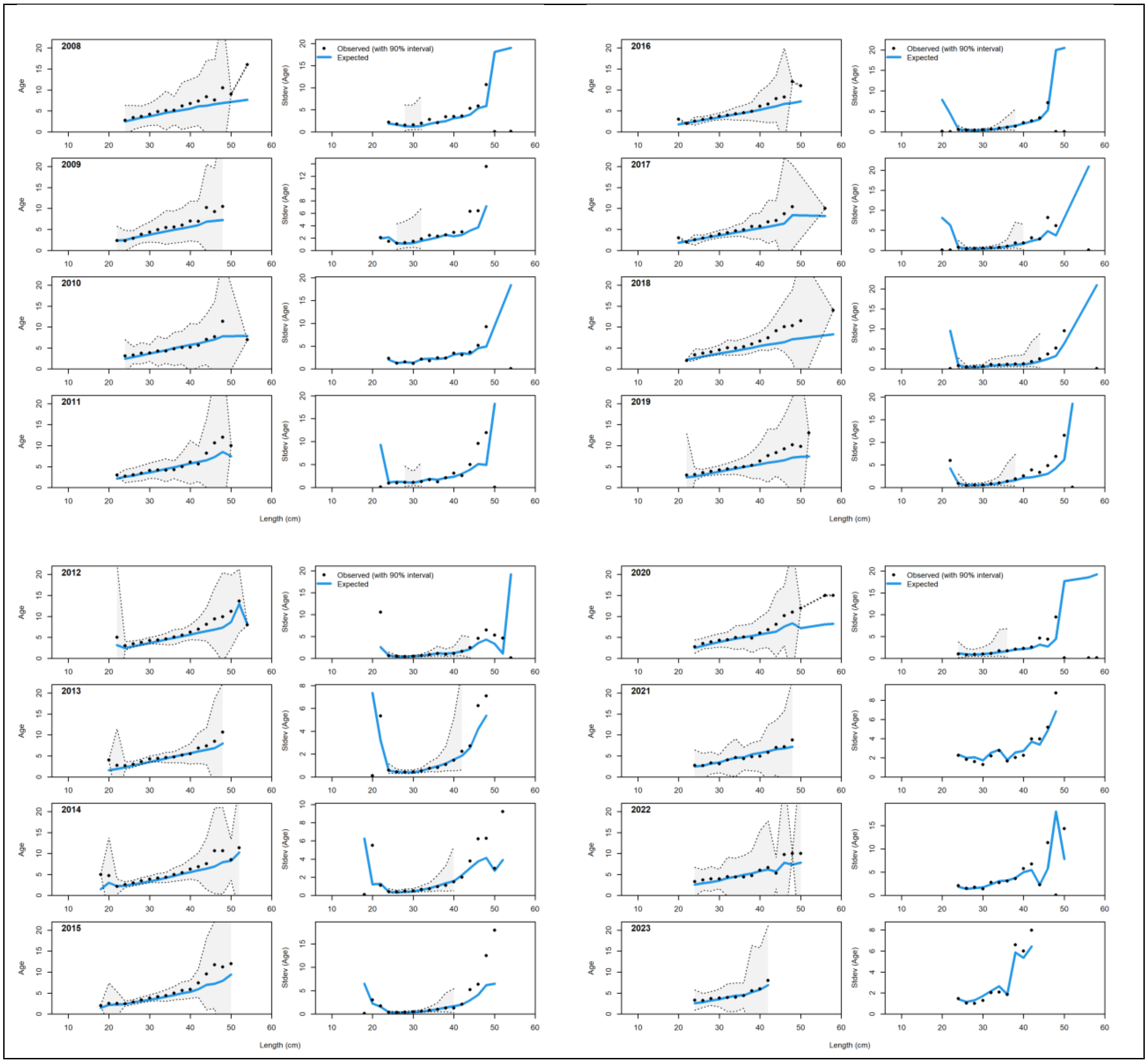

Figure 50 continued. Model fits to the annual conditional age-at-length data from retained catch by the commercial fleet for southeastern U.S. Yellowtail Snapper. In the left plots, the blue lines represent predicted mean age-at-length by size class while the black dots and grey shaded regions represent 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.

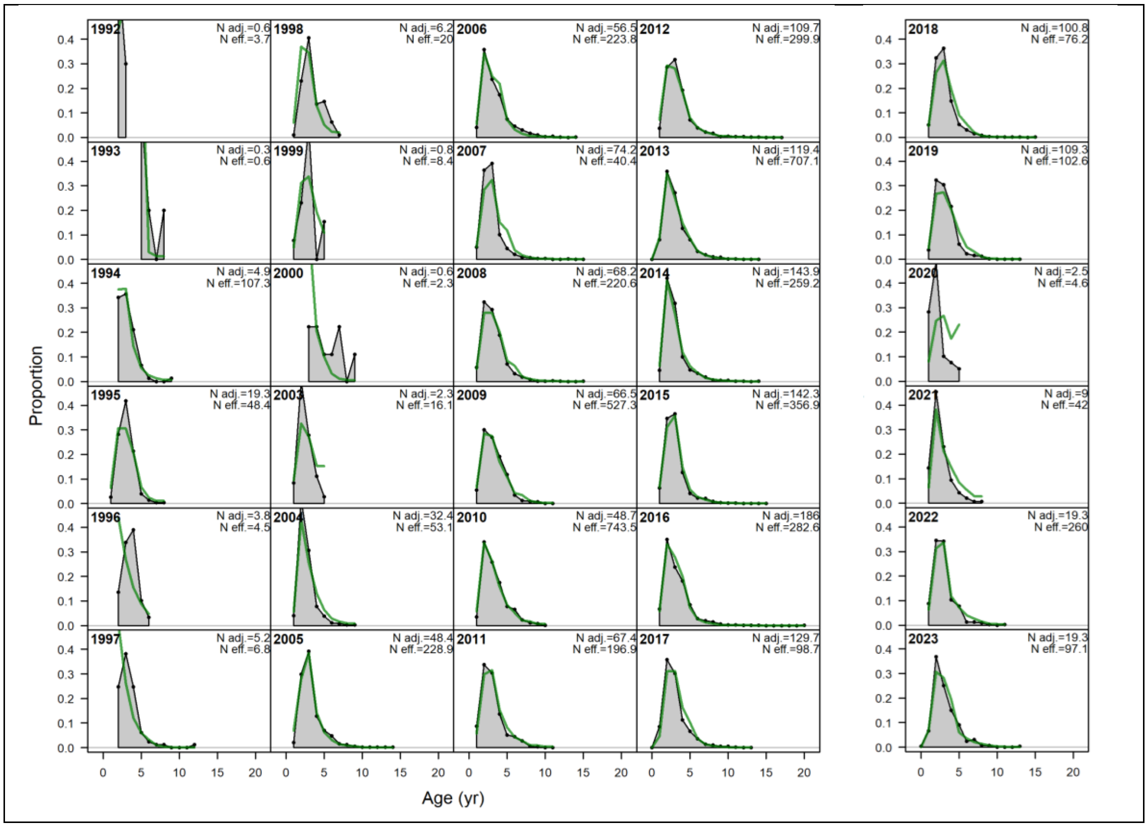

Figure 51. Model fits to the annual age composition data from retained catch by the headboat fleet for southeastern U.S. Yellowtail Snapper. Green lines represent predicted length compositions, while grey shaded regions represent observed length compositions. In the upper right hand corners, 'N adj.' 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.

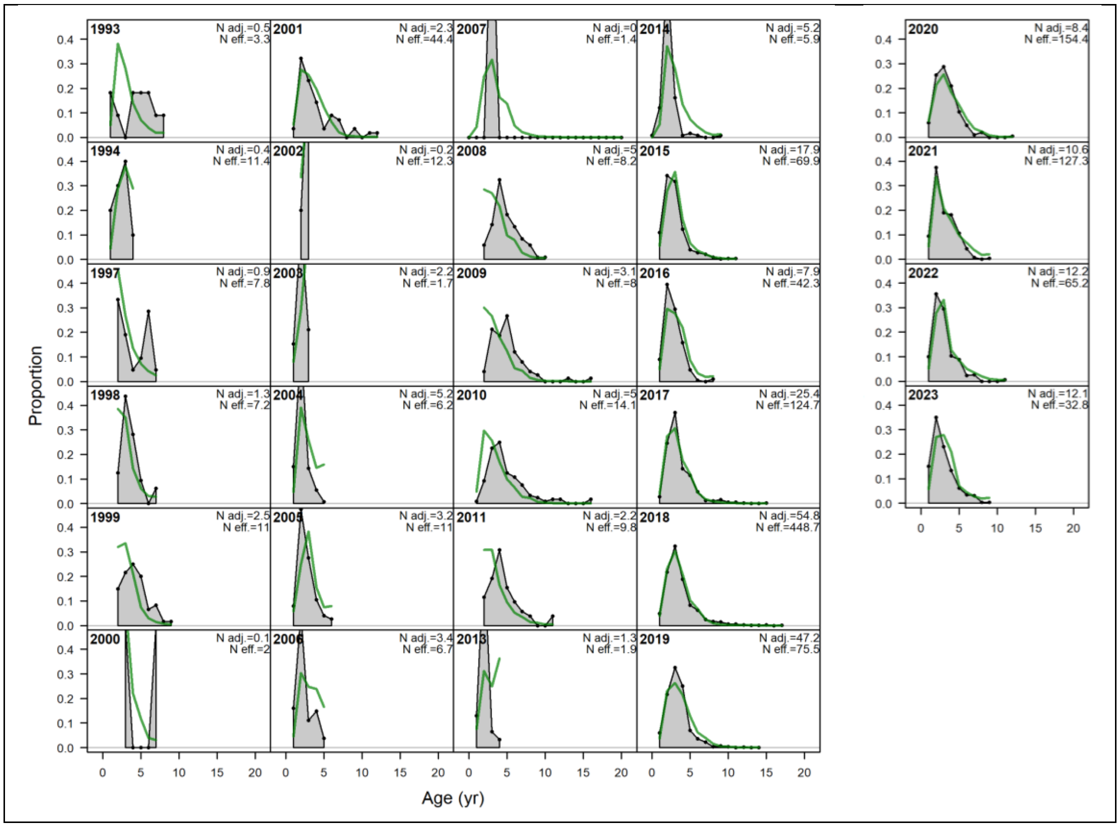

Figure 52. Model fits to the annual age composition data from retained catch by the MRIP SRFS fleet for southeastern U.S. Yellowtail Snapper. Green lines represent predicted length compositions, while grey shaded regions represent observed length compositions. In the upper right hand corners, 'N adj.' 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.

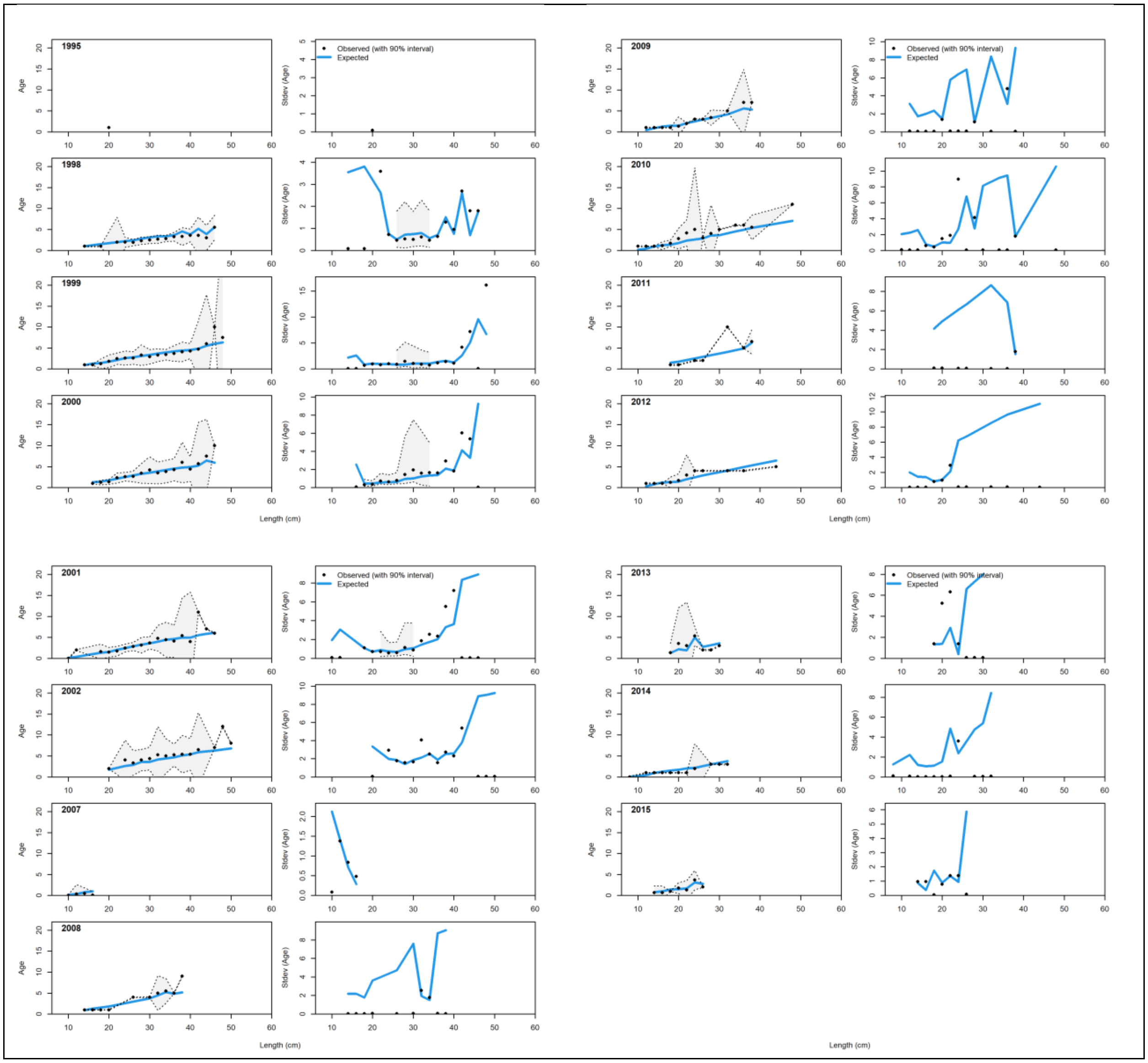

Figure 53. Model fits to the annual conditional age-at-length data from fishery-independent data sources for southeastern U.S. Yellowtail Snapper. In the left plots, the blue lines represent predicted mean age-at-length by size class while the black dots and grey shaded regions represent the observed 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.

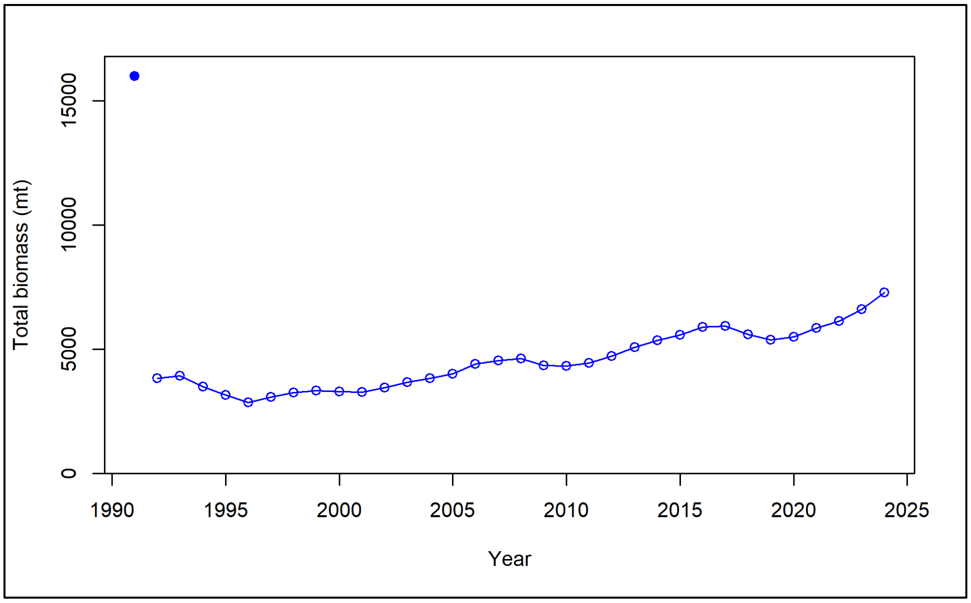

Figure 54. Estimates of total biomass (in metric tons) of southeastern U.S. Yellowtail Snapper (open circles) from 1992 – 2023. The solid blue dot is the estimated unfished total biomass.

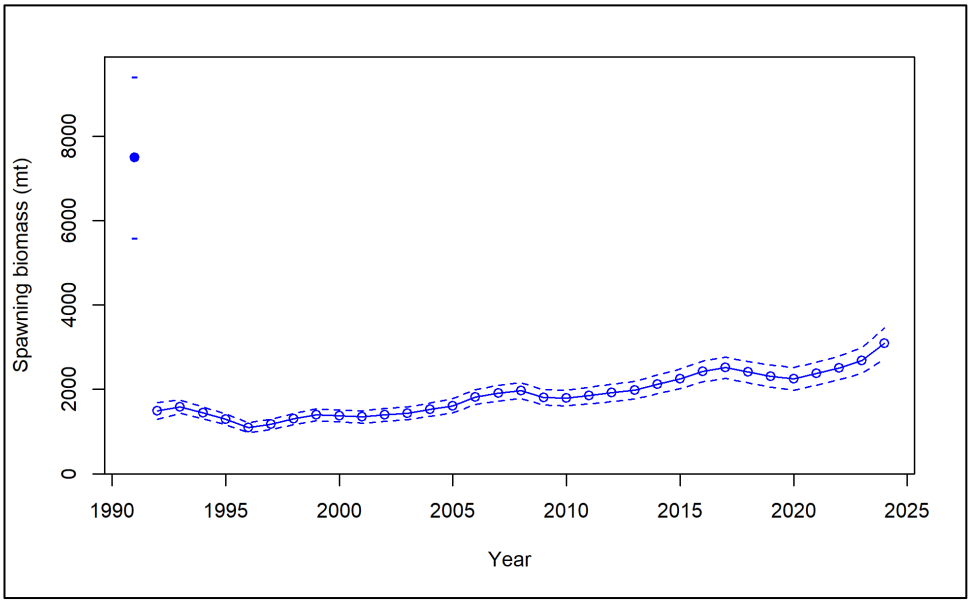

Figure 55. Estimate of female spawning stock biomass (in metric tons, open circles) with approximate 95% confidence intervals (dashed lines) for southeastern U.S. Yellowtail Snapper from 1992 – 2023. Unfished spawning stock biomass is shown by the solid blue point.

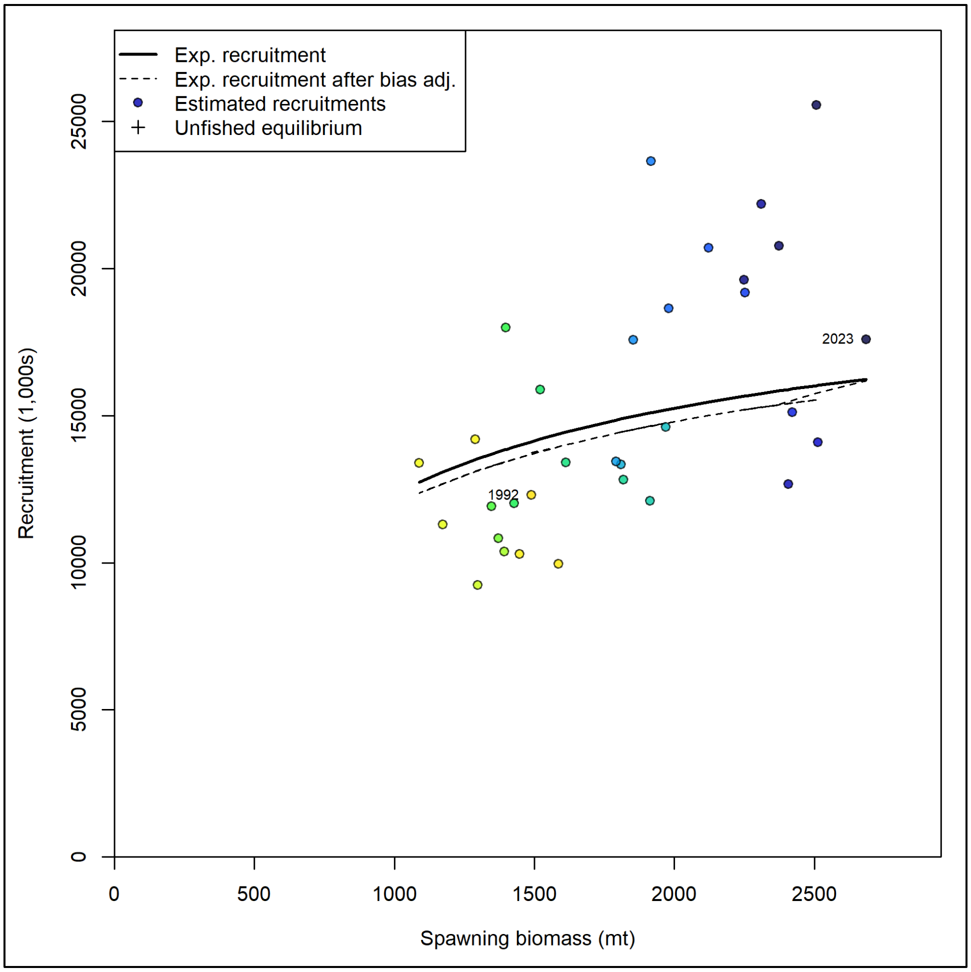

Figure 56. Expected stock-recruitment relationship for southeastern U.S. Yellowtail Snapper. Steepness was estimated at 0.767 and sigmaR was estimated at 0.266. Plotted are expected annual recruitments from the SEDAR 96 base model (circles), expected recruitment from the stock-recruitment relationship (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.

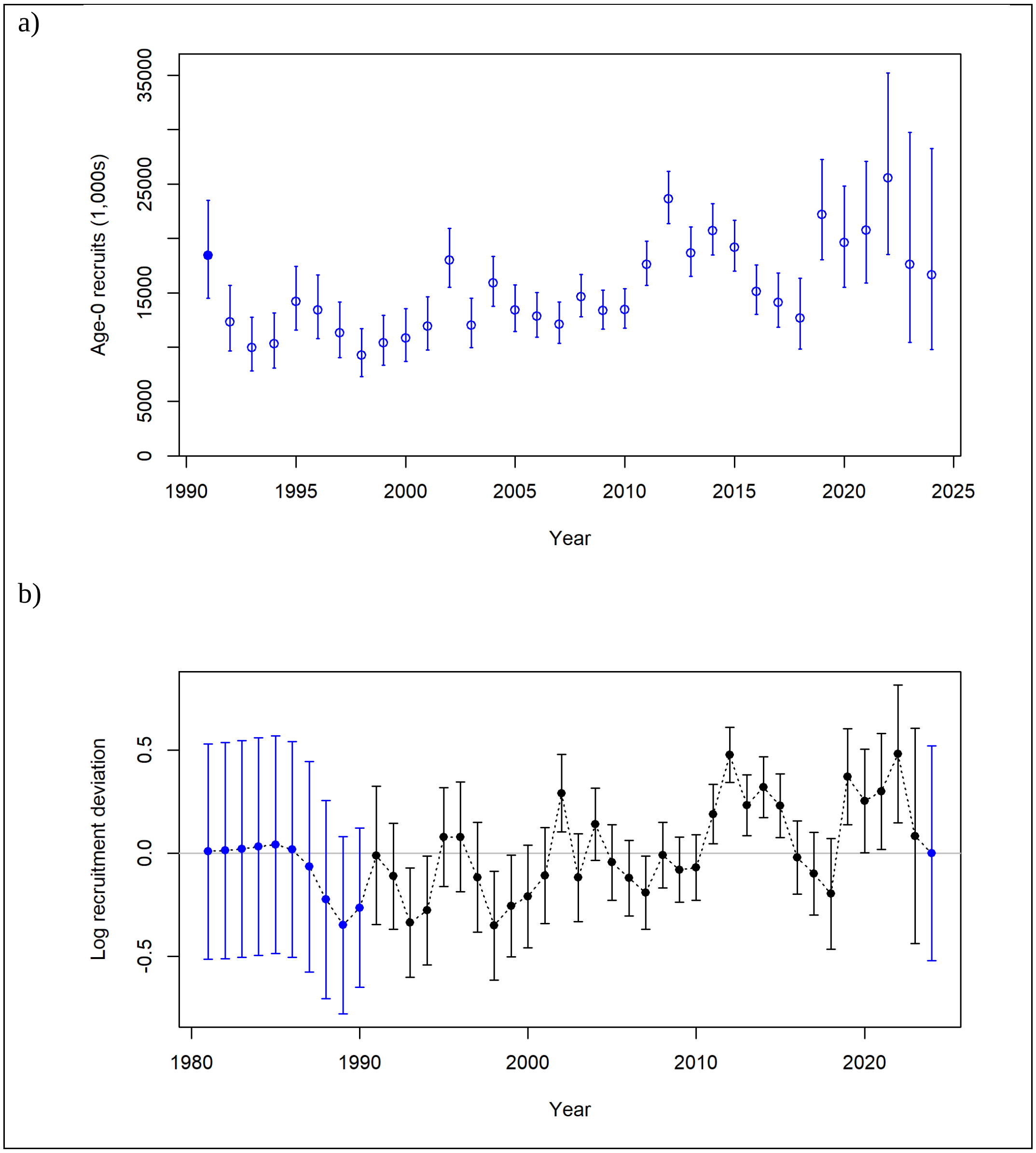

Figure 57. Estimated recruitment for southeastern U.S. Yellowtail Snapper. a) Annual estimated age-0 recruitment (open circles) with 95% confidence intervals (lines) as well as estimated initial equilibrium recruitment (blue dot). b) Log-scaled recruitment deviations (dots) with 95% confidence intervals (lines) where blue indicates early recruitment deviations (1981 – 1990) or a single year of projection (2024) while black indicates main recruitment deviations (1991 – 2023).

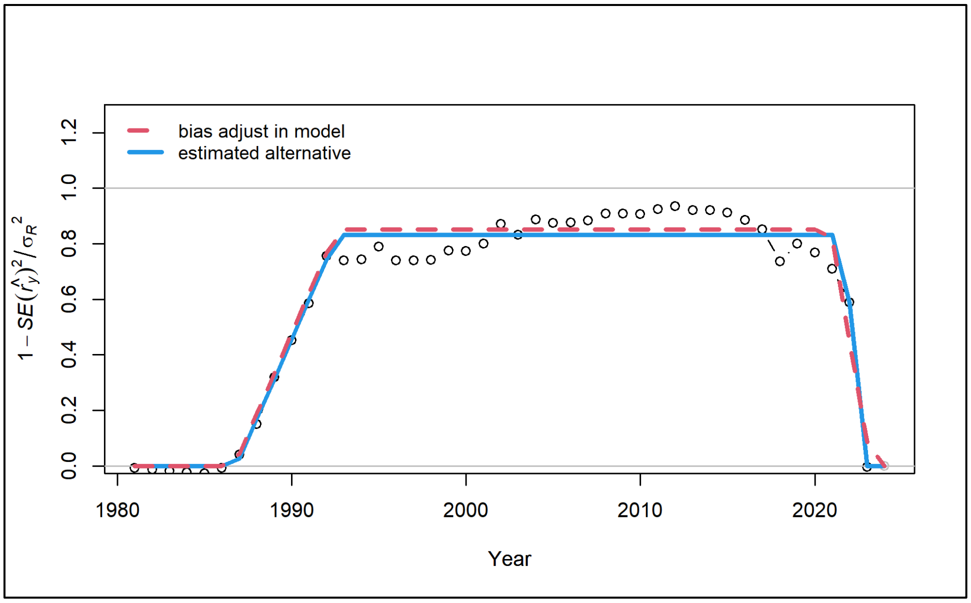

Figure 58. Points are transformed variances. Red line shows current settings for bias adjustment specified for the SEDAR 96 base model, which coincides with the least squares estimate of alternative bias adjustment relationship for recruitment deviations (dashed red line). For more information, see Methot and Taylor (2011).

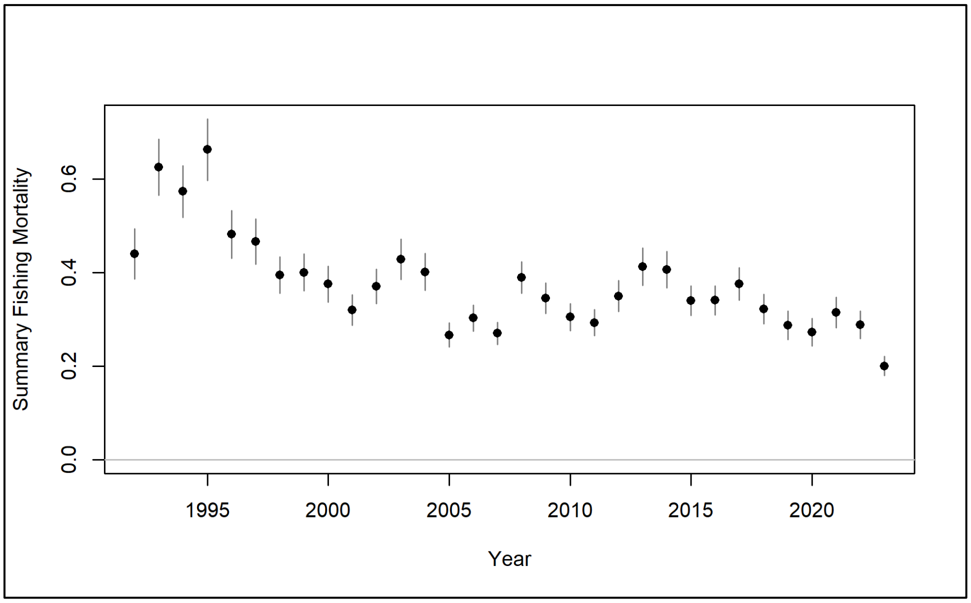

Figure 59. Annual instantaneous fishing mortality rates for age-4 southeastern U.S. Yellowtail Snapper with 95% confidence intervals for the SEDAR 96 base model.

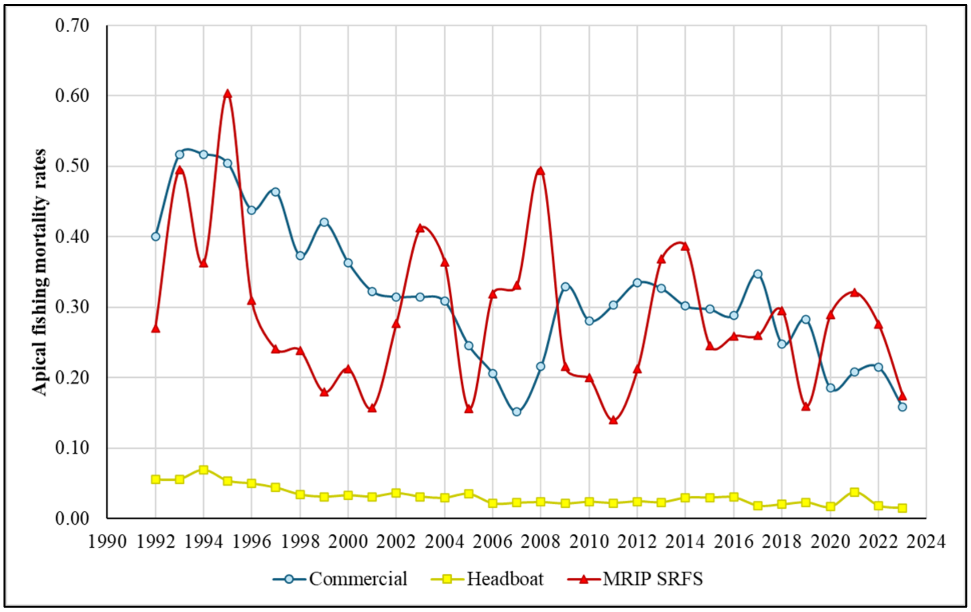

Figure 60. Annual fleet-specific instantaneous apical fishing mortality rates for southeastern U.S. Yellowtail Snapper for the SEDAR 96 base model. This represents the instantaneous fishing mortality level on the most vulnerable age class for each fleet.

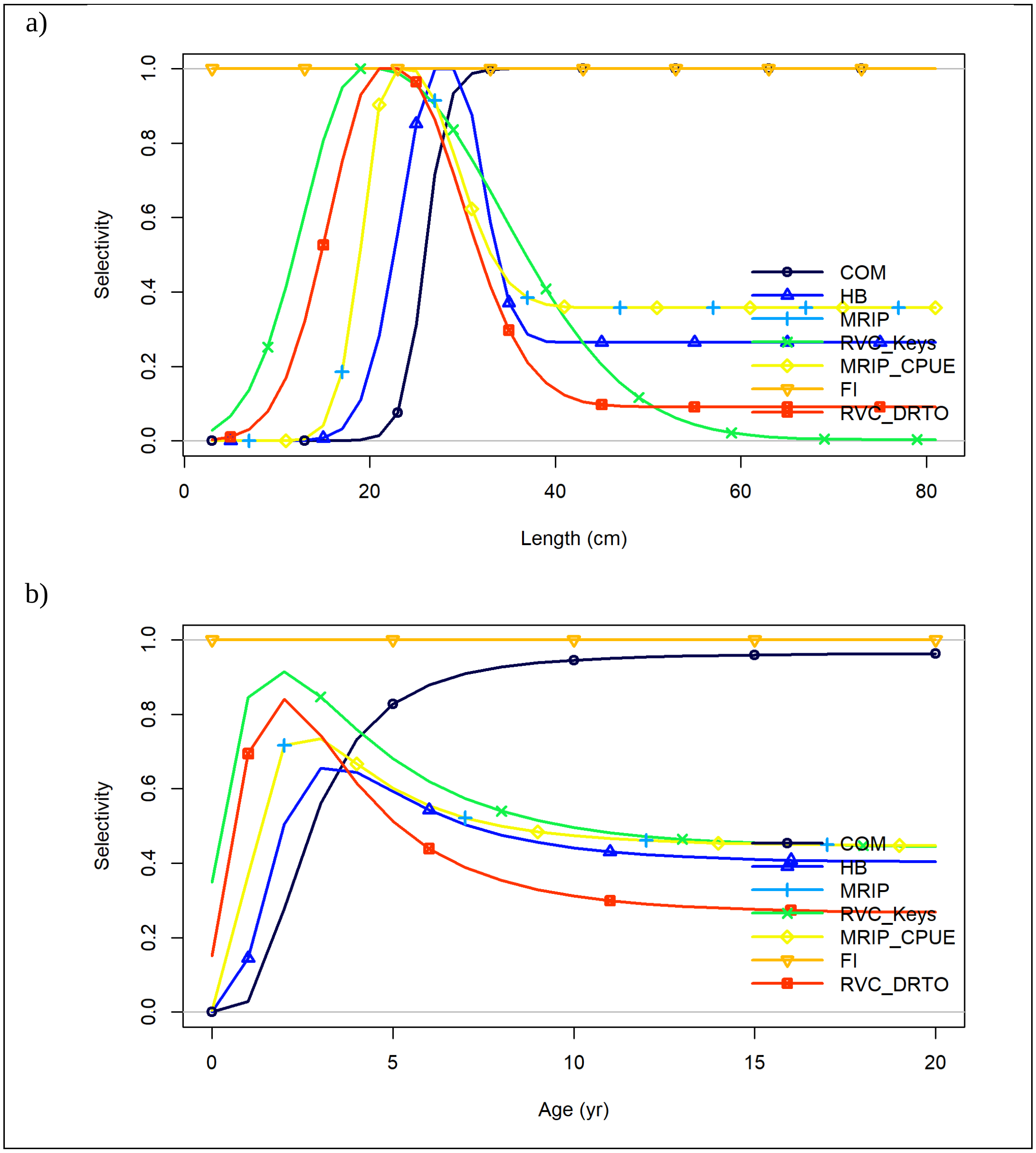

Figure 61. Length-based selectivity (a) for each fleet in the SEDAR 96 base model and related age-derived selectivity (b).

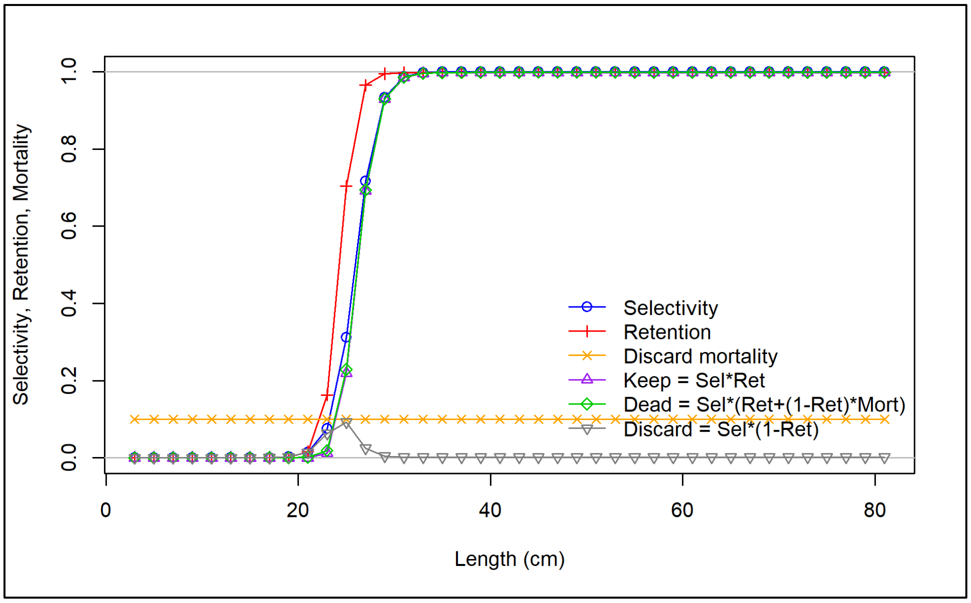

Figure 62. Terminal year (2023) length-based selectivity, retention, and discard mortality pattern for the commercial fleet for southeastern U.S. Yellowtail Snapper.

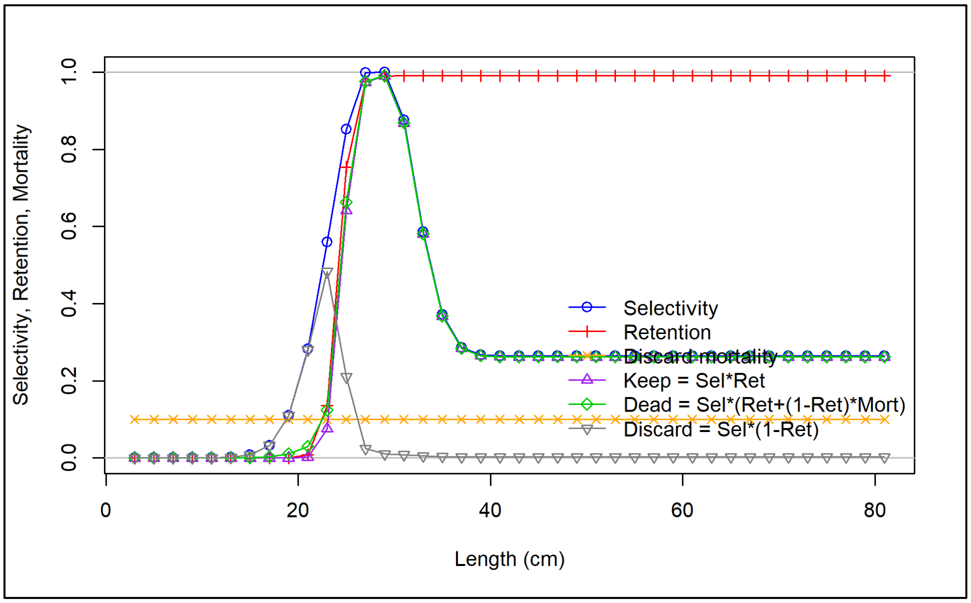

Figure 63. Terminal year (2023) length-based selectivity, retention, and discard mortality pattern for the headboat fleet for southeastern U.S. Yellowtail Snapper.

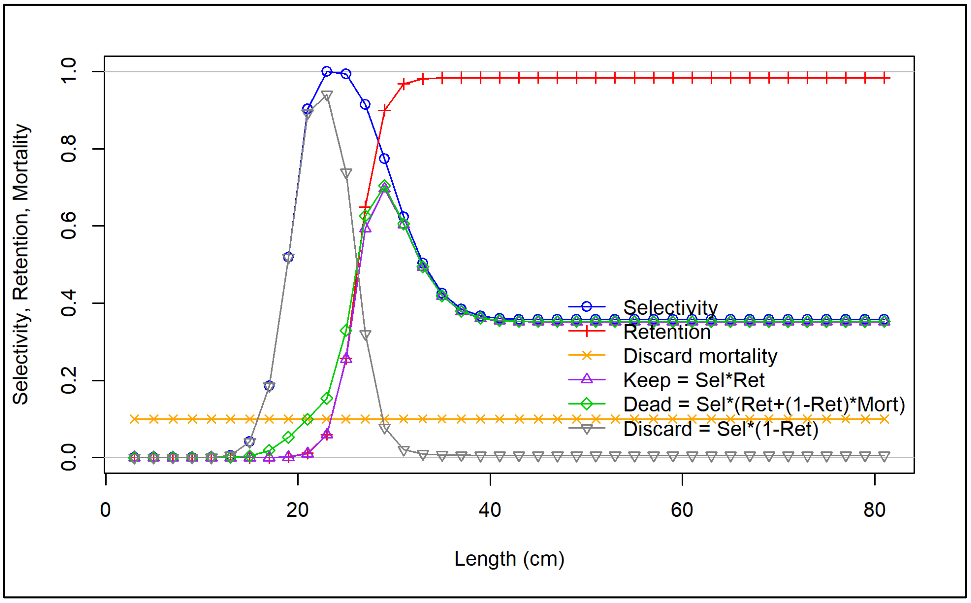

Figure 64. Terminal year (2023) length-based selectivity, retention, and discard mortality pattern for the MRIP SRFS fleet for southeastern U.S. Yellowtail Snapper.

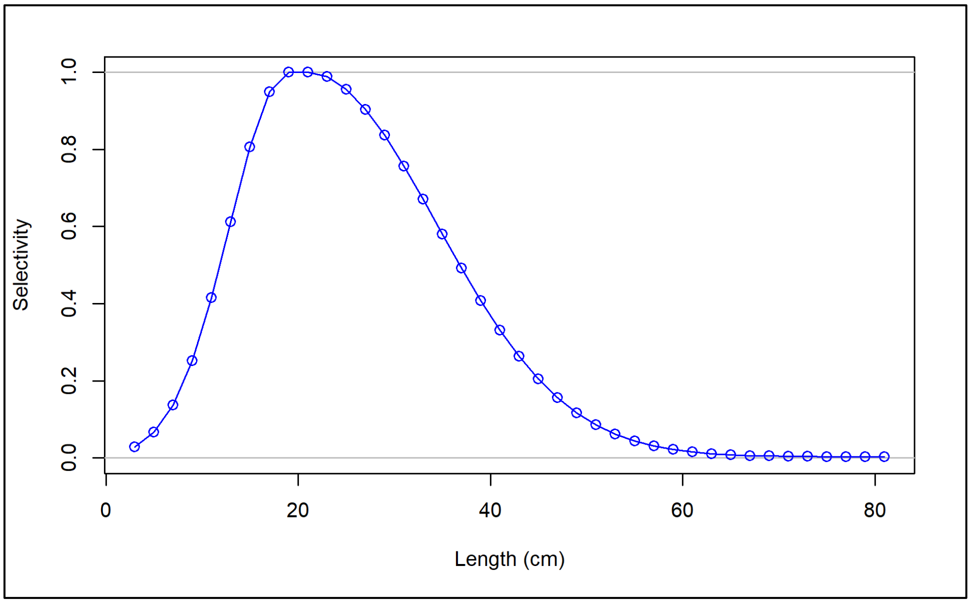

Figure 65. Terminal year (2023) length-based selectivity pattern for the RVC Florida Keys index for southeastern U.S. Yellowtail Snapper.

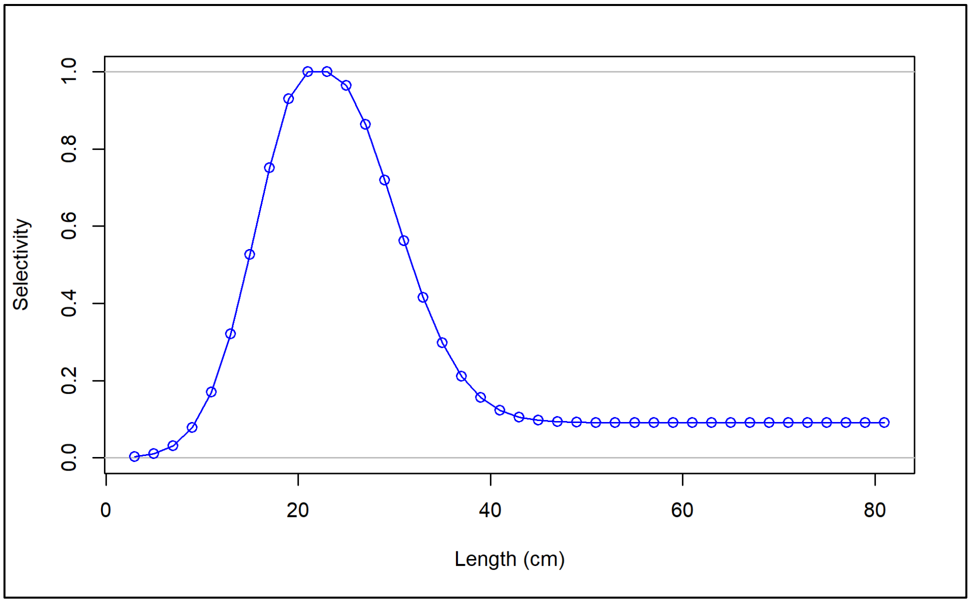

Figure 66. Terminal year (2023) length-based selectivity pattern for the RVC Dry Tortugas index for southeastern U.S. Yellowtail Snapper.

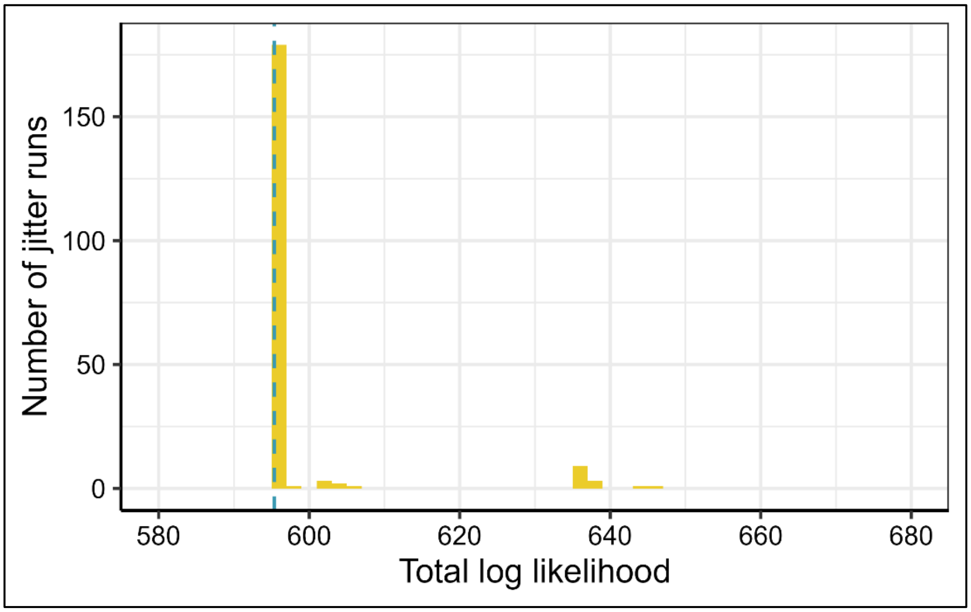

Figure 67. Total log-likelihood values of model runs performed by the jitter analysis (yellow bars) and the SEDAR 96 base model (blue dashed line).

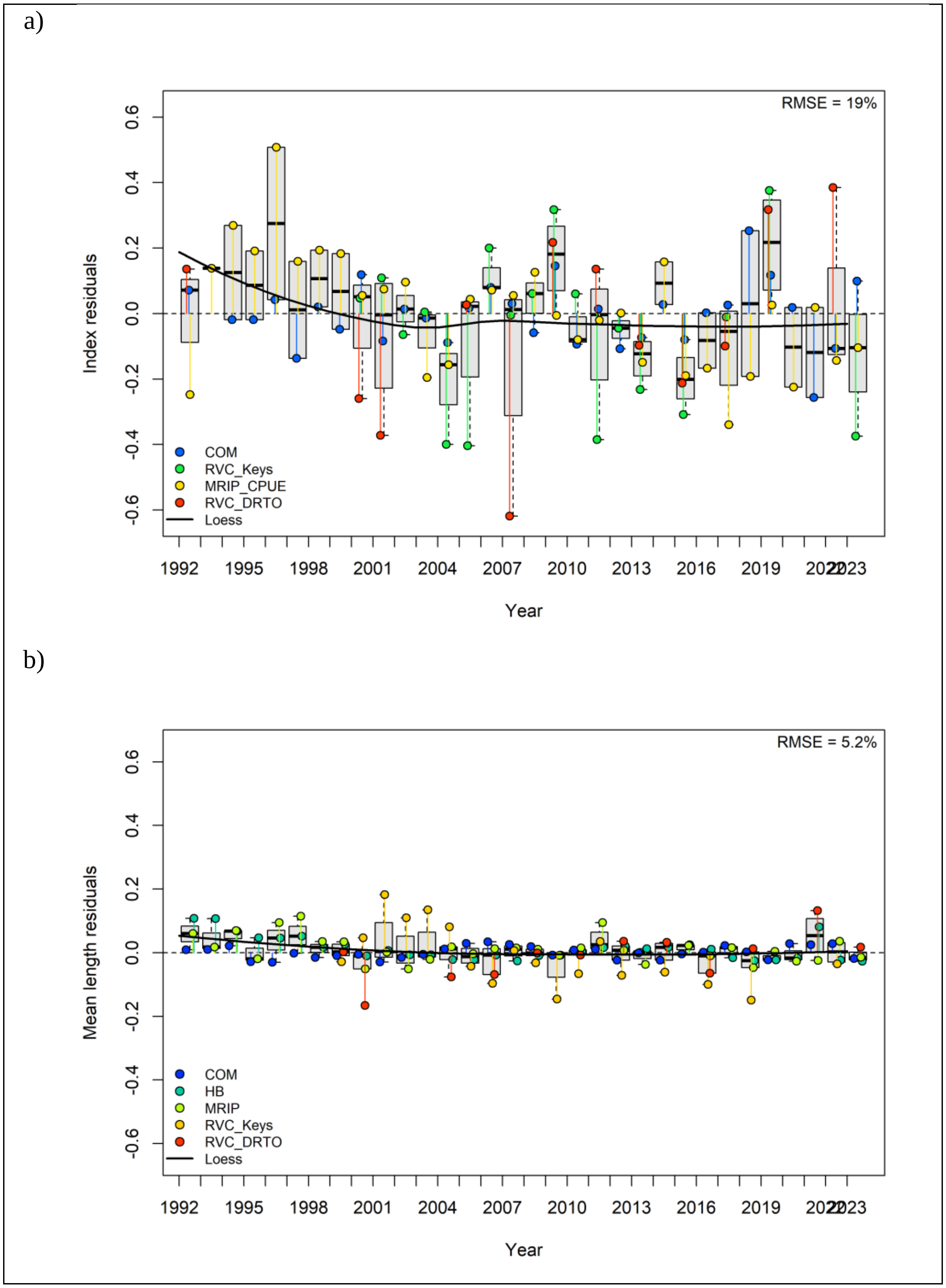

Figure 68. Joint residual plots for a) the indices of abundance and b) the annual mean length estimates of available fleets and indices from the SEDAR 96 base model. Vertical lines with points show the residuals, boxplots show residual medians and quantiles, and solid black lines are a loess smoother. Root-mean squared errors (RMSE) are included in the upper right-hand corner of each plot.

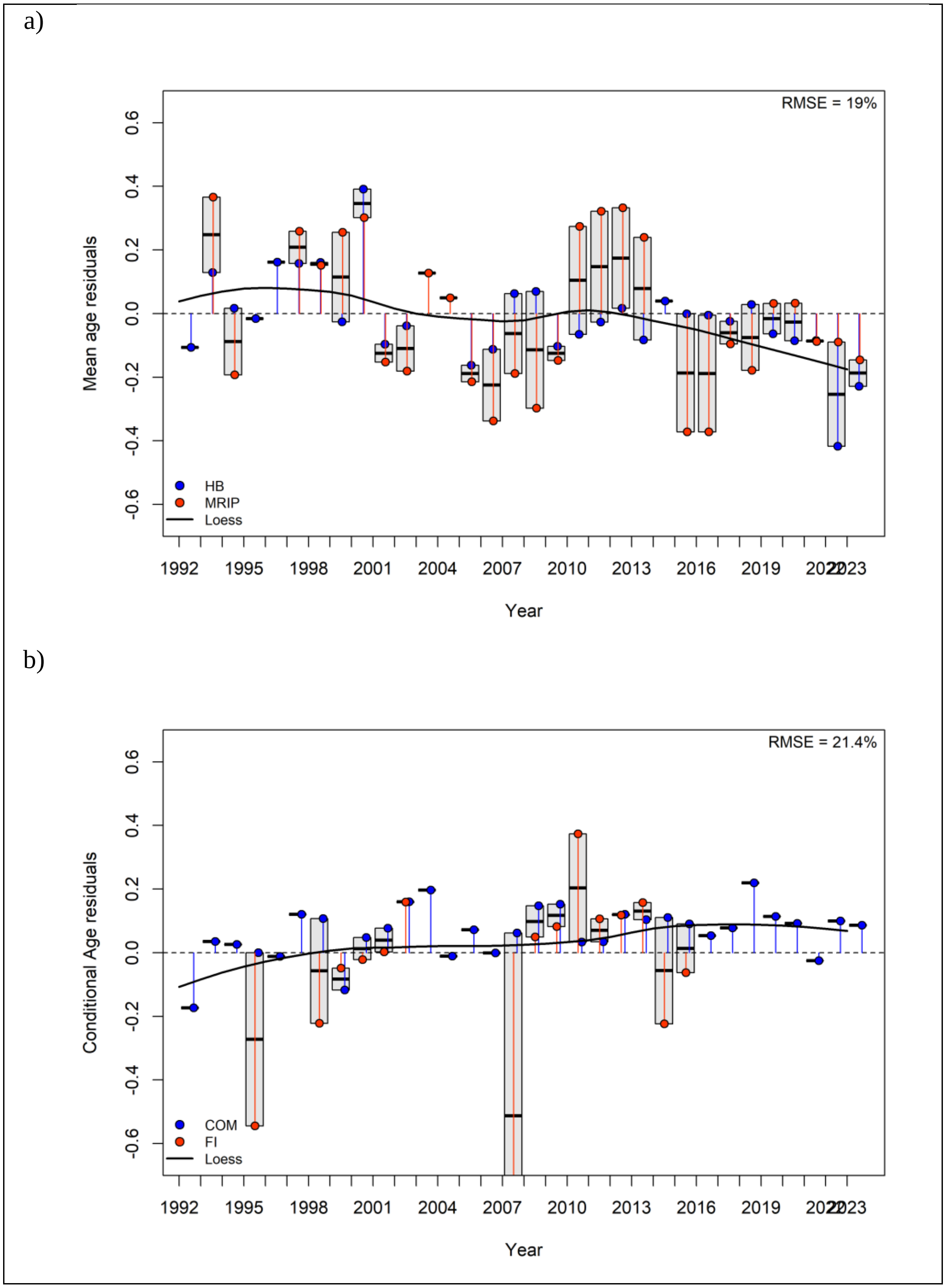

Figure 69. Joint residual plots for a) the annual mean age estimates and b) the annual conditional age-at-length estimates of available fleets and indices from the SEDAR 96 base model. Vertical lines with points show the residuals, boxplots show residual medians and quantiles, and solid black lines are a loess smoother. Root-mean squared errors (RMSE) are included in the upper right-hand corner of each plot.

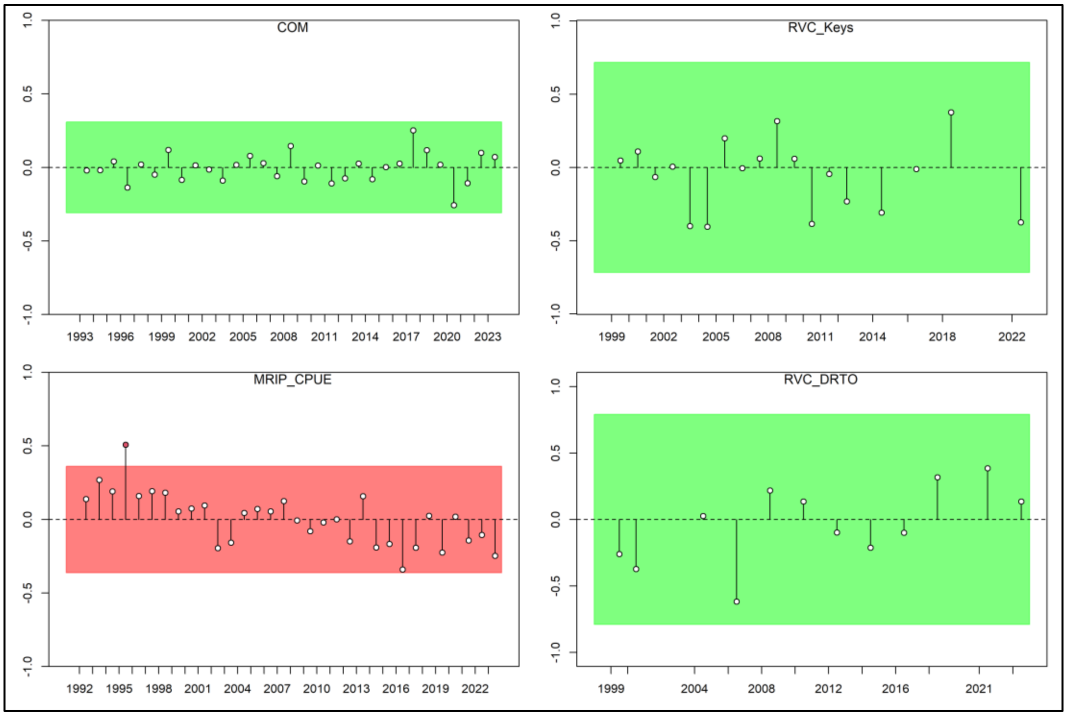

Figure 70. Runs tests results for the indices of abundance from the SEDAR 96 base model. Green shading indicates no evidence ($p \geq 0.05$) and red shading evidence ($p < 0.05$) to reject the hypothesis of a randomly distributed time-series of residuals, respectively. Shaded regions span three residual standard deviations to either side from zero and red points outside of the shading indicate a violation of that ‘three-sigma limit’.

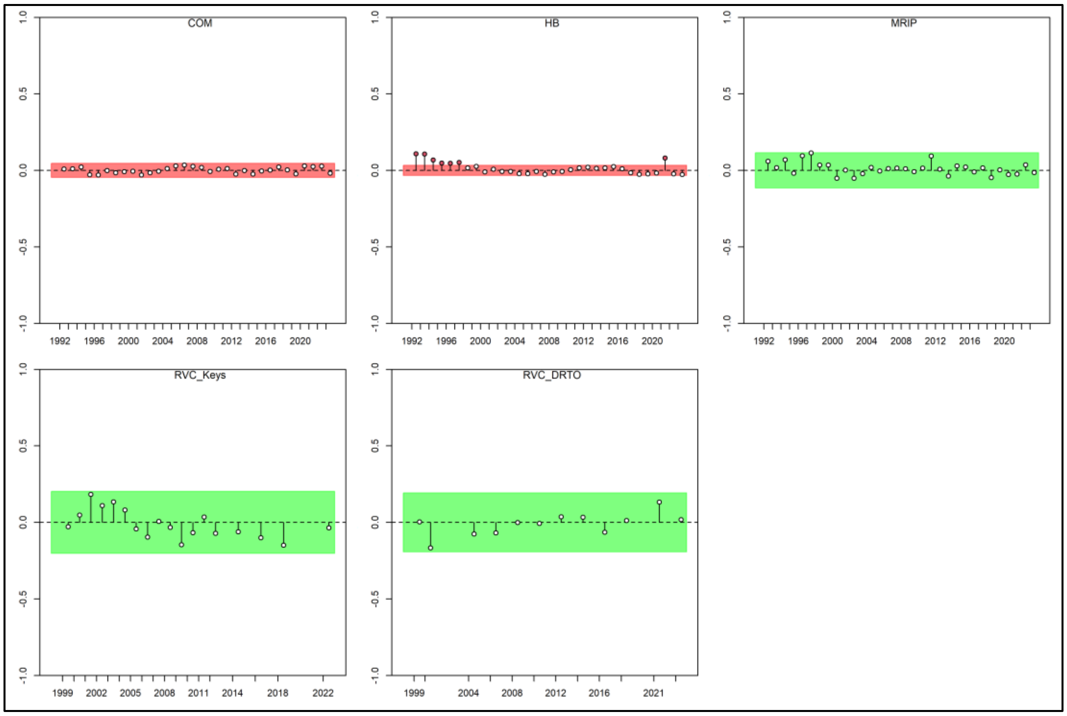

Figure 71. Runs tests results for the annual mean length estimates from the SEDAR 96 base model. Green shading indicates no evidence ($p \geq 0.05$) and red shading evidence ($p < 0.05$) to reject the hypothesis of a randomly distributed time-series of residuals, respectively. Shaded regions span three residual standard deviations to either side from zero and red points outside of the shading indicate a violation of that 'three-sigma limit'.

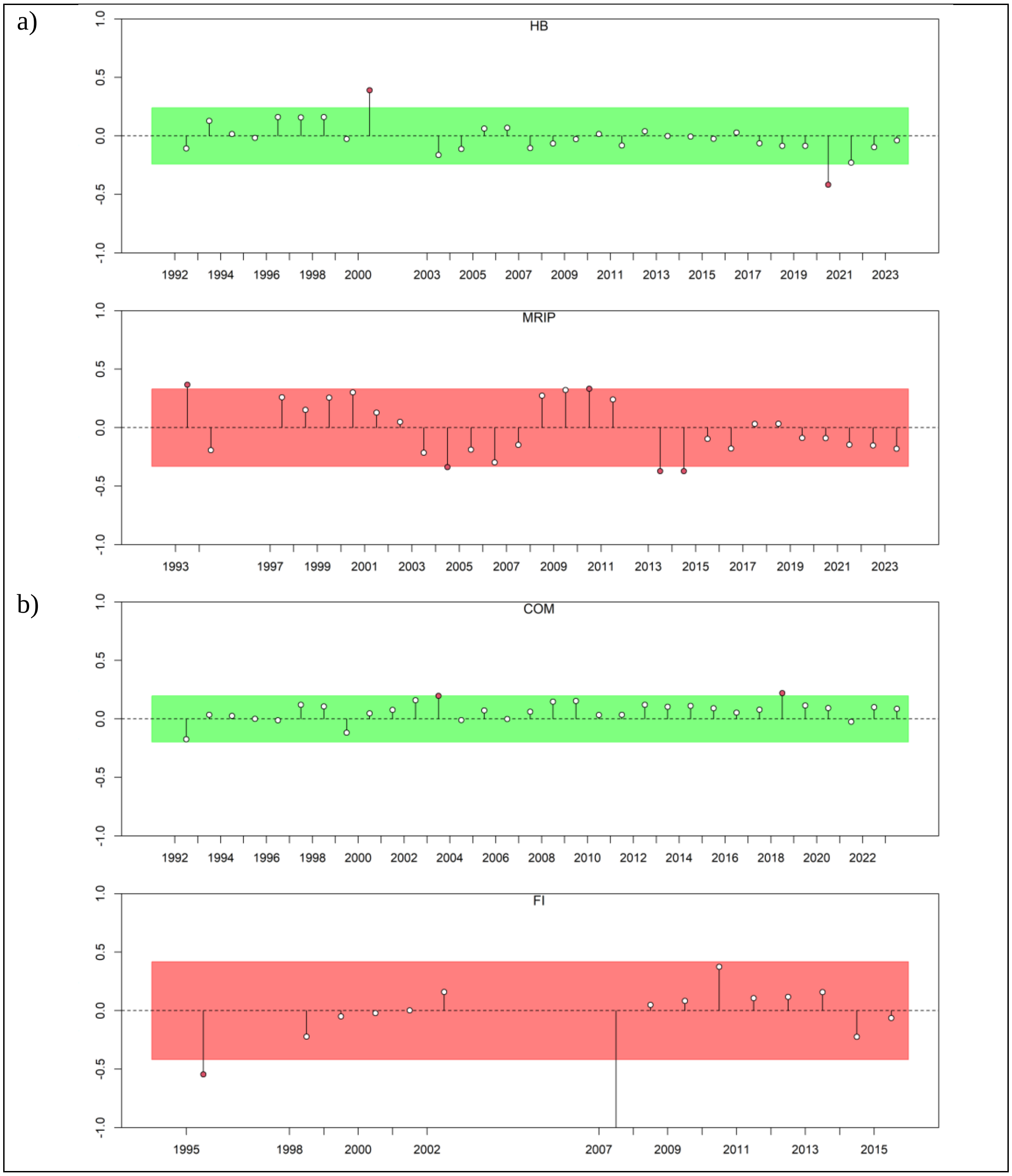

Figure 72. Runs tests results for the annual mean age estimates (a) and the conditional age-at-length estimates (b) from the SEDAR 96 base model. Green shading indicates no evidence ($p \geq 0.05$) and red shading evidence ($p < 0.05$) to reject the hypothesis of a randomly distributed time-series of 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'.

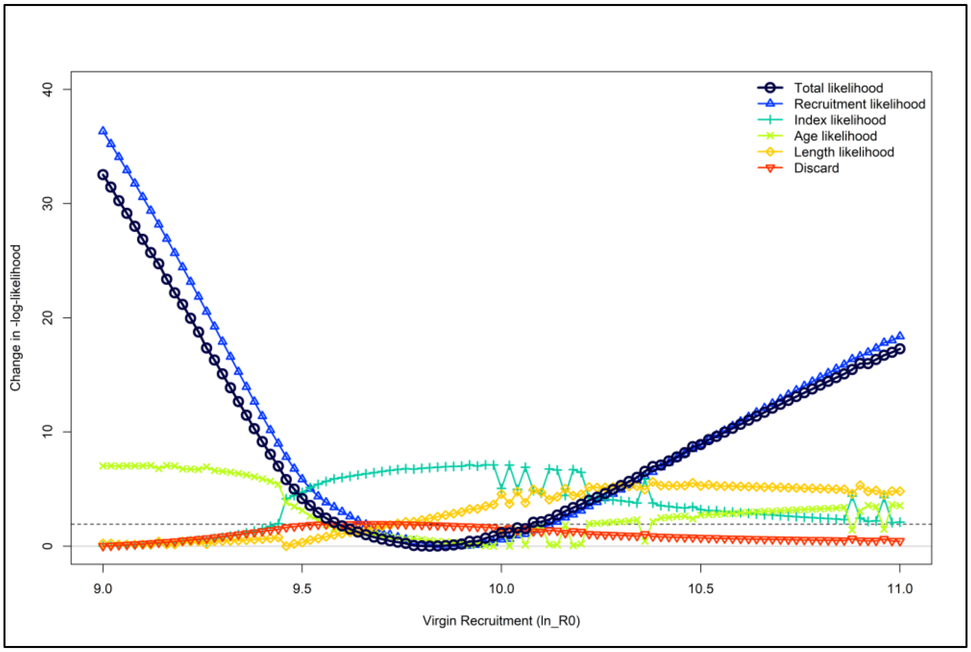

Figure 73. Log-likelihood profiles of the unfished (i.e., virgin) recruitment (*ln(R0)*) parameter for various data components in the SEDAR 96 base model.

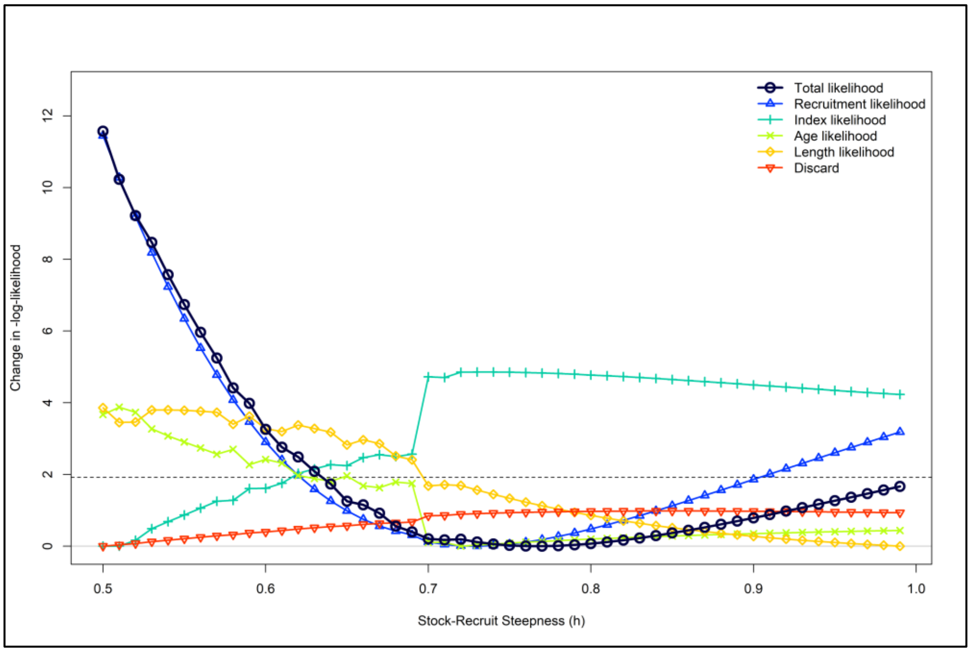

Figure 74. Log-likelihood profiles of the *steepness (h)* parameter for various data components in the SEDAR 96 base model.

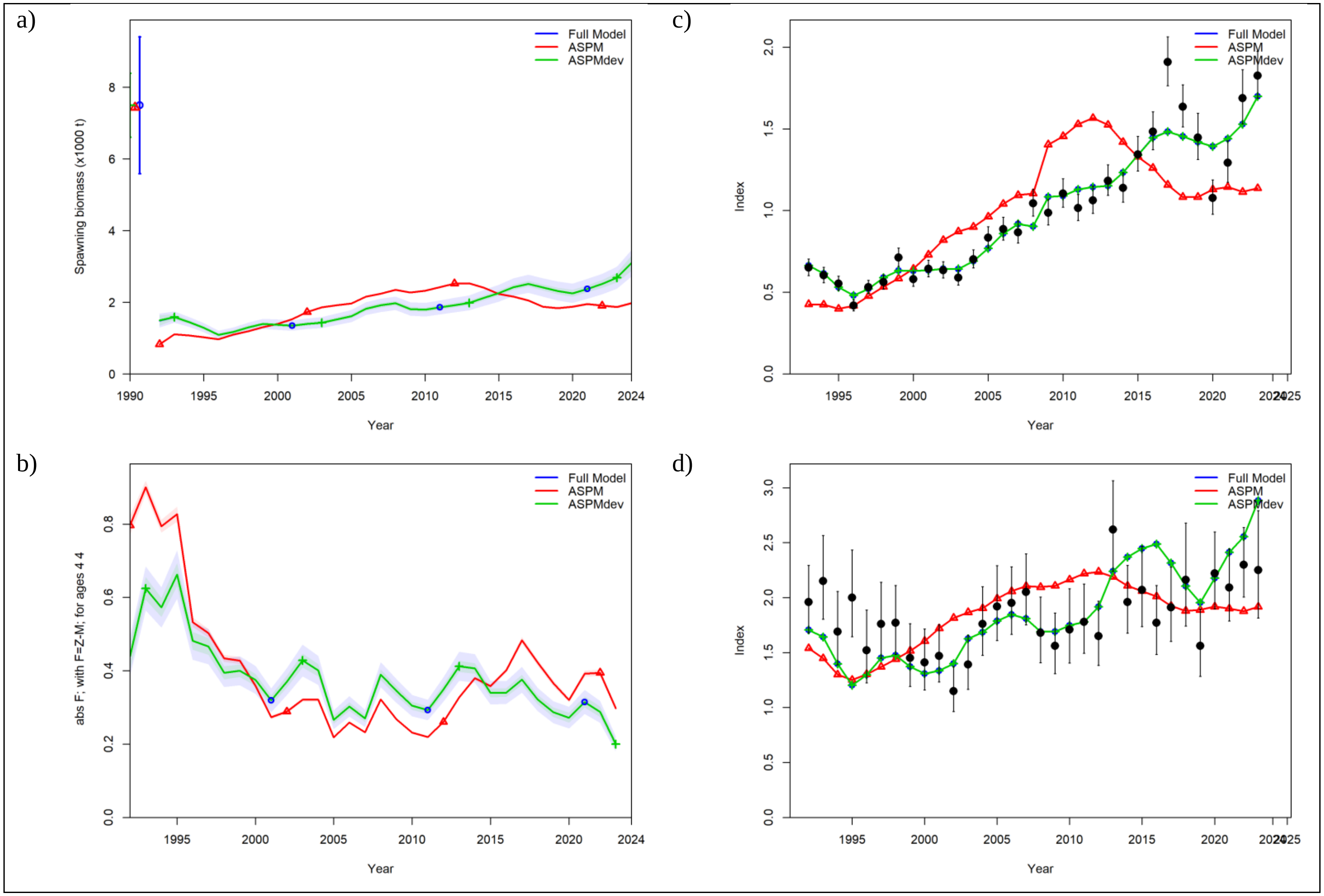

Figure 75. Results comparison between the SEDAR 96 base model (Full Model), the deterministic Age-Structured-Production Model (ASPM), and the ASPM with recruitment deviations (ASPMdev) showing a) spawning stock biomass, b) age-4 fishing mortality rates, c) observed and predicted values for the commercial CPUE index, and d) observed and predicted values for the MRIP CPUE index.

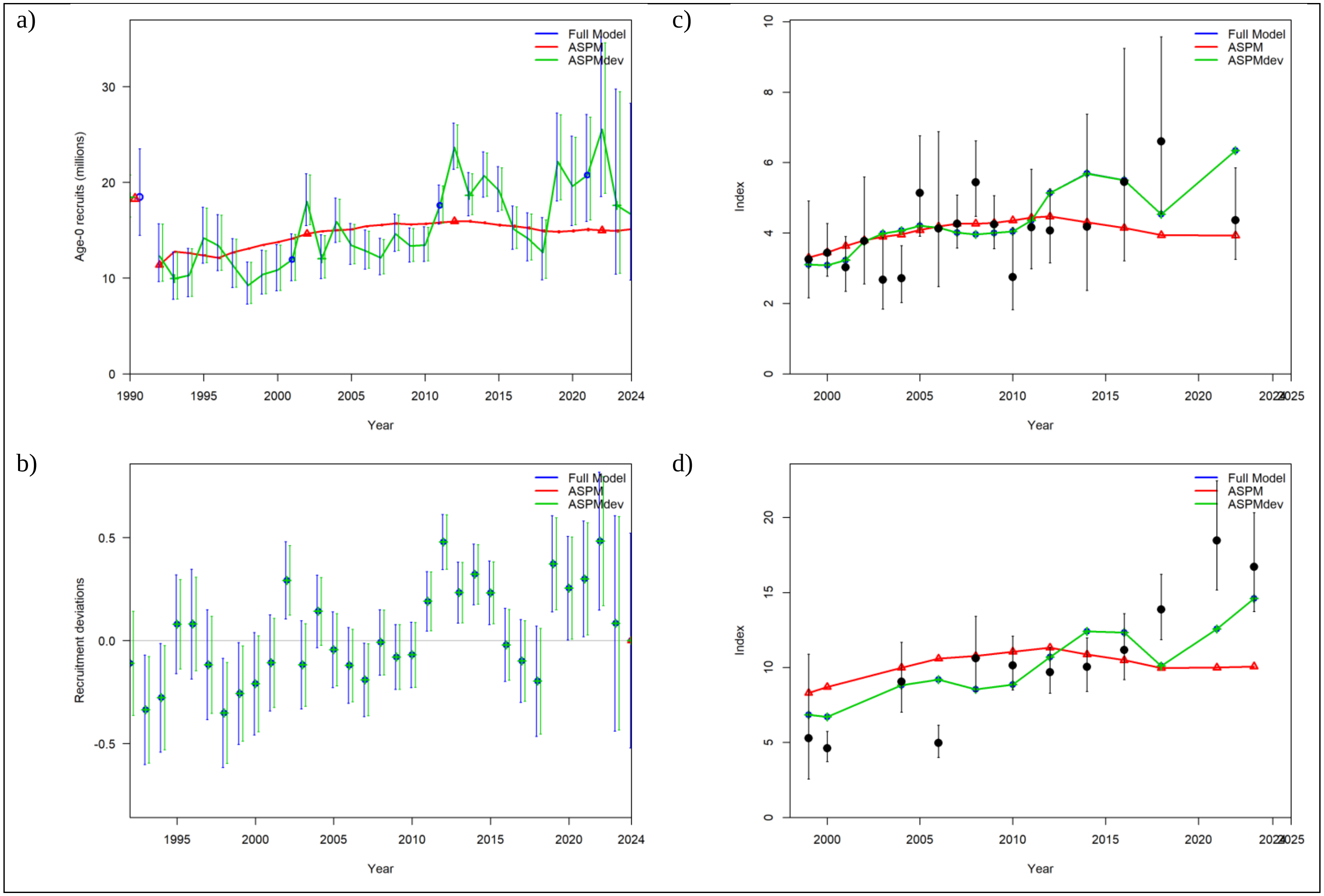

Figure 76. Results comparison between the SEDAR 96 base model (Full Model), the deterministic Age-Structured-Production Model (ASPM), and the ASPM with recruitment deviations (ASPMdev) showing a) estimates of age-0 recruitment, b) estimates of recruitment deviations, c) observed and predicted values for the RVC Florida Keys index, and d) observed and predicted values for the RVC Dry Tortugas index.

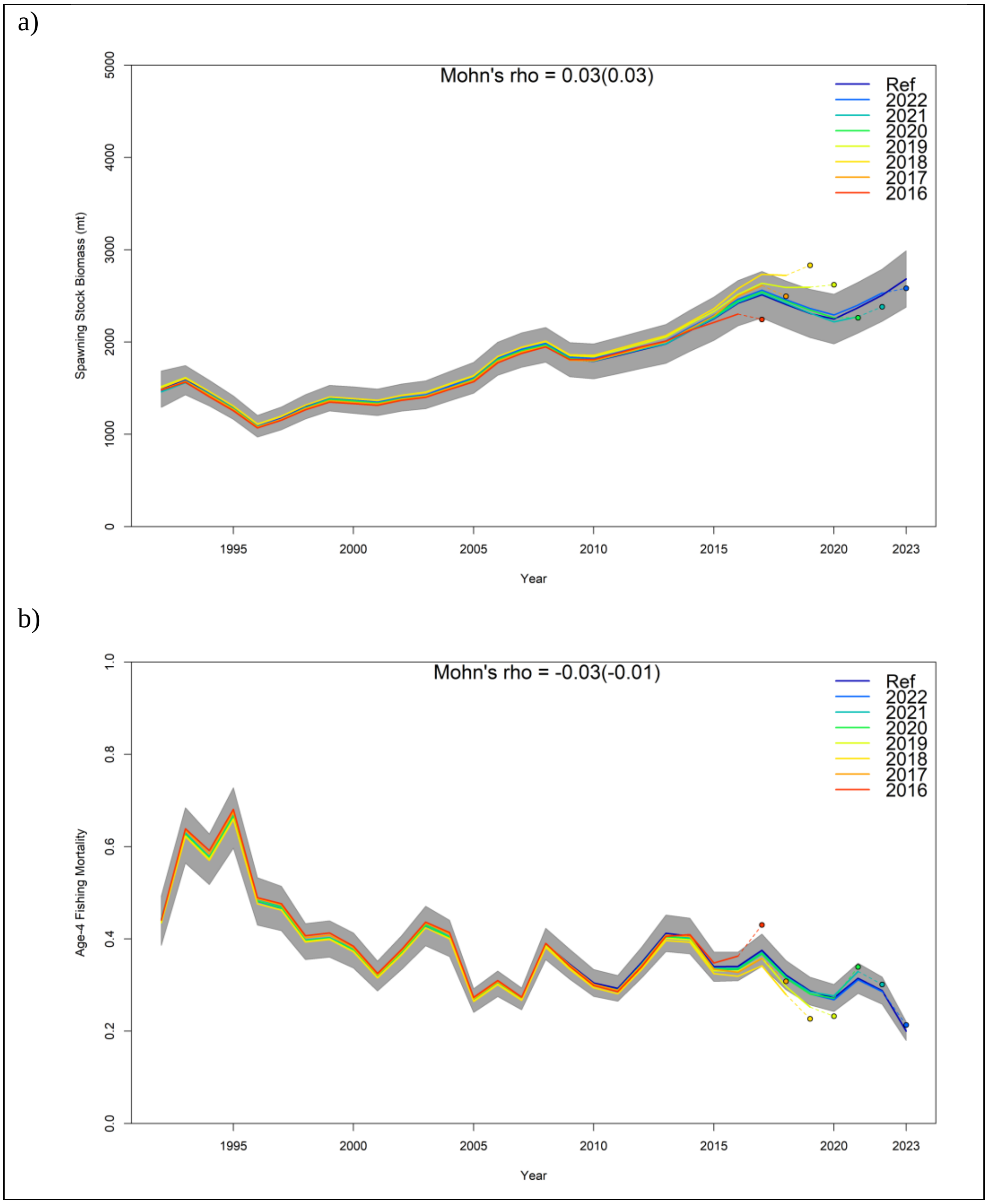

Figure 77. Retrospective forecast results of a) spawning stock biomass and b) age-4 fishing mortality conducted by re-fitting the SEDAR 96 base model (Ref) after sequentially removing seven years of observations. The Mohn’s rho (ρ_M) statistic and corresponding forecast rho (ρ_F) values (in parenthesis) 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 96 base model.

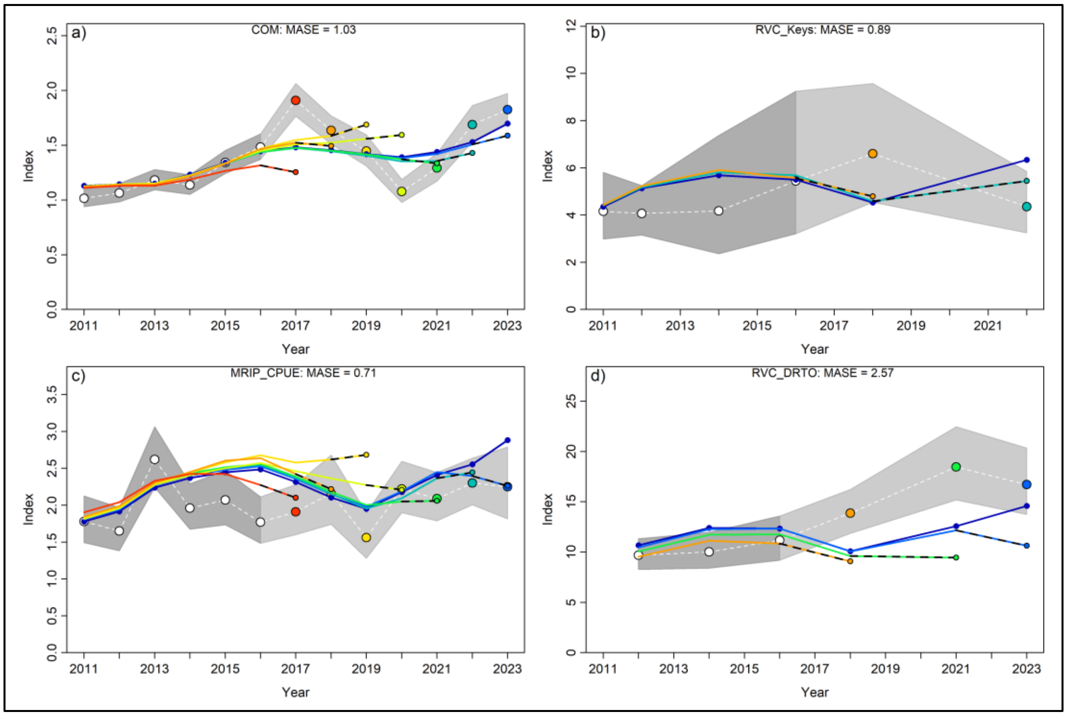

Figure 78. Hindcasting cross-validation results for the a) commercial CPUE index, b) RVC Florida Keys index, c) MRIP CPUE index, and d) RVC Dry Tortugas index from the SEDAR 96 base model showing observed (large white points connected with dashed line), fitted (solid lines), and one-year ahead forecast 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.

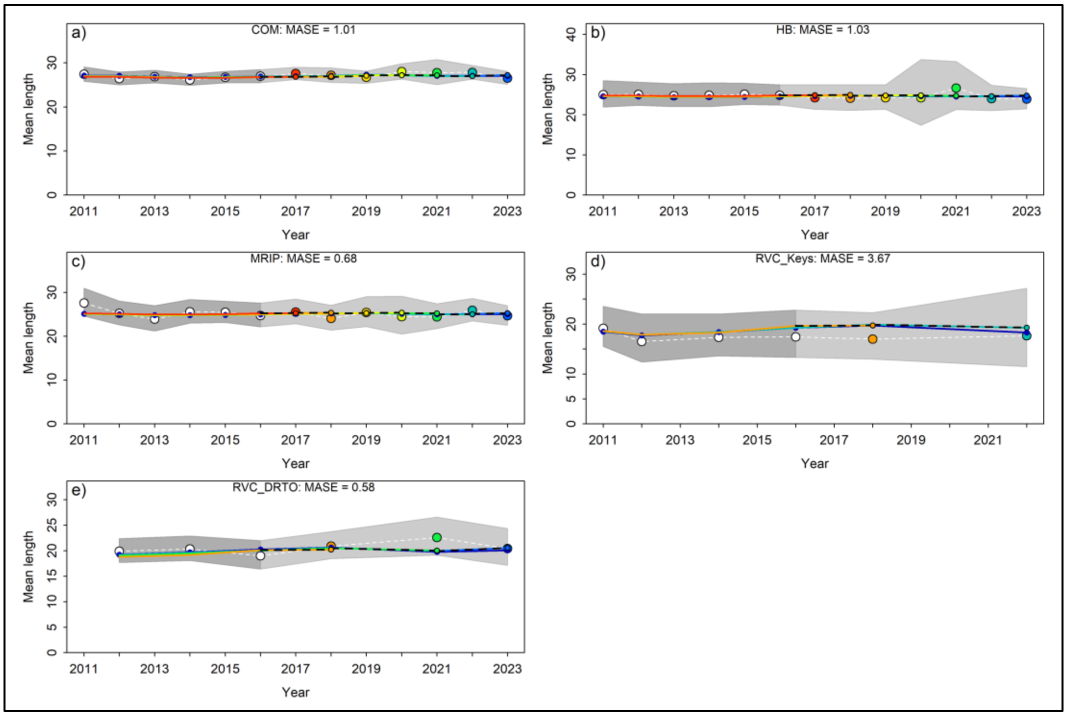

Figure 79. Hindcasting cross-validation results for a) Commercial, b) Headboat, c) MRIP SRFS, d) RVC Florida Keys, and e) RVC Dry Tortugas annual mean length estimates from the SEDAR 96 base model showing observed (large white points connected with dashed line), fitted (solid lines), and one-year ahead 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.

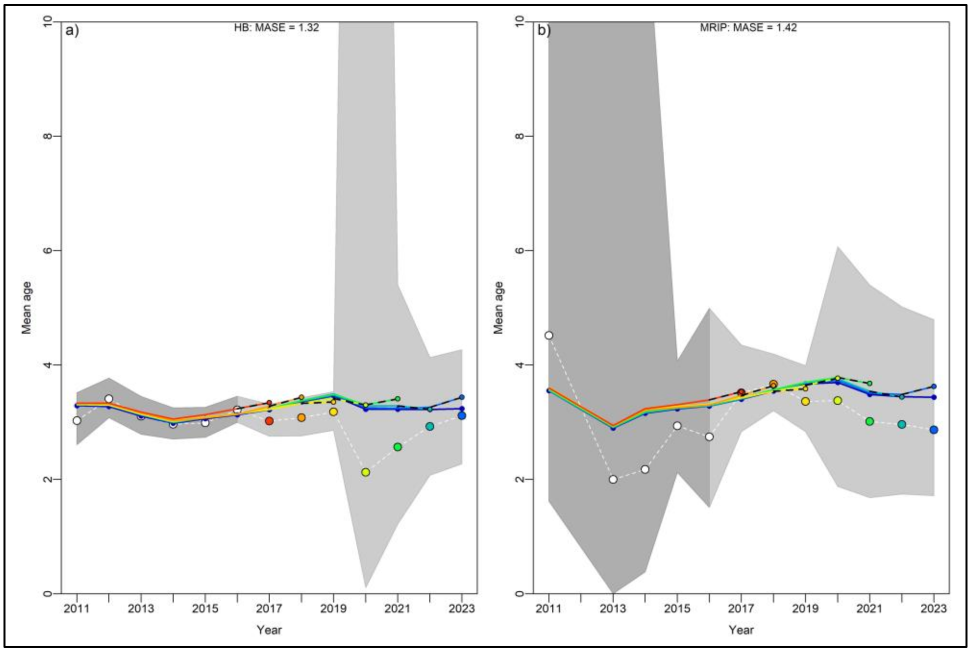

Figure 80. Hindcasting cross-validation results for a) Headboat and b) MRIP SRFS annual mean age estimates from the SEDAR 96 base model showing observed (large white points connected with dashed line), fitted (solid lines), and one-year ahead forecast values (small terminal points). The color-coded solid 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 age composition series are provided at the top of each panel.

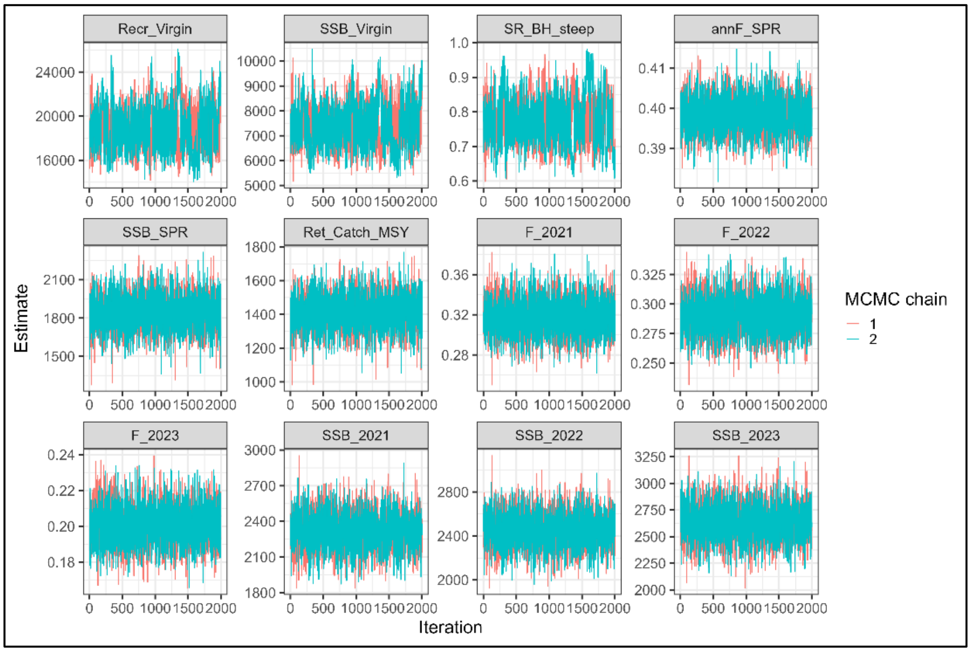

Figure 81. Combined trace plots of the two MCMC chains for selected parameters and derived quantities from the SEDAR 96 base model.

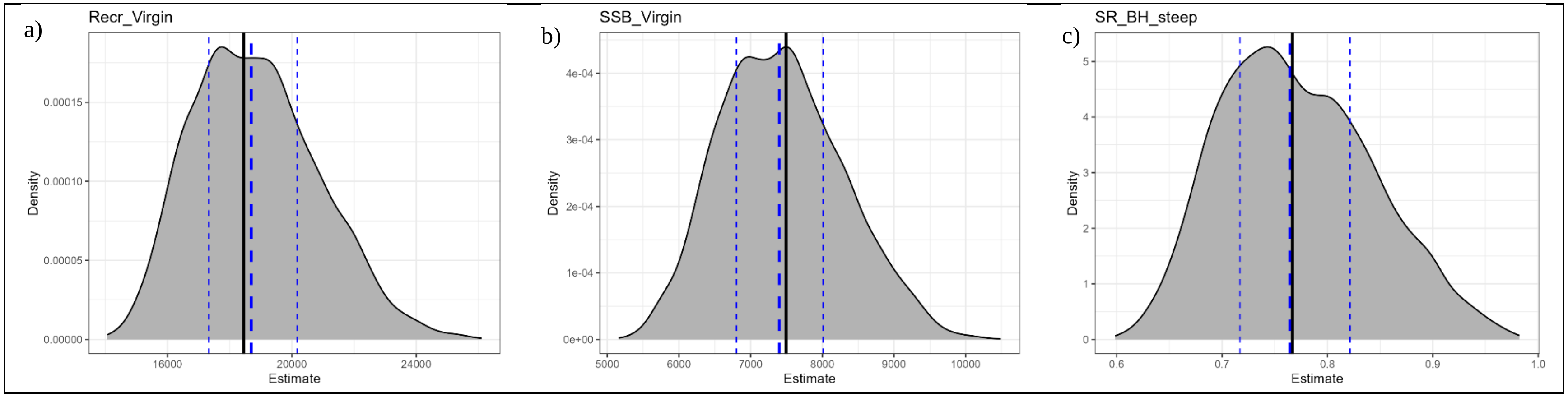

Figure 82. The posterior distributions for a) R_0 (i.e., virgin recruitment), b) SSB_0 (i.e., virgin spawning stock biomass), and c) steepness from the combined two-chain MCMC. The blue dashed lines indicate the median and interquartile range while the solid black line is the estimate from the SEDAR 96 base model.

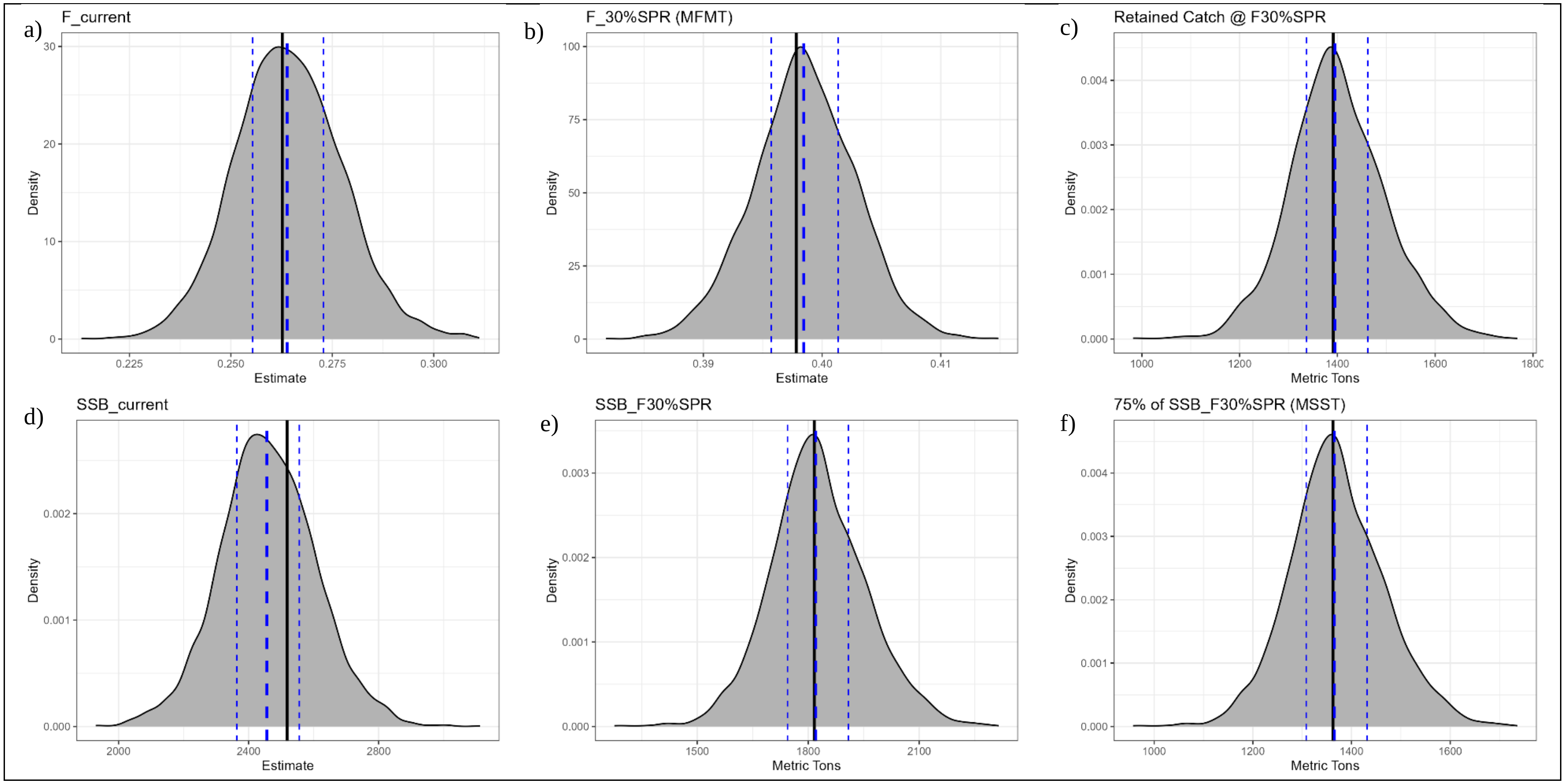

Figure 83. The posterior distributions for a) F$_{\text{current}}$ (i.e., geometric mean of F for years 2021 – 2023), b) F$_{\text{30\%SPR}}$ (i.e., MFMT), and c) the retained yield associated with F$_{\text{30\%SPR}}$, d) SSB$_{\text{curren}}$t (i.e., geometric mean of SSB for years 2021 – 2023), e) SSB at F$_{\text{30\%SPR}}$, and f) 75% of SSB at F$_{\text{30\%SPR}}$ (i.e., MSST) from the combined two-chain MCMC. The blue dashed lines indicate the median and interquartile range while the solid black line is the estimate from the SEDAR 96 base model.

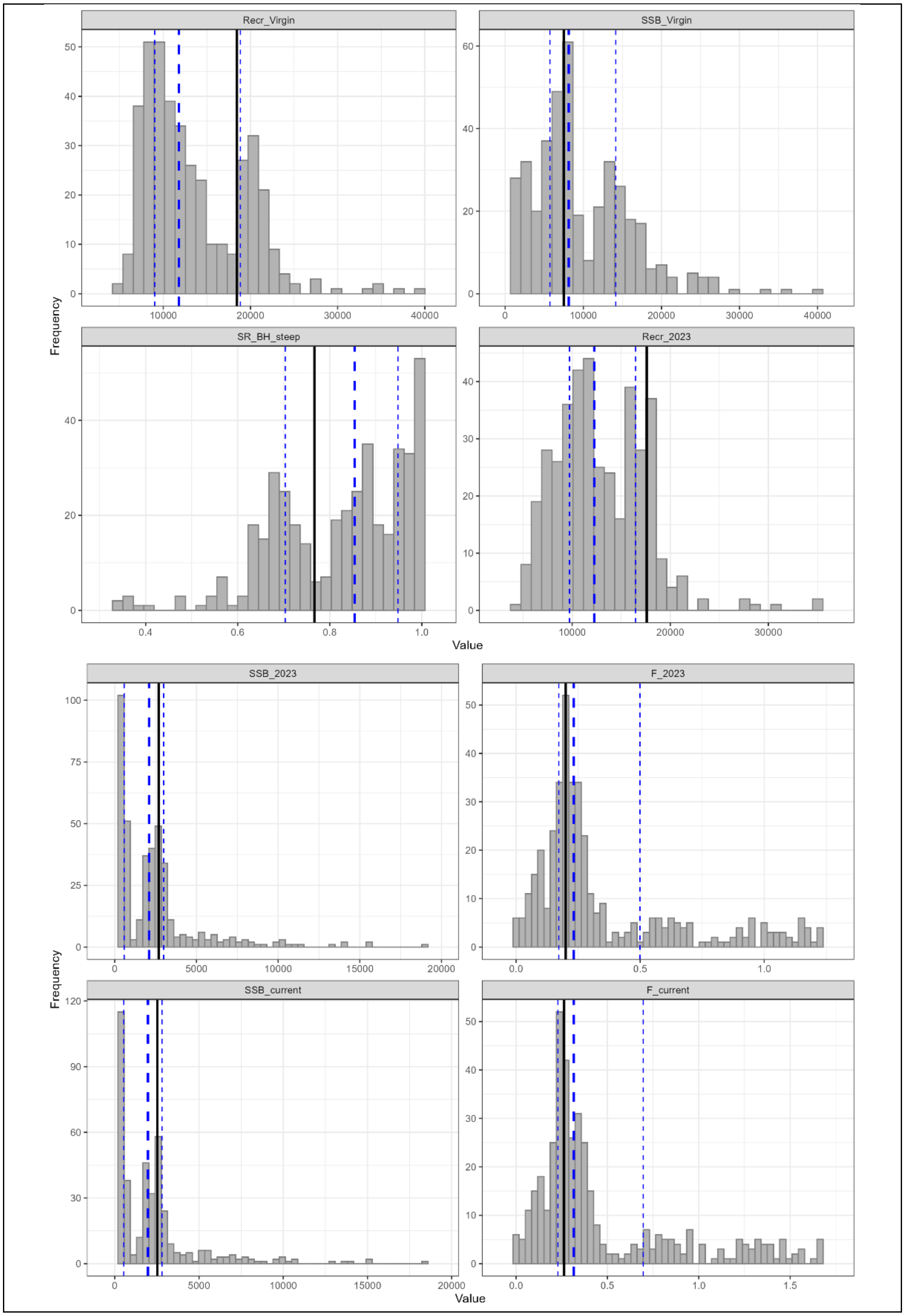

Figure 84. Distributions of selected parameter estimates and derived quantities from parametric bootstrapping the SEDAR 96 base model.

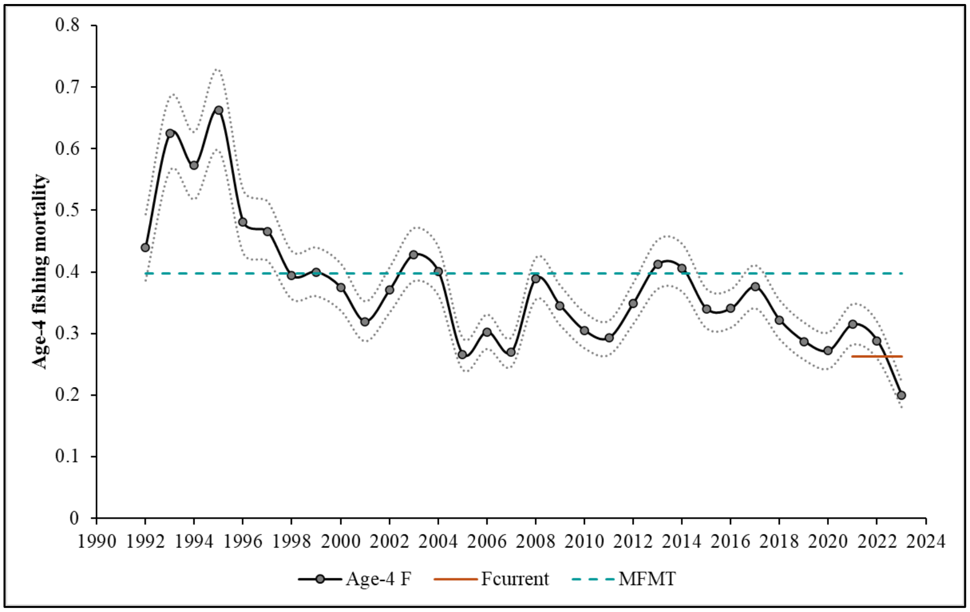

Figure 85. Annual estimates of age-4 fishing mortality relative to MFMT (i.e., $F_{30\%SPR}$) and the geometric mean of fishing mortality in the last three years ($F_{current}$). Dotted lines represent 95% confidence intervals.

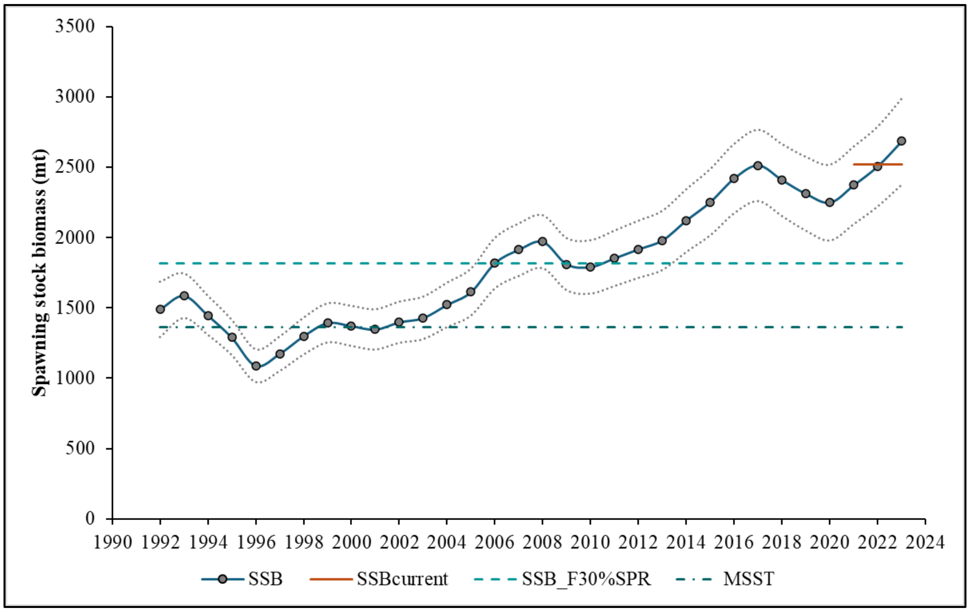

Figure 86. Annual estimates of spawning stock biomass (SSB) relative to MSST (i.e., 75% $SSB_{F30\%SPR}$), $SSB_{F30\%SPR}$, and the geometric mean of SSB in the last three years ($SSB_{current}$). Dotted lines represent 95% confidence intervals.

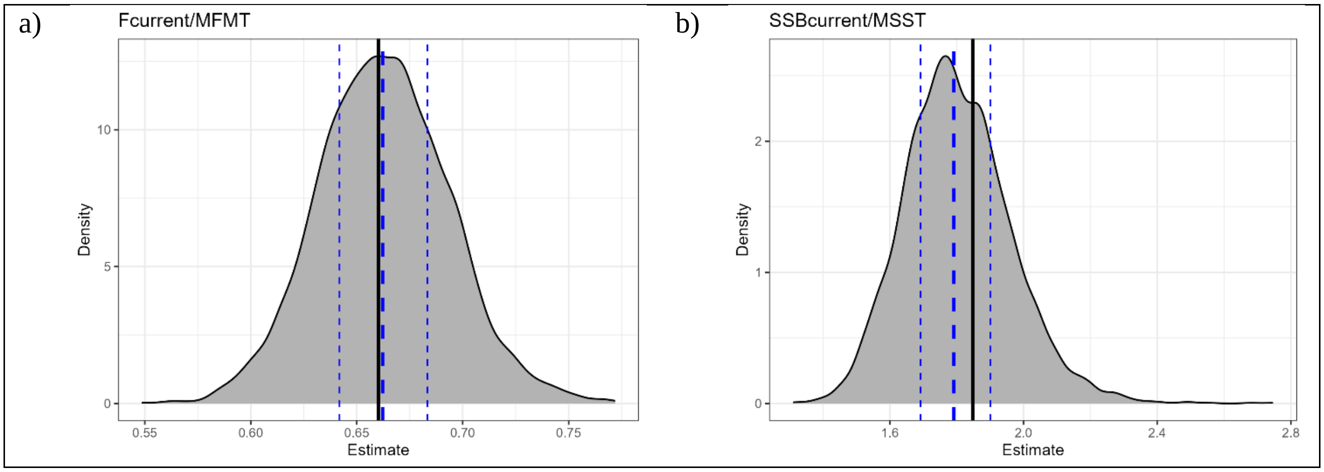

Figure 87. The posterior distribution for the F ratio ($F_{current}$/MFMT) and SSB ratio ($SSB_{current}$/MSST) values from the combined two-chain MCMC. The blue dashed lines indicate the median and interquartile range while the solid black line is the estimate from the SEDAR 96 base model.

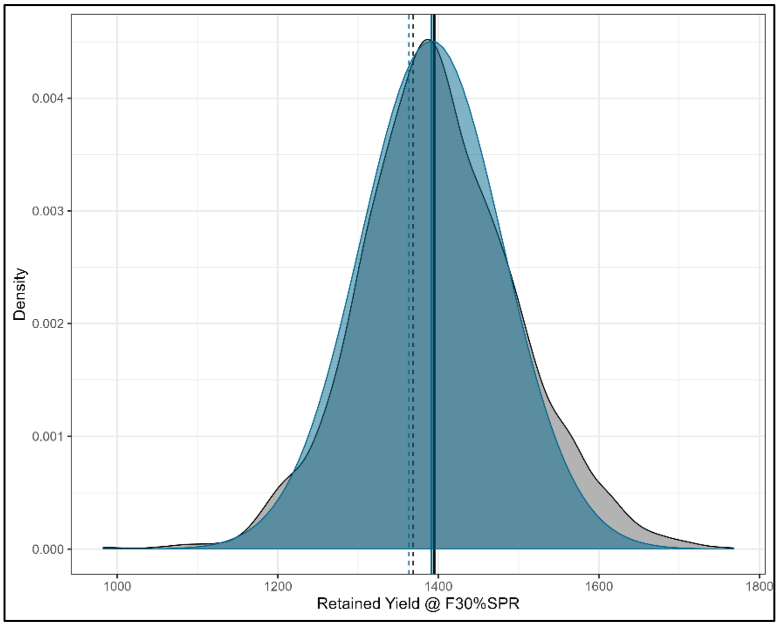

Figure 88. A comparison between the MCMC distribution of the equilibrium retained yield at $F_{30\%SPR}$ (grey) and an approximate normal distribution with a mean and standard error estimated by the SEDAR 96 base model (blue). The medians and 37.5th quantiles are shown by the solid and dashed lines, respectively.

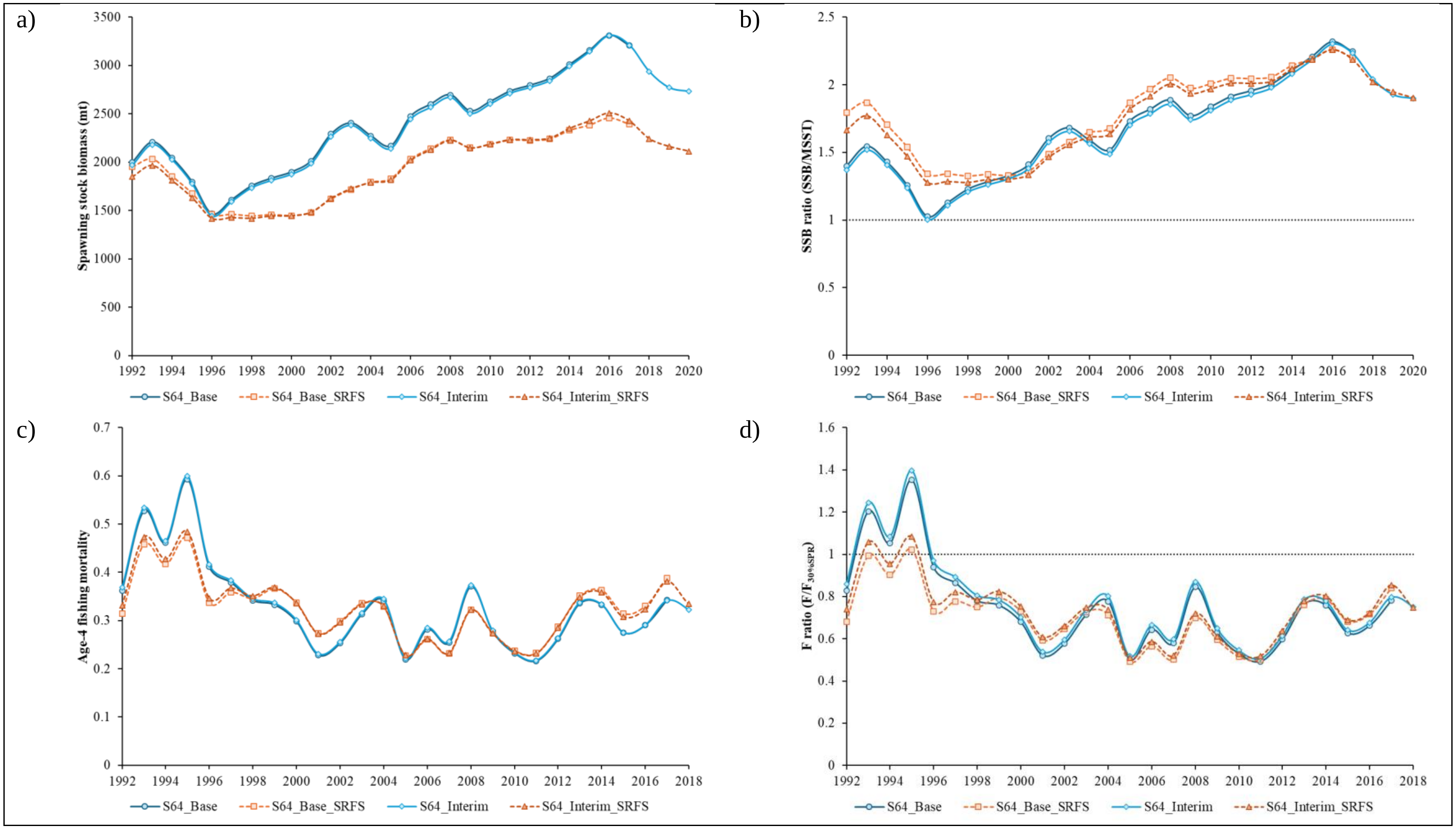

Figure 89. A comparison of the results between the SEDAR 64 base model (S64_Base) and the Interim Analysis (S64_Interim) for a) spawning stock biomass, b) spawning stock biomass ratio (SSB/MSST), c) age-4 fishing mortality rate, and d) age-4 fishing mortality ratio ($F/F_{30\%SPR}$) when replacing the MRIP fleet catch timeseries with the 'Full SRFS' catch timeseries (SRFS).

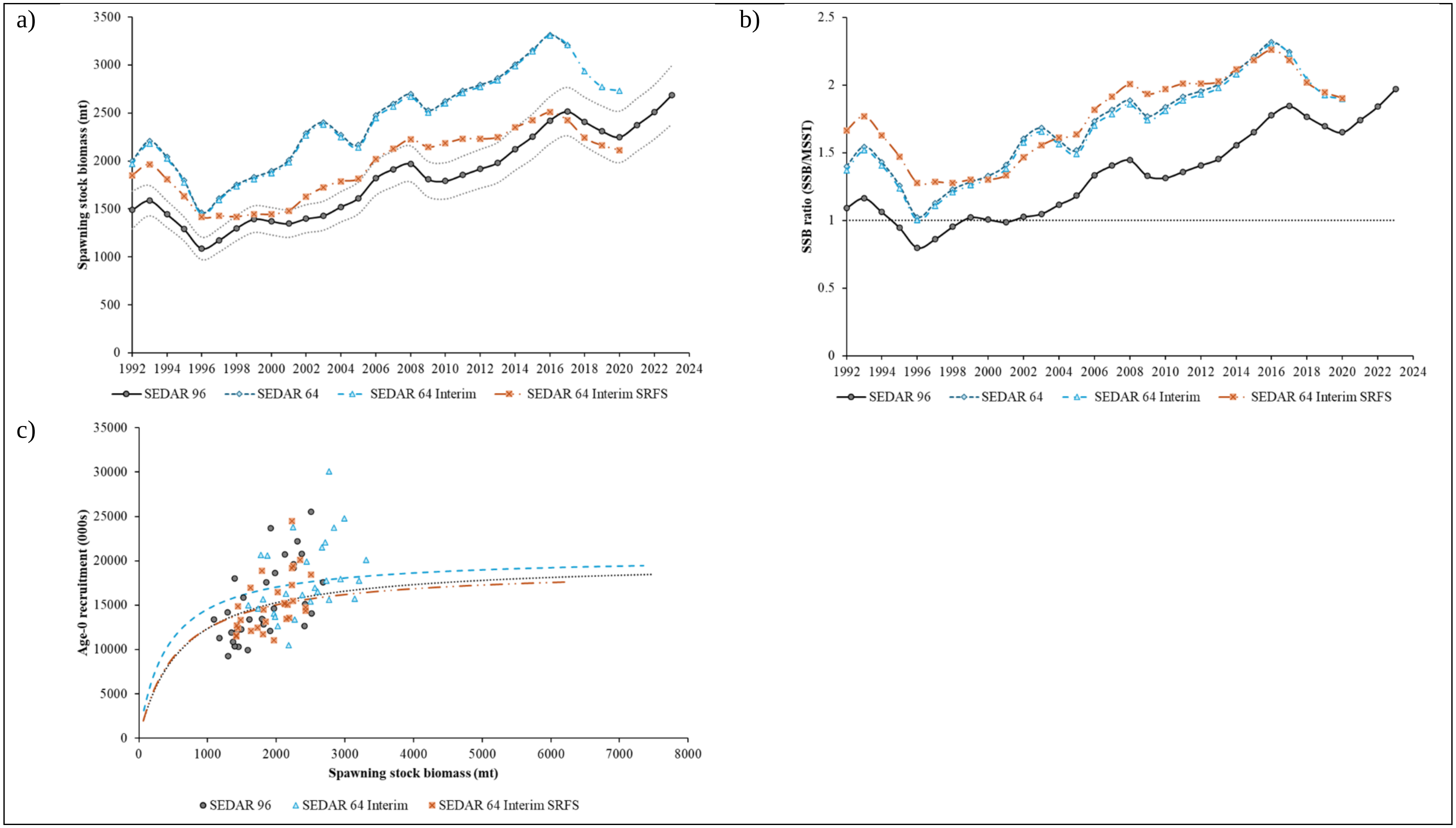

Figure 90. A comparison of the results between the SEDAR 96 base model, the SEDAR 64 base model, the Interim Analysis, and the Interim Analysis containing the ‘Full SRFS’ catch timeseries (SEDAR 64 Interim SRFS) for a) spawning stock biomass, b) spawning stock biomass ratio (SSB/MSST), and c) the estimated stock-recruitment relationship. Plotted in panel (c) are expected annual recruitments from the SEDAR 96 base model (black circles), the Interim Analysis (blue triangles), and the SEDAR 64 Interim SRFS model (orange X), as well as expected recruitment from corresponding stock-recruitment curves.

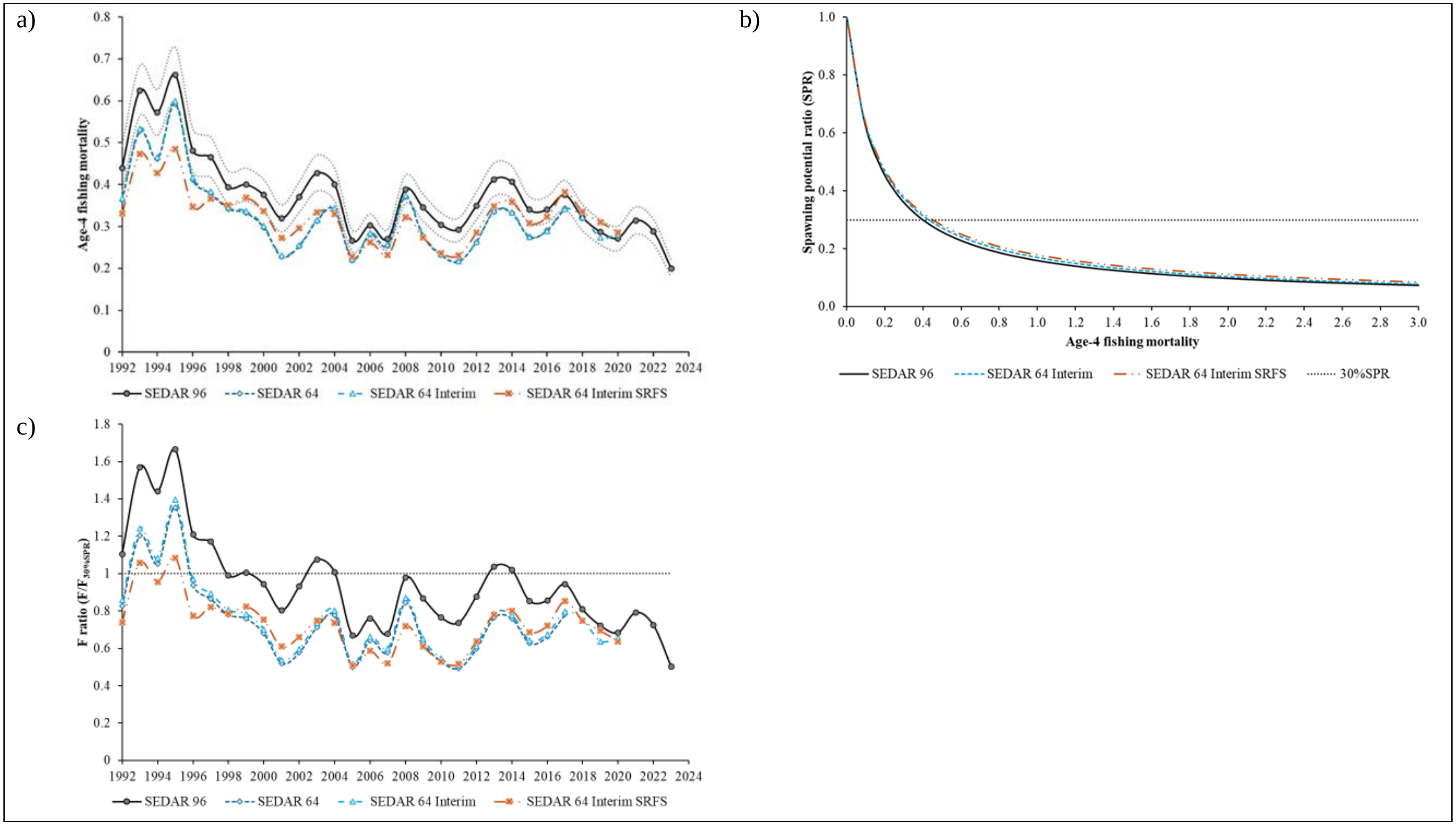

Figure 91. A comparison of the results between the SEDAR 96 base model, the SEDAR 64 base model, the Interim Analysis, and the Interim Analysis containing the ‘Full SRFS’ catch timeseries (SEDAR 64 Interim SRFS) for a) the age-4 fishing mortality rate, b) the spawning potential ratio by age-4 fishing mortality rate, and c) the age-4 fishing mortality ratio ($F/F_{30\%SPR}$).

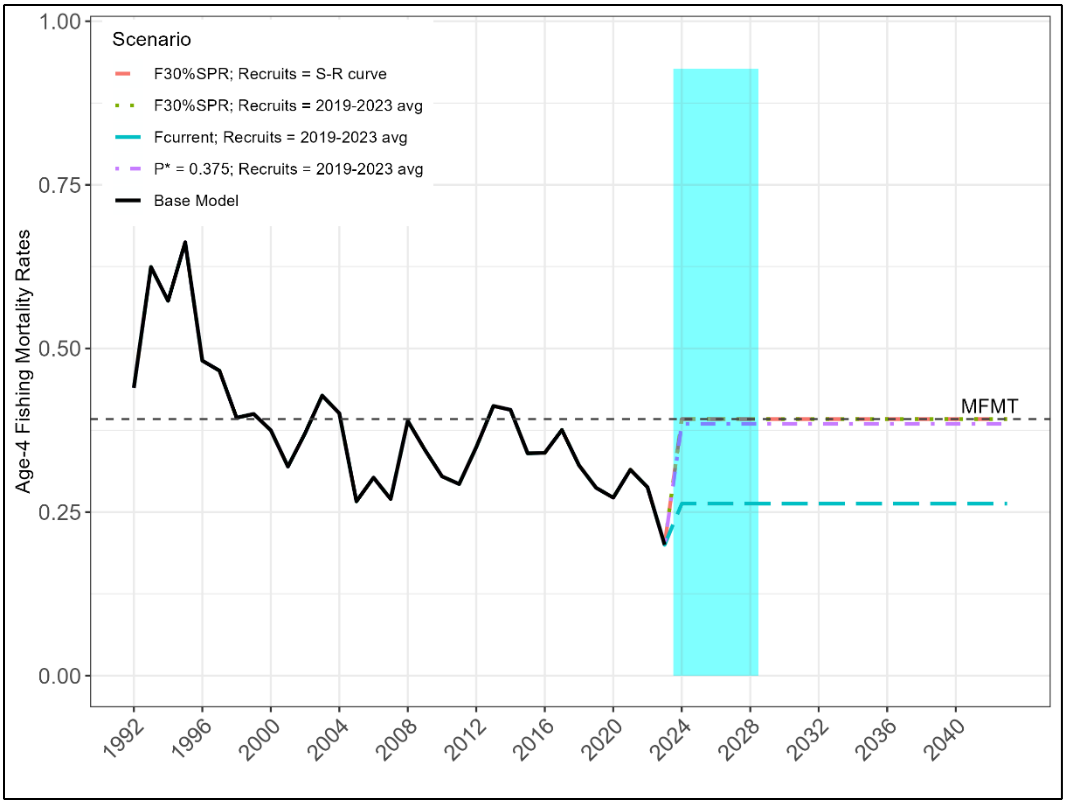

Figure 92. Age-4 fishing mortality rates based on projections under long-term equilibrium $F_{30\%SPR}$ (red dashed line), short-term $F_{30\%SPR}$ (mustard dotted line), $F_{current}$ (teal dashed line), the level that corresponds to a P* value of 0.375 (purple dot-dashed line), and as estimated by the SEDAR 96 base model (black solid line). The cyan region highlights the first five years of the projection (2024 – 2028).

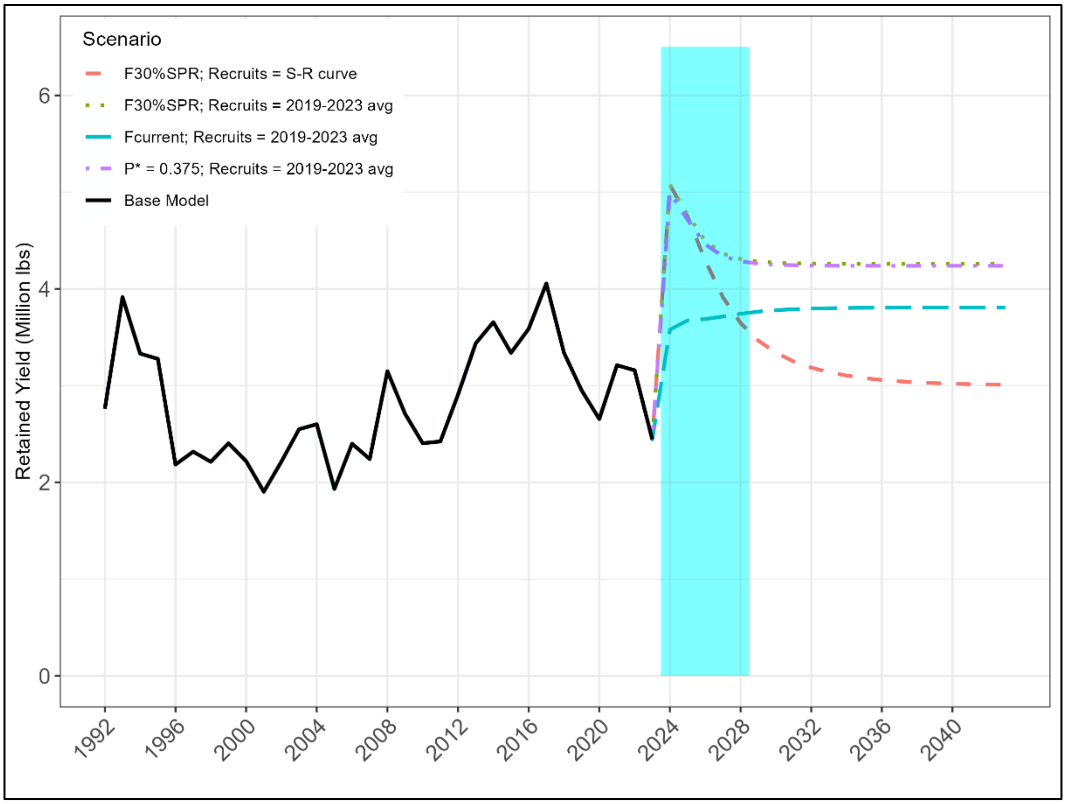

Figure 93. Retained yield (million pounds) based on projections under long-term equilibrium $F_{30\%SPR}$ (red dashed line), short-term $F_{30\%SPR}$ (mustard dotted line), $F_{current}$ (teal dashed line), the level that corresponds to a P* value of 0.375 (purple dot-dashed line), and as estimated by the SEDAR 96 base model (black solid line). The cyan region highlights the first five years of the projection (2024 – 2028).

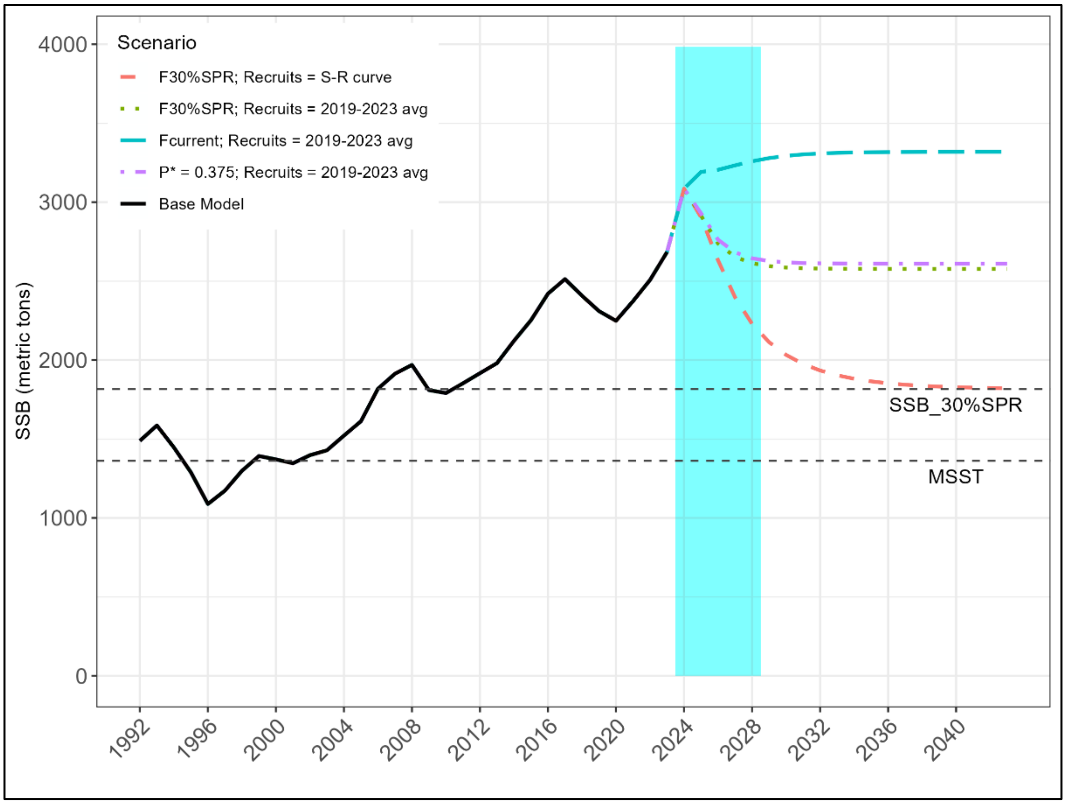

Figure 94. Spawning stock biomass (metric tons) based on projections under long-term equilibrium $F_{30\%SPR}$ (red dashed line), short-term $F_{30\%SPR}$ (mustard dotted line), $F_{current}$ (teal dashed line), the level that corresponds to a P* value of 0.375 (purple dot-dashed line), and as estimated by the SEDAR 96 base model (black solid line). The cyan region highlights the first five years of the projection (2024 – 2028).

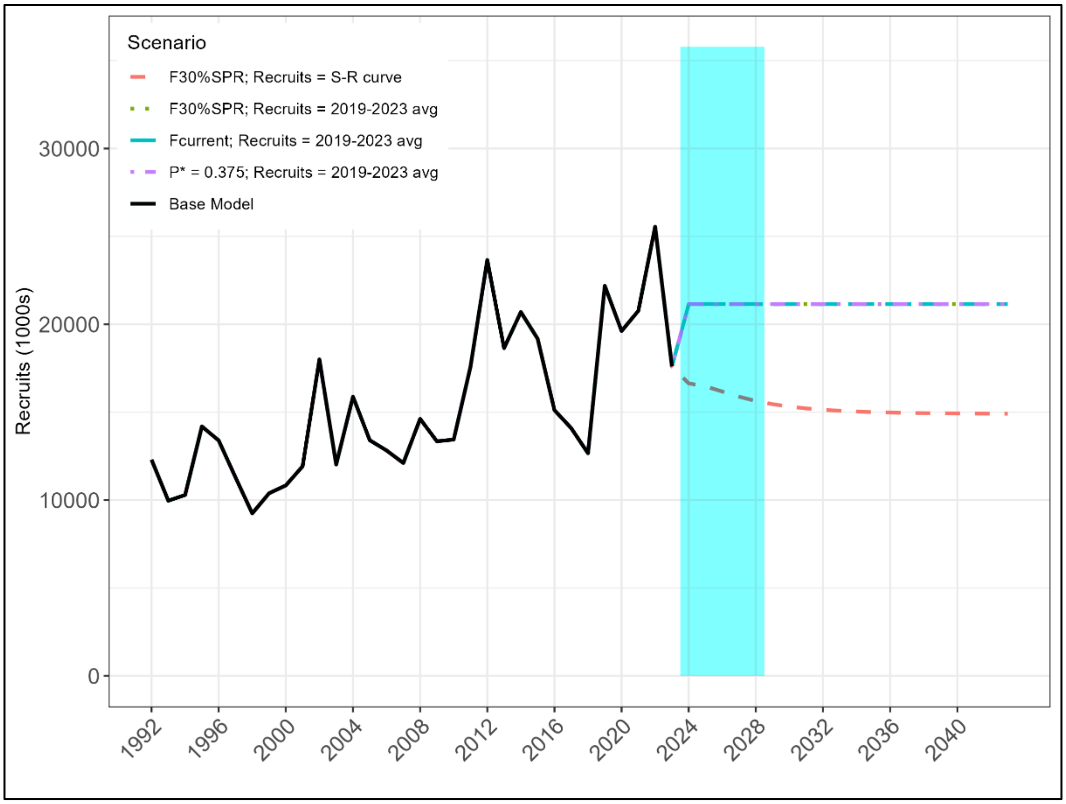

Figure 95. Age-0 recruits (in thousands) based on projections under long-term equilibrium $F_{30\%SPR}$ (red dashed line), short-term $F_{30\%SPR}$ (mustard dotted line), $F_{current}$ (teal dashed line), the level that corresponds to a P* value of 0.375 (purple dot-dashed line), and as estimated by the SEDAR 96 base model (black solid line). The cyan region highlights the first five years of the projection (2024 – 2028).

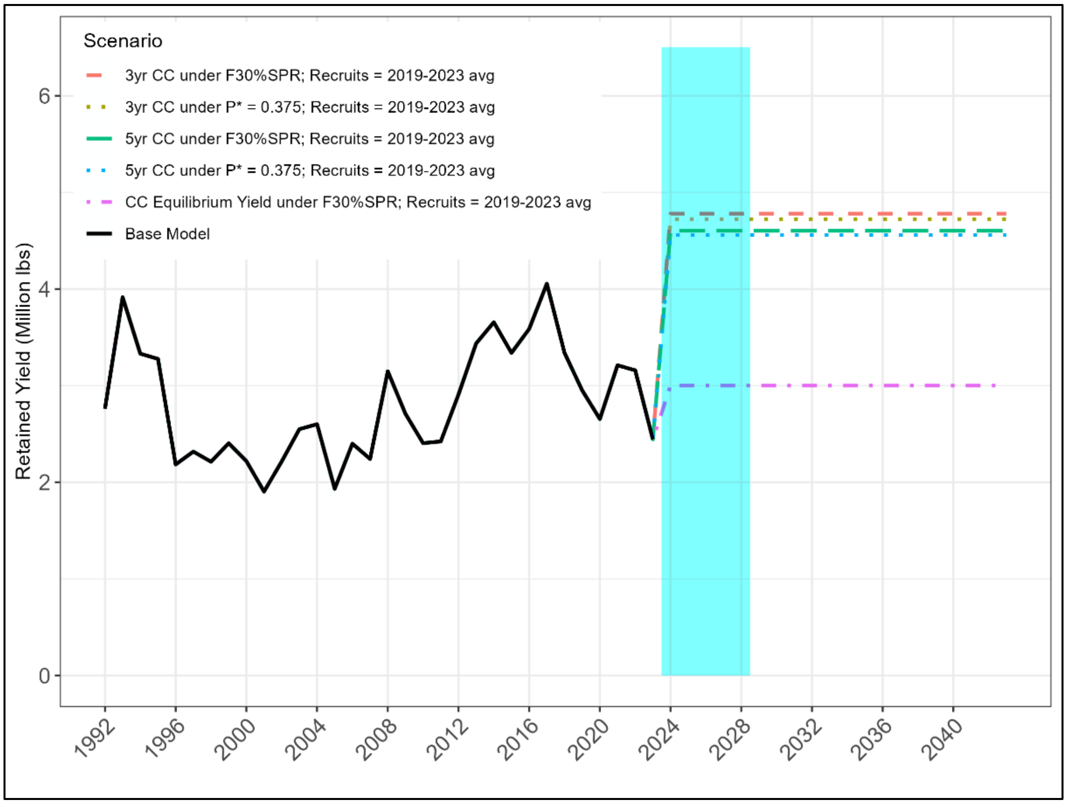

Figure 96. Retained yield (million pounds) under several constant catch scenarios; retained yield under $F_{30\%SPR}$ averaged over 3 and 5 years (red dashed line and green dashed line, respectively), retained yield under the level that corresponds to a P* value of 0.375 averaged over 3 and 5 years (mustard dotted line and blue dotted line, respectively), equilibrium retained yield associated with $F_{30\%SPR}$ (purple dot-dashed line), and as estimated by the SEDAR 96 base model (black solid line). The cyan region highlights the first five years of the projection (2024 – 2028).

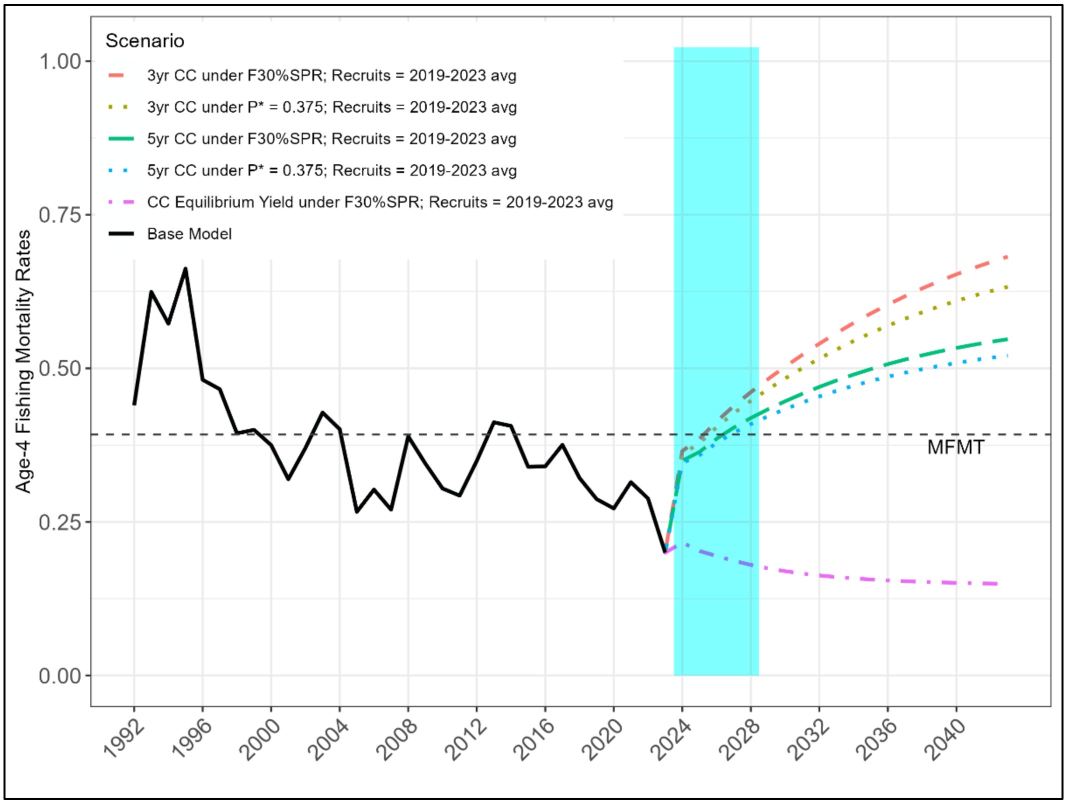

Figure 97. Age-4 fishing mortality values under several constant catch scenarios; retained yield under $F_{30\%SPR}$ averaged over 3 and 5 years (red dashed line and green dashed line, respectively), retained yield under the level that corresponds to a P* value of 0.375 averaged over 3 and 5 years (mustard dotted line and blue dotted line, respectively), equilibrium retained yield associated with $F_{30\%SPR}$ (purple dot-dashed line), and as estimated by the SEDAR 96 base model (black solid line). The cyan region highlights the first five years of the projection (2024 – 2028).

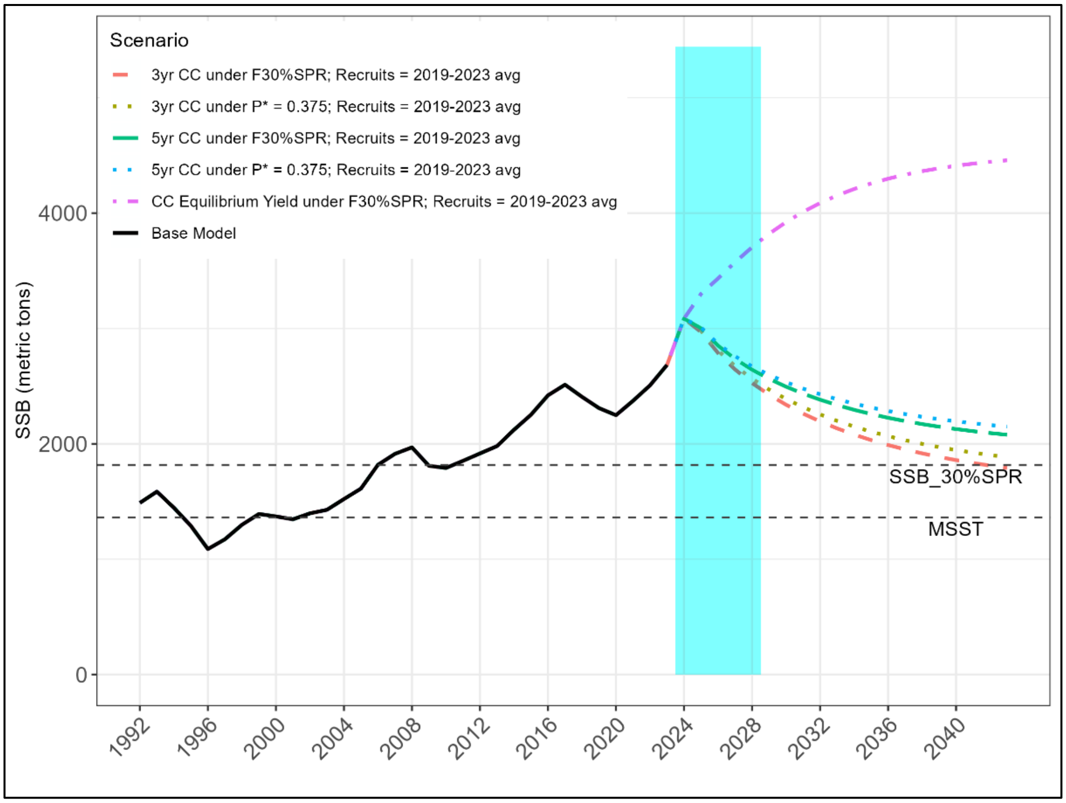

Figure 98. Spawning stock biomass (metric tons) under several constant catch scenarios; retained yield under $F_{30\%SPR}$ averaged over 3 and 5 years (red dashed line and green dashed line, respectively), retained yield under the level that corresponds to a P* value of 0.375 averaged over 3 and 5 years (mustard dotted line and blue dotted line, respectively), equilibrium retained yield associated with $F_{30\%SPR}$ (purple dot-dashed line), and as estimated by the SEDAR 96 base model (black solid line). The cyan region highlights the first five years of the projection (2024 – 2028).

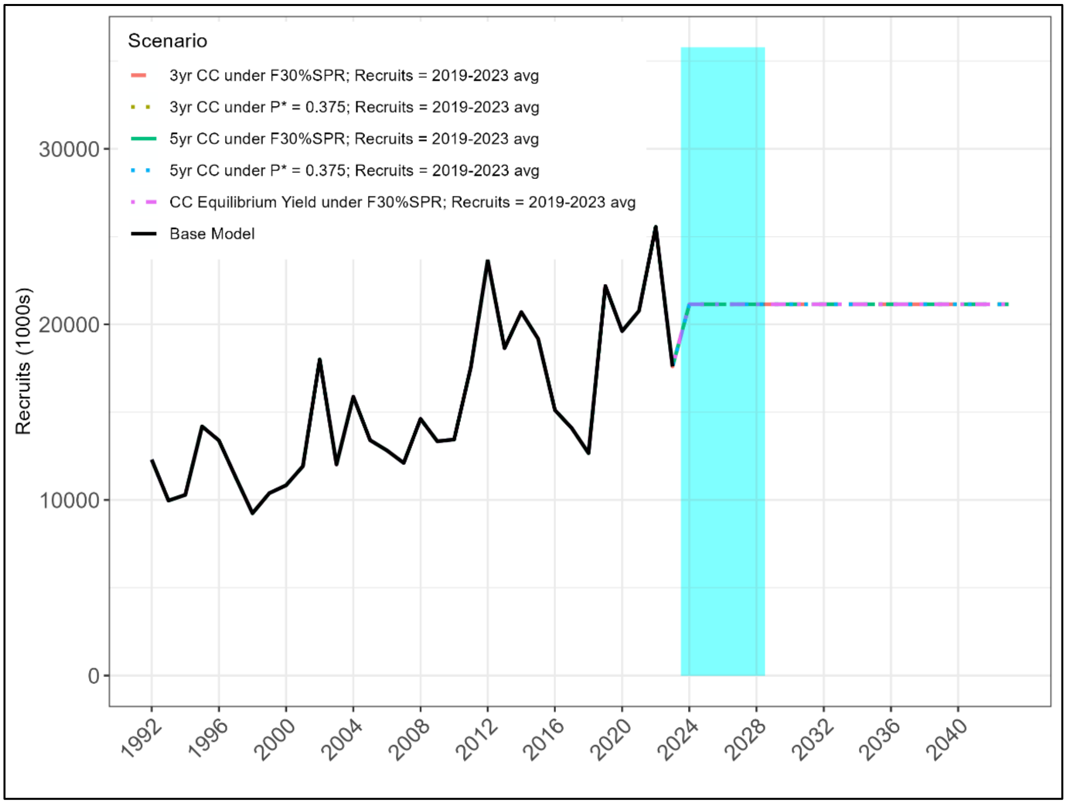

Figure 99. Age-0 recruits (millions) under several constant catch scenarios; retained yield under $F_{30\%SPR}$ averaged over 3 and 5 years (red dashed line and green dashed line, respectively), retained yield under the level that corresponds to a P* value of 0.375 averaged over 3 and 5 years (mustard dotted line and blue dotted line, respectively), equilibrium retained yield associated with $F_{30\%SPR}$ (purple dot-dashed line), and as estimated by the SEDAR 96 base model (black solid line). The cyan region highlights the first five years of the projection (2024 – 2028).